APPENDIX D

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Wildlife Hazard Management at Airports

A Manual for Airport Personnel

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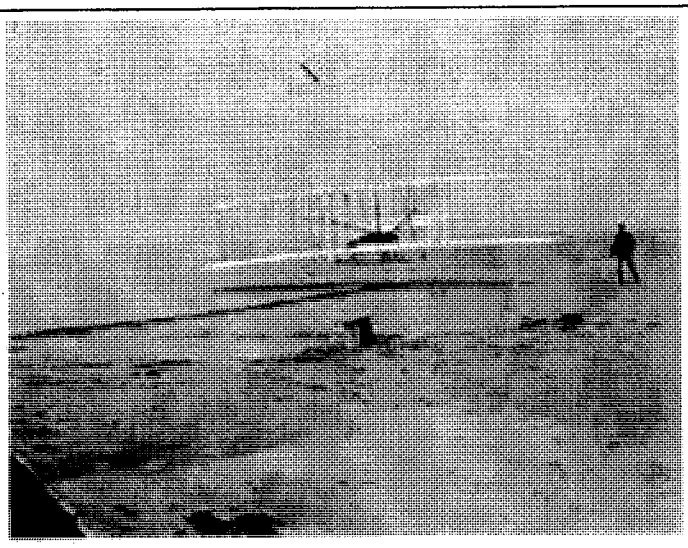
CHAPTER 1:
INTRODUCTION TO THE WILDLIFE STRIKE PROBLEM

Birds and aircraft are increasingly competing for airspace in crowded skies, as demonstrated over the threshold of runway 31R at Ferihegy Airport, Budapest, Hungary, 15 June 2004 (photo © Adam Samu, used with permission).

Throughout history, humans have been intrigued and inspired by the beauty of birds and their ability to fly. Birds first took to the air about 150 million years ago. Humans first began to share their airspace only 100 years ago. Unfortunately, when aircraft and birds attempt to use the same airspace at the same time, collisions occur.

Birds are not the only wildlife problem for aircraft. Deer, coyotes, and even alligators wandering onto runways can create serious problems for departing and landing aircraft. Aircraft collisions with wildlife, also commonly referred to as wildlife strikes, annually cost the civil aviation industry in the USA at least $500 million in direct damage and associated costs and over 500,000 hours of aircraft down time. Although the economic costs of wildlife strikes are extreme, the cost in human lives lost when aircraft crash as a result of strikes best illustrates the need for management of the wildlife strike problem. This manual is designed to inform airport personnel about the scope of the wildlife strike problem and to serve as a ready reference on legal authority, regulations, and the development, implementation, and evaluation of Wildlife Hazard Management Plans for airports.



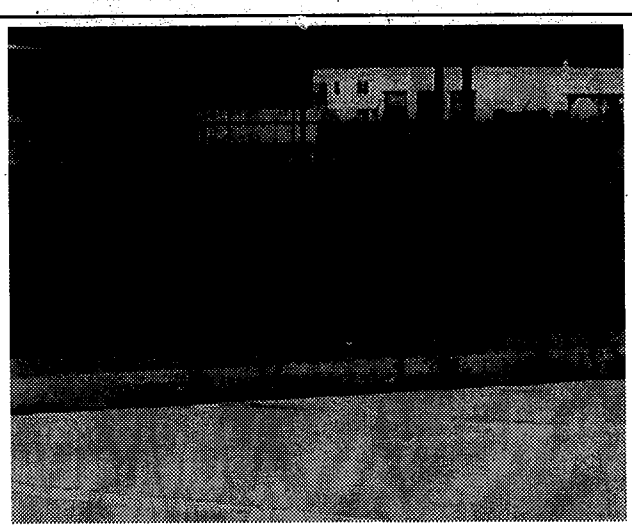
Oliver Wright recorded the first bird strike in 1905 in Ohio, less than 2 years after the Wright Brothers' first powered flight.

The first powered flight by the Wright Brothers occurred in December 1903, and the wildlife strike problem began shortly thereafter. On 7 September 1905, the first reported bird strike, as recorded by Oliver Wright in his diary, occurred when his aircraft hit a bird (probably a red-winged blackbird) as he flew over a cornfield near Dayton Ohio. The first reported mammal strike occurred on 25 July 1909 at the start of Louis Bleriot's historic first flight across the English Channel from Les Baraques, France. During engine warm-up of his Bleriot XI aircraft, a farm dog ran into the propeller. On 3 April 1912 Calbraith Rodgers, the first person to fly across the continental USA, was also the first to die as a result of a wildlife strike when his aircraft struck a gull along the coast of Southern California. Since those first wildlife strikes, aircraft designs and performance have changed radically, and wildlife populations and air traffic have increased. As a result, at least 122 civil aircraft have been destroyed and over 255 civilian lives have been lost worldwide due to wildlife strikes from 1960 to 2004. During this same period, wildlife strikes have resulted in at least 333 military aircraft destroyed and over 150 military personnel killed.

The onset of the jet age revolutionized air travel, but magnified the wildlife strike problem. Early piston-powered aircraft were noisy and relatively slow. Wildlife could usually avoid these aircraft, and strikes that did occur typically resulted in little or no damage. However, modern jet aircraft are fast and relatively quiet, and their engine fan blades are often more vulnerable than propellers to wildlife-strike damage. When turbine-powered aircraft collide with birds or other wildlife, serious structural damage and engine failure can occur. Multiple-engine damage from the ingestion of flocks of birds is of particular concern as the fleet of two-engine passenger aircraft increases in the USA. In 1969, 75% of the 2,100 passenger aircraft had 3 or 4 engines. In 1998, the fleet had grown to 5,400 primarily turbine-powered aircraft, of which only 30% had three or four engines. By 2008, the fleet will consist of about 7,000 aircraft, and less than 10% will have three or four engines.

Air travel has become commonplace in the USA. Aircraft have also assumed a vital role in tactical and logistical military operations. These factors have resulted in increased air traffic. For example, commercial air movements in the USA increased about 3% per year between 1985 and 2004. Coincidentally, human use of the skies has increased during an extremely successful period of wildlife management in North America. Aggressive natural resource and environmental protection programs by public and private wildlife management groups have contributed to impressive increases in

populations of many large-bodied species such as alligators, cormorants, cranes, deer, geese, gulls, herons, pelicans, raptors (falcons, hawks, eagles, and owls), vultures, and wild turkeys. At the same time, many of these species (e.g., Canada geese, coyotes, deer, and turkeys), have expanded into suburban and urban areas, including airports, and are thriving in response to protection and changes to habitats in these areas. Almost all of these species have body masses over 4 pounds (1.8 kg), which exceed the airframe and engine certification standards for wildlife strikes. These concurrent increases in air traffic and wildlife populations contribute to an increased probability of damaging wildlife strikes. These two factors, combined with the increased speed, quietness, and vulnerability of modern aircraft, interact to form the basis of the wildlife strike problem that airport managers face. As a final factor, airport managers also face increased concerns about airport liability in the aftermath of damaging wildlife strikes (see Appendix N).

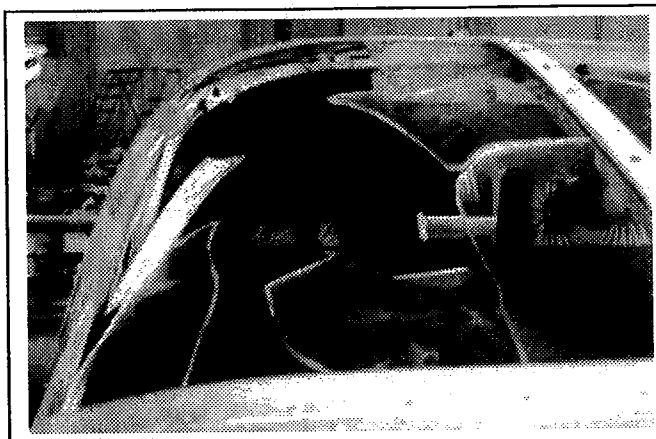


The resident Canada goose population in the USA increased at an annual rate of 8% per year between 1980 and 2004. Notice that the tall grass does not deter Canada geese from grazing and loafing at the airport (photo by M. Begier, USDA).

Wildlife strike problems at individual airports result from these above-described factors interacting at the local level. The nature and magnitude of the problem an individual airport faces will depend on many factors, including air traffic type and volume, local and migratory wildlife populations, and local wildlife habitat conditions. Wildlife is attracted to an airport environment because desirable food, water, or habitat is present. The majority of wildlife strikes occur within the immediate airport environment: 74% of all strikes occur at or below 500 feet above ground level (AGL). Eighteen of the 19 civil and military large-transport aircraft destroyed because of bird strikes between 1960 and 2004 resulted from strikes that occurred on the airport. Therefore, most wildlife involved in strikes is using the airport or its immediate vicinity, and the most logical place to begin correcting the problem is on and near the airport.

Airport sponsors and managers have a legal responsibility under federal regulations (Title 14 Code of Federal Regulations, part 139 [14 CFR, part 139]) to ensure the airport maintains a safe operating environment. As part of this responsibility, they must assess the risk and magnitude of the wildlife strike problem for their airport (14 CFR, part 139.337). This assessment must include accurate and complete reporting of all strike incidents, assessment of wildlife using the airport environment, and assessment of wildlife habitat available to wildlife on the airport. Based on airport conditions and assessed strike risk, airport personnel might need to devise a Wildlife Hazard Management Plan for reducing strike risk and occurrence. Airport personnel must then act to implement and periodically evaluate the plan.

This manual contains a compilation of information to assist airport personnel in conducting Wildlife Hazard Assessments and in the development, implementation, and evaluation of Wildlife Hazard Management Plans. This manual includes specific information on the nature of wildlife strikes, legal authority, government agency roles and responsibilities, regulations, wildlife management techniques, Wildlife Hazard Assessments, Wildlife Hazard Management Plans, and sources of help and information. It is emphasized that this manual provides only a starting point for addressing wildlife hazard issues on airports. Wildlife management is a complex, evolving, and public-sensitive discipline, and ecological conditions vary widely across the USA. Therefore, the assessment of wildlife hazards, the development of Wildlife Hazard Management Plans, and the implementation of management actions by airport personnel must be under consultation by qualified wildlife biologists trained in wildlife damage control.



While on approach to a southern USA airport in March 2003, this PA-34 aircraft struck a pair of red-breasted mergansers at 800 feet AGL. The birds penetrated both windshields. The pilot was not hurt.

CHAPTER 2:
THE FAA NATIONAL WILDLIFE STRIKE DATABASE FOR CIVIL AVIATION

Each autumn, clouds of greater snow geese arrive at Chincoteague National Wildlife Refuge, Virginia, and elsewhere along the Atlantic coast of USA from their Arctic breeding grounds in Canada and Greenland. The greater snow goose population increased from about 50,000 birds in 1966 to over 700,000 birds in 2004 (photo © Brian Kennedy/briankennedy.net, used with permission).

2.1 INTRODUCTION

Before a problem can be solved, the problem must first be understood. A necessary first step toward understanding the complex problem of aircraft collisions with wildlife is the collection and analysis of data from actual wildlife strike events. This chapter provides an overview of the structure and management of the Federal Aviation Administration (FAA) National Wildlife Strike Database for Civil Aviation. The chapter emphasizes the need for accurate reporting of wildlife strikes and the methods for reporting strike events. A statistical summary of reported wildlife strikes for civil aircraft (1990—2003) is also presented to demonstrate the types of information obtained from the database. Finally, a list of selected individual strike cases provides an overview of the nature and magnitude of the wildlife strike problem in the USA.

2.2 REPORTING WILDLIFE STRIKES

The FAA has a standard form (Form 5200-7, Bird/Other Wildlife Strike Report [see Appendix I]) for the voluntary reporting of bird and other wildlife strikes with aircraft. To improve the ease of reporting, strikes can also be reported via the Internet (http://wildlife-mitigation.tc.faa.gov).

Pilots, airport operations, aircraft maintenance personnel, or anyone else who has knowledge of a strike should report strikes. It is important to include as much information as possible on Form 5200-7. The identification of the species of wildlife struck is particularly important. Bird strike remains that cannot be identified by airport personnel can often be identified by a local biologist or, by sending feather remains (with Form 5200-7) to—

For Material Sent via Express Mail Service:	For Material Sent via U.S. Postal Service:
Feather Laboratory Smithsonian Institution NHB, E610, MRC 116 10th & Constitution Ave. NW Washington DC 20560-0116	Feather Laboratory Smithsonian Institution, Div. of Birds PO Box 37012 NHB, E610, MRC 116 Washington DC 20013-7012
(Identify as "safety investigation material")	(Not recommended for priority cases)
The Smithsonian does not charge for feather identification services when the feathers are accompanied by an FAA Bird/Other Wildlife Strike Report (FAA Form 5200-7). Please send whole feathers if available, as diagnostic characteristics are often found in downy barbules at feather base. If available, include wings, breast, and tail feathers. Beaks, feet, bones, and talons are also useful diagnostic materials. Do not send entire bird carcasses through the mail.	

Chapter 7 and Appendix I provide more details on strike reporting.

Analyses of wildlife strike data have proven invaluable in determining the magnitude, nature, and severity of the wildlife strike problem. The database provides a scientific basis for identifying risk factors; justifying, implementing, and defending corrective actions at airports; and judging the effectiveness of those corrective actions. The database is also of critical value to engine manufacturers and aeronautical engineers.

2.3 MANAGEMENT OF THE DATABASE

The FAA National Wildlife Strike Database is managed by the Wildlife Services program of the U.S. Department of Agriculture (USDA) under terms of an Interagency Agreement with the FAA. All strike reports are sent to Wildlife Services for entry into the database after review by the staff Wildlife Biologist at the FAA, Office of Airport Safety and Standards. At the Wildlife Services office, a database manager edits each strike report and consolidates multiple reports for the same strike before entering the data.

Contacts with persons making reports are sometimes made for clarification of details. In addition to FAA Form 5200-7, strike reports are also obtained from other sources (Table 2-1). After entry into the database, the original reports are filed chronologically for future reference if necessary. There are approximately 52,500 strike records for civil aircraft in the database for 1990 through 2003.

Table 2-1. Source of information for reported wildlife strikes to civil aircraft, USA, 1990–2003.

Source	14-year total	% of total known
FAA Form 5200-7[1] (Paper)	31,497	60
FAA Form 5200-7E (Electronic)[2]	2,948	6
Airline report	7,003	13
Multiple[3]	4,704	9
Airport report	2,861	5
Other[4]	1,059	2
Engine manufacturer	793	2
Aircraft Incident Report	720	1
Preliminary Aircraft Incident Report	628	1
Aviation Safety Reporting System	152	<1
Aircraft Incident Preliminary Notice	60	<1
National Transportation Safety Board	57	<1
U.S. Air Force BASH program	11	<1
Total	52,493	100

[1] Bird/Other Wildlife Strike Report.
[2] Electronic filing of reports (http://wildlife-mitigation.tc.faa.gov) began in April 2001. In 2001, <1% of reports were filed electronically compared to 21% in 2002 and 29% in 2003.
[3] More than one report was filed for the same strike.
[4] Various sources, such as news media and Commercial Incident Reports.

In addition to the civil aviation strike reports, strike reports for military aircraft in the U.S. Air Force (USAF) database (where the strike occurred at joint use civil/military airports) have been merged into the FAA database (approximately 6,000 from 1990 to 2003). Civil and military strikes are labeled so analyses can be done with data combined or separated.

2.4 USE OF AND ACCESS TO INFORMATION IN THE DATABASE

Maintaining a consistent record of wildlife strikes at an airport is essential for defining the wildlife hazard level and for evaluating the airport's Wildlife Hazard Management Plan, as discussed in Chapter 7. In addition to their internal use at the airport, the strike reports, when incorporated into the National Wildlife Strike Database, provide a means for engineers, biologists, and safety analysts to better understand national and regional trends in strikes and thereby develop, justify, and defend more effective management programs and wildlife-resistant aircraft and engines. For example, the database has been extremely useful in identifying which wildlife species are most commonly involved in strikes, the seasonal pattern of strikes for various species, the extent and types of damage resulting from strikes, and which aircraft types and components are most vulnerable. It is emphasized that for annual reports and other publicly released analyses, the strike records in the national database are summarized statistically at the regional or national level for trends. Comparisons among individual airports, commercial air carriers, or engine manufacturers are not made.

Selected strike records and data fields are available to the public and aviation industry online at http://wildlife-mitigation.tc.faa.gov. The general public can access information on the number of strikes by year, state, and species of wildlife. Engine manufacturers, commercial airlines, and airports, with a password supplied by the FAA, can access strike reports involving their company or airport. USDA Wildlife Services biologists and FAA Airport Certification Safety Inspectors can access strike reports for airports in the state or region, respectively, where they work.

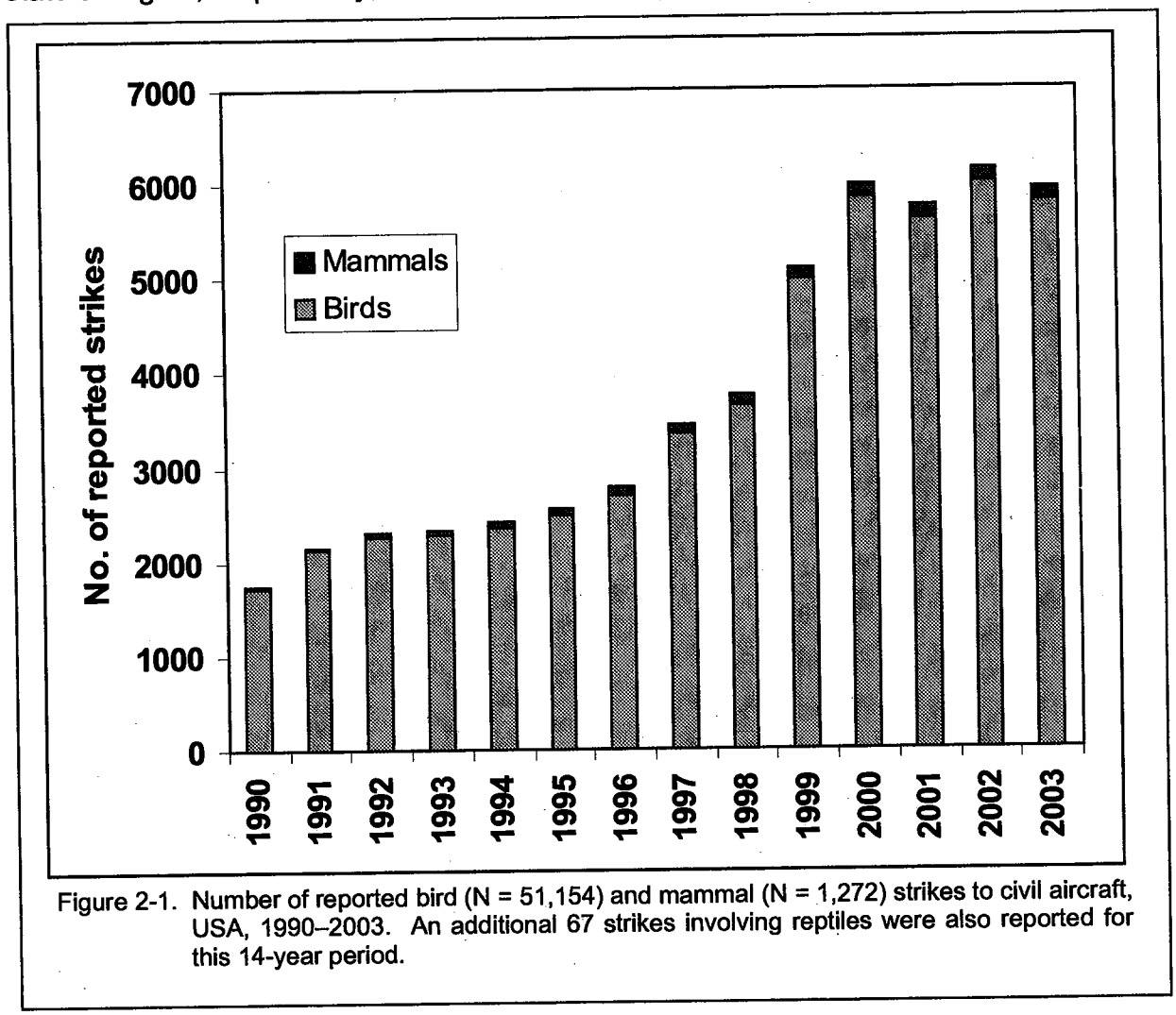


Figure 2-1. Number of reported bird (N = 51,154) and mammal (N = 1,272) strikes to civil aircraft, USA, 1990–2003. An additional 67 strikes involving reptiles were also reported for this 14-year period.

2.5 SUMMARY OF WILDLIFE STRIKE RECORDS, 1990–2003

The FAA's Office of Airport Safety and Standards, in cooperation with USDA Wildlife Services, publishes an annual report, *Wildlife Strikes to Civil Aircraft in the United States*. This report contains a detailed analysis of strike data from 1990 to the most recent year. Copies of the annual report can be downloaded from the FAA's Wildlife Hazard Mitigation Website at http://wildlife-mitigation.tc.faa.gov.

Table 2-2. Person filing report of wildlife strike to civil aircraft, USA, 1990–2003.

Person filing report	14-year total	% of total known
Airline operations	11,313	28
Pilot	10,762	27
Tower	6,672	17
Carcass found[1]	5,809	15
Airport operations	3,971	10
Other	1,520	4
Total known	40,047	100
Unknown	12,446	
Total	52,493	

[1] Airport operations personnel found wildlife remains within 200 feet of a runway centerline that appeared to have been struck by aircraft and no strike was reported by pilot, tower, or airline.

The following section presents a summary analysis of reported wildlife strikes to civil aircraft in the USA for 1990 through 2003 to provide an overview of the types of information obtained from the database. Reports were received from 1,212 airports encompassing all 50 states and some U.S. territories and from 170 foreign airports when U.S. registered aircraft were involved in a strike. Because less than 20% of all strikes have been reported to the FAA and many reports received by the FAA did not include cost or damage data or were filed before aircraft damage was fully assessed, the number of strikes and associated cost data compiled from the voluntary reporting program greatly underestimate the magnitude of the problem.

2.5.A STRIKE FREQUENCY

For the 14-year period (1990–2003), 52,493 strikes were reported to the FAA. Birds were involved in 97.4% of the reported strikes, mammals in 2.4%, and reptiles in less than 0.2% (Figure 2-1).

The number of strikes annually reported tripled from 1990 (1,739) to 2000 (5,979). From 2000 to 2003, reported strikes plateaued at about 6,000 per year with 5,940 strikes reported in 2003 (Figure 2-1). We suggest that the steady increase in reports for 1990 to 2000 was the result of several factors: an increased awareness of the wildlife strike issue, an increase in aircraft operations, an increase in populations of hazardous wildlife species, and an increase in the number of strikes. The plateau in reported strikes from 2000 to 2003 might be related to a slight (<6%) decline in air traffic after the events of September 2001 and to more aggressive wildlife hazard management programs at airports.

Table 2-3. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990–2003.

Type of operator	14-year total	% of total known
Commercial	38,005	84
Business	5,596	12
Private	1,567	4
Government/Police	266	<1
Total known	45,434	100
Unknown	7,059	
Total	52,493	

Most (66%) of the 52,493 strike reports filed during the 14-year period were submitted using the paper (60%) or electronic (6%) version of FAA Form 5200-7, *Bird/Other Wildlife Strike Report*. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically. Almost 28% of the strike reports filed in 2003 were done using this system (Table 2-1).

Table 2-4. Number of reported bird, mammal, and reptile strikes to civil aircraft by USA state, including the District of Columbia (DC), Puerto Rico (PR), USA-possessed Pacific Islands (PI), and the U.S. Virgin Islands (VI), 1990–2003.

	Reported strikes					Reported strikes			
State	Birds	Mammals	Reptiles	Total	State	Birds	Mammals	Reptiles	Total
AK	393	14	0	407	NC	997	20	0	1,017
AL	489	12	0	501	ND	121	3	0	124
AR	222	13	0	235	NE	461	13	0	474
AZ	712	51	0	763	NH	297	10	0	307
CA	4,325	54	0	4,379	NJ	1,427	67	7	1,501
CO	1,290	59	0	1,349	NM	94	2	0	96
CT	561	16	0	577	NV	248	3	0	251
DC	1,307	30	0	1,337	NY	2,903	96	10	3,009
DE	36	1	0	37	OH	1,626	53	0	1,679
FL	3,622	49	40	3,711	OK	470	19	2	491
GA	866	15	0	881	OR	810	8	0	818
HI	1,047	4	0	1,051	PA	1,962	63	0	2,025
IA	335	12	0	347	PI	80	0	0	80
ID	102	5	0	107	PR	85	0	5	90
IL	2,521	71	1	2,593	RI	209	7	0	216
IN	527	11	0	538	SC	248	12	0	260
KS	148	5	0	153	SD	82	6	0	88
KY	1,203	12	0	1,215	TN	1,328	15	0	1,343
LA	949	18	1	968	TX	3,416	60	0	3,476
MA	684	12	0	696	UT	535	10	0	545
MD	556	40	0	596	VA	735	42	0	777
ME	157	8	0	165	VI	67	0	0	67
MI	1,248	70	0	1,318	VT	41	1	0	42
MN	435	13	0	448	WA	785	11	0	796
MO	1,040	26	0	1,066	WI	437	43	0	480
MS	171	4	0	175	WV	123	45	0	168
MT	61	5	0	66	WY	39	4	0	43
					Total known[1]	44,633	1,243	66	45,942
					Foreign[2]	983	8	0	991
					Unknown	5,538	21	1	5,560
					Total	51,154	1,272	67	52,493

[1] Strikes were reported at 1,212 airports in the USA.
[2] Strikes to USA air carriers were reported at 170 foreign airports.

Table 2-5. Number of reported strikes, strikes with damage, and strikes having a negative effect-on-flight (EOF) for the five most commonly struck bird species groups and two most commonly struck mammal groups, USA, 1990–2003.

	Reported strikes		Strikes with damage		Strikes with EOF	
Species group	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
Birds						
Gulls	5,323	25	891	28	710	30
Doves/pigeons	2,966	14	245	8	264	11
Raptors	2,666	12	537	17	351	15
Waterfowl	2,217	10	1,023	32	477	20
Blackbirds/starlings	2,210	10	131	4	156	7
All other known	6,302	29	390	12	406	17
Total known	21,684	100	3,217	100	2,364	100
Unknown	29,470		3,483		1,952	
Total birds	51,154		6,700		4,316	
Mammals						
Artiodactyls[1]	643	51	524	94	339	85
Carnivores[2]	312	25	23	4	48	12
All other known	305	24	11	2	10	3
Total known	1,260	100	558	100	397	100
Unknown	12		6		6	
Total mammals	1,272		564		403	

[1] Deer and elk, respectively, comprised 614 and 8 of the 643 strikes with artiodactyls.
[2] Coyotes and foxes, respectively, comprised 150 and 59 of the 312 strikes with carnivores.

Pilots and airline personnel filed 28% and 27% of these 52,493 reports, respectively (Table 2-2). About 84% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous aircraft (Table 2-3). California, Florida, and Texas had the most (3,416–4,325) bird strike reports (Table 2-4). Twelve other states each had over 1,000 bird strikes reported. New York, Illinois, Michigan, New Jersey, Pennsylvania, and Texas each had 60 or more mammal strikes.

Table 2-6. Number of reported bird and mammal strikes to civil aircraft by month, USA, 1990–2003[1].

	All birds		All mammals		Deer only[2]	
Month	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
Jan	1,969	4	60	5	27	4
Feb	1,806	4	50	4	21	3
Mar	2,712	5	73	6	31	5
Apr	3,537	7	83	7	40	7
May	4,729	9	65	5	27	4
Jun	3,806	7	102	8	45	7
Jul	5,678	11	127	10	50	8
Aug	6,845	13	154	12	50	8
Sep	6,919	14	150	12	64	10
Oct	6,685	13	171	13	85	14
Nov	4,100	8	168	13	126	21
Dec	2,368	5	69	5	48	8
Total	51,154	100	1,272	100	614	100

[1] In addition, 67 strikes with reptiles were reported, of which 16 (24%) occurred in September.
[2] Deer strikes were comprised of 574 white-tailed deer, 24 mule deer, and 16 deer not identified to species. Other wild ungulates reported struck (but not included in this column of table) were 8 elk, 7 pronghorns, 7 moose, and 1 caribou.

Table 2-7. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990–2003.

	Birds		Mammals	
Time of day	14-year total	% of total known	14-year total	% of total known
Dawn	1,567	4	23	3
Day	22,632	63	200	24
Dusk	1,922	5	81	10
Night	9,562	27	536	64
Total known	35,683	100	840	100
Unknown	15,471		432	
Total[1]	51,154		1,272	

[1] In addition, 67 strikes with reptiles were reported: 56 for which the time was not reported, 6 during the day, 3 at night, 1 at dawn, and 1 at dusk.

2.5.B TYPES OF WILDLIFE INVOLVED

Gulls (25%), doves (14%), raptors (12%), and waterfowl (10%) were the most frequently struck bird groups (Table 2-5). Gulls were involved in more than twice as many strikes as waterfowl (5,323 and 2,217, respectively). Waterfowl, however, were involved in more damaging strikes (1,023 or 32% of all damaging strikes in which the bird type was identified) than were gulls (891 or 28% of all damaging strikes in which the bird type was identified). Gulls were responsible for the greatest number of bird strikes (710 or 30%) that had a negative effect-on-flight.

The most frequently struck mammals were Artiodactyls—primarily deer (51%)—and Carnivores—primarily coyotes (25%, Table 2-5). Artiodactyls were responsible for 94% of the mammal strikes that resulted in damage and 85% of the mammal strikes that had a negative effect-on-flight. In all, 38 identified species of mammals were reported struck; 17 identified species caused damage.

2.5.C CHARACTERISTICS OF STRIKES

Most bird strikes (51%) occurred between July and October (Table 2-6); 63% occurred during the day (Table 2-7); 58% occurred during the landing (descent, approach, or landing roll) phase of flight; and 39% occurred during takeoff and climb (Table 2-8). About 61% of the bird strikes occurred when the aircraft was at a height of 100 feet or less above ground level (AGL), 74% occurred at 500 feet or less AGL, and 92% occurred at or below 3,000 feet AGL (Table 2-9).

Table 2-8. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990–2003.

	Birds		Mammals	
Phase of flight	14-year total	% of total known	14-year total	% of total known
Parked	24	<1	0	0
Taxi	161	<1	24	3
Takeoff run	7,810	20	318	33
Climb	7,327	19	26	2
En route	1,148	3	1	<1
Descent	1,463	4	4	<1
Approach	15,065	38	82	8
Landing roll	6,461	16	498	52
Total known	39,459	100	953	100
Unknown	11,695		319	
Total[1]	51,154		1,272	

[1] In addition, 67 strikes with reptiles were reported.

Most mammal strikes (50%) occurred between August and November with 35% of deer strikes concentrated in October and November (Table 2-6). Most mammal strikes (64%) occurred at night (Table 2-7), 52% occurred during the landing roll, and 33% occurred during the takeoff run. About 10% of the reported mammal strikes occurred while the aircraft was in the air, e.g., when the aircraft struck deer with the landing gear or encountered bats (Table 2-8).

2.5.D AIRCRAFT COMPONENTS STRUCK AND DAMAGED

The aircraft components most commonly reported as struck by birds were the nose/radome, windshield, engine, wing/rotor, and fuselage (Table 2-10). Aircraft

engines were the component most frequently reported as being damaged by bird strikes (33% of all damaged components). Of the 7,511 aircraft engines reported as being struck by birds, 34% (2,591) were damaged (Table 2-10).

There were 6,761, 350, 10, and 5 incidents in which one, two, three, and four engines, respectively, were struck by birds on a single aircraft. There were 2,424, 80, 1, and 1 incidents in which one, two, three, and four engines, respectively, were damaged by birds on a single aircraft.

Table 2-9. Number of reported bird strikes to civil aircraft by height (feet) above ground level (AGL), USA, 1990–2003.

Height of strike (feet AGL)	14-year total	% of total known	% cumulative total
0	14,471	41	41
1-100	6,716	19	61
101-200	1,704	5	65
201-300	1,126	3	69
301-400	682	2	71
401-500	1,204	3	74
501-600	333	1	75
601-700	262	1	76
701-800	561	2	77
801-900	186	1	78
901-1,000	1,002	3	81
1,001-2,000	2,570	7	88
2,001-3,000	1,517	4	92
3,001-4,000	776	2	95
4,001-5,000	575	2	96
5,001-10,000	1,062	3	99
10,001-20,000	237	<1	99
20,001-30,000	11	<1	99
>30,000	1	<1	100
Total known	34,996	100	
Unknown	16,158		
Total	51,154		

Aircraft components most commonly reported as struck by mammals were the landing gear, propeller, and wing/rotor. These same components ranked highest for the parts most often reported as damaged by mammals (Table 2-10).

2.5.E Effects of Wildlife Strikes on Aircraft and Flights

For the 14-year period, 7,265 reports (17% of known total) indicated the strike damaged one or more aircraft components (Table 2-9), and 4,726 reports (15% of known total) indicated the strike had a negative effect on the flight (Table 2-11). Only 2,630 strike reports provided an estimate of the aircraft down time (total = 455,931 hours, average = 173 hours/incident), and 1,759 reports provided an estimate of the direct or other costs (total = $195,034,000, average = $147,000/incident). Of the 1,759 reports providing a damage cost estimate, 1,637 provided an estimate of direct aircraft damage (total = $169,045,000, average = $103,000/incident), and 595 provided an estimate of other monetary losses (total = $25,989,000, average = $44,000/incident).

Assuming all reported wildlife-aircraft strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of down time and/or monetary losses and that these reports are all of the damaging strikes that occurred, wildlife strikes cost the U.S. civil aviation industry a minimum of 118,663 hours per year of aircraft down time and

$100.58 million in monetary losses ($70.68 million per year in direct costs and $29.90 million per year in associated costs). Further, assuming a 20% reporting rate, the annual cost of wildlife-aircraft strikes to the U.S. civil aviation industry is estimated to be in excess of 593,317 hours of aircraft downtime and $502.91 million in monetary losses ($353.42 million per year in direct costs and $149.49 million per year in associated costs).

Table 2-10. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990–2003.

	Birds (14-year total)				Mammals (14-year total)			
Aircraft component	Number struck	% of total	Number damaged	% of total	Number struck	% of total	Number damaged	% of total
Radome/nose	12,044	26	1,201	15	69	6	65	6
Windshield	8,145	18	482	6	16	1	11	1
Engine(s)	7,511[1]	16	2,591[1]	33	98	8	95	9
Wing/rotor	6,243	14	1,751	22	144	12	141	14
Fuselage	5,726	12	275	3	82	7	91	9
Landing gear	2,252	5	249	3	452	37	239	24
Propeller	1,415	3	153	2	169	14	157	15
Tail	693	2	305	4	37	3	45	4
Light	386	1	305	4	15	1	22	2
Other	1,675	4	631	8	146	12	148	14
Total[2]	46,090	100	7,943	100	1,228	100	1,014	100

[1] There were 7,126 bird-strike incidents in which a total of 7,511 engines were reported as struck (6,761 incidents with one engine struck, 350 with two engines struck, 10 with three engines struck, and five with four engines struck). In 2,506 (35%) of these 7,126 strike incidents, a total of 2,591 engines were damaged (2,424 incidents with one engine damaged, 80 with two engines damaged, one with three engines damaged, and one with four engines damaged).

[2] In addition, 67 strikes with reptiles were reported; 15 indicated the part struck and 5 indicated the strike damaged an aircraft component: Windshield (1 struck, 1 damaged), Wing/rotor (1 struck, 1 damaged), Fuselage (1 struck, 1 damaged), Landing gear (10 struck, 0 damaged), Tail (1 struck, 1 damaged), Other (1 struck, 1 damaged).

Table 2-11. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990–2003.

	Reported strikes					
	Birds		Mammals		Total[1]	
Damage category[2]	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
None	36,122	84	348	38	36,481	83
Damage	6,700	16	564	62	7,265	17
Minor	3,659	9	262	29	3,921	9
Uncertain	1,184	3	39	4	1,223	3
Substantial	1,845	4	247	27	2,093	5
Destroyed	12	<1	16	2	28	<1
Total known	42,822	100	912	100	43,746	100
Unknown	8,332		360		8,747	
Total	51,154		1,272		52,493	

[1] Included in totals are 67 strikes involving reptiles in which 11 reports indicated no damage, 55 failed to report damage (if any), and 1 reported substantial damage.

[2] The damage codes and descriptions follow the *International Civil Aviation Organization Bird Strike Information System (1989):* Minor = the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary; Uncertain = the aircraft was damaged, but details as to the extent of the damage are lacking; Substantial = the aircraft incurs damage or structural failure that adversely affects the structure strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component (specifically excluded are bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antenna, tires, or brakes; and engine blade damage not requiring blade replacement); Destroyed = the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 2-12. Reported effect-on-flight (EOF) of wildlife strikes to civil aircraft, USA, 1990–2003.

	Reported strikes					
	Birds		Mammals		Total[1]	
Effect-on-flight[2]	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
None	26,493	86	315	44	26,821	85
Negative effect	4,316	14	403	56	4,726	15
Precautionary landing	2,235	7	63	9	2,299	7
Aborted takeoff	1,072	4	130	18	1,202	4
Engine shutdown	251	1	22	3	273	1
Other	758	3	188	26	952	3
Total known	30,809	100	718	100	31,547	100
Unknown	20,345		554		20,946	
Total	51,154		1,272		52,493	

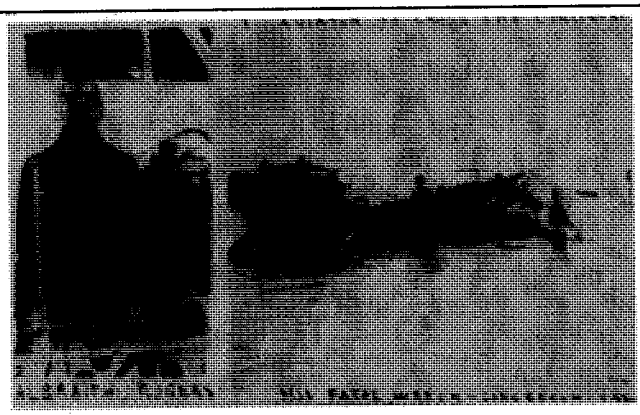
[1] Included in totals are 67 strikes involving reptiles in which 13 reports indicated no effect-on-flight, 47 failed to report on effect-on-flight (if any), 1 reported a precautionary landing, and 6 reported "other".

[2] Effect-on-flight: None = flight continued as scheduled, although delays and other cost caused by inspections or repairs may have been incurred after landing; Aborted takeoff = pilot aborted the takeoff; Precautionary landing = pilot landed at other-than-destination airport after strike; Engine shut down = pilot shut down the engine or the engine stopped running because of strike; Other = miscellaneous effects, such as reduced speed because of shattered windshield, emergency landing at destination airport, or crash landing; Unknown = report did not give sufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

2.6 SELECTED EXAMPLES OF WILDLIFE STRIKES

Below are descriptions of some wildlife strikes that are either of historic interest, have influenced flight safety, or are typical of damaging strikes in recent years in the USA.

7 September 1905. From the Wright Brothers diaries, "Orville ... flew 4,751 meters in 4 minutes 45 seconds, four complete circles. Twice passed over fence into Beard's cornfield. Chased flock of birds for two rounds and killed one which fell on top of the upper surface and after a time fell off when swinging a sharp curve." This was the first reported bird-aircraft strike. Because of the location near Dayton, Ohio, and time of year, the bird struck was probably a red-winged blackbird.



Calbraith Rogers and his aircraft the Vin Fizz following his fatal encounter with a gull (photo courtesy National Air and Space Museum, Smithsonian Institution, SI Neg. No. A-43520-E).

25 July 1909. During engine warm-up for Louis Bleriot's historic first flight across the English Channel from Les Baraques, France, a farm dog ran into the propeller of the Bleriot XI aircraft. This was the first reported terrestrial wildlife (mammal) strike.

3 April 1912. Calbraith Rogers, the first person to fly across the continental USA, was also the first to die as a result of a wildlife strike. On 3 April 1912, Rodgers' Wright Pusher struck a gull, causing the aircraft to crash into the surf at Long Beach, California. Rodgers was pinned under the wreckage and drowned.

4 October 1960. A Lockheed Electra turbo-prop ingested European starlings into all four engines during takeoff from Boston Logan Airport (Massachusetts). The plane crashed into Boston Harbor, killing 62 people. Following this accident, the FAA initiated action to develop minimum bird ingestion standards for turbine-powered engines.

26 February 1973. On departure from Atlanta's Peachtree-Dekalb Airport (Georgia), a Lear 24 jet struck a flock of brown-headed cowbirds attracted to a nearby trash disposal area. Engine failure resulted. The aircraft crashed, killing seven people and seriously injuring one person on the ground. This incident prompted the FAA to develop guidelines for the location of solid waste disposal facilities on or near airports.

12 November 1975. On departure roll from John F. Kennedy International Airport (New York), the pilot of a DC-10 aborted takeoff after ingesting gulls into one engine. The plane ran off runway and caught fire as a result of engine fire and overheated brakes. The resultant fire destroyed the aircraft. All 138 people on board, airline personnel trained in emergency evacuation, evacuated safely (see photo page 18). Following this accident, the National Transportation Safety Board recommended the FAA evaluate the effect of bird ingestion on large, high-bypass, turbofan engines and the adequacy of engine certification standards. The FAA initiated a nationwide data collection effort to document bird strike and engine ingestion events.

This DC-10 was destroyed by fire when several herring gulls were ingested into an engine during takeoff from JFK International Airport, November 1975 (see story on page 17; photo courtesy Port Authority New York and New Jersey).

25 July 1978. A Convair 580 departing Kalamazoo Airport (Michigan) ingested one American kestrel into an engine on takeoff. The aircraft auto-feathered and crashed in a nearby field, injuring 3 of the 43 passengers.

18 June 1983. The pilot of a Bellanca 1730, landing at Clifford, Texas, saw two "buzzards" on final approach. He added power and maneuvered to avoid them, then continued approach. This resulted in a landing beyond the intended point. The middle of the runway was higher than either end; therefore, the pilot was unable to see a large canine moving toward the landing area until aircraft was halfway down the runway. A go-around was initiated, but the lowered landing gear hit some treetops causing the pilot to loose control. The aircraft came to rest in a milo field about 250 yards from initial tree impact after flying through additional trees. The aircraft suffered substantial damage, and two people in the aircraft were seriously injured.

6 January 1985. A Beechcraft King Air 90 departing Smith Reynolds Airport (North Carolina) at dusk hit a large feral dog on the runway just at rotation. The aircraft suffered substantial damage.

17 March 1987. A Boeing-737 struck an 80-pound deer at Chicago O'Hare (Illinois) airport. The aircraft suffered over $114,000 in damage.

5 November 1990. During takeoff at Michiana Regional Airport (Indiana), a BA-31 flew through a flock of mourning doves. Several birds were ingested in both engines, and takeoff was aborted. Both engines were destroyed. Cost of repairs was $1 million, and time out of service was 60 hours.

30 December 1991. A Citation 550, taking off from Angelina County Airport (Texas), struck a turkey vulture. The strike caused major damage to the #1 engine and resulting shrapnel caused minor damage to the wing and fuselage. Cost of repairs was $550,000 and time out of service was 2 weeks.

2 February 1992. A Piper Cherokee struck a deer at rotation during takeoff from Sandstone Municipal Airport (MN). The pilot attempted to turn back to the airport but collided into trees just south of airport. The aircraft was destroyed and the pilot seriously injured.

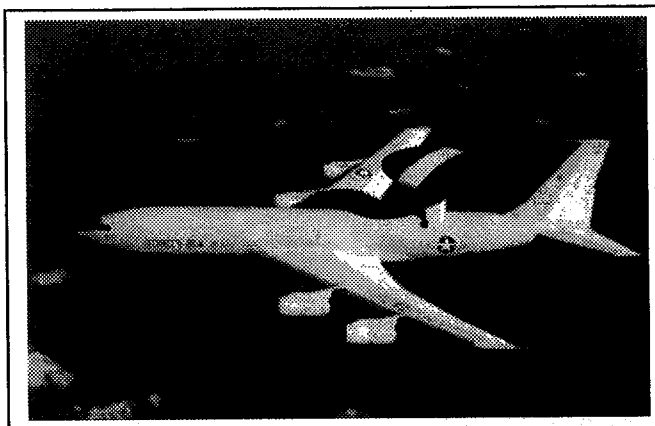
3 December 1993. A Cessna 550 struck a flock of geese during the initial climb out of DuPage County Airport (Illinois). The pilot heard a loud bang, and the aircraft yawed to the left and right. Instruments showed loss of power to the #2 engine and a substantial fuel leak on the left side. An emergency was declared, and the aircraft landed at

Midway Airport. The cost to repair two engines was $800,000, and time out of service was about 3 months.

21 October 1994. A Cessna 210 struck a coyote during the landing roll at Higginsville Industrial Municipal Airport (Missouri) at night. The nose gear collapsed and the propeller hit the runway, resulting in major damage to the engine and crankshaft.

3 June 1995. An Air France Concorde, at about 10 feet AGL while landing at John F. Kennedy International Airport (New York), ingested one or two Canada geese into the #3 engine. The engine suffered an uncontained failure. Shrapnel from the #3 engine destroyed the #4 engine and cut several hydraulic lines and control cables. The pilot was able to land the plane safely, but the runway was closed for several hours. Damage to the Concorde was estimated at over $7 million. The French Aviation Authority sued the Port Authority of New York and New Jersey and eventually settled out of court for $5.3 million.

22 September 1995. A U.S. Air Force Airborne Warning and Control System (AWACS) aircraft (modified Boeing 707) crashed, killing all 24 on board, after ingesting four Canada geese into the #1 and #2 engines during takeoff from Elmendorf Air Force Base (Alaska). This was the first crash of an AWACS plane since the Air Force began using them in 1977.



A USAF AWACS aircraft similar to this was lost in 1995 and 24 airmen were killed when Canada geese were struck just after rotation. The USAF was aware of geese living on the airbase, yet had taken no direct action to eliminate the birds (photo courtesy USAF).

5 October 1996. A Boeing-727 departing Washington Reagan National Airport (District of Columbia) struck a flock of gulls just after takeoff, ingesting at least one bird. One engine began to vibrate and was shut down. A burning smell entered the cockpit. An emergency was declared, and the aircraft, carrying 52 passengers, landed at Washington Reagan National. Several engine blades were damaged.

7 January 1997. An MD-80 aircraft struck over 400 blackbirds just after takeoff from Dallas-Fort Worth International Airport (Texas). Almost every part of the plane was hit. The pilot declared an emergency and returned to land without event. Substantial damage was found on various parts of the aircraft, and the #1 engine had to be replaced. The runway was closed for 1 hour. The birds had been attracted to an un-harvested wheat field on the airport.

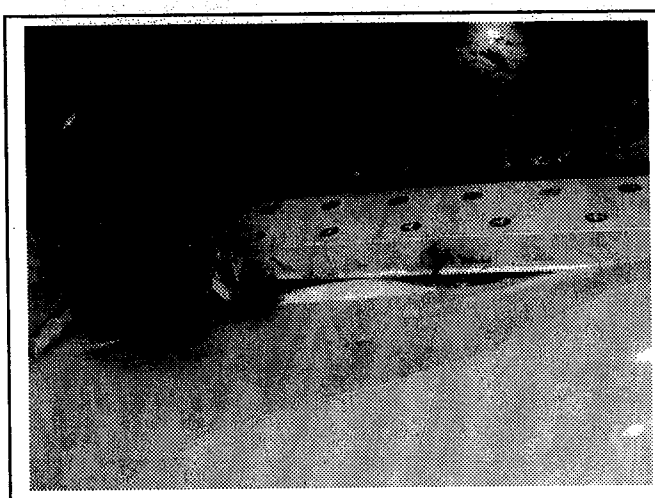
9 January 1998. While climbing through 3,000 feet, following takeoff from Houston Intercontinental Airport (Texas), a Boeing-727 struck a flock of snow geese with three to five birds ingested into one engine. The engine lost all power and was destroyed. The radome was torn from aircraft and leading edges of both wings were damaged. The pitot tube for the first officer was torn off. Intense vibration was experienced in the airframe and the noise level in the cockpit increased to the point that communication

among crewmembers became difficult. An emergency was declared. The flight returned safely to Houston with major damage to aircraft.

22 February 1999. A Boeing-757 departing Cincinnati/Northern Kentucky International Airport (Kentucky) had to return and make an emergency landing after hitting a large flock of starlings. Both engines and one wing received extensive damage. About 400 dead starlings were found on the runway area.

7 February 2000. An American-owned cargo company's DC-10-30 departing Subic Bay, Philippines, ingested a fruit bat into one engine at 250 feet AGL. The aircraft returned to the airport. Five damaged fan blades had to be replaced. Time out of service was 3 days. Total repair and related costs exceeded $3 million.

21 January 2001. An MD-11 departing Portland International Airport (Oregon) ingested a herring gull into the #3 engine during the takeoff run. The engine stall blew off the nose cowl that was sucked back into the engine and shredded. The engine had an uncontained failure. The pilot aborted takeoff and blew two tires. The 217 passengers were safely deplaned and rerouted to other flights. Smithsonian Feather Lab identified bird.



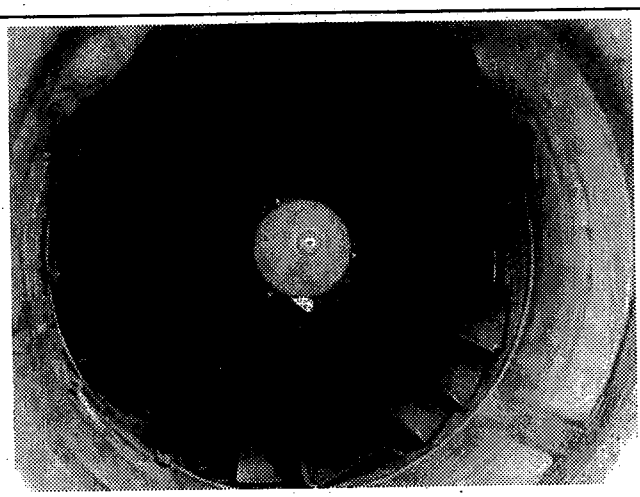
One of the two turkeys that penetrated a Canadair RJ 200 fuselage below the windshield; parts of the bird entered the cockpit.

09 March 2002. A Canadair RJ 200 at Dulles International Airport (Virginia) struck two wild turkeys during the takeoff roll. One shattered the windshield spraying the cockpit with glass fragments and remains. Another hit the fuselage and was ingested. There was a 14-by 4-inch section of fuselage skin damaged below the windshield seal on the flight officer's side. The cost of repairs was estimated at $200,000. Time out of service was at least 2 weeks.

19 October 2002. A Boeing 767 departing Logan International Airport (Massachusetts) encountered a flock of over 20 double-crested cormorants. At least 1 cormorant was ingested into the #2 engine. There were immediate indications of engine surging followed by compression stall and smoke from the engine. The engine was shutdown. An overweight landing with one engine was made without incident. The nose cowl was dented and punctured. There was significant fan blade damage with abnormal engine vibration. One fan blade was found on the runway. The aircraft was towed to the ramp. Hydraulic lines were leaking, and several bolts were sheared off inside engine. Many pieces fell out when the cowling was opened. The aircraft was out of service for 3 days. The cost of repairs was $1.7 million.

8 January 2003. A Bombardier de Havilland Dash 8 collided with a flock of lesser scaup at 1,300 feet AGL on approach to Rogue Valley International Airport (Oregon). At least one bird penetrated the cabin and hit the pilot who turned control over to the first officer for landing. Emergency power switched on when the birds penetrated the

radome and damaged the DC power system and instruments systems. The pilot was treated for cuts and released from the hospital.



This picture shows a close-up of the #2 engine from the Fokker-100 that ingested Canada geese on 4 September 2004.

4 September 2003. A Fokker 100 struck a flock of at least five Canada geese over the runway shortly after takeoff at LaGuardia Airport (New York), ingesting one or two geese into the #2 engine. Engine vibration occurred. The pilot was unable to shut the engine down with the fuel cutoff lever, so the fire handle was pulled and the engine finally shut down, but the vibration continued. The flight was diverted to nearby JFK International Airport where a landing was made. The NTSB found a 20- by 36-inch wide depression on the right side of nose behind radome. Maximum depth was 4 inches. Impact marks were found on the right wing. A fan blade separated from the disk and penetrated the fuselage. Several fan blades were deformed. Holes were found in the engine cowling. Bird remains were recovered and identified by Wildlife Services.

17 February 2004. A Boeing 757 during a takeoff run from Portland International Airport (Oregon) hit five mallards and returned with one engine out. At least one bird was ingested, and parts of five birds were collected from the runway. Engine damage was not repairable, and the engine had to be replaced. The cost was $2.5 million, and time out of service was 3 days.

This is the #1 engine of the MD-80 after ingesting at least 1 double-crested cormorant on 16 September 2004. (See story on page 22.)

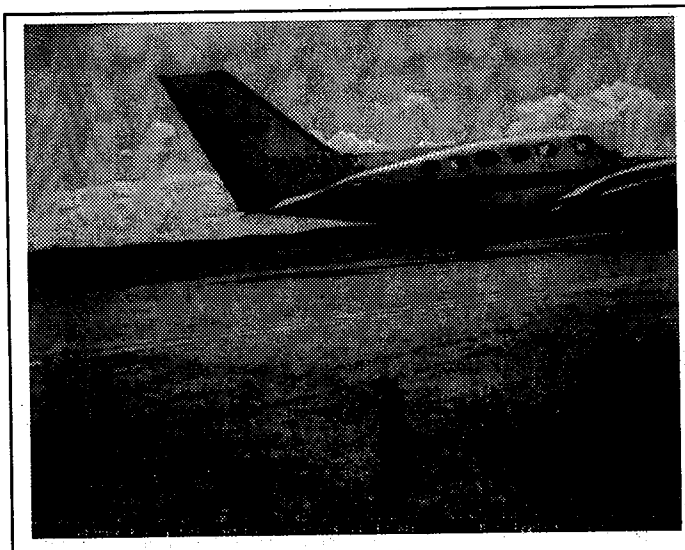
15 April 2004. An Airbus 319 climbing out of Portland International Airport (Oregon) ingested a great blue heron into the #2 engine, causing extensive damage. The pilot shut the engine down as a precaution and made an emergency landing. The runway was closed 38 minutes for cleaning. The flight was cancelled. The engine and nose cowl were replaced. Time out of service was 72 hours. The damage totaled $388,000.

14 June 2004. A Boeing 737 struck a great horned owl during a nighttime landing roll at Greater Pittsburgh International Airport (Pennsylvania). The bird severed a cable in the front main gear. The steering

failed, and the aircraft ran off the runway and became stuck in mud. Passengers were bused to the terminal. Two nose wheels, two main wheels, and brakes were replaced. The aircraft was out of service 24 hours. The cost was estimated at $20,000.

16 September 2004. A MD 80 departing Chicago O'Hare (Illinois) hit several double-crested cormorants at 3,000 feet AGL and 4 miles from airport. The #1 engine caught fire and failed, sending metal debris to the ground in a Chicago neighborhood. The aircraft made an emergency landing back at O'Hare with no injuries to the 107 passengers. (See photo on page 21.)

24 October 2004. A Boeing 767 departing Chicago O'Hare (Illinois) hit a flock of birds during the takeoff run. A compressor stall caused the engine to flame out. A fire department got calls from local residents who reported seeing flames coming from the plane. The pilot dumped approximately 11,000 gallons of fuel over Lake Michigan before returning to land. Feathers found in engine were sent to the Smithsonian, Division of Birds, for identification.

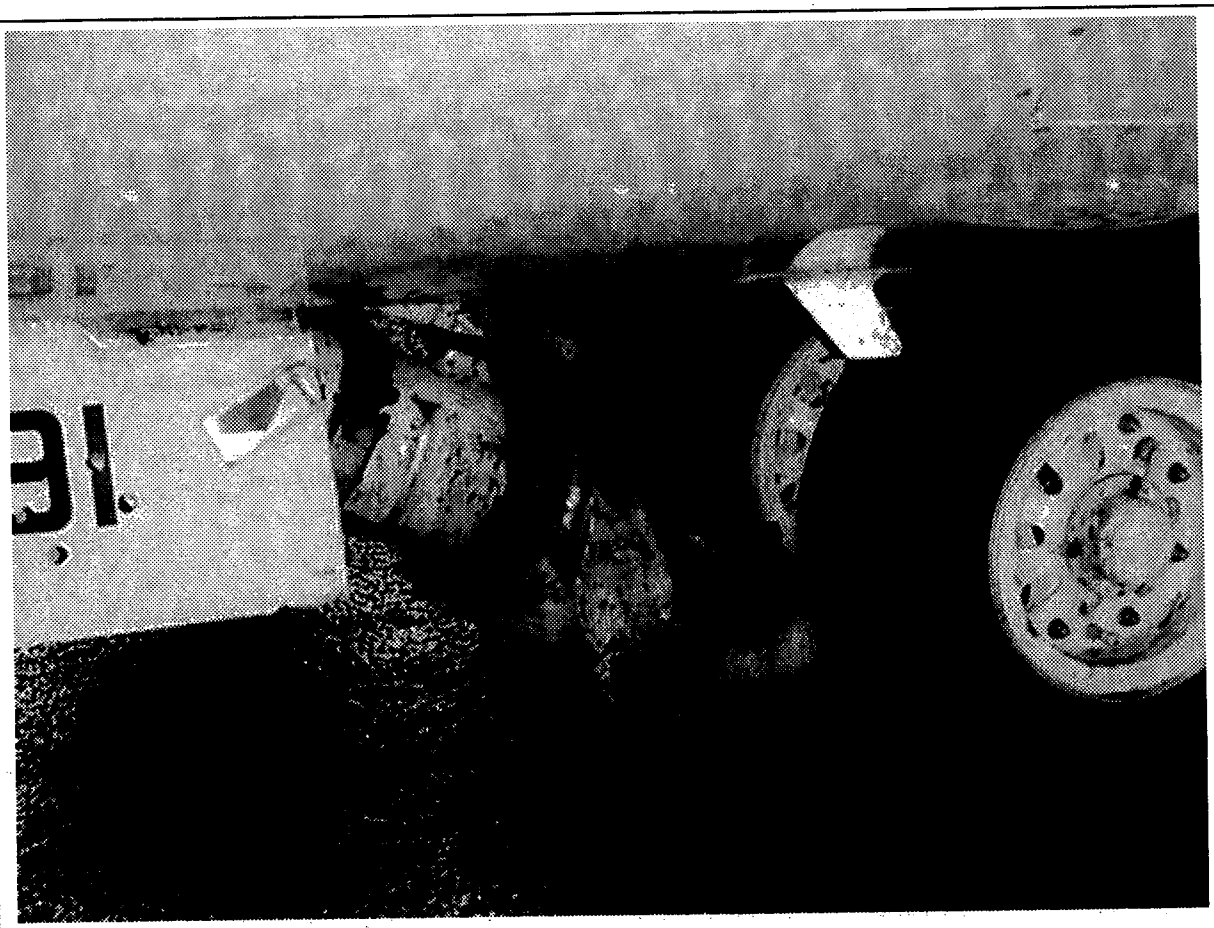


Besides having the potential to cause damaging strikes, small mammals, such as this prairie dog at a southwestern USA airport, can create problems by burrowing, gnawing on wiring, and serving as a food attractant for large birds of prey.

2.7 CONCLUSIONS

Wildlife strikes can cause serious damage to aircraft and the occasional loss of human life. Because most strikes occur on or near airports, airports are the logical locations to place emphasis in addressing the problem. The following chapters and appendices, coupled with guidance from professional wildlife biologists trained in wildlife damage management, provide the information needed to develop, implement, and evaluate wildlife hazard management programs to minimize the likelihood of wildlife strikes on airports.

CHAPTER 3:
AGENCIES AND ORGANIZATIONS IMPACTING WILDLIFE HAZARD MANAGEMENT ON AIRPORTS



In December 2002, this Dash-8 struck a deer while landing at a southeastern USA airport. The impact caused the nose gear to collapse. The white-tailed deer population in the USA increased from a low of about 350,000 in 1900 to at least 24 million in 2004.

3.1 INTRODUCTION

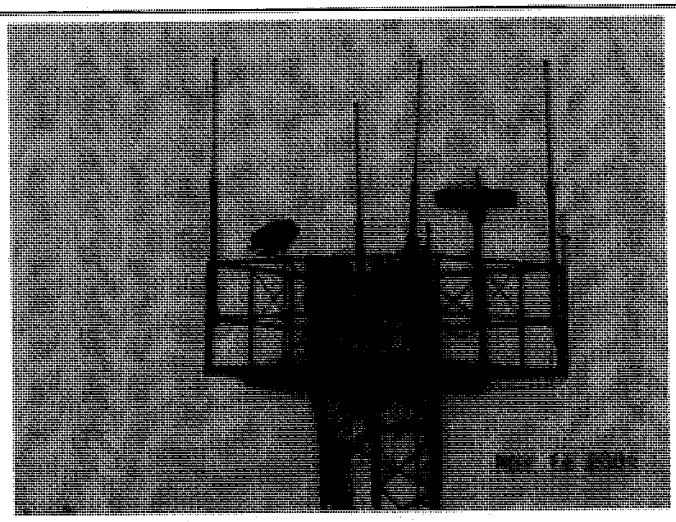
Wildlife management is a complex mixture of science, experience, and art, regulated and implemented by various federal, state, and local governmental agencies. Overlapping federal, state, and local regulations enforced by various governmental organizations protect wildlife and associated wildlife habitat. This chapter provides an overview of the roles and responsibilities of various agencies and organizations that influence wildlife management on or near airports.

3.2 FEDERAL AGENCIES

3.2.A U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION

3.2.A.I MISSION

The mission of the Federal Aviation Administration (FAA) is to provide a safe, secure, and efficient global aviation system that contributes to national security and the promotion of U.S. aviation. As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of customer needs, economic conditions, and environmental concerns.



High-profile species such as bald eagles present special problems for airport managers (photo by E. Cleary, FAA).

3.2.A.II AUTHORITY

Since 1970, Section 612 of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1432), has empowered the FAA Administrator to issue airport operating certificates to airports serving certain air carriers and to establish minimum safety standards for the operation of those airports. Some of these regulations and policies directly involve the management of wildlife and wildlife hazards on and/or near airports.

3.2.A.III ROLE AND RESPONSIBILITY

Among its other responsibilities, the FAA is responsible for enforcement of Title 14 Code of Federal Regulations, part 139 (14 CFR 139). To carry out this role, the FAA has responsibilities for various aspects of aviation that include air navigation, air traffic control, aviation certification and regulation, aviation security, environmental impact minimization, and aviation research and development.

The FAA roles and responsibilities relating to wildlife hazards and their associated human health and safety concerns are addressed in 14 CFR 139.337. The FAA's Office of Airport Safety and Standards' 150/5200 series Advisory Circulars (AC), Program Policy and Guidance, and Certalerts further clarify this information.

3.2.A.III.A OFFICE OF AIRPORT SAFETY AND STANDARDS

A staff wildlife biologist is assigned to the Office of Airport Safety and Standards, Washington, DC. The biologist works with airport operators and certificate holders through the FAA regional and district offices in matters related to wildlife hazards on airports. Responsibilities of the staff wildlife biologist include reviewing development plans of all certificated airports to minimize wildlife hazards; managing the wildlife aircraft strike database designed to document the history of reported strikes at airports

throughout the USA and its territories; and serving as an internal consultant to the FAA on the appropriateness of Wildlife Hazard Management Plans, wildlife hazard research, and other wildlife management issues of concern to the FAA.

Airport operators are required to conduct a Wildlife Hazard Assessment when wildlife capable of causing substantial aircraft damage are observed to have access to the aircraft movement area (photo courtesy USDA).

The FAA staff wildlife biologist examines all wildlife aircraft strike reports submitted to the FAA. Copies of major strike reports (14 CFR 139.337(b)(1-4)), together with the strike history for the particular airport, are forwarded to the appropriate FAA regional personnel. See also FAA Office of Airport Safety and Standards' Policies and Program Guidance Policy No. 79, *Review of Airport Wildlife Hazard Management Plans* (Appendix D).

3.2.A.III.B WILDLIFE HAZARD ASSESSMENTS

Operators of certificated airports are required by regulation to conduct a Wildlife Hazard Assessment when specific wildlife events occur, as discussed in Chapter 6 (14 CFR 139.337(b)(1-4), see Appendix P). FAA Office of Airport Safety and Standards' Program Policy and Guidance No. 77, *Initiation of Wildlife Hazard Assessments at Airports* (Appendix D), establishes the procedures followed by FAA Airport Certification Safety Inspectors when it is determined that an airport needs to conduct a Wildlife Hazard Assessment. Under terms of the Memorandum of Understanding between the FAA and U.S. Department of Agriculture, Wildlife Services (USDA/WS, Appendix G), the USDA/WS program can provide assistance with the conduct of Wildlife Hazard Assessments and the development of Wildlife Hazard Management Plans. FAA Office of Airport Safety and Standards' Certalert No. 04-09, Relationship Between FAA and WS (Appendix E), further clarifies the roles of, and relationship between, the FAA and USDA/WS with regard to wildlife hazards on or near airports. See Chapter 6 for a discussion of the contents of a Wildlife Hazard Assessment.

3.2.A.III.C WILDLIFE HAZARD MANAGEMENT PLANS

The FAA Administrator considers the Wildlife Hazard Assessment, aeronautical activity at the airport, views of the airport operator and its users, and other pertinent factors in determining whether a Wildlife Hazard Management Plan is needed (14 CFR 139.337(d)(1-6), see Appendix P). See Chapter 6 for a discussion of the contents of a Wildlife Hazard Management Plan.

3.2.A.III.D ADVISORY CIRCULARS (150/5200 SERIES)

The FAA issues Advisory Circulars (AC) to systematically inform the aviation public of nonregulatory material of interest. The standards, practices, and suggestions contained

in AC are recommended by the FAA for use by the operators and sponsors of all public-use airports. An AC provides guidance and information in its designated subject area and/or shows methods acceptable to the FAA Administrator for complying with 14 CFR 139. Unless incorporated into regulation by reference, the contents of an AC are not binding on the public. FAA Advisory Circulars germane to airport wildlife issues can be found in Appendix C.

3.2.B U.S. Department of Agriculture, Wildlife Services

Bayberry bushes produce fruits that often attract large flocks of tree swallows along the east coast of the USA during fall migration. Identifying and removing such preferred food plants is an important part of a wildlife hazard management control program (photo by R. A. Dolbeer, USDA).

3.2.B.I Mission

The mission of the U.S. Department of Agriculture/Wildlife Services (USDA/WS) is to provide federal leadership in managing problems caused by wildlife. USDA/WS helps manage wildlife to reduce damage to agriculture, natural resources, and property; minimizes potential threats to human health and safety; and assists in the protection of threatened and endangered species.

3.2.B.II Authority

The primary statutory authority for the USDA/WS program is the Animal Damage Control Act of March 2, 1931, as amended (7 U.S.C. 426-426c; 46 Statute 1468)(See Appendix B).

USDA/WS has the authority to manage migratory bird damage only as specified in the Code of Federal Regulations and under permits issued by the U.S. Fish and Wildlife Service (USFWS) (50 CFR 21). USDA/WS does not have the authority to issue migratory bird depredation permits.

3.2.B.III Role and Responsibility

Wildlife is a public resource greatly valued by the citizens of the USA. However, wildlife can cause damage to agricultural and industrial resources, pose risks to human health and safety, and impact other natural resources. USDA/WS has the federal responsibility to help resolve conflicts that occur when human activity and wildlife are in proximity to one another. USDA/WS has primary responsibility of responding to threats caused by migratory birds.

Wildlife Services Directive 2.305, Wildlife Hazards to Aviation (Appendix F), provides guidance for USDA/WS wildlife biologists in providing technical assistance or direct control to airport managers, state aviation agencies, the aviation industry, the FAA, and the Department of Defense (DOD) on hazards caused by wildlife to airport safety.

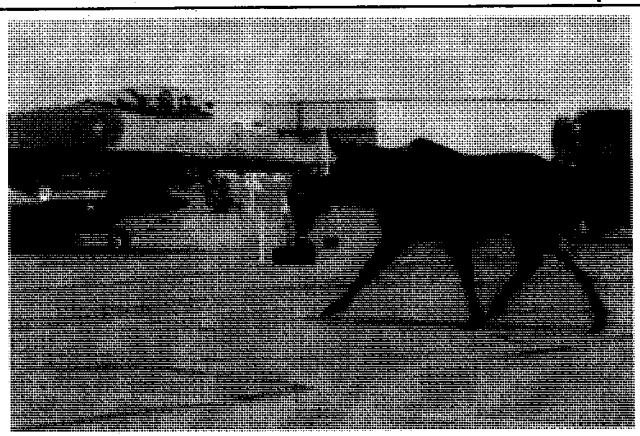
USDA/WS assists federal, state, and local agencies; airport managers; the aviation industry; and the military in reducing wildlife hazards on and in the vicinity of airports

and air bases according to the Memoranda of Understanding with the FAA (Appendix G) and Department of Defense and guidelines published elsewhere.

In addition, it is the responsibility of USDA/WS personnel that observe existing or potential wildlife hazards at airports or air bases to immediately notify the appropriate aviation authorities.

USDA/WS may enter into cooperative agreements to develop Wildlife Hazard Assessments and Wildlife Hazard Management Plans and to conduct direct wildlife hazard reduction programs. These activities are performed pursuant to agreements that are funded by cooperating entities.

USDA/WS biologists may provide training for airport and air base personnel in wildlife and hazard identification and the safe and proper use of wildlife control equipment and techniques.



Birds are not the only wildlife that pilots must watch out for. Proper fencing would have prevented this incident.

USDA/WS biologists may provide recommendations and assistance to airport managers and air base commanders in obtaining federal, state, and local permits to remove protected wildlife species.

3.2.C U.S. Department Of Defense

3.2.C.I Mission

The U.S. Department of Defense (USDOD) is responsible for providing the military forces needed to deter war and protect the security of the USA.

3.2.C.II Authority

The USDOD is the successor agency to the National Military Establishment created by the National Security Act of 1947 (50 U.S.C. 401). It was established as an executive department of the Government by the National Security Act Amendments of 1949 with the Secretary of Defense as its head (5 U.S.C. 101). The USDOD's primary authority is established under 32 CFR 1-2900.

3.2.C.III Role and Responsibility

Each military department (Department of the Navy includes the U.S. Marine Corps) is separately organized under its own Secretary and functions under the authority, direction, and control of the Secretary of Defense. The commanders of unified and specified combat commands are responsible to the President and the Secretary of Defense for accomplishing the military missions assigned to them and exercising command authority over forces assigned to them.

The U.S. Air Force (USAF) Bird Aircraft Strike Hazard (BASH) Team, HQ Air Force Safety Center, Kirtland Air Force Base, New Mexico, oversees the USAF wildlife strike reduction efforts. The BASH team maintains a wildlife strike database for strikes

involving USAF aircraft (http://afsafety.af.mil/afsc/Bash/home.html) similar to the database maintained by the FAA for civil aircraft (Chapter 2).

3.2.D U.S. ARMY CORPS OF ENGINEERS

3.2.D.I MISSION

The U.S. Army Corps of Engineers (COE) is charged with a wide range of functions related to water resources. Among these is the protection of navigation and safeguarding the nation's water resources.

3.2.D.II AUTHORITY

Regulatory authorities of the COE include Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403), which prohibits the obstruction or alteration of navigable waters of the U.S. without a COE permit; Section 404 of the Clean Water Act (33 U.S.C. 1344), which regulates the excavation and discharge of dredged or fill materials into waters of the U.S.; and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, which regulates deposition of fill material into ocean waters.

Recognizing that landfills can attract hazardous birds, the USEPA requires municipal solid waste landfills to be operated in a manner that does not pose a hazard to aviation safety (photo by E. Cleary, FAA).

3.2.D.III ROLE AND RESPONSIBILITY

The COE regulatory branch administers a permit system under Section 404 of the Clean Water Act. All proposed management actions involving any wetland habitat modification or excavation of fill material from or discharged into waters of the USA must be evaluated for Section 404 applicability and permit requirements. Projects requiring permits might require mitigation of impacted resources.

3.2.E U.S. ENVIRONMENTAL PROTECTION AGENCY

3.2.E.I MISSION

The mission of the U.S. Environmental Protection Agency (USEPA) is to safeguard the nation's environment.

3.2.E.II AUTHORITY

The USEPA was established in 1970 in response to concerns about polluted air and rivers, unsafe drinking water, endangered species, and waste disposal. The USEPA's primary regulatory responsibilities are established under 40 CFR 1-799.

3.2.E.III ROLE AND RESPONSIBILITY

USEPA functions include setting and enforcing environmental standards and

regulations related to air and water pollution, hazardous wastes, pesticides, and toxic substances. The USEPA's mission is accomplished through partnerships with state and local governments. USEPA responsibilities include pesticide registration and regulation and siting and construction of wastewater treatment and solid waste disposal facilities, which are permitted through state and local agencies. The FAA and USDA/WS may be consulted by airport authorities or state and local agencies to review impacts of proposed USEPA-regulated projects on aviation safety.

3.2.E.III.A LANDFILLS

Approval or disapproval of a landfill site is the responsibility of the USEPA, state and local governing bodies, and zoning boards. Other federal agencies, such as the FAA and USDA/WS, may only comment as to whether they would consider the proposed landfill to be compatible or non-compatible with their mission requirements.

3.2.E.III.B PESTICIDES

As one facet of an integrated hazardous wildlife management program, licensed falconers may occasionally use trained raptors, such as this peregrine falcon, at airports to repel other birds (photo by E. Cleary, FAA).

Before any pesticide may be used, it must be registered with the USEPA and with the appropriate state pesticide regulating authority. Pesticides are generally classified as either restricted use or general use. Restricted-use pesticides may only be sold to and used by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification. There are few restrictions on who may purchase or use general-use pesticides. Persons who want to use restricted-use pesticides, apply any pesticide to the land of another, or apply any pesticides for hire must be a Certified Applicator or working under the direct supervision of a Certified Applicator, and then only use pesticides covered by the Certified Applicator's certification (see state EPA below).

3.2.F U.S. DEPARTMENT OF INTERIOR, U.S. FISH AND WILDLIFE SERVICE

3.2.F.I MISSION

The mission of the U.S. Fish and Wildlife Service (USFWS) is to conserve, protect, and enhance the nation's fish and wildlife and their habitats for the continuing benefit of all people.

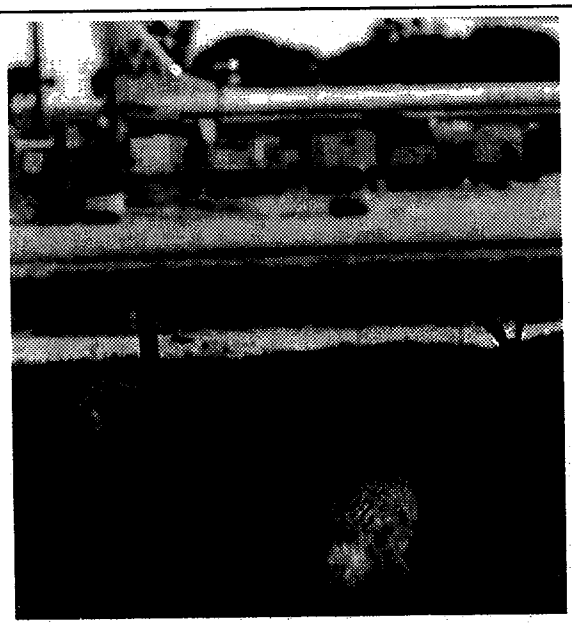
3.2.F.II AUTHORITY

The USFWS has management authority for migratory birds and federally listed

threatened and endangered wildlife species. The USFWS primary regulatory responsibilities are established under 50 CFR 1-199.

3.2.F.III ROLE AND RESPONSIBILITY

The USFWS is responsible for the conservation and enhancement of migratory birds, threatened and endangered species, certain marine mammals, anadromous fishes, and wetlands. The USFWS also manages the National Wildlife Refuge System, enforces federal wildlife laws, and conducts biological reviews of the environmental impacts of development projects.



Most mammals are protected by state wildlife agencies, and it is generally necessary to obtain a State Depredation Permit before taking these species on an airport. The first step in obtaining such a permit is to contact the nearest office of USDA Wildlife Services (see Appendix A).

The USFWS renders biological opinions on proposed federal activities that might impact federally listed or proposed endangered or threatened species or result in the destruction or adverse modification of designated or proposed critical habitat. These opinions are solicited through a "Section 7 consultation", as required under the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Statute 884, as amended).

3.3 STATE AGENCIES

Specific state regulations and their enforcement are not addressed in this manual because of their wide variability. The following general comments are provided as background information.

Consult state and local regulatory agencies having jurisdiction over wildlife and natural resources, environmental protection, health, law enforcement, transportation, and others as applicable, when working with airport wildlife issues.

3.3.A STATE WILDLIFE MANAGEMENT AGENCIES

Wildlife management authority for resident nonmigratory birds, terrestrial mammals, freshwater fish, reptiles, and other taxa rest with state wildlife management agencies. These agencies establish the take and possession regulations for all state-protected species. States set their migratory game-bird hunting seasons and bag limits within the guidelines established by the USFWS. States also may list certain wildlife and plant species as threatened or endangered that are not considered as such at the federal level.

Persons needing to take state-protected species outside of the legal hunting season or beyond the established bag limits to promote airport safety must first secure a state

depredation permit. Contact the nearest USDA/WS office (Appendix A) for assistance in obtaining any necessary state depredation permits.

3.3.B STATE ENVIRONMENTAL PROTECTION AGENCIES

3.3.B.I LANDFILL SITING PERMITS AND INSPECTIONS

With concurrence from the USEPA, state EPAs, local governing bodies, and zoning boards have the final responsibility for issuing landfill permits. It is also a state responsibility to inspect all landfills to ensure compliance with all applicable federal and state regulations.

3.3.B.II PESTICIDE REGISTRATION

Before a pesticide may be sold or used, it must be registered with the USEPA and with the respective state's pesticide regulatory agency. Special Local Need (SLN) registered pesticides may only be used in the state—and in some cases, the specific geographical location—for which the SLN registration has been issued.

3.3.B.III PESTICIDE APPLICATOR LICENSING

With USEPA concurrence, each state is responsible for establishing pesticide applicator licensing requirements and applicator training procedures. The retail sale and use of restricted-use pesticides is limited to Certified Applicators or persons working under their direct supervision and only for those uses covered by the Certified Applicator's certification.

Within 2 weeks of completion, starlings and pigeons had started roosting in this canopy constructed over the passenger drop-off area at a major USA airport (photo by S. Gordon).

Anyone who uses restricted-use pesticides, applies any pesticides for hire, or applies any pesticide to the land of another must be a Certified Applicator or working under the direct supervision of a Certified Applicator, and may only use pesticides covered by the Certified Applicator's certification.

3.4 AIRPORTS

3.4.A AIRPORT OPERATOR

The operator of a certificated airport[1] must demonstrate that the airport is properly and adequately equipped and programs are in place to provide a safe airport-operating environment in accordance with all sections of 14 CFR 139 subpart D. Included in this regulation is the need to address

[1] Airports that have received an Airport Operating Certificate from the FAA, issued under 14 CFR 139, to operate a Class I, II, III, or IV airport.

wildlife hazard issues, conduct Wildlife Hazard Assessments, and develop Wildlife Hazard Management Plans, as conditions dictate.

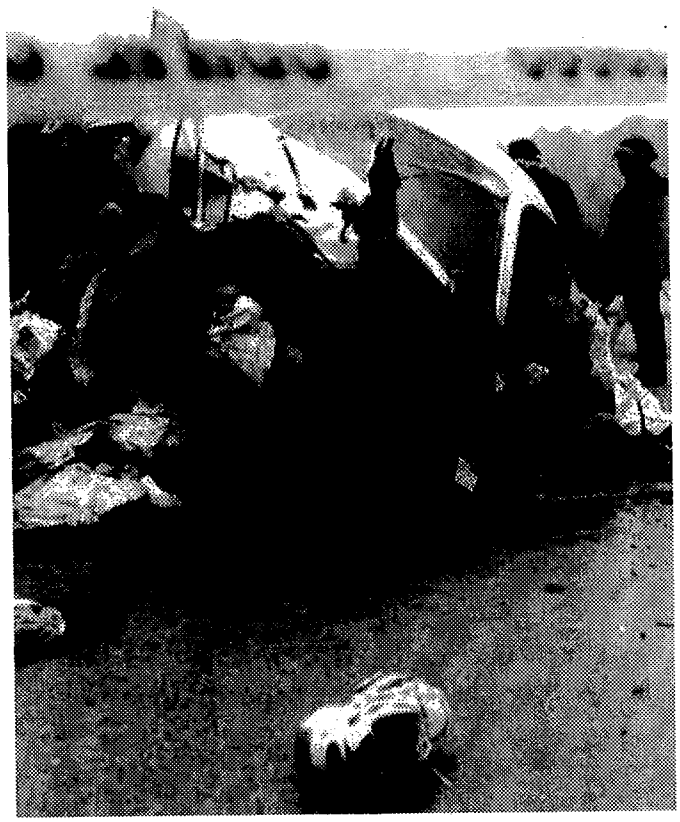
In accordance with its Airport Certification Manual and the requirements of section 139.337(a), each certificate holder must take immediate action to alleviate wildlife hazards whenever they are detected. An important part of this process is establishing procedures for airport employees or tenants to report hazardous wildlife on or near the air operation areas (AOA) to the appropriate airport personnel.

3.4.B AIR TRAFFIC CONTROL

Air traffic control personnel must report any unsafe conditions, including hazardous wildlife on or near the AOA, to the appropriate airport personnel anytime they are observed.

Also, to the extent permitted by higher priority duties and other circumstances, air traffic controllers are required to—

- Issue advisory information on pilot-reported, tower-reported, or radar-observed and pilot-verified bird activity;
- Relay bird activity information to adjacent facilities and to Flight Service Stations (FSS) whenever it appears the wildlife hazard will become a factor in the area (FAA Order 7110.65, 2-1-22).



Pilots using uncontrolled airports need to be alert to the possibility of wildlife on the runway. This Learjet was destroyed when it struck two deer on landing at a southern USA airport, January 2001. In 2004, there were 3,344 airports in the FAA's National Plan of Integrated Airport Systems; less than 650 had an air traffic control tower.

3.4.C PILOTS

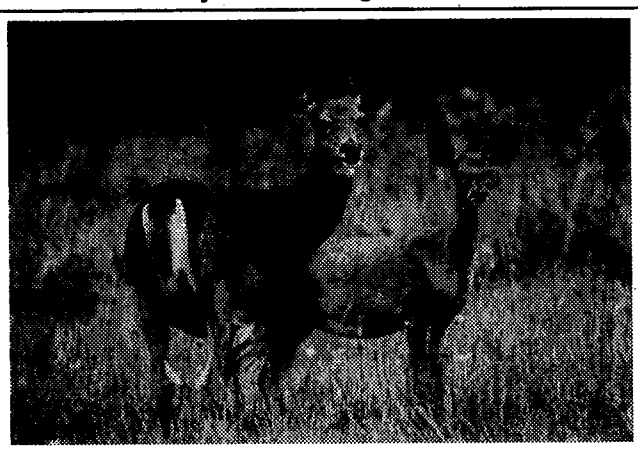
Pilots have a responsibility to report all unsafe conditions on or near an airport, including birds or other wildlife that could pose a threat to aircraft safety. Pilots and other airline or airport personnel should report all known wildlife strikes. Strikes can be reported electronically at http://wildlife-mitigation.tc.faa.gov. Wildlife strikes can also be reported by completing and mailing FAA Form 5200-7 *Bird/Other Wildlife Strike Report* (Appendix I). No postage is required if this form is mailed within the USA. This form can be downloaded and printed from the above website and duplicated as needed. All strike reports are closely screened and edited to prevent duplicate entries in the

database.

3.5 BIRD STRIKE COMMITTEE–USA

Bird Strike Committee–USA (BSC–USA) was formed in 1991 to facilitate the exchange of information, promote the collection and analysis of accurate wildlife strike data, promote the development of new technologies for reducing wildlife hazards, promote professionalism in wildlife management programs on airports through training and advocacy of high standards of conduct of airport biologists and bird patrol personnel, and serve as a liaison to similar organizations in other countries.

Bird Strike Committee USA is directed by a 9- to 12-person steering committee consisting of two to three members each from the FAA, USDA/WS, DOD, and the aviation industry. The organization meets annually, in conjunction with Bird Strike Committee Canada, at an airport in the USA or Canada. There are generally four parts to a BSC–USA meeting. Part 1 is classroom and field training sessions on wildlife control at airports, which cover both civil and military aviation. Part 2 consists of the presentation of technical papers and posters. Part 3 comprises exhibits and demonstrations with vendors. Part 4 is a field trip that generally covers the host airport and surrounding areas to observe management programs and habitat issues related to wildlife and aviation safety. Participation in the annual meetings is open to any person interested in reducing wildlife hazards to aviation and in environmental and land-use issues related to airports. BSC–USA does not charge membership fees; however, a registration fee is charged for attendance at annual meetings.



Between 1990 and 2003, deer were responsible for 16 (76 percent) of the mammal strikes that resulted in injury or death and for 23 (77 percent) of the 30 deaths or injuries resulting from wildlife strikes with civil aircraft in the USA (photo by S. Wright, USDA).

Additional information about BSC–USA can be found at BSC–USA's website: http://www.birdstrike.org.

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CHAPTER 4:
FEDERAL REGULATIONS AND DEPARTMENTAL POLICIES IMPACTING AIRPORT WILDLIFE MANAGEMENT

Four men escaped unhurt when their Learjet 36 struck an elk and caught fire during takeoff at a western USA airport in December 2002. The pilot was able to bring the plane to a stop in a marsh just off the end of the runway and evacuate the aircraft before it was destroyed by fire.

4.1 INTRODUCTION

Wildlife is often protected by overlapping federal, state, and local laws, regulations, and ordinances, enforceable by a diversity of governmental organizations. Chapter 3 provided an overview of the roles and responsibilities of the various agencies. This chapter will discuss some of the more important federal regulations and departmental policies that influence wildlife management on or near airports.

4.2 SUMMARY OF APPLICABLE FEDERAL REGULATIONS

4.2.A TITLE 14, CODE OF FEDERAL REGULATIONS, PART 139

14 CFR 139 governs the certification and operation of land airports that serve any scheduled or unscheduled passenger operation of an air carrier that is conducted with an aircraft having a seating capacity of more than 9 passengers. Part 139.337 (Appendix P) speaks specifically to the airport operator's responsibilities when dealing with the reduction of wildlife strike hazards on and around airports. A detailed discussion of Part 139.337 can be found in Chapter 6.

4.2.B TITLE 40, CODE OF FEDERAL REGULATIONS, PART 258.10

The U.S. Environmental Protection Agency (USEPA), recognizing that birds can be attracted in large numbers to municipal solid waste landfills (MSWLF) and recognizing the potential threat posed by birds to aircraft safety, requires owners or operators of new MSWLF units—or lateral expansions of existing MSWLF units that are located within 10,000 feet of any airport runway used by turbojet aircraft or within 5,000 feet of any airport runway used only by piston-type aircraft—to demonstrate successfully that such units do not create hazardous conditions for aircraft.

Because of conservation efforts by government agencies and private organizations, many wildlife species once on the brink of extinction are now on the road to recovery. This juvenile bald eagle, hatched in New York, was rescued after a storm in Indiana. Management of migratory bird species is the responsibility of the USFWS (photo by E. Cleary, FAA).

The USEPA also requires any operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal.

4.2.C TITLE 50, CODE OF FEDERAL REGULATIONS, PARTS 1 TO 199

These regulations govern the management of federally protected wildlife within the United States and its territories based on the authority established in the Migratory Bird Treaty Act (see below). These regulations also establish procedures for issuing permits to take federally protected species. In general, a federal depredation permit, issued by the U.S. Fish and Wildlife Service (USFWS), must be obtained before any non-game migratory birds may be taken, or before any migratory game birds may be taken outside of the normal hunting season or beyond established bag limits.

Federal law protects all migratory birds, including their nests and eggs:

"A migratory bird [is]...any bird whatever its origin and whether or not raised in captivity,

which belongs to a species listed in sect. 10.13 [of 50 CFR] or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consist, or is composed in whole or part, of any such bird, or any part, nest, or egg there of." (50 CFR 10.12). This list includes almost all native bird species in the United States, with the exception of nonmigratory game birds, such as turkeys and grouse, and some introduced game birds, such as pheasants and chukars. Exotic and feral species, such as graylag geese, muscovy ducks, European starlings, house (English) sparrows, and rock doves (pigeons), are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

In addition to federal protection, all states protect migratory birds as well as game birds, such as pheasants, turkeys, grouse, and partridges. States might or might not protect exotic or feral species.

With the exception of federally listed or proposed threatened or endangered species, federal law does not protect terrestrial mammals, reptiles, or other wildlife taxa (e.g., deer, coyotes, raccoons, groundhogs, snakes, turtles, and freshwater fish). Protection of these wildlife groups is left to the individual states.

Blackbirds traveling to and from roosting sites near an airport can create hazardous conditions for aircraft. A federal permit is not required to control blackbirds when "concentrated in such numbers and manner as to constitute a health hazard or other nuisance" (photo by R. A. Dolbeer, USDA).

4.2.C.I DEPREDATION PERMITTING REQUIREMENTS AND PROCEDURES

Persons wishing to take migratory birds, nests, or eggs as part of an airport wildlife management program must first secure a depredation permit from the USFWS. Some state wildlife management agencies may require that a state permit be obtained also. Persons wishing to take state-protected species must first secure a permit from their respective state wildlife management agency. For assistance in obtaining federal and state depredation permits, contact the local U.S. Department of Agriculture, Wildlife Services (USDA/WS) office (Appendix A).

4.2.C.II STANDING DEPREDATION ORDERS

Federal law allows people to protect themselves and their property from damage caused by migratory birds. Provided no effort is made to kill or capture the birds, a depredation permit is not required to merely scare or herd depredating migratory birds other than endangered or threatened species or bald or golden eagles (50 CFR 21.41).

In addition, certain species of migratory birds may be killed or captured without a federal permit under specific circumstances, most of which relate to agricultural situations. A Standing Depredating Order that has applicability at airports relates to blackbirds and related species:

"A federal permit shall not be required to control yellow-headed, red-winged, rusty and Brewer's blackbird, cowbirds, all grackles, crows, and magpies, when found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance ..." (50 CFR 21.43).

This Navy T-44A suffered a turkey vulture strike to the right horizontal stabilizer during a routine training flight in October 2002 in Texas. The T-44A is the U.S. Navy's version of a Beechcraft King Air 90, a twin turboprop corporate and utility transport aircraft. The turkey vulture population in the USA increased at a mean annual rate of over 2% from 1980–2004.

However, state laws may not mirror federal law in this respect. For example, in Ohio, crows may not be killed in any circumstances, outside of the state crow-hunting season, without a state-issued depredation permit, and blackbirds may not be killed on Sundays.

Persons wishing to take any other migratory birds, or to take migratory birds in situations other than those described above, must first secure a federal Migratory Bird Depredation Permit from the USFWS, and in some case a State Depredation Permit. The first step in obtaining the necessary permits is to contact the nearest USDA/WS state office (Appendix A).

4.2.D The Migratory Bird Treaty Act of 1918, as amended (U.S. Code 603–711; 40 Statute 755)

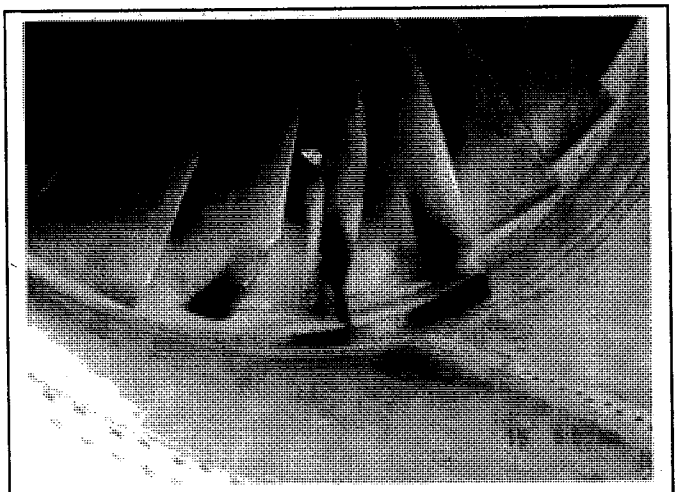
The United States of America, Canada, the United Mexican States, Russia and Japan are signatories to the Migratory Bird Treaty Act (MBTA). This act provides the statutory foundation for the federal protection and management of migratory birds in the United States (50 CFR, Parts 1–199).

4.2.E The Animal Damage Control Act of 1931, as amended (7 U.S. Code 426–426c; 46 Statute 1468)

This act authorizes and directs the Secretary of Agriculture to manage wildlife injurious to agricultural interests, other wildlife, or human health and safety, including wildlife hazards to aviation (Appendix B). The U.S. Department of Agriculture's Wildlife Services (USDA/WS) is the agency that carries out this mandate. USDA/WS, because of the experience, training, and background of its personnel, is recognized throughout the world for expertise in dealing with wildlife damage management issues. USDA/WS has an active presence in all U.S. states and territories. USDA/WS also has a National Wildlife Research Center in Colorado and eight regional research field stations.

4.2.F FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT, AS AMENDED (7 U.S. CODE 136; PUBLIC LAW 104.317)

This act, administered by USEPA, governs the registration, labeling, classification, and use of pesticides. Any substance used as a pesticide must be registered with the USEPA and with the respective state pesticide-regulatory agency. Anyone wishing to use restricted-use pesticides, applying any pesticides to the land of another, or applying any pesticides for hire, must be a Certified Applicator, or working under the direct supervision of a Certified Applicator, and then may only use pesticides covered by the Certified Applicator's certification.



This engine on an A320 ingested a great blue heron on departure from a western USA airport in 2002. The pilot observed the bird just prior to impact. The aircraft made an emergency landing with the engine out. The engine and nose cowl were replaced. The runway was closed for 38 minutes while fire trucks washed the debris from the runway (photo courtesy S. Gordon).

4.3 DEPARTMENTAL POLICIES

4.3.A FAA ADVISORY CIRCULARS

The FAA recommends that public-use airport operators implement the standards and practices contained in all applicable Advisory Circulars (AC). Holders of Airport Operating Certificates issued under Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Subpart D (Part 139), may use the standards, practices, and recommendations contained in an AC to comply with the airport management requirements of Part 139. In general, airports that have received federal grant-in-aid assistance must use the standards presented in an AC. See Appendix C for copies of the current version (as of July 2005) of AC mentioned in this Manual. AC are revised on an irregular schedule. Copies of revised AC can be accessed at: http://www.faa.gov/arp/

4.3.A.I 150/5200-32A. REPORTING WILDLIFE AIRCRAFT STRIKES.

This AC explains the importance of reporting wildlife strikes. It also examines recent improvements in the FAA's Bird/Other Wildlife Strike Reporting system, how to report a wildlife strike, what happens to the wildlife strike report data, how to access the FAA National Wildlife Aircraft Strike Database, and the FAA's Feather Identification Program.

4.3.A.II 150/5200-33A. HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

This AC provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or in the vicinity of public-use airports. It also provides guidance on the placement of new airport development projects (including airport construction, expansion, and renovation) pertaining to aircraft movement in the vicinity of hazardous

wildlife attractants.

4.3.A.III 150/5200-34. CONSTRUCTION OR ESTABLISHMENT OF LANDFILLS NEAR PUBLIC AIRPORTS.

This AC provides guidance on meeting the requirements of Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106–181) (AIR 21), which prohibits the construction or establishment of a new Municipal Solid Waste Landfill within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet very specific conditions. These restrictions do not apply to airports or landfills located within the state of Alaska (see § 5.3.A.I of this manual).

Between 1990 and 2003, vultures were involved in 374 reported wildlife strikes to US civil aircraft; 219 (59%) of those strikes caused damage to the aircraft. Vultures readily feed at landfills (photo by M. Colunga, Aeropuertos y Servicios Auxiliares).

4.3.B FAA, AIRPORTS: AIRPORT CERTIFICATION PROGRAM POLICIES AND GUIDANCE

Program Policies and Guidance documents provide FAA personnel with interpretations of and directions for applying various aspects of federal regulations related to aviation safety. See Appendix D for Program Policies and Guidance related to airport wildlife management.

4.3.B.I POLICY NO. 77. INITIATION OF WILDLIFE HAZARD ASSESSMENTS AT AIRPORTS.

This policy establishes the procedures for FAA Airport Certification Safety Inspectors to follow when it is determined that an airport needs to conduct a Wildlife Hazard Assessment to address an airport wildlife hazard.

4.3.B.II POLICY NO. 78. SECTION 7 CONSULTATION ON ENDANGERED OR THREATENED SPECIES.

This policy establishes the procedures for coordinating and documenting FAA compliance with the Endangered Species Act when requiring an airport operator to develop, submit for approval, and implement a Wildlife Hazard Management Plan.

4.3.B.III POLICY NO. 79. REVIEW OF AIRPORT WILDLIFE HAZARD MANAGEMENT PLANS.

This policy establishes the procedures to be followed when an incident occurs that would initiate a Wildlife Hazard Assessment under 14 CFR 139.337(b)(1-4), and directs Airport Certification Safety Inspectors to review an airport's Wildlife Hazard Management Plan to ensure that it meets all requirements of 14 CFR 139.337(e) and (f), as part of their preparation for a certification inspection.

4.3.B.IV POLICY NO. 82. WASTE DISPOSAL FACILITY COORDINATION.

This policy establishes the procedures for coordinating and documenting FAA determinations on developing new, or expanding existing, waste disposal sites within 5 miles of a public-use airport.

This retention pond, located less than 2,000 feet from the main runway at a major USA airport, had 3 duck and 1 Canada goose nests when surveyed in 2002 (photo by E. Cleary, FAA).

4.3.C FAA, AIRPORTS, OFFICE OF AIRPORT SAFETY AND STANDARDS, CERTALERTS RELATING TO AIRPORT WILDLIFE MANAGEMENT

Certalerts provide non-directive advisory or cautionary information dealing with aviation safety to the aviation community. See Appendix E for Certalerts dealing with aviation wildlife hazards.

4.3.C.I CERTALERT NO. 98-05. GRASSES ATTRACTIVE TO HAZARDOUS WILDLIFE.

This Certalert warns airport operators against the use of millet and any other large-seed producing grasses or other plants attractive to hazardous wildlife for revegetation of construction sites or other disturbed areas on the airport

4.3.C.II CERTALERT NO. 04-09. THE RELATIONSHIP BETWEEN FAA AND USDA/WS.

This Certalert clarifies the roles of and relationship between the Federal Aviation Administration (FAA) and the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA/WS) with regards to wildlife hazards on or near airports.

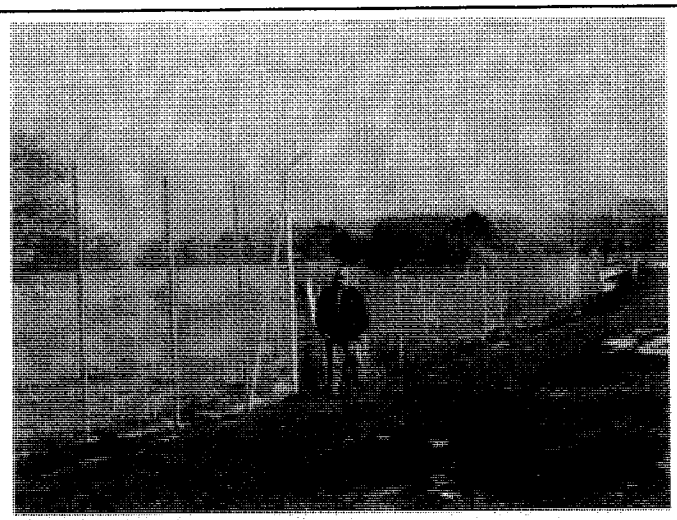
4.3.C.III CERTALERT NO 04-16. DEER HAZARDS TO AVIATION AND DEER FENCING.

In light of recent incidents where a Learjet landing at an airport in Alabama and a Learjet departing an airport in Oregon were destroyed after colliding with deer or elk, airport operators are reminded of the importance of controlling deer and other wild ungulates on and around airfields.

4.3.D USDA, WILDLIFE SERVICES DIRECTIVE 2.305, WILDLIFE HAZARDS TO AVIATION

This directive provides general guidelines for USDA/WS technical and direct control assistance to airport managers, state aviation agencies, aviation industry, FAA, and Department of Defense about hazards caused by wildlife to airport safety (Appendix F).

4.3.E MEMORANDUM OF UNDERSTANDING: FAA AND USDA/WS



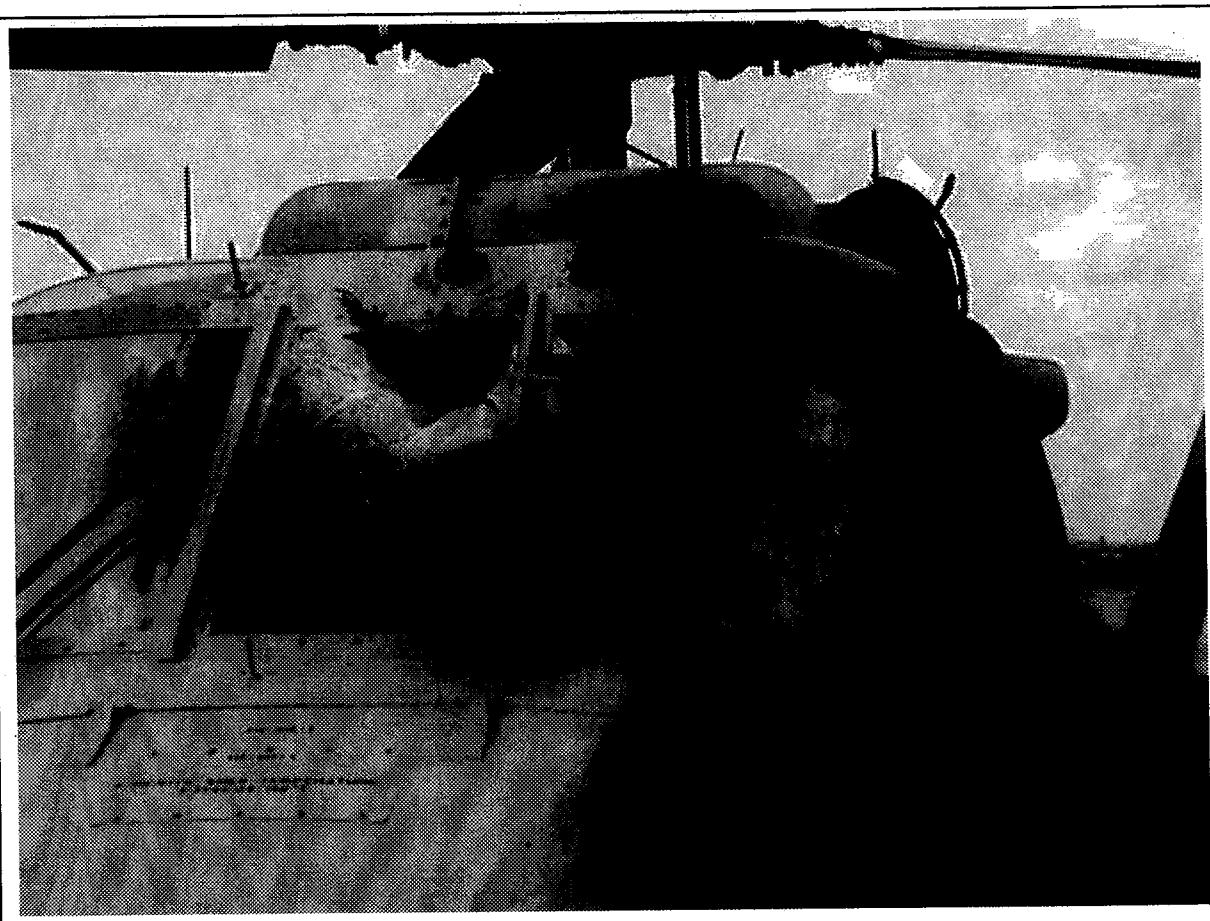
A well-maintained fence, at least 10-feet high with no gaps at the bottom, is the primary defense to keep deer and other large animals off the airport's AOA. Deer can easily jump fences that are only 6 feet high (right) (photo by R. A. Dolbeer, USDA).

A Memorandum of Understanding between the FAA and USDA/WS (No. 12-14-71-0003-MOU), establishing a cooperative relationship between the two agencies, has been in effect since 1989. The FAA relies heavily on the assistance of USDA/WS for resolving problems involving wildlife hazards to aviation at airports (Appendix G).

4.3.F INTERAGENCY MEMORANDUM OF AGREEMENT

The Federal Aviation Administration, 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 (Appendix H).

CHAPTER 5:
RECOGNIZING HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS



A Eurasian crane penetrated the windshield of this Israeli helicopter in March 2003. In the USA, vultures and waterfowl have been responsible for the most losses of military aircraft to bird strikes.

5.1 INTRODUCTION

Land-use practices and habitat are the key factors determining the wildlife species and the size of wildlife populations that are attracted to airport environments. The recognition and control of those land-use practices and habitats on or near airports that attract hazardous wildlife are fundamental to effective Wildlife Hazard Management Plans.

The FAA (through Advisory Circular 150/5200-33A, Hazardous Wildlife Attractants on or Near Airports, Appendix C) provides guidance on locating certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects (including airport construction, expansion, and renovation) affecting aircraft movement near hazardous wildlife attractants.

5.2 SEPARATION CRITERIA FOR HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

The minimum separation criteria outlined below are recommended for land-use practices that attract hazardous wildlife to the vicinity of airports. Please note that these criteria include land uses that cause movement of hazardous wildlife onto, into, or across the approach or departure airspace, air operation area (AOA), loading ramps, or aircraft parking area of airports.

Piston engines are not as susceptible to bird-strike damage as turbine engines. However, other parts of piston-powered aircraft can be severely damaged. This Rockwell Commander, flying at 1,500 feet AGL and 130 knots, struck a large bird. This was the second damaging bird strike this aircraft had suffered in less than 10 years (photo courtesy B. McKinnon, Transport Canada).

The basis for the separation criteria contained in this section can be found in existing FAA regulations. The separation distances are based on (1) flight patterns of piston-powered aircraft and turbine-powered aircraft, (2) the altitude at which most strikes happen (81 percent occur under 1,000 feet and 92 percent occur under 3,000 feet above ground level), and (3) National Transportation Safety Board (NTSB) recommendations. The recommended separation distances are diagramed in Figure-5-1.

5.2.A AIRPORTS SERVING PISTON-POWERED AIRCRAFT

Airports that do not sell Jet-A fuel normally serve piston-powered aircraft. Notwithstanding more stringent requirements for specific land uses, a minimum separation distance of 5,000 feet is recommended at these airports for known hazardous wildlife attractants or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA, loading ramps, and aircraft parking areas and the hazardous wildlife attractant. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.2.B AIRPORTS SERVING TURBAN-POWERED AIRCRAFT

Airports selling Jet-A fuel normally serve turbine-powered aircraft. Notwithstanding more stringent requirements for specific land uses, a minimum separation distance of 10,000 feet is recommended at these airports for known hazardous wildlife attractants or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA, loading ramps, and aircraft parking areas and the hazardous wildlife attractant. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.2.C PROTECTION OF APPROACH OR DEPARTURE AIRSPACE

For all airports, a minimum separation distance of 5 statute miles is recommended between the farthest edge of the airport's AOA and known hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.3 LAND-USE PRACTICES THAT POTENTIALLY ATTRACT HAZARDOUS WILDLIFE

Because most agricultural crops attract birds at some point during their production cycle, the FAA recommends against allowing farming on airport property (photo by R. DeFusco, BASH, Inc.).

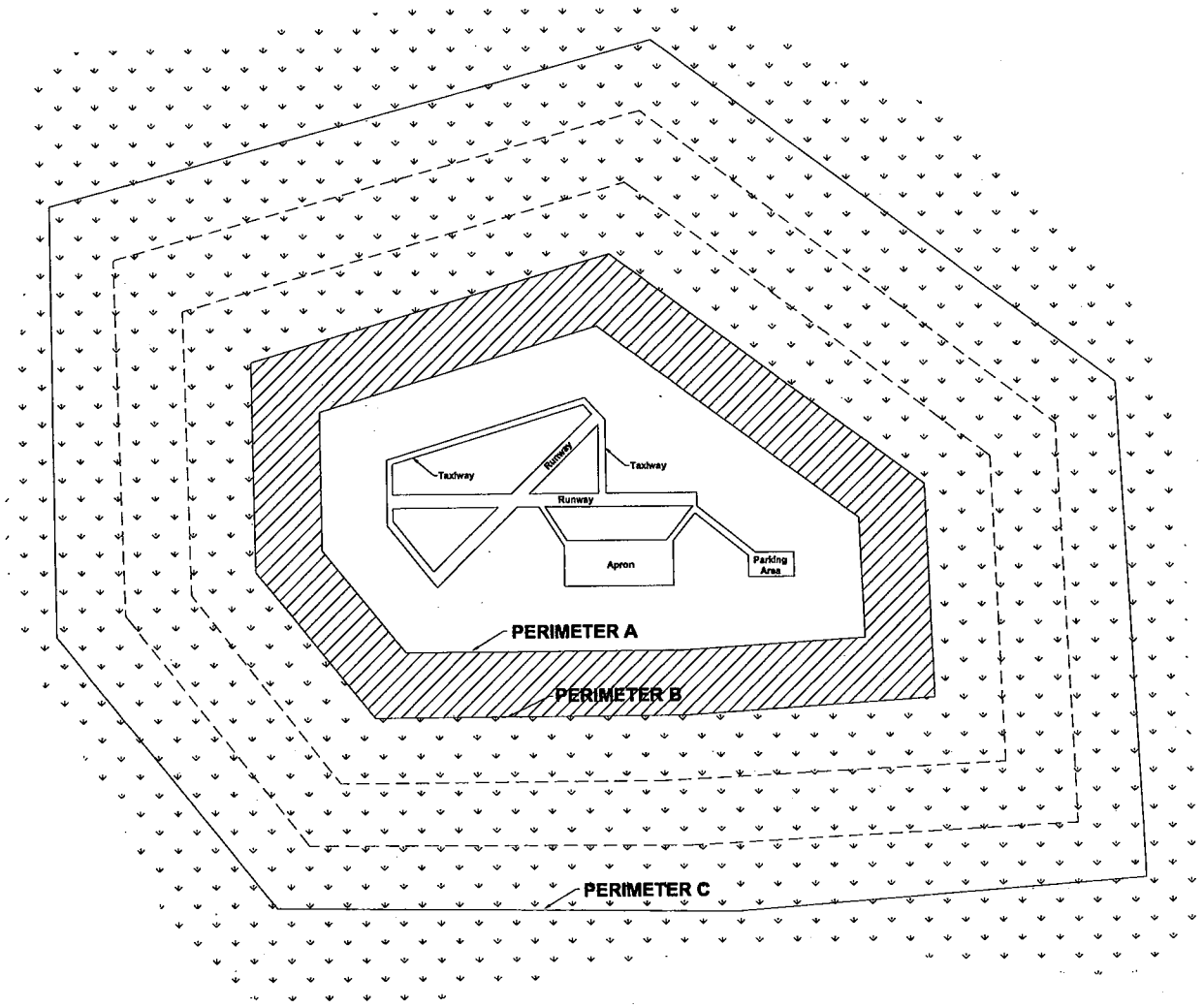
The wildlife species and the size of the populations attracted to the airport environment vary considerably, depending on several factors, including land-use practices on or near the airport. This section discusses land-use practices having the potential to attract hazardous wildlife and threaten aviation safety.

5.3.A WASTE DISPOSAL OPERATIONS

Municipal solid waste landfills (MSWLF) are known to attract large numbers of hazardous wildlife, particularly birds. Because of this, these operations, when located within the separations identified in the siting criteria in AC 150/5200-33A (see above and Appendix C), are considered incompatible with safe airport operations.

5.3.A.1 SITING NEW MUNICIPAL SOLID WASTE LANDFILLS SUBJECT TO AIR 21

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



Perimeter A:

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

Perimeter B:

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

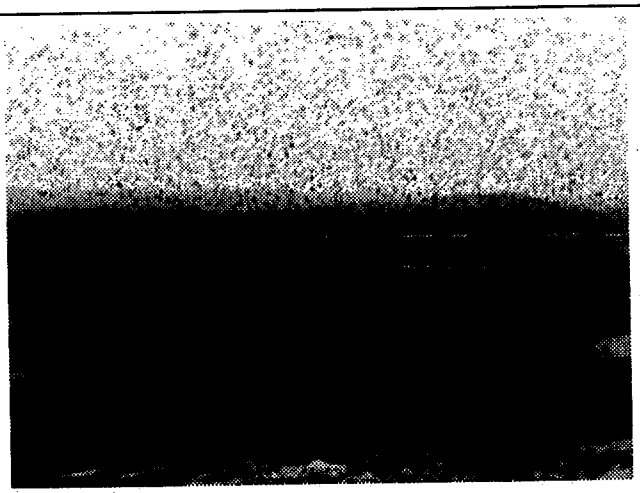
Perimeter C:

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

Figure 5-1. Separation distances within which hazardous wildlife attractants should be avoided, eliminated, or mitigated.

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

The proposed MSWLF must (1) be within 6 miles of the airport, as measured from airport property line to MSWLF property line, and (2) have started construction or establishment on or after April 5, 2001. Public Law 106–181 only limits the construction or establishment of some new MSWLF. It does not limit the expansion, either vertical or horizontal, of existing landfills. Consult the most recent version of AC 150/5200-34, *Construction or Establishment of Landfills Near Public Airports* (Appendix C), for a more detailed discussion of these restrictions.



It is widely recognized that open-faced, putrescible waste landfills attract gulls. However, these landfills also attract other birds hazardous to aviation. Over 5,000 starlings were counted at this Midwestern USA landfill (photo by E. Cleary, FAA).

5.3.A.II SITING NEW MUNICIPAL SOLID WASTE LANDFILLS NOT SUBJECT TO AIR 21

If an airport and MSWLF do not meet the restrictions of Public Law 106–181, do not locate new MSWLF within the separation distances identified in AC 150/5200-33A (see above and Appendix C). Measure the separation distances from the closest point of the airport's AOA to the closest planned MSWLF cell.

5.3.A.III CONSIDERATIONS FOR EXISTING WASTE DISPOSAL FACILITIES WITHIN THE LIMITS OF SEPARATION CRITERIA

Do not locate airport development projects that would increase the number of aircraft operations or accommodate larger or faster aircraft near MSWLF operations within the separations identified in AC 150/5200-33A (see above and Appendix C). In addition, in accordance with 40 CFR 258.10, owners or operators of existing MSWLF units that are located within the separations listed in AC 150/5200-33A (see above and Appendix C) must demonstrate that the unit is designed and operated so it does not pose a bird hazard to aircraft.

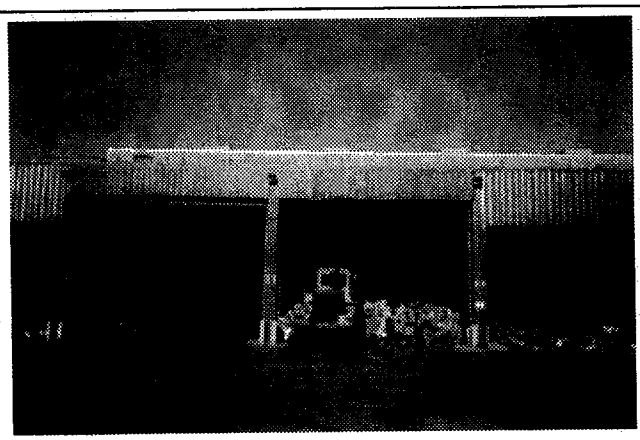
To claim successfully that a waste-handling facility sited within the separations identified in AC 150/5200-33A (see above and Appendix C) does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than in fully enclosed transfer stations (see 5.4.b, below).

In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents

might offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, no such facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating. For this reason, the FAA does not consider the demonstration of experimental wildlife control at putrescible-waste landfills within the separation distances specified in AC 150/5200-33A to be an acceptable alternative to locating the landfill beyond the separation distances.

5.3.B TRASH TRANSFER STATIONS

Enclosed waste-handling facilities that receive garbage behind closed doors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles generally are compatible with safe airport operations, provided they are not located on airport property or within the Runway Protection Zone (RPZ). Do not handle or store putrescible waste outside or in a partially enclosed structure accessible to hazardous wildlife at these facilities. Trash transfer facilities that leave the main doors open during normal operations, are open on one or more sides, that temporarily store uncovered quantities of municipal solid waste outside, that use semi-trailers that leak or have trash clinging to the outside, or that do not control odors by ventilation and filtration systems (odor masking is not acceptable) do not meet the FAA's definition of fully enclosed trash transfer stations. The FAA considers these facilities incompatible with safe airport operations if they are located closer than the separation distances specified in AC 150/5200-33A (see above and Appendix C).



Open-sided trash transfer stations attract gulls, starlings, and other birds that can pose a hazard to aviation safety. Any waste-management facility that has exposed putrescible waste must not be located closer to an airport than the separation distance specified in AC 150/5200-33A (Appendix C) (photo by L. Henze, USDA).

5.3.C COMPOSTING OPERATIONS ON OR NEAR AIRPORT PROPERTY

Composting operations that accept only yard waste (e.g., leaves, lawn clippings, or branches) generally do not attract hazardous wildlife. Sewage sludge, woodchips, and similar material are not municipal solid wastes and may be used as compost bulking agents. The compost, however, must never include food or other municipal solid waste. Do not locate composting operations on airport property. Do not locate off-airport property composting operations closer than the greater of the following distances: 1,200 feet from any AOA, loading ramp, or aircraft parking space or the distance called for by airport design requirements (see AC 150/5300-13, Airport Design). This spacing is meant to prevent material, personnel, or equipment from penetrating any Object Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway. Monitor composting operations located in proximity to the airport to ensure that steam or

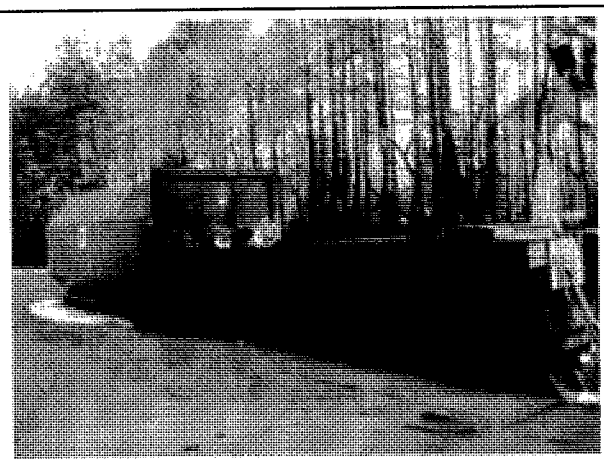
thermal rise does not adversely affect air traffic. On-airport disposal of compost by-products is not recommended.

5.3.D UNDERWATER WASTE DISCHARGES

The underwater discharge of any food waste (e.g., fish processing offal) within the separations identified in AC 150/15200-33A (see above and Appendix C) is not recommended because it could attract scavenging hazardous wildlife.

5.3.E RECYCLING CENTERS

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



Small recycling bins and compactor stations, properly maintained so that putrescible waste is covered at all times, are generally not attractive to birds (photos by E. Cleary, FAA).

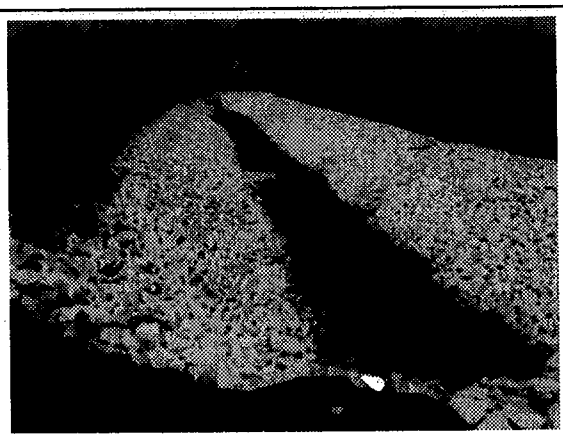
5.3.F CONSTRUCTION AND DEMOLITION DEBRIS FACILITIES

Construction and demolition debris (C&D) landfills do not generally attract hazardous wildlife and are acceptable if maintained in an orderly manner, admit no putrescible waste, and are not co-located with other putrescible waste disposal operations. C&D landfills have similar visual and operational characteristics to putrescible waste disposal sites. When co-located with putrescible waste disposal operations, C&D landfills are more likely to attract hazardous wildlife because of the similarities between these disposal facilities. Site C&D landfills co-located with other putrescible waste disposal operations outside of the separations identified in AC 150/5200-33A (see above and Appendix C).

5.3.G FLY ASH DISPOSAL

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

Since varying degrees of waste consumption are associated with general incineration (not resource recovery power/heat-generating facilities), the FAA considers the ash from general incinerators a regular waste disposal by-product and, therefore, a hazardous wildlife attractant if disposed of within the separation criteria outlined in AC 150/5200-33A (see above and Appendix C).



Water detention basins at airports, such as this French-drain system at an eastern USA airport, should be designed to completely drain within 48 hours after the design storm event (photo by R. A. Dolbeer, USDA).

5.4 WATER MANAGEMENT FACILITIES

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

5.4.A EXISTING STORM WATER MANAGEMENT FACILITIES

On-airport storm water management facilities allow the quick removal of surface water, including discharges related to aircraft deicing, from impervious surfaces, such as pavement and terminal/hangar building roofs. Existing on-airport detention ponds collect storm water, protect water quality, and control runoff. Because they slowly release water after storms, they create standing bodies of water that can attract hazardous wildlife. Using appropriate wildlife hazard mitigation techniques, airport management should take immediate corrective actions to address any wildlife hazards arising from existing storm water or other such facilities located on or near an airport (14 CFR 139.337 (a)). Develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

This storm water basin was designed to drain within 48 hours following a major storm event (the design storm). The rip-rap lining helps prevent vegetation growth and bird use of the pond (photo courtesy FAA).

Where possible, modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. Avoid or remove retention ponds and detention ponds featuring long-term storage to eliminate standing water. Design or modify

detention basins to remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide cover and food for wildlife.

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

Floating plastic balls can be used to cover ponds and prevent birds from using the site. FAA approval is required before physical barriers may be used over ponds at certificated airports (photo courtesy Wildlife Materials, Inc.).

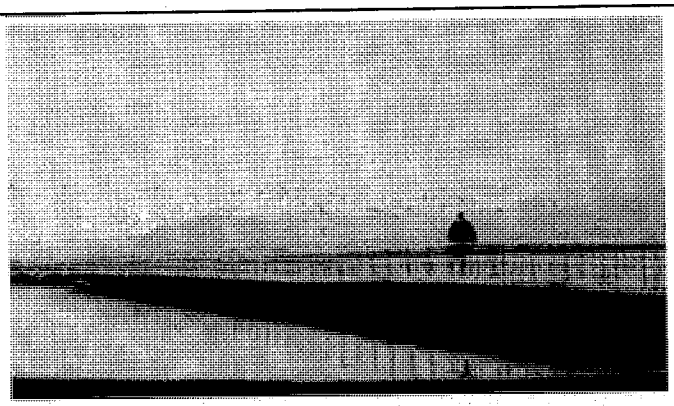
Encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into storm water treatment facility operating practices when their facility is located within the separation criteria specified in AC 150/5200-33A (see above and Appendix C).

5.4.B NEW STORM WATER MANAGEMENT FACILITIES

Design and operate off-airport storm water management systems located within the separations identified in AC 150/5200-33A (see above and Appendix C) so as not to create above-ground standing water. Design, engineer, construct, and maintain on-airport storm water detention ponds for a maximum 48–hour detention period for the design storm and so the ponds remain completely dry between storms. Use steep-sided, narrow, linearly shaped water detention basins to facilitate the control of hazardous wildlife. When it is not possible to place these ponds away from the AOA, use physical barriers, such as bird balls, wires grids, pillows, or netting, to prevent access of hazardous wildlife to open water and minimize aircraft-wildlife interactions. When physical barriers are used, carefully evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, get approval from the appropriate FAA Regional Airports Division Office. Eliminate all vegetation in or around detention basins that provides food or cover for hazardous wildlife. If soil conditions and other requirements allow, use underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

5.4.C EXISTING WASTEWATER TREATMENT FACILITIES

Immediately correct any wildlife hazards arising from existing wastewater treatment or similar facilities located on or near the airport (14 CFR 139.337). Encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Encourage wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices. In addition, consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.



In tropical regions, cattle egrets appear to fill the ecological niche occupied by gulls at waste management facilities in North America. Over 13,000 cattle egrets were seen at this sewage treatment and landfill complex near Mexico City (photo by E. Cleary, FAA).

5.4.D NEW WASTEWATER TREATMENT FACILITIES

Do not construct new wastewater treatment facilities or associated settling ponds within the separations identified in AC 150/15200-33A (see above and Appendix C). Wastewater treatment facilities are "any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes." The definition includes any pretreatment involving the reduction of the amount of pollutants or the elimination of pollutants prior to introducing such pollutants into a publicly owned treatment works (wastewater treatment facility). Consider the potential to attract hazardous wildlife during the site-location analysis for wastewater treatment facilities if an airport is in the vicinity of the proposed site. Oppose such facilities if they are within the separations identified in AC 150/5200-33A (see above and Appendix C).

5.4.E ARTIFICIAL MARSHES

In warmer climates, wastewater treatment facilities sometimes employ artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by various species of birds, such as blackbirds and waterfowl, for nesting, feeding, or roosting. Do not establish artificial marshes within the separations identified in AC 150/5200-33A (see above and Appendix C).

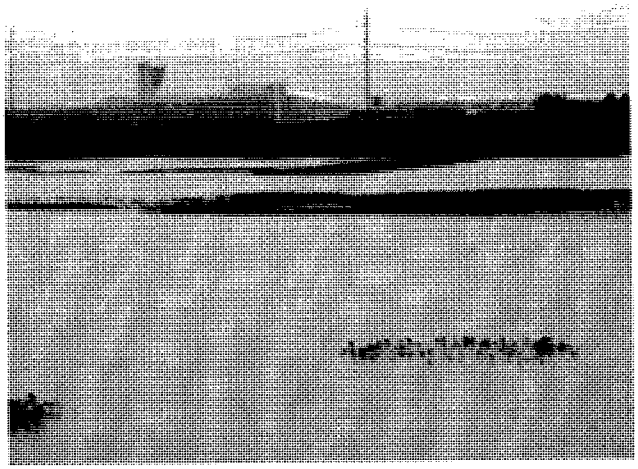
5.4.F WASTEWATER DISCHARGE AND SLUDGE DISPOSAL

Do not discharge of wastewater or sludge on airport property because it may improve soil moisture and quality on unpaved areas and lead to improved turf growth that can be an attractive food source for many species of animals. Also, the turf requires more frequent mowing, which in turn might mutilate or flush insects or small animals and produce thatch, both of which can attract hazardous wildlife. In addition, the improved turf might attract grazing wildlife, such as deer and geese. Problems might also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

5.5 WETLANDS

Wetlands provide a variety of functions and can be regulated by local, state, and federal laws. Wetlands typically attract diverse species of wildlife, including many that rank high on the list of hazardous wildlife species (Table 7-1).

If questions exist as to whether an area qualifies as a wetland, contact the local division of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, or a wetland consultant qualified to delineate wetlands. A MOA among six federal agencies was signed in 2003 (Appendix H) to facilitate, among other things, resolution of wetland management issues at airports without compromising aviation safety related to wildlife hazards.



This photo is from a National Wildlife Refuge located adjacent to a major USA airport (note air traffic control tower in background). These incompatible land uses were established years ago, before the FAA had set minimum separation distances. In this type of situation, both the airport manager and the refuge manager must be extra vigilant and ready to respond to rapidly developing wildlife hazard conditions (photo by E. Cleary, FAA).

5.5.A EXISTING WETLANDS ON OR NEAR AIRPORT PROPERTY

If wetlands are located on or near airport property, be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations. At public-use airports, immediately correct, in cooperation with local, state, and federal regulatory agencies, any wildlife hazards arising from existing wetlands located on or near airports. Where required, a Wildlife Hazard Management Plan (WHMP) will outline appropriate wildlife hazard mitigation techniques. Develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

5.5.B NEW AIRPORT DEVELOPMENT

Whenever possible, locate new airports using the separations from wetlands identified in AC 150/5200-33A (see above and Appendix C). Where alternative sites are not practicable, or when expanding an existing airport into or near wetlands, in consultation with a wildlife damage management biologist, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the state wildlife management agency, evaluate the wildlife hazards and prepare a WHMP that indicates methods of minimizing the hazards.

5.5.C MITIGATION FOR WETLAND IMPACTS FROM AIRPORT PROJECTS

This water body at a major west coast USA airport should be removed because it provides ideal habitat for waterfowl and wading birds hazardous to aircraft. However, the water has also been designated as critical habitat for the endangered Riverside fairy shrimp. Airports must work closely with multiple federal and state agencies to resolve such conflicts (Photo by T. Pitlik, USDA)

Wetland mitigation might be necessary when wetland disturbances result from new airport development projects or projects required to correct wildlife hazards from wetlands. Wetland mitigation must be designed so it does not create a wildlife hazard. Locate wetland mitigation projects that may attract hazardous wildlife outside of the separations identified in AC 150/5200-33A (see above and Appendix C).

5.5.C.1 ON-SITE MITIGATION OF WETLAND FUNCTIONS

The FAA may consider exceptions to locating mitigation activities outside the separations identified in AC 150/5200-33A (see above and Appendix C) if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Using existing airport property is sometimes the only feasible way to achieve the mitigation ratios mandated in regulatory orders and settlement agreements with the resource agencies. Conservation easements are an additional means of providing mitigation for project impacts. Typically the airport operator continues to own the property, and an easement is created stipulating that the property will be maintained as habitat for state or federally listed species.

Mitigation must not inhibit the airport operator's ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Avoid enhancing such mitigation areas to attract hazardous wildlife. The FAA may review any onsite mitigation proposals to determine compatibility with safe airport operations. In cooperation with a wildlife damage management biologist, evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in AC 150/5200-33A (see

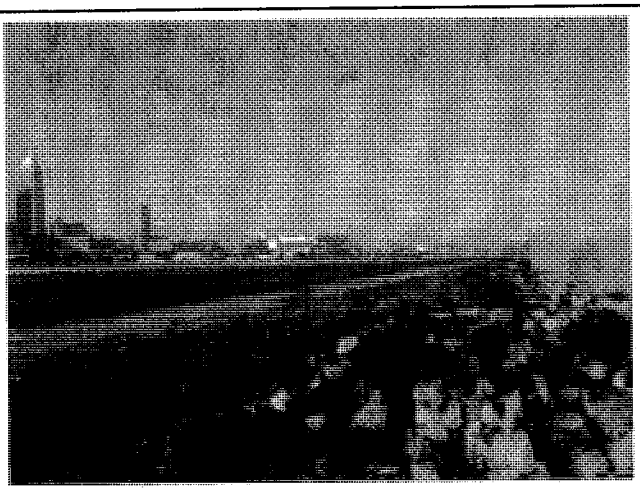
above and Appendix C) before the mitigation is implemented. Develop a WHMP to reduce any identified wildlife hazards.

5.5.C.II OFF-SITE MITIGATION OF WETLAND FUNCTIONS

Site wetland mitigation projects that might attract hazardous wildlife outside of the separations identified in AC 150/5200-33A (see above and Appendix C) unless they provide unique functions that must remain onsite (see 2-4c(1)). Agencies that regulate impacts to or around wetlands recognize that it might be necessary to split wetland functions in mitigation schemes. Therefore, regulatory agencies may, under certain circumstances, allow portions of mitigation to take place in different locations.

5.5.C.III MITIGATION BANKING

Wetland mitigation banking is the creation or restoration of wetlands in order to provide mitigation credits that can be used to offset permitted wetland losses. Mitigation banking benefits wetland resources by providing advance replacement for permitted wetland losses; consolidating small projects into larger, better-designed and managed units; and encouraging integration of wetland mitigation projects with watershed planning. This last benefit is most helpful for airport projects, as wetland impacts mitigated outside of the separations identified in AC 150/5200-33A (see above and Appendix C) can still be located within the same watershed. Wetland mitigation banks meeting the separation criteria offer an ecologically sound approach to mitigation in these situations. Working with local watershed management agencies or organizations, develop mitigation banking for wetland impacts on airport property. See Appendix M for a more detailed discussion of this issue.



During the first winter following its completion, over 20,000 Bonaparte's gulls used this dredge spoil containment area (far right of photo) constructed next to an airport on Lake Erie's shoreline. The airport's main runway can be seen to the left (photo by E. Cleary, FAA).

5.6 DREDGE SPOIL CONTAINMENT AREAS

Do not locate dredge spoil containment areas (also known as Confined Disposal Facilities) within the separations identified in AC 150/5200-33A (see above and Appendix C) if the containment area has standing water or the spoils contain material that would attract hazardous wildlife.

5.7 AGRICULTURAL ACTIVITY

5.7.A CROP PRODUCTION

Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, do not use airport property for crop production, including hay

crops, within the separations identified in AC 150/5200-33A (see above and Appendix C).

If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport must follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 19. Avoid production of cereal grains and sunflowers. Weigh the cost of wildlife control and potential accidents against the income produced by the on-airport crops when deciding whether to allow crops on the airport.

5.7.B LIVESTOCK PRODUCTION

Confined livestock operations (i.e., feedlots, dairy operations, hog or chicken production facilities, or egg-laying operations) often attract flocking birds, such as starlings, that pose a hazard to aviation. Therefore, keep such facilities outside of the separations identified in AC 150/5200-33A (see above and Appendix C). Develop a program to reduce the attractiveness of any livestock operation within these separations. Do not graze free-ranging livestock on airport property because the animals might wander onto the AOA. Livestock feed, water, and manure might attract hazardous birds.

Various fish-eating birds are attracted to aquaculture facilities as demonstrated by these great egrets at a southern USA catfish pond complex. Attempts to repel the birds using propane exploders failed because the birds habituated to the sound (photo by D. LeBlanc, USDA).

5.7.C AQUACULTURE

Aquaculture activities (e.g., catfish, trout, bait fish production) conducted outside of fully enclosed buildings are inherently attractive to a variety of birds. Existing aquaculture facilities/activities within the separations listed in AC 150/5200-33A (see above and Appendix C) must have a program developed to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Oppose the establishment of new aquaculture facilities/activities within the separations listed in AC 150/5200-33A (see above and Appendix C).

5.7.D ALTERNATIVE USES OF AGRICULTURAL LAND

Some airports are surrounded by vast areas of farmed land within the distances specified in AC 150/5200-33A (see above and Appendix C). Seasonal uses of these agricultural lands for activities such as waterfowl hunting can create a hazardous wildlife situation. Rice farmers, for example, might flood their land during waterfowl hunting season and obtain additional revenue by renting out duck blinds. The duck hunters,

using decoys and calls, draw in large numbers of birds, creating a threat to aircraft safety. It is recommended that a wildlife damage management biologist review, in coordination with local farmers and airport management, these types of seasonal land uses. Restrictions to seasonal land uses that are incompatible with aviation safety should be incorporated into the WHMP.

5.8 GOLF COURSES, LANDSCAPING, AND OTHER LAND-USE CONSIDERATIONS

5.8.A GOLF COURSES

The large grassy areas and open water found on most golf courses are attractive to hazardous wildlife, particularly Canada geese, mallards, and gulls. These species can pose a threat to aviation safety. Do not site new golf courses within the separations identified in AC 150/5200-33A (see above and Appendix C). Existing golf courses located within these separations must develop a program to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Ensure these golf courses are monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, take corrective actions immediately.

Trees and shrubs that produce fruits that are attractive to birds, such as these pyracanthas at a western USA airport, should not be used in landscape designs on airport property. Dense stands of evergreen trees also should be avoided as they provide ideal roosting sites for flocks of starlings and blackbirds (photo by R. A. Dolbeer, USDA).

5.8.B LANDSCAPING AND LANDSCAPE MAINTENANCE

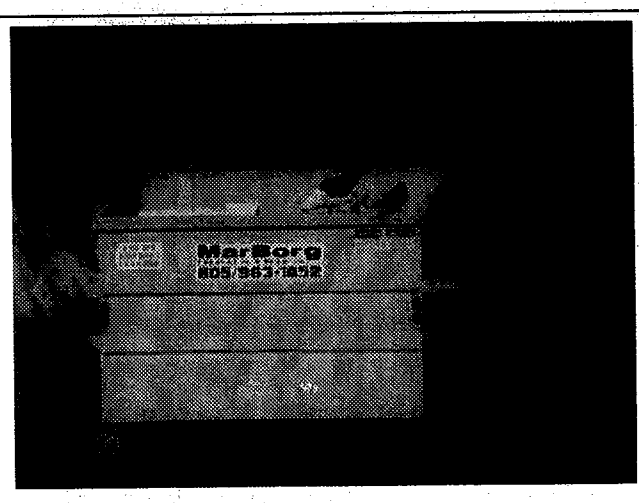
Depending on geographic location and plant selection and spacing, airport landscaping can attract hazardous wildlife. Approach landscaping with caution, and confine it to airport areas not associated with aircraft movements. In cooperation with a wildlife damage management biologist, review all landscaping plans. Monitor all landscaped areas on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, take corrective actions immediately.

Turf grass areas can be highly attractive to a variety of hazardous wildlife species. Research conducted by the USDA/WS National Wildlife Research Center has shown that no one grass management regime will deter all species of hazardous wildlife in all situations. In cooperation with a wildlife damage management biologist, develop airport turf grass management plans on a prescription basis, depending on the airport's geographic location and the type of hazardous wildlife likely to frequent the airport. See Chapter 9 and Appendix O for more information on vegetation management.

Ensure that plant varieties attractive to hazardous wildlife are not used on the airport. Do not plant disturbed areas or areas in need of re-vegetating with seed mixtures containing millet or any other large-seed producing grass. Prevent plant maturation and seed head production on airport property already planted with seed mixtures containing millet, rye grass, or other large-seed producing grasses by the use of disking, plowing, or another suitable agricultural practice. Follow the specific recommendations for grass management and seed and plant selection made by the State University Cooperative Extension Service, the local office of USDA/Wildlife Services, or a qualified wildlife damage management biologist. Consider developing and implementing a preferred/prohibited plant species list, reviewed by a wildlife damage management biologist, which has been designed for the geographic location to reduce the attractiveness to hazardous wildlife for landscaping airport property. Avoid installation of ponds, fountains, reflecting pools, and other water bodies as part of an airport's landscaping scheme.

5.8.c OTHER HAZARDOUS WILDLIFE ATTRACTANTS

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



This open dumpster at a park 0.5 mile from a west coast USA airport served as a strong attractant for gulls, pigeons, and crows. Airports must work with surrounding landowners and local governments to prevent bird attractants near airports (photo by R. A. Dolbeer, USDA).

5.9 SYNERGISTIC EFFECTS OF SURROUNDING LAND USES

There might be circumstances where two (or more) different land uses that would not, by themselves, be considered hazardous wildlife attractants or that are located outside of the separations identified in AC 150/5200-33A (see above and Appendix C) that are in such an alignment with the airport as to create a wildlife corridor directly through the airport and/or surrounding airspace. An example of this situation might involve a lake located outside of the separation criteria on the east side of an airport and a large hayfield on the west side of an airport—land uses that together could create a flyway for Canada geese directly across the airspace of the airport. There are numerous examples of such situations; therefore, airport operators and the wildlife damage management biologist must consider the entire surrounding landscape and community when developing the WHMP.

CHAPTER 6:
DEVELOPING WILDLIFE HAZARD MANAGEMENT PROGRAMS AT AIRPORTS

The pilot of this Cessna 172 made a Mayday call to a nearby Air Traffic Control Tower in Texas after hitting a bird (likely a vulture) with the left wing at 800 feet AGL on 8 July 2003. The pilot attempted to make an emergency landing in a field but lost control and crashed, killing him and his passenger (photo courtesy of FAA).

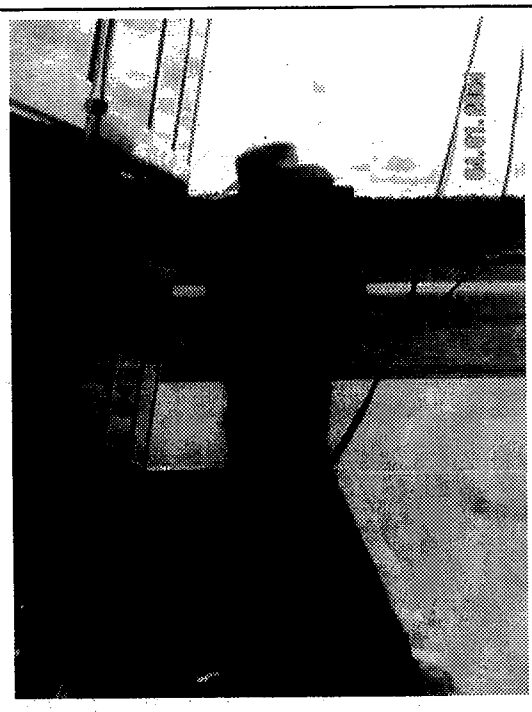
6.1 INTRODUCTION

In recognition of the increased risk of serious aircraft damage or the loss of human life that can result from a wildlife strike, greater emphasis is being placed on preparing airport Wildlife Hazard Management Plans that effectively deal with the problem. This heightened awareness and increased effort has raised many questions about the preparation and content of an FAA-approved Wildlife Hazard Management Plan for an airport. The specific events that trigger a Wildlife Hazard Assessment and the specific issues that a Wildlife Hazard Management Plan must address for FAA approval and inclusion in the airport's Airport Certification Manual (ACM)

are described in 14 CFR 139.337 (Appendix P).

It is important to note that regardless of whether a Wildlife Hazard Assessment has ever been required or a Wildlife Hazard Management Plan has been developed, airport operators must be ready to deal with hazardous wildlife on or near the airport. The airport operator must be prepared to take immediate action to deal with unexpected incursions of hazardous wildlife into the AOA, loading ramps, or parking areas (14 CFR 139.337(a)).

14 CFR 139.337	Comments
(a). In accordance with its Airport Certification Manual and the requirements of this section, each certificate holder shall take immediate action to alleviate wildlife hazards whenever they are detected.	Public-use airport operators need to be aware of any hazardous wildlife attractants on or near their airport, even if a wildlife strike has never been reported from the airport. Airport personnel need at least a minimal understanding of wildlife hazard control issues.



The Air Traffic Control (ATC) Tower is a good place to start a Wildlife Hazard Assessment. The tower presents an excellent overview of the airport and provides an opportunity to talk to ATC personnel about wildlife they have seen on the airport (photo by A. Gosser, USDA).

6.2 WILDLIFE HAZARD ASSESSMENT

The first step in preparing an airport Wildlife Hazard Management Plan is to conduct a Wildlife Hazard Assessment. The Wildlife Hazard Assessment, conducted by a wildlife damage management biologist, provides the scientific basis for the development, implementation, and refinement of a Wildlife Hazard Management Plan. Though parts of the Wildlife Hazard Assessment may be incorporated directly into the Wildlife Hazard Management Plan, they are two separate documents.

6.2.A REQUIREMENT FOR WILDLIFE HAZARD ASSESSMENT

Title 14 CFR 139.337(b)(1–4) requires that, in a manner authorized by the Administrator, each certificate holder must ensure that a Wildlife Hazard Assessment is conducted when any of the following events occurs on or near the airport:

1. An air carrier aircraft experiences multiple wildlife strikes;
2. An air carrier aircraft experiences substantial damage from striking wildlife;

3. An air carrier aircraft experiences an engine ingestion of wildlife; or
4. Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b)(1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area.

The following provides a point-by-point comment on the regulations concerning the events that trigger a wildlife hazard assessment.

14 CFR 139.337	Comments
(b) In a manner authorized by the Administrator, each certificate holder shall ensure that a Wildlife Hazard Assessment is conducted when any of the following events occurs on or near the airport.	A wildlife hazard assessment, conducted by a qualified wildlife damage management biologist, must be conducted if—
(b) (1) An air carrier aircraft experiences a multiple wildlife strike	Aircraft strikes more than one animal (geese, starlings, bats, deer, coyotes, etc.).
(b) (2) An air carrier aircraft experiences substantial damage from striking wildlife. As used in this paragraph, substantial damage means damage or structural failure incurred by an aircraft that adversely affects the structural strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component	The definition of substantial damage is taken directly form the International Civil Aviation Organization (ICAO) *Manual on the International Civil Aeronautics Organization Bird Strike Information System.*
(b) (3) An air carrier aircraft experiences an engine ingestion of wildlife; or	Wildlife is ingested into a turboprop, turbofan, or turbojet engine. Engine damage does not have to result from the ingestion.
(b) (4) Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b)(1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area.	Airports with a standing Notice to Airmen (NOTAM), announcements on their Automatic Terminal Information Service (ATIS), or comments in Airport/Facility Directory (A/FD) warning pilots of wildlife hazards on or near the airport meet this condition.

6.2.B NECESSARY ELEMENTS OF A WILDLIFE HAZARD ASSESSMENT

Title 14 CFR 139.337 (c)(1–5) provides specific guidance as to what facts must be addressed in a Wildlife Hazard Assessment. The following is a point-by-point comment

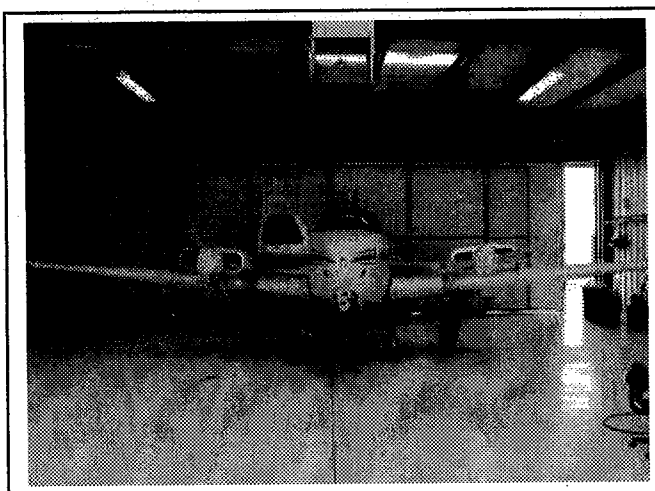
on each section of the regulations concerning the factors to be addressed in a Wildlife Hazard Assessment.

14 CFR 139.337	Comments
(c) The Wildlife Hazard Assessment ... shall be conducted by wildlife damage management biologist ... having training or experience in wildlife hazard management at airports ... or working under the direct supervision ...	The Wildlife Hazard Assessment (WHA) is to be conducted by someone having the following qualifications: Education: Meets U.S. Office of Personal Management standards for GS-486 Wildlife Biologist. Work experience: Has prepared a WHA acceptable to the FAA. Has prepared a Wildlife Hazard Management Plan acceptable to the FAA. Or, is working under the direct supervision of someone who meets the above requirements.
(c) cont. ... the Wildlife Hazard Assessment shall contain:	
(c) (1) Analysis of the event or circumstances that prompted the study.	Who, what, when, where, why of the situation prompting the WHA.
(c) (2) Identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences.	What wildlife species have access to the airport? What are their legal status, movement patterns, and seasonal patterns? Refer to Table 7-1 for a ranked listing of hazardous species. Pay particular attention to those species considered the most hazardous occurring on or near the airport.
(c) (3) Identification and location of features on and near the airport that attract wildlife.	Wildlife are attracted to an airport because something exists on or near the airport that they desire, such as large open areas where they can loaf in relative safety; abundant food or water; and escape, loafing, or nesting cover. These attractants need to be identified and evaluated.

14 CFR 139.337	Comments
(c) (4) Description of the wildlife hazards to air carrier operations.	This is a judgment call best made by a professional wildlife management biologist trained in dealing with airport issues. Hitting 3-4 swallows is much less hazardous than hitting one 12-pound Canada goose (see Table 7-1).
(c) (5) Recommended actions for reducing identified wildlife hazards to air carrier operations.	The biologist preparing the WHA must provide prioritized recommendations for mitigating the hazardous wildlife attractants identified in (c)(3).

6.2.c DURATION OF WILDLIFE HAZARD ASSESSMENT AND BASIC SURVEY TECHNIQUES

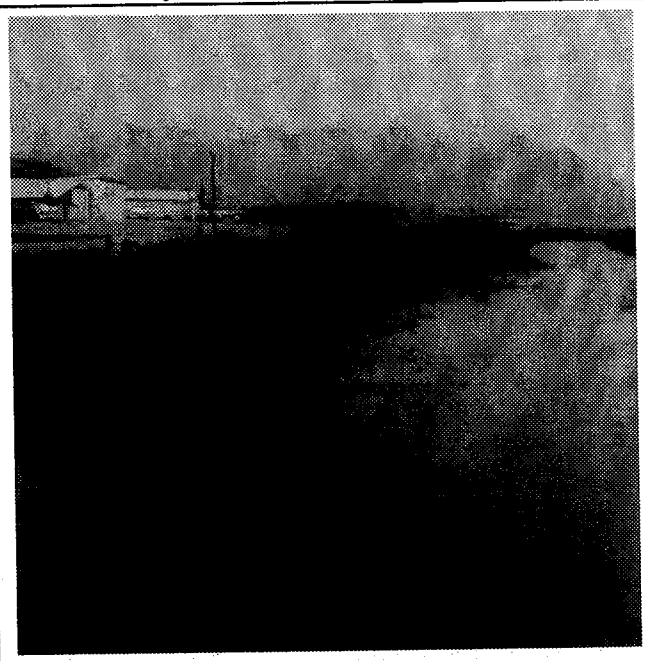
In conducting a Wildlife Hazard Assessment 14 CFR Part 139.337 (c)(2) requires the "identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences." In most cases, this requirement dictates that a 12-month assessment be conducted so the seasonal patterns of birds and other wildlife using the airport and surrounding area during an annual cycle can be properly documented. Most regions of the USA have dramatic seasonal differences in numbers and species of migratory birds. Even for non-migratory wildlife, such as deer and resident Canada geese, behavior and movement patterns can change significantly among seasons. Observations of wildlife at an airport and surrounding areas limited to a few days in a single season generally cannot adequately assess hazardous wildlife issues and associated habitat attractants.



During the WHA, special attention must be paid to the presence of domestic animals on the airport. This Beachcraft Baron struck an 80-pound dog (chow) during a night departure. The center landing gear collapsed and both propellers struck the ground.

In order to adequately identify "the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences" during a Wildlife Hazard Assessment, the FAA and USDA/WS recommend that standardized survey procedures be used. These standardized procedures should provide an objective assessment of hazardous wildlife in the airport environment that can be repeated in future years for comparative purposes. One objective procedure for assessing bird populations, based on North American Breeding Bird Survey methodology, is the establishment of standardized survey points about ½ mile apart throughout the AOA (10-20 survey points are generally recommended depending on

size of airport). Assigning each bird or bird flock observed during a point count to a grid location can be useful in further refining spatial distributions of birds on the airport. Additional survey points may be established in nearby off-airport areas (e.g., taxicab lot, golf course, or city park) suspected of attracting hazardous birds that move across the AOA. Standardized counts of birds should be made at each of these survey points at least twice monthly. In addition, specialized surveys might be needed as part of the overall assessment to document large-to-mid-sized mammals, such as deer or jackrabbits (from vehicle using spotlight or night vision equipment), and small mammals, such as voles and mice (snap traps), on the airport. These specialized mammal surveys should be conducted at least twice during a 12-month WHA.



Bodies of open water adjacent to airports, such as this drainage canal, are often magnets for waterfowl and wading birds. Note the shallow slope that allows birds easy access in and out of the water. Such canals should be covered if possible or diverted away from the airport (photo by E. Cleary, FAA).

6.3 WILDLIFE HAZARD MANAGEMENT PLAN

6.3.A REQUIREMENT FOR WILDLIFE HAZARD MANAGEMENT PLAN

When complete, the Wildlife Hazard Assessment is submitted to the FAA for evaluation and determination whether a Wildlife Hazard Management Plan needs to be developed for the airport. In reaching this decision, the FAA will consider the Wildlife Hazard Assessment, the aeronautical activity at the airport, the views of the certificate holder and airport users, and any other pertinent information (14 CFR 139.337 (d)(1–6)). At a minimum, it is recommended that the airport manager develop and implement a plan to deal with any hazardous wildlife attractants or situations identified in the Wildlife Hazard Assessment.

If the FAA determines that a Wildlife Hazard Management Plan is needed, the airport operator must then formulate and implement a Wildlife Hazard Management Plan, using the Wildlife Hazard Assessment as the basis for the plan (14 CFR 139.337 (e)(1–3)). At the same time, the FAA regional coordinator will contact the local U.S. Fish and Wildlife Service (USFWS), Ecological Services Field Office and request information about the presence of federally listed or proposed endangered or threatened species or designated or proposed critical habitat on or near the airport. (See FAA Airport Certification Program, Program Policy and Guidance No. 78, Section-7 Consultation on Endangered or Threatened Species, Appendix D.) The USFWS response will be forwarded to the airport operator to be taken into account when preparing the required plan.

If federally listed or proposed endangered or threatened species or designated or proposed critical habitat are present, the airport operator must prepare a Biological Assessment (50 CFR 402.13) assessing the impacts of the Wildlife Hazard Management Plan on these species or habitats. The Biological Assessment and draft Wildlife Hazard Management Plan must be submitted to the FAA for review and approval.

Airport management may request the wildlife biologist who prepared the Wildlife Hazard Assessment to assist with the preparation of the Wildlife Hazard Management Plan and to review the finished plan. However, only the airport operator can commit airport resources (time, money, personal), and the ultimate responsibility for the development and implementation of the plan rests with the airport operator. When the plan is completed the airport operator must submit the draft plan, together with a copy of the Biological Assessment, to the FAA for approval. The FAA will conduct any needed Section 7 consultations with the USFWS.

The presence of a threatened or endangered species on an airport, such as this nesting California least tern, would constitute extraordinary circumstances and require preparation of either an Environmental Assessment or an Environmental Impact Statement before the Wildlife Hazard Management Plan could receive FAA approval (photo courtesy of USFWS, NTCT Image Library).

6.3.B. National Environmental Policy Act Review

The FAA's approval of a draft Wildlife Hazard Management Plan is covered by the categorical exclusion in FAA Order 1050.1E, paragraph 308e. Before the FAA approves a draft Wildlife Hazard Management Plan, the FAA must determine whether or not the draft Wildlife Hazard Management Plan involves extraordinary circumstances (see FAA Order 1050.1E, paragraphs 303c and 304).

- If a draft Wildlife Hazard Management Plan does not involve extraordinary circumstances, the FAA may categorically exclude the Wildlife Hazard Management Plan under FAA Order 1050.1E, paragraph 308e.
- If a draft Wildlife Hazard Management Plan involves extraordinary circumstances, the FAA may require the airport sponsor to prepare an EA, or the FAA may prepare an EIS.

Once a draft Wildlife Hazard Management Plan is approved, the plan is returned to the airport sponsor for inclusion in the airport's Airport Certification Manual and is enforceable.

6.3.C NECESSARY ELEMENTS OF A WILDLIFE HAZARD MANAGEMENT PLAN

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

As part of the Wildlife Hazard Management Plan, pilots should be reminded to conduct a pre-flight inspection of their aircraft for bird nesting material, especially if the aircraft is parked outside or has not been used for some time (photo courtesy USDA).

The Wildlife Hazard Management Plan must accomplish the following:

- Identify personal responsible for implementing each phase of 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,
- Identify training requirements for the airport personnel who will implement the Wildlife Hazard Management Plan, and
- Identify when and how the plan will be reviewed and updated.

It is often helpful for the airport manager to appoint a Wildlife Hazards Working Group that periodically reviews the airport's Wildlife Hazard Management Plan and the plan's implementation to make recommendations for further refinements or modifications (see Chapter 7).

14 CFR 139.337 (f)(1–7) provides specific guidance as to what facts must be addressed in a Wildlife Hazard Management Plan. The following table details how the requirements of Part 139.337 (f) (1–7) are to be addressed in an FAA-approved Wildlife Hazard Management Plan (see also Appendix E).

14 CFR 139.337	Comments
(f). The Wildlife Hazard Management Plan shall include at least the following :	
(f) (1) A list of the individuals having authority and responsibility for implementing each aspect of the plan.	Assign or delegate specific responsibilities for various sections of the Wildlife Hazard Management Plan to various airport departments, such as— • Airport Director • Operations Dept. • Maintenance Dept. • Security Dept. • Planning Dept. • Finance Dept. • Wildlife Coordinator • Wildlife Hazards Working Group • Local law enforcement authorities that might provide wildlife law enforcement and other support include — o U.S. Fish and Wildlife Service o State Wildlife Agency o City Police o County Sheriff

14 CFR 139.337	Comments
(f) (2) A list prioritizing the following actions identified in the wildlife hazard assessment and target dates for their initiation and completion:	Provide a prioritized list of problem wildlife populations and wildlife attractants (food, cover, and water) identified in the WHA, proposed mitigation actions, and target starting and completion dates. A list of completed wildlife population management projects and habitat modification projects designed to reduce the wildlife strike potential can be included to provide a history of work already accomplished. It is helpful to group attractants by areas and ownership. Airport property: • Air Operations Area (AOA) • Within 2 miles of AOA • Airport structures Non-airport property • Within 2 miles of AOA • Within 5 miles of AOA
(f) (2) (i) Wildlife population management;	Address species-specific population management plans (e.g., deer, gulls, geese, and coyotes): • Habitat modification • Resource protection • Repelling/exclusion • Removal Chapter 9 provides a discussion of the various wildlife control methods.

14 CFR 139.337	Comments
(f) (2) (ii) Habitat modification; and	Food/prey management: • Rodents • Earthworms • Insects • Grain/seeds • Garbage –handling, storage • Handouts (feeding wildlife) Vegetation management: • AOA vegetation • Drainage ditch vegetation • Landscaping • Agriculture Water management: • Permanent Water • Wetlands • Canals/ditches/streams • Holding ponds • Sewage (glycol) treatment ponds • Other water areas • Ephemeral water o Runways, taxiways, aprons o Other wet areas Airport buildings: • Airfield structures • Abandoned structures • Terminal • Airport construction

14 CFR 139.337	Comments
(f) (2) (ii) [cont.] [and] land use changes.	i.e., Elimination of agricultural activities on or near the airport, surface mining, urban development, creation of off-airport storm water management systems.
(f) (3) Requirements for and, where applicable, copies of local, state, and federal wildlife control permits.	Certain species of wildlife might be protected at all levels of government—local, state, and federal—or might not be protected at all, depending on location and species. Address the specific species involved and their legal status in this section. Describe the wildlife management permitting requirements and procedures for all levels of government having jurisdiction, i.e.— • Federal – 50 CFR, Parts 1 to 199. • State – Fish and Game Code (or equivalent) • City, county – ordinances • If pesticides are to be used, the following are also needed: o Pesticide-use regulations: o Federal: Federal Insecticide, Fungicide, and Rodenticide Act. o State (varies by state) o Pesticide-use licensing requirements o State regulations Summaries are generally adequate. It is not necessary to quote chapter and verse of federal, state, and local laws and regulations.

14 CFR 139.337	Comments
(f) (4) Identification of resources that the certificate holder will provide to implement the plan.	Provide information identifying what resources the airport will supply in terms of— • Personal • Time • Equipment (e.g., radios, vehicles, guns, traps, propane cannons, etc.) • Supplies (e.g., pyrotechnics) • Pesticides (restricted/non-restricted use) • Application equipment • Sources of supply for equipment and supplies
(f) (5) Procedures to be followed during air carrier operations that at a minimum includes—	
(f) (5) (i) Designation of personnel responsible for implementing the procedures;	Who, when, what circumstances: • Wildlife Control Personnel • Wildlife Coordinator • Operations Dept. • Maintenance Dept. • Security Dept. • Air Traffic Control
(f) (5) (ii) Provisions to conduct physical inspections of the aircraft movement areas and other areas critical to successfully manage known wildlife hazards before air carrier operations begin;	Who, when, how, what circumstances: • Runway, taxiway sweeps • AOA monitoring • Other areas attractive to wildlife

14 CFR 139.337	Comments
(f) (5) (iii) Wildlife hazard control measures; and	Who, what circumstances, when, and how are Wildlife Control Personnel contacted? What methods are to be used to— • Repel • Capture • Kill
(f) (5) (iv) Ways to communicate effectively between personnel conducting wildlife control or observing wildlife hazards and the air traffic control tower.	Training in communication procedures Equipment needed Radios, cellular phones, lights
(f) (6) Procedures to review and evaluate the wildlife hazard management plan annually or following an event described in paragraphs (b)(1), (2), and (3) of this section, including:	At a minimum, hold annual meetings, or meet after an event described in 139.337(a)(1–3) with representatives from all airport departments involved in wildlife hazard management efforts and the wildlife damage management biologist who did the original Wildlife Hazard Assessment.
(f) (6) (i) The plans effectiveness in dealing with known wildlife hazards on and in the airport's vicinity and:	Input from all airport departments, Air Traffic Control, and the wildlife biologist as to effectiveness of the plan. Good records are required for evaluating the effectiveness of a program (see Chapter 7).
(f) (6) (ii) Aspects of the wildlife hazards described in the wildlife hazard assessment that should be reevaluated.	For example— • Number of times wildlife seen on AOA. • Requests for wildlife dispersal from air traffic control, pilots, or others. • Increased number of strikes.

14 CFR 139.337	Comments
(f) (7) A training program conducted by a qualified wildlife damage management biologist to provide airport personnel with the knowledge and skills needed to successfully carry out the wildlife hazard management plan required by paragraph (d) of this section.	Training for— • Wildlife control personnel • Other airport personnel • Pesticide user training and certification (See Chapter 8)
(g) FAA Advisory Circulars contain methods and procedures for wildlife hazard management at airports that are acceptable to the Administrator.	AC 150/5200-33A, *Hazardous Wildlife Attractants on or Near Airports*

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Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 1 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Wildlife Hazard Assessment Evaluation			
Elements	Reference 14 CFR 139.337	Complete	Comments
The wildlife hazard assessment ... shall contain at least the following:	(c)		
Analysis of event(s) or circumstances that prompted the assessment.	(c) (1)		
Identification of the wildlife species observed, and	(c) (2)		
description of species numbers,	(c) (2)		
description of species local movements,	(c) (2)		
description of daily occurrences,	(c) (2)		
description of seasonal occurrences.	(c) (2)		
Identification and location of features on and near the airport that attract wildlife.	(c) (3)		
Description of wildlife hazard to air carries operations.	(c) (4)		
Recommendations for mitigation of identified wildlife attractants.	(c) (5)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 2 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Determination of Need for Wildlife Hazard Management Plan			
Elements	Reference 14 CFR 139.337	Complete	Comments
Review of Wildlife Hazard Assessment.	(d)		
Wildlife Hazard Assessment.	(d) (1)		
Actions recommended in WHA.	(d) (2)		
Aeronautical activity.	(d) (3)		
Certificate holder's views.	(d) (4)		
Airport users' views.	(d) (5)		
Other factors.	(d) (6)		
Development of Wildlife Hazard Management Plan to be required by FAA.	Yes	No	
Endangered Species Act, Section 7 consultation needed.	Yes	No	
Letter sent to USFWS.	Yes	No	Date sent
USFWS response received.	Yes	No	Date received
USFWS response forwarded to airport sponsor, if positive.	Yes	No	Date sent
FAA Official making this determination:	Signature		Date

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 3 of 5

Airport Name (LOCID)			
City: State: FAA Region:			
Wildlife Hazard Management Plan Evaluation			
Elements	Reference 14 CFR 139.337	Complete	Comments
The plan shall include at least the following:	(f)		
A list of the individuals having authority and responsibility for implementing each aspect of the plan (Airport and non-airport personnel).	(f) (1)		
A list prioritizing the following actions identified in the wildlife hazard assessment and, target dates for their initiation and completion:	(f) (2)		
Wildlife population management;	(f) (2) (i)		
Habitat modification; and	(f) (2) (ii)		
Land-use changes.	(f) (2) (iii)		
Requirements for and, where applicable, copies of local, state, and federal wildlife control permits (Including pesticide use, where applicable).	(f) (3)		
Identification of resources that the certificate holder will provide to implement the plan.	(f) (4)		
Procedures to be followed during air carrier operations that at a minimum includes:	(f) (5)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 4 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Wildlife Hazard Management Plan Evaluation (Continued)			
Elements	Reference 14 CFR 139.337	Complete	Comments
Designation of personnel responsible for implementing the procedures;	(f) (5) (i)		
Provisions to conduct physical inspections of the aircraft movement areas and other areas critical to successfully manage known wildlife hazards before air carrier operations begin;	(f) (5) (ii)		
Wildlife hazard control measures; and	(f) (5) (iii)		
Ways to communicate effectively between personnel conducting wildlife control or observing wildlife hazards and the air traffic control tower.	(f) (5) (iv)		
Procedures to review and evaluate the wildlife hazard management plan annually or following an event described in paragraphs (b)(1), (2), and (3) of this section, including:	(f) (6)		
The plans effectiveness in dealing with known wildlife hazards on and in the airport's vicinity and:	(f) (6) (1)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 5 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Wildlife Hazard Management Plan Evaluation (Continued)			
Elements	Reference 14 CFR 139.337	Complete	Comments
Aspects of the wildlife hazards described in the wildlife hazard assessment that should be reevaluated.	(f) (6) (ii)		
A training program conducted by a qualified wildlife damage management biologist to provide airport personnel with the knowledge and skills needed to successfully carry out the wildlife hazard management plan required by paragraph (d) of this section.	(f) (7)		
FAA Advisory Circulars contain methods and procedures for wildlife hazard management at airports that are acceptable to the Administrator.	(g)		
Section 7 Consultation completed with USFWS.	Yes	No	Date completed
NEPA coordination.	Yes	No	
Categorical exclusion.	Yes	No	
EA/EIS required.	Yes	No	
Wildlife Hazard Management Plan approved by:			
	Signature		Date

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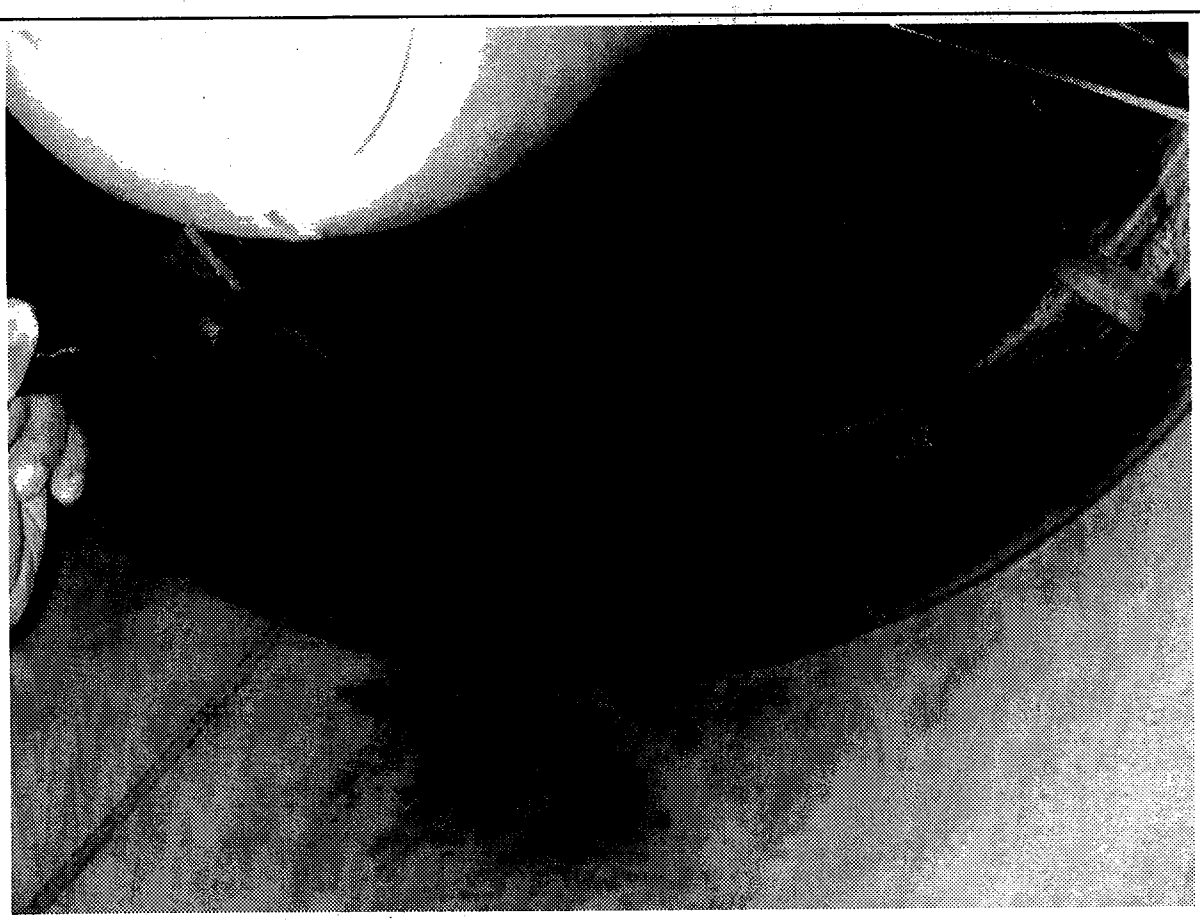
CHAPTER 7:
EVALUATING WILDLIFE HAZARD MANAGEMENT PROGRAMS AT AIRPORTS



This engine suffered major damage after ingesting a large bird on departure from a midwestern USA airport. A UV emitting "black light" flashlight can be useful in detecting organic remains from birds in the engine.

7.1 INTRODUCTION

Wildlife populations on and in the vicinity of airports are constantly changing in response to changes in land use, state and federal management policies, and environmental factors. In addition, wildlife might adapt or habituate to control strategies that were once effective, or they might develop new behavioral or feeding patterns on or near the airport. New wildlife control technologies might become available, or established products or techniques might be withdrawn or banned. Finally, there might be changes in wildlife control and management personnel at an airport. Once a Wildlife Hazard Management Plan is in place, develop a process to evaluate the plan at least annually.

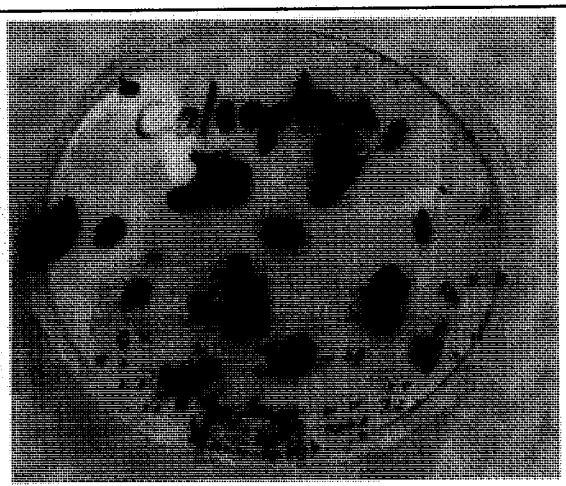
Update the plan as needed, based on the annual evaluation (14 CFR 139.337 [f][6]). This chapter outlines a means of conducting such evaluations.

7.2 MONITORING AND RECORD KEEPING

The importance of accurate monitoring and record keeping cannot be overemphasized. Without consistently maintained records of wildlife activity, wildlife strikes, and wildlife management actions, the proper evaluation of a program is impossible. Without evaluation, no assessment of the effectiveness of a program can be made. Furthermore, without accurate records and proper evaluation, it might be difficult to justify and defend certain management actions, such as wildlife removal, or to defend the airport during litigation in the aftermath of a damaging wildlife strike (see Appendix N).

7.2.A HAZARD ASSESSMENTS, PLANS, AND STUDIES

As discussed in Chapter 8, to facilitate access and reduce losses, keep all reference books, such as wildlife field guides, videos, posters, and other training and educational materials, in a specific location. For ready reference, have copies of Wildlife Hazard Assessments, Wildlife Hazard Management Plans, and other relevant wildlife studies conducted at the airport available at this site. Ideally, locate the wildlife library at the site where information on wildlife control activities and wildlife strikes is entered into logs, files, and databases.



Sweep nets can be used to monitor and identify insect populations, such as Japanese beetles, that attract gulls and other birds to an airport so pesticide applications and other control strategies can be implemented in a timely manner (photos by T. W. Seamans, USDA).

7.2.B DAILY LOG OF WILDLIFE CONTROL ACTIVITIES

Maintain a daily log of wildlife activity and management actions; important factors to record include—

- Date, time, and location on airport where wildlife is observed.
- Species of wildlife and approximate numbers.

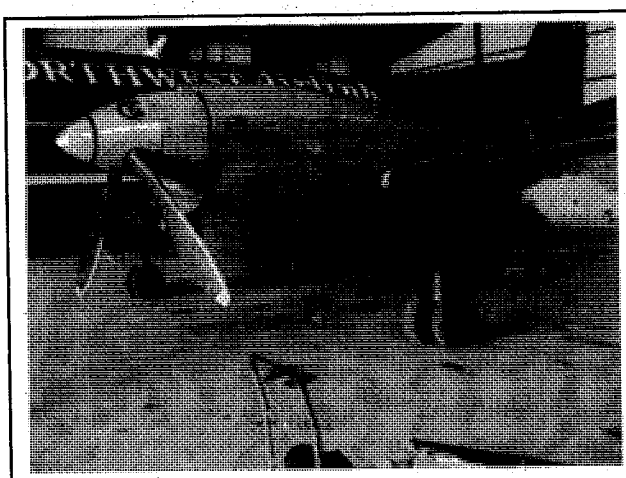
- Control actions taken and response of wildlife.

Record this information on a standard form (see Table 7-1 for an example of a daily log form) that can be used by wildlife control personnel at the site where the activity takes place. If a form is not available, record the information in a log book kept at the operations base.

The use of a standardized form or recording format, such as that presented in Table 7-1, is strongly recommended. The information recorded will be most useful if it is summarized into monthly and annual statistics (see below). Use of a standardized format allows this summarization to be easily done. The use of computerized database systems customized to provide summaries of wildlife control activities is recommended.

7.2.C DAILY LOG OF WILDLIFE STRIKES

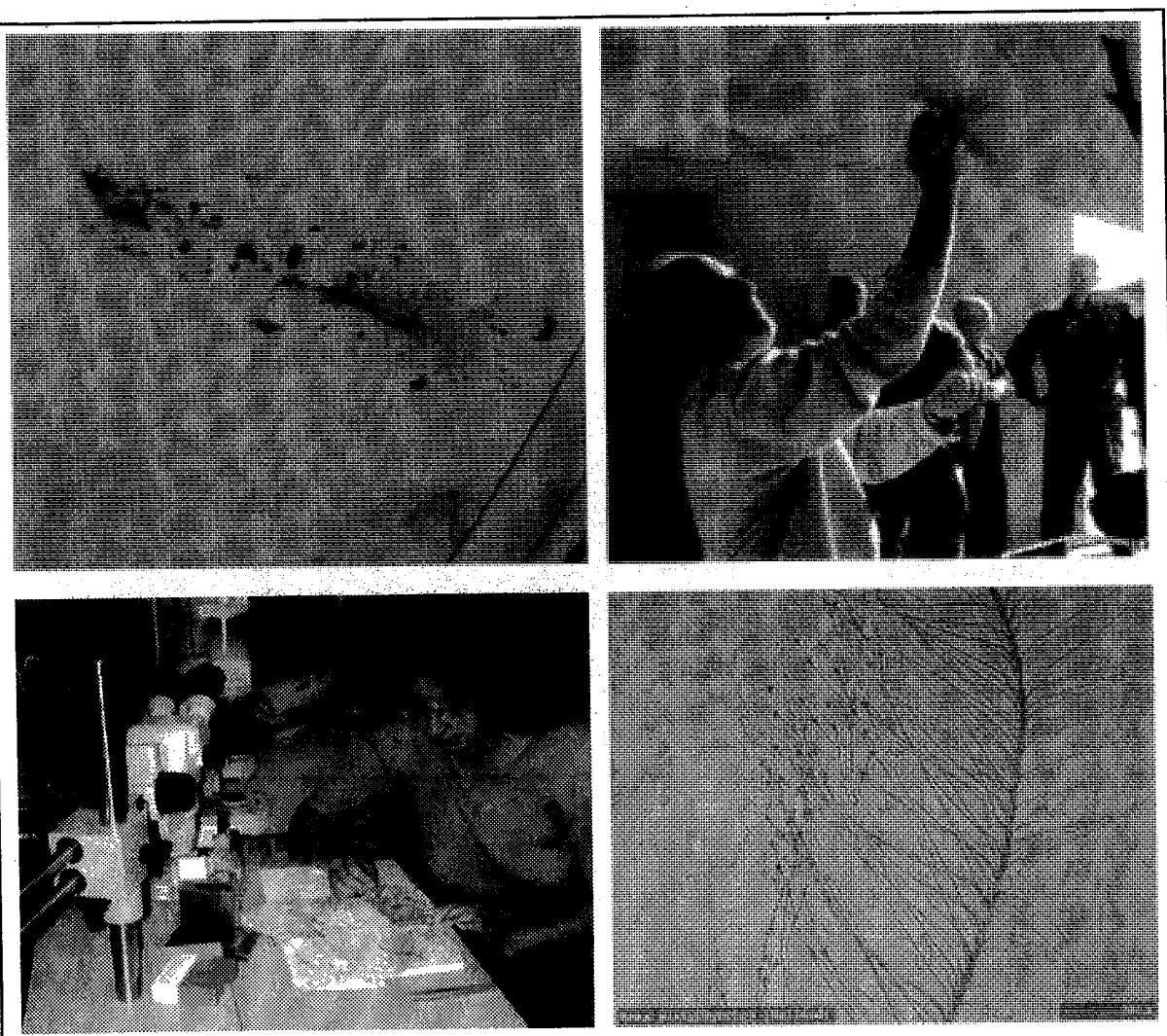
Maintaining a consistent record of wildlife strikes is essential for defining the wildlife hazard level for an airport and for evaluating the airport's Wildlife Hazard Management Plan. In addition to maintaining these strike records for internal use at the airport, surface-mail (using FAA Form 5200-7) or electronically submit strike reports to the FAA (http://wildlife.mitigation.tc.faa.gov). The FAA will incorporate the information into the National Wildlife Strike Database (Chapter 2).



This Saab 340 hit a deer on landing at a Midwest USA airport in April 2000, ripping the engine from its mountings (photo courtesy Northwest Airlines).

As defined in the glossary, a wildlife strike has occurred when—

1. A pilot reports striking one or more birds or other wildlife;
2. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;
3. Personnel on the ground report seeing an aircraft strike one or more birds or other wildlife;
4. Bird or other wildlife remains are found within 200 feet of the centerline of a runway, unless another reason for the animal's death is identified;
5. The animal's presence on the airport had a significant negative effect on a flight (e.g., aborted takeoff or landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal).



Top Left. Bird strike remains on an aircraft. **Top Right.** Strike remains being collected. (Smithsonian feather identification specialists refer to the collected material as "snarge.") **Lower Left.** Smithsonian feather identification specialist preparing snarge to identify the bird. **Lower Right.** Micrograph of a downy feather recovered from the snarge. The feather belongs to a mallard (photos by: Top – M. Begier, USDA; Bottom – C. Dove, Smithsonian Institution).

Record each strike event under categories 1-3 or 5 (reported strike) on FAA Form 5200-7 (Appendix I) and mail (the form is pre-addressed and franked on the back side) or transmit electronically to the FAA. Send photocopies of the form that do not have the address and frank on the back to—

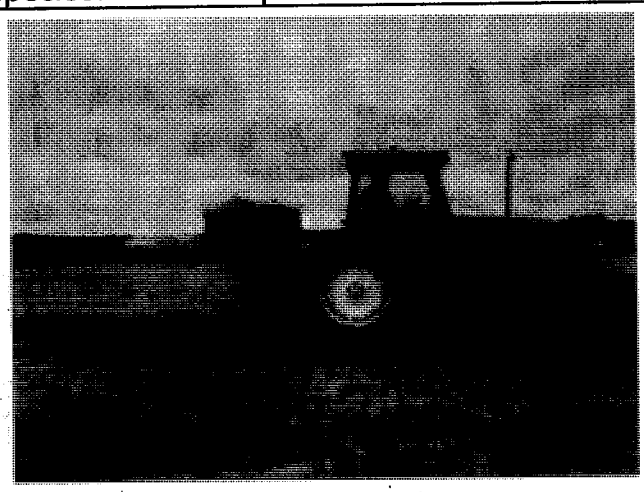
Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
Washington, DC 20591

Copies of this form (with the address and frank) can be downloaded and printed from http://wildlife-mitigation.tc.faa.gov. The form also can be filled out and filed electronically at this site.

When filling out Form 5200-7, include as much of the information requested as is available. Typically, not all information requested on the form will be available or known, but the report is valuable even if some information is missing.

For category 4 strikes (wildlife remains found but no report of strike), a log of these incidents should be maintained with the date, location, number, and species of animals struck recorded (Table 7-2). A copy of this log should also be mailed monthly to the FAA at the above address, or these strikes should be reported individually on FAA Form 5200-7 with a notation that a carcass was found but no strike was reported.

For all strike reports, make every effort to have the wildlife correctly identified to species. Freeze specimens that cannot be readily identified in a labeled bag until a local wildlife expert can be consulted. If only feather remains are available, mail them to the Smithsonian Institution Feather Lab for identification (see instructions and address in Chapter 2, and in Advisory Circular 150/5200-32A *Reporting Wildlife Aircraft Strikes*, Appendix C). There is no charge for this identification service. Please include a copy of the strike report or other relevant information with the bird remains to assist the feather experts in identifying the bird.



One approach to controlling rodent populations at airports is the periodic treatment of grass areas with zinc phosphide-treated bait. The application must be under the supervision of a person certified in vertebrate pest control (Photo by R. A. Dolbeer, USDA).

7.2.D RECORDS OF SIGNIFICANT MANAGEMENT ACTIONS TAKEN

In addition to maintaining a daily log of wildlife control activities and wildlife strikes, it is important to keep records of other preventative management actions that might not be part of the daily routine of wildlife control. Examples of such actions might be installing or repairing fencing, thinning trees, clearing construction debris, applying pesticides or repellents, conducting grass-height management, installing netting in hangers or wires over ponds, and regrading pavement or grass areas to eliminate standing water. In addition, activities such as writing letters to catering services about proper storage of food waste are also important management actions. Documenting these activities in some type of summary file or table can aid in determining the total cost and effectiveness of the wildlife control program.

7.2.E SUMMARY REPORTS BY MONTH AND YEAR

Periodically summarize information from the Daily Wildlife Control Activities log and from wildlife strikes records to provide baseline data for analyzing and evaluating the

wildlife control program. A logical approach is to conduct monthly summaries that are then incorporated into an annual report. These summaries do not need to be complex but must reflect the level of activity for the common control techniques deployed. For example, monthly summaries of pyrotechnics fired, runway sweeps to clear birds, distress call deployments, birds and mammals removed by species, and wildlife strikes by species would be useful (Table 7-3). Prepare a short paragraph outlining other significant activities during the month, such as repairing a fence, meetings with airport tenants about wildlife issues (e.g., feeding birds in taxi stand area), or regrading an area to remove standing water. Prepare an annual report (Table 7-4) by combining data from the monthly reports. It is emphasized that Tables 7-3 and 7-4 are only presented as examples to provide guidance in developing a format to summarize data. A particular airport might use methods not listed in Tables 7-3 and 7-4, such as falconry, radio-controlled model airplanes, dogs, or propane cannons. The important point is that there must be an objective, numerical documentation of wildlife control methods deployed and wildlife strikes occurring on the airport. The use of a computer database program can be extremely helpful in producing these summary reports.

All airport management, as well as airport operations and maintenance personnel, need a basic understanding of wildlife aircraft strike issues on their airport. Specialized courses in managing wildlife hazards at airports, taught by recognized experts, provide a practical way of doing this. The FAA and USDA/WS can provide this type of training (photo by C. Steves, FAA).

7.2.F TRAINING

Maintain and annually summarize a record of all training that wildlife control personnel have received. Include attendance at conferences, courses and workshops (e.g., firearms safety), self-study courses, and specialized on-the-job training.

7.3 ASSESSMENT OF WILDLIFE HAZARD MANAGEMENT PLAN

All FAA approved Wildlife Hazard Management Plans must be reviewed at least annually or following an event that would normally trigger a Wildlife Hazard Assessment (see 14 CFR 139.337 (b)(1-4) and 139.337 (f)(6)). The review must include: the plan's effectiveness in dealing with known wildlife hazards on and in the vicinity of the airport, and aspects of the wildlife hazards described in the Wildlife Hazard Assessment that should be reevaluated (14 CFR 139.337 (f)(6)). The wildlife damage management biologist that helped prepare the plan and a sub-group from the Airport's Wildlife Hazard Working Group should conduct this review.

Appendix K describes a simple system (modified from Seubert 1994) for assessing a Wildlife Hazard Management Plan at an airport. Five assessment categories are used to indicate the adequacy of a Wildlife Hazard Management Plan and how well the plan is being implemented:

Category 1. Management functions related to wildlife hazards on or in the vicinity of the airport.

Category 2. Bird control on or in the vicinity of the airport.

Category 3. Mammal control on or in the vicinity of the airport.

Category 4. Management of habitat and food sources on airport property related to wildlife hazards.

Category 5. Land uses and food sources off of the airport potentially related to wildlife hazards on airport.

Within Categories 1-4 (activities on the airport), a series of elements are listed that are evaluated as either "Satisfactory", "Unsatisfactory", "Needs Improvement", or "Not Applicable". For Category 5 (off-airport attractants), the elements are scored on a scale of 0 (not present) to 3 (site creates significant wildlife hazard for airport; action should be taken). Those elements deemed "Unsatisfactory" or "Needs Improvement" (in Categories 1-4) or that are scored 2 or 3 (in Category 5) are then commented on in a summary form. The elements listed within each category are not intended to cover every possibility at every airport. The elements can be modified or expanded to meet situations unique to an airport.

Wetlands on airport provide both habitat and food for wildlife. Such areas can be eliminated through wetland mitigation programs (photo by E. Cleary, FAA).

7.4 AIRPORT WILDLIFE HAZARDS WORKING GROUP

7.4.A FUNCTION

Wildlife hazard management on an airport often requires communication, cooperation, and coordination among various groups on the airport and with various local, state, and federal agencies and private entities. For many airports, the establishment of a Wildlife Hazards Working Group (WHWG) will greatly facilitate this communication, cooperation, and coordination.

7.4.B MEMBERSHIP

Include a representative from each of the key groups and agencies that have a significant involvement or interest in wildlife issues on the airport in the WHWG. Airport groups might include representatives from security, maintenance, operations, and air traffic control. From government, representatives from the state wildlife agency, the U.S. Fish and Wildlife Service and USDA/WS might be appropriate. Include representatives from any facility near the airport that significantly attracts wildlife (such

as a landfill or wildlife refuge).

In general, do not exceed 10 people in the core WHWG. This will keep meetings from becoming unwieldy. In addition to regular members, invite people with specialized knowledge, interest, or concerns to the meetings as appropriate. Typically, someone from airport management chairs the WHWG. The chair can be rotated among various airport departments.

Airports should establish a Wildlife Hazards Working Group (WHWG) that meets at least annually to facilitate communication, cooperation, and coordination among the various agencies and airport departments. The WHWG also provides a forum to review and update the airport's Wildlife Hazard Management Plan (photo by R. A. Dolbeer, USDA).

7.4.C MEETINGS

At least annually hold a meeting of the WHWG to conduct a general review of the overall wildlife hazard management program for the airport and to discuss special issues or problems as needed. Include the following in the general discussion:

- Strike trends and significant strike events (based on data summarized using formats in Tables 7-3 and 7-4).
- Source of wildlife causing strike problems.
- Wildlife control activities (based on data and commentary summarized using formats in Tables 7-3 and 7-4.
- Wildlife Hazard Management Plan evaluation (based on most recent assessment using format in Appendix K).

Special issues to be discussed might include projected impacts of land-use changes on or near the airport, trends in populations or behavior of various species of wildlife, wildlife removal permits, evaluation of new wildlife control technologies, and clarification of roles and responsibilities. A good way to end the meeting might be with a field demonstration of a wildlife management activity on the airport or a site visit to a nearby wildlife attractant (e.g., sewage treatment facility) that might need addressing.

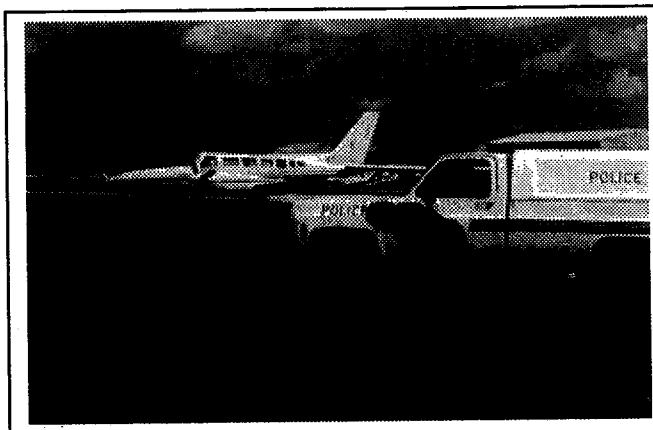
Special meetings of the entire WHWG or a subgroup might be needed after significant strike events or other developments affecting wildlife hazards if a regular meeting is not scheduled for the near future.

7.4.D MEETING REPORTS

Make arrangements to have minutes taken and a summary report written for each meeting. Include in the report a list of attendees, decisions made by the group, deadlines and responsible parties for task assignments, and a list of critical issues that were not resolved.

7.5 SUMMARY AND CONCLUSIONS

Periodic evaluations of an airport's Wildlife Hazard Management Plan and the activities undertaken to implement the plan are critical because of the dynamic nature of wildlife hazards and control technologies. The foundation for these evaluations is the maintenance of consistent records of wildlife control activities and wildlife strikes. The use of standardized formats for keeping these records, such as those presented in Tables 7-1 to 7-4, permits easy compilation of events and activities into monthly and annual statistical and narrative summaries. Once these summaries are available, objective examinations and comparisons can be made of trends in strikes, wildlife activities, control methods deployed, and other factors.



All wildlife carcasses found during aircraft movement area inspections should be removed immediately. Unless another reason for the animal's death can be determined, the incident should be reported as a wildlife strike and recorded in the airport's wildlife strike database (photo courtesy USDA).

An objective, standardized format for assessing a Wildlife Hazard Management Plan and its implementation is presented in Appendix K. This format allows an outside biologist or evaluation group to systematically review the actions being taken and make recommendations in areas where improvement is needed. The availability of summary statistics, such as provided through records maintained in Tables 7-1 to 7-4, is essential for this assessment.

Finally, the establishment of a WHWG provides an excellent means of improving communication, coordination, and cooperation among the diverse groups involved in wildlife hazard management on an airport. The WHWG also can provide an important forum for reviewing, evaluating, and improving an airport's wildlife hazard management program.

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Table 7-1. Example of a daily log of wildlife control activities.

Airport					Month	Year	
		Location (Grid)	Wildlife		Control method	Results/comments	Initials
Date	Time		Species	No.			

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Table 7-2. Example of a Wildlife Strike Log for recording bird or other wildlife remains found within 200 feet of runway centerline that, in the judgment of wildlife control personnel, were killed as a result of interacting with an aircraft.

Airport				Month		Year
Date	Time found	Species	Runway	Location on runway	Was strike reported[1]?	Comments

[1]If strike was reported, complete FAA Form 5200-7.

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Table 7-3. Example of a form to provide monthly summary of wildlife control activities.

Airport			Month	Year
Control activity (modify list as appropriate)	This month	Same month last year	Comments (list wildlife dispersed or removed by species and method)	
No. of pyrotechnics fired				
No. of times distress calls deployed				
No. of runway sweeps to clear birds				
No. of wildlife removed				
Miles driven by wildlife patrol				
No. of reported strikes				
No. of reported strikes with damage				
No. of carcasses found (no strike reported)				

Summary paragraph of other wildlife control activities:

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Table 7-4. Example of a form to provide annual summary of wildlife control activities derived from monthly reports (Table 7-3). Modify each airport's form to reflect the common control activities undertaken during the year. The data may also be presented graphically.

Airport				Year					
	Number of:								
Month	Pyro-technics fired	Times distress calls deployed	Runway sweeps to clear birds	Wildlife dispersed	Wildlife removed[1]	Miles driven by wildlife patrol	Reported strikes[2]	Reported strikes with damage	Carcasses found (no strike reported)[2]
Jan									
Feb									
Mar									
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Total									

[1]Provide separate list by species and method.

[2]Provide separate list by species.

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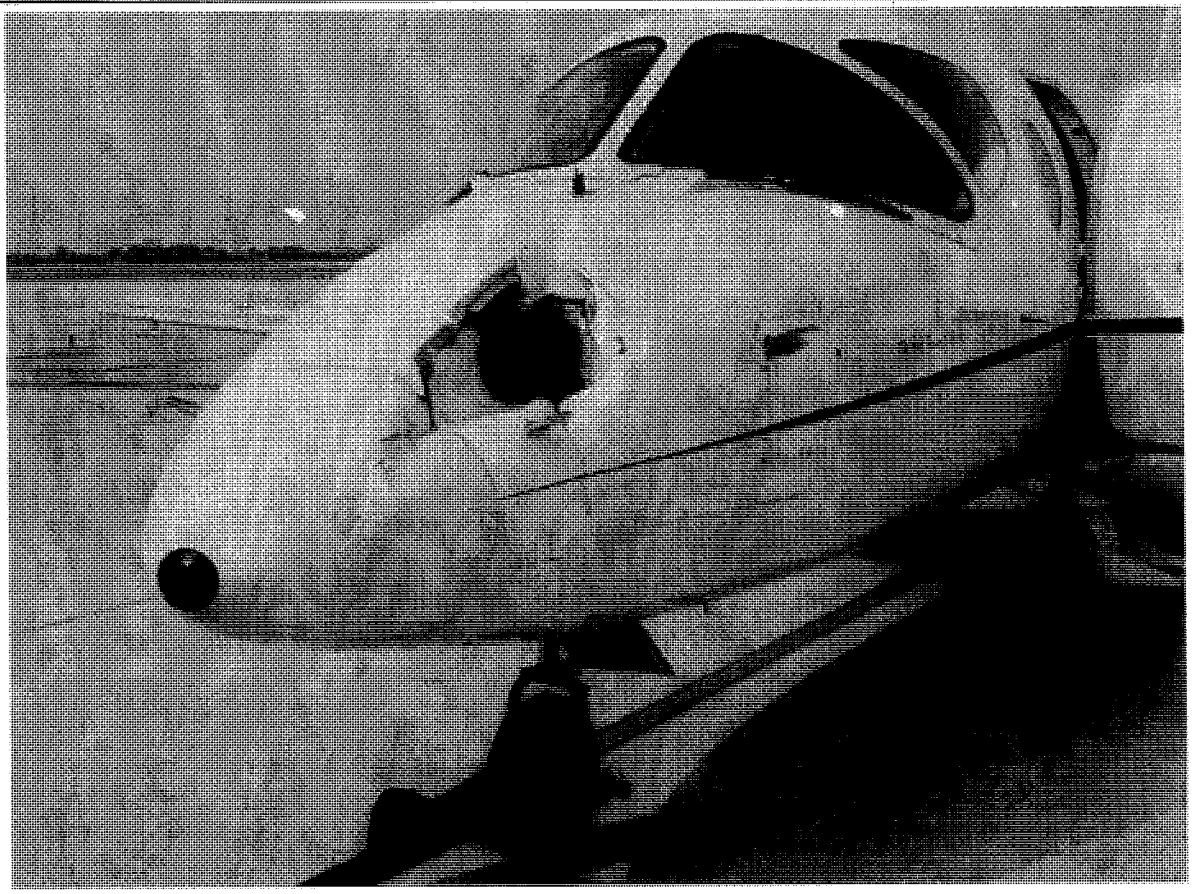
CHAPTER 8:
WILDLIFE HAZARD MANAGEMENT TRAINING FOR AIRPORT PERSONNEL



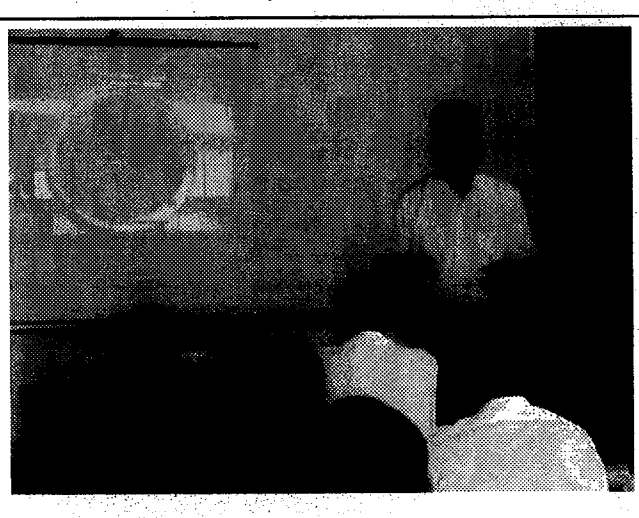
Populations of most bird species weighing over 4 pounds have increased dramatically in the USA since 1980. These large birds can cause substantial damage when struck by aircraft (photo courtesy USAF).

8.1 INTRODUCTION

The management of wildlife is a complex endeavor that often attracts public interest. Once an assessment of hazards has been completed and a Wildlife Hazard Management Plan has been developed, the plan must be implemented by well-trained and knowledgeable individuals if it is to be successful in reducing wildlife strikes and accepted by the public.

Depending on the size of an airport and the level of wildlife hazard, the Wildlife Hazard Management Plan may be implemented by a single airport employee undertaking wildlife control activities on an occasional "as needed" basis or by a full-time wildlife biologist with a staff of operations personnel providing continuous bird patrols.

Some of the personnel involved in these control activities, hereafter referred to as wildlife control personnel (WCP), might not have formal education in wildlife biology. All WCP must have sufficient training to be knowledgeable in the basic principles of wildlife management and in the identification, behavior, general life history, and legal status of the hazardous species in the area. WCP also must be trained in the proper implementation or deployment of various control strategies and techniques outlined in the Wildlife Hazard Management Plan. Finally, an awareness of endangered and threatened wildlife species that might visit or reside on the airport is critical.



Training, provided by recognized experts, should include classroom instruction, fieldwork, and attendance at conferences, such as Bird Strike Committee USA/Canada (photo by C. Steves, FAA).

8.2 TRAINING

The following areas of training and levels of skill are suggested for WCP implementing control activities on airports under a Wildlife Hazard Management Plan. It is emphasized that, once a plan is in place, in addition to the training provided to WCP, there must be periodic oversight and review of the plan and its implementation by a professional biologist trained in wildlife damage control (14 CFR 139.337 (f)(7)).

8.2.A BIRD IDENTIFICATION

There are over 600 species of birds that reside in or migrate through the USA. Many of these species, such as gulls, have quite different plumage patterns and bill colors as subadults (year of hatching up to 3 years in some species) than as adults (as an example, see Appendix J for a fact sheet on North American gulls). Some birds, such as laughing gulls, European starlings, and black-bellied plovers, have different summer and winter plumage patterns and bill colors. In other species, such as northern harriers and red-winged blackbirds, males and females appear quite different. Some species are present in an area all year, others only in migration (spring, fall), and others only in winter or in summer. All species have unique vocalizations, behaviors, and habitat preferences that are useful in field identification. Thus, to become an expert in field identification of all bird species at a location requires many years of training and practice. WCP require basic training so they can identify, in all plumages, commonly seen hazardous birds, as well as those rarer species that are considered hazardous when present or are of concern because of endangered- or threatened-species status. Table 8-1 provides a list of the relative hazard of various species groups based on the percent of reported strikes that cause damage or an effect-on-flight.

Table 8-1. Ranking of 25 species groups as to relative hazard to aircraft (1=most hazardous) based on three criteria (damage, major damage, and effect-on-flight), a composite ranking based on all three rankings, and a relative hazard score. Data were derived from the FAA National Wildlife Strike Database, January 1990–April 2003[1].

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

[1] Excerpted from the *Special Report for the FAA, Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003.* Refer to this report for additional explanations of criteria and method of ranking.

[2] Aircraft incurred at least some damage (destroyed, substantial, minor, or unknown) from strike.

[3] Aircraft incurred damage or structural failure that adversely affected the structure strength, performance, or flight characteristics and that would normally require major repair or replacement of the affected component, or the damage sustained makes it inadvisable to restore aircraft to airworthy condition.

[4] Aborted takeoff, engine shutdown, precautionary landing, or other.

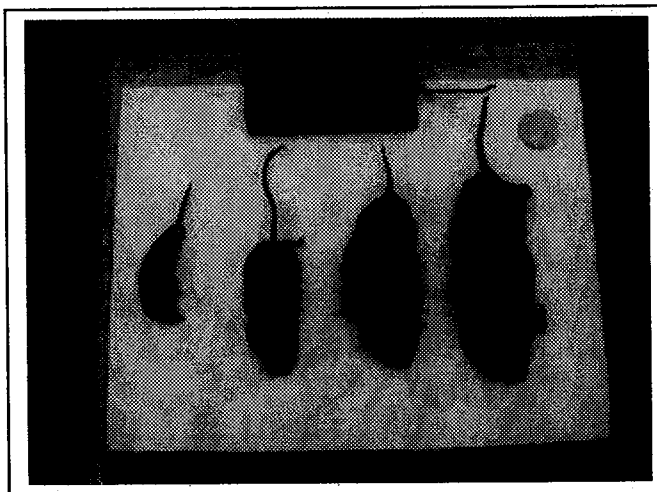
[5] Relative rank of each species group was compared with every other group for the three variables, placing the species group with the greatest hazard rank for $\geq$ 2 of the 3 variables above the next highest ranked group, then proceeding down the list.

[6] Percentage values, from Tables 3 and 4 in Footnote 1 of the *Special Report*, for the three criteria were summed and scaled down from 100, with 100 as the score for the species group with the maximum summed values and the greatest potential hazard to aircraft.

Binoculars are essential for detailed, close-up observations sometimes necessary for identification as well as for the detection and identification of birds or other wildlife at a distance. Provide WCP with a quality pair of binoculars, and train WCP in their use.

Equip each WCP with his or her own bird identification field guide, to be carried in the vehicle while on patrol. As a learning aid, encourage WCP to make annotations in their field guides regarding behavior or appearance next to identified birds.

There are a number of excellent field guides available from bookstores, some of which are listed at the end of this chapter. There are also bird identification guides available on CDs that provide useful life history information and vocalizations.



Grass areas at airports often contain several species of small mammals that are an attractive food for hawks, owl, herons, and egrets. Vagrant shrews, deer mice, gray-tailed voles, and Townsend's voles (left to right) were all captured during one night of trapping at a western USA airport in September 2003 (photo by R. A. Dolbeer, USDA).

8.2.B MAMMAL IDENTIFICATION

Unlike birds, there are typically only a few mammal species of importance on an airport. Train WCP to identify, not only by sight but also by sign (e.g., tracks, burrows, and fecal material), the common large and mid-sized mammals (e.g., deer, raccoons, woodchucks, coyotes) that live around the airport. Train WCP to identify signs (e.g., trails in grass, burrows) indicative of a population eruption of field rodents, such as voles, deer mice, or rats. A survey by a biologist using snap traps might be necessary to identify the species and relative abundance of rodents occupying various airport habitats. In addition, rodent species can be identified by examination of skull remains in pellets (boluses) regurgitated by hawks and owls. These pellets are often found on the ground beneath perching sites used by raptors.

Citations for field guides covering mammals and their tracks throughout the USA are provided at the end of this chapter. In addition, there are many state and regional field guides for identifying mammals and their signs. A good field guide to mammals is a necessary part of any airport's hazardous wildlife control library.

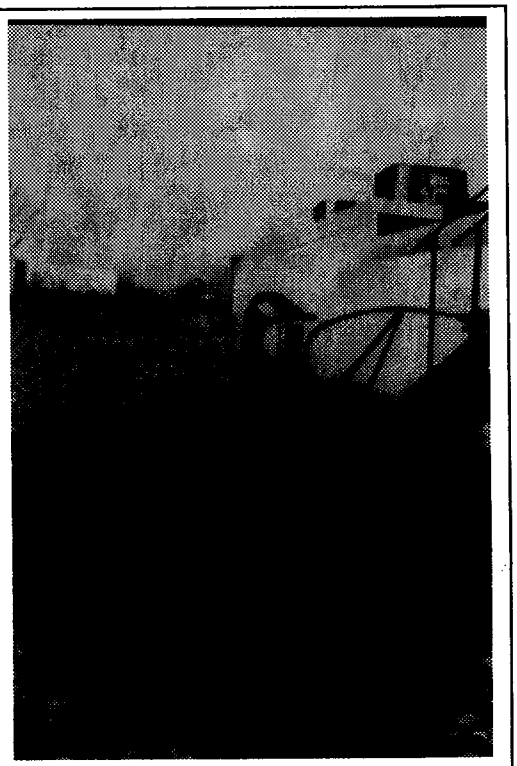
8.2.C BASIC LIFE HISTORIES AND BEHAVIOR OF COMMON SPECIES

In addition to learning to identify the hazardous birds and mammals on the airport, WCP should have some understanding of the biology and behavior of these species. This information will make the job of wildlife hazard management more interesting and be useful in anticipating problems and deploying control measures more effectively.

For each species of bird, it is important to know if it is present year round or only in summer, in winter, or during migration. For example, in which habitats and at what time

of year do locally breeding bird species nest and when are young fledged from nests? What are the daily movement patterns between roosting, feeding and loafing areas in relation to the airport? What are the feeding behaviors and food preferences of each species on the airport? Which habitats does each species prefer? How does weather influence the presence and behavior of various species on the airport? How does each species react to approaching aircraft and to various repellent devices? By being observant and noting the behavior of these hazardous species, useful insights can be gained that will lead to more effective habitat management or repellent strategies.

Most bird and mammal field guides provide information on geographic range, feeding habits, and habitat preferences for each species. Alsop (2001), Sibley (2001), and Ehrlich et al. (1988) provide concise summaries of life history information (nesting, feeding, habitat preferences) for most birds in North America. Appendix J provides some life history facts for various gull species in the USA. Such books and fact sheets provide an excellent starting point for knowledge about a species. However, the most useful information will come from careful observation of what the birds and mammals are doing on your airport.



Canada geese have adapted to nesting on rooftops, often well away from water (photo courtesy USDA).

8.2.D WILDLIFE AND ENVIRONMENTAL LAWS AND REGULATIONS

As presented in Chapter 4, there is a complexity of federal and state laws protecting wildlife and regulating the issuance of permits to take (capture or kill) individuals causing problems. In addition, environmental laws and regulations regarding pesticide applications, drainage of wetlands, and endangered species must be considered in implementing Wildlife Hazard Management Plans. All WCP should have a basic understanding of the federal Migratory Bird Treaty Act (MBTA) whereby almost all native migratory birds are protected regardless of their abundance (see Chapter 4). WCP must understand that federal and often state permits must be issued before protected species can be taken on an airport. WCP must know that wild mammals are regulated at the state level, which may require permits for activities involving removal (killing or trapping/relocating). Non-native birds, such as pigeons, house sparrows, and starlings, and gallinaceous game birds, such as turkeys, grouse, and pheasants, are not protected by the MBTA but often have state protection. WCP involved in taking any wildlife species must have a clear understanding of which species have no legal protection and, for all others, the species and numbers allowed to be taken under permits issued. Permits also will list the methods of removal allowed and acceptable procedures for disposing of removed wildlife. Detailed records must be maintained of wildlife taken under permit.

8.2.E WILDLIFE CONTROL TECHNIQUES

Chapter 9 provides a brief description of most wildlife control techniques used on airports. WCP will need training to deploy these techniques safely and effectively.

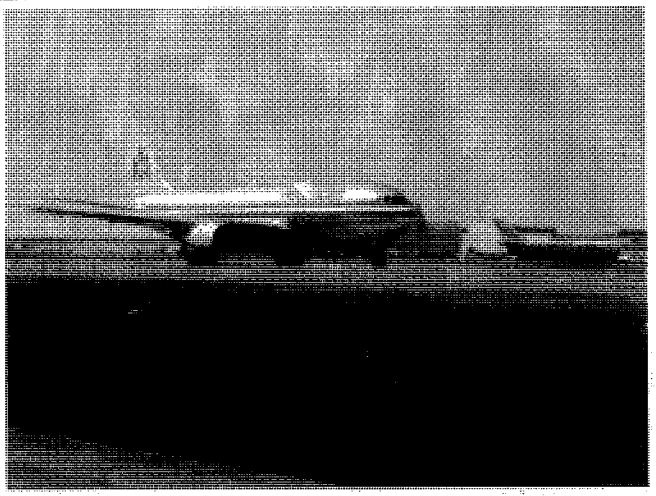
The use of pyrotechnics, such as cracker shells fired from a 12-gauge shotgun (left) or screamers fired from a pistol launcher, should be part of an airport's integrated management program to disperse hazardous birds. Occasional lethal control by shooting might be necessary to reinforce pyrotechnics and other nonlethal dispersal techniques used against common species such as gulls and Canada geese. Permits and proper training must be in place before lethal control is implemented (photos by R. A. Dolbeer, USDA).

Firearms. It is critical that only personnel trained in the use of firearms, authorized under depredation permit, and knowledgeable in field identification of the target and similar-looking non-target species are allowed to use firearms on the airport. Skill, experience, and the proper equipment are needed to be safe and to maximize the effectiveness of a shooting program, whether it is to remove specific problem animals or to kill one or more individuals to reinforce repellent techniques. All discharged shell casings are potential Foreign Object Debris (FOD) and must be picked up.

Pyrotechnics. Pyrotechnics can cause injury or damage if discharged incorrectly or carelessly. For example, serious injuries have occurred when pyrotechnics were accidentally discharged inside vehicles. Proper equipment (safety glasses, ear protection) and training is essential for safe use of pyrotechnics. In addition, training is needed to deploy the correct pyrotechnic for each situation and wildlife species and to minimize habituation. It is critical that pyrotechnics (and other repellent devices) not be deployed in situations where the birds or mammals might be flushed into the path of departing or arriving aircraft.

Pesticide application. WCP applying restricted-use pesticides, applying pesticides for hire, or applying pesticides to the land of another must be Certified Applicators or

working under the direct supervision of a Certified Applicator and then may only use pesticides covered by the Certified Applicator's certification. Proper application equipment and safety clothing must be used. Detailed records of pesticide applications must be maintained.



Propane cannons can be used as part of an integrated program to disperse birds from airports. However, birds quickly habituate to the loud bangs if the cannons are used continuously and not integrated with other frightening devices (photo by R. A. Dolbeer, USDA).

For information on the training requirements for becoming a Certified Pesticide Applicator, contact the State University Cooperative Extension Service.

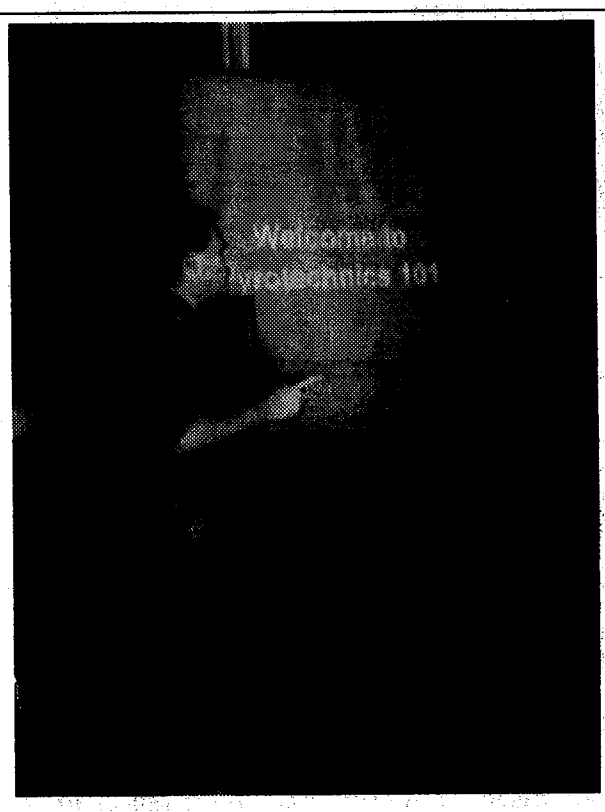
Distress call tapes, propane cannons, and miscellaneous techniques. As emphasized in Chapter 9, a major problem in the use of repellent techniques or devices is habituation of the wildlife species to the threats. These techniques all require training for their proper deployment. The most critical factor for most repellent devices is that they be deployed sparingly and appropriately when the target wildlife is present and be reinforced occasionally by a real threat such as shooting. More detailed information on the use of various repellent devices is presented in Chapter 9 and Hygnstrom et al. (1994).

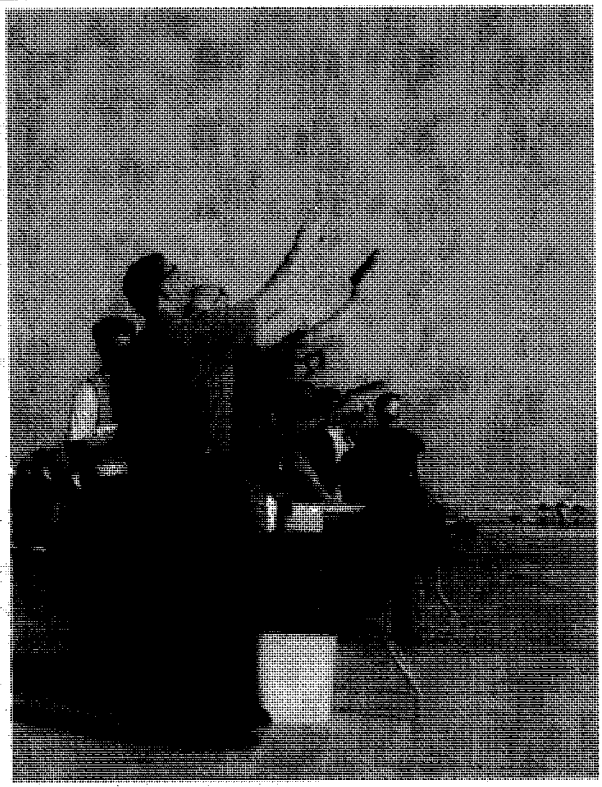
8.2.F RECORD KEEPING AND STRIKE REPORTING

A key component of a Wildlife Hazard Management Plan is developing a system to (1) document the daily activities of WCP, (2) log information about wildlife numbers and behavior on the airport, and (3) record all wildlife strikes with aircraft. This information is essential to document the effort being made by the airport in reducing wildlife hazards. The information is also extremely useful during periodic evaluations of the Wildlife Hazard Management Plan and when revisions to the plan are proposed. Instruct WCP on the importance of record keeping and train them to record this information in a standardized format. Chapter 7 provides more details about record keeping and wildlife strike reporting.

8.3 SOURCES OF TRAINING

Wildlife control workshops at airports. Books, manuals, and videos can provide a starting point for building skills to manage hazardous wildlife on airports. However, hands-on training is essential to develop the necessary skills and confidence to successfully and safely carry out wildlife control activities. Workshops on airport wildlife control offered by the USDA/WS or other entities are an excellent means of obtaining training in wildlife identification, legal issues, and the deployment of various control techniques specific for a given airport or region of the country. These workshops can be held for all WCP at a single airport or at a centralized airport with participants coming from airports throughout the state or region.





A special classroom and field training program in the proper and safe use of pyrotechnics to disperse birds was provided at the 2002 and 2004 meetings of Bird Strike Committee–USA/Canada (photos by R. DeFusco).

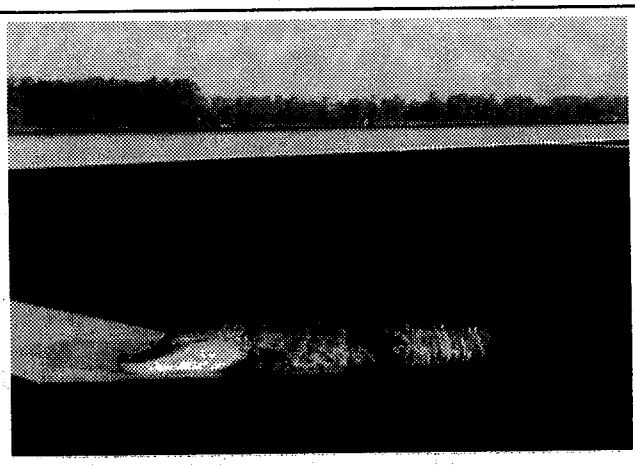
Contact the Wildlife Services office in your state (Appendix A) for more information.

Bird Strike Committee USA meetings. Bird Strike Committee–USA (BSC–-USA) holds joint meetings annually with Bird Strike Committee Canada at a USA or Canadian airport. This annual meeting provides an excellent forum to discuss the latest issues and techniques in wildlife control for airports. The meeting includes a field trip to the host airport with demonstrations by vendors and wildlife specialists of various wildlife

control equipment and techniques. Chapter 3 provides more information on BSC–USA. Information on annual meetings, as well as information on various aspects of wildlife hazard management for airports, can be found at BSC–USA's web site: www.birdstrike.org.

Hunter safety and firearms courses. Require airport personnel who will be using firearms to complete a hunter safety or firearms safety course. The state wildlife agency can provide information on these courses.

Miscellaneous courses and activities. Many universities and some community colleges offer courses in ornithology, principles of wildlife management, principles of wildlife damage control, or other related topics. Local Audubon Society chapters or park districts sometimes offer workshops or short courses in field identification of birds. Participation in conservation organization activities, such as Christmas Bird Counts and spring migration counts, is an excellent means of building bird identification skills and developing contacts with local wildlife experts.



Birds and mammals are not the only wildlife groups that can cause problems on airports. This 7-foot alligator wandered onto the runway at a southern USA airport in September 2002, threatening both aircraft and personnel. The alligator was relocated unharmed. For the 14-year period 1990–2003, reports of 15 alligator-aircraft strikes with civil aircraft were received by the FAA (photo by J. Metcalf).

8.4 WILDLIFE HAZARD MANAGEMENT LIBRARY

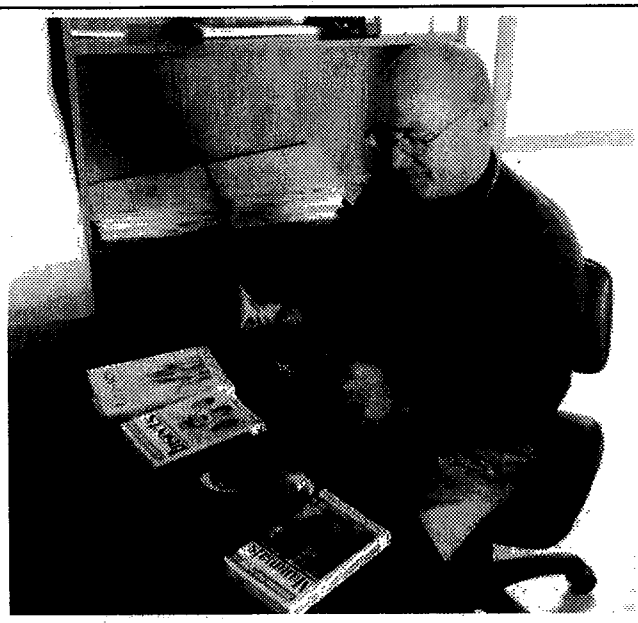
Establish a designated location for reference books, such as wildlife field guides, videos, posters, and other training and educational materials and the airport's Wildlife Hazard Management Plan if one has been developed. Ideally, locate this wildlife library at the site where information on wildlife control activities and wildlife strikes is entered into logs, files, and databases.

8.5 FIELD GUIDES AND REFERENCE BOOKS

There are many excellent field guides and reference books for learning about wildlife. To provide examples, a selection of books that cover North America or large regions of the USA is listed below. This list is not intended as an endorsement of these books to the exclusion of others. There are also many field guides for individual states and specialized books for various wildlife species or species groups.

Field Guides–Birds

Bull, J., J. Farrand, Jr., and, L. Hogan. 1994. *National Audubon Society field guide to North American birds: Eastern region.* Alfred Knopf, New York, New York. 796 pages. 2nd edition.



Airports should maintain a small library of field guides that can be referenced by biologists and operations personnel to identify and learn about birds, mammals, plants, and insects found on the airport. These field guides should be located with the Wildlife Hazard Management Plan and other related documents (photo by B. Washburn, USDA).

National Geographic Society. 2002. *Field guide to the birds of North America.* National Geographic Society, Washington, District of Columbia. 480 pages. 4th edition.

Griggs, J. L. 1997. *All the birds of North America: American Bird Conservancy's field guide.* Harper Collins, New York, New York. 172 pages.

Peterson, R. T. 1998. *A field guide to the birds: a completely new guide to all the birds of Eastern and Central North America.* Houghton Mifflin Company, New York, New York. 384 pages. 4th edition.

Peterson, R. T. 1990. *A field guide to Western birds: a completely new guide to field marks of all species found in North America west of the 100th meridian and north of Mexico.* Houghton Mifflin Company, New York, New York. 431 pages. Reissue edition.

Robbins, C. S., B. Bruun, and H. S. Zim. 1983. *Birds of North America.* Golden Press, New York, New York. 360 pages.

Field Guides - Mammals

Burt, W. H., and R. P. Grossenheider. 1998. *A field guide to the mammals: North America north of Mexico.* Houghton Mifflin Company, New York, New York. 3rd edition. 289 pages.

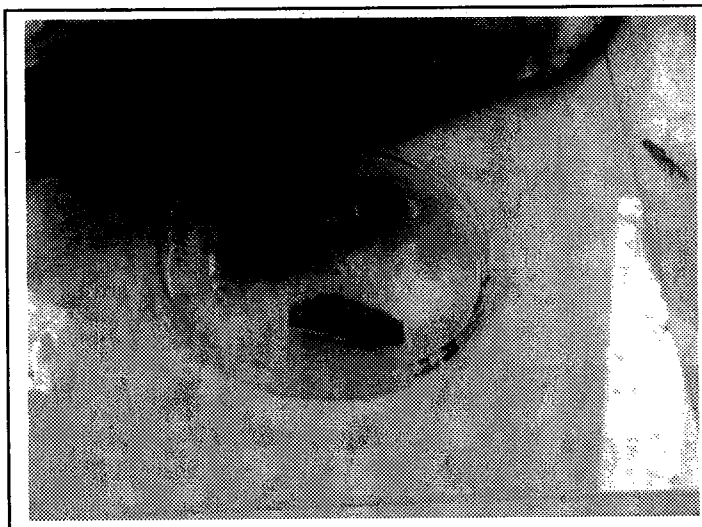
National Audubon Society. 2000. N*ational Audubon Society field guide to North American mammals* (revised and expanded). Alfred Knopf, New York, New York. 937 pages.

Elbroch, M. 2003. *Mammal tracks and sign: A guide to North American species.* Stackpole Books, Mechanicsburg, Pennsylvania. 792 pages.

Murie, O. J. 1954. *A field guide to animal tracks.* Houghton Mifflin Company, New York, New York. 374 pages.

Life Histories

Alsop, F. J., III. 2001. *Birds of North America, Eastern Region* (751 pages), *Western Region* (752 pages). DK Publishing, Inc., New York, New York.



An examination of the stomach contents of aircraft-struck birds found on runways can often identify food sources that are attracting the birds to the airport. A chicken neck and undigested French-fried potato found in this laughing gull stomach indicated a nearby source of uncovered garbage (photo by G. E. Bernhardt, USDA).

Ehrlich. P. R., D. S. Dobkin, and D. Wheye. 1988. *The birder's handbook: a field guide to the natural history of North American birds, including all species that regularly breed north of Mexico.* Simon and Schuster, New York. 785 pages.

Chapman, J. A., and G. A. Feldhamer (editors). 1982. *Wild mammals of North America.* Johns Hopkins University Press, Baltimore, Maryland. 1,147 pages.

Sibley, D. A. 1991. *The Sibley guide to bird life and behavior.* Alfred A. Knopf, New York, New York. 580 pages.

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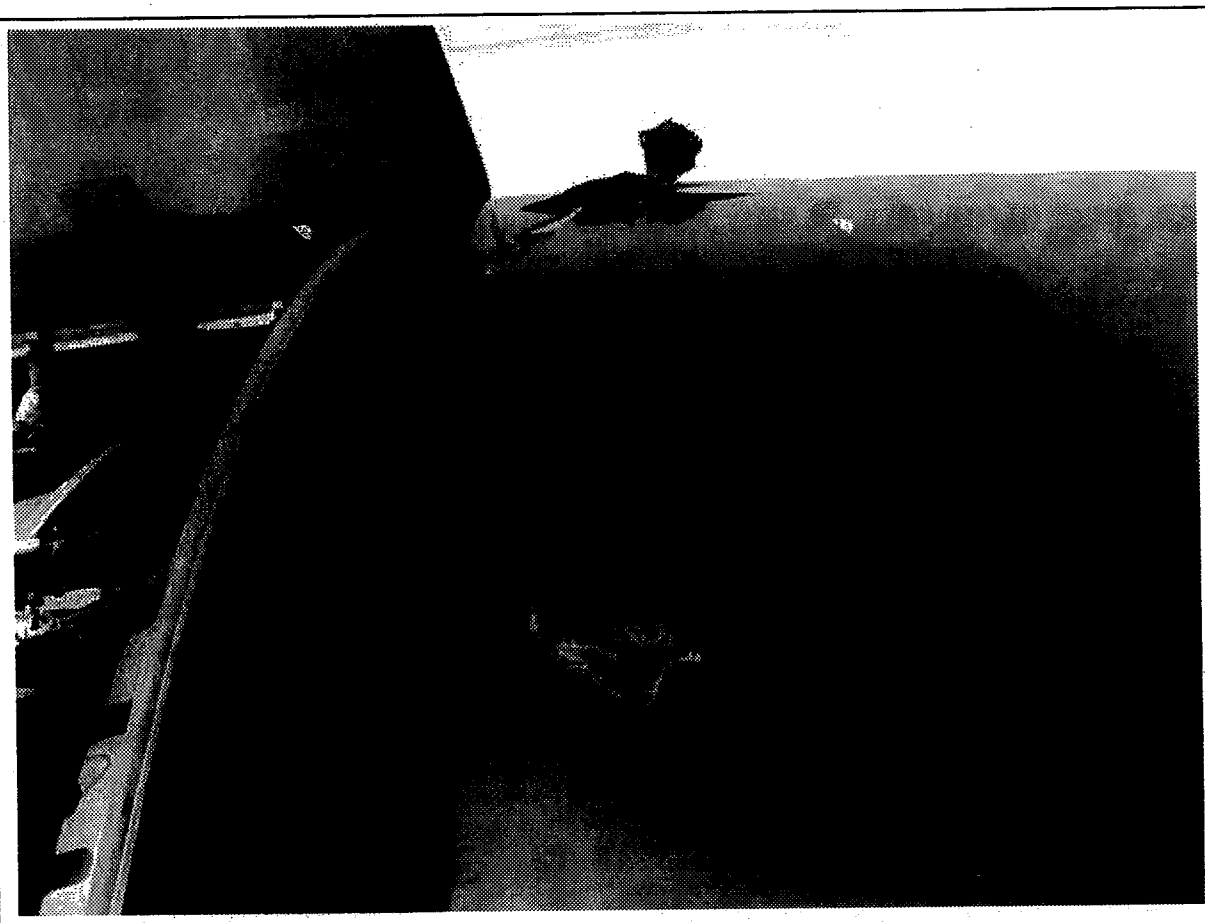
CHAPTER 9:
WILDLIFE CONTROL STRATEGIES AND TECHNIQUES AT AIRPORTS



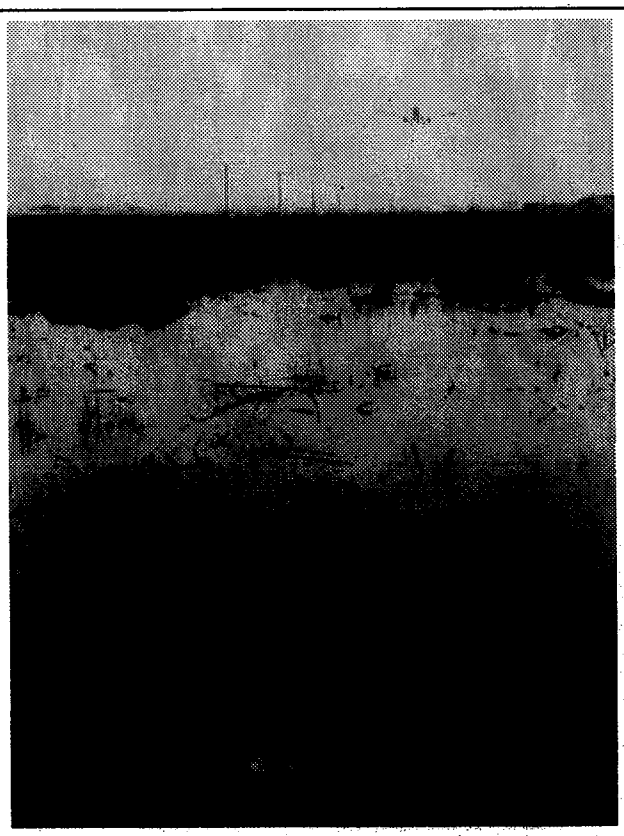
A B-767 departing an east coast USA airport in October 2002 ingested at least one double-crested cormorant into the #2 engine. Parts of the engine broke loose and penetrated the engine casing, resulting in an uncontained engine failure. The strike also damaged the landing light and leading edge of the right wing. The cormorant population increased at an annual rate of 7% in the USA from 1980–2004.

9.1 INTRODUCTION

No airport or aircraft type is immune from the hazards of wildlife strikes. Many species of birds and mammals have been involved in damaging strikes (Chapter 2). A flock of starlings suddenly rising from the ground, a lone kestrel hovering in search of prey, a pair of Canada geese taking flight after grazing in the infield, or a deer bounding across a runway—all can result in significant aircraft damage or in extreme cases, a crash and loss of human lives. In addition to strikes, wildlife that are roosting, nesting, or burrowing on airports can cause structural damage to buildings, equipment, and aircraft as well as nuisance and health problems for workers and passengers.

As discussed in Chapters 5 and 6 about the conduct of Wildlife Hazard Assessments and development of Wildlife Hazard Management Plans, the first step in solving any wildlife damage problem is to answer the following nine questions for each species:

1. What are the wildlife doing that make the control of their numbers or damage necessary? The type of activity that needs to be controlled will determine both the severity of the problem and the type of control methods used.



There should be zero tolerance for nesting by Canada geese and other large birds at airports. Permits should be in place so any nests discovered can be destroyed immediately and adult nesting birds dispersed or removed (photo by R. White, USDA).

2. Which species of wildlife are causing the problem? Accurate identification of the exact species is critical because different species often require different management techniques.
3. Why are the wildlife on the airport? Are they attracted to the airport for food, water, or shelter; or are they just flying over the airport from nighttime roosting sites to daytime feeding sites? The answer to this question will determine, to a large extent, the most appropriate control methods to use.
4. What are the daily and seasonal movement patterns of the wildlife among feeding, loafing, and roosting/nesting areas? Try to identify the times of day and seasons of year, as well as locations on airport, where the wildlife pose the most critical threat to aviation safety and where they are most vulnerable to management actions.
5. What is the legal status at the federal, state, and local levels of the problem species? All wildlife species are not afforded equal legal protection by all levels of government.
6. What effective and legal management methods are available? In wildlife hazard management, effective and legal are not necessarily synonymous.
7. How selective are these control methods? The objective is to control only the target wildlife, not every species in the area.
8. How much will it cost to apply the selected control methods? The cost of control might dictate which methods are practical, given the seriousness of the threat caused by the species.

9. What are public attitudes toward the problem wildlife species and the hazards that these species pose? Public opinion also may influence the type of management actions taken.

Elimination of wildlife habitat and attractants on or near airports will reduce wildlife strikes. Exposed I beams, such as used in the canopy over the passenger pick-up area at a Midwestern USA airport, make ideal roosting habitat for flocks of European starlings (photo by R. White, USDA).

This chapter presents the overall approach to be taken when managing wildlife hazards on airports. Once the overall approach is established, the chapter outlines the strengths and weaknesses of various wildlife control methods recommended for use on airports, as well as certain methods that should not be used. This chapter is not the final word on this subject. Wildlife damage control is a dynamic field, and new products, technologies, and innovations are continuously being introduced. In addition, changes in the legal status of control techniques, chemical registrations, and wildlife species occur at the federal and state level. Thus, this chapter is only a starting point for information on wildlife control techniques.

It is recommended that this chapter be used in conjunction with the two-volume manual *Prevention and Control of Wildlife Damage* published in 1994 by Cooperative Extension, University of Nebraska at Lincoln (see full citation at end of this chapter). This manual, written by various experts in the field of wildlife damage control, provides detailed information on the techniques, equipment, chemical registrations, species-specific management recommendations, and sources of supply for the various control strategies presented in this chapter. This manual is also available online in a periodically updated version at: ianrwww.unl.edu/wildlife/solutions/handbook/.

9.2 WILDLIFE CONTROL STRATEGIES

Four basic control strategies are available to solve wildlife problems on airports:

1. Aircraft flight schedule modification;
2. Habitat modification and exclusion;
3. Repellent and harassment techniques; and
4. Wildlife removal.

Integrate all four control strategies into the Wildlife Hazard Management Plan as appropriate.

9.2.A AIRCRAFT FLIGHT SCHEDULE MODIFICATION

Although not generally practical for regularly scheduled commercial traffic on larger airports, there may be various situations when flight schedules of some aircraft can be adjusted to minimize the chance of a strike with a wildlife species that has a predictable pattern of movement. For example, pilots could be advised not to depart during a 20-minute period at sunrise or sunset during winter when large flocks of blackbirds cross an airport going to and from an off-airport roosting site. In situations such as at Midway Atoll where albatrosses and other seabirds are abundant during parts of the year, scheduling nighttime arrivals and departures, when birds are not flying, might be the only means of avoiding strikes. Finally, air traffic controllers on occasion might need to temporarily close a runway with unusually high bird activity or a large mammal (e.g., deer) incursion until wildlife control personnel can disperse the animals.

Poles and other structures that are no longer in use should be removed from airport property. Such structures make ideal perching sites for hawks and owls searching for prey. The pellets at the base of this pole are undigested fur and bones of rodents that were regurgitated by red-tailed hawks (photo by R. A. Dolbeer, USDA).

9.2.B HABITAT MODIFICATION AND EXCLUSION

Habitat modification means changing the environment to make it less attractive or inaccessible to the problem wildlife. All wildlife require food, cover, and water to survive. Any action that reduces, eliminates, or excludes one or more of these elements will result in a proportional reduction in the wildlife population at the airport. Habitat modifications to make the airport and surrounding area as unattractive as possible to hazardous wildlife must be the foundation of every airport's Wildlife Hazard Management Plan.

Initially, management actions to reduce food, cover, and water on an airport might be expensive. However, when costs are amortized over several years, these actions might be the least expensive approach to reducing wildlife populations on the airport. Once a habitat modification is done correctly, it is generally not necessary to go back and do it again. Also, these control methods are generally well accepted by the public and minimize the need to harass or kill wildlife on the airport.

9.2.B.I FOOD

Some of the more common urban food sources for birds on and near airports include handouts from people in taxi stands and parks, grain elevators, feed mills, sewer treatment plants, and improperly stored food waste around grocery stores, restaurants, and catering services. Rural food sources attractive to birds include sanitary landfills, feedlots, certain agricultural crops (especially cereal grains and sunflower), and spilled grain along road and rail rights-of-way.

Be aware of food attractants for birds that exist on and in proximity to the airport. On the airport, require bird-proof storage of food waste, prohibit bird feeding, and promote good sanitation and litter control programs.

Gulls and other birds concentrate at locations where people regularly provide food such as bread and seeds. Feeding birds should be prohibited on and in the vicinity of airports (photo by R. White, USDA).

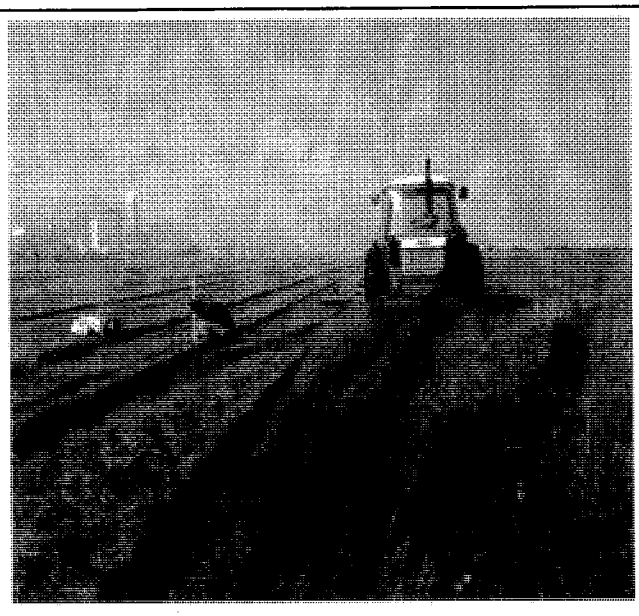
Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, the FAA recommends against the use of airport property for agricultural production, including hay crops, within the separations identified in Chapter 5, § 5.2. If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport must follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 19 (see Appendix C). Weigh the cost of wildlife control and potential accidents against the income produced by the on-airport crops when deciding whether to allow crops on the airport (AC 150/5200-33A) (see Chapter 5 and Appendix C). For nearby off-airport areas, work closely with local governmental entities and landowners to discourage land-use practices and activities that provide food sources for problem bird species.

Do not use trees and other landscaping plants for the street side of airports that produce fruits or seeds attractive to birds. On airside areas, the large expanses of grass and forbs can sometimes provide ideal habitat for rodent and insect populations that attract raptors, gulls, other bird species, and mammalian predators such as coyotes. In addition, grasses allowed to produce seed heads can provide a desirable food source for doves, blackbirds, and other flocking species. The management of airside vegetation to minimize rodents, insects, and seeds might be complex, requiring insecticide, herbicide, and rodenticide applications; changes in vegetation cover; and adjustments in mowing schedules (e.g., mowing at night to minimize bird feeding on insects exposed by the mowing). Such management plans will need to be developed in conjunction with professional wildlife biologists and horticulturists knowledgeable with the local wildlife populations, vegetation, and growing conditions (see below).

9.2.B.II COVER

All wildlife require cover for resting, roosting, escape, and reproduction. Non-migratory Canada geese in urban areas, left undisturbed, will establish territories on corporate lawns, golf courses, and even building roofs associated with nearby ponds. Pigeons, house sparrows, and European starlings use building ledges, abandoned buildings, open girders and bridge work, and dense vegetation for cover. Blackbirds use marsh

vegetation, such as cattails, for nesting and roosting. Many bird problems can be solved by eliminating availability of such areas either through removal or by exclusion.



The maintenance of monotypic, uniform stands of tall (e.g., 10-inch) grass is difficult and expensive at most airports, requiring fertilizer, herbicides, and water (photo by R. A. Dolbeer, USDA).

Take care when selecting and spacing plants for airport landscaping. Avoid plants that produce fruits and seeds desired by birds. Also avoid the creation of areas of dense cover for roosting, especially by European starlings and blackbirds. Thinning the canopy of trees, or selectively removing trees to increase their spacing, can help eliminate bird roosts that form in trees on airports.

The management of an airport's airside ground cover to minimize bird activity is a controversial subject in North America. The general recommendation, based on studies in England in the 1960s and 1970s, has been to maintain a monoculture of grass at a height of 6-10 inches (Transport Canada) or 7-14 inches (U.S. Air Force). Tall grass, by interfering with visibility and ground movements, is thought to discourage many species of birds from loafing and feeding. However, the limited studies conducted in North America have not provided a consensus of opinion on the utility of tall-grass management for airports. For example, Canada geese do not appear to be discouraged by tall grass. In addition, maintenance of tall grass can result in increased rodent populations, a food source for raptors. Finally, maintenance of monotypic, uniform stands of tall grass is difficult and expensive on many airports because of varying soil conditions and the need for fertilizer and herbicide applications. Arid regions in the western USA cannot maintain tall grass without irrigation.

A promising approach to reducing wildlife attraction to airport ground cover, irrespective of the height, is the use of vegetation that is undesirable or mildly toxic to wildlife. For example, there are varieties of fescue grass that contain fungal endophytes. Some of these endophytes are unpalatable to grazing birds, such as geese, as well as to rodents and deer. These endophytic grasses might also support fewer insect numbers. Other ground cover, such as wedelia or Bermuda grass, might be appropriate for subtropical airfields. Finally, artificial (synthetic) turf in selected areas might be useful in providing a more sterile environment for wildlife at airports.

Until more research is completed, no general guidelines on grass height or vegetation type for airside ground cover will be made. See Appendix O, Summary of Studies on Vegetation Management for North American Airfields, for a literature review of the current state of knowledge on airport grass management. Consult with professional

wildlife hazard management biologists and horticulturists to develop a vegetation type and mowing schedule appropriate for the growing conditions and wildlife at the location. The main principles to follow are to use a vegetation cover and mowing regime that do not result in a build-up of rodent numbers or the production of seeds, forage, or insects desired by birds.

Finally, dense stands of trees and undergrowth on airport property can provide excellent cover for deer, coyotes, nesting geese and raptors, roosting blackbirds, rodents, and other wildlife. In general, clear or at least sufficiently thin these habitats to eliminate the desired cover and to allow easy visual and physical access by wildlife control personnel. Remove all unnecessary posts, fences, and other structures that can be used as perches by raptors and other birds. Piles of construction debris and discarded equipment, unmowed fence rows, and other unmanaged areas are not only esthetically unpleasing but typically provide excellent cover for commensal rodents (rats and house mice) and den sites for woodchucks, feral dogs and coyotes. Eliminate such areas on airports.

Standing water is a strong attractant to waterfowl, gulls, and wading birds such as egrets and herons. Airport managers should strive to eliminate all standing water (photo by R. A. Dolbeer, USDA).

9.2.B.III WATER

Water acts as a magnet for birds; therefore, eliminate all standing water on an airport to the greatest extent possible. Fill or modify to allow rapid drainage of depressions in paved and vegetated areas, and disturbed areas at construction sites that accumulate standing water after rain. This is particularly important at coastal airports where fresh water is highly attractive to birds for drinking and bathing. Do not establish retention ponds, open drainage ditches, outdoor fountains and other wetland sites on or adjacent to airports.

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

When it is not possible to drain a large detention pond completely, use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. Evaluate the use of physical barriers and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139

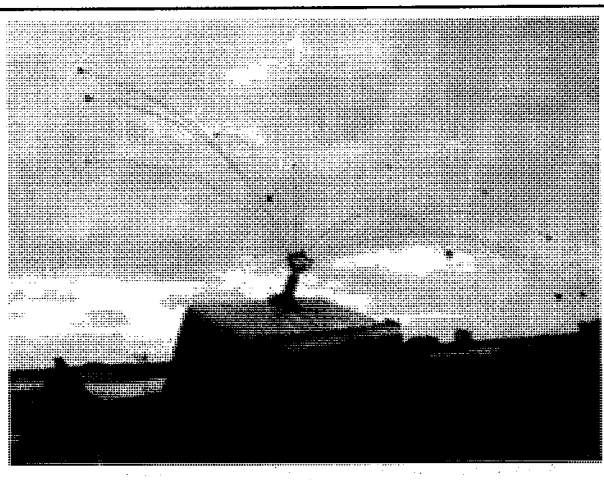
certificated airports, obtain approval from the appropriate FAA Regional Airports Division Office.

Birds are permanently excluded from this storm water detention facility through the use of a floating permeable barrier (Photo courtesy Industrial & Environmental Concepts, Inc.).

Encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into their operating practices when the facility is located within the separation criteria specified in AC 150/15200-33A (see 5-2 above and Appendix C).

9.2.B.IV EXCLUSION TECHNIQUES

If food, water, or cover cannot be eliminated by habitat modification, then actions can sometimes be taken to exclude the wildlife from the desired resource. Exclusion involves the use of physical barriers to deny wildlife access to a particular area. As with habitat modification, exclusion techniques, such as installing a covered drainage ditch instead of an open ditch, can initially be costly. However, exclusion provides a permanent solution that is not only environmentally friendly, but when amortized over many years, might actually be the least expensive solution.



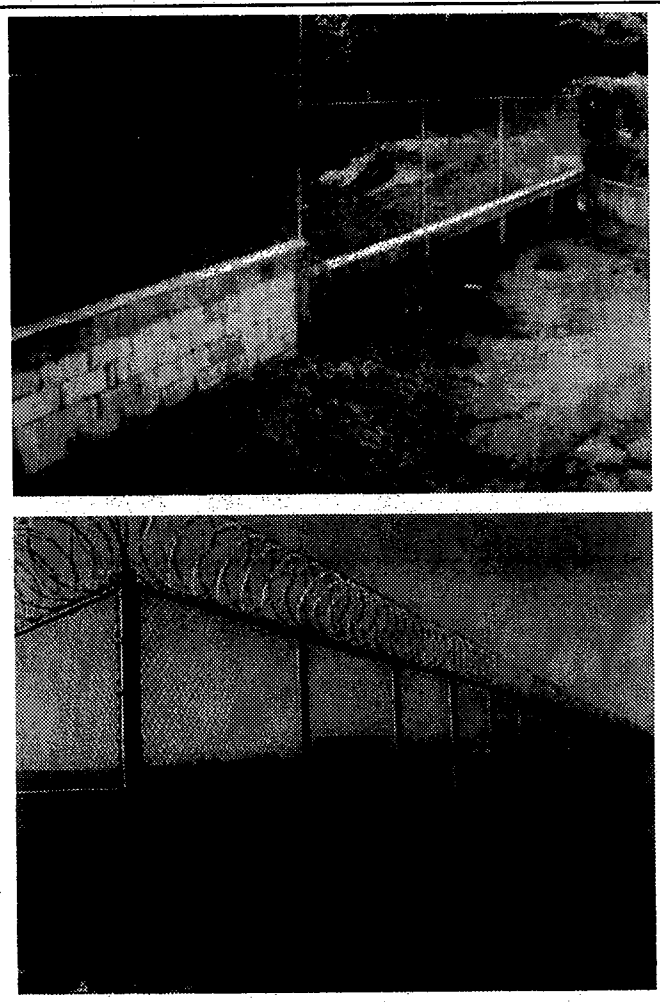
Light posts and other structures in taxicab lots at airports can be fitted with anti-perching devices to discourage gulls and other birds from using the area. Feeding of birds should also be prohibited on airport property.

9.2.B.IV.A EXCLUSION OF BIRDS

Architects should consult biologists during the design phase of buildings, hangers, bridges, and other structures at airports to minimize exposed areas that birds can use for perching and nesting. For example, tubular steel beams are much less attractive as perching sites for starlings and pigeons than are I-beams. If desirable perching sites are present in older structures, access to these sites (such as rafter and girded areas in hangers, warehouses, and under bridges) often can be eliminated with netting. Curtains made of heavy-duty plastic sheeting, cut into 12-inch strips, and hung in warehouse or hanger doorways, can discourage birds from entering these openings. Anti-perching devices, such as spikes, can be installed on ledges, roof peaks, rafters, signs, posts, and other roosting and perching areas to keep certain birds from using them. Changing the angle of building ledges to 45 degrees or

more will deter birds. However, it is emphasized that incorporating bird exclusion or deterrence into the design of structures is the most effective, long-term solution.

Gull and waterfowl use of retention ponds and drainage ditches can be reduced with over-head wire systems. A system of wires spaced 10 feet apart or in a 10- x 10-foot grid will discourage most gulls and waterfowl from landing. Similar wire systems have been successfully used to keep gulls off roofs and out of landfills and crows out of electrical substations. When it is desirable to eliminate all bird use, netting can be installed over small ponds and similar areas. However, birds are sometimes tangled in the netting and maintenance problems arise with high winds and freezing weather. Complete coverage of ponds with plastic, 3-inch diameter "bird balls" or floating mats will completely exclude birds and yet allow evaporation of water. Designing ponds with steep slopes will discourage wading birds such as herons. Use of culverts to totally cover water in drainage ditches is recommended whenever possible.



A well-maintained fence, at least 10-feet high with no gaps at the bottom, is the primary defense to keep deer and other large animals off of the AOA at airports. Gates must also be close-fitting, and water drains under the fence must be equipped with exclusion devices (top photo by E. Cleary, FAA).

9.2.B.IV.B EXCLUSION OF MAMMALS

Institute a "zero tolerance" policy for deer, livestock, and other large mammals in the AOA because of their severe threat to aviation safety (see Table 8-1). The best, albeit most costly, procedure for excluding these animals off the AOA is proper fencing. The FAA recommends a 10-12 foot chain link fence with 3-strand barbed wire outriggers. In some cases, an airport might be able to use an 8-foot chain link fence with 3-strand barbed outriggers, depending on the amount of deer activity in the area (see Certalert No. 04-16, Appendix E). A 4-foot skirt of chain-link fence material, attached to the bottom of the fence and buried at a 45° angle on the outside of the fence will prevent animals from digging under the fence and reduce the chance of washouts. This type of fencing also greatly increases airport security. There are also numerous electric-fence designs for excluding deer, discussed in Hygnstrom et al. (1994), that are not as costly as permanent fencing but have drawbacks in safety

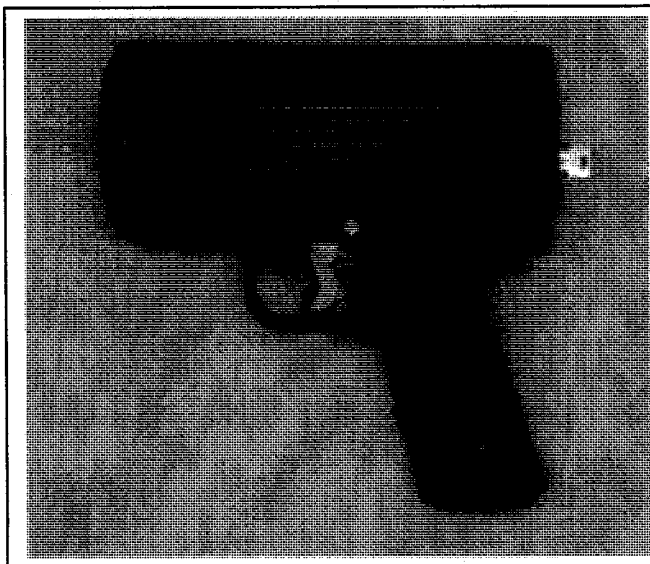
and maintenance.

Properly install and maintain all fencing. Keep the fence line right-of-way free of excess vegetation. Patrol the fence line at least daily, and fix any washouts, breaks, or other holes in the fence as soon as they are discovered. Take immediate action to remove any deer or other large mammals observed on or near the AOA.

Cattle Guards are widely used to prevent hoofed livestock from traversing across fenced areas through permanent openings maintained for vehicular access. These devices, if at least 15 feet in length perpendicular to the fence, will prevent deer from entering through gated areas on airports.

9.2.c REPELLENT TECHNIQUES

Repellent and harassment techniques are designed to make the area or resource desired by wildlife unattractive or to make the wildlife uncomfortable or fearful. Long term, the cost-effectiveness of repelling wildlife usually does not compare favorably with habitat modification or exclusion techniques. No matter how many times wildlife are driven from an area that attracts them, they or other individuals of their species will return as long as the attractant is accessible. However, habitat modifications and exclusion techniques will never completely rid an airport of problem wildlife; therefore, repellent techniques are a key component of any wildlife hazard management plan.



Under low-light conditions, specially designed lasers can be effective in dispersing geese, cormorants, and other bird species.

Repellents work by affecting the animal's senses through chemical, auditory, or visual means. Habituation or acclimation of birds and mammals to most repellent devices or techniques is a major problem. When used repeatedly without added reinforcement, wildlife soon learn that the repellent devices or techniques are harmless. The devices become a part of their "background noise", and they ignore them.

Critical factors to be recognized in deploying repellents are—

1. There are no "silver bullets" that will solve all problems;
2. Likewise, there is no standard protocol or set of procedures that is best for all situations. Repelling wildlife is an art as much as a science. The most important factor is having motivated, trained, appropriately equipped personnel who understand the wildlife situation on their airport;
3. Each wildlife species is unique and will often respond differently to various repellent techniques. Even within a group of closely related species, such as gulls, the

various species will often respond differently to various repellent techniques; and

4. Habituation to repellent techniques can be minimized by—
   a) using each technique sparingly and appropriately when the target wildlife is present,
   b) using a variety of repellent techniques in an integrated fashion, and
   c) reinforcing repellents with occasional lethal control (with necessary permits in place) directed at abundant problem species such as gulls or geese.

Advances in electronics, remote sensing capabilities, and computers are resulting in the development of "intelligent" systems that can automatically deploy repellent devices (e.g., noisemakers, chemical sprays) when targeted wildlife enter a designated area. These devices might help reduce habituation and increase effectiveness of repellents in some situations. However, these devices will never replace the need for trained people on the ground to respond appropriately to incursions by a variety of highly adaptable, sentient wildlife species.

9.2.C.I WILDLIFE PATROLS AND RUNWAY SWEEPS IN VEHICLES

Regular patrols of airside areas to disperse birds and other hazardous wildlife are a critical component of an integrated program of wildlife hazard management on airports. Often, driving a vehicle toward the wildlife will be enough to cause the wildlife to disperse, especially if the driver has been deploying repellent and removal techniques and strategies as outlined below. Regular patrols and sweeps also permit wildlife control personnel to learn the daily movement patterns, habitat preferences, and behavior of wildlife on the airport. This information can be useful in determining wildlife attractants on the airport that need to be removed (e.g., low areas that gather standing water after rains) and in anticipating problem situations. All wildlife carcasses found during runway sweeps should be removed, identified to species, and documented on a wildlife strike log for carcass remains (Table 7-2).

Chemical repellents, such as methyl anthranilate, can be applied to temporary pools of standing water on airports to repel birds until the water evaporates. The preferred long-term solution is to improve drainage to avoid standing water after significant rain events (photo courtesy USDA).

9.2.C.II CHEMICAL REPELLENTS FOR BIRDS

Chemical repellents, toxicants, and capturing agents must be registered with the U.S. Environmental Protection Agency (USEPA) or Food and Drug Administration (FDA) before they can be used to manage wildlife on airports. Products must also be registered in each state. Hygnstrom et al. (1994) provides a listing of chemical products, by active ingredient and by company

name, registered for birds and mammals. The following chemical repellents, listed by active ingredient, are presently available for use on airports.

Perching structures (polybutenes). Several commercial products are available in liquid or paste form. These sticky formulations make birds uncomfortable when they alight on them, encouraging the birds to look elsewhere to perch or roost. To be effective, all perching surfaces in a problem area must be treated, or the birds will move a short distance to an untreated surface. Under normal conditions, the effective life of these materials is 6 months to 1 year. Dusty environments can substantially reduce the life expectancy. Once the material loses effectiveness, it is necessary to remove the old material and apply a fresh coat. Applying the material over duct tape, rather than directly to the building ledge or rafter surface, will facilitate clean up.

Turf feeding (methyl anthranilate, anthraquinone). There are two chemicals presently (2005) registered as bird repellents for turf (grass). One repellent is an anthraquinone formulation for repelling geese from turf. Anthraquinone apparently acts as a conditioned-aversion repellent with birds. Birds ingesting food treated with anthraquinone become slightly ill and develop a post-ingestion aversion to the treated food source. Birds visually identify anthraquinone in the UV light spectrum and become conditioned to avoid the treated food source. Because of its conditioned-aversion properties, anthraquinone use does not require treatment of the entire airfield, but only areas where birds are grazing and/or higher risk areas such as runway approaches.

The other repellent is methyl anthranilate, an artificial grape flavoring commonly used in foods and beverages. Birds have a taste aversion to methyl anthranilate, apparently reacting to it in much the same way that mammals react to concentrated ammonia (smelling salts). Methyl anthranilate is registered under formulations as a feeding repellent for geese and other birds on turf.

A recent study showed that predator urines (coyote, bobcat) had no influence on deer movements along established trails or at feeding sites (photo by T. Seamans, USDA).

Both anthraquinone and methyl anthranilate products are liquid formulations applied by sprayer to the vegetation. Effectiveness of these sprays in repelling geese can be variable, depending on growing conditions, rainfall, mowing, and availability of alternate feeding areas. In general, repellency based on conditioned aversion is longer lasting than repellency based on taste.

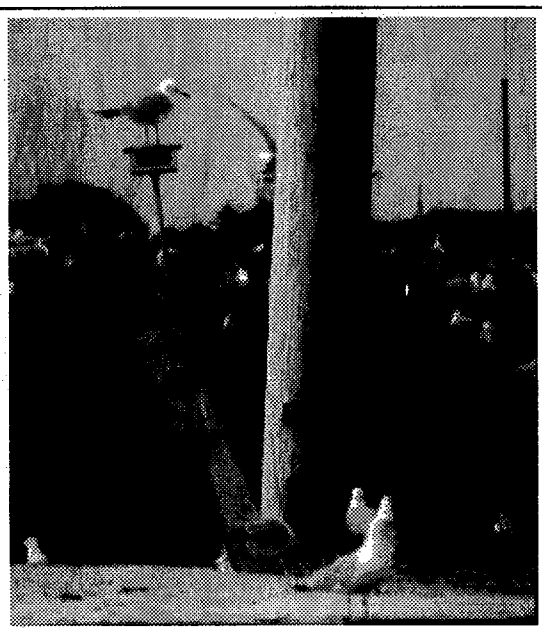
Water (methyl anthanilate). Methyl anthranilate formulations are also available for application to pools of standing water on airports and at other locations to repel birds from drinking and bathing. This application is probably best for temporary pools of water after rainfall, where repellency of only a few days is needed.

General area (fogging with methyl anthanilate). A methyl anthranilate formulation is

also available for use in fogging machines (thermal or mechanical) to disperse birds from hangers, lawns, and other areas.

Frightening agent (Avitrol [4-Aminopyridine]). Avitrol is registered for repelling pigeons, house sparrows, black-birds, grackles, cowbirds, starlings, crows, and gulls from feeding, nesting, loafing, and roosting sites. Birds eating Avitrol-treated baits react with distress symptoms and calls, behaviors that frighten away other birds in the flock. Avitrol, although registered as a "frightening agent", is lethal to the birds that eat treated baits. Therefore, recognize that Avitrol is a toxic to the birds that consume treated bait. Avitrol-treated bait is diluted with untreated bait so most birds in the flock do not ingest treated bait. The primary use of Avitrol at airports has been in pigeon control around buildings. The use of Avitrol requires knowledge of the feeding patterns of the birds, proper prebaiting procedures to ensure bait acceptance and avoidance of non-target species, and removal of dead birds after treatment.

9.2.C.III CHEMICAL REPELLENTS FOR MAMMALS



In most cases, birds rapidly adapt to and then ignore recorded distress calls and other noises produced by electronic auditory devices. Such devices, as shown on the pole in the photo, can be useful only if used sparingly as part of an integrated program of bird dispersal (photo by R. A. Dolbeer, USDA).

There are a number of taste and odor repellents marketed to repel deer, rabbits, and other mammals from browsing on vegetation (Hygnstrom et al. 1994). These include products that are applied directly to the vegetation and general area (odor) repellents (e.g., predator urine). Some of these products might be appropriate for short-term protection of valuable landscaping plants and fruit trees. However, their use on airports to repel or discourage deer or other mammals is not recommended because they are unlikely to have any influence on wildlife movements in the airport operating area.

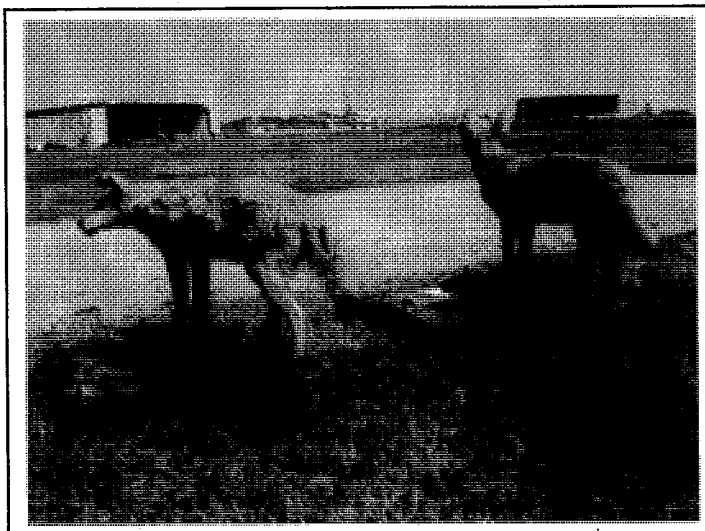
9.2.C.IV AUDIO REPELLENTS FOR BIRDS

Propane cannons. Propane cannons (exploders) generate a shotgun-sounding blast. In general, birds quickly habituate to cannons that detonate at systematic or random intervals throughout the day. Thus, to ensure they remain effective, use cannons sparingly and only when birds are in the area. Reinforcement by occasional killing a few birds (of common species such as gulls and Canada geese under an appropriate permit) with a shotgun might also enhance effectiveness. Systems designed so cannons placed around an airport can be detonated remotely on demand by radio signal when birds are in the area are a useful means of reducing habituation.

Distress-call and electronic noise-generating systems. Recorded distress calls are available for common birds on airports, such as gulls, crows, and starlings. Such calls,

broadcast from speakers mounted on a vehicle, will often initially draw the birds toward the sound source to investigate the threat. The birds then can be dispersed by pyrotechnics or by using a shotgun to shoot an occasional bird. As with propane cannons, distress calls routinely broadcast from stationary speakers, with no associated follow-up stimuli that provide additional fear or stress, have little utility. Birds also habituate rapidly to other electronic sound systems that generate a variety of synthetic sounds from stationary speakers.

Shell crackers and other pyrotechnics. There are a variety of projectiles that can be fired from breech-loaded shotguns or from specialized launchers to provide an auditory blast or scream, as well as smoke and flashing light, to frighten birds. Some of the newer cartridges have ranges of up to 300 yards. These pyrotechnics, when used skillfully in combination with other harassment techniques and limited lethal control (shooting via shotgun), can be very useful in driving birds off of an airport. An advantage of these pyrotechnic devices is that they require a person to fire the projectile, thus ensuring that they are deployed directly at the target birds and that the birds associate the pyrotechnic with a threat (person).



Taxidermy mounts of coyotes deployed to move in the wind might be useful as part of an integrated program to disperse Canada geese and other birds from airports. Such effigies must be used sparingly and moved to various locations to prevent habituation. Permanently mounted effigies have little deterrent effect (photo by R. A. Dolbeer, USDA).

Ultrasonic devices. Ultrasonic (i.e., above the sound range detected by humans) devices have not proven to be effective bird repellents. In fact, most birds do not detect frequencies as high as humans can detect, much less frequencies above the level of human detection. During tests conducted by the U.S. Department of Agriculture's National Wildlife Research Center, pigeons showed no response when exposed within 10 feet to a fully functional, high-frequency sound generating device. Do not deploy these devices in hangers or other airport settings to deter birds.

9.2.C.V AUDIO REPELLENTS FOR MAMMALS

Probably the most commonly used audio scaring device for deer is the propane cannon. However, deer rapidly habituate to propane cannons. Their use on airports to repel deer and other mammals from runways is not recommended except for short-term (i.e., several days), emergency situations until a more permanent solution (fencing or deer removal) can be achieved. Other electronic noise-generating devices also have proven ineffective in repelling deer or other mammals for more than a few days. Pyrotechnics also provide only short-term repellency for mammals.

9.2.C.VI VISUAL REPELLENTS FOR BIRDS

Most visual repellents are simply a variation on an ancient theme—the scarecrow. In general, visual repellents, such as hawk effigies or silhouettes, eye-spot balloons, flags, and Mylar reflecting tapes, have shown only short-term effectiveness and are inappropriate for use as a long-term solution to bird problems on airports. Most short-term success achieved with these devices is likely attributable to "new object reaction" rather than to any actual frightening effect produced by them. For example, in a test in Ohio, a flag with a large eye-spot was exposed to pigeons in an abandoned building. As soon as the flag was put up, the pigeons left the building, giving the impression that the eye-spot was highly repellent to the birds. However, within 24 hours, the pigeons returned. From then on, the pigeons behaved in a completely normal fashion and showed no interest in, or reaction to, the flag.

The successful use of border collies to repel birds requires a high degree of dedication and commitment by the handlers. Jet was among the first border collies to successfully work at an airport to control birds.

One visual deterrent that has been successfully used in recent years is the display of dead birds in a "death pose." 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.

Another new concept in visual repellency that has shown utility in recent years is the use of hand-held laser devices that project a 1-inch diameter red beam to disperse birds. These devises have been used successfully to disperse birds such as Canada geese, double-crested cormorants, and crows from nighttime roosting areas in reservoirs and trees. Advantages are effectiveness at long range (over ¼ mile) and lack of noise. Lasers have also shown some effectiveness in dispersing birds from hangers. Effectiveness is diminished or nonexistent in daylight

conditions. As with the use of firearms, the use of lasers in an airport environment obviously requires caution.

9.2.C.VII VISUAL REPELLENTS FOR MAMMALS

For the most part, visual repellents such as flags and effigies have proven ineffective for repelling mammals. Their use is not recommended for keeping deer or other mammals off airports. Red lasers (see above) were ineffective in dispersing deer.

9.2.C.VIII TRAINED FALCONS AND DOGS TO REPEL BIRDS

Radio-controlled aircraft, such as this Robo-Falcon™, can be useful as part of an integrated program in dispersing birds from airports and landfills. Considerable training is required to operate these devices in the airport environment (photo by R. A. Dolbeer, USDA).

Trained falcons and other birds of prey have been used intermittently on various airports in Europe and North America to disperse birds since the late 1940s. The advantage of falconry is that the birds on the airport are exposed to a natural predator for which they have an innate fear. The disadvantage is that a falconry program is often expensive, requiring a number of birds that must be maintained and cared for by a crew of trained, highly motivated personnel. Furthermore, the effectiveness of falconry programs in actually reducing strikes has been difficult to evaluate.

Blokpoel (1976) outlined the following summary of falconry for airports that is still a good overall assessment: (1) properly trained birds of prey of the right species for the job at hand, used regularly and persistently by skilled and conscientious personnel, are effective in clearing birds from airfields during daylight and good weather; (2) for good results, daily operations on a year-round basis are required in most cases, (3) several falcons are required to have at least one bird ready at all times, and (4) to obtain, train, operate, and care for falcons, a staff of at least two full-time, well-trained personnel is required.

The use of trained dogs, especially border collies, to chase geese and other birds from golf courses, airports, and other sites is a recent development. As with falcons, the advantage is exposure to a natural predator. Likewise, the disadvantage is that the dog must be under the control of a trained person at all times, and the dog must be cared for and exercised 365 days a year. A dog will have little influence on birds that are flying over the airport.

9.2.C.IX RADIO-CONTROLLED MODEL AIRCRAFT TO REPEL BIRDS

Radio-controlled (RC) model aircraft, which provide both visual and auditory stimuli, occasionally have been used to harass birds on airports. One advantage is that the RC aircraft is under the control of a person and can be directed precisely to herd the birds

away from the airport runway. A second advantage is that the RC aircraft can be deployed on an "as needed" basis with little maintenance needed between flights. Some RC aircraft have been designed to mimic the appearance of a falcon and even to remotely fire pyrotechnics. The disadvantage is that a trained person is required to operate the RC aircraft in an airport environment. Before using RC aircraft, ensure that the radio frequencies used are compatible with other radio uses in the airfield environment.

9.2.C.X NONLETHAL PROJECTILES TO REPEL BIRDS

Paint balls and rubber or plastic projectiles, fired from paint-ball guns and 12-gauge shotguns, respectively, can be used to reinforce other dispersal techniques employed to repel Canada geese, roosting vultures, and perhaps other species of birds. With paint balls, a high-quality paint-ball gun should be used to provide sufficient accuracy and velocity (typically fired from 20 to 100 feet from bird). There are several types of rubber or plastic projectiles (slugs, buck shot, pellets, beads) for use in a shotgun. The proper distance from the bird for firing varies by projectile and species of bird. Personnel using these techniques need to be trained in firearm use and in the use of the particular projectiles being deployed. The objective is to shoot from a sufficient distance so that the projectile induces temporary pain, but no injury, in the bird struck.

Birds of prey, such as this red-tailed hawk, are captured with bal-chatri traps at some USA airports and relocated 50-100 miles from the airport. Studies have shown that relocated juvenile hawks typically do not return to the airport. Adult territorial birds will often return (photo courtesy of L. Schafer, USDA).

9.2.D WILDLIFE REMOVAL TECHNIQUES

Habitat modification, exclusion, and repellent techniques are the first lines of action in any Wildlife Hazard Management Plan. However, these actions will not solve every problem; therefore, hazardous wildlife sometimes must be removed from an airport. Such removal can be accomplished by capturing and relocating or by killing the target animals. With few exceptions, a federal Migratory Bird Depredation Permit, and in many cases a state permit, is required before any migratory birds may be taken (captured or killed). A state permit is generally necessary before any state-protected birds or mammals may be taken. Any capturing or killing must be done humanely and only by people who are trained in wildlife species identification and the techniques to be deployed.

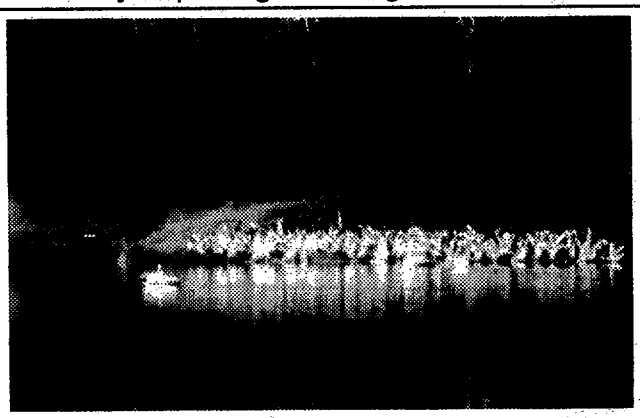
9.2.D.I CAPTURING BIRDS AND MAMMALS

The disposition of live-captured birds and mammals will depend on the legal, political, and social realities of each situation. State wildlife agencies are increasingly restrictive

about the relocation of captured wild animals, particularly for common species, because of disease concerns and the creation of additional wildlife problems at release sites. When practical, euthanize unprotected birds, such as pigeons, house sparrows, and European starlings, using procedures recommended by the American Association of Wildlife Veterinarians (AAWV). Dispose of common mammals, such as raccoons, woodchucks, and coyotes, captured on airports by following state regulations. Resident Canada geese captured during molt or by nets can be euthanized and donated to soup kitchens or food banks, provided the necessary federal and state permits are in place.

9.2.D.I.A CHEMICAL CAPTURE OF BIRDS

Alpha Chloralose (A-C) is registered with the FDA as an immobilizing agent for use in capturing waterfowl, coots, and pigeons. A-C can only be used by people certified to use A-C working under the authority of personnel with the U.S. Department of Agriculture Wildlife Services (USDA/WS). A-C, incorporated into bread baits, is ideal for selectively capturing ducks, geese, and coots that can be hand-fed at urban ponds and parks. Corn baits are recommended for pigeons or groups of waterfowl or coots that cannot be individually baited. Birds ingesting a clinical dose of A-C can be captured in 30- to 90-minutes. Complete recovery normally occurs within 8 hours but can take up to 24 hours.



Cannon or rocket nets are well suited for capturing up to 100 or more waterfowl, pigeons, or gulls in situations where other methods might not be practical. The net must be placed where it can be safely discharged, and the target birds must be trained to feed in front of it. Depending on the situation, prebaiting can take several days. Here, white pelicans are being captured for banding to study migration patterns (photo by T. King, USDA).

9.2.D.I.B LIVE-TRAPPING BIRDS

The major advantage of live trapping is selectivity: any non-target birds can be released unharmed. The major disadvantage is that live trapping is often labor intensive. Traps must be tended frequently to remove captured animals and, in the case of cage traps with decoy birds, to provide food and water. Hygnstrom et al. (1994) provides detailed descriptions of various trap designs.

Trapping is used on some airports to remove raptors (hawks and owls) in the aircraft operating area. Bal-chatri, noose carpets, Swedish goshawk, or sliding padded pole traps are typically used. Because raptors are desirable components of bird communities, most permits for trapping raptors require that the birds be banded and relocated into suitable habitat at least 50 miles from the airport.

Live trapping, using walk-in type traps on roofs or other isolated sites, can be used to remove pigeons at airports. Euthanize captured pigeons following AAWV guidelines. If relocated, pigeons can fly long distances to return to the site of capture.

Net launchers use a blank rifle cartridge to propel a net. Fired from the shoulder much

like a shotgun or rifle, net launchers can capture individual or small groups of problem birds that can be approached within about 50 feet.

9.2.D.I.C CHEMICAL CAPTURE OF MAMMALS

Large mammals, such as deer, can be captured with tranquilizer guns, but this is generally not a practical or desirable option for airports. Live capture and relocation of deer is not recommended or permitted in most states because deer populations are at or near carrying capacity. However, in those situations where the use of firearms is not safe or practical, the use of tranquilizer guns might be appropriate. The use of tranquilizer guns requires personnel with a high degree of skill and experience. If used in an airport environment, safeguards must be in place to ensure partially tranquilized deer do not enter runway areas.

9.2.D.I.D LIVE-TRAPPING MAMMALS

Specialized drop-door traps, drop nets, or rocket net set-ups can be used to live-capture deer, but live-capturing deer generally is not recommended for airport situations for reasons outlined above. However, smaller box-type or basket live-traps can be used to capture medium-sized mammals, such as raccoons, woodchucks, beavers, and feral dogs. Leg-hold traps and snares can be used to capture coyotes, feral dogs and raccoons.

Hunting during the regular deer season should be encouraged in areas adjacent to airports having deer problems to reduce the population in the general area. Archery hunting sometimes can be used in areas closed to firearms (photo by E. Cleary, FAA).

Successful mammal trapping, especially with leg-hold traps and snares, requires a high degree of skill and experience. Once set, traps must be checked frequently (at least once every 24 hours and more frequently in hot or cold weather). Trappers must be knowledgeable in procedures for handling and euthanizing mammals. State and local regulations might restrict the use of some types of traps.

9.2.D.II KILLING BIRDS AND MAMMALS

In general, killing of wildlife on an airport is the last option deployed after habitat modification, exclusion techniques, and repellent actions have been implemented. However, the management of a wildlife hazard situation on an airport might require killing a particular animal or require that a local population of a problem species be reduced by lethal means until a long-term, nonlethal solution is implemented (e.g., erection of deer-proof fence, relocation of nearby gull nesting colony). In addition, lethal control of a few individuals is sometimes necessary to reinforce nonlethal frightening techniques. Some lethal control is usually necessary as part of an integrated Wildlife Hazard Management Plan for an airport.

The following information must be developed to justify lethal control and to minimize

adverse public reaction to a program involving killing:

- Documentation that the wildlife species is an economic, safety, or health threat.
- Justification of why nonlethal options are not adequate to solve the problem.
- An assessment of the impact that the killing will have on local and regional populations of the species (i.e., is the level of killing planned likely to result in a significant reduction in numbers of the species at the local or regional level?).
- Assurance that the killing procedure is appropriate (i.e., safe, effective, and humane) and specific for the target wildlife species.
- Documentation of the effectiveness of the killing program in helping to solve the problem (e.g., reduction in bird strikes).
- Recommended steps to be taken, if any are feasible, to reduce the need for killing in the future.

Canada geese should not be allowed to nest on airports. Nests and eggs should be destroyed after appropriate permits are obtained (photo courtesy of J. Bucknall, USDA).

9.2.D.II.A DESTROYING EGGS AND NESTS

Do not allow Canada geese, mute swans, and gulls to nest on airport property. Provided the correct permits are in place, destroy (break eggs and remove nest material) any goose, mute swan, or gull nests with eggs found on an airport. Egg addling (oiling, shaking, or puncturing), whereby the birds continue to incubate nonviable eggs, is not recommended for airports. Egg addling encourages the nesting birds (and any nonbreeding birds associated with them) to stay on the airport. At the time of nest destruction, harass the adult birds from the airport. Check the nesting area weekly for renesting until the end of the nesting season (generally the end of June). As an alternative to harassment, it may be better to shoot nesting geese and mute swans (see below).

Destroy pigeons, starlings, and house sparrows nests whenever they are encountered in airport buildings and structures. Where practical, install physical barriers, as discussed above, to prevent renesting.

Nests of other birds hazardous to aviation generally also should be destroyed when encountered on airports. Remember that migratory bird nests are protected by federal law and may not be taken without a Depredation Permit. Each situation will have to be addressed on a case-by-case basis, depending on the species of bird and level of threat posed, location from runways, bird movement patterns, and other factors.

9.2.D.II.B SHOOTING BIRDS

Shooting birds in an airport environment generally falls into two main categories. First,

pigeons using hangers, bridge girders, and other sites can be shot at night with an air rifle. This nighttime shooting is done quietly and discretely, with the objective being to disturb the birds as little as possible so that the maximum number can be removed.

In the second category of shooting, common birds, such as gulls and geese, in the AOA that are not responding to various repellent methods can be shot with a 12-gauge shotgun. This shooting is done during daylight in the open so that other birds can witness the action. Shooting a shotgun has several effects on a flock of birds. First, it reinforces other audio or visual repelling techniques. Second, the loud noise, coupled with the death of one or more of the flock members, can frighten the rest of the flock away. Third, the target birds are permanently removed.

Compressed CO_2-powered pellet rifles, with laser pointers and telescopic sights, are an effective means of removing rock doves (pigeons) from hangers and other structures at airports. Personnel must be properly trained in the use of all pyrotechnic devices and firearms, and their use must be coordinated with airport security (photo by R. A. Dolbeer).

Four cardinal rules apply when using shooting as a control method at airports:

1. Use only personnel who are trained in the use of firearms and who have an excellent knowledge of wildlife identification.
2. Use the proper gun and ammunition for the situation.
3. Have necessary federal and state wildlife kill permits in place, and keep accurate records of birds killed by species and date.
4. Notify airport security, air traffic control, and, if appropriate, the local law enforcement authority before instituting a shooting program. Local ordinances against the discharge of firearms within certain distances of buildings, or within the city limits, may need to be waived.

9.2.D.II.C SHOOTING MAMMALS

Adopt a "zero tolerance" for deer on airports. If fencing is inadequate to keep deer off an airport or if deer have gotten inside the airport's fence, shooting is the best procedure for removing the deer. Because of inherent safety considerations and to ensure safe and efficient removal, shooting on airports must be by professional sharpshooters, using non-ricocheting bullets in rifles equipped with night-vision scopes and noise suppressers. Elevated shooting stands can be erected on the ground or on a truck bed to direct shots toward the ground. When practical, donate the meat from deer that are removed from airports to charity. Shooting of deer on airports must be coordinated through the state wildlife agency.

Encourage hunting during the regular deer season in areas adjacent to airports with deer problems to reduce the population in the general area. Archery hunting sometimes can be used in areas closed to firearms.

9.2.D.II.D ORAL TOXICANTS FOR BIRDS

Currently in the USA, only one oral toxicant, DRC-1339 or Starlicide (active ingredient 3-chloro-p-toluidine hydrochloride), is registered with the USEPA for use in bird population management. Starlicide (0.1% active ingredient) is formulated in a pellet bait for use at feedlots to control starlings and blackbirds. DRC-1339 (98% active ingredient) can be formulated with a variety of baits and used to control starlings, pigeons, gulls, ravens, and blackbirds under certain conditions, some of which might be applicable at airports. The control of pigeons around airport buildings and starlings roosting on or near an airport are the situations most likely applicable. Only USDA/WS personnel or persons working under their direct supervision can use DRC-1339.

RESTRICTED USE PESTICIDE

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators certification.

ZINC PHOSPHIDE ON WHEAT

FOR MOUSE CONTROL

For the control of meadow voles, prairie voles, pine voles, mountain voles, and white-footed mice in ornamentals, orchards, vineyards, rangelands, forests, lawns, golf courses, parks, nurseries, and highway medians.

ACTIVE INGREDIENT:	
Zinc Phosphide	1.82%
INACTIVE INGREDIENTS:	98.18%
TOTAL	100.00%

This is the center portion of a zinc phosphide rodenticide label showing the restricted use statement, target species, and ingredients list. Other parts of the label provide important information such as the manufacturer, EPA registration number, and the directions for use. Always read the entire label before using any pesticide.

The use of toxic baits to kill target birds without affecting non-target species requires considerable skill and patience. Daily movement patterns of the target birds among feeding, loafing, and roosting sites must be determined so attractive bait sites that are controlled from public access (such as a roof top) can be selected. The proper bait (a highly desired food) must be selected, and the birds then must be prebaited, often for a week or more, to ensure good bait acceptance and that non-target animals are not visiting the bait site. Proper prebaiting is the most critical step of a successful program. During the baiting period, all uneaten bait must be removed daily. With DRC-1339, birds typically die 1 to 3 days after bait ingestion; therefore, areas surrounding bait sites will need to be searched for several days after baiting to remove dead birds.

9.2.D.II.E CONTACT TOXICANTS FOR BIRDS

Hollow metal perches containing a wick treated with the toxicant fenthion previously were used to control pigeons, house sparrows, and starlings in and around buildings. The USEPA has phased out the use of fenthion-treated perches because of concerns for secondary poisoning of raptors and mammalian scavengers feeding on dying birds. No replacement chemical has been registered at this time (2005).

If toxic perches become available, their use outside of buildings is not recommended

because there is no way of preventing non-target birds from landing on them. Even when used inside buildings, careful placement of perches and monitoring must be done to ensure non-target birds such as swallows are not exposed to the toxicant. Pick up and properly dispose of all dead birds.

Anticoagulant rodenticides in covered bait stations are being used to control mice and voles in the AOA of this airport in Mexico. The bait stations are checked regularly and old, moldy bait is removed and properly disposed. This airport also uses falconry as part of its integrated program (photo by R. A, Dolbeer, USDA).

9.2.D.II.F TOXICANTS FOR MAMMALS

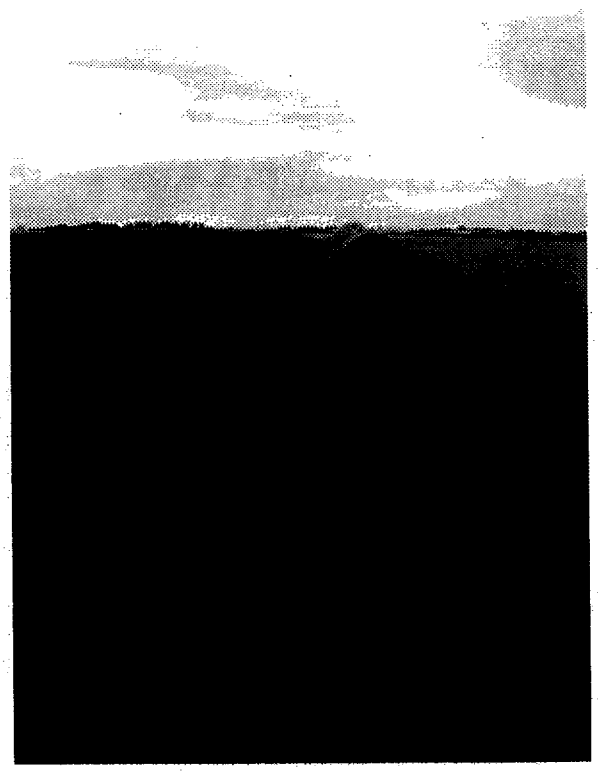
Small rodent populations (e.g., voles, house and deer mice, Norway rats) might erupt in grassy and brushy areas or around construction debris on airports, attracting raptors and creating a hazard to aviation. In general, control rodent populations by habitat management (mowing, sanitation, clean-up of brushy areas and piles of debris). However, there might be situations where the use of a rodenticide is appropriate to reduce rodent populations in airside vegetation. The control of commensal rodents in airport terminal buildings and other facilities will not be discussed here because these jobs are usually handled by private pest control operators.

There are two types of rodenticides that might be available for use in airside vegetation, anticoagulants and acute toxicants. Anticoagulants, of which there are several types registered, cause the rodent to die from internal bleeding. Some anticoagulants require multiple feedings to induce sufficient bleeding for death whereas others require only a single feeding. The only acute toxicant registered for above-ground treatment of field rodents is zinc phosphide, available in pellet and grain-bait formulations and as a concentrate for specialized bait formulations.

Depending on registration label instructions, rodenticide baits can be broadcast in the vegetation or hand-placed in burrows and runways. Anticoagulant baits can also be placed in various types of bait containers placed in areas of high rodent activity. Care must be taken to minimize non-target bird and mammal exposure with broadcast and hand-placed baits.

9.2.D.II.G FUMIGANTS FOR MAMMALS

Burrowing rodents on airports, such as woodchucks (ground hogs) and prairie dogs, can be killed by fumigation of burrows with either gas cartridges or aluminum phosphide tablets. Gas cartridges, ignited from a burning fuse after placement in the burrow, generate carbon monoxide. Aluminum phosphide pellets react with moisture in the burrow to produce phosphine gas. Care must be taken to plug all burrow entrances with sod after placement of the cartridge or pellets in the burrow. Gas cartridges are a general use, over-the-counter pesticide. Aluminum phosphide pellets can only be applied by certified pesticide applicators and might not be available in all states. As with all pesticides, it is critical to make sure the wildlife species you are treating is covered under the registration for your state.



Earthworms crawling onto runways after heavy rains can be a strong attractant to gulls and other birds. This runway in New Zealand uses slit drains to block worms from reaching the runway. Other options include brush-sweeping runway edges to remove worms and deploying extra personnel to disperse gulls. As of 2005, there are no chemicals registered in the USA to control earthworms (photo by R. A. Dolbeer, USDA).

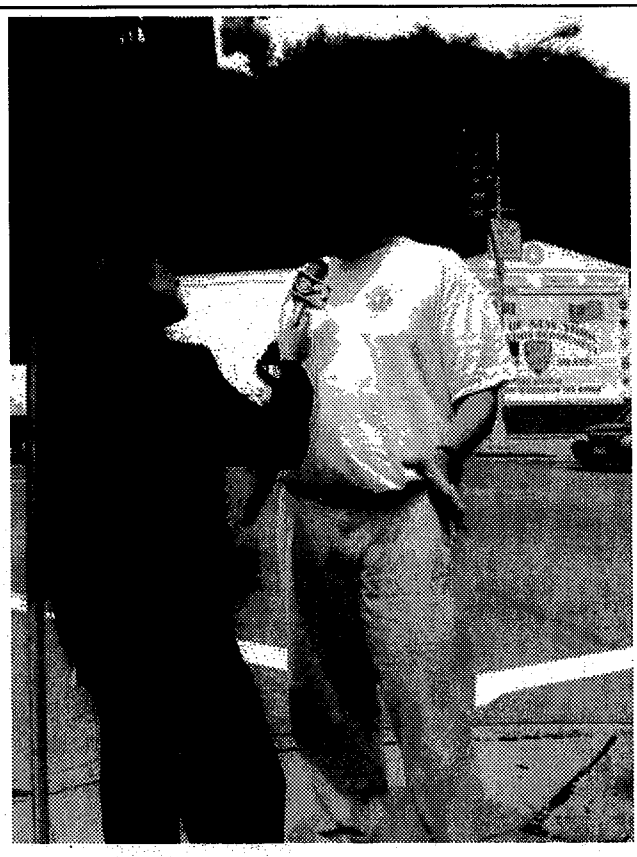
9.2.D.II.H LETHAL TRAPS FOR MAMMALS

Depending on state and local laws, Conibear® (body gripping) traps can be used to remove woodchucks, beaver, and other medium-sized mammals that create problems on airports. Neck snares can be used to capture coyotes, beaver, and certain other mammals. The use of these lethal traps requires a high degree of skill and experience to selectively capture the target animal. Once set, traps must be checked frequently (at least once every 24 hours and more frequently in hot or cold weather) to euthanize any animals that might be captured but not killed. Trappers must be knowledgeable in procedures for handling and euthanizing captured mammals.

9.3 CONCLUSIONS

Habitat modifications to minimize food, cover, and water and physical barriers to exclude wildlife are the foundations of wildlife hazard management programs for airports. In addition, an integrated array of repellent techniques is necessary to disrupt normal behavior and to stress hazardous wildlife that attempt to use the airport. These repellent techniques must be used judiciously and backed by real threats to minimize habituation. To this end, lethal control of selected individuals of common species is sometimes necessary to reinforce repellent actions. Furthermore, the management of a

wildlife hazard situation on an airport might require removal of a particular animal or group of animals or require that a local population of a problem species be reduced by lethal means until a long-term, nonlethal solution is implemented. Finally, the most critical factor for the success of a wildlife hazard management program is to have motivated and trained professionals who are knowledgeable about the wildlife species attempting to use the airport environment and the techniques used to manage the problems these species create.



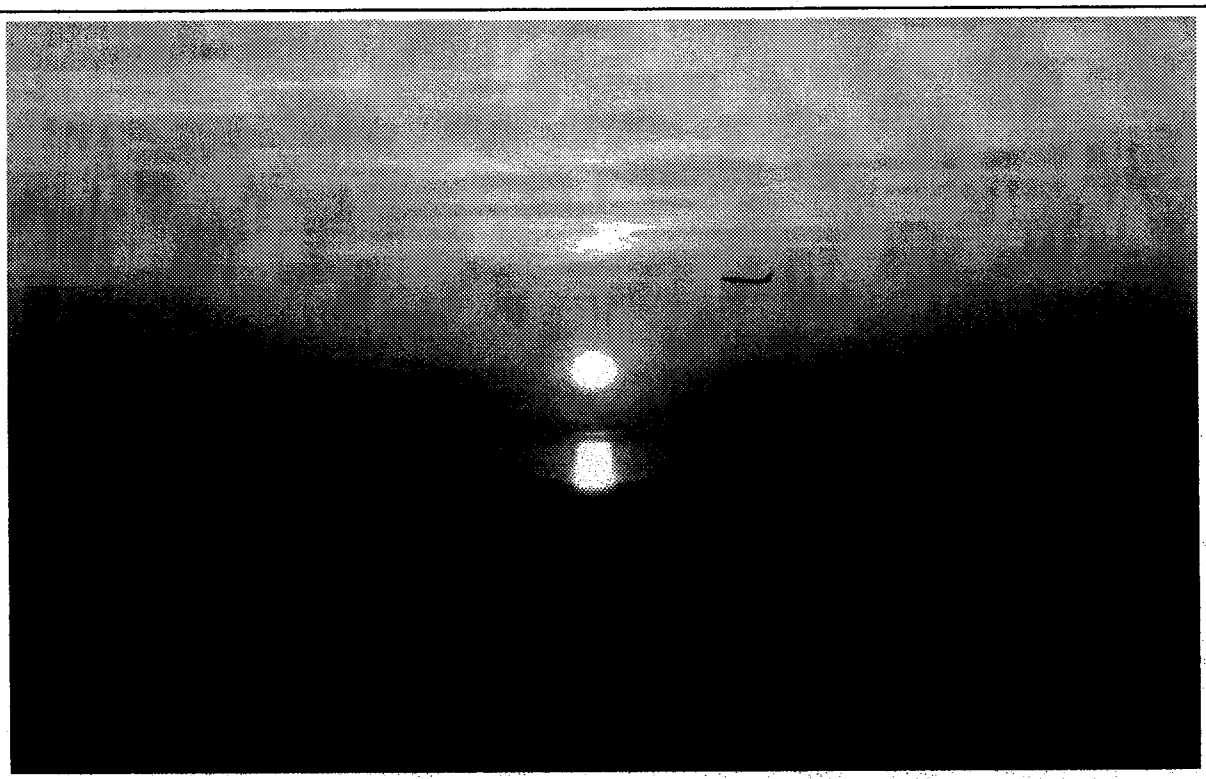
The management of hazardous wildlife at airports often generates interest from the public and news media. Professional biologists and public relations personnel at airports must be prepared to explain and defend actions taken to protect the flying public from wildlife hazards to aviation (photo by R. A. Dolbeer, USDA).

9.4 OTHER SOURCES OF INFORMATION

For details on techniques, equipment, chemical registrations, species-specific management recommendations, and sources of supply, the reader is referred to—

Hygnstrom, S. C., R. M. Timm, and G. E. Larson, editors. 1994. *Prevention and control of wildlife damage*. University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. (This 2-volume manual is also available online at ianrwww.unl.edu/wildlife/solutions/handbook/.)

In addition, Appendix L provides a list of research publications by the U.S. Department of Agriculture, National Wildlife Research Center (NWRC), documenting results of evaluations of various wildlife control products and strategies. These evaluations were conducted between 1992 and 2004 with support from the FAA under an interagency agreement with NWRC. This is not a complete list of all evaluations that have been done on all wildlife control methods, but it does provide information on many of the control methods discussed in this chapter.



Birds and aircraft will always share the skies, and there will always be the risk of collisions. To minimize that risk, airports must be managed to be as unattractive to birds as possible. Integrating various control strategies offers the maximum long-term effectiveness and immediate relief from a hazardous situation and minimizes the need for the use of lethal control methods (photo by B. Washburn, USDA).

ACKNOWLEDGEMENTS

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SELECTED PUBLICATIONS AND WEB SITES

In addition to these publications and web sites, a list of wildlife field guides and reference books is provided at the end of Chapter 8. Also, a list of publications on wildlife control techniques by the U.S. Department of Agriculture, National Wildlife Research Center, is provided in Appendix L.

Belant, J. L., S. K. Ickes, and T. W. Seamans. 1998. Importance of landfills to urban-nesting herring and ring-billed gulls. Landscape and Urban Planning 43:11-19.

Bellrose, F. C. 1980. Ducks, geese, and swans of North America, third edition. Stackpole Books, Harrisburg, Pennsylvania. 540 pages.

Blokpoel, H. 1974. Bird hazards to aircraft. Canadian Wildlife Service. Ministry of Supply and Services, Ottawa, Ontario, Canada. 236 pages.

Blokpoel, H., and, G. D. Tessier. 1984. Overhead wires and monofilament lines exclude ring-billed gulls from public places. Wildlife Society Bulletin 12:55-53

Cleary, E. C., R. A. Dolbeer, and S. E. Wright. 2004. Wildlife strikes to civil aircraft in the United States, 1990-2003. U.S. Department of Transportation, Federal Aviation Administration, Serial Report No. 10, DOT/FAA/AS/00-6(AAS-310). Washington DC USA. 56 pages. (http://wildlife-mitigation.tc.faa.gov/).

Code of Federal Regulations (CFR): available at http://www.gpoaccess.gov/cfr/index.html

CFR Title 40, Part 258, Criteria for Municipal Solid Waste Landfills, section 258.10, Airport Safety, pages 395-396 (July 2003).

CFR Title 50, Parts 1-100, Wildlife and Fisheries, 494 pages (October 2003).

CFR Title 14, Part 139, Certification and Operations: Land Airports Serving Certain Air Carriers, section 139.337, Wildlife Hazard Management, pages 846-847 (June 2004).

Dolbeer, R. A., J. L. Belant, and J. L. Sillings. 1993. Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport. Wildlife Society Bulletin 21:442-450.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 2000. Ranking the hazard level of wildlife species to aviation. Wildlife Society Bulletin 28:372-378 (updated in special report to Federal Aviation Administration in 2003 that was incorporated into AC 150/5200-7 [Appendix C].

Dolbeer, R. A., and P. Eschenfelder. 2002. Population increases of large birds, airworthiness standards, and high-speed flight: a precarious combination. Pages 273-281 in Proceedings of the 55th International Air Safety Seminar, Dublin, Ireland (Flight Safety Foundation, Alexandria, Virginia).

Dunning, J. B. Jr., editor. 1993. CRC Handbook of Avian Body Masses. CRC Press. Boca Raton, Florida. 371 pages. (Body weights for birds throughout the world)

Gill, F. B. 1990. Ornithology. W. H. Freeman and Company. New York, New York. 660 pages.

Hygnstrom, S. C., R. M. Timm, and G. E. Larson, *editors.* 1994. *Prevention and control of wildlife damage.* University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. (This 2-volume manual is also available online at: ianrwww.unl.edu/wildlife/solutions/handbook/)

Knittle, C. E., and R. D. Porter, 1993. Waterfowl damage and control methods in ripening grain: an overview, US Fish and Wildlife Service, Fish and Wildlife Technical Report 14, Washington, DC. 17 pages.

Linnell, M. A., M. R. Conover, and T. J. Ohashi. 1999. Biases in bird strike statistics based on pilot reports. Journal of Wildlife Management 63:997-1003.

MacKinnon, B., R. Sowden, and S. Dudley (Editors). 2001. Sharing the skies: an aviation guide to the management of wildlife hazards. Transport Canada, Aviation Publishing Division, Tower C, 330 Sparks Street, Ottawa, Ontario, K1A 0N8 Canada. 316 pages.

Seubert, J. L. 1994. Assessing the implementation of wildlife hazard management programs at civil airports. Proceedings Bird Strike Committee Europe 22:275-284.

Smith, A. E., S. R. Craven, and P. D. Curtis. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16, and Cornell Cooperative Extension, Ithaca, New York.

Transport Canada. 2002. Wildlife Control Procedures Manual. Safety and Security, Aerodrome Safety Branch. TP11500E. Ottawa, Ontario. (www.tc.gc.ca/civilaviation/aerodrome/wildlifecontrol/)

Web Sites:

Bird Strike Committee Canada. www.birdstrikecanada.com/

Bird Strike Committee USA. www.birdstrike.org/

Prevention and control of wildlife damage (2-volume manual). University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. ianrwww.unl.edu/wildlife/solutions/handbook/

Transport Canada. www.tc.gc.ca/civilaviation/aerodrome/wildlifecontrol/

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. www.aphis.gov.usda.gov/ws

U.S. Department of Defense, U.S. Air Force Bird Aircraft Strike Hazard (BASH) Team. http://afsafety.af.mil/afsc/bash/home.html.

U.S. Department of Interior, Fish and Wildlife Service. www.fws.gov/

U.S. Department of Transportation, Federal Aviation Administration, Airports Division. www.faa.gov/arp/.

U.S. Department of Transportation, Federal Aviation Administration, Wildlife Mitigation and Wildlife Strike Database. http://wildlife-mitigation.tc.faa.gov/.

Wright, S. E., R. A. Dolbeer, and A. J. Montoney. 1998. Deer on airports: an accident waiting to happen. Vertebrate Pest Conference 18:90-95.

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GLOSSARY

Air carrier. A person who holds or who is required to hold an air carrier operating certificate issued under this chapter [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers] while operating aircraft having a seating capacity of more than 10 passengers (14 CFR 139.5).

Air carrier aircraft. An aircraft that is being operated by an air carrier and is categorized as either a large air carrier aircraft if designed for at least 31 passenger seats or a small air carrier aircraft if designed for more than 9 passenger seats but less than 31 passenger seats, as determined by the aircraft type certificate issued by a competent civil aviation authority (14 CFR 139.5).

Air carrier operation. The takeoff or landing of an air carrier aircraft and includes the period of time from 15 minutes before until 15 minutes after the takeoff or landing (14 CFR 139.5).

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

Airport. An area of land or other hard surface, excluding water, that is used or intended to be used for the landing and takeoff of aircraft, including any buildings and facilities (14 CFR 139.5).

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

Airport Operating Certificate. A certificate, issued under this part [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers], for operation of a Class I, II, III, or IV airport.

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

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

Bird hazard. See Wildlife hazard.

Bird strike. See Wildlife strike

Carrying capacity. The maximum number of animals of a given species, which a habitat is capable of supporting on a sustained basis. The goal of wildlife management programs on airports is to eliminate or minimize the carrying capacity of habitat for species hazardous to aviation.

Categorical exclusion (NEPA): A category of actions that do not individually or cumulatively have a significant effect on the human environment (40 CFR, 1508.4).

Certificate holder. The holder of an Airport Operating Certificate issued under this part. [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers] (14 CFR 139.5).

Class I airport. An airport certificated to serve scheduled operations of large air carrier aircraft that can also serve unscheduled passenger operations of large air carrier aircraft and/or scheduled operations of small air carrier aircraft.

Class II airport. An airport certificated to serve scheduled operations of small air carrier aircraft and the unscheduled passenger operations of large air carrier aircraft. A Class II airport cannot serve scheduled large air carrier aircraft.

Class III airport. An airport certificated to serve scheduled operations of small air carrier aircraft. A Class III airport cannot serve scheduled or unscheduled large air carrier aircraft.

Class IV airport. An airport certificated to serve unscheduled passenger operations of large air carrier aircraft. A Class IV airport cannot serve scheduled large or small air carrier aircraft.

Concurrent use. Aeronautical property used for compatible non-aviation purposes while at the same time serving the primary purpose for which it was acquired; and the use is clearly beneficial to the airport. The concurrent use should generate revenue to be used for airport purposes (see Order 5190.6A, *Airport Compliance Requirements*, sect. 5h).

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

Cover. Vegetation covering a ground surface and serving as shelter for wildlife that are roosting, resting, nesting, or feeding.

Cover types. A descriptive term characterizing vegetative composition and physical characteristics of a plant community.

Detention ponds. Storm water management ponds that hold storm water for short periods of time, generally less than then 48 hours (compare with retentions ponds).

Dump. The actively used and unvegetated part of an area where refuse (garbage) is placed and allowed to accumulate on the ground surface without periodic covering or compacting. This includes both authorized and unauthorized areas.

Establish a new Municipal Solid Waste Landfill. When the first load of putrescible waste is received on-site for placement in a prepared municipal solid waste landfill.

Extraordinary circumstances: Environmental conditions associated with an action that is normally categorically excluded and that: (1) involves one or more of the circumstances listed in FAA Order 1050.1E, paragraph 304a through 304k; and may cause a significant environmental effect.

Fly ash. The fine, sand-like residue resulting from the complete incineration of an

organic fuel source. Fly ash typically results from the combustion of coal or organic waste used to operate a power generating plant.

Hazardous wildlife. Species of wildlife (birds, mammals, reptiles, insects, earth worms), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard (Advisory Circular 150/5200-33A – Hazardous Wildlife Attractants on or Near Airports; 14 CFR 139.3)

Heliport. An airport or an area of an airport used or intended to be used for the landing and takeoff of helicopters (14 CFR 139.3).

Mammal strike. See Wildlife strike.

Migratory Bird. "[A] migratory bird [is] ... any bird whatever its origin and whether or not raised in captivity, which belongs to a species listed in Section 10.13 [of 50 CFR] or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consist, or is composed in whole or part, of any such bird, or any part, nest, or egg thereof." (50 CFR 10.12). This list includes almost all native bird species in the United States, with the exception of nonmigratory game birds such as pheasants, turkeys and grouse. Exotic and feral species such as graylag geese, muscovy ducks, European starlings, house (English) sparrows, and rock doves (pigeons) also are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

Migration. The periodic movement of a wildlife species from one geographic area to another, usually in correlation with seasonal changes in weather.

Municipal Solid Waste Landfill (MSWLF). A publicly or privately owned discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. An MSWLF may receive other types wastes, such as commercial solid waste, non-hazardous sludge, small-quantity generator waste, and industrial solid waste, as defined under 40 CFR § 258.2. An MSWLF can consist of either a stand alone unit or several cells that receive household waste.

Movement area. The runways, taxiways, and other areas of an airport which are used for taxiing or hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and aircraft parking areas (14 CFR 139.3).

New MSWLF. A municipal solid waste landfill that was established or constructed after April 5, 2001 (AC 150/5200-34).

Pesticide. (1) Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer (7 U.S.C.A. 136[u]).

Piston-powered aircraft. Fixed-wing aircraft powered by piston engines. Such aircraft normally use LL-100 fuel.

Piston-use airport. Any airport that does not sell Jet-A fuel for fixed-wing turbine-powered aircraft, and primarily serves fixed-wing, piston-powered aircraft. Incidental use of the airport by turbine-powered, fixed-wing aircraft would not affect this designation. However, such aircraft should not be based at the airport (AC 150/5200-33A).

Public airport. An airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(16)).

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

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

Propane cannon/exploder. A hollow cylinder that produces a loud explosion to frighten wildlife by the ignition of a metered amount of propane at timed or random intervals or by remote control.

Pyrotechnics. Various combustible projectiles launched from a shotgun, pistol or other device that produce noise, light and smoke to frighten wildlife.

Retention ponds. Storm water management ponds that hold water for long periods of time, generally more then 48 hours (compare with detentions ponds).

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

Scheduled operation. Any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier for which the air carrier or its representatives offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR part 121 or public charter operations under 14 CFR part 380.

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

municipal sewage and/or industrial wastes, including sewage sludge as referenced in USEPA's *Effluent Guidelines and Standards*, 40 CFR Part 401.

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

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

Take (of wildlife). To pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect any wild animal (50 CFR 10.12).

Turbine-powered aircraft. Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft, rotary-wing aircraft. Such aircraft normally use Jet-A fuel (AC 150/5200-33A).

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

Wastewater treatment facility. Any devices or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1937 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW (40 CFR 403.3 [o], [p], [q]).

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

Wildlife attractants. Any human-made structure, land-use practice, or human-made or natural geographic feature, that can attract or sustain hazardous wildlife within the landing or departure airspace, AOA, loading ramps, or aircraft parking areas

of an airport. These attractants can include but are not limited to architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquaculture activities, surface mining, or wetlands (AC 150/5200-33).

Wildlife hazard. A potential for a damaging aircraft collision with wildlife on or near an airport (14 CFR 139.3).

Wildlife strike. A wildlife strike has occurred when:

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

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

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

4. 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;

5. The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (criteria 1-4 adopted from Transport Canada (MacKinnon et al. 2001).

ACRONYMS

AAWV	American Association of Wildlife Veterinarians
AC	Advisory Circular
A-C	Alpha-Chloralose
ADC	Animal Damage Control (former name of USDA/WS)
AGL	Above Ground Level
AOA	Air Operations Area
APHIS	Animal and Plant Health Inspection Service
ATC	Air Traffic Control
BASH	Bird Aircraft Strike Hazard (USAF)
BSCC	Bird Strike Committee Canada
BSC-USA	Bird Strike Committee USA
C&D Landfills	Construction and Demolition Landfills
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FOD	Foreign Object Debris, Foreign Object Damage
MBTA	Migratory Bird Treaty Act
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding

MSWLF	Municipal Solid Waste Landfill
NEPA	National Environmental Policy Act
NIPAS	National Integrated Plan of Airport System
NWRC	National Wildlife Research Center (USDA)
OFA	Object Free Area
OFZ	Obstacle Free Zone
RPZ	Runway Protection Zone
TSS	Threshold Siting Service
USAF	United States Air Force
USCOE	United States Army Corps of Engineers
USDOD	United States Department of Defense
USDA/WS	United States Department of Agriculture, Wildlife Services
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WCP	Wildlife Control Personnel
WHA	Wildlife Hazard Assessment
WHMP	Wildlife Hazard Management Plan
WHWG	Wildlife Hazard Working Group
WS	Wildlife Services (USDA)

COUNTY OF SAN MATEO
Inter-Departmental Correspondence

March 9, 1994

To: Patrick Sanchez, Parks and Recreation Division

From: Sam Herzberg, Planner II SH

Subject: Pillar Point Marsh Wetland Delineation

I am writing to brief you on the status of the Army Corps of Engineers' findings regarding the wetland delineation of the Pillar Point Marsh.

On February 8, 1994, I sent you a memo describing the initial findings of the Corps' wetland delineation, as performed by Dan Martell. As you recall when the County initially requested the Corps perform a formal wetland delineation of the Pillar Point Marsh in September 1993, it was assumed the Corps would concur with Charles Pattersen's 1987 Wetland Delineation and Report - Pillar Point Marsh, and facilitate a land appraisal of the marsh and its surrounding areas for the purpose of County acquisition from the current property owners. Mr. Martell indicated that his initial findings of the wetland boundaries identified a wetland considerably smaller than Charles Pattersen's delineation. Due to unexpected delays in the Corps' ability to produce an immediate wetland delineation of Pillar Point Marsh, Mr. Martell recommended the County proceed with its property acquisition based on Charles Pattersen's delineation.

On March 7, 1994, Mr. Martell called to inform me his initial assumptions of the hydrology of the Marsh were incorrect. Pillar Point Marsh is unlike typical coastal wetlands, because it is a perched wetland. Due to shale deposits located upstream the alluvium that collects in the wetland, due to erosion over time, forms a clay sealant which causes the water to stay on the surface and not percolate subsurface. Unlike the Pescadero Marsh, which is wet annually, Pillar Point Marsh holds the water at the surface until it either runs off, or evaporates. Mr. Martell indicated that he has made further inspections of the Marsh, following recent past rainfalls, and performed soil testing. He has determined that with minor exceptions he concurs with Charles Pattersen's wetland delineation of the Marsh. He is currently in the process of acquiring aerial photos from the San Mateo County Harbor District, at 50' scale, for the purposes of mapping the wetland boundaries. This map with a report on his findings regarding the hydrology of the Pillar Point Marsh will be forthcoming within the next several weeks.

If you have any further questions please feel free to contact me at ext. 1823.

SH:cdn - SFHE0479.ACO

cc: Paul Koenig, Director of Environmental Services
Terry Burnes, Planning Administrator
Mike Murphy, Deputy County Counsel
Linda Green, Real Property Division
Bob Emert, Superintendent of Parks
Roman Gankin, Principal Planner
Bill Rozar, Development Review Manager
Janice Jagelski, Planner

CALIFORNIA GEOLOGICAL SURVEY

NOTE 49

GUIDELINES FOR EVALUATING THE HAZARD OF SURFACE FAULT RUPTURE

GUIDELINES FOR EVALUATING THE HAZARD OF SURFACE FAULT RUPTURE
(Similar guidelines were adopted by the State Mining and Geology Board for advisory purposes in 1996.)

These guidelines are to assist geologists who investigate faults relative to the hazard of surface fault rupture. Subsequent to the passage of the Alquist-Priolo Earthquake Fault Zoning Act (1972), it became apparent that many fault investigations conducted in California were incomplete or otherwise inadequate for the purpose of evaluating the potential of surface fault rupture. It was further apparent that statewide standards for investigating faults would be beneficial. These guidelines were initially prepared in 1975 and have been revised several times since then.

The investigation of sites for the possible hazard of surface fault rupture is a deceptively difficult geologic task. Many active faults are complex, consisting of multiple breaks. Yet the evidence for identifying active fault traces is generally subtle or obscure and the distinction between recently active and long-inactive faults may be difficult to make. It is impractical from an economic, engineering, and architectural point of view to design a structure to withstand serious damage under the stress of surface fault rupture. Once a structure is sited astride an active fault, the resulting fault-rupture hazard cannot be mitigated unless the structure is relocated, whereas when a structure is placed on a landslide, the potential hazard from landsliding often can be mitigated. Most surface faulting is confined to a relatively narrow zone a few feet to few tens of feet wide, making avoidance (i.e., building setbacks) the most appropriate mitigation method. However, in some cases primary fault rupture along branch faults can be distributed across zones hundreds of feet wide or manifested as broad warps, suggesting that engineering strengthening or design may be of additional mitigative value (e.g., Lazarte and others, 1994).

No single investigative method will be the best, or even useful, at all sites, because of the complexity of evaluating surface and near surface faults and because of the infinite variety of site conditions. Nonetheless, certain investigative methods are more helpful than others in locating faults and evaluating the recency of activity.

The evaluation of a given site with regard to the potential hazard of surface fault rupture is based extensively on the concepts of recency and recurrence of faulting along existing faults. In a general way, the more recent the faulting the greater the probability for future faulting (Allen, 1975). Stated another way, faults of known historic activity during the last 200 years, as a class, have a greater probability for future activity than faults classified as Holocene age (last 11,000 years), and a much greater probability of future activity than faults classified as Quaternary age (last 1.6 million years). However, it should be kept in mind that certain faults have recurrent activity measured in tens or hundreds of years whereas other faults may be inactive for thousands of years before being reactivated. Other faults may be characterized by creep-type rupture that is more or less ongoing. The magnitude, sense, and nature of fault rupture also vary for different faults or even along different strands of the same fault. Even so, future faulting generally is expected to recur along pre-existing faults (Bonilla, 1970). The development of a new fault or reactivation of a long-inactive fault is relatively uncommon and generally need not be a concern in site development.

As a practical matter, fault investigation should be directed at the problem of locating existing faults and then attempting to evaluate the recency of their activity. Data should be obtained both from the site and outside the site area. The most useful and direct method of evaluating recency is to observe (in a trench or road cut) the youngest geologic unit faulted and the oldest unit that is not faulted. Even so, active faults may be subtle or discontinuous and consequently overlooked in trench exposures (Bonilla and Lienkaemper, 1991). Therefore, careful logging is essential and trenching needs to be conducted in conjunction with other methods. For example, recently active faults may also be identified by direct observation of young, fault-related geomorphic (i.e., topographic) features in the field or on aerial photographs. Other indirect and more interpretive methods are identified in the outline below. Some of these methods are discussed in Bonilla (1982), Carver and McCalpin (1996), Hatheway and Leighton (1979), McCalpin (1996a, b, c), National Research Council (1986), Sherard and others (1974), Slemmons (1977), Slemmons and dePolo (1986), Taylor and Cluff (1973), the Utah Section of the Association of Engineering Geologists (1987), Wallace (1977), Weldon and others (1996), and Yeats and others (1997). McCalpin (1996b) contains a particularly useful discussion of various field techniques. Many other useful references are listed in the bibliographies of the references cited here.

The purpose, scope, and methods of investigation for fault investigations will vary depending on conditions at specific sites and the nature of the projects. Contents and scope of the investigation may also vary based on guidelines and review criteria of agencies or political organizations having regulatory responsibility. However, there are topics that should be considered in all comprehensive

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fault investigations and geologic reports on faults. For a given site some topics may be addressed in more detail than at other sites because of the difference in the geologic and/or tectonic setting and/or site conditions. These investigative considerations should apply to any comprehensive fault investigation and may be applied to any project site, large or small. Suggested topics, considerations, and guidelines for fault investigations and reports on faults are provided in the following annotated outline. Fault investigations may be conducted in conjunction with other geologic and geotechnical investigations (DMG Notes 42 and 44). Although not all investigative techniques need to be or can be employed in evaluating a given site, the outline provides a checklist for preparing complete and well-documented reports. Most reports on fault investigations are reviewed by local or state government agencies. Therefore it is necessary that the reports be documented adequately and written carefully to facilitate that review. The importance of the review process is emphasized here, because it is the reviewer who must evaluate the adequacy of reports, interpret or set standards where they are unclear, and advise the governing agency as to their acceptability (Hart and Williams, 1978; DMG Note 41).

The scope of the investigation is dependent not only on the complexity and economics of a project, but also on the level of risk acceptable for the proposed structure or development. A more detailed investigation should be made for hospitals, high-rise buildings, and other critical or sensitive structures than for low-occupancy structures such as wood-frame dwellings that are comparatively safe. The conclusion drawn from any given set of data, however, must be consistent and unbiased. Recommendations must be clearly separated from conclusions, because recommendations are not totally dependent on geologic factors. The final decision as to whether, or how, a given project should be developed lies in the hands of the owner and the governing body that must review and approve the project.

CONTENTS OF GEOLOGIC REPORTS ON FAULTS

Suggested topics, considerations, and guidelines for investigations and reports

The following topics should be considered and addressed in detail where essential to support opinions, conclusions, and recommendations, in any geologic report on faults. It is not expected that all the topics or investigative methods would be necessary in a single investigation. In specific cases it may be necessary to extend some of the investigative methods well beyond the site or property being investigated. Particularly helpful references are cited parenthetically below.

I. Text

- A. Purpose and scope of investigation; description of proposed development.
- B. Geologic and tectonic setting. Include seismicity and earthquake history.
- C. Site description and conditions, including dates of site visits and observations. Include information on geo logic units, graded and filled areas, vegetation, existing structures, and other factors that may affect the choice of investigative methods and interpretation of data.
- D. Methods of investigation.
  1. Review of published and unpublished literature, maps, and records concerning geologic units, faults, ground-water barriers, and other factors.
  2. Stereoscopic interpretation of aerial photographs and other remotely sensed images to detect fault-related topography (geomorphic features), vegetation and soil contrasts, and other lineaments of possible fault origin. The area interpreted usually should extend beyond the site boundaries.
  3. Surface observations, including mapping of geologic and soil units, geologic structures, geomorphic features and surfaces, springs, deformation of engineered structures due to fault creep, both on and beyond the site.
  4. Subsurface investigations.
     a. Trenching and other excavations to permit detailed and direct observation of continuously exposed geologic units, soils, and structures; must be of adequate depth and be carefully logged (Taylor and Cluff, 1973; Hatheway and Leighton, 1979; McCalpin, 1996b).
     b. Borings and test pits to permit collection of data on geologic units and ground water at specific locations. Data points must be sufficient in number and spaced adequately to permit valid correlations and interpretations.
     c. Cone penetrometer testing (CPT) (Grant and others, 1997; Edelman and others, 1996). CPT must be done in conjunction with continuously logged borings to correlate CPT results with on-site materials. The number of borings and spacing of CPT soundings should be sufficient to adequately image site stratigraphy. The existence and location of a fault based on CPT data are interpretative.
  5. Geophysical investigations. These are indirect methods that require a knowledge of specific geo logic conditions for reliable interpretations. They should seldom, if ever, be employed alone without knowledge of the geology (Chase and Chapman, 1976). Geophysical methods alone never prove the absence of a fault nor do they identify the recency of activity. The types of equipment and techniques used should be described and supporting data presented (California Board of Registration for Geologists and Geophysicists, 1993).
     a. High resolution seismic reflection (Stephenson and others, 1995; McCalpin, 1996b).
     b. Ground penetrating radar (Cai and others, 1996).
     c. Other methods include: seismic refraction, magnetic profiling, electrical resistivity, and gravity (McCalpin, 1996b).
  6. Age-dating techniques are essential for determining the ages of geologic units, soils, and surfaces that bracket the time(s) of faulting (Pierce, 1986; Birkeland and other, 1991; Rutter and Catto, 1995; McCalpin, 1996a).
     a. Radiometric dating (especially 14C).
     b. Soil-profile development.

c. Rock and mineral weathering.

d. Landform development.

e. Stratigraphic correlation of rocks/minerals/fossils.

f. Other methods — artifacts, historical records, tephrochronology, fault scarp modeling, thermoluminescence, lichenometery, paleomagnetism, dendrochronology, etc.

7. Other methods should be included when special conditions permit or requirements for critical structures demand a more intensive investigation.

a. Aerial reconnaissance overflights.

b. Geodetic and strain measurements.

c. Microseismicity monitoring.

E. Conclusions.

1. Location and existence (or absence) of hazardous faults on or adjacent to the site; ages of past rupture events.

2. Type of faults and nature of anticipated offset, including sense and magnitude of displacement, if possible.

3. Distribution of primary and secondary faulting (fault zone width) and fault-related deformation.

4. Probability of or relative potential for future surface displacement. The likelihood of future ground rupture seldom can be stated mathematically, but may be stated in semi-quantitative terms such as low, moderate, or high, or in terms of slip rates determined for specific fault segments.

5. Degree of confidence in and limitations of data and conclusions.

F. Recommendations.

1. Setback distances of proposed structures from hazardous faults. The setback distance generally will depend on the quality of data and type and complexity of fault(s) encountered at the site. In order to establish an appropriate setback distance from a fault located by indirect or interpretative methods (e.g., borings or cone penetrometer testing), the area between data points also should be considered underlain by a fault unless additional data are used to more precisely locate the fault. State and local regulations may dictate minimum distances (e.g., Section 3603 of California Code of Regulations in Appendix B in Hart and Bryant, 1997).

2. Additional measures (e.g., strengthened foundations, engineering design, flexible utility connections) to accommodate warping and distributive deformation associated with faulting (Lazarte and others, 1994).

3. Risk evaluation relative to the proposed development.

4. Limitations of the investigation; need for additional studies.

II. References.

A. Literature and records cited or reviewed; citations should be complete.

B. Aerial photographs or images interpreted — list type, data, scale, source, and index numbers.

C. Other sources of information, including well records, personal communications, and other data sources.

III. Illustrations — these are essential to the understanding of the report and to reduce the length of text.

A. Location map — identify site locality, significant faults, geographic features, regional geology, seismic epicenters, and other pertinent data; 1:24,000 scale is recommended. If the site investigation is done in compliance with the Alquist-Priolo Act, show site location on the appropriate Official Map of Earthquake Fault Zones.

B. Site development map — show site boundaries, existing and proposed structures, graded areas, streets, exploratory trenches, borings geophysical traverses, locations of faults, and other data; recommended scale is 1:2,400 (1 inch equals 200 feet), or larger.

C. Geologic map — show distribution of geologic units (if more than one), faults and other structures, geomorphic features, aerial photo graphic lineaments, and springs; on topographic map 1:24,000 scale or larger; can be combined with III(A) or III(B).

D. Geologic cross sections, if needed, to provide three-dimensional picture.

E. Logs of exploratory trenches and borings — show details of observed features and conditions; should not be generalized or diagrammatic. Trench logs should show topographic profile and geologic structure at a 1:1 horizontal to vertical scale; scale should be 1:60 (1 inch = 5 feet) or larger.

F. Geophysical data and geologic interpretations.

IV. Appendix: Supporting data not included above (e.g., water well data, photographs, aerial photographs).

V. Authentication: Investigating geologist's signature and registration number with expiration data.

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* DMG Note 41 — General guidelines for reviewing geologic reports, 1998.

* DMG Note 42 — Guidelines for geologic/seismic reports, 1986.

* DMG Note 44 — Recommended guidelines for preparing engineering geologic reports, 1986.

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BUILDING AND SAFETY DIVISION

STANDARD PROCEDURE

NO. A-146
REV BY W. Reeder PAGE 1 OF 3
EFFECTIVE 11/8/84 REVISED 9/28/07

SUBJECT

FAULT-RUPTURE HAZARD INVESTIGATION AND REPORT STANDARDS

APPROVED, Barbara Johnston, Building Official

The Alquist-Priolo Earthquake Fault Zoning Act is intended to provide policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibility to prohibit the location of developments and structures for human occupancy across the trace of active faults. The Act allows cities and counties to establish additional policies and criteria so long as they are not less restrictive. These include setting specific investigation and report standards.

Generally, fault rupture hazard investigations and associated reports must adhere to the guidelines outlined in California Geological Survey (CGS) Note 49 entitled "Guidelines for Evaluating the Hazard of Surface Fault Rupture", with Appendix C of CGS Special Publication 42 entitled "Fault-Rupture Hazard Zones in California" and with Chapter 82.15 of the County Development Code.

The policies and criteria outlined in this standard procedure are intended to clarify County requirements and augment the State guidelines.

1. Trenches and/or other exposures in Quaternary age alluvium must provide adequate subsurface coverage for that portion of the project proposed within the Alquist-Priolo Earthquake Fault Zone or, when approved by the County Geologist, for individual building envelopes within the Alquist-Priolo Earthquake Fault Zone.

2. In determining the amount of subsurface coverage provided by widely spaced trenches and/or other exposures in Holocene age alluvium, a 5 degree "factor of safety" that is based on the overall trend of the principal faulting will be considered appropriate. Subsurface data (trench coverage or fault location) should not be extrapolated more than 600 feet without additional surface or subsurface information. *En echelon* or other complex faulting may require closer spacing of trenches.

3. The County Geologist shall be notified at least two working days prior to the start of trenching and shall be provided a trench schedule and a site map showing the approximate location of the proposed trenches. In most cases, the County Geologist must inspect the trenches once they are completed, cleaned and logged. Failure to notify the County Geologist may result in the need to re-excavate trenches.

4. A grading permit is currently not required for the excavation and backfilling of fault trenches when conducted under the supervision of a California Professional Geologist. However, exemption from a grading permit does not grant authorization for any work that may be regulated by other agencies. It is the responsibility of the applicant to determine the need for any additional biological, air quality or water quality, studies, permits or monitoring that may be necessary to excavate trenches on a particular site.

5. Appropriate erosion and sediment control measures are expected during and/or following a site investigation when the excavation and backfilling could result in erosion or migration of sediments off site.

6. Trenches excavated in Holocene age alluvium must be a minimum depth of 10 feet. Deeper trenching may be appropriate depending upon the recency of the deposit. In pre-Holocene materials, trenches must be excavated to a reasonable depth to adequately expose faulting.

7. A trench log must be completed on each trench. The log must be a reasonable graphic representation of the subsurface conditions encountered within the trench, show the topographic profile and be at an undistorted scale no smaller than 1 inch equals 5 feet. Trench logs must show distances along the trench, depth and direction and/or identify which trench wall was logged. The strike and dip of faulting, fracturing, bedding and any other prominent features must be clearly shown.

8. The determined or estimated age of faulted and unfaulted materials exposed within the trenches must be discussed within the report.

9. In accordance with Section 82.15.040 of the County Development Code, a minimum 50 foot setback from active faulting is required for non-critical structures. Greater setbacks may be appropriate from poorly defined faulting or complex faulting such as low angle and thrust faulting. Lesser setbacks may be considered from well defined active faulting exposed in pre-Holocene age materials. The Development Code requires a minimum setback of 150 feet for critical facilities such as police and fire stations, schools, hospitals, nursing homes and emergency communication facilities.

10. If there is a potential for active faulting to occur within 50 feet beyond the end of a trench, a 50 foot setback from the end of the trench will be considered appropriate.

11. An active fault is a fault that has produced surface ground rupture during Holocene time (within approximately the last 11,000 years). A potentially active fault is a Quaternary age fault with unknown Holocene activity. For purposes of the Alquist-Priolo Earthquake Fault Zone Act, if it can be demonstrated that surface ground rupture has not occurred along a fault during all of the Holocene, the fault should be designated as "not active". However, determining fault activity is often difficult and may require multiple lines of evidence including soil profiling, geomorphology and age dating techniques. Building setbacks will be required from faults where Holocene activity remains unknown.

12. Principal faulting exposed within the trenches must be accurately located and staked in the field. Fault laths must be surveyed or tied to a recoverable monument. Trench locations must be tied to a recoverable point. Building setback lines must be tied to a surveyed point.

14. Fault location and building setbacks must be shown on a plat within the report and on the Composite Development Plan as well as any other required development or grading plans. The direction, length and setback distance of each segment of the recommended building setbacks must be specified on the plat within the report as well as discussed within the text.

15. Conclusions based solely on geophysical investigation methods are unacceptable. Geophysical methods alone never prove the absence of faulting nor do they determine the recency of activity.

16. Any portion of a site that lies within an Alquist-Priolo Earthquake Fault Zone which was not covered by trenching or other approved means during the fault rupture hazard investigation, must remain restricted. No human occupancy structures or fault sensitive development can occur within that portion of the site unless a subsequent investigation demonstrates it is free of active faulting.

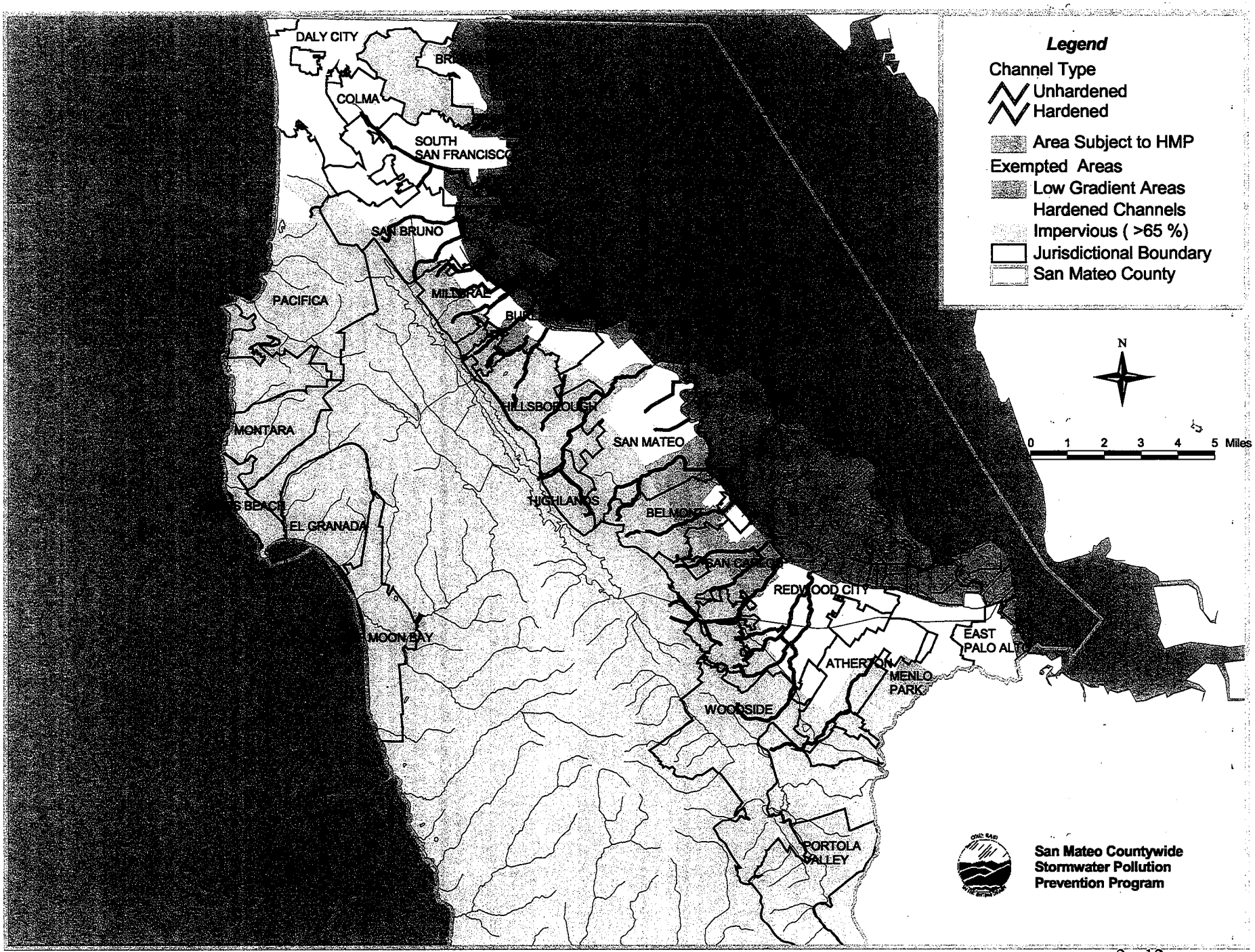


Figure 3-1. Watershed areas proposed as exempt from hydromodification requirements.

Chapter

7

Hydromodification Management Measures

In this Chapter

- *Explanation of hydromodification*
- *Description of hydromodification management controls*
- *Summary of requirements for reducing erosive flows from development projects*

7.1 What is Hydromodification?

Key Point

Changes in the timing and volume of runoff from a site are known as "hydrograph modification" or "hydromodification". When a site is developed, much of the rainwater can no longer infiltrate into the soils, so it flows offsite at ***faster rates and greater volumes***. As a result, erosive levels of flow occur more frequently and for longer periods of time in creeks and channels downstream of the project. Hydrograph modification is illustrated in Figure 7-1, which shows the stormwater peak discharges after rainstorms in an urban watershed (the red, or dark, line) and a less developed (the yellow, or light, line). The axes indicate the volume of water discharged, and the time over which it is discharged.

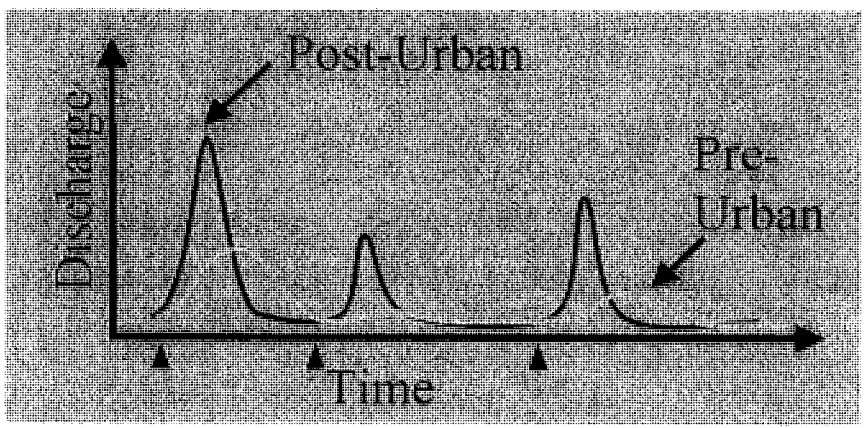


Figure 7-1: Stormwater Peak Discharges in Urban (Red) and Less Developed (Yellow) Watersheds (Source: NEMO-California Partnership, No Date)

In watersheds with large amounts of impervious surface, the larger volumes, faster rates and extended durations of discharge often cause natural creeks or earthen channels to erode, as the channel enlarges in response to the increased flows. ***Problems from this additional erosion*** often include property damage, degradation of stream habitat and loss of water quality, and have not been addressed by traditional detention designs. Figures 7-2 and 7-3 illustrate the effect of increasing urbanization on stormwater volumes.

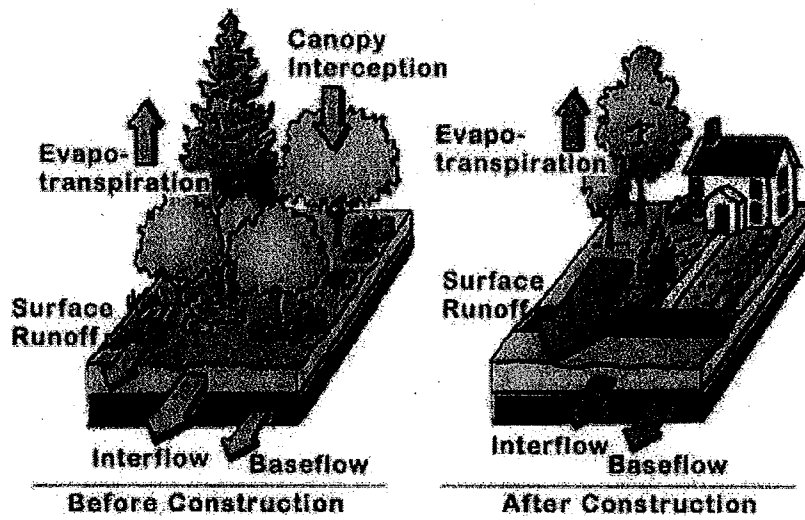


Figure 7-2: Effects of Urbanization on the Local Hydrologic Cycle (Source: 2000 Maryland Stormwater Design Manual)

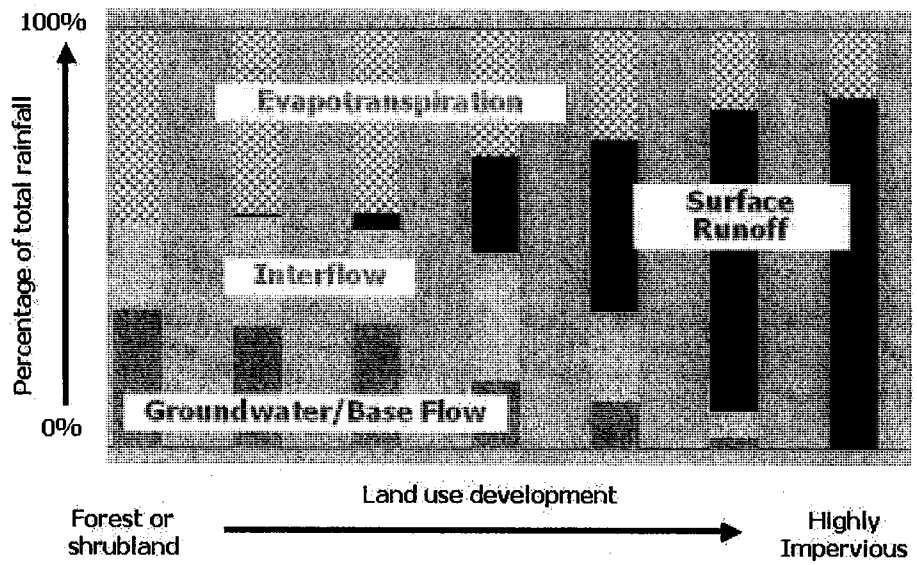


Figure 7-3. Variation in rainfall contribution to different components of the hydrological cycle for areas with different intensity of urban development. (Chart used by permission of Clear Creek Solutions.)

7.2 Hydromodification Management (HM) Controls

Hydromodification management (HM) measures can be grouped into three types:

- ***Integrated management practices***, or IMPs, which are small-scale, stormwater management techniques that are generally distributed throughout a project site. IMPs are designed to minimize directly-connected impervious areas, slow runoff, and maximize infiltration (where appropriate) as described in *Start at the Source* (BASMAA, 1999: www.cleanwaterprogram.org/uploads/SAS_Manual_index.pdf). IMPs may also include the use of bioretention areas, vegetated buffer strips, vegetated swales, roofs that detain water, and multi-functional landscape areas.
- ***Flow duration control measures*** are used to manage excess runoff from the site after IMPs are applied. These ***"end-of-pipe" measures*** mitigate the effects of hydrograph changes from stormwater collected in pipes and channels before the runoff is discharged to a natural channel that could suffer adverse effects. Examples include extended detention basins, wet ponds and constructed wetlands. Please note that there is a difference between the design approach for sizing measures to remove pollutants from stormwater and the approach for designing flow duration controls to prevent an increase in the potential for creek bank erosion. The treatment of stormwater pollutants targets capture of 80% of average runoff volume, which means that treatment measures will be bypassed every one to two years. Flow duration controls must be sized to control the statistical duration of a wide range of flow levels under simulated runoff conditions. Depending on pre-project and post project conditions, the required detention volume is ***likely to be greater*** than the capture volume required for treatment. Flow duration controls are typically used on-site, but larger facilities, such as detention basins, may be sized to control runoff from a regional drainage area.

  Flow duration control measures are sized to control the flow and duration of stormwater runoff according to a ***Flow Duration Control*** standard, which is often greater than size requirements for volume-based treatment.

- ***In-creek or restorative measures*** that modify susceptible watercourses to withstand projected increases in runoff flows and durations without increasing erosion or other impacts to beneficial uses. In-creek measures are more complicated to use than the IMPs and flow duration controls, and are best suited for creeks or channels that have ***already received impacts*** from previous development and have only localized channel instability. Examples include biostabilization techniques using roots of live vegetation roots to stabilize banks and localized structural measures such as rock weirs, boulder clusters or deflectors. These measures will not automatically provide HM protection for channel reaches farther downstream and may require longer planning timelines and cooperation among multiple jurisdictions compared to flow duration controls.

7.3 Hydromodification Management Plan (HMP) Requirements

The Water Board required the Countywide Program to prepare a hydrograph modification management plan, or ***"Hydromodification Management Plan" (HMP)*** in order to reduce erosive flows that result from increasing impervious surfaces in the watersheds of natural creeks. The Water Board is scheduled to adopt an amendment to the countywide municipal stormwater NPDES permit approving the HMP in March 2007. The HMP requirements will go into effect immediately, or as specified in the permit amendment.

HMP Management Objective

Key Point

The HMP's management objective is to control stormwater discharges from non-exempt development projects so that these discharges do ***not increase the erosion potential*** of the receiving creek over the pre-project (existing) condition. This will be accomplished by implementing four performance criteria:

- Projects shall ***provide hydromodification management (HM) controls*** as needed to maintain the pre-project creek erosion potential. These controls may include a combination of on-site or off-site (regional drainage area and/or in-creek) control measures. An erosion potential (Ep) of up to 1.0 shall be maintained for creek segments downstream of the discharge point. Ep can be expressed as the ratio of post-project to pre-project erosive "work" done on the creek.
- On-site stormwater controls that are designed to provide ***flow duration control*** to the pre-project condition shall meet the erosion potential management objective and comply with the HMP. Flow duration controls shall be designed so that the post-project stormwater discharge rates and durations match those of the pre-project condition, from 10 percent of the pre-project two-year peak flow up to the pre-project 10-year peak flow.

> Flow Duration Control looks at the full range of flows in a simulated long-term history, and is ***not directly comparable*** to approaches based on one or a few synthetic "design storms".

- ***Where on-site measures are impracticable*** for achieving flow duration control criteria, projects shall comply with the HMP requirements through the use of appropriate site design, source control and treatment control measures with flow control benefits to the maximum extent practicable. In addition, where available, off-site control measures must be used to meet the hydromodification management objective.
- Projects may use ***off-site control measures*** in lieu of or in combination with on-site controls, where an approved plan – including an appropriate funding mechanism – is in place and accounts for the creek changes expected to result from changes in project runoff conditions. The off-site control measures or combination of controls shall be designed to achieve the management objective of keeping the erosion potential (Ep) at 1.0 or less, from the point of discharge to the creek as far down stream as potential impacts will occur.

Map of Exempt Areas

The HMP includes a map showing areas that are exempt from the HMP requirements, due to their ***limited potential for hydromodification*** to occur. These areas were identified as exempt because they met at least one of following three criteria:

- Low-gradient bayside areas within or adjoining the tidal zone;
- Areas that are tributary to channel segments that have been hardened on all three sides and/or culverted continuously downstream to their outfall to low-gradient bayside areas or Pacific Ocean; and/or
- Highly developed areas with potential for infill projects.

The exempt areas tend to be ***heavily developed areas of the bayside***, while the more open and residential hillside, and coastside areas are subject to the HMP. Four municipalities – East Palo Alto, Foster City, Daly City, and Colma – are totally exempt, while all of the other municipalities have at least portions of their jurisdictions subject to the HMP.

Before they can be implemented, key provisions of the Program's HMP must be approved by the Water Board. Full implementation of the HMP will be required upon approval. Use this link, www.flowstobay.org/pdfs/New%20Development/HMP%20Report%20Final.pdf, to access the HMP on the Internet.

7.4 Determining Applicability

Unless it is listed as exempt in Table 7-1, your project will be required to comply with the HMP if it meets the following applicability criteria:

- The project creates one acre or more of new impervious surface.
- The project is not located in an exempt area, as shown on the HMP's map of exempt areas (included in Appendix J).

If your project will create one acre or more of impervious surface, the local municipality will use the map in Appendix J to determine whether it will need to comply with the HMP requirements. Specific types of projects are also exempt from the HMP requirements, as listed in Table 7-1. Please note that projects located in areas subject to the HMP should include appropriate integrated management practices (IMPs) for hydromodification management if they are likely to cause hydrograph changes, ***even if they do not meet the other applicability criteria.***

Table 7-1
Projects Exempt from HMP Requirements

1	The construction of a single-family residence that is not part of a larger plan of development (NOTE: the permit requires the project to use pollutant source control, site design, and landscaping to treat stormwater runoff from impervious surfaces.)
2	A redevelopment project that does not increase the amount of impervious surface and the time

Table 7-1 Projects Exempt from HMP Requirements	
	of concentration of stormwater runoff (NOTE: these projects should use appropriate integrated management practices (IMPs) to prevent the volume of runoff and time of concentration from increasing compared with the pre-project condition.)
3	A transit type of development within ¼ to ½ mile of a transit station and/or intermodal facility
4	A project within a "Redevelopment Project Area" that redevelops an existing brownfield site or creates housing units affordable to persons of low or moderate income.

7.5 How to Implement HMP Requirements

Projects subject to HMP requirements need to consider HM at every stage of project development, following the step-by-step instructions for C.3 submittals in Chapter 3. The most effective use of land and resources may require a combination of IMPs, flow duration control facilities and in-creek measures, which are described in Section 7.2. In general, the strategy for designing HM measures should:

- ***Start with site design*** to minimize the amount of runoff to be managed (see Chapter 4).
- Where possible, ***maximize infiltration*** to further reduce detention requirements. Note that infiltration is limited by site constraints such as slope stability concerns, low-permeability soils or groundwater protection constraints.
- Use ***flow duration controls*** to detain the remaining calculated runoff from the site enough to ***control its release*** in a way that meets the remaining runoff design requirements. This may be accomplished with a measure that also provides volume-based treatment, such as an extended detention basin. For some project locations, off-site options may be available to reduce or eliminate the need for onsite detention.

7.5.1 Flow Duration Control

The duration of channel flows below the ***"critical flow"*** may be increased indefinitely without significant contribution to hydromodification impacts.

Key Point

Flow Duration Control (FDC) differs from traditional "design storm" approaches used to design detention facilities for flood control or water quality treatment. Instead of specifying static holding times for one or a few discrete events, the Flow Duration standard manages runoff discharge over the full range of runoff flow levels predicted through continuous hydrologic simulation modeling, based on a long-term precipitation record. Flow Duration Control requires that the increase in surface runoff resulting from new impervious surfaces be ***retained on-site with gradual discharge*** either to groundwater through infiltration, losses by evapotranspiration, and/or discharge to the downstream watercourse at a level below the critical flow that causes creek channel erosion. ***Critical flow,*** or Qc, is the lower threshold of in-stream flows that contribute to sediment erosion and sediment

transport or effective work. The duration of channel flows below Qc may be increased indefinitely without significant contribution to hydromodification impacts.

7.5.2 Application of Flow Duration Control to Project Areas

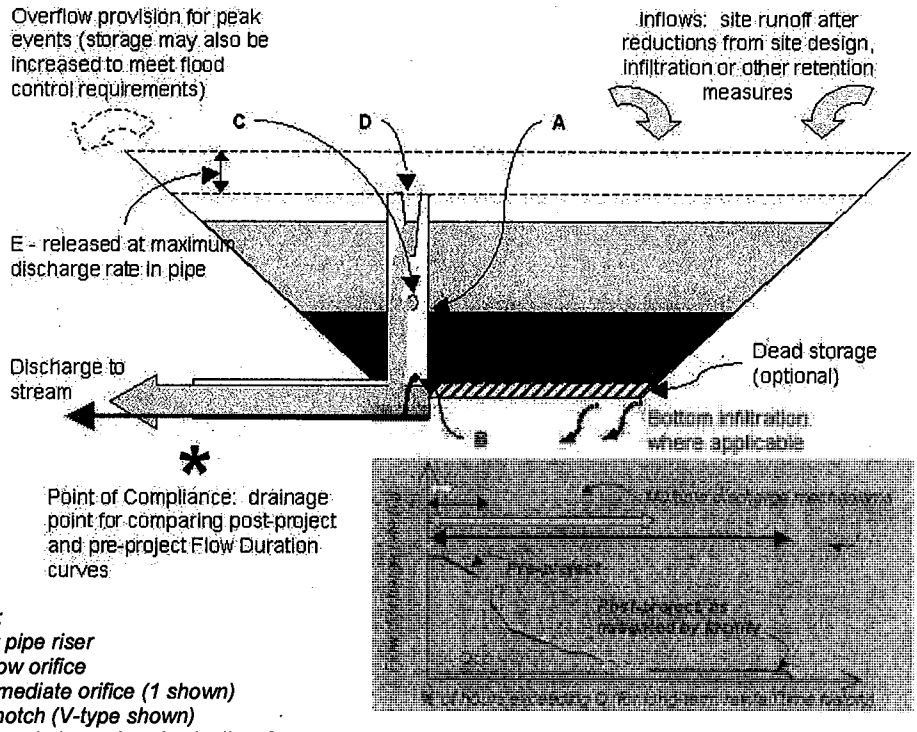
The Flow Duration approach involves a continuous model that applies a time series of at least 20 years of rainfall records to a watershed area or project site to generate a simulated stormwater runoff record based on two sets of inputs, one representing future development and the other representing pre-project conditions. The 20-year precipitation record is the minimum length necessary to capture the range of runoff conditions that are cumulatively responsible for most of the erosion and sediment transport in the watershed, primarily flow levels that would recur at average intervals of 10 years or less in the pre-project condition. The design objective is to ***preserve the pre-project cumulative frequency*** distribution of flow durations and sizes under post-project flows. This is done with a combination of site design, infiltration and detention. Typically the post-project increase in surface runoff volume is routed through a ***flow duration control basin*** or other structure that detains a certain portion of the increased runoff and discharges it through a ***specialized outlet structure*** (see Figure 7-4).

The flow duration basin, tank or vault is designed conceptually to incorporate multiple pools that are filled with different frequencies and discharge at different rates. The low-flow pool is the bottom level designed to capture and retain small to moderate size storms, the initial portions of larger storms, and dry weather flows. These flows are discharged through the lowest orifice which allows continuous ***discharge below the critical flow rate*** for a project (Qcp). Successively higher-flow pools store and release higher but less frequent flows through other orifices or graded weir notches to approximate the pre-project runoff durations. In practice the multiple pools are usually integrated into a single detention basin, tank or vault that works as a unit with the specialized outlet structure. Matching the pre-project flow durations is achieved through fine-tuning of the number, heights and dimensions of orifices or weir notches, as well as depth and volume of the basin, tank or vault.

Flow Duration facilities are subject to ***Operations and Maintenance*** reporting and verification requirements similar to those for numerically sized treatment measures.

As shown in the example chart of Figure 7-4, the post-project flow duration curve (red, or dark line) is reduced by the facility to remain ***at or below the pre-project curve*** (yellow, or light line), except for flows less than Qcp. Minor exceedances are permissible at a limited number of higher flows since at other flow levels the post-project duration is actually less than the pre-project condition.

If feasible, ***combining flow duration and water quality treatment*** into a single facility reduces the overall land requirements for stormwater management. Adequate maintenance of the low-flow orifice or notch is critical to proper performance. The outlet may be in a protective enclosure to reduce risk of clogging. Please note that Flow Duration facilities are subject to Operations and Maintenance verification requirements similar to those for numerically sized treatment measures.



Legend:
A-outlet pipe riser
B-low flow orifice
C- intermediate orifice (1 shown)
D-weir notch (V-type shown)
E-freeboard above riser (typically 1 foot)

Figure 7-4: Schematic flow duration pond and flow duration curves matched by varying discharge rates according to detained volume. (Source: ACCWP, 2006)

7.5.3 Bay Area Hydrology Model (BAHM)

To facilitate the simulation modeling aspect of FDC for project applicants and their engineers, the Countywide Program collaborated with the Santa Clara and Alameda counties' stormwater programs to develop a Bay Area Hydrology Model ***software package*** that is adapted from Version 3 of the Western Washington Hydrology Model (WWHM) developed by Clear Creek Solutions for the State of Washington Department of Ecology (WDOE). The WWHM was specifically developed to help engineers design facilities to meet a Flow Duration Control standard for development projects.

Key Point

The BAHM, which may be downloaded from the Program's website together with county-specific data, includes:

- Databases to automatically assign default ***rainfall conditions*** for a project location selected within the County boundary.
- A user interface for developing a ***schematic drainage model*** of the project site, with forms for entering areas of land use or impervious surface for multiple sub-basins.

- Continuous simulation modeling of ***pre-project and post-project runoff*** from the site using actual long-term rainfall records appropriately scaled for the project location.
- A design module for sizing a ***FDC detention facility*** and designing the discharge structure to meet the Flow Duration standard for matching post-project and pre-project duration-frequency curves. Pre-project and post-project runoff are compared at a "point of compliance" selected by the designer, usually near the point where runoff leaves the project area.
- Options to check facility sizing for ***volume-based treatment***, and incorporate runoff reductions attributable to some common hydrologic source control measures.
- Standardized output ***report files*** that can be saved in Word format, and include all information about data inputs, model runs, facility design, and summary of the hydrological statistics showing the compliance of post-project flow duration curves with the Flow Duration standard. Project input and output data can also be saved in Excel and other formats for other uses.

7.6 Area-Specific HM Provisions

Individual municipalities may have special policies or ordinances for creek protection applicable in all or part of their jurisdictions. ***Contact the municipal staff from your jurisdiction*** to identify any special local provisions that may encourage or affect specific forms of HM implementation. Examples of area-specific HM provisions can include:

- Watershed-based land-use planning measures, such as creek buffers, which may be incorporated in local General Plans, zoning codes or watercourse ordinances.
- Special permitting provisions for project design and review of projects on streamside properties.
- Specific plans for regional HM measures or in-stream restoration projects.
- Any Equivalent Limitation Protocols that may be proposed, in accordance with Provision C.3.f.vii of the municipal stormwater permit, as alternatives to the default HM requirements in specific jurisdictions or watersheds.

Individual municipalities may have special policies or ordinances for ***creek protection*** applicable in all or part of their jurisdictions.

Pacific Institute: Sea-Level Rise - Mozilla Firefox

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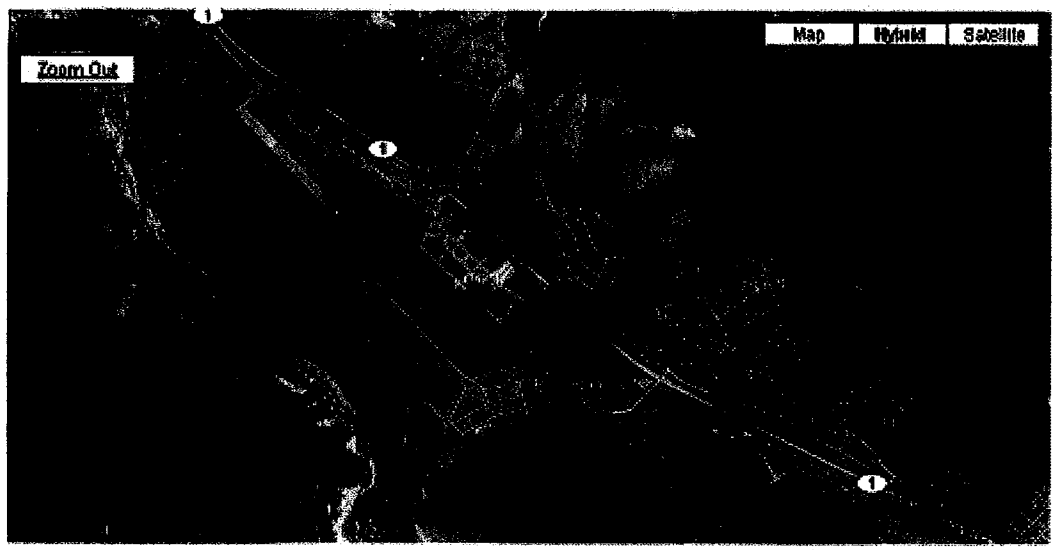
Impacts of Sea Level Rise on the California Coast

Pacific Institute

Areas and infrastructure vulnerable to flooding and erosion

Please see full report for assumptions, methods, and conclusions.



Hazard Zones

- ☑ Area at risk from a 100-year coastal flood event
  - Current area at risk
  - Area at risk with a 1.4 meter sea-level rise
- ☐ Erosion
  - Area at risk from erosion in 2100 with a 1.4 meter sea-level rise
- ☐ Wetland Frontier
  - Areas where wetlands may migrate by 2100 if unimpeded

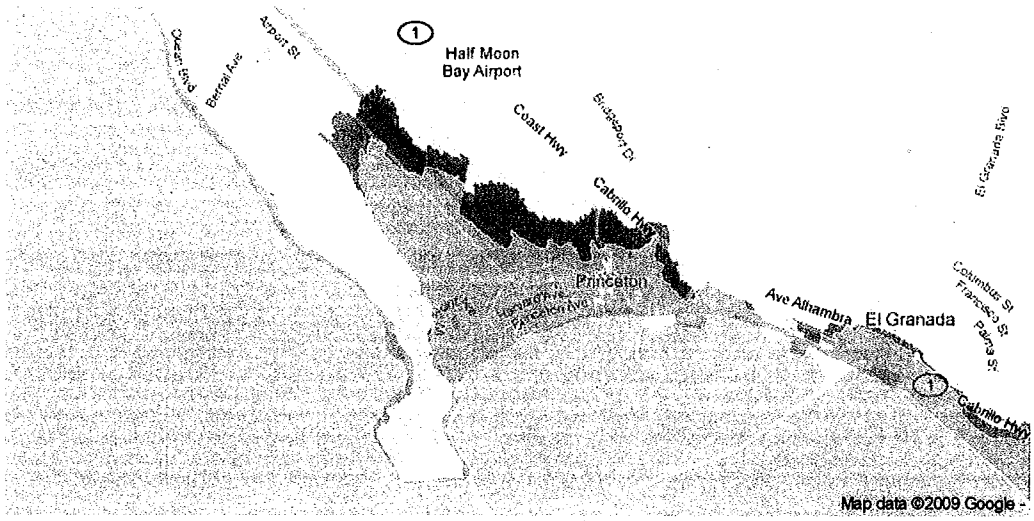
Data Layer Opacity

1/4 | 1/2 | 3/4 | Solid

Done

Impacts of Sea Level Rise on the California Coast

Areas and infastructure vulnerable to flooding and erosion
Please see full report for assumptions, methods, and conclusions.



Pacific Institute

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  - Areas where wetlands may migrate by 2100 if unimpeded

Data Layer Opacity

1/4 | 1/2 | 3/4 | Solid

Infrastructure at Risk

Click map icon for details

- ☐ CA Coastal Zone
- ☐ Health-care facilities
- ☐ Schools
- ☐ Police stations
- ☐ Fire stations
- ☐ Wastewater treatment plants
- ☐ EPA-regulated sites

Disclaimer

This information is being made available for informational purposes only. Users of this information agree by their use to hold blameless the State of California, and its respective officers, employees, agents, contractors, and subcontractors for any liability associated with its use in any form. This work shall not be used to assess actual coastal hazards, insurance requirements, or property values and specifically shall not be used in lieu of Flood Insurance Studies and Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).

State of California
Department of Fish and Game

Flex your POWER

Memorandum

Date: October 15, 2009

To: Mr. Charles Fielder, District 1 Director
CA Department of Transportation – District 1
Post Office Box 3700
Eureka, CA 95502-3700

From: for Kenneth L. Moore
GARY B. STACEY, Regional Manager
Northern Region, Department of Fish and Game
601 Locust Street
Redding, CA 96001

Subject: **Eureka – Arcata Corridor Improvement Project – Draft EIR/EIS SCH # 2001092035 –Impacts Related to Sea Level Rise and Climate Change**

On July 3, 2009, the California Department of Fish and Game (DFG) received a request from your agency for comments and concurrence on the preliminary Least Environmentally Damaging Practicable Alternative (LEDPA) determination for the proposed Route 101 Eureka-Arcata Corridor Improvement Project (project). On July 21, 2009, DFG received a draft prospectus for a Humboldt Bay Transportation Mitigation Bank, which includes a conceptual wetland mitigation plan for this project.

As a trustee for the State's fish and wildlife resources, DFG has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants and the habitat necessary to sustain their populations. As a responsible agency, DFG administers the California Endangered Species Act (CESA) and other provisions of the Fish and Game Code that afford protection to the State's fish and wildlife public trust resources. While DFG is not a signatory agency to the National Environmental Policy Act and Clean Water Act Section 404 process, the refinement of the scope of the project to LEDPA Alternative 3(a), is an appropriate opportunity for DFG to provide additional comments and recommendations regarding impacts on Humboldt Bay habitats and species under the most recent sea level rise (SLR) scenarios. DFG is currently reviewing the wetland bank prospectus and comments on it will be included in a separate memorandum.

DFG has written two previous memoranda on this project, including one on the Draft Environmental Impact Report/Statement (DEIR/S). DFG Staff Environmental Scientists Craig Martz and Gordon Leppig have also attended a number of meetings with Department of Transportation (Caltrans) and wildlife agency staff to review potential environmental impacts and mitigation measures for this project.

DFG offers these comments pursuant to the California Environmental Quality Act (CEQA) in our role as a responsible and trustee agency for California's fish and wildlife.

Project Scope

According to the LEDPA determination, major project features may include: closing all Route 101 median openings; extending acceleration and deceleration lanes at existing intersections; constructing a Route 101/Indianola Cutoff interchange; realigning and signalizing Airport Road at Route 101; constructing an additional lane from the existing Cole Avenue acceleration lane to the Mid City Motor World entrance; replacing the bridge rails on the northbound Jacoby Creek and Gannon Slough Bridges; and replacing the southbound Jacoby Creek Bridge. The total estimated project cost ranges from $39 million to $62 million.

The project includes a section of highway approximately 10 kilometers (six miles) long. National Oceanic and Atmospheric Administration tide station elevation data indicates land within or adjacent to a majority of the project site's length is below year 2000 mean higher high water (MHHW) tidal elevation and a projected 1.4-meter sea level rise places nearly the entire project area below Humboldt Bay's MHHW. The MHHW is a 19-year average of the higher of the two daily high tides.

Nearly all of the project area is former tidal saltmarsh or intertidal mudflat. Open water in the form of sloughs, streams, and tidal drainage canals, or coastal wetlands, including subtidal mudflat, saltmarsh, brackish marsh, and freshwater palustrine wetlands occur directly adjacent to the majority of the project's length. The Humboldt Bay National Wildlife Refuge borders the project site to the north and east for approximately four kilometers (2.5 miles) and the DFG Fay Slough Wildlife Area borders the project site to the south-southeast for approximately two kilometers (1.25 miles).

Project Setting and Biological Significance of Humboldt Bay

Humboldt Bay is California's second largest estuary and provides regionally significant fish and wildlife habitat. Humboldt Bay provides refuge and nursery habitat for more than 120 fish species, many with important commercial and recreational fisheries value. Humboldt Bay is also a biodiversity hotspot in that its wetlands and dunes are habitat for at least 20 State-and federally-listed or otherwise sensitive species. Humboldt Bay is also California's largest producer of oysters and a vital nursery for juvenile Dungeness crab (*Cancer magister*).

Jacoby Creek is habitat for the State and federal "threatened" coho salmon (*Oncorhynchus kisutch*), as well as coastal cutthroat trout (*Oncorhynchus clarki clarki*), a California species of special concern; steelhead trout (*Oncorhynchus mykiss*) a federal "threatened" species; and tidewater goby (*Eucyclogobius newberryi*) a federal "endangered" species and California species of special concern. Longfin smelt (*Spirinchus thaleichthys*), a State "threatened" species, is documented in Humboldt Bay and its major tributaries. Areas within the project site, including Jacoby Creek, appear to provide habitat for this species.

The coho salmon population in Jacoby Creek has been designated by DFG as a key population to maintain or improve as part of the *Recovery Strategy of California Coho Salmon* (DFG 2004). Coho salmon have undergone at least a 70% decline in abundance since the 1960s, and is currently at 6 to 15% of its abundance during the 1940s (DFG 2004).

Humboldt Bay contains more than half of all the native eelgrass (*Zostera marina*) in California. Native eelgrass beds are highly productive nurseries and refuge areas that are widely recognized for their critically important ecological function in Pacific Northwest estuaries (Phillips 1984). The Pacific Flyway population of black brant (*Branta bernicla*) is dependent upon the eelgrass in Humboldt Bay because it has the greatest amount of eelgrass between the black brant wintering areas in Baja California and Willapa Bay in Washington. Native eelgrass may not be cut or disturbed (Title 14, California Code of Regulations §30.10) and is considered Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

More than two hundred species of birds have been recorded in the north Humboldt Bay area, including a wide variety of wetland, riparian and migratory species. The coastal wetlands around Humboldt Bay are essential habitat for shorebirds and more than one hundred thousand shorebirds winter in or migrate through Humboldt Bay annually (Galbraith et al., 2002; WHSRN 2009). Humboldt Bay, combined with the Eel River delta, is recognized as a site of national and international importance for shorebirds by the Western Hemisphere Shorebird Reserve Network (WHSRN 2009) and is used by greater than 10% of Pacific Flyway shorebirds.

Climate Change-Induced Sea Level Rise (SLR)

Information presented below is guided by the analysis and conclusions of the Intergovernmental Panel on Climate Change (IPCC 2001), U.S. Global Change Research Program (USGCRP 2009), and reports produced by the California Energy Commission for the California Climate Change Center (CEC 2005, 2009a, 2009b, 2009c). The research funded and produced by the California Energy Commission is the leading authoritative body of work on direct and indirect climate change effects on the

State's resources, infrastructure and economy. SLR is of significant concern to the State's leadership and in November 2008 the Governor signed Executive Order S-13-08 to create the first state-wide SLR assessment report to advise how California should plan for future SLR, as well as initiating the State's first climate change adaptation planning effort.

During the last 100 years, globally-averaged sea level has risen approximately 10 to 20 centimeters (approximately 4 to 8 inches), or about 1.0 to 2.0 millimeters/year (IPCC 2001). Tidal gauge data for California and the west coast of the United States have shown a similar trend in SLR during this period (CEC 2005). Current scenarios for the California coast project an increase in sea level from 1.0 to 1.4 meters (approximately 3.2 to 4.6 feet) by the year 2100 (CEC 2009a). Current SLR scenarios are roughly linear throughout their projected horizon, thus approximately half of the anticipated 2100 sea level rise is likely to occur by year 2050 (CEC 2009a).

Global warming is expected to result in an acceleration of current rates of SLR, resulting in inundation of many low-lying coastal areas (IPCC 2001; CEC 2005, 2009a; Nicholls and Tol 2006; USGCRP 2009). Throughout the current century, coastal areas worldwide are expected to experience higher rates of coastal erosion, flooding, inundation, and storm surges as a result of SLR (EPA 1988; IPCC 2001; CEC 2005, 2009a; USGCRP 2009). There is strong scientific consensus that coastal marine ecosystems, along with the goods and services they provide, are threatened by climate change-induced SLR (IPCC 2001; Scavia et al., 2002; Harley et al., 2006; Nicholls and Tol 2006; CEC 2009a; USGCRP 2009). By the 2080s, sea level rise could cause the loss of up to 22% of the world's coastal wetlands, according to a global analysis done by Nicholls et al., (1999).

The most recent and authoritative synthesis of future climate change and SLR scenarios and anticipated consequences for California come from the California Climate Change Center (CEC 2005, 2009a, 2009b, 2009c); some of their key findings include:

- During the last 100 years, sea level has risen nearly eight inches along the California coast, and general circulation model scenarios suggest very substantial increases in sea level as a significant impact of climate change over the coming century.

- Under medium to medium-high greenhouse-gas emissions scenarios, mean sea level along the California coast is projected to rise from 1.0 to 1.4 meters (approximately 3.2 to 4.6 feet) by the year 2100.

- National studies on the economic cost of sea-level rise suggest that while adapting to climate change will be expensive, so are the costs of doing nothing, as substantial investments are already at risk and vulnerable.

- Sea level rise must be integrated into the design of all coastal structures.

- Current efforts to build, maintain, or modify structures in coastal areas at risk of sea-level rise must be based on current estimates of a projected 1.4-meter sea level rise by the year 2100.

This project includes the replacement of the southbound Route 101 Bridge over Jacoby Creek and construction of a Route 101/Indianola Cutoff interchange. Caltrans currently designs bridges and overpasses with a 75-year design life (AASHTO 2007). Given a 75-year design life for these structures, if construction of this project is not scheduled to be completed until 2015, then the project life-span squarely overlaps with current SLR projections for this century.

Climate change, and consequent SLR, is principally driven by greenhouse gas (GHG) emissions (IPCC 2001). Given current and on-going state, national, and international efforts, GHG emissions during coming decades could be substantially reduced and climate change scenarios modified accordingly. However, even if GHG emissions are stabilized, the rate of SLR will likely continue to increase beyond 2100 because of the time it takes for oceans and ice sheets to approach equilibrium with the atmosphere (Scavia et al., 2002; CEC 2009a).

Changes in the rate of SLR at a given site will vary from global averages based upon local and regional variability in tectonic uplift, land subsidence, post-glacial isostatic rebound, compaction of sedimentary soils, and oil, natural gas, and water withdrawal (EPA 1988; Galbraith et al., 2002; Scavia et al., 2002).

Increased sea levels, especially in combination with storm-driven surges, extreme waves, intense low-pressure autumn or winter storms, high tides, and El Niño conditions, are predicted to result in extensive flooding in coastal regions of California and the Pacific Northwest and significant damage to coastal infrastructure (CEC 2005; USGCRP 2009). Kelvin waves, for instance, are generated in the tropical western Pacific during El Niño events and can intensify the impact of Northcoast winter storms. These waves move northward up the California coast bringing an influx of warm water and raising sea level by 15-25 cm (6-10 inches) as they pass (CEC 2005). The wave climate at Humboldt Bay is currently described as "extreme" in comparison to most inlets in the United States, and the Bay's orientation combines with prevailing winds to produce significant wind-generated waves within the Bay (Costa and Glatzel 2002; Claasen 2003).

In an analysis of 140 years of tidal data from central California, Bromirski et al., (2003) found that since about 1950, California has experienced a significant increasing trend in extreme winter storms resulting in extreme high sea level residuals. Intense storm events cause the greatest coastal erosion and have the greatest impact on coastal

development (Bromirski et al., 2003). In the past two decades, California has experienced significant increases in annual maximum wave heights and in the number of waves classified as extreme as a result of more intense El Niño events (Seymour 2003). The lower sloughs of the largest bay tributaries presently experience seasonal fluctuations in tidal height of up to 3 meters (Wallace and Allen 2009).

Despite considerable uncertainty in State-wide climate model predictions (CEC 2009b), regional climate studies project an increase in the frequency and intensity of high precipitation and high runoff storm events in Northern California and the northern Coast Range in the next 50 years (Kim et al., 2002; Snyder et al., 2002; Bell et al., 2004; Kim 2005; CEC 2009c). By projecting changes in streamflow output for eighteen stream gauging stations statewide, California Energy Commission scenarios show all California rivers studied will have an increase in average flow during January to April by the end of the century (years 2070–2099) compared to historical periods (CEC 2009c). Projections under certain high greenhouse gas emission scenarios predict spikes in February river flows of 60% above historic levels, and increases in December river flows of 20% to almost 40% in other scenarios (CEC 2009c).

Climate models predict the number of occasions when high sea levels and high river flows coincide will increase markedly in this century (CEC 2009b). According to CEC (2009b), "The combined impacts of sea level rise (and high sea-level stands) with concurrent flood flows have the potential to imperil many smaller coastal and estuarine settings and communities along the California coast."

According to CEC (2009a), to guard against flooding from a 1.4-meter sea level rise, Humboldt County will need an estimated 58 kilometers (36 miles) of new levees and 10.6 kilometers (6.6 miles) of new seawalls, with an estimated capital cost of $460 million (in year 2000 dollars). State wide, the estimated capital cost to guard against flooding from a 1.4-meter sea level rise will be $14 billion (in year 2000 dollars) (CEC 2009a).

According to the National Research Council (1987) and Nicholls and Tol (2006), the main environmental effects of SLR on coastal communities include:

- Inundation and flooding including storm damage from sea surges and backwater effects from rivers and steams,
- Wetland loss and change,
- Beach and shoreline erosion,
- Saltwater intrusion to surface waters and groundwater, and
- Rising water tables and impeded drainage.

According to the National Research Council (1987), there are two major options for addressing flooding and erosion caused by SLR:

- stabilize the shoreline either through beach nourishment or by new or augmented coastal armoring, or

- retreat from the shoreline, maintaining a more-or-less equal elevation above local sea level.

Potential Indirect Project Impacts and Ecosystem Interactions

Given the State-wide efforts to incorporate climate change into all levels of State Government planning activities, and Caltrans' specific role in the statewide adaptation planning effort, DFG is concerned this project's DEIR/S, Draft Biological Assessment, and LEDPA determination include no mention of SLR, despite the project's large size, significant cost, and close proximity to current sea level.

While the project description includes no SLR adaptation strategy, it is reasonable to assume that future abandonment of this section of highway is not being considered. Therefore, new or augmented armoring can be anticipated during the life of the project. According to the Humboldt Bay Management Plan Final EIR (HBHRCD 2006), "While the appropriate solutions to the quandaries posed by sea level rise are currently not known, these solutions almost certainly will involve placing fill into the bay's waters and/or into other wetlands behind the levees."

According to the preliminary recommendations in the 2009 California Climate Adaptation Strategy Discussion Draft (California Natural Resources Agency 2009):

> "State agencies should generally not plan, develop, or build any new significant structure in a place where that structure will require significant protection from sea-level rise, storm surges, or coastal erosion during the expected life of the structure. However, vulnerable shoreline areas containing existing and proposed development that have regionally significant economic, cultural, or social value may have to be protected, and in-fill development in these areas should be accommodated."

The Eureka-Arcata 101 Corridor is currently prone to overtopped levees, coastal erosion and flooding. The railroad levee, which follows the project site to the west, occurs between Humboldt Bay and the highway and has been out of use and unmaintained for more than a decade. This levee is currently ineffective in protecting the proposed project alignment from erosion, storm surges, and flood inundation. A storm on New Year's Eve 2005/2006 caused Humboldt Bay's surface elevation to overtop the railroad levee and partially

inundate the southbound lanes of Highway 101. Erosion of the ballast material from beneath the rails locally has reduced the effective levee height by as much as a foot in some locations, potentially increasing the risk of future flooding on the project site because of increased tidal elevations (HBHRCD 2006).

Based upon the above climate change and SLR data and the project's size, location, design life, and reasonable foreseeable adaptation strategy, there is a fair argument this project could have the following significant impacts on the Humboldt Bay ecosystem:

Direct Loss and Impacts to Wetlands

Much of the project site is directly adjacent to wetlands. Given the project site's current and accelerating risk of erosion and flooding, it is reasonably foreseeable that construction or reconstruction of armoring such as seawalls, levees, or rock slope protection is likely to result in wetland loss. As a result of SLR-related armoring, this project's wetland impacts are likely greater than those disclosed or evaluated by the project's current environmental documents. DFG believes further losses of Humboldt Bay saltmarsh should be considered cumulatively significant given diking and filling have already reduced bay saltmarsh habitat by 85 to 90% since 1897 (Barnhart et al.,1992).

The final EIS/EIR must evaluate the impacts to wetlands from the anticipated armoring and wetland filling needed to protect the project from SLR-related flooding and damage during its design life.

Indirect Habitat Loss by Prevention of Landward Migration

Coastal wetlands and subtidal habitats can adjust to changes in sea level when they are capable of remaining at the same elevation relative to the tidal range (EPA 1988; NOAA 2000). This can occur if sediment buildup (accretion) equals the rate of relative SLR or if the wetland is able to migrate landward (NOAA 2000; Morris et al., 2002; Scavia et al., 2002; CEC 2009a). If wetlands are unable to keep pace with relative SLR, or if their migration is blocked by coastal development or shoreline protection structures, then it will become immersed and eventually lost as rising seas submerge it (Titus 1991; NOAA 2000; Galbraith et al., 2002; CEC 2009a). The greatest loss and ecological impacts to intertidal habitats from future SLR is likely to occur at sites where the tidal zone is not allowed to migrate inland either by topography or by coastal protections such as seawalls, roads, and other infrastructure (Galbraith et al., 2002).

Humboldt County ranks third among California counties for total area of existing coastal wetlands, and second among California counties for both percentage and total area of coastal wetlands that can viably migrate upslope as a result of rising sea level (CEC 2009a). Of the approximately 52 square kilometers (20 square miles) of potential

coastal wetland migration area in Humboldt County, 39% is viable wetland habitat post-SLR (undeveloped), and an additional 54% is viable but with some economic loss to property owners (CEC 2009a). At least 7.8 square kilometers (three square miles) of potential wetland and intertidal mudflat migration area lies landward (east-southeast) of the project site.

Galbraith et al., (2002) conducted an analysis of the loss of intertidal shorebird habitat in Humboldt Bay based upon lower SLR estimates found in EPA (1995). Their model predictions assume that no new coastal protection structures will be installed. They project that by 2100, Humboldt Bay will lose approximately 29% of its intertidal habitat. This scale of habitat loss is highly likely to impair Humboldt Bay's ability to continue to support its current number of shorebirds (Galbraith et al., 2002). Under current SLR scenarios, this project has the potential to block the landward migration of saltmarsh and subtidal mudflats, and must be addressed in the final EIR.

Alterations to Humboldt Bay's Hydrology and Physical Processes

Construction of coastal armoring such as seawalls modifies waves that interact with them causing wave refraction, reflection, and changes in energy patterns (Sylvester and Hsu 1993). This in turn can alter numerous physical processes in the Humboldt Bay, including: circulation patterns; sediment transport and rates and patterns of deposition/accretion; current patterns and velocity; tidal exchange, mixing, and timing; and ultimately, Humboldt Bay's bathymetry (depth and topography) and shoreline erosion patterns and intensity (Sylvester and Hsu 1993; Claasen 2003).

These alterations to Humboldt Bay's physical processes are likely to affect wetland and intertidal habitats and their vital fisheries and wildlife values. Changes in marine and estuarine physical processes can affect, for instance, Humboldt Bay's ecological keystone eelgrass beds (*Zostera marina*). Eelgrass is sensitive to alterations in estuarine processes such as water depth, turbidity, substrate size and sorting, and current velocities (Phillips 1984).

The project's potential impacts on Humboldt Bay's sediment transport and deposition patterns, and erosion patterns and rates, combined with impediments to habitat migration are also likely to impact habitat for saltmarsh plants such as Humboldt Bay owl's clover (*Castilleja ambigua* var. *humboldtiensis*) and Point Reyes bird's beak (*Cordylanthus maritimus* ssp. *palustris*), both of which are present on the project site. Humboldt Bay owl's clover and Point Reyes bird's beak are listed by the California Native Plant Society (CNPS) as 1B species and have a State rank of S2.2. DFG believes these species meet the criteria of rare as provided by CEQA Guidelines Section 15380. Adverse impacts to these species could potentially constitute a significant effect on the environment.

Given the importance of the fish and wildlife habitat within and adjacent to the project site and the potentially significant SLR-related adaptation (armoring) impacts on Humboldt Bay's physical processes, DFG recommends the final EIR include these impacts in its environmental analysis.

Flooding

The DEIR/S states "Most of the existing Route 101 roadway and bridges within the project limits are either adjacent to, or within the 100-year floodplain. Any improvements to this facility to avoid floodplain encroachment would not be feasible."

The DEIR/S (pages 164-165) states: 1) the proposed drainage improvements for this project will result in no decrease in capacity, 2) the proposed work would not have a substantial effect on base flood elevations, and 3) there would be no increase in flooding risks because of this project.

However, the environmental analysis for this project does not utilize the most current (CEC 2009a; 2009b) climate change and SLR projections to determine the project's hydrologic impacts on the flooding regime and drainage capacity of adjacent wetlands and streams. Periodic flooding is an essential characteristic of wetlands (Titus 1991). In all floodplains, hydrology is a major driving ecological force and changes in the amplitude, duration, shape, frequency, and timing of flood events can have significant consequences for wetland habitat quality and biodiversity (Junk and Wantzen 2006).

As stated in DFG's September 28, 2007 memorandum, the Jacoby Creek Route 101 bridges and the railroad crossing immediately downstream currently constrict flood flows on Jacoby Creek, resulting in channel aggradation and backwater flooding upstream. The project design remains unclear as to whether the new southbound Jacoby Creek bridge design will result in increased channel capacity. The DEIR/S does not indicate the return frequency of the discharge the new Jacoby Creek structure will be designed to pass.

A recommended management action for North Coast estuaries is to assure adequate tidal circulation in estuarine restoration or enhancement projects through levee removal or setback, tidegate removal, and tidal circulation improvement (Waterboards 2009). An inadequate tidal prism has been identified as a principal limiting factor in a number of Humboldt Bay saltmarsh restoration projects. Without utilizing the most current 2100 SLR hydrologic projections, Caltrans cannot adequately evaluate what effect this project will have on adjacent floodplain hydrology and biodiversity, including the tidal circulation of existing, on-going, and future wetland, estuarine and riparian restoration projects.

The Recovery Strategy for California Coho Salmon (DFG 2004) includes the following specific watershed recommendations to promote coho salmon recovery in the Humboldt Bay Hydrologic Unit:

- work with agencies and landowners to re-establish estuarine function,
- maintain and restore a functioning flood plain and natural channel processes where practicable, and
- maintain functional riparian habitat.

The *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan* (RCAA 2005) identifies a lack of estuary habitat as a limiting factor for steelhead trout in Jacoby Creek. Specific habitat goals for Jacoby Creek include the restoration of floodplain and estuarine processes that benefit salmonids (RCAA 2005).

We reiterate here the concerns expressed in DFG's 2007 memorandum, that to benefit future riparian, floodplain, and wetland functions adjacent to the project site, the Jacoby Creek bridge and all of the project's other stream crossings and drainage facilities should provide adequate channel or flow capacity based upon calculations using current SLR and climate change projections. By using the most current SLR and climate change projections, the project will have the highest likelihood of protecting and maintaining adjacent wetland and riparian habitats and preventing project structures from impeding flow and becoming bottlenecks during high flow or high tide events.

Without incorporating SLR into the hydrologic analysis of this project, it is difficult to assess with a high degree of confidence the project's impacts on the numerous State- and federal-listed fish species documented as occurring in the project area.

Humboldt Bay Sea Level Rise Adaptation Strategy

The integration of SLR into the design of coastal structures and local coastal plan and general plan updates is currently recommended by the State (CEC 2009a; California Natural Resources Agency 2009). However, effective adaptation to climate change and sea level rise requires a coordinated regional or community-level planning approach (see for example van Aalst et al., 2008). This is especially important when the area at risk is covered by multiple plans implemented by numerous local, State, and federal agencies. Therefore, DFG recommends Caltrans participate in a Humboldt Bay SLR adaptation planning process with agencies such as the Humboldt Bay Harbor, Recreation, and Conservation District; the Cities of Arcata and Eureka; the County of Humboldt; the North Coast Regional Water Quality Control Board; DFG; the National Marine Fisheries Service; and the U.S. Fish and Wildlife Service, among others. While the process to develop an adaptation strategy is not currently underway, DFG encourages its establishment, looks forward to participating, and anticipates it will soon begin.

Conclusions

Based upon the most current, reasonably foreseeable and State-adopted SLR scenarios, DFG makes a fair argument supported by substantial evidence that this project is likely to have significant environmental impacts that are not analyzed or addressed in its current CEQA documents. Furthermore, this project does not appear to comply with State recommendations that SLR be integrated into the design of all coastal structures (CECa 2009).

The ecological impacts of SLR and its engineering implications for coastal ecosystems and structures have been well known for over 20 years (EPA 1988; National Research Council 1987). Likewise, local agencies in California and elsewhere have incorporated SLR into coastal development for more than 20 years. By 1987, California's Bay Area Conservation and Development Commission was requiring an additional one foot of elevation on any newly reclaimed land in San Francisco Bay, based on a scenario of a one-foot rise in fifty years (EPA 1995). Reclamation in Hong Kong also includes a safety margin for accelerated sea level rise, as do the design of new seawalls in eastern Britain and the Netherlands (EPA 1995).

DFG recommends this project's Final EIR evaluate how this project will adapt to SLR. While adaptation options are reasonably foreseeable, they need not be undertaken in the current project. However, given that potentially significant indirect environmental impacts from such adaptations are reasonably foreseeable, they should be evaluated during the current environmental review for this project.

According to CEQA Section 15378(a), the definition of a project includes, "...a reasonably foreseeable indirect physical change in the environment." DFG believes this project's impacts on coastal wetlands and marine, brackish, and freshwater species in Humboldt Bay, when analyzed using current SLR and climate change scenarios are both reasonably foreseeable and significant.

Specific Recommendations

1) The project's bridges, culverts and other drainage facilities should be evaluated and designed to provide adequate channel or flow capacity based upon calculations using current year 2100, 1.4-meter SLR and climate change hydrology projections.

2) The final EIR should describe and evaluate the following potential direct and indirect SLR-related impacts:

    a) How and where will the project be protected from SLR-induced flooding, inundation, and erosion, and what impacts or loss will this protection have on intertidal, wetland, riparian, and other sensitive habitats and the species that depend on them?

b) Under a 1.4-meter year 2100 SLR scenario, what is the project's potential to block the landward migration of saltmarsh and intertidal habitat?

c) How will the project's new and augmented armoring such as seawalls and rock-slope protection affect the Humboldt Bay's hydrology and physical processes?

d) The hydrology and floodplain evaluation (Section 3.2.1) should be revised to evaluate the project's floodplain impacts in relation to year 2100, 1.4-meter SLR and climate change hydrology projections.

Thank you for the opportunity to provide comments on this project. For questions or additional information, contact Staff Environmental Scientist Gordon Leppig at 441-2062 or via e-mail at gleppig@dfg.ca.gov.

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FIRST AMENDMENT TO AGREEMENT BETWEEN THE COUNTY OF SAN MATEO AND CHRISTOPHER A. JOSEPH & ASSOCIATES

THIS FIRST AMENDMENT TO THE AGREEMENT, entered into this _____ day of _____, 20_____, by and between the COUNTY OF SAN MATEO, hereinafter called "County," and Christopher A. Joseph & Associates, hereinafter called "Contractor";

W I T N E S S E T H:

WHEREAS, pursuant to Government Code, Section 31000, County may contract with independent contractors for the furnishing of such services to or for County or any Department thereof; and

WHEREAS, on December 5, 2006, the parties entered into an Agreement for environmental consulting services for the preparation of Draft and Final Environmental Impact Reports (EIR) for the Big Wave project; and

WHEREAS, the parties wish to amend the Agreement to add additional funding in the amount of $137,700 and extend the term to June 30, 2010,

NOW, THEREFORE, IT IS HEREBY AGREED BY THE PARTIES HERETO AS FOLLOWS:

1. Paragraph 3, Payments, is amended in its entirety to read as follows:

   In consideration of the services provided by Contractor in accordance with all terms, conditions and specifications set forth herein and in Exhibit "A," County shall make payment to Contractor based on the rates and in the manner specified in Exhibits "B," "C," "D" and "E." The County reserves the right to withhold payment if the County determines that the quantity or quality of the work performed is unacceptable. In no event shall the County's total fiscal obligation under this Agreement exceed Three Hundred Forty-Two Thousand One Hundred Two Dollars ($342,102).

2. Paragraph 4, Term and Termination, is amended in its entirety to read as follows:

   Subject to compliance with all terms and conditions, the term of this Agreement shall be from December 5, 2006 through June 30, 2010.

   This Agreement may be terminated by Contractor, the Director of Community Development or his/her designee at any time without a requirement of good cause upon thirty (30) days' written notice to the other party.

   In the event of termination, all finished or unfinished documents, data, studies, maps, photographs, reports, and materials (hereafter referred to as materials) prepared by

Contractor under this Agreement shall become the property of the County and shall be promptly delivered to the County. Upon termination, the Contractor may make and retain a copy of such materials. Subject to availability of funding, Contractor shall be entitled to receive payment for work/services provided prior to termination of the Agreement. Such payment shall be that portion of the full payment which is determined by comparing the work/services completed to the work/services required by the Agreement.

3. Exhibit E, Additional Scope of Work with Cost Amendment and Schedule, attached hereto, is added to the Agreement and incorporated herein by reference.

4. All other terms and conditions of the Agreement dated December 5, 2006 between the County and Contractor shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto, by their duly authorized representatives, have affixed their hands.

COUNTY OF SAN MATEO

By:_____
President,
Board of Supervisors, San Mateo County

Date:_____

ATTEST:

By:_____
Clerk of Said Board

Christopher A. Joseph & Associates

Jennie Anderson
Contractor's Signature

Date: 3·19·09

EXHIBIT E

ADDITIONAL SCOPE OF WORK

Big Wave Wellness Center and Office Park Environmental Impact Report (EIR) Scope and Budget

ESTIMATED ADDITIONAL TIME AND EXPENSES (*CAJA AMENDMENT 1*)

The following includes the scope of work tasks and associated expenses for the remaining EIR process. This information follows those EIR Tasks outlined in the executed original contract scope of work with supplements included as necessary to reflect the revised Project Description, associated technical data, and time lapsed since the execution of the original contract.

Task 1. Project Management

This budget amendment includes 38 additional hours for project management by Geoff Reilly (Principal/Project Manager) and Jennie Anderson (Project Manager). This includes additional time for: project scheduling; budgeting/invoicing; management & coordination of CAJA staff; oversight of production and circulation of EIR and notices; review of EIR sections for quality assurance; oversight of document format and word processing; and coordination with County staff and preparation of status updates.

Task 2. Finalize Project Description

Based on a review of the Draft Facilities Plan, CAJA submitted a Draft Project Description to the County for review on January 28, 2009. This Draft version included various comments and data gaps for response from the County/Applicant. Per email correspondence from the County/Applicant on February 27, 2009 the Applicant will be providing additional data to CAJA for Project Description finalization during the scheduled March 4, 2009 meeting. This scope of work task includes time for CAJA to finalize the Project Description for use in the update of the EIR.

Deliverables: One electronic copy of the Final Project Description for County verification.

Task 3. Prepare and Update Administrative Draft EIR (ADEIR)

Prepare and Update General Sections/Section I of the ADEIR – Cover, Title Page, Table of Contents, Introduction

CAJA will update the abovementioned sections of the ADEIR to reflect the Final Project Description and tasks completed since 2007 hold date.

Prepare and Update Section II of ADEIR – Summary

CAJA will prepare and update the following subtopics to be included in the Summary Section of the ADEIR: Introduction; Summary of the Proposed Project; Topics of Known Concern; Summary of Alternatives to the Proposed Project; Areas of Controversy; and Summary of Environmental Impacts and Mitigation Measures (including a summarized Table).

Prepare and Update Section III of ADEIR – Project Description

See Task 2 outlined above regarding CAJA's finalization of project description. Additionally, CAJA will update Related Projects Table; amendment assumes County will assist in providing the most recent related project County list.

Prepare and Update Section IV of ADEIR - Environmental Impact Analysis

For each Impact Analysis section in Section IV, CAJA will prepare and update: the introduction and methodology subsections, the environmental setting, the regulatory framework, the impact analysis, the cumulative impacts analysis based on the related projects list to be provided by the County, and mitigation measures (as appropriate). The section scopes will follow the CEQA Guidelines and will factor applicable environmental-related comments (as appropriate) received during the NOP and scoping meeting period, as well as from the County on the project referral. Additionally, this amendment includes funding and time for the preparation of associated graphics and technical appendices updates. In addition to completing the abovementioned tasks, other specific tasks related to each respective section are provided below for each of the following section titles.

Section IV.A (Aesthetics)

- CAJA will review all revised technical documents and materials associated with the revised proposed project for completeness, methodology, findings, adequacy, and relevance with regard to potential aesthetic impacts.
    - CAJA will peer review and provide feedback on the updated simulations provided in the Draft Facilities Plan once the final Project Description is determined and (if necessary) during the preparation of the EIR, specifically, the Aesthetics section analysis. Based on a preliminary review by our Graphics Department, the provided simulations appear adequate. Any applicable CAD files, etc. would be required to facilitate edits as necessary. Additional figures will be updated and provided as necessary for this visual analysis.
- As part of the Environmental Setting update, based on past site visits and using information in the County's General Plan, Facilities Plan, and other recent County CEQA documents, CAJA will confirm the regional and local context relative to aesthetics and the existing physical characteristics of the project site, focusing on visual features such as topography, vegetation, existing uses, and the site's relationship to nearby uses. In addition, CAJA will describe views from and of the project site, focusing on character-defining features and the project site's relationship to the entire field of view.
- CAJA will define scenic vistas and scenic resources in the project area. Generally describe any scenic vistas available from nearby public vantage points and the location of any scenic resources in relation to the project site (e.g., scenic roadways). Note whether the project site is visible and/or how much of the project

site is visible within these views. Describe how these views and/or resources might change due to the project, using the Applicant-provided visual simulations as a guide.

- Describe the overall visual character of the project site and areas surrounding the site. Describe how the revised project would alter the existing visual character of the site and surrounding area, focusing on how the project would change the character-defining features described previously. This discussion will be based on revised project plan elevations and descriptions of building materials and design as provided by the Applicant. Based on this discussion, determine whether the project would adversely change the existing character of the site and/or the surrounding area, and the potential to result in a significant impact under CEQA.
- Describe the types and relative amounts of light and glare that would be associated with the revised project and describe how these sources might affect the surrounding area. Based on this discussion, determine whether the project would result in significant light and/or glare impacts.
- Recommend updated mitigation measures as necessary.

Section IV.B (Agriculture Resources)

- CAJA will update and reconfirm the agriculture impact analysis via the CEQA process in order to determine if the revised project would result in significant impacts to agriculture resources. Should the analysis determine that impacts would be significant, mitigation measures would beprepared. As the site is not under contract with the County under the provisions of a Williamson Act contract, CAJA will evaluate the project's impacts to agriculture resources based on the Land Evaluation and Site Assessment (LESA) analysis in order to determine if the project would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.

Section IV.C (Air Quality)

- CAJA will utilize as much existing data as possible provided by the Applicant in the Facilities Plan.
- Describe baseline air quality information, including the pollutants of concern in the Bay Area, the agencies responsible for improving air quality in the Bay Area, and the existing air quality conditions in the county and local vicinity. Existing regional emissions will be identified using information obtained from the California Air Resources Board. Existing localized emissions of carbon monoxide will be calculated using data from the revised project traffic report, as described in Section IV (Transportation/Traffic). Any emissions that may be associated with the existing conditions at the project site will also be discussed.
- Identify the thresholds of significance recommended by the Bay Area Air Quality Management District (BAAQMD) as presented in the BAAQMD CEQA Guidelines and used by the County to evaluate air quality impacts under CEQA.
- Construction-related activities are generally short-term in duration, and the BAAQMD does not recommend any thresholds of significance for their associated emissions. Instead, the BAAQMD bases the determination of significance on a consideration of the control measures to be implemented. Therefore, the

EIR will discuss the potential impacts that would occur during construction and recommend the appropriate measures to reduce these impacts to less-than-significant levels.

- Calculate operational mobile and area source emissions for reactive organic gases, nitrogen oxides, and particulates using the URBEMIS model recommended for use by the BAAQMD. Calculations will be based on the trip generation factors provided in the revised project traffic study. The predicted emissions will be compared to the thresholds of significance recommended by the BAAQMD.

- Calculate future localized carbon monoxide concentrations at intersections in the project vicinity that would be most affected by project-generated traffic. These emissions will be calculated using data from the revised project traffic report. The resulting emissions will be compared to state and national ambient air quality standards. These methods are based on the Caline4 Line Source Dispersion Model.

- Discuss the consistency of the project with the current Clean Air Plan for the Bay Area.

- Generally characterize the types of emissions, including toxic air contaminant (TAC) emissions, associated with the wastewater treatment plant, etc. Qualitatively discuss potential health risks associated with siting new residences in proximity to these stationary sources.

- Discuss the potential for the project to result in a cumulatively considerable net increase in emissions. The BAAQMD recommends that projects that generate project-specific emissions that exceed their recommended thresholds of significance also be considered to cause a significant cumulative air quality impact.

- Identify mitigation measures as necessary to reduce or avoid any potential project-specific or cumulative impacts to air quality, and quantify their effectiveness based on methodologies available from BAAQMD and other sources.

- CAJA will prepare a Greenhouse Gas (GHG) Emission Analysis to assess the project's expected contributions to global warming via the emission of GHGs. At this time there are currently no thresholds or official guidance adopted by the Air Districts or other agencies in California to assess the significance of potential GHG emissions. However, Senate Bill 97 (SB 97), which was enacted in 2007, requires the State Office of Planning and Research (OPR) to develop CEQA guidelines for the effects and mitigation of GHG emissions. These guidelines and regulations are expected to be certified and adopted by the State Resources Agency before January 1, 2010. In the interim, OPR recently provided a new technical advisory containing informal guidance for public agencies as they address the issue of climate change in their CEQA documents.

  The OPR technical advisory recommends each public agency that is a lead agency for complying with CEQA develop its own approach to performing a climate change analysis for projects that generate GHG emissions. A consistent approach should be applied for the analysis of such projects, and the analysis must be based on best available information. For such projects, three types of analyses are used to determine whether the project could be in conflict with the State, regional, and local measures for reducing greenhouse gas emissions. The analyses will include the following:

  - Quantify the potential GHG emissions associated with the implementation of the project.

- Assess the significance of the impact on climate change using applicable guidance documents and State, regional, and local GHG reduction goals.
- Assess whether elements of the project and associated mitigation measures contribute to the efficiency of the project and sufficiently reduce GHG emissions.

Section IV.D (Biological Resources)

- Per previous memo discussions, CAJA has agreed that the Biological Resources data provided by WSP appears adequate and appropriate and has therefore agreed to use it as part of our updated ADEIR Biological Resources impact analysis. Under this scope, CAJA Biologists will continue to work with WSP, the County, and Applicant for any additional data necessary to complete our analysis. The Biological Resources section will be updated based on the above and the revised Project Description. Additional mitigation measures, etc. will be suggested as appropriate.

Section IV.E (Cultural Resources)

- CAJA has incorporated the *Cultural Resources Survey for the Big Wave Project, prepared by Tom Origer and Associates, February 28, 2007* into the Cultural Resources section of the ADEIR. Per the report, a 100-foot buffer zone was recommended to help protect resources from the original project development footprint; however, CAJA does not know how far into the site the resources extended. Under this scope, CAJA will reconfirm the extent with our cultural subconsultant.

Section IV.F (Geology & Soils)

- Treadwell & Rollo conducted one peer review based on the original Project Description (*Third Party Geotechnical Peer Review, prepared by Treadwell & Rollo, April 3, 2007*). Based on the supplemental information provided in the Facilities Plan (*BAGG's Response to Treadwell & Rollo Third Party Geotechnical Review, 2008*), Treadwell & Rollo will need to review and provide updated comments as appropriate. Per Treadwell & Rollo their remaining contract budget ($1,248.63) will be adequate to complete their updated review.
- The Geology & Soils section of the ADEIR will be updated from the available and pending project's Geotechnical Report database including revising any impact analyses and mitigation measures based on the revised Project Description as necessary.

Section IV.G (Hazards & Hazardous Materials)

- CAJA utilized the site Phase I report prepared by Treadwell & Rollo (*Phase I Environmental Site Assessment for the Big Wave Site (Phase I ESA), prepared by Treadwell & Rollo, March 26, 2007*) in order to prepare the Draft Environmental Setting of the Hazards & Hazardous Materials section of the ADEIR. Based on the revised Project Description, the impacts and mitigation measures will need to be updated accordingly. No additional Phase I data revisions are anticipated at this time, as historical/existing conditions information still remains applicable. Per the Applicant, a Phase II will also be prepared as part of the mitigation to be outlined in the EIR impact analysis. However, we do have concerns related to the new proposed operational uses (e.g., microwave towers, etc.) and potential associated hazards. *Although,*

not included in this amendment, if deemed necessary during future research efforts, we may need the assistance of a subconsultant (i.e., Paul Spillane of Acumen (Industrial Hygienist), as appropriate – Treadwell & Rollo is not experienced in this analysis)) to determine the associated environmental impacts during the ADEIR analysis. If this is found to be necessary, a small supplemental budget may be warranted and will be negotiated and approved by the County/Applicant prior to initiation.

Section IV.H (Hydrology & Water Quality)

- The hydrology & water quality information provided in the Facilities Plan will be incorporated into the Hydrology & Water Quality section analysis as appropriate. Per the original contract included for the EIR analysis, no peer review was provided; instead, Schaaf & Wheeler prepared the preliminary version of the EIR Hydrology & Water Quality section of the ADEIR based on the original Project Description (*Hydrology and Water Quality Review for Big Wave, prepared by Schaaf & Wheeler, May 2007*). Further, as stated previously, Schaaf & Wheeler prepared an additional hydrology study related to the wetlands issues in late 2007 (*Review of Wetland Hydrology Indicators for Big Wave Jurisdictional Delineation Including Site Visit Commentary prepared by Schaaf & Wheeler on September 17, 2007*). In order to reflect the revised Project Description, additional time and budget has been included herein for Schaaf & Wheeler to update the section accordingly utilizing the revised Site Plans and additional information provided in the Facilities Plan.

<u>Schaaf & Wheeler Scope/Cost</u>

- Review the new Project Description and Facilities Plan.
- Revise hydrologic calculations to reflect new Project Description.
- Analyze the water quality impacts of the newly proposed water recycling facility and increased groundwater infiltration.
- Update the Regulatory Setting section of the EIR document to reflect current regulations.
- Incorporate the more recent wetlands delineation work by CAJA, WSP. Prepare a revised section for Hydrology and Water Quality. Text and figures will be provided to CAJA in Microsoft Word and pdf formats, or as otherwise mutually arranged.
- A two hour meeting or site visit requested by the County is included as part of this amendment.
- Approximately 12 hours are included to assist CAJA in the response to comments efforts during the DEIR phase.
- Based on Schaaf & Wheeler's current fee schedule, the not-to-exceed fee for the above work is $10,300. Approximately $2,300 remains in their original budget, so the required contract amendment for this additional work is $8,000, which is provided for herein.

Section IV.I (Land Use & Planning)

- Update existing land uses and features of the project site. Also, under this scope, confirm existing land uses in the vicinity, based on aerial photographs and an additional windshield survey (if necessary).

- Confirm exhibits showing existing General Plan Land Use Map designations and Zoning Map districts for the site and vicinity.

- Evaluate and update the revised proposed project's consistency with relevant plans, policies, and regulations. In accordance with CEQA Guidelines Section 15125(b), the analysis will include applicable general plans and regional plans. Plans and policies that will be evaluated include (among others):

  - San Mateo County General Plan
  - Mid-Coast LCP
  - Montara/Moss Beach/El Granada Community Plan
  - LAFCO (regarding water service from CCWD)
  - Half Moon Bay Comprehensive Airport Land Use Plan
  - Existing County ordinances and regulations

- The General Plan consistency analysis will be updated based on the revised project and presented in a tabular format. County staff will be consulted to determine other relevant plans, if any. Where appropriate, the evaluation will cross-reference other section updates, such as Biological Resources or Transportation/Traffic.

- Updates to discuss potential impacts relating to policy inconsistency and land use compatibility from revised project. This discussion will cross-reference the analyses of other impacts in the EIR (as necessary).

Section IV.J (Noise)

- The information provided in the Facilities Plan will be confirmed and/or supplemented as part of the Noise ADEIR analysis. Per the original contract, CAJA will conduct a noise analysis (utilizing the steps outlined below), which will occur once the final revised traffic data and Project Description is confirmed.

- Define and describe the fundamentals of sound and environmental noise, and groundborne vibration.

- Discuss relevant noise policies, regulations and standards, including the relevant State noise guidelines and noise/land use compatibility standards used by San Mateo County.

- Confirm noise-sensitive land uses or activities in the vicinity of the project site or along roads providing access to the site.

- Briefly confirm and describe existing major noise sources in the project vicinity. Conduct up to four short-term noise measurements on the project site, along roadways most affected by increases in project traffic and airport associated noise events.

- Calculate existing noise levels for the roadway segments in the project vicinity that would be affected by project-generated traffic. These noise levels will be calculated using the Federal Highway Administration's (FHWA) Noise Prediction Model and data from the project traffic report.

- Discuss existing groundborne vibrations levels at the project site and local vicinity.
- Confirm significance thresholds based on these standards and consultation with San Mateo County.
- Describe characteristics of the revised proposed project that are relevant to the analysis of noise, based on the revised project site plan, the conceptual grading plan, and trip generation estimates from the revised project traffic study.
- Discuss construction noise impacts, based on revised proposed construction activities and scheduling information. Noise impacts from construction will be evaluated based on the duration, nature, phasing, and level of various construction activities.
- Describe typical noise generated by various elements of the revised project, including project-generated motor vehicle traffic.
- Calculate the expected increases in noise levels at noise sensitive locations along roadways most affected by project traffic using the FHWA Noise Prediction Model and data from the revised project traffic report.
- Discuss the potential for noise from the revised project or related activities to adversely affect sensitive land uses or activities, or to conflict with established noise compatibility guidelines.
- Discuss the potential for noise from the Half Moon Bay Airport to affect project site residents.
- Evaluate the compatibility of the proposed land uses with the existing and future noise environment at the site.
- Identify mitigation measures as necessary to avoid or reduce significant noise impacts, and evaluate their effectiveness based on published technical documents.

Section IV.K (Population & Housing)

- CAJA will initiate the peer review by Bay Area Economics once the Project Description has been finalized. As outlined in the original contract, Bay Area Economics will conduct a third party peer review of the Applicant's economic analysis, which will address the assumptions, methodology and overall conclusions regarding the overall demand for the project and the job match with employed residents on the coast area. Bay Area Economics will prepare an administrative draft memo outlining their peer review. Bay Area Economics will also review the memo with CAJA and County staff. Based on oral and written comments, Bay Area Economics will revise the administrative memo and produce a final memo. As stated above, the peer review of the Economic Analysis was included in the original contract and to date budget remains to complete this task. This peer review will be submitted to the County as an independent report, and will not be appended to the EIR.
- Prepare and update existing population and housing estimates, as well as policies and forecasts pertaining to population and housing growth in the County of San Mateo. The population and housing data and forecasts will be updated from the County's Housing Element, the California Department of Finance, the Association of Bay Area Governments (ABAG) and the U.S. Census Bureau, as needed.

- Based on population per household ratios provided by the County, CAJA will calculate the number of residents that would be accommodated by the revised proposed project.

- Evaluate the consistency of the project-generated population with County and regional growth forecasts and policies. Calculate the project's contribution as a percentage of the County's overall growth allocation by ABAG, the California Department of Finance, and other sources.

- Identify mitigation measures to reduce or avoid significant impacts for each of the sub-issues analyzed in the Population/Housing section, if any significant impacts are identified.

Section IV.L (Public Services)

- Confirm and update existing conditions in the County and project area, as appropriate. This will be done by contacting the current contacts at the Fire Department, Police Department, Parks and Recreation Department, and School District responsible for serving the project site by telephone or letter to obtain updated information on existing conditions, assess the potential impacts of the revised proposed project and cumulative development, and provide input on appropriate mitigation measures (as necessary).

- Based on updated population per household ratios provided by the County and/or the service providers (such as the Department of Finance), recalculate the number of residents that would be accommodated by the revised proposed project.

- Discuss the School District's eligibility to levy alternate developer fees.

- Based on County park standards, calculate the park acreage or in-lieu fee that would be required with buildout of the revised proposed project. Determine whether existing and planned parks in the County would be adequate to cover the revised proposed project and County-wide demand (as necessary). Consult with the County regarding cumulative projects in the area and their proposed parklands.

- Discuss potential impacts of revised project buildout in terms of demand for public services, ability to provide services, and the possible need for construction of additional facilities.

- Document project characteristics that would "pre-mitigate" potential impacts of the revised project.

- Update and list mitigation measures recommended by the service providers.

- Discuss the potential for the revised project in conjunction with related projects to result in cumulative impacts to public services.

Section IV.M (Transportation/Traffic)

- Per the Applicant and the January 1, 2009 Facilities Plan, the preferred Office Park option would include the 225,000 s.f. commercial/office space use. For $32,000 (in the requested amendment [included in this *CAJA Amendment 1*]), Hexagon Transportation Consultants, Inc. assisted the Applicant in the development of an Office Park option revised traffic analysis (which included the revised project and the 225,000 s.f. alternative). No updated peer review is required. $22,905 from the current budget has been used to pay for this work. The revised budget includes $9,095 for the balance of this work.

- The updated traffic report (*Revised Traffic Report for the Big Wave Office Park and Wellness Center, prepared by Hexagon Transportation Consultants, Inc., June 25, 2008*) will be incorporated by CAJA into the Transportation/Traffic ADEIR section analysis to reflect the revised proposed project. CAJA will work with Hexagon for any applicable updates and/or clarifications utilizing the requested remaining $9,095.

Section IV.N (Utilities & Service Systems)

- The information provided in the Facilities Plan will be incorporated into the ADEIR Utilities & Service Systems subsections (i.e., Water, Wastewater, Service Systems; as appropriate) and will be supplemented by our CAJA team as necessary. CAJA has reviewed the Solid Waste discussion in the Facilities Plan and this seems appropriate. In previous memos, CAJA encouraged the Applicant to narrow down various Utilities options to one option (e.g., various options proposed for water supply, wastewater treatment and energy). Otherwise, the project may appear to be more programmatic (i.e., necessitating the preparation of a Program EIR), potentially resulting in more environmental review at a later time when more specifics are provided or available. However, per direction from the Applicant, we will analyze each "option" in detail in the EIR analysis, pending that detailed data is available for each Water/Wastewater/Energy "option".

- The Utilities & Service Systems section of the ADEIR will be updated from the available and pending project's Utilities Report database including revising any impact analyses and mitigation measures based on the revised Project Description as necessary. Although not included in the original scope, based on the scope of the revised project, CAJA will include an Energy subsection analysis in the Utilities & Service Systems section to reflect all of the proposed Energy systems.

- For proposed municipal service options, CAJA will conduct the following tasks:

  - Confirm and update existing conditions in the County and project area, as appropriate. This will be done by contacting the currently proposed municipal contacts by telephone or letter to obtain updated information on existing conditions, assess the potential impacts of the revised proposed project and cumulative development, and provide input on appropriate mitigation measures (as necessary).

  - Based on readily available solid waste, water and sewage generation factors, calculate the revised project's estimated solid waste and sewage generation, as well as water demand.

  - Discuss LAFCO annexation requirements of the project site into the CCWD.

  - Discuss potential impacts of revised project buildout in terms of demand for municipal services, ability to provide services, and the possible need for construction of additional facilities.

  - Document project characteristics that would "pre-mitigate" potential impacts of the revised project.

  - Update and list mitigation measures recommended by the service providers.

  - Discuss the potential for the revised project in conjunction with related projects to result in cumulative impacts to public services.

- Additional CAJA subconsultants are necessary in order to assess and conduct peer reviews of the potential environmental impacts associated with the proposed wastewater (i.e., on-site MBR plant, drip irrigation of recycled wastewater) and water (on-site wells and groundwater/aquifer impacts, water treatment) systems.

This was not included in the original scope (Note: Per the original project RFP, the original scope was based on municipal hook-ups only) and hence requires a supplemental budget and scope, which is provided for herein. This review will be provided by Questa Engineering Corporation (water supply and wastewater). The additional scope and cost for Questa Engineering Corporation is included below.

Questa Engineering Corporation Scope/Cost

Water Supply

- Available background reports, maps and data relative to water availability in the project area will be compiled and reviewed.
- The water supply setting for the project will be described based upon the information developed in the background review. The Applicant's plan for supplying water to the project will be described and reviewed. This will include the sources of supply, treatment requirements (if any), storage and distribution system, and ownership and management of the system.
- The Applicant's estimated water demand for the proposed project will be reviewed for independent confirmation. It is anticipated that estimates will be broken down by the different elements of the project site and will include annual and seasonal demand, daily average and peak water supply requirements. The water needs will consider residential water demands (interior and exterior), other common area uses, fire flow, and storage requirements.
- The availability of a sufficient, dependable supply of water to serve the project will be evaluated and presented. Various possible sources of water to service the development have been identified including on-site well water, recycled water, and imported potable water. This analysis will also address the water quality and treatment requirements.
- Mitigations will be identified for water supply impacts determined to be significant or potentially significant. Mitigations may include such measures as limitations on the scale of development and corresponding water demand, incorporation of specific water conservation measures, and additional water storage.

Wastewater Treatment and Disposal

- Compile and review all available background information pertaining to wastewater treatment and disposal-reclamation plans for the project. This will include peer review of technical report(s) and supporting information supplied by the Applicant, as well as relevant publications related to soils, water resources, hydrogeology and water quality and information regarding the El Granada Wastewater District Facilities. A reconnaissance-level site visit will be performed to observe relevant landscape features and existing infrastructure. Contacts will be made with County and Regional Water Board staff, El Granada Wastewater District personnel, project consultants (as appropriate), and other knowledgeable individuals.
- Review and describe federal, state and local regulatory requirements applicable to the construction and operation of the proposed wastewater system, including, but not limited to, the Water Quality Control Plan for the San Francisco Bay Region (Basin Plan), Title 22 Water Recycling Criteria, County policies and standards.

- The proposed wastewater treatment plans will be reviewed for technical adequacy including compliance with accepted engineering standards, limitations of the project site, and applicable regulatory requirements. This will include review and independent confirmation and/or revisions of the sewage flow estimates for the project based on information provided by the Applicant. It will also include review of: (a) plans for wastewater collection; (b) proposed location and type of treatment system; (c) any plans for wastewater storage; (d) locations, methods and capacity for wastewater disposal and reclamation; (e) plans for system management; and (f) any identified water quality issues, including impacts to surface water and groundwater resources.

- Using information compiled from the background and regulatory review, prepare the environmental setting section for the EIR.

- Based on the results of the project analysis task, identify and describe any potentially significant impacts of the proposed wastewater treatment and disposal-reclamation plans for the project for inclusion in the EIR. Impacts discussion may include construction-related issues, operational impacts related to the collection, treatment and disposal-reclamation facilities; and potential short-term or long-term water quality and public health issues

- Identify and describe feasible mitigation measures to address any significant or potentially significant impacts related to the development and operation of wastewater collection, treatment and disposal-reclamation facilities for the project.

Associated Tasks to Complete Above

- (Task 1) Site Visits, Data Collection and Analysis. Questa will collect and review existing information related to the wastewater and water supply aspects of the project. Interviews, file research, peer review of consultant-provided reports, and site reconnaissance by experienced environmental personnel will be conducted. Contacts will be made with appropriate agencies to evaluate pertinent requirements and background information.

- (Task 2) Water Supply Analysis. Questa will identify and evaluate the potentially significant and significant water supply impacts associated with development of the proposed project. The analysis will include evaluation of the proposed methods of water supply for the project including on-site well water, recycled water and water imported from the Coastside County Water District (CCWD).

- (Task 3) Wastewater Disposal Analysis. Questa will identify and evaluate the potentially significant and significant wastewater treatment impacts associated with development of the proposed project. Methods for wastewater treatment and disposal that will be evaluated include on-site treatment and recycling, on-site disposal by spray irrigation and other methods, and off-site disposal to the El Granada Wastewater District.

- (Task 4) Formulate Mitigation Measures. Questa will develop reasonable and appropriate additional mitigation measures to offset the identified impacts. The mitigation measures may include development restrictions in sensitive or constraining project areas, on- and off-site infrastructure improvements, structural and non-structural best management practices, remedial action, and design recommendations related to the development of the project site. Additionally, Questa may develop monitoring and reporting strategies for mitigation measures.

- (Task 5) Review Project Alternatives. Questa will review alternatives to the proposed project. This will include the no project alternative, the proposed project, and one other alternative to be presented as part of the EIR. Questa will evaluate the Wastewater Treatment and Water Supply impacts associated with the project alternatives.

- (Task 6) Prepare Administrative DEIR. Questa will prepare the Water Supply and Wastewater sections of the EIR in an acceptable format.

- (Task 7) Response to Comments and Preparation of DEIR. Questa will respond to comments made to the ADEIR and finalize the DEIR sections.

- (Task 8) Response to Comments and Preparation of FEIR. Questa will assist in the final response to comments and preparation of the FEIR sections. We have included a limited budget for response to comments. If extensive comments are received requiring significant review and response time, additional budget may be required for this task.

- (Task 9) Public Hearings and Meetings. Questa will attend public hearings and meetings on a time-and-expenses basis. Questa has not included a budget for hearings/meetings. Any attendance at hearings or meeting would be in addition to the costs outlined in this amendment.

- The cost for the work effort described above in Tasks 1 to 8 is $18,600.

Prepare and Update Section V of ADEIR - General Impact Categories

The General Impact Categories section of the ADEIR will summarize the following: significant unavoidable impacts that were identified in the updated Environmental Impact Analysis (if any are identified); growth-inducing impacts of the revised proposed project; and the significant irreversible environmental changes associated with the revised project. Additionally, this section will include a discussion of the Impacts Found to be Less Than Significant. This section will include a discussion of the issues and sub-issues that were focused out for further analysis in the Initial Study. However, as the Initial Study format does not include detailed data on why these issues were scoped out, these issues will be confirmed for accuracy and will be documented in the above subsection analysis.

Prepare and Update Section VI of ADEIR - Summary of Cumulative Impacts

The cumulative impacts and mitigation (if appropriate) in each respective Environmental Impact Analysis section will be updated based on the revised Project Description, section analyses, and the updated related projects list provided by the County.

Prepare and Update Section VII of ADEIR - Alternatives to the Proposed Project

This section of the ADEIR will identify and evaluate a reasonable range of alternatives to the revised proposed project that are crafted to avoid or significantly lessen the significant environmental impacts of the project while still meeting most of the revised project objectives. One of the alternatives that will be analyzed in the EIR will be the No Project Alternative (assuming continuation of the existing conditions, no development of the site), as required by CEQA. As the project site does not permit residential uses, the EIR will address implementation of the proposed project at an alternative site(s). Other alternatives could include a Reduced Density Alternatives or

Modified Site Plan Alternative. The selection of other project alternatives will be made in consultation with County staff after all of the significant impacts of the revised proposed project have been identified. For the purposes of this amendment, CAJA will analyze up to four alternatives, including the No Project Alternative.

Prepare and Update Section VIII of ADEIR - Preparers of the EIR and Persons Consulted

This section will be updated to identify the lead agency staff, project Applicant and subconsultant staff, EIR consultant and subconsultant staff, and all agency personnel consulted during the preparation of the EIR.

Prepare and Update Section IX of ADEIR - Bibliography

The Bibliography section will be updated to list all sources of revised information used during the preparation of the EIR.

Deliverables: Five (5) bound hard copies and one electronic PDF copy of the ADEIR. CAJA will submit copies of the ADEIR to the County staff for distribution and one round of review.

Task 4. Preparation of the DEIR

CAJA will address all of the County's comments on the updated ADEIR. This amendment assumes one-round of review by the County and all comments made on the updated ADEIR will be submitted to CAJA in one consolidated set. *(Note: Any changes to the project description made during this review could require changes to the analysis in the ADEIR and could require additional amendments.)* After the review of the document, CAJA staff will address all comments and will prepare and submit one electronic PDF version of the Screencheck DEIR (SDEIR) to the County to confirm that all requested changes have been incorporated into the document. This SDEIR will be submitted to the County for approval as a DEIR. Once the County approves the SDEIR, CAJA will produce 50 copies of the DEIR and Technical Appendices for use and distribution by the County during the prescribed 45-day public review period. Additionally, CAJA will also prepare 15 electronic PDF copies of the DEIR and Technical Appendices and 15 hard copies of the Summary section for County submittal to the State Clearinghouse. CAJA will also prepare the Notice of Completion (NOC) for the State Clearinghouse per the CEQA requirements. This amendment assumes that the County will distribute the DEIR and NOC.

Additionally, it is assumed in this amendment that CAJA will produce a Notice of Availability (NOA) for the DEIR utilizing all three NOA noticing options as outlined in Section 15087(a)(1),(2),(3) of the CEQA Guidelines (although only one is required to fulfill the 45-day public review period, it is recommended by CAJA to utilize all three noticing methods during the public review period due to the controversial nature of the project). This includes: 1) publication of the NOA in a local newspaper, 2) posting the NOA on- and off-site, and 3) direct mailing of the NOA to contiguous property owners. Further, the NOA shall be sent to applicable state and local agencies; individuals that commented on during the NOP or scoping meeting process and that have requested to be notified throughout the EIR process; as well as the applicable County Clerk to post during the 45-day review period. This amendment assumes that the County will also distribute the NOA.

Deliverables: One (1) electronic PDF copy of the SDEIR; 50 bound copies of the DEIR and Technical Appendices, one electronic PDF format on a CD, 15 copies for the State Clearinghouse and one copy of the NOC for distribution by the County. The DEIR will be in 8.5-inch x 11-inch, black

and white format; color where applicable. Additionally, a electronic (PDF) copy of the NOA for distribution by County.

Task 5. Preparation of FEIR and Mitigation Monitoring Program (MMP)

The number of comments received at the end of the 45-day review period and the level of effort involved with preparing responses varies widely between projects. Following closure of the 45-day DEIR public comment period, CAJA staff will prepare responses to all written and oral comments received on the DEIR and will make any changes to the DEIR resulting from responses to comments. The FEIR will ultimately include the following chapters: Introduction, Response to Comments, Corrections and Additions to the DEIR, Mitigation Monitoring Program (MMP). CAJA will prepare the AFEIR and submit 5 copies to the County for one round of review. After the review of the document, CAJA staff will address all comments and will prepare and submit one electronic PDF version of the SFEIR to the County to confirm that all requested changes have been incorporated into the document. Once the SFEIR is approved for release as the FEIR, CAJA will produce 50 copies (as well as 15 copies for State Clearinghouse, if necessary) of the FEIR for County circulation to all appropriate commenting agencies and individuals ten days prior to consideration of certification of the EIR. This amendment assumes that the County will distribute the FEIR.

Although not required under CEQA, CAJA can prepare and provide the County with a NOA for the FEIR. This task is not included within our amendment; however (if requested, due to the controversial nature of the project), CAJA can be available to assist the County with this task utilizing a time and materials rate based on our current fee schedule. CAJA preparation of the NOA would follow those steps outlined under Task 4.

In accordance with CEQA Guidelines Section 15075, CAJA will prepare the Notification of Determination (NOD) for use by the County to file with the applicable County Clerk and State Clearinghouse (if necessary) within five days of certifying the EIR and approving the project. This amendment assumes that the County will file the FEIR.

Deliverables: Five (5) hard copies and one electronic (PDF) copy of the AFEIR; one electronic (PDF) of the SFEIR; 50 hard copies and one electronic (PDF) of the FEIR (as well as 15 copies for the State Clearinghouse, if necessary) for distribution by the County; and one electronic (PDF) copy of the NOD for filing by the County.

Task 6. Hearings and Meetings

While a public hearing on the DEIR during the 45-day review period is not required by CEQA (Section 15087(i), CEQA Guidelines), this amendment includes attendance by the appropriate CAJA staff member(s), but not its subconsultants, at one public hearing either on the DEIR during the 45-day review period or on the FEIR certification/final decision on the project. If the County chooses to hold a public hearing during the 45-day DEIR review period, County staff will schedule the meeting and arrange for the meeting space. CAJA highly recommends that if many people are expected to attend the public hearing and comment, a court reporter should be present to record all comments. CAJA staff will assist the County in preparing necessary materials for the hearing, such as: a) a handout depicting and briefly describing the project and summarizing impacts and mitigation measures, and b) other large-scale graphics. CAJA staff will arrange for a court reporter to attend the meeting to

record all oral comments, but the cost of a court reporter is not included in this amendment. After the close of the public comment period for the DEIR, CAJA staff will review all comments, identify which comments require special attention, and discuss response approach with County staff and CAJA team members. CAJA will prepare a topic-by-topic matrix summarizing all written and oral comments submitted during the hearing.

This amendment also includes the attendance of Ms. Anderson and Mr. Reilly at two Planning Commission hearings and one Board of Supervisors hearing. CAJA staff will be available to give a presentation related to the CEQA process, analysis, and conclusions. Additionally, time for 8 team meetings/conference calls has been included in this amendment. *Additional County-requested hearings and meetings attendance will be billed on a time-and-materials basis based on our agreed fee schedule.*

Deliverables: One (1) memo summarizing all substantive points made by the public hearing commenters.

Task 7. Findings of Fact and Statement of Overriding Considerations

Prior to consideration of the proposed project and subsequent to certification of the FEIR, CAJA staff will prepare the Statement of Facts and Findings (the Findings) for any significant environmental effects identified in the EIR. The Findings will individually identify the significant environmental effects of the proposed project and provide a reasoned discussion of the appropriate findings.

Also included in this amendment, prior to consideration of the proposed project and subsequent to certification of the FEIR, CAJA will prepare the Statement of Overriding Considerations in accordance with the specifications of Section 15093 of CEQA (if applicable). The Statement of Overriding Considerations will describe why the benefits of the project outweigh its significant and unavoidable effects.

Deliverables: Five (5) copies of each will be provided, as well as one electronic PDF copy.

Schedule and Cost

CAJA proposes the following draft schedule to prepare the EIR (see attached Table 1). This schedule is dependent on approval of the finalized Project Description and availability of Applicant-prepared data. Therefore, the proposed schedule dates would be updated accordingly based on actual completion dates. Overall, as shown in the attached Cost Amendment (Table 2), the total cost for the *Cost Amendment 1* scope of work is $137,700. CAJA's associated billing rate is included below:

Billing Rates

CAJA Fee Schedule
(*Effective January 1, 2009*)

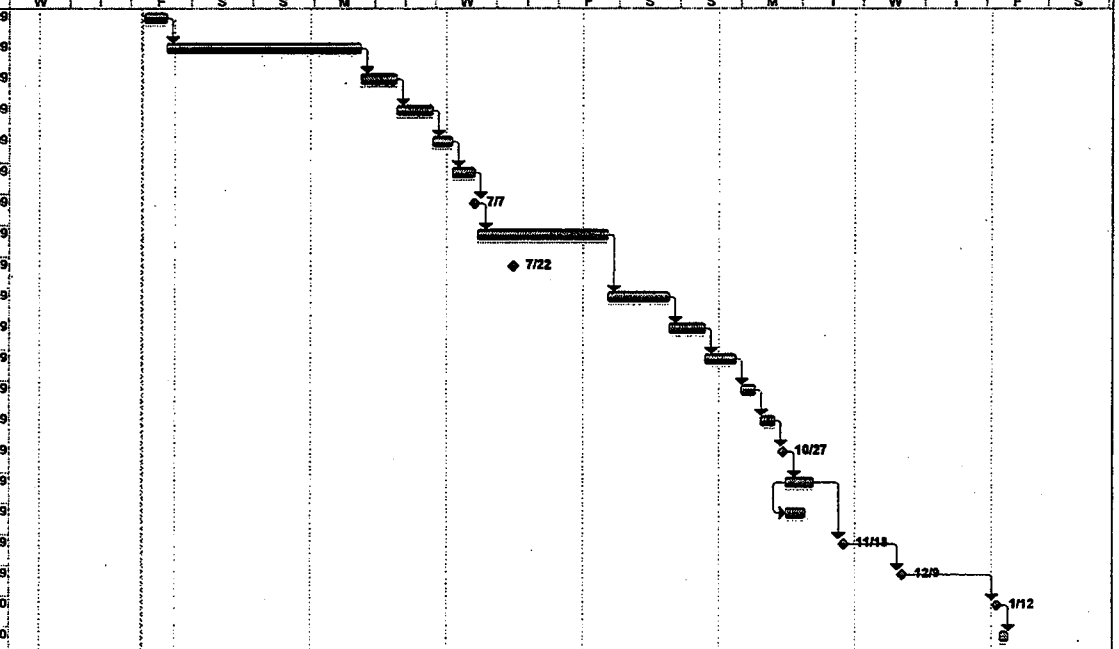
• Principal	$160.00/hour
• Project Manager	$135.00/hour
• Environmental Specialist (e.g., Biologist, Noise, Air Quality)	$135.00/hour
• Environmental Planner	$120.00/hour
• Associate Environmental Planner	$110.00/hour

• Assistant Environmental Planner	$95.00/hour
• Research Assistant	$55.00/hour
• Graphics Director	$60.00/hour

Attachments: Table 1 (Revised Draft Schedule)
Table 2 (Cost Amendment)

Big Wave Wellness Center and Office Park EIR -- Revised Draft Schedule

ID	Task Name	Duration	Start	Finish
1	Finalize Project Description for County Verification [1]	6 days	Wed 3/11/09	Wed 3/18/09
2	Prepare ADEIR for County Review	50 days	Thu 3/19/09	Wed 5/27/09
3	County Review of ADEIR [2]	9 days	Thu 5/28/09	Tue 6/9/09
4	Prepare SDEIR for County Review	9 days	Wed 6/10/09	Mon 6/22/09
5	County Review of SDEIR [2]	5 days	Tue 6/23/09	Mon 6/29/09
6	Prepare DEIR and Notices (NOA/NOC)	5 days	Tue 6/30/09	Tue 7/7/09
7	County to Circulate DEIR, NOC, and NOA	0 days	Tue 7/7/09	Tue 7/7/09
8	Circulate & Publish DEIR & Notices for 45-day Public Review	45 days	Thu 7/9/09	Mon 8/24/09
9	Attend Public Hearing at DEIR (at County discretion) [3]	0 days	Wed 7/22/09	Wed 7/22/09
10	Prepare Responses to Comments, AFEIR/MMP for County Review [4]	15 days	Tue 8/25/09	Tue 9/15/09
11	County Review of AFEIR/MMP [2]	9 days	Wed 9/16/09	Mon 9/28/09
12	Prepare SFEIR/MMP for County Review	9 days	Tue 9/29/09	Fri 10/9/09
13	County Review of SFEIR/MMP [2]	5 days	Mon 10/12/09	Fri 10/16/09
14	Prepare FEIR/MMP	5 days	Mon 10/19/09	Fri 10/23/09
15	County to Circulate FEIR/MMP	0 days	Tue 10/27/09	Tue 10/27/09
16	Circulate & Publish FEIR/MMP for Commenting Agencies (& Public)	10 days	Wed 10/28/09	Fri 11/6/09
17	Prepare Findings of Fact and SOC	7 days	Wed 10/28/09	Tue 11/3/09
18	EIR Meeting/Hearing (PC) [2]	0 days	Wed 11/18/09	Wed 11/18/09
19	EIR Meeting/Hearing (PC) [2]	0 days	Wed 12/9/09	Wed 12/9/09
20	EIR Meeting/Hearing (Board) [2]	0 days	Tue 1/12/10	Tue 1/12/10
21	Preparation of the NOD, Filing NOD with Clerk [2]	3 days	Wed 1/13/10	Fri 1/15/10



Note: Schedule is dependant on availability of all Project Facilities/technical reports from the Applicant, as well as the complexity of the multiple Utilities analyses. Schedule may need to be adjusted.

1 **Finalize Project Description for County Verification [1]**
[1] Assumes a finalization and approval date of March 18, 2009. This date is subject to change pending actual approval by the County. Schedule will be updated accordingly, if necessary.

3 **County Review of ADEIR [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

5 **County Review of SDEIR [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

9 **Attend Public Hearing at DEIR (at County discretion) [3]**
[3] Date is subject to change depending on availability of Planning Commission during this time. Overall, Public Hearing would be scheduled to take place during the 45-day review period.

10 **Prepare Responses to Comments, AFEIR/MMP for County Review [4]**
[4] May need to be revised depending on actual level of comments received, which is outside the control of CAJA and the County.

11 **County Review of AFEIR/MMP [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

13 **County Review of SFEIR/MMP [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

18 **EIR Meeting/Hearing (PC) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

19 **EIR Meeting/Hearing (PC) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

20 **EIR Meeting/Hearing (Board) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

21 **Preparation of the NOD, Filing NOD with Clerk [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

Note: Schedule is dependant on availability of all Project Facilities/technical reports from the Applicant, as well as the complexity of the multiple Utilities analyses. Schedule may need to be adjusted.

Table 2
Big Wave EIR, Cost Amendment #1

LABOR COSTS					
Task 1. Project Management					
Budgeting and Scheduling	Geoff Reilly	2	$160.00	Principal	$320.00
	Jennie Anderson	5	$135.00	Project Manager	$675.00
Coordination with County, Applicant & Subconsultants	Geoff Reilly	3	$160.00	Principal	$480.00
	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Document Review/Quality Assurance	Geoff Reilly	6	$160.00	Principal	$960.00
	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Administrative	Megan Steer	4	$55.00	Research Asst.	$220.00
	Jennie Anderson	2	$135.00	Project Manager	$270.0
Task 1 Subtotal		***38***			***$5,085.0***
Task 2. Finalize Project Description	Jennie Anderson	***6***	$135.00	Project Manager	***$810.00***
Task 3. Preparation of Administrative Draft EIR (ADEIR)					
Cover, Title Page, TOC	Megan Steer	1	$55.00	Research Asst.	$55.00
Introduction	Megan Marruffo	1	$95.00	Asst. Env. Planner	$95.00
Summary	Jennie Anderson	1	$135.00	Project Manager	$135.00
	Patricia Preston	6	$120.00	Env. Planner	$720.00
Project Description	Jennie Anderson	1	$135.00	Project Manager	$135.00
Regulatory Setting	Jasmine Patel	2	$110.00	Assoc. Env. Planner	$220.00
Aesthetics	Patricia Preston	30	$120.00	Env. Planner	$3,600.00
Agriculture Resources	Jasmine Patel	16	$110.00	Assoc. Env. Planner	$1,760.00
Air Quality (w/ GHG)	Dan Hooper	36	$135.00	Air Specialist	$4,600.00
Biological Resources	Amy Parravano	48	$135.00	Principal Biologist	$6,480.00
	Patricia Preston	4	$120.00	Env. Planner	$480.00
Cultural Resources	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00
Geology & Soils	Jennie Anderson	2	$135.00	Project Manager	$270.0
	Patricia Preston	16	$120.00	Env. Planner	$1,920.0
Hazards & Hazardous Materials	Jasmine Patel	16	$110.00	Assoc. Env. Planner	$1,760.00
Hydrology & Water Quality	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Land Use & Planning	Patricia Preston	12	$120.00	Env. Planner	$1,440.00
Noise	Scott Wirtz	30	$135.00	Noise Specialist	$4,050.00
Population & Housing	Jasmine Patel	22	$120.00	Assoc. Env. Planner	$2,640.00
Public Services	Jessica Viramontes	16	$120.00	Env. Planner	$1,920.00
Transportation/Traffic	Jessica Viramontes	16	$120.00	Env. Planner	$1,920.00
Utilities & Service Systems	Jennie Anderson	6	$135.00	Project Manager	$810.00
	Jessica Viramontes	32	$120.00	Env. Planner	$3,840.00
General Impact Categories	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00
Summary of Cumulative Impacts	Jasmine Patel	8	$110.00	Assoc. Env. Planner	$880.00

Table 2
Big Wave EIR, Cost Amendment #1

Alternatives to the Proposed Project	Geoff Reilly	4	$160.00	Principal	$640.00
	Jennie Anderson	24	$135.00	Project Manager	$3,240.00
Preparers of the EIR & Persons Consulted	Megan Steer	1	$55.00	Research Asst.	$55.00
Bibliography	Megan Steer	1	$55.00	Research Asst.	$55.00
Technical Appendices	Megan Steer	2	$55.00	Research Asst.	$110.00
Project Referral Comments	Megan Steer	3	$55.00	Research Asst.	$165.00
Task 3 Subtotal		***381***			***$46,595.00***
Task 4. Preparation of the Draft EIR (DEIR) *					
Screencheck Draft EIR (SDEIR)	Geoff Reilly	2	$160.00	Principal	$320.00
	Jennie Anderson	10	$135.00	Project Manager	$1,350.00
	Patricia Preston	14	$120.00	Env. Planner	$1,680.00
DEIR	Jennie Anderson	2	$135.00	Project Manager	$270.00
	Jasmine Patel	8	$110.00	Assoc. Env. Planner	$880.00
Task 4 Subtotal		***36***			***$4,500.00***
Task 5. Preparation of Final EIR (FEIR) and Mitigation Monitoring Program (MMP) [1]*					
Appendices & Delineation of Comments on DEIR	Geoff Reilly	1	$160.00	Principal	$160.00
	Jennie Anderson	10	$135.00	Project Manager	$1,350.00
	Jasmine Patel	20	$110.00	Assoc. Env. Planner	$2,200.00
Response to Comments	Geoff Reilly	3	$160.00	Principal	$480.00
	Jennie Anderson	20	$135.00	Project Manager	$2,700.00
	Patricia Preston	36	$120.00	Env. Planner	$4,320.00
	Jasmine Patel	38	$110.00	Assoc. Env. Planner	$4,180.00
Administrative Final EIR (AFEIR)	Jennie Anderson	4	$135.00	Project Manager	$540.00
	Patricia Preston	10	$120.00	Env. Planner	$1,200.00
Screencheck Final EIR (SFEIR)	Geoff Reilly	1	$160.00	Principal	$160.00
	Jennie Anderson	6	$135.00	Project Manager	$810.00
FEIR	Jennie Anderson	2	$135.00	Project Manager	$270.00
	Megan Marruffo	4	$95.00	Asst. Env. Planner	$380.00
MMP	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Task 5 Subtotal		***163***			***$19,830.00***
Task 6. Hearings & Meetings					
(4) Hearings	Geoff Reilly	12	$160.00	Principal	$1,920.00
	Jennie Anderson	12	$135.00	Project Manager	$1,620.00
(8) Meetings/Conference Calls	Geoff Reilly	12	$160.00	Principal	$1,920.00
	Jennie Anderson	12	$135.00	Project Manager	$1,620.00
Preparation of Materials	Jessica Viramontes	2	$120.00	Env. Planner	$240.00
	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00

Table 2
Big Wave EIR, Cost Amendment #1

Task 6 Subtotal		***58***			***$8,080.00***
Task 7. Findings of Facts and Statement of Overriding Considerations	Jennie Anderson	7	$135.00	Project Manager	$945.00
	Megan Marruffo	2	$95.00	Asst. Env. Planner	$190.00
Task 7 Subtotal		***9***			***$1,135.00***
Graphics					
EIR Graphics/Simulation Peer Review	Scott Johnson	***40***	$60.00	Graphics Director	***$2,400.00***
Production of Notices *					
Notice of Availability (NOA) - DEIR	Patricia Preston	1	$120.00	Env. Planner	$120.00
Notice of Completion (NOC)	Patricia Preston	1	$120.00	Env. Planner	$120.00
Notice of Determination (NOD)	Jennie Anderson	1	$135.00	Project Manager	$135.0
Subtotal		***3***			***$375.00***
Word Processing & EIR Production	Megan Marruffo	6	$95.00	Asst. Env. Planner	$570.00
	Megan Steer	5	$55.00	Research Asst.	$275.00
Subtotal		***11***			***$845.00***
	TOTAL CAJA LABOR COSTS				**$89,655.00**
SUBCONSULTANT COSTS					
Labor/Expenses to Complete Remaining Work					
Hydrology and Water Quality (Shaaf & Wheeler)		*Fixed Fee*			$8,000.00
Transporation/Traffic (Hexagon)		*Fixed Fee*			$9,095.00
Utilities & Service Systems - Water/Wastewater (Questa)		*Fixed Fee*			$18,600.00
TOTAL SUBCONSULTANT COSTS					**$35,695.00**
DIRECT EXPENSES					
Printing and Reproduction					
Notices (NOA, NOC, NOD)					$100.00
ADEIR w/Appendices (5)					$1,000.00
DEIR w/Appendices (50)					$6,500.00
AFEIR w/Appendices (5)					$750.00
FEIR w/Appendices (50)					$3,000.00
Graphics/Map Reproductions					$150.00
Circulate Notices, EIRs to County					$200.00
Other Mailing/Publication Expenses (e.g., FedEx, supplies)					$150.00
Travel Expenses/Misc. Materials					$500.00
TOTAL EXPENSES					**$12,350.00**
GRAND TOTAL					**$137,700.00**

* This amendment assumes that the County will distribute the DEIR, FEIR and all Notices (NOA, NOC, NOD).

Table 2

Big Wave EIR, Cost Amendment #1

[1] This amendment assumes an average number of comments on the DEIR. Additional hours may be necessary depending on the number of comments received and the complexity of responses. Additional requested and approved hours will be billed at a Time & Materials rate utilizing CAJA's agreed fee schedule.

Global and regional climate changes due to black carbon

Black carbon in soot is the dominant absorber of visible solar radiation in the atmosphere. Anthropogenic sources of black carbon, although distributed globally, are most concentrated in the tropics where solar irradiance is highest. Black carbon is often transported over long distances, mixing with other aerosols along the way. The aerosol mix can form transcontinental plumes of atmospheric brown clouds, with vertical extents of 3 to 5 km. Because of the combination of high absorption, a regional distribution roughly aligned with solar irradiance, and the capacity to form widespread atmospheric brown clouds in a mixture with other aerosols, emissions of black carbon are the second strongest contribution to current global warming, after carbon dioxide emissions. In the Himalayan region, solar heating from black carbon at high elevations may be just as important as carbon dioxide in the melting of snowpacks and glaciers. The interception of solar radiation by atmospheric brown clouds leads to dimming at the Earth's surface with important implications for the hydrological cycle, and the deposition of black carbon darkens snow and ice surfaces, which can contribute to melting, in particular of Arctic sea ice.

V. RAMANATHAN[1] AND G. CARMICHAEL[2]

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Black carbon (BC) is an important part of the combustion product commonly referred to as soot[1]. BC in indoor environments is largely due to cooking with biofuels such as wood, dung and crop residue. Outdoors, it is due to fossil fuel combustion (diesel and coal), open biomass burning (associated with deforestation and crop residue burning), and cooking with biofuels[1]. Soot aerosols absorb and scatter solar radiation. BC refers to the absorbing components of soot, often defined using elemental carbon and some condensed organics[2]. Recent findings suggest other secondary organics also contribute to strong absorption in the ultraviolet region of the spectrum, components that were presumably ignored in the original definition of BC[3]. Dust, which also absorbs solar radiation, is not included in the definition of BC. Globally, the annual emissions of BC are (for the year 1996) ~8 Tg yr^{-1} (ref. 4), with about 20% from biofuels, 40% from fossil fuels and 40% from open biomass burning. The uncertainty in the published estimates for BC emissions is a factor of two to five on regional scales and at least ±50% on global scales.

High BC emissions (Fig. 1) occur in both the northern and the Southern Hemisphere, resulting largely from fossil fuel combustion and open burning, respectively. Atmospheric brown clouds (ABCs) are composed of numerous submicrometre aerosols, including BC, but also sulphates, nitrates, fly ash and others. ABCs have been extensively documented by surface observatories, field observations and satellite data[5–15]. Single-particle mass spectrometer data reveal that BC is internally mixed with other aerosol species such as sulphates, nitrates, organics, dust and sea salt[16]. BC is removed from the atmosphere by rain and snowfall[2]. Wet removal as well as direct deposition to the surface limits the atmospheric lifetime of BC to about one (±1) week[17].

REGIONAL HOTSPOTS

Until about the 1950s, North America and Western Europe were the major sources of soot emissions, but now developing nations in the tropics and East Asia are the major source regions[18,19] (Fig. 1). Historical BC emissions are available for fossil fuel combustion and biofuel cooking[18,19]. Past emissions of BC from biomass burning are very uncertain[19], although, published reports of extensive brown clouds and their possible effects on the atmosphere date back to at least the 1880s[20].

Integration of field observations[7,14] and new satellite aerosol sensors[15] have revealed the global distribution of ABCs and their radiative forcing[21–23]. Their concentrations peak close to major source regions and give rise to regional hotspots of BC-induced atmospheric solar heating (Fig. 1b). Such hotspots have recently been identified[24] as the Indo-Gangetic plains in South Asia; eastern China; most of Southeast Asia including Indonesia; regions of Africa between sub-Sahara and South Africa; Mexico and Central America; and most of Brazil and Peru in South America. Populations of about 3 billion are living under the influence of these regional ABC hotspots.

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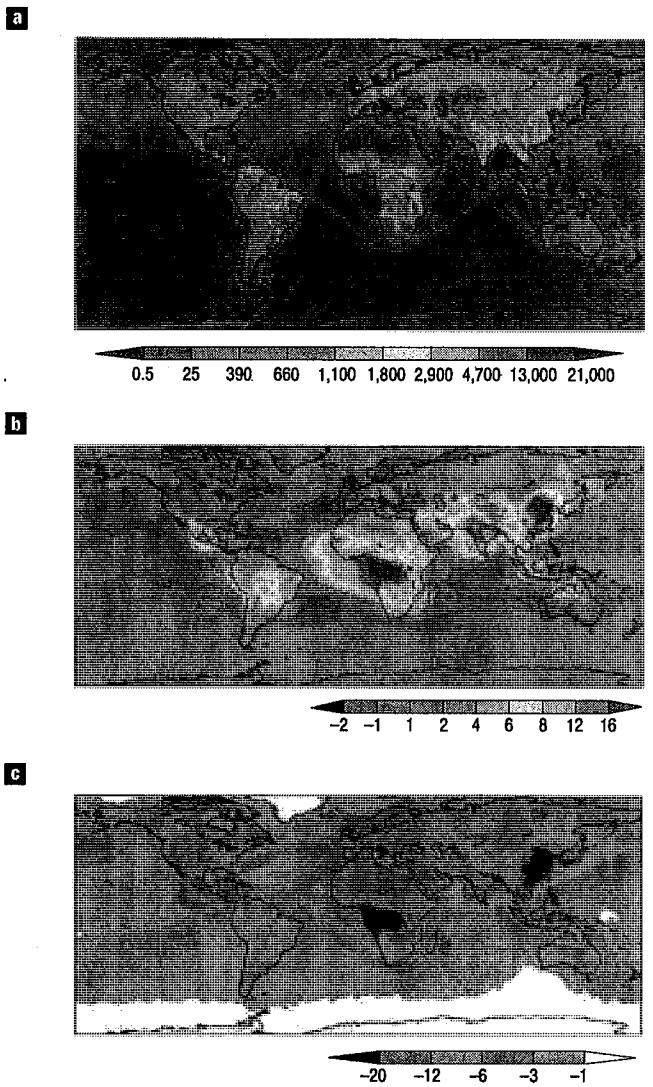

Figure 1 Global distribution of BC sources and radiative forcing. **a**, BC emission strength in tons per year from a study by Bond *et al.*[4], including emissions from fuel combustion (fossil fuels and biofuels) and open biomass burning (forest fires, savanna burning and outdoor cooking) for the year 1996. The uncertainty in the regional emission is about ±100% or more. **b**, Atmospheric solar heating due to BC from the study by Chung *et al.*[23] for the 2001 to 2003 period. This study integrates satellite aerosol data, surface network of aerosol remote sensing instruments and field observations with an aerosol-transport-chemical model and a radiative transfer model to obtain the forcing. Uncertainty in the forcing is ±30%. **c**, As in **b**, but for surface dimming due to ABCs. This shows the reduction in absorbed solar radiation at the surface by all anthropogenic aerosols (BC and non-BC) in ABCs.

RADIATIVE FORCING OF THE CLIMATE SYSTEM

Solar absorption by BC increases inversely with wavelengths from near-infrared (1 μm) to ultraviolet wavelengths with a power law of one to three depending on the source[3,25], thus giving the brownish colour to the sky. Unlike the greenhouse effect of CO_2, which leads to a positive radiative forcing of the atmosphere and at the surface[26] with moderate latitudinal gradients[27,28], black carbon has opposing effects of adding energy to the atmosphere and reducing it at the surface. Furthermore the forcing has significant latitudinal gradients. It alters the radiative forcing through a complex web of processes[7].

The first concerns the increase in top-of-the atmosphere (TOA) radiative forcing. This occurs via several pathways: (1) by absorbing the solar radiation reflected by the surface–atmosphere–cloud system, BC reduces the albedo of the planet; (2) soot deposited over snow and sea ice can decrease the surface albedo[29–32]; (3) soot inside cloud drops and ice crystals can decrease the albedo of clouds by enhancing absorption by droplets and ice crystals[31–34]. All three of these processes contribute to a positive TOA forcing. On the other hand, non-BC aerosols such as sulphates, nitrates and organics in ABCs reflect more solar radiation, increasing the albedo of the planet and resulting in a negative TOA forcing. In addition non-BC aerosols also nucleate cloud drops and thus increase the albedo of clouds. This effect is referred to as an indirect effect or 'cloud-albedo effect'[35–37].

Figure 2 compares the BC forcing (Fig. 2c) with forcing due to all greenhouse gases (GHGs; Fig. 2a), forcing due to CO_2 alone (Fig. 2b) and forcing of all aerosols other than BC (Fig. 2d). The BC forcing includes only the direct forcing from pathway 1 because pathways 2 and 3 are more uncertain and, furthermore, contribute only about 0.1 W m^{-2} to the global forcing[33]. At the TOA, the ABC (that is, BC + non-BC) forcing of −1.4 W m^{-2} (sum of TOA values in Figs 2c,d), which includes a −1 W m^{-2} indirect forcing, may have masked as much as 50% (±25%) of the global forcing due to GHGs. The estimated aerosol forcing of −1.4 W m^{-2} due to ABCs is within 15% of the aerosol forcing derived in the recent IPCC report[37] and is also consistent with other studies[35,36].

The BC forcing of 0.9 W m^{-2} (with a range of 0.4 to 1.2 W m^{-2}) (Fig. 2c) is as much as 55% of the CO_2 forcing and is larger than the forcing due to the other GHGs such as CH_4, CFCs, N_2O or tropospheric ozone[37]. Similar conclusions regarding the large magnitude of the BC forcing have been inferred by others[38–41] and their estimates range from 0.4 W m^{-2} to 1.2 W m^{-2}. The estimate shown in Fig. 2c is obtained from the observationally constrained study of Chung *et al.*[23]. Values generated by many general circulation climate models (GCMs) are mostly in the lower range of 0.2 W m^{-2} to 0.4 W m^{-2} (refs 37,42,43). There are several reasons for the lower estimates. Many ignore the internally mixed state of BC with other aerosols. Such mixing enhances forcing by a factor of two (ref. 39). Field observations have consistently shown that BC is well mixed with sulphates, organics and others[16,44]. Another factor contributing to lower BC forcing in GCMs is that observed BC concentrations peak at about 2 km above the surface[7,14,44] whereas, in most models they are concentrated close to the surface[45]. BC at elevated levels enhances solar absorption significantly because it can absorb the solar radiation reflected by the highly reflective low clouds[38,40,46]. Furthermore, GCMs with lower positive forcing, in general, ignore biomass burning, which is about 40% of the total BC emission. Column integrated aerosol absorption has been retrieved from a worldwide surface network of solar spectral radiometers, referred to as AERONET[47]. The retrieved aerosol absorption[11,48] is a factor of two or more larger than the GCM simulated values[41,49]. The exceptions to the low forcing bias of GCMs are the models that constrain aerosol solar absorption with AERONET values[50] and models that account for the mixing state of BC with other aerosols and include BC from biomass burning[39,40]. The BC forcings estimated by these models are in the range of 0.6 to 0.8 W m^{-2} (refs 39,40) and 0.8 to 1.2 W m^{-2} (refs 41,50).

The second process concerns atmospheric solar heating. In addition to absorbing reflected solar radiation, BC absorbs direct solar radiation and together the two processes contribute to a

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significant enhancement of lower atmosphere (from the surface to about 3 km altitude) solar heating, by as much as 50% in the hotspots (that is, regions with 15 W m^{-2} forcing) (see Fig. 1b). Direct measurement of this solar heating has evaded us until now as it requires multiple aircraft flying over the same domain at different altitudes to measure flux divergences (that is, heating rates) for an extensive period of time. These challenges were recently overcome by deploying three lightweight unmanned aerial vehicles (UAVs) with well-calibrated and miniaturized instruments to simultaneously measure aerosols, BC and spectral as well as broadband radiation fluxes[14,51,52]. The UAV study[14] demonstrated that ABCs with a visible absorption optical depth as low as 0.02 are sufficient to enhance solar heating of the lower atmosphere by 50%. Global average BC solar heating of the atmosphere, as per the present estimate, is 2.6 W m^{-2} (Fig. 2c), which is comparable to the TOA GHG forcing (Fig. 2a).

The third process is the surface dimming. The BC absorption of direct solar radiation reduces the solar radiation reaching the surface and leads to dimming (Fig. 2c). The BC dimming is further enhanced by the direct and indirect effects of non-BC aerosols (Fig. 2d). The total dimming effect is −4.4 W m^{-2} (sum of Fig. 2c,d) — about −3.4 W m^{-2} from the direct effect of ABCs and the remaining −1 W m^{-2} from the indirect effect[35–37]. The dimming can be as large as 5 to 10% over the regional hotspots (Fig. 1). It is important to note that the surface dimming and absorption of direct solar radiation do not contribute much to TOA forcing as it is simply a redistribution of the direct solar radiation between the surface and the atmosphere. However, globally, this redistribution can weaken the radiative–convective coupling of the atmosphere and decrease global mean evaporation and rainfall[26].

Is the planet dimmer now than it was during the early twentieth century? Solar radiometers around the world are indicating that surface solar radiation in the extra tropics was lower by as much as 5% to 10% during the mid-twentieth century[53,54], whereas in the tropics such dimming trends have been reported to extend into the twenty-first century. But many of these radiometers are close to urban areas and it is unclear if the published trends are representative of true regional to global averages[55]. The Indian Ocean Experiment[7] used a variety of chemical, physical and optical measurements to convincingly demonstrate that ABCs can lead to dimming as large as 5–10% (Fig. 1c) over widespread regions in the North Indian Ocean and South Asia. In order to get a handle on the global average dimming, Chung *et al.*[23] integrated field observations with satellite data and aerosol transport models to retrieve an observationally constrained estimate. As seen from Fig. 1c, over large regions the reduction of solar absorption at the surface exceeds 10 W m^{-2} (>5%), which is consistent with the dimming reported from surface observations. The global annual average dimming (for 2001–2003), however, is −4.4 W m^{-2}, as opposed to the −10 W m^{-2} estimated by surface radiometers. Thus, great care should be exercised to extrapolate surface measurements over land areas to global averages. The global dimming of −4.4 W m^{-2} has been compared to the GHGs forcing of 3 W m^{-2} from 1850 to present[54]. Such comparisons, without a proper context could be misleading because, as shown in Fig. 2, for BC, the surface forcing is negative whereas the TOA forcing is positive (Fig. 2c).

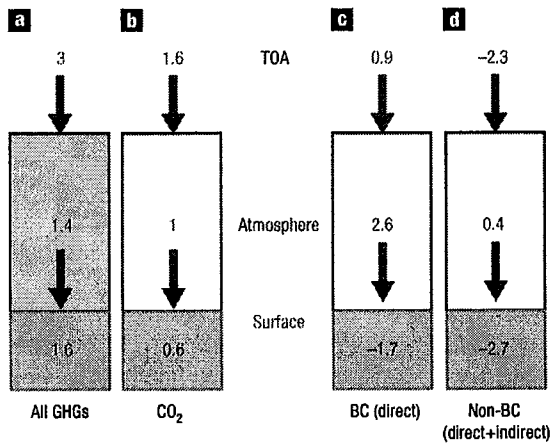

Figure 2 Comparison of the global mean radiative forcing due to greenhouse gases (GHGs) with that of ABCs. **a**,**b**, Forcing for all GHGs (CO_2, CH_4, N_2O, halons and ozone) (**a**), and for CO_2 (**b**). The number at the top of the atmosphere box (blue box) is the top-of-the atmosphere (TOA) forcing; the number within the atmosphere box is the atmospheric forcing; and the number within the brown box is the forcing at the surface. The TOA forcing is the sum of the forcing of the atmosphere and the surface. The forcing values represent the change in radiative forcing due to increase in gases for the year 2005, which is the same as the forcing from pre-industrial to present. The TOA numbers are taken from ref. 68 and the atmospheric and surface forcings are derived from an atmospheric radiative transfer model. The numbers at the surface and the atmosphere are slightly adjusted to agree with the TOA IPCC forcing. The uncertainty in the forcing values is ±20%. **c**, BC forcing obtained by running the Chung *et al.* analysis[23] with and without BC. The forcing values are valid for the 2001–2003 period and have an uncertainty of ±50%. **d**, Non-BC forcing. This includes the direct and the indirect forcing. The direct forcing is obtained by subtracting the total anthropogenic forcing in Chung *et al.* from the BC forcing shown in **b**. The indirect forcing (of about 1 W m^{-2} at the TOA and at the surface) is an average of values derived from recent studies[35–37].

GLOBAL CLIMATE EFFECTS

The TOA BC forcing implies that BC has a surface warming effect of about 0.5 to 1 °C, where we have assumed a climate sensitivity of 2 to 4 °C for a doubling of CO_2. Conversely, ABCs have a cooling effect of about −0.75 to −2.5 °C (ref. 35). Because BC forcing results in a vertical redistribution of the solar forcing, a simple scaling of the forcing with the CO_2 doubling climate sensitivity parameter may not be appropriate[40,56,57]. For example, GCMs suggest that the reduction of sea ice and snow albedo by BC is three times as effective as CO_2 forcing for global average surface warming[57].

BC and non-BC aerosols perturb the hydrological cycle significantly. The surface and atmospheric warming due to GHGs would lead to an increase in atmospheric humidity (owing to an increase in saturation vapour pressure) and rainfall (owing to an increase in the radiative heating at the surface)[26,58]. With respect to ABCs, the overall negative forcing at the TOA, as well as the surface dimming, should lead to a decrease in evaporation and rainfall[7,37]. It is difficult to predict the net effect of GHGs and ABCs on global rainfall, given the large positive forcing at the TOA and the larger negative forcing at the surface. We can not resort to observed rainfall trends to infer the net anthropogenic effect on global rainfall as long-term rainfall measurements are only available for land regions.

REGIONAL CLIMATE EFFECTS

We have just begun to comprehend the chain of response and feedbacks on the regional climate due to BC[9,12,14,23,59–65]. In regions where radiative–convective coupling of the surface and the atmosphere is strong (for example, equatorial oceans and tropical

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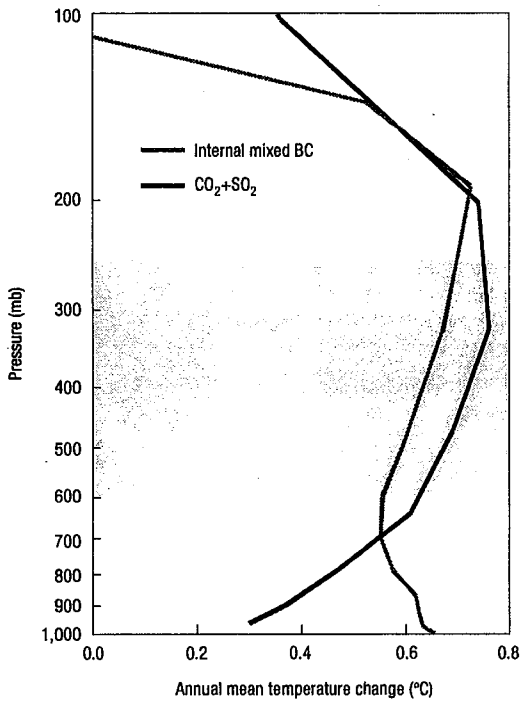

Figure 3 Simulated atmospheric temperature change due to GHGs and BC for the South Asian region. The values are annual mean temperature changes over the South Asian region, averaged from 20° N to 40° N and from 70° E to 100° E. The blue line is the change due to the increase in all GHGs and sulphate aerosols as simulated by ref. 60. The red line is the estimated temperature change due to BC taken from the global circulation model study of Chung and Seinfeld[67].

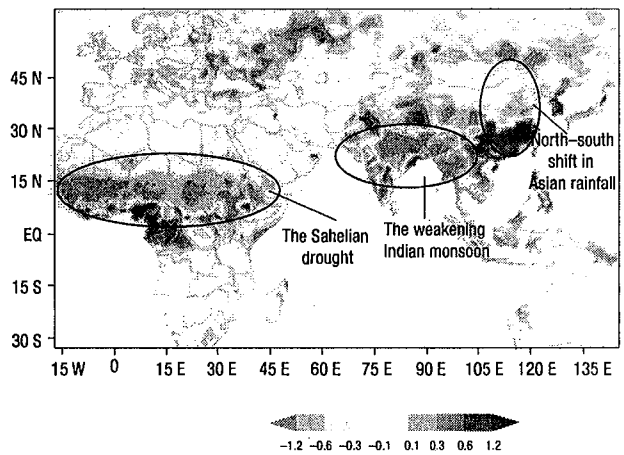

Figure 4 Precipitation trend from 1950–2002. The plot is adopted from ref. 65. (units: change in mm per day from 1950 to 2002). The red and dark blue shaded regions are statistically significant.

land during wet seasons), the surface–atmosphere response will be determined by the TOA forcing, and as a result BC by itself will lead to a warming of both the surface (in spite of the surface dimming) and the atmosphere (in spite of the atmospheric solar heating), whereas ABCs will lead to a cooling of both the surface and the atmosphere. In regions where such coupling is weak (for example, dry seasons in the tropics), the surface dimming due to ABCs can lead to surface cooling and thus can mask the greenhouse warming[66], whereas the atmospheric solar heating by BCs can lead to a warming of the atmosphere and intensify the greenhouse warming of the troposphere. GCMs that include just the BC forcing[14,64,67] show that BC leads to a warming from the surface to about 12 km altitude, by as much 0.6 °C over most of the Northern Hemisphere including the Arctic region (for example, see Fig. 11 in Chung and Seinfeld[40], and ref. 64). The magnitude of the BC atmospheric warming is comparable to the simulated warming due to GHGs forcing[68]. Regionally, the combined effect of ABCs is to cause a surface cooling[65] over South Asia while warming the atmosphere by as much as 0.6 °C during winter and spring[14,60]. Such differential warming of the atmosphere with respect to the surface over the South Asian region has also been observed with microwave satellite sensor observations of the trends from 1979 to 2003[14,60].

BC atmospheric heating may be an important contributing factor to the retreat of Himalayan glaciers. Analysis of temperature trends on the Tibetan side of the Himalayas reveals warming in excess of 1 °C since the 1950s. This large warming trend at the elevated levels is proposed as the causal factor for the retreat of glaciers through melting[69,70]. GCM simulations suggest that advection of the warmer air heated by BC from South and East Asia over the Himalayas contributes to a warming of about 0.6 °C (annual mean) in the lower and mid troposphere (see Fig. 3) of the Himalayan region[14,64]. This is as large as the warming trend due to the GHGs (Fig. 3), leading to the inference[14] that BC forcing is as important as GHGs in the observed retreat of over two thirds of the Himalayan glaciers[71].

BC contributes to melting of snow through another process. When soot is deposited over snow and sea ice, it darkens the snow and significantly enhances solar absorption by snow and ice[30,32]. Recent studies suggest that this is one of the important contributors to the retreat of the Arctic sea ice (see summary of earlier studies in ref. 57). Simulations by Flanner *et al.*[57] showed that the deposition of BC from sources in North America and Europe over the Arctic sea ice may have resulted in an Arctic surface warming trend of as much as 0.5 to 1 °C (ref. 72). In addition, the study estimated that BC-induced reduction of snow albedo is a major forcing term (about 20 W m^{-2}) in the Tibetan side of the Himalayas. Ice-core records of BC deposition over Greenland from the early nineteenth century onwards have now provided a historical record for examining the role of BC forcing in the retreat of sea ice[73].

Atmospheric heating and dimming by BC and non-BC aerosols can perturb the monsoon significantly. Precipitation trends over many regions of the tropics during the last 50 years have been negative, particularly over Africa, South Asia and northern China (Fig. 4)[68]. These drying patterns can not be explained solely by global warming[74,75]. Natural variability and anthropogenic aerosol forcing are emerging as major players in the observed trends[60,74–76]. The impacts of ABCs and BC on the South Asian monsoon have received attention recently[40,59,60,62,63,65,67,74]. Precipitation over land is driven by evaporation from the land surface and long-range transport of moisture from the surrounding Indian Ocean. These model studies reveal that ABCs have three distinct effects on the long-range transport of moisture and its convergence over South Asia:

(i) A decrease in the evaporation of the Indian Ocean owing to dimming. Emissions of BC and other aerosol precursors from South Asia have increased significantly since 1950s[18,19]. This has resulted in a dimming trend of about 7% as detected by surface radiometers in India[60]. Similar dimming has also occurred

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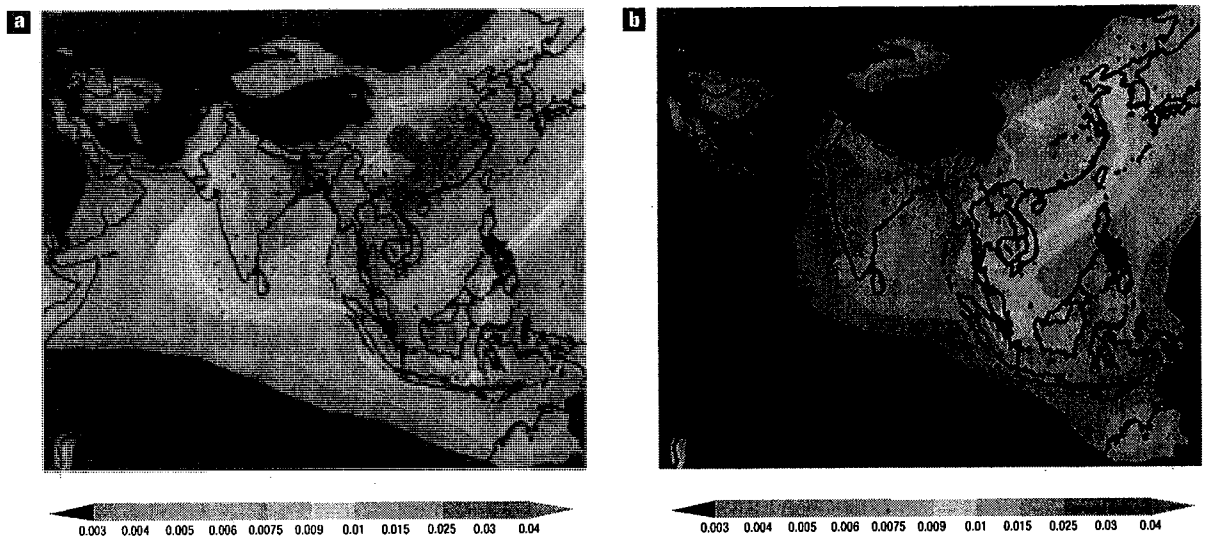

Figure 5 The effect of biofuel cooking on Asian BC loading. **a**, The simulated annual mean optical depth of BC aerosols for 2004–2005 using the regional aerosol/chemical/transport model described in ref. 96. The values include BC emissions from biofuel cooking (indoor cooking with wood/dung/crop residues), fossil fuels and biomass burning. **b**, As for **a**, but without biofuel cooking.

over the Indian Ocean[7] (See Fig. 1c). As about 75% or more of the surface radiative heating is balanced by evaporation[26], the dimming trend leads to a decrease in evaporation from the North Indian Ocean[60], so less moisture is fed to the monsoonal inflow into South Asia.

(ii) A decrease in meridional sea surface temperature (SST) gradient. Because ABCs are concentrated over the North Indian Ocean (Fig 1), the dimming is suppressing the greenhouse warming over the North Indian Ocean while the GHGs warming is proceeding unabated over the southern Indian Ocean. As a result, the summertime north-to-south SST gradient (with warmer waters over the North Indian Ocean) has decreased since the 1950s, as has been seen from observations[60,74]. The weakening of the SST gradient weakens the monsoonal circulation, as shown by numerous studies[60,74,75], and in turn weakens the monsoonal rainfall during summertime. It is important to note that, although the ABC dimming peaks in winter and spring, the SST response is delayed until summer owing to the slower response time of the ocean[60,64,74].

(iii) An increase in atmospheric meridional heating gradient. The stronger BC solar heating of the atmosphere over South Asia (Fig. 1b) strengthens the monsoonal outflow with stronger rising motions over the subcontinent, accompanied by a stronger moisture flux into South Asia[60,63,64,74]. This effect, which increases rainfall, peaks during spring when the BC heating is at its peak value.

The atmospheric heating shown in Fig. 1b is solely due to BC, whereas the dimming is due to both the BCs and non-BC aerosols in ABCs (Figs 1c and 2d). The larger dimming over the land regions compared with the adjacent oceans also suggest that the dimming decreases the land–sea contrast in surface temperature — a major monsoon forcing term. In order to account for the delayed oceanic response to the dimming, fully coupled ocean–atmosphere models are required. To date, three such studies have been published[60,62,64] and all of them estimate an increase in pre-monsoon rainfall during spring followed by a decrease in summer monsoon rainfall, in agreement with observed trends (Fig. 4; ref. 60). The link between dimming, the north–south SST gradient and a decrease in land rainfall has also been invoked to explain the Sahel drought[75] of the 1970s and 1980s.

CLIMATE SYSTEM RESPONSE AND FEEDBACKS

The immediate response of the atmosphere to ABCs is to increase or decrease cloud cover. The non-BC aerosols, by nucleating more cloud drops, decrease the effective radius of the cloud drop. This can suppress formation of larger drizzle drops, extend the lifetime of clouds, and thus increase cloud cover[37]. On the other hand, BC solar heating can decrease the relative humidity of the cloud layer, leading to evaporation of cloud drops and thus decreasing low cloud fraction and albedo. This semi-direct effect can enhance the positive climate forcing by BC[37]. A relative comparison of the increase in cloud cover by non-BC aerosols and the decrease due to BC was undertaken[77] empirically with a surface network of sun photometers[47]. This study suggested that the non-BC effects dominate overall, except for in heavily polluted regions with absorption optical depths exceeding 0.05 (for example, the Amazon during the burning season; Africa during Savanna burning season; and urban regions in South and East Asia). An alternative scenario is that BC solar heating induces convection and consequently leads to cloud formation[78]. The global magnitude of the semi-direct effect is highly uncertain.

Spring season dust storms from Asia and Africa transport large quantities of dust across the Pacific Ocean[79,80] and the Atlantic Ocean[81]. The dust is transported either as individual layers or mixed with industrial soot. Such dust–soot mixtures increase the atmospheric solar heating and surface dimming significantly[79,80] and can also serve as nuclei for ice clouds and feedback on precipitation[82]. For the first time, such dust–soot mixtures were tracked in an aircraft all the way across the Pacific Ocean from near the surface to about 14 km altitude[83].

An increase in drought intensity due to global warming can intensify occurrence of forest fires, as has been documented for California[84]. Increase in forest fires, such as the boreal forest fires of 1996, can increase soot deposition in sea ice and enhance its melting[57]. Surface cooling occurring simultaneously with lower atmosphere warming (due to BC and dust) can stabilize the

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boundary layer during the dry season and increase the lifetimes of aerosols in ABCs and increase persistence of soot-filled fog. Soot can also influence precipitation formation mechanisms[85,86].

Two extreme scenarios have been proposed for such feedbacks. For South Asia, GCM simulations suggest that a two- to threefold increase in soot loading (from present day levels) is sufficient to substantially weaken the monsoon circulation, decrease rainfall by more than 25% and increase drought frequency significantly[59]. As wash out by rain is a major sink for BC, large decreases in rainfall can have a positive feedback on BC concentrations. The other scenario is the so-called nuclear winter scenario[87–89], in which large-scale increase in BC from fires resulting from a global-scale nuclear war can nearly shut down sunlight at the ground (total dimming), which can collapse the troposphere and decrease rainfall drastically.

REDUCING FUTURE BLACK CARBON EMISSIONS

Given that BC has a significant contribution to global radiative forcing, and a much shorter lifetime compared with CO_2 (which has a lifetime of 100 years or more), a major focus on decreasing BC emissions offers an opportunity to mitigate the effects of global warming trends in the short term (see, for example, refs 90–92). Reductions in BC are also warranted from considerations of regional climate change and human health[93,94].

It is clear from Fig. 2 that air pollution mitigation steps can have significant impacts on future climate changes. The logical deduction from Fig. 2a,c,d is that the elimination of present day ABCs through emission reduction strategies would intensify surface warming by about 0.4 to 2.4 °C (see also, ref. 35). If only the non-BC aerosols were controlled, it could potentially add 2.3 W m^{-2} to the TOA forcing and push the system closer to the 3 °C cumulative warming (since 1850s), which is a likely threshold for unprecedented climate change[95]. If on the other hand, the immediate target for control shifts entirely to BC (owing to its health impacts) without a reduction in non-BC aerosols, the elimination of the positive forcing by BC will decrease both the global warming and the retreat of sea ice and glaciers. It is important to emphasize that BC reduction can only help delay and not prevent unprecedented climate changes due to CO_2 emissions.

ASIAN EMISSIONS AND FUTURE TRENDS

Given the fact that technology exists for large reductions of soot emissions, we explore the impact of a major focus on soot reductions. We focus on Asia, where emissions from China and India alone account for ~25 to 35% of global BC emissions and the regional climate responses to BC are (expected to be) large. In addition, with the economies of China and India expanding with double digit growth rates, Asia can become a much larger source of ABCs, depending on the energy path taken to sustain this growth rate. In fact new estimates indicate that BC emissions for China in 2006 have doubled since 2000, whereas SO_2 emissions have grown during this period by more than 50% (D. G. Streets, manuscript in preparation, data available at http://www.cgrer.uiowa.edu/EMISSION_DATA_new/summary_of_changes.html). East Asia and South Asia also represent a different mix of emissions, and therefore can illustrate potentials for various control options that are also representative of global choices. The majority of soot emission in South Asia is due to biofuel cooking, whereas in East Asia, coal combustion for residential and industrial uses plays a larger role. The large BC emissions are reflected in the geographical extent of the large absorbing component of aerosol optical depth, simulated with a regional aerosol-chemistry transport model[96] (see areas with BC optical depth > 0.01 in Fig. 5a).

What are the opportunities to reduce the positive forcing by BC? Providing alternative energy-efficient and smoke-free cookers and introducing transferring technology for reducing soot emissions from coal combustion in small industries could have major impacts on the radiative forcing due to soot[97]. Figure 4b shows the impact of replacing biofuel cooking with BC-free cookers (solar and bio and natural gas) in South and East Asia. The impacts are dramatic: over South Asia, a 70 to 80% reduction in BC heating; and in East Asia, a 20 to 40% reduction. The impact on human health will potentially be even more dramatic as over 400,000 annual fatalities among women and children are attributed to smoke inhalation during indoor cooking[93,94]. However, changes in BC alone do not tell the entire story as the climate response also depends on how the BC to non-BC aerosol fraction responds to future emissions. As BC is co-emitted with non-BC aerosols, it is necessary to evaluate how various mitigation strategies impact this fraction. With an emphasis on the opportunities discussed here, this ratio would probably decrease in the future, more quickly in East Asia, amplifying the effectiveness of BC reductions[98].

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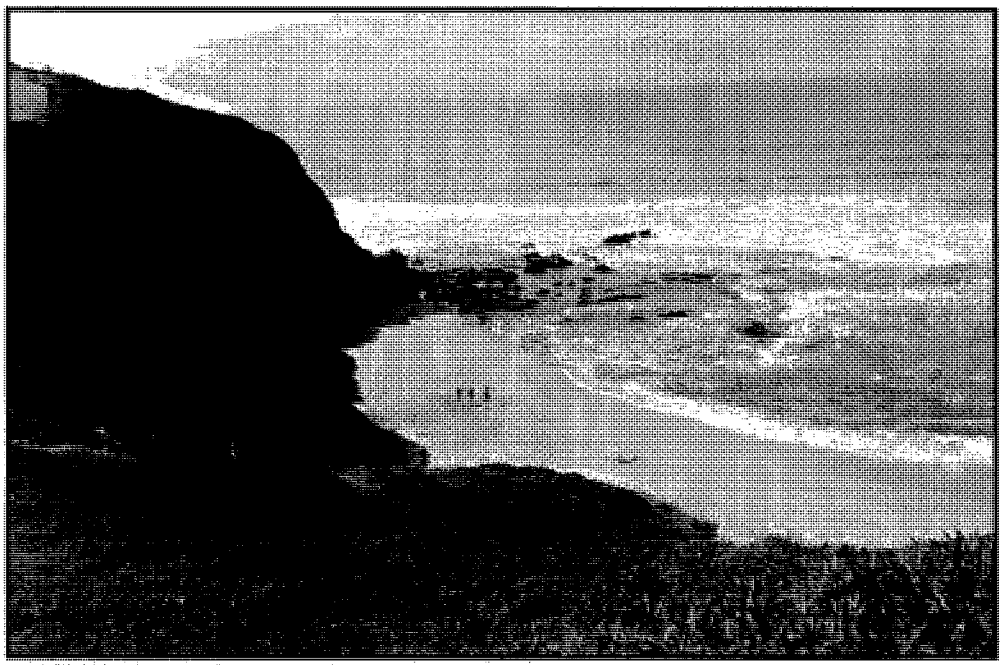
C. NATURAL RESOURCE MANAGEMENT PROGRAM

The primary goal of the Master Plan is to preserve the natural resources of the Reserve, and to enhance them through careful management. Policies and activities that would accomplish this goal are described below.

Policy 1. **Natural resources within the Fitzgerald Marine Reserve will be protected and restored through development and implementation of resource management policies and programs.**

Policy 2. **Visitor management policies and programs will focus on education, one of the priority missions of the Reserve.**



Policy 3. **The Moss Beach Reef and Frenchman's Reef will be continuously monitored over a minimum period of 10 years to develop baseline information on the ecological system, to determine the rate and degree of recovery, and to determine the effectiveness of Master Plan policies limiting visitor use.**

Biological monitoring has been conducted by Reserve staff and volunteers between 1973 and the present, and the Reserve now participates in a joint research program with San Francisco State University. However, additional monitoring and scientific investigations are needed to establish baseline information from which to develop effective monitoring programs and long term management strategies. This Plan proposes that a program for monitoring be developed jointly by the County of San Mateo and the State of California Department of Fish and Game, with participation

by the Monterey Bay National Marine Sanctuary, that will meet the purposes stated in Policy 3, above. This information will be used to meet scientific and research objectives as well as to evaluate the effectiveness of management programs in achieving reef recovery and conservation goals. A monitoring report will be provided every two years to evaluate effectiveness of reef recovery measures and visitor management programs.

Policy 4. **Portions of the Moss Beach Reef may be closed to visitors as warranted by environmental conditions, research objectives, and monitoring activities.**

In order to conduct monitoring activities and scientific investigations of the Moss Beach Reef, portions of the reef may require closure to all visitors from time to time. Configuration of such closures, and the appropriate techniques for closure, would be determined by the Reserve Manager, as part of the adaptive management program for the Reserve.

Policy 5. **The Feasibility of Restoring Tidal Action to the Freshwater Marsh across West Point Avenue to the northeast of the existing saltwater marsh will be determined.**

Expansion of the saltwater marsh would be accomplished by creating channels for tidal flows through the area that was filled to create West Point Drive, and with dredging of fills placed in this area. Hydrologic and biological studies should be undertaken to determine whether restoration of a saltwater marsh is feasible, and the

relative environmental impacts and benefits of replacing the freshwater (seasonal) marsh that exists in this area now with tidal saltwater marsh.

Policy 6. **Water quality improvements in San Vicente Creek and Pillar Point Marsh will be undertaken.**

The program shall include drainage improvements, removal of fill in the San Vicente Creek drainage, implementation of Best Management Practices (BMPs), and enforcement of non-point source water quality regulations. The County will coordinate with surrounding landowners to implement BMPs to improve upstream water quality. Specifically, the County will coordinate with the Half Moon Bay Airport to develop detention basins and vegetation buffers within the Airport's drainage system to minimize impacts to the water quality of the Pillar Point Marsh, and will work with local landowners, the surrounding communities of Princeton, Half Moon Bay and Moss Beach, and the local resource agencies, such as the Farm Bureau, San Mateo County Resource Conservation Service and the Regional Water Quality Control Board to develop best management practices to improve water quality in the San Vicente, Denniston Creek and other drainages upstream from the Reserve.

Policy 7. **Special status wildlife and plant species shall be protected within the Reserve, and habitat management plans shall be developed to protect and restore all identified special status species.**

During implementation of the Master Plan, all areas where work is to be conducted shall be surveyed for special status wildlife and plant species prior to commencement of work. Habitat management programs shall be undertaken when special status species are identified, and impacts to such species shall be avoided or mitigated, as required by State and federal law.

Improvements to the San Vicente Creek and Pillar Point Marsh shall include creation and protection of habitat for the red-legged frog, a federally listed threatened species. A habitat management plan for the red-legged frog shall be implemented within the San Vicente Creek corridor and Pillar Point Marsh.

Policy 8. **A vegetation management program will be developed to restore and protect native plant communities.**

Specific objectives of this program will be to maintain the grove of Monterey cypress trees and to restore native vegetation to the San Vicente Creek channel, to upland areas and the Pillar Point Marsh. Non-native vegetation will be removed from the San Vicente Creek channel and the Pillar Point Marsh, and in the upland areas. The Monterey cypress grove will be thinned to improve the health of the forest and understory plants, and to remove eucalyptus trees, hazardous limbs and trees, and young cypress trees invading adjacent native habitat.

Policy 9. **Maintain the historic character and health of the plant community at the Smith-Dolger historic site.**

The landscape surrounding the historic Smith-Dolger home contributes to the historic character of the site. Some of the plants, such as the palm trees, are not native, but are typical of early California residential settlements of this period. This landscape should be protected and maintained. Invasive non-native plants that are not part of the historic landscape should be removed from around the home and archaeological site; other non-natives should be maintained as needed to protect the historic character of the site.

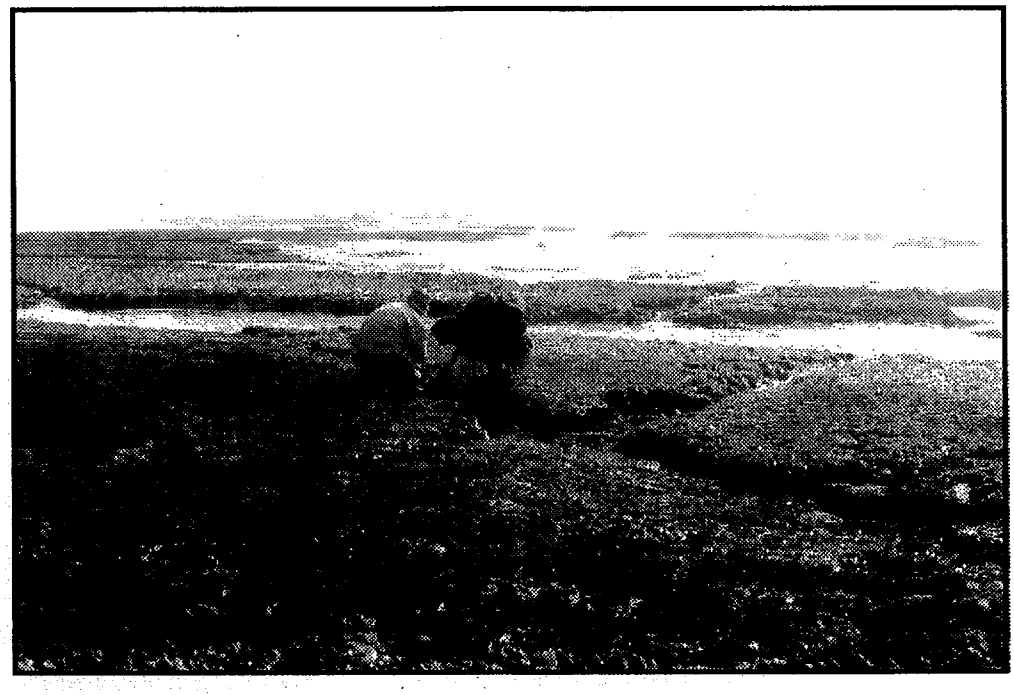
Policy 10. **Acquire land in the vicinity of Pillar Point Marsh and lands adjacent to the Reserve, as it becomes available, to add to the ecological system of the**

Reserve. Establish a working committee of the County Park and Recreation Commission and Board of Supervisors to coordinate and facilitate acquisitions.

The Pillar Point Marsh land is now separated from the main body of the Reserve. The County should acquire land as it becon..es available in order to connect Pillar Point Marsh with the Reserve, to expand the ecological system of the Reserve, to provide opportunities for future educational activities, and to avoid potential land use impacts that could result from management practices on adjacent lands in different ownership. Acquisition efforts should focus on land between the Reserve and Airport Street to the east, land between Pillar Point Marsh and the Reserve, and lands inland of Pillar Point, including the Pillar Point Air Force Station, should it become available at any time in the future.

Policy 11. **Introduction and possession of domestic and feral animals, including dogs, cats, ducks and any exotic, non-naturalized species are prohibited in the Reserve.**

Due to the potential for impacts to biological resources from predation or disease, dogs and other non-native species are not allowed within the Reserve. This policy will be implemented and enforced to prevent interference with and mortality of native species. Dogs will be allowed only on leash on the California Coastal Trail. Actions to reduce or remove existing populations of domestic and feral animals will be implemented by Reserve staff. This policy is consistent with County Code Section 3.68.080(i).



Policy 12. **Recreational hunting, gathering and collecting are prohibited within the Reserve because of the potential risks to public safety and biological resources.**

California Department of Fish and Game regulations for Marine Life Refuges limit taking and possession of species (see Part One, Section 8.a.1 of this report). However, gathering of species has been a common recreational activity within the Reef and has been responsible for impacts on the biodiversity of the Reef. Hunting has occurred in the bluff area of the Reserve, although infrequently. Subsistence gathering has also occurred on the Reef. These illegal activities have been discouraged through education and outreach by Reserve staff and volunteers; however, many of the Reef resources have been depleted through these activities. As a result, efforts are underway to establish the Reserve as a Marine Life Reserve (for additional discussion, see Part One. Chapter A.5 of this report). The Reserve Manager will be responsible for enforcement of this policy as part of the adaptive management program. This requirement is consistent with County Code Section 3.68.080(d), (g), (h) and (n).

FIRST AMENDMENT TO AGREEMENT BETWEEN THE COUNTY OF SAN MATEO AND CHRISTOPHER A. JOSEPH & ASSOCIATES

THIS FIRST AMENDMENT TO THE AGREEMENT, entered into this _____ day of _____, 20_____, by and between the COUNTY OF SAN MATEO, hereinafter called "County," and Christopher A. Joseph & Associates, hereinafter called "Contractor";

W I T N E S S E T H:

WHEREAS, pursuant to Government Code, Section 31000, County may contract with independent contractors for the furnishing of such services to or for County or any Department thereof; and

WHEREAS, on December 5, 2006, the parties entered into an Agreement for environmental consulting services for the preparation of Draft and Final Environmental Impact Reports (EIR) for the Big Wave project; and

WHEREAS, the parties wish to amend the Agreement to add additional funding in the amount of $137,700 and extend the term to June 30, 2010,

NOW, THEREFORE, IT IS HEREBY AGREED BY THE PARTIES HERETO AS FOLLOWS:

1. Paragraph 3, Payments, is amended in its entirety to read as follows:

   In consideration of the services provided by Contractor in accordance with all terms, conditions and specifications set forth herein and in Exhibit "A," County shall make payment to Contractor based on the rates and in the manner specified in Exhibits "B," "C," "D" and "E." The County reserves the right to withhold payment if the County determines that the quantity or quality of the work performed is unacceptable. In no event shall the County's total fiscal obligation under this Agreement exceed Three Hundred Forty-Two Thousand One Hundred Two Dollars ($342,102).

2. Paragraph 4, Term and Termination, is amended in its entirety to read as follows:

   Subject to compliance with all terms and conditions, the term of this Agreement shall be from December 5, 2006 through June 30, 2010.

   This Agreement may be terminated by Contractor, the Director of Community Development or his/her designee at any time without a requirement of good cause upon thirty (30) days' written notice to the other party.

   In the event of termination, all finished or unfinished documents, data, studies, maps, photographs, reports, and materials (hereafter referred to as materials) prepared by

Contractor under this Agreement shall become the property of the County and shall be promptly delivered to the County. Upon termination, the Contractor may make and retain a copy of such materials. Subject to availability of funding, Contractor shall be entitled to receive payment for work/services provided prior to termination of the Agreement. Such payment shall be that portion of the full payment which is determined by comparing the work/services completed to the work/services required by the Agreement.

3. Exhibit E, Additional Scope of Work with Cost Amendment and Schedule, attached hereto, is added to the Agreement and incorporated herein by reference.

4. All other terms and conditions of the Agreement dated December 5, 2006 between the County and Contractor shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto, by their duly authorized representatives, have affixed their hands.

COUNTY OF SAN MATEO

By:_____
President,
Board of Supervisors, San Mateo County

Date:_____

ATTEST:

By:_____
Clerk of Said Board

Christopher A. Joseph & Associates

Jennie Anderson
Contractor's Signature

Date: 3·19·09

EXHIBIT E

ADDITIONAL SCOPE OF WORK

Big Wave Wellness Center and Office Park Environmental Impact Report (EIR) Scope and Budget

ESTIMATED ADDITIONAL TIME AND EXPENSES (*CAJA AMENDMENT 1*)

The following includes the scope of work tasks and associated expenses for the remaining EIR process. This information follows those EIR Tasks outlined in the executed original contract scope of work with supplements included as necessary to reflect the revised Project Description, associated technical data, and time lapsed since the execution of the original contract.

Task 1. Project Management

This budget amendment includes 38 additional hours for project management by Geoff Reilly (Principal/Project Manager) and Jennie Anderson (Project Manager). This includes additional time for: project scheduling; budgeting/invoicing; management & coordination of CAJA staff; oversight of production and circulation of EIR and notices; review of EIR sections for quality assurance; oversight of document format and word processing; and coordination with County staff and preparation of status updates.

Task 2. Finalize Project Description

Based on a review of the Draft Facilities Plan, CAJA submitted a Draft Project Description to the County for review on January 28, 2009. This Draft version included various comments and data gaps for response from the County/Applicant. Per email correspondence from the County/Applicant on February 27, 2009 the Applicant will be providing additional data to CAJA for Project Description finalization during the scheduled March 4, 2009 meeting. This scope of work task includes time for CAJA to finalize the Project Description for use in the update of the EIR.

Deliverables: One electronic copy of the Final Project Description for County verification.

Task 3. Prepare and Update Administrative Draft EIR (ADEIR)

Prepare and Update General Sections/Section I of the ADEIR – Cover, Title Page, Table of Contents, Introduction

CAJA will update the abovementioned sections of the ADEIR to reflect the Final Project Description and tasks completed since 2007 hold date.

Prepare and Update Section II of ADEIR – Summary

CAJA will prepare and update the following subtopics to be included in the Summary Section of the ADEIR: Introduction; Summary of the Proposed Project; Topics of Known Concern; Summary of Alternatives to the Proposed Project; Areas of Controversy; and Summary of Environmental Impacts and Mitigation Measures (including a summarized Table).

Prepare and Update Section III of ADEIR – Project Description

See Task 2 outlined above regarding CAJA's finalization of project description. Additionally, CAJA will update Related Projects Table; amendment assumes County will assist in providing the most recent related project County list.

Prepare and Update Section IV of ADEIR - Environmental Impact Analysis

For each Impact Analysis section in Section IV, CAJA will prepare and update: the introduction and methodology subsections, the environmental setting, the regulatory framework, the impact analysis, the cumulative impacts analysis based on the related projects list to be provided by the County, and mitigation measures (as appropriate). The section scopes will follow the CEQA Guidelines and will factor applicable environmental-related comments (as appropriate) received during the NOP and scoping meeting period, as well as from the County on the project referral. Additionally, this amendment includes funding and time for the preparation of associated graphics and technical appendices updates. In addition to completing the abovementioned tasks, other specific tasks related to each respective section are provided below for each of the following section titles.

Section IV.A (Aesthetics)

- CAJA will review all revised technical documents and materials associated with the revised proposed project for completeness, methodology, findings, adequacy, and relevance with regard to potential aesthetic impacts.
    - CAJA will peer review and provide feedback on the updated simulations provided in the Draft Facilities Plan once the final Project Description is determined and (if necessary) during the preparation of the EIR, specifically, the Aesthetics section analysis. Based on a preliminary review by our Graphics Department, the provided simulations appear adequate. Any applicable CAD files, etc. would be required to facilitate edits as necessary. Additional figures will be updated and provided as necessary for this visual analysis.
- As part of the Environmental Setting update, based on past site visits and using information in the County's General Plan, Facilities Plan, and other recent County CEQA documents, CAJA will confirm the regional and local context relative to aesthetics and the existing physical characteristics of the project site, focusing on visual features such as topography, vegetation, existing uses, and the site's relationship to nearby uses. In addition, CAJA will describe views from and of the project site, focusing on character-defining features and the project site's relationship to the entire field of view.
- CAJA will define scenic vistas and scenic resources in the project area. Generally describe any scenic vistas available from nearby public vantage points and the location of any scenic resources in relation to the project site (e.g., scenic roadways). Note whether the project site is visible and/or how much of the project

site is visible within these views. Describe how these views and/or resources might change due to the project, using the Applicant-provided visual simulations as a guide.

- Describe the overall visual character of the project site and areas surrounding the site. Describe how the revised project would alter the existing visual character of the site and surrounding area, focusing on how the project would change the character-defining features described previously. This discussion will be based on revised project plan elevations and descriptions of building materials and design as provided by the Applicant. Based on this discussion, determine whether the project would adversely change the existing character of the site and/or the surrounding area, and the potential to result in a significant impact under CEQA.

- Describe the types and relative amounts of light and glare that would be associated with the revised project and describe how these sources might affect the surrounding area. Based on this discussion, determine whether the project would result in significant light and/or glare impacts.

- Recommend updated mitigation measures as necessary.

Section IV.B (Agriculture Resources)

- CAJA will update and reconfirm the agriculture impact analysis via the CEQA process in order to determine if the revised project would result in significant impacts to agriculture resources. Should the analysis determine that impacts would be significant, mitigation measures would beprepared. As the site is not under contract with the County under the provisions of a Williamson Act contract, CAJA will evaluate the project's impacts to agriculture resources based on the Land Evaluation and Site Assessment (LESA) analysis in order to determine if the project would convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use.

Section IV.C (Air Quality)

- CAJA will utilize as much existing data as possible provided by the Applicant in the Facilities Plan.

- Describe baseline air quality information, including the pollutants of concern in the Bay Area, the agencies responsible for improving air quality in the Bay Area, and the existing air quality conditions in the county and local vicinity. Existing regional emissions will be identified using information obtained from the California Air Resources Board. Existing localized emissions of carbon monoxide will be calculated using data from the revised project traffic report, as described in Section IV (Transportation/Traffic). Any emissions that may be associated with the existing conditions at the project site will also be discussed.

- Identify the thresholds of significance recommended by the Bay Area Air Quality Management District (BAAQMD) as presented in the BAAQMD CEQA Guidelines and used by the County to evaluate air quality impacts under CEQA.

- Construction-related activities are generally short-term in duration, and the BAAQMD does not recommend any thresholds of significance for their associated emissions. Instead, the BAAQMD bases the determination of significance on a consideration of the control measures to be implemented. Therefore, the

EIR will discuss the potential impacts that would occur during construction and recommend the appropriate measures to reduce these impacts to less-than-significant levels.

- Calculate operational mobile and area source emissions for reactive organic gases, nitrogen oxides, and particulates using the URBEMIS model recommended for use by the BAAQMD. Calculations will be based on the trip generation factors provided in the revised project traffic study. The predicted emissions will be compared to the thresholds of significance recommended by the BAAQMD.

- Calculate future localized carbon monoxide concentrations at intersections in the project vicinity that would be most affected by project-generated traffic. These emissions will be calculated using data from the revised project traffic report. The resulting emissions will be compared to state and national ambient air quality standards. These methods are based on the Caline4 Line Source Dispersion Model.

- Discuss the consistency of the project with the current Clean Air Plan for the Bay Area.

- Generally characterize the types of emissions, including toxic air contaminant (TAC) emissions, associated with the wastewater treatment plant, etc. Qualitatively discuss potential health risks associated with siting new residences in proximity to these stationary sources.

- Discuss the potential for the project to result in a cumulatively considerable net increase in emissions. The BAAQMD recommends that projects that generate project-specific emissions that exceed their recommended thresholds of significance also be considered to cause a significant cumulative air quality impact.

- Identify mitigation measures as necessary to reduce or avoid any potential project-specific or cumulative impacts to air quality, and quantify their effectiveness based on methodologies available from BAAQMD and other sources.

- CAJA will prepare a Greenhouse Gas (GHG) Emission Analysis to assess the project's expected contributions to global warming via the emission of GHGs. At this time there are currently no thresholds or official guidance adopted by the Air Districts or other agencies in California to assess the significance of potential GHG emissions. However, Senate Bill 97 (SB 97), which was enacted in 2007, requires the State Office of Planning and Research (OPR) to develop CEQA guidelines for the effects and mitigation of GHG emissions. These guidelines and regulations are expected to be certified and adopted by the State Resources Agency before January 1, 2010. In the interim, OPR recently provided a new technical advisory containing informal guidance for public agencies as they address the issue of climate change in their CEQA documents.

  The OPR technical advisory recommends each public agency that is a lead agency for complying with CEQA develop its own approach to performing a climate change analysis for projects that generate GHG emissions. A consistent approach should be applied for the analysis of such projects, and the analysis must be based on best available information. For such projects, three types of analyses are used to determine whether the project could be in conflict with the State, regional, and local measures for reducing greenhouse gas emissions. The analyses will include the following:

  - Quantify the potential GHG emissions associated with the implementation of the project.

- Assess the significance of the impact on climate change using applicable guidance documents and State, regional, and local GHG reduction goals.
- Assess whether elements of the project and associated mitigation measures contribute to the efficiency of the project and sufficiently reduce GHG emissions.

Section IV.D (Biological Resources)

- Per previous memo discussions, CAJA has agreed that the Biological Resources data provided by WSP appears adequate and appropriate and has therefore agreed to use it as part of our updated ADEIR Biological Resources impact analysis. Under this scope, CAJA Biologists will continue to work with WSP, the County, and Applicant for any additional data necessary to complete our analysis. The Biological Resources section will be updated based on the above and the revised Project Description. Additional mitigation measures, etc. will be suggested as appropriate.

Section IV.E (Cultural Resources)

- CAJA has incorporated the *Cultural Resources Survey for the Big Wave Project, prepared by Tom Origer and Associates, February 28, 2007* into the Cultural Resources section of the ADEIR. Per the report, a 100-foot buffer zone was recommended to help protect resources from the original project development footprint; however, CAJA does not know how far into the site the resources extended. Under this scope, CAJA will reconfirm the extent with our cultural subconsultant.

Section IV.F (Geology & Soils)

- Treadwell & Rollo conducted one peer review based on the original Project Description (*Third Party Geotechnical Peer Review, prepared by Treadwell & Rollo, April 3, 2007*). Based on the supplemental information provided in the Facilities Plan (*BAGG's Response to Treadwell & Rollo Third Party Geotechnical Review, 2008*), Treadwell & Rollo will need to review and provide updated comments as appropriate. Per Treadwell & Rollo their remaining contract budget ($1,248.63) will be adequate to complete their updated review.
- The Geology & Soils section of the ADEIR will be updated from the available and pending project's Geotechnical Report database including revising any impact analyses and mitigation measures based on the revised Project Description as necessary.

Section IV.G (Hazards & Hazardous Materials)

- CAJA utilized the site Phase I report prepared by Treadwell & Rollo (*Phase I Environmental Site Assessment for the Big Wave Site (Phase I ESA), prepared by Treadwell & Rollo, March 26, 2007*) in order to prepare the Draft Environmental Setting of the Hazards & Hazardous Materials section of the ADEIR. Based on the revised Project Description, the impacts and mitigation measures will need to be updated accordingly. No additional Phase I data revisions are anticipated at this time, as historical/existing conditions information still remains applicable. Per the Applicant, a Phase II will also be prepared as part of the mitigation to be outlined in the EIR impact analysis. However, we do have concerns related to the new proposed operational uses (e.g., microwave towers, etc.) and potential associated hazards. *Although,*

not included in this amendment, if deemed necessary during future research efforts, we may need the assistance of a subconsultant (i.e., Paul Spillane of Acumen (Industrial Hygienist), as appropriate – Treadwell & Rollo is not experienced in this analysis)) to determine the associated environmental impacts during the ADEIR analysis. If this is found to be necessary, a small supplemental budget may be warranted and will be negotiated and approved by the County/Applicant prior to initiation.

Section IV.H (Hydrology & Water Quality)

- The hydrology & water quality information provided in the Facilities Plan will be incorporated into the Hydrology & Water Quality section analysis as appropriate. Per the original contract included for the EIR analysis, no peer review was provided; instead, Schaaf & Wheeler prepared the preliminary version of the EIR Hydrology & Water Quality section of the ADEIR based on the original Project Description (*Hydrology and Water Quality Review for Big Wave, prepared by Schaaf & Wheeler, May 2007*). Further, as stated previously, Schaaf & Wheeler prepared an additional hydrology study related to the wetlands issues in late 2007 (*Review of Wetland Hydrology Indicators for Big Wave Jurisdictional Delineation Including Site Visit Commentary prepared by Schaaf & Wheeler on September 17, 2007*). In order to reflect the revised Project Description, additional time and budget has been included herein for Schaaf & Wheeler to update the section accordingly utilizing the revised Site Plans and additional information provided in the Facilities Plan.

Schaaf & Wheeler Scope/Cost

- Review the new Project Description and Facilities Plan.
- Revise hydrologic calculations to reflect new Project Description.
- Analyze the water quality impacts of the newly proposed water recycling facility and increased groundwater infiltration.
- Update the Regulatory Setting section of the EIR document to reflect current regulations.
- Incorporate the more recent wetlands delineation work by CAJA, WSP. Prepare a revised section for Hydrology and Water Quality. Text and figures will be provided to CAJA in Microsoft Word and pdf formats, or as otherwise mutually arranged.
- A two hour meeting or site visit requested by the County is included as part of this amendment.
- Approximately 12 hours are included to assist CAJA in the response to comments efforts during the DEIR phase.
- Based on Schaaf & Wheeler's current fee schedule, the not-to-exceed fee for the above work is $10,300. Approximately $2,300 remains in their original budget, so the required contract amendment for this additional work is $8,000, which is provided for herein.

Section IV.I (Land Use & Planning)

- Update existing land uses and features of the project site. Also, under this scope, confirm existing land uses in the vicinity, based on aerial photographs and an additional windshield survey (if necessary).

- Confirm exhibits showing existing General Plan Land Use Map designations and Zoning Map districts for the site and vicinity.
- Evaluate and update the revised proposed project's consistency with relevant plans, policies, and regulations. In accordance with CEQA Guidelines Section 15125(b), the analysis will include applicable general plans and regional plans. Plans and policies that will be evaluated include (among others):
  - San Mateo County General Plan
  - Mid-Coast LCP
  - Montara/Moss Beach/El Granada Community Plan
  - LAFCO (regarding water service from CCWD)
  - Half Moon Bay Comprehensive Airport Land Use Plan
  - Existing County ordinances and regulations
- The General Plan consistency analysis will be updated based on the revised project and presented in a tabular format. County staff will be consulted to determine other relevant plans, if any. Where appropriate, the evaluation will cross-reference other section updates, such as Biological Resources or Transportation/Traffic.
- Updates to discuss potential impacts relating to policy inconsistency and land use compatibility from revised project. This discussion will cross-reference the analyses of other impacts in the EIR (as necessary).

Section IV.J (Noise)

- The information provided in the Facilities Plan will be confirmed and/or supplemented as part of the Noise ADEIR analysis. Per the original contract, CAJA will conduct a noise analysis (utilizing the steps outlined below), which will occur once the final revised traffic data and Project Description is confirmed.
- Define and describe the fundamentals of sound and environmental noise, and groundborne vibration.
- Discuss relevant noise policies, regulations and standards, including the relevant State noise guidelines and noise/land use compatibility standards used by San Mateo County.
- Confirm noise-sensitive land uses or activities in the vicinity of the project site or along roads providing access to the site.
- Briefly confirm and describe existing major noise sources in the project vicinity. Conduct up to four short-term noise measurements on the project site, along roadways most affected by increases in project traffic and airport associated noise events.
- Calculate existing noise levels for the roadway segments in the project vicinity that would be affected by project-generated traffic. These noise levels will be calculated using the Federal Highway Administration's (FHWA) Noise Prediction Model and data from the project traffic report.

- Discuss existing groundborne vibrations levels at the project site and local vicinity.
- Confirm significance thresholds based on these standards and consultation with San Mateo County.
- Describe characteristics of the revised proposed project that are relevant to the analysis of noise, based on the revised project site plan, the conceptual grading plan, and trip generation estimates from the revised project traffic study.
- Discuss construction noise impacts, based on revised proposed construction activities and scheduling information. Noise impacts from construction will be evaluated based on the duration, nature, phasing, and level of various construction activities.
- Describe typical noise generated by various elements of the revised project, including project-generated motor vehicle traffic.
- Calculate the expected increases in noise levels at noise sensitive locations along roadways most affected by project traffic using the FHWA Noise Prediction Model and data from the revised project traffic report.
- Discuss the potential for noise from the revised project or related activities to adversely affect sensitive land uses or activities, or to conflict with established noise compatibility guidelines.
- Discuss the potential for noise from the Half Moon Bay Airport to affect project site residents.
- Evaluate the compatibility of the proposed land uses with the existing and future noise environment at the site.
- Identify mitigation measures as necessary to avoid or reduce significant noise impacts, and evaluate their effectiveness based on published technical documents.

Section IV.K (Population & Housing)

- CAJA will initiate the peer review by Bay Area Economics once the Project Description has been finalized. As outlined in the original contract, Bay Area Economics will conduct a third party peer review of the Applicant's economic analysis, which will address the assumptions, methodology and overall conclusions regarding the overall demand for the project and the job match with employed residents on the coast area. Bay Area Economics will prepare an administrative draft memo outlining their peer review. Bay Area Economics will also review the memo with CAJA and County staff. Based on oral and written comments, Bay Area Economics will revise the administrative memo and produce a final memo. As stated above, the peer review of the Economic Analysis was included in the original contract and to date budget remains to complete this task. This peer review will be submitted to the County as an independent report, and will not be appended to the EIR.
- Prepare and update existing population and housing estimates, as well as policies and forecasts pertaining to population and housing growth in the County of San Mateo. The population and housing data and forecasts will be updated from the County's Housing Element, the California Department of Finance, the Association of Bay Area Governments (ABAG) and the U.S. Census Bureau, as needed.

- Based on population per household ratios provided by the County, CAJA will calculate the number of residents that would be accommodated by the revised proposed project.

- Evaluate the consistency of the project-generated population with County and regional growth forecasts and policies. Calculate the project's contribution as a percentage of the County's overall growth allocation by ABAG, the California Department of Finance, and other sources.

- Identify mitigation measures to reduce or avoid significant impacts for each of the sub-issues analyzed in the Population/Housing section, if any significant impacts are identified.

Section IV.L (Public Services)

- Confirm and update existing conditions in the County and project area, as appropriate. This will be done by contacting the current contacts at the Fire Department, Police Department, Parks and Recreation Department, and School District responsible for serving the project site by telephone or letter to obtain updated information on existing conditions, assess the potential impacts of the revised proposed project and cumulative development, and provide input on appropriate mitigation measures (as necessary).

- Based on updated population per household ratios provided by the County and/or the service providers (such as the Department of Finance), recalculate the number of residents that would be accommodated by the revised proposed project.

- Discuss the School District's eligibility to levy alternate developer fees.

- Based on County park standards, calculate the park acreage or in-lieu fee that would be required with buildout of the revised proposed project. Determine whether existing and planned parks in the County would be adequate to cover the revised proposed project and County-wide demand (as necessary). Consult with the County regarding cumulative projects in the area and their proposed parklands.

- Discuss potential impacts of revised project buildout in terms of demand for public services, ability to provide services, and the possible need for construction of additional facilities.

- Document project characteristics that would "pre-mitigate" potential impacts of the revised project.

- Update and list mitigation measures recommended by the service providers.

- Discuss the potential for the revised project in conjunction with related projects to result in cumulative impacts to public services.

Section IV.M (Transportation/Traffic)

- Per the Applicant and the January 1, 2009 Facilities Plan, the preferred Office Park option would include the 225,000 s.f. commercial/office space use. For $32,000 (in the requested amendment [included in this *CAJA Amendment 1*]), Hexagon Transportation Consultants, Inc. assisted the Applicant in the development of an Office Park option revised traffic analysis (which included the revised project and the 225,000 s.f. alternative). No updated peer review is required. $22,905 from the current budget has been used to pay for this work. The revised budget includes $9,095 for the balance of this work.

- The updated traffic report (*Revised Traffic Report for the Big Wave Office Park and Wellness Center, prepared by Hexagon Transportation Consultants, Inc., June 25, 2008*) will be incorporated by CAJA into the Transportation/Traffic ADEIR section analysis to reflect the revised proposed project. CAJA will work with Hexagon for any applicable updates and/or clarifications utilizing the requested remaining $9,095.

Section IV.N (Utilities & Service Systems)

- The information provided in the Facilities Plan will be incorporated into the ADEIR Utilities & Service Systems subsections (i.e., Water, Wastewater, Service Systems; as appropriate) and will be supplemented by our CAJA team as necessary. CAJA has reviewed the Solid Waste discussion in the Facilities Plan and this seems appropriate. In previous memos, CAJA encouraged the Applicant to narrow down various Utilities options to one option (e.g., various options proposed for water supply, wastewater treatment and energy). Otherwise, the project may appear to be more programmatic (i.e., necessitating the preparation of a Program EIR), potentially resulting in more environmental review at a later time when more specifics are provided or available. However, per direction from the Applicant, we will analyze each "option" in detail in the EIR analysis, pending that detailed data is available for each Water/Wastewater/Energy "option".

- The Utilities & Service Systems section of the ADEIR will be updated from the available and pending project's Utilities Report database including revising any impact analyses and mitigation measures based on the revised Project Description as necessary. Although not included in the original scope, based on the scope of the revised project, CAJA will include an Energy subsection analysis in the Utilities & Service Systems section to reflect all of the proposed Energy systems.

- For proposed municipal service options, CAJA will conduct the following tasks:

  - Confirm and update existing conditions in the County and project area, as appropriate. This will be done by contacting the currently proposed municipal contacts by telephone or letter to obtain updated information on existing conditions, assess the potential impacts of the revised proposed project and cumulative development, and provide input on appropriate mitigation measures (as necessary).

  - Based on readily available solid waste, water and sewage generation factors, calculate the revised project's estimated solid waste and sewage generation, as well as water demand.

  - Discuss LAFCO annexation requirements of the project site into the CCWD.

  - Discuss potential impacts of revised project buildout in terms of demand for municipal services, ability to provide services, and the possible need for construction of additional facilities.

  - Document project characteristics that would "pre-mitigate" potential impacts of the revised project.

  - Update and list mitigation measures recommended by the service providers.

  - Discuss the potential for the revised project in conjunction with related projects to result in cumulative impacts to public services.

- Additional CAJA subconsultants are necessary in order to assess and conduct peer reviews of the potential environmental impacts associated with the proposed wastewater (i.e., on-site MBR plant, drip irrigation of recycled wastewater) and water (on-site wells and groundwater/aquifer impacts, water treatment) systems.

This was not included in the original scope (Note: Per the original project RFP, the original scope was based on municipal hook-ups only) and hence requires a supplemental budget and scope, which is provided for herein. This review will be provided by Questa Engineering Corporation (water supply and wastewater). The additional scope and cost for Questa Engineering Corporation is included below.

Questa Engineering Corporation Scope/Cost

Water Supply

- Available background reports, maps and data relative to water availability in the project area will be compiled and reviewed.
- The water supply setting for the project will be described based upon the information developed in the background review. The Applicant's plan for supplying water to the project will be described and reviewed. This will include the sources of supply, treatment requirements (if any), storage and distribution system, and ownership and management of the system.
- The Applicant's estimated water demand for the proposed project will be reviewed for independent confirmation. It is anticipated that estimates will be broken down by the different elements of the project site and will include annual and seasonal demand, daily average and peak water supply requirements. The water needs will consider residential water demands (interior and exterior), other common area uses, fire flow, and storage requirements.
- The availability of a sufficient, dependable supply of water to serve the project will be evaluated and presented. Various possible sources of water to service the development have been identified including on-site well water, recycled water, and imported potable water. This analysis will also address the water quality and treatment requirements.
- Mitigations will be identified for water supply impacts determined to be significant or potentially significant. Mitigations may include such measures as limitations on the scale of development and corresponding water demand, incorporation of specific water conservation measures, and additional water storage.

Wastewater Treatment and Disposal

- Compile and review all available background information pertaining to wastewater treatment and disposal-reclamation plans for the project. This will include peer review of technical report(s) and supporting information supplied by the Applicant, as well as relevant publications related to soils, water resources, hydrogeology and water quality and information regarding the El Granada Wastewater District Facilities. A reconnaissance-level site visit will be performed to observe relevant landscape features and existing infrastructure. Contacts will be made with County and Regional Water Board staff, El Granada Wastewater District personnel, project consultants (as appropriate), and other knowledgeable individuals.
- Review and describe federal, state and local regulatory requirements applicable to the construction and operation of the proposed wastewater system, including, but not limited to, the Water Quality Control Plan for the San Francisco Bay Region (Basin Plan), Title 22 Water Recycling Criteria, County policies and standards.

- The proposed wastewater treatment plans will be reviewed for technical adequacy including compliance with accepted engineering standards, limitations of the project site, and applicable regulatory requirements. This will include review and independent confirmation and/or revisions of the sewage flow estimates for the project based on information provided by the Applicant. It will also include review of: (a) plans for wastewater collection; (b) proposed location and type of treatment system; (c) any plans for wastewater storage; (d) locations, methods and capacity for wastewater disposal and reclamation; (e) plans for system management; and (f) any identified water quality issues, including impacts to surface water and groundwater resources.

- Using information compiled from the background and regulatory review, prepare the environmental setting section for the EIR.

- Based on the results of the project analysis task, identify and describe any potentially significant impacts of the proposed wastewater treatment and disposal-reclamation plans for the project for inclusion in the EIR. Impacts discussion may include construction-related issues, operational impacts related to the collection, treatment and disposal-reclamation facilities; and potential short-term or long-term water quality and public health issues

- Identify and describe feasible mitigation measures to address any significant or potentially significant impacts related to the development and operation of wastewater collection, treatment and disposal-reclamation facilities for the project.

Associated Tasks to Complete Above

- (Task 1) Site Visits, Data Collection and Analysis. Questa will collect and review existing information related to the wastewater and water supply aspects of the project. Interviews, file research, peer review of consultant-provided reports, and site reconnaissance by experienced environmental personnel will be conducted. Contacts will be made with appropriate agencies to evaluate pertinent requirements and background information.

- (Task 2) Water Supply Analysis. Questa will identify and evaluate the potentially significant and significant water supply impacts associated with development of the proposed project. The analysis will include evaluation of the proposed methods of water supply for the project including on-site well water, recycled water and water imported from the Coastside County Water District (CCWD).

- (Task 3) Wastewater Disposal Analysis. Questa will identify and evaluate the potentially significant and significant wastewater treatment impacts associated with development of the proposed project. Methods for wastewater treatment and disposal that will be evaluated include on-site treatment and recycling, on-site disposal by spray irrigation and other methods, and off-site disposal to the El Granada Wastewater District.

- (Task 4) Formulate Mitigation Measures. Questa will develop reasonable and appropriate additional mitigation measures to offset the identified impacts. The mitigation measures may include development restrictions in sensitive or constraining project areas, on- and off-site infrastructure improvements, structural and non-structural best management practices, remedial action, and design recommendations related to the development of the project site. Additionally, Questa may develop monitoring and reporting strategies for mitigation measures.

- (Task 5) Review Project Alternatives. Questa will review alternatives to the proposed project. This will include the no project alternative, the proposed project, and one other alternative to be presented as part of the EIR. Questa will evaluate the Wastewater Treatment and Water Supply impacts associated with the project alternatives.

- (Task 6) Prepare Administrative DEIR. Questa will prepare the Water Supply and Wastewater sections of the EIR in an acceptable format.

- (Task 7) Response to Comments and Preparation of DEIR. Questa will respond to comments made to the ADEIR and finalize the DEIR sections.

- (Task 8) Response to Comments and Preparation of FEIR. Questa will assist in the final response to comments and preparation of the FEIR sections. We have included a limited budget for response to comments. If extensive comments are received requiring significant review and response time, additional budget may be required for this task.

- (Task 9) Public Hearings and Meetings. Questa will attend public hearings and meetings on a time-and-expenses basis. Questa has not included a budget for hearings/meetings. Any attendance at hearings or meeting would be in addition to the costs outlined in this amendment.

- The cost for the work effort described above in Tasks 1 to 8 is $18,600.

Prepare and Update Section V of ADEIR - General Impact Categories

The General Impact Categories section of the ADEIR will summarize the following: significant unavoidable impacts that were identified in the updated Environmental Impact Analysis (if any are identified); growth-inducing impacts of the revised proposed project; and the significant irreversible environmental changes associated with the revised project. Additionally, this section will include a discussion of the Impacts Found to be Less Than Significant. This section will include a discussion of the issues and sub-issues that were focused out for further analysis in the Initial Study. However, as the Initial Study format does not include detailed data on why these issues were scoped out, these issues will be confirmed for accuracy and will be documented in the above subsection analysis.

Prepare and Update Section VI of ADEIR - Summary of Cumulative Impacts

The cumulative impacts and mitigation (if appropriate) in each respective Environmental Impact Analysis section will be updated based on the revised Project Description, section analyses, and the updated related projects list provided by the County.

Prepare and Update Section VII of ADEIR - Alternatives to the Proposed Project

This section of the ADEIR will identify and evaluate a reasonable range of alternatives to the revised proposed project that are crafted to avoid or significantly lessen the significant environmental impacts of the project while still meeting most of the revised project objectives. One of the alternatives that will be analyzed in the EIR will be the No Project Alternative (assuming continuation of the existing conditions, no development of the site), as required by CEQA. As the project site does not permit residential uses, the EIR will address implementation of the proposed project at an alternative site(s). Other alternatives could include a Reduced Density Alternatives or

Modified Site Plan Alternative. The selection of other project alternatives will be made in consultation with County staff after all of the significant impacts of the revised proposed project have been identified. For the purposes of this amendment, CAJA will analyze up to four alternatives, including the No Project Alternative.

Prepare and Update Section VIII of ADEIR - Preparers of the EIR and Persons Consulted

This section will be updated to identify the lead agency staff, project Applicant and subconsultant staff, EIR consultant and subconsultant staff, and all agency personnel consulted during the preparation of the EIR.

Prepare and Update Section IX of ADEIR - Bibliography

The Bibliography section will be updated to list all sources of revised information used during the preparation of the EIR.

Deliverables: Five (5) bound hard copies and one electronic PDF copy of the ADEIR. CAJA will submit copies of the ADEIR to the County staff for distribution and one round of review.

Task 4. Preparation of the DEIR

CAJA will address all of the County's comments on the updated ADEIR. This amendment assumes one-round of review by the County and all comments made on the updated ADEIR will be submitted to CAJA in one consolidated set. *(Note: Any changes to the project description made during this review could require changes to the analysis in the ADEIR and could require additional amendments.)* After the review of the document, CAJA staff will address all comments and will prepare and submit one electronic PDF version of the Screencheck DEIR (SDEIR) to the County to confirm that all requested changes have been incorporated into the document. This SDEIR will be submitted to the County for approval as a DEIR. Once the County approves the SDEIR, CAJA will produce 50 copies of the DEIR and Technical Appendices for use and distribution by the County during the prescribed 45-day public review period. Additionally, CAJA will also prepare 15 electronic PDF copies of the DEIR and Technical Appendices and 15 hard copies of the Summary section for County submittal to the State Clearinghouse. CAJA will also prepare the Notice of Completion (NOC) for the State Clearinghouse per the CEQA requirements. This amendment assumes that the County will distribute the DEIR and NOC.

Additionally, it is assumed in this amendment that CAJA will produce a Notice of Availability (NOA) for the DEIR utilizing all three NOA noticing options as outlined in Section 15087(a)(1),(2),(3) of the CEQA Guidelines (although only one is required to fulfill the 45-day public review period, it is recommended by CAJA to utilize all three noticing methods during the public review period due to the controversial nature of the project). This includes: 1) publication of the NOA in a local newspaper, 2) posting the NOA on- and off-site, and 3) direct mailing of the NOA to contiguous property owners. Further, the NOA shall be sent to applicable state and local agencies; individuals that commented on during the NOP or scoping meeting process and that have requested to be notified throughout the EIR process; as well as the applicable County Clerk to post during the 45-day review period. This amendment assumes that the County will also distribute the NOA.

Deliverables: One (1) electronic PDF copy of the SDEIR; 50 bound copies of the DEIR and Technical Appendices, one electronic PDF format on a CD, 15 copies for the State Clearinghouse and one copy of the NOC for distribution by the County. The DEIR will be in 8.5-inch x 11-inch, black

and white format; color where applicable. Additionally, a electronic (PDF) copy of the NOA for distribution by County.

Task 5. Preparation of FEIR and Mitigation Monitoring Program (MMP)

The number of comments received at the end of the 45-day review period and the level of effort involved with preparing responses varies widely between projects. Following closure of the 45-day DEIR public comment period, CAJA staff will prepare responses to all written and oral comments received on the DEIR and will make any changes to the DEIR resulting from responses to comments. The FEIR will ultimately include the following chapters: Introduction, Response to Comments, Corrections and Additions to the DEIR, Mitigation Monitoring Program (MMP). CAJA will prepare the AFEIR and submit 5 copies to the County for one round of review. After the review of the document, CAJA staff will address all comments and will prepare and submit one electronic PDF version of the SFEIR to the County to confirm that all requested changes have been incorporated into the document. Once the SFEIR is approved for release as the FEIR, CAJA will produce 50 copies (as well as 15 copies for State Clearinghouse, if necessary) of the FEIR for County circulation to all appropriate commenting agencies and individuals ten days prior to consideration of certification of the EIR. This amendment assumes that the County will distribute the FEIR.

Although not required under CEQA, CAJA can prepare and provide the County with a NOA for the FEIR. This task is not included within our amendment; however (if requested, due to the controversial nature of the project), CAJA can be available to assist the County with this task utilizing a time and materials rate based on our current fee schedule. CAJA preparation of the NOA would follow those steps outlined under Task 4.

In accordance with CEQA Guidelines Section 15075, CAJA will prepare the Notification of Determination (NOD) for use by the County to file with the applicable County Clerk and State Clearinghouse (if necessary) within five days of certifying the EIR and approving the project. This amendment assumes that the County will file the FEIR.

Deliverables: Five (5) hard copies and one electronic (PDF) copy of the AFEIR; one electronic (PDF) of the SFEIR; 50 hard copies and one electronic (PDF) of the FEIR (as well as 15 copies for the State Clearinghouse, if necessary) for distribution by the County; and one electronic (PDF) copy of the NOD for filing by the County.

Task 6. Hearings and Meetings

While a public hearing on the DEIR during the 45-day review period is not required by CEQA (Section 15087(i), CEQA Guidelines), this amendment includes attendance by the appropriate CAJA staff member(s), but not its subconsultants, at one public hearing either on the DEIR during the 45-day review period or on the FEIR certification/final decision on the project. If the County chooses to hold a public hearing during the 45-day DEIR review period, County staff will schedule the meeting and arrange for the meeting space. CAJA highly recommends that if many people are expected to attend the public hearing and comment, a court reporter should be present to record all comments. CAJA staff will assist the County in preparing necessary materials for the hearing, such as: a) a handout depicting and briefly describing the project and summarizing impacts and mitigation measures, and b) other large-scale graphics. CAJA staff will arrange for a court reporter to attend the meeting to

record all oral comments, but the cost of a court reporter is not included in this amendment. After the close of the public comment period for the DEIR, CAJA staff will review all comments, identify which comments require special attention, and discuss response approach with County staff and CAJA team members. CAJA will prepare a topic-by-topic matrix summarizing all written and oral comments submitted during the hearing.

This amendment also includes the attendance of Ms. Anderson and Mr. Reilly at two Planning Commission hearings and one Board of Supervisors hearing. CAJA staff will be available to give a presentation related to the CEQA process, analysis, and conclusions. Additionally, time for 8 team meetings/conference calls has been included in this amendment. *Additional County-requested hearings and meetings attendance will be billed on a time-and-materials basis based on our agreed fee schedule.*

Deliverables: One (1) memo summarizing all substantive points made by the public hearing commenters.

Task 7. Findings of Fact and Statement of Overriding Considerations

Prior to consideration of the proposed project and subsequent to certification of the FEIR, CAJA staff will prepare the Statement of Facts and Findings (the Findings) for any significant environmental effects identified in the EIR. The Findings will individually identify the significant environmental effects of the proposed project and provide a reasoned discussion of the appropriate findings.

Also included in this amendment, prior to consideration of the proposed project and subsequent to certification of the FEIR, CAJA will prepare the Statement of Overriding Considerations in accordance with the specifications of Section 15093 of CEQA (if applicable). The Statement of Overriding Considerations will describe why the benefits of the project outweigh its significant and unavoidable effects.

Deliverables: Five (5) copies of each will be provided, as well as one electronic PDF copy.

Schedule and Cost

CAJA proposes the following draft schedule to prepare the EIR (see attached Table 1). This schedule is dependent on approval of the finalized Project Description and availability of Applicant-prepared data. Therefore, the proposed schedule dates would be updated accordingly based on actual completion dates. Overall, as shown in the attached Cost Amendment (Table 2), the total cost for the *Cost Amendment 1* scope of work is $137,700. CAJA's associated billing rate is included below:

Billing Rates

CAJA Fee Schedule
(Effective January 1, 2009)

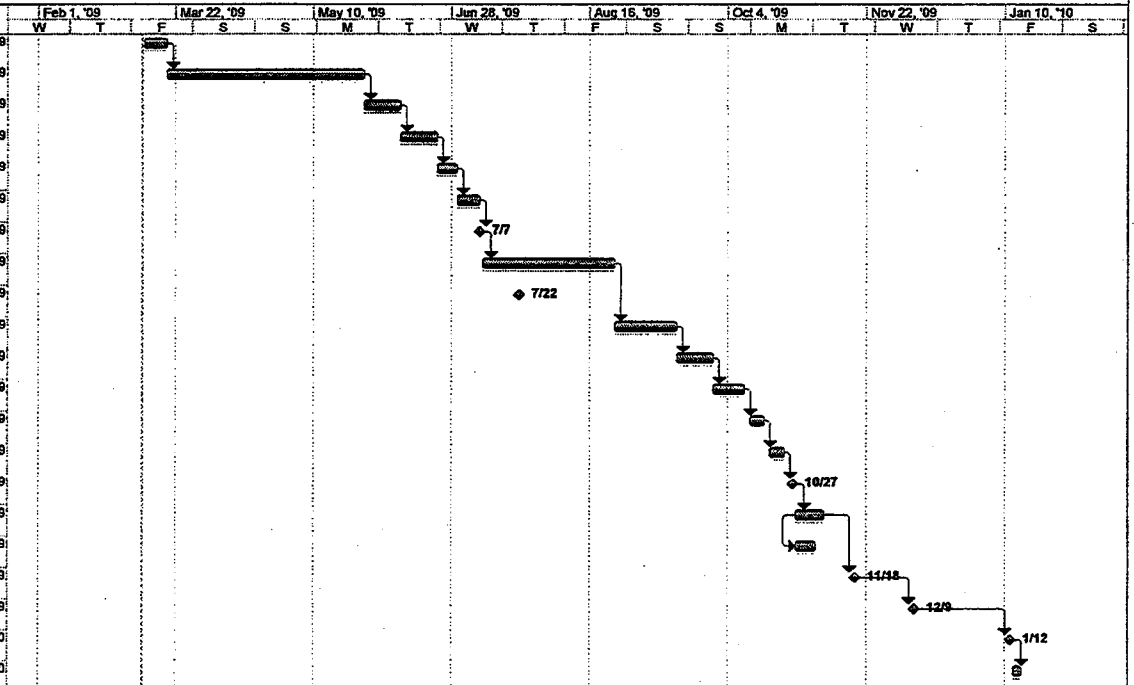
• Principal	$160.00/hour
• Project Manager	$135.00/hour
• Environmental Specialist (e.g., Biologist, Noise, Air Quality)	$135.00/hour
• Environmental Planner	$120.00/hour
• Associate Environmental Planner	$110.00/hour

• Assistant Environmental Planner	$95.00/hour
• Research Assistant	$55.00/hour
• Graphics Director	$60.00/hour

Attachments: Table 1 (Revised Draft Schedule)
Table 2 (Cost Amendment)

Big Wave Wellness Center and Office Park EIR -- Revised Draft Schedule

ID	Task Name	Duration	Start	Finish
1	Finalize Project Description for County Verification [1]	6 days	Wed 3/11/09	Wed 3/18/09
2	Prepare ADEIR for County Review	50 days	Thu 3/19/09	Wed 5/27/09
3	County Review of ADEIR [2]	9 days	Thu 5/28/09	Tue 6/9/09
4	Prepare SDEIR for County Review	9 days	Wed 6/10/09	Mon 6/22/09
5	County Review of SDEIR [2]	5 days	Tue 6/23/09	Mon 6/29/09
6	Prepare DEIR and Notices (NOA/NOC)	5 days	Tue 6/30/09	Tue 7/7/09
7	County to Circulate DEIR, NOC, and NOA	0 days	Tue 7/7/09	Tue 7/7/09
8	Circulate & Publish DEIR & Notices for 45-day Public Review	45 days	Thu 7/9/09	Mon 8/24/09
9	Attend Public Hearing at DEIR (at County discretion) [3]	0 days	Wed 7/22/09	Wed 7/22/09
10	Prepare Responses to Comments, AFEIR/MMP for County Review [4]	15 days	Tue 8/25/09	Tue 9/15/09
11	County Review of AFEIR/MMP [2]	9 days	Wed 9/16/09	Mon 9/28/09
12	Prepare SFEIR/MMP for County Review	9 days	Tue 9/29/09	Fri 10/9/09
13	County Review of SFEIR/MMP [2]	5 days	Mon 10/12/09	Fri 10/16/09
14	Prepare FEIR/MMP	5 days	Mon 10/19/09	Fri 10/23/09
15	County to Circulate FEIR/MMP	0 days	Tue 10/27/09	Tue 10/27/09
16	Circulate & Publish FEIR/MMP for Commenting Agencies (& Public)	10 days	Wed 10/28/09	Fri 11/6/09
17	Prepare Findings of Fact and SOC	7 days	Wed 10/28/09	Tue 11/3/09
18	EIR Meeting/Hearing (PC) [2]	0 days	Wed 11/18/09	Wed 11/18/09
19	EIR Meeting/Hearing (PC) [2]	0 days	Wed 12/9/09	Wed 12/9/09
20	EIR Meeting/Hearing (Board) [2]	0 days	Tue 1/12/10	Tue 1/12/10
21	Preparation of the NOD, Filing NOD with Clerk [2]	3 days	Wed 1/13/10	Fri 1/15/10



Note: Schedule is dependant on availability of all Project Facilities/technical reports from the Applicant, as well as the complexity of the multiple Utilities analyses. Schedule may need to be adjusted.

1 **Finalize Project Description for County Verification [1]**
[1] Assumes a finalization and approval date of March 18, 2009. This date is subject to change pending actual approval by the County. Schedule will be updated accordingly, if necessary.

3 **County Review of ADEIR [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

5 **County Review of SDEIR [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

9 **Attend Public Hearing at DEIR (at County discretion) [3]**
[3] Date is subject to change depending on availability of Planning Commission during this time. Overall, Public Hearing would be scheduled to take place during the 45-day review period.

10 **Prepare Responses to Comments, AFEIR/MMP for County Review [4]**
[4] May need to be revised depending on actual level of comments received, which is outside the control of CAJA and the County.

11 **County Review of AFEIR/MMP [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

13 **County Review of SFEIR/MMP [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

18 **EIR Meeting/Hearing (PC) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

19 **EIR Meeting/Hearing (PC) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

20 **EIR Meeting/Hearing (Board) [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

21 **Preparation of the NOD, Filing NOD with Clerk [2]**
[2] Duration and completion of County document review is outside the control of CAJA.

Note: Schedule is dependant on availability of all Project Facilities/technical reports from the Applicant, as well as the complexity of the multiple Utilities analyses. Schedule may need to be adjusted.

Table 2

Big Wave EIR, Cost Amendment #1

[1] This amendment assumes an average number of comments on the DEIR. Additional hours may be necessary depending on the number of comments received and the complexity of responses. Additional requested and approved hours will be billed at a Time & Materials rate utilizing CAJA's agreed fee schedule.

Table 2
Big Wave EIR, Cost Amendment #1

LABOR COSTS					
Task 1. Project Management					
Budgeting and Scheduling	Geoff Reilly	2	$160.00	Principal	$320.00
	Jennie Anderson	5	$135.00	Project Manager	$675.00
Coordination with County, Applicant & Subconsultants	Geoff Reilly	3	$160.00	Principal	$480.00
	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Document Review/Quality Assurance	Geoff Reilly	6	$160.00	Principal	$960.00
	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Administrative	Megan Steer	4	$55.00	Research Asst.	$220.00
	Jennie Anderson	2	$135.00	Project Manager	$270.00
Task 1 Subtotal		***38***			***$5,085.00***
Task 2. Finalize Project Description	Jennie Anderson	***6***	$135.00	Project Manager	***$810.00***
Task 3. Preparation of Administrative Draft EIR (ADEIR)					
Cover, Title Page, TOC	Megan Steer	1	$55.00	Research Asst.	$55.00
Introduction	Megan Marruffo	1	$95.00	Asst. Env. Planner	$95.00
Summary	Jennie Anderson	1	$135.00	Project Manager	$135.00
	Patricia Preston	6	$120.00	Env. Planner	$720.00
Project Description	Jennie Anderson	1	$135.00	Project Manager	$135.00
Regulatory Setting	Jasmine Patel	2	$110.00	Assoc. Env. Planner	$220.00
Aesthetics	Patricia Preston	30	$120.00	Env. Planner	$3,600.00
Agriculture Resources	Jasmine Patel	16	$110.00	Assoc. Env. Planner	$1,760.00
Air Quality (w/ GHG)	Dan Hooper	36	$135.00	Air Specialist	$4,600.00
Biological Resources	Amy Parravano	48	$135.00	Principal Biologist	$6,480.00
	Patricia Preston	4	$120.00	Env. Planner	$480.00
Cultural Resources	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00
Geology & Soils	Jennie Anderson	2	$135.00	Project Manager	$270.00
	Patricia Preston	16	$120.00	Env. Planner	$1,920.00
Hazards & Hazardous Materials	Jasmine Patel	16	$110.00	Assoc. Env. Planner	$1,760.00
Hydrology & Water Quality	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Land Use & Planning	Patricia Preston	12	$120.00	Env. Planner	$1,440.00
Noise	Scott Wirtz	30	$135.00	Noise Specialist	$4,050.00
Population & Housing	Jasmine Patel	22	$120.00	Assoc. Env. Planner	$2,640.00
Public Services	Jessica Viramontes	16	$120.00	Env. Planner	$1,920.00
Transportation/Traffic	Jessica Viramontes	16	$120.00	Env. Planner	$1,920.00
Utilities & Service Systems	Jennie Anderson	6	$135.00	Project Manager	$810.00
	Jessica Viramontes	32	$120.00	Env. Planner	$3,840.00
General Impact Categories	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00
Summary of Cumulative Impacts	Jasmine Patel	8	$110.00	Assoc. Env. Planner	$880.00

Table 2
Big Wave EIR, Cost Amendment #1

Alternatives to the Proposed Project	Geoff Reilly	4	$160.00	Principal	$640.00
	Jennie Anderson	24	$135.00	Project Manager	$3,240.00
Preparers of the EIR & Persons Consulted	Megan Steer	1	$55.00	Research Asst.	$55.00
Bibliography	Megan Steer	1	$55.00	Research Asst.	$55.00
Technical Appendices	Megan Steer	2	$55.00	Research Asst.	$110.00
Project Referral Comments	Megan Steer	3	$55.00	Research Asst.	$165.00
Task 3 Subtotal		***381***			***$46,595.00***
Task 4. Preparation of the Draft EIR (DEIR) *					
Screencheck Draft EIR (SDEIR)	Geoff Reilly	2	$160.00	Principal	$320.00
	Jennie Anderson	10	$135.00	Project Manager	$1,350.00
	Patricia Preston	14	$120.00	Env. Planner	$1,680.00
DEIR	Jennie Anderson	2	$135.00	Project Manager	$270.00
	Jasmine Patel	8	$110.00	Assoc. Env. Planner	$880.00
Task 4 Subtotal		***36***			***$4,500.00***
Task 5. Preparation of Final EIR (FEIR) and Mitigation Monitoring Program (MMP) [1] *					
Appendices & Delineation of Comments on DEIR	Geoff Reilly	1	$160.00	Principal	$160.00
	Jennie Anderson	10	$135.00	Project Manager	$1,350.00
	Jasmine Patel	20	$110.00	Assoc. Env. Planner	$2,200.00
Response to Comments	Geoff Reilly	3	$160.00	Principal	$480.00
	Jennie Anderson	20	$135.00	Project Manager	$2,700.00
	Patricia Preston	36	$120.00	Env. Planner	$4,320.00
	Jasmine Patel	38	$110.00	Assoc. Env. Planner	$4,180.00
Administrative Final EIR (AFEIR)	Jennie Anderson	4	$135.00	Project Manager	$540.00
	Patricia Preston	10	$120.00	Env. Planner	$1,200.00
Screencheck Final EIR (SFEIR)	Geoff Reilly	1	$160.00	Principal	$160.00
	Jennie Anderson	6	$135.00	Project Manager	$810.00
FEIR	Jennie Anderson	2	$135.00	Project Manager	$270.00
	Megan Marruffo	4	$95.00	Asst. Env. Planner	$380.00
MMP	Jennie Anderson	8	$135.00	Project Manager	$1,080.00
Task 5 Subtotal		***163***			***$19,830.00***
Task 6. Hearings & Meetings					
(4) Hearings	Geoff Reilly	12	$160.00	Principal	$1,920.00
	Jennie Anderson	12	$135.00	Project Manager	$1,620.00
(8) Meetings/Conference Calls	Geoff Reilly	12	$160.00	Principal	$1,920.00
	Jennie Anderson	12	$135.00	Project Manager	$1,620.00
Preparation of Materials	Jessica Viramontes	2	$120.00	Env. Planner	$240.00
	Megan Marruffo	8	$95.00	Asst. Env. Planner	$760.00

Table 2
Big Wave EIR, Cost Amendment #1

Task 6 Subtotal		***58***			***$8,080.00***
Task 7. Findings of Facts and Statement of Overriding Considerations	Jennie Anderson	7	$135.00	Project Manager	$945.00
	Megan Marruffo	2	$95.00	Asst. Env. Planner	$190.00
Task 7 Subtotal		***9***			***$1,135.00***
Graphics					
EIR Graphics/Simulation Peer Review	Scott Johnson	***40***	$60.00	Graphics Director	***$2,400.00***
Production of Notices *					
Notice of Availability (NOA) - DEIR	Patricia Preston	1	$120.00	Env. Planner	$120.00
Notice of Completion (NOC)	Patricia Preston	1	$120.00	Env. Planner	$120.00
Notice of Determination (NOD)	Jennie Anderson	1	$135.00	Project Manager	$135.0
Subtotal		***3***			***$375.00***
Word Processing & EIR Production	Megan Marruffo	6	$95.00	Asst. Env. Planner	$570.00
	Megan Steer	5	$55.00	Research Asst.	$275.00
Subtotal		***11***			***$845.00***
	TOTAL CAJA LABOR COSTS				**$89,655.00**
SUBCONSULTANT COSTS					
Labor/Expenses to Complete Remaining Work					
Hydrology and Water Quality (Shaaf & Wheeler)		*Fixed Fee*			$8,000.00
Transporation/Traffic (Hexagon)		*Fixed Fee*			$9,095.00
Utilities & Service Systems - Water/Wastewater (Questa)		*Fixed Fee*			$18,600.00
TOTAL SUBCONSULTANT COSTS					**$35,695.00**
DIRECT EXPENSES					
Printing and Reproduction					
Notices (NOA, NOC, NOD)					$100.00
ADEIR w/Appendices (5)					$1,000.00
DEIR w/Appendices (50)					$6,500.0
AFEIR w/Appendices (5)					$750.00
FEIR w/Appendices (50)					$3,000.00
Graphics/Map Reproductions					$150.00
Circulate Notices, EIRs to County					$200.00
Other Mailing/Publication Expenses (e.g., FedEx, supplies)					$150.00
Travel Expenses/Misc. Materials					$500.00
TOTAL EXPENSES					**$12,350.00**
GRAND TOTAL					**$137,700.00**

* This amendment assumes that the County will distribute the DEIR, FEIR and all Notices (NOA, NOC, NOD).

Hawaii Water Environment Association

Water Reuse Clean Water Act Sanitary Sewer OverflowsHonouliuli WRF

Education - Sanitary Sewer Overflows (SSOs)

Overflows and spills from sewer lines onto our roadways and into our streams and oceans spoil our beautiful Hawaiian environment and can endanger public health. Read more on how **you** can help prevent overflows and spills from occurring.

PREVENTING SEWAGE OVERFLOWS AND SPILLS - Page 1

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Click here to download this entire paper in Adobe PDF Format (890 kb)
Click here to download the Official PSA brochure in Adobe PDF Format (763 kb)

Preventing Sewage Spills

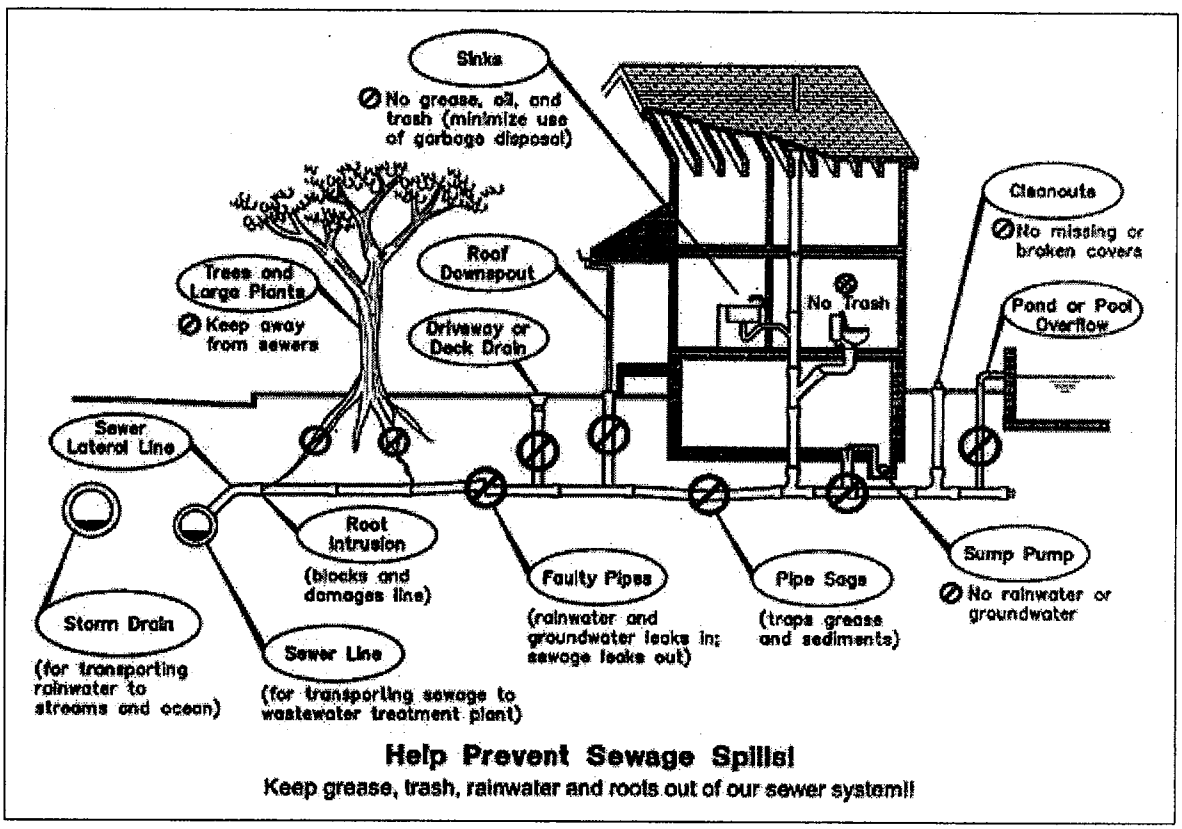
Overflows and spills from sewer lines onto our roadways and into our streams and oceans spoil our beautiful Hawaiian environment and can endanger public health. Sewage spills are costly to clean up (increasing your sewer bills) and can even hurt our tourist industry by causing beach closures. In a typical year, there are over 400 spills statewide involving more than two million gallons of raw sewage!

Learn about the sanitary sewer system and what you can do to help prevent SEWAGE SPILLS!

A Quick Overview

Preventing sewage spills is quite simple. Spills are simply caused by clogged pipes and/or too much flow. All everyone needs to do is keep unwanted things out of our sewer pipes such as grease, trash, rainwater and tree roots.

Illustrated below are some of the causes of sewage spills and how you can help prevent these spills (click here to download a higher resolution image shown below):



More Information on Sewage Spills

Now that you have a feel for the basic ways to prevent sewage spills, take some time to learn about the fascinating details of sewage spills and your underground sewer system. By reading through the information presented below, you can learn:

- Important sewer system terms.
- The difference between "sanitary sewers" and storm drains.
- Why sewage spills are a BIG problem.
- Typical causes of sewage spills.
- How to keep grease and oils out of the sewer system.
- How to keep rubbish out of the sewer system.

- What infiltration and inflow are and why it is important to keep rainwater and other excess water out of the sewer system.
- What you should do if you see a sewage spill.
- Where more information on your sewer system can be obtained.

Ten Terms to Help You Better Understand Your Sewer System

1. **"SEWAGE"** or **"WASTEWATER."** This is the "used" water that contains human wastes from toilets and water from other sources such as sinks, showers, washing machines, etc. In addition to being odorous, sewage can contain large amounts of germs that cause disease. The term "wastewater" is often used in place of "sewage" to make things sound more pleasant when discussing this unpleasant subject.

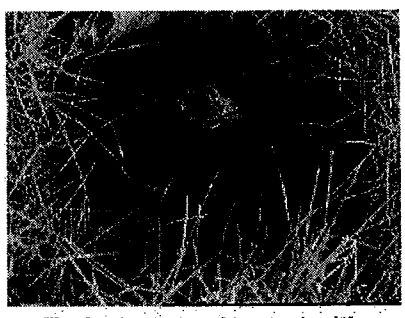
2. **"SANITARY SEWER SYSTEM,"** also known as **"WASTEWATER COLLECTION SYSTEM,"** or **"SEWERS."** These are pipes through which sewage is carried from homes and businesses to a treatment plant. The sanitary sewer system includes the main sewer lines in the streets and the branch lines to individual sewer customers called "sewer laterals."

   Sewer systems are generally designed to flow by gravity through sloped pipes until it reaches either the treatment plant or a sewage pumping station (which pumps the sewage up to another higher sewer or a treatment plant).

   Although sewage is very unsanitary, the term "sanitary sewer" is used because the sewer pipes are separate from the pipes used for storm water drainage. This helps protect public health and the environment. In some older cities, sewage and rainwater flow through the same pipes. This can cause major environmental and public health problems because untreated or partially treated-sewage is discharged into streams, rivers and other water bodies during heavy rain.

3. **"SEWER LATERAL."** This is the sewer pipe that connects a building's plumbing system to the main sewer line in the street. Maintenance of sewer lateral pipes located within private property is generally the responsibility of the property owner. Sewer laterals are also called "service laterals," "house laterals," or simply "laterals."

4. **"SEWER CLEANOUT."** This is a pipe rising from the sewer lateral to the ground surface with a removable cap or plug. It is used to access the sewer lateral to free blockages. A sewer cleanout is usually located just inside the property line. There may be additional sewer cleanouts at various other locations in your property.

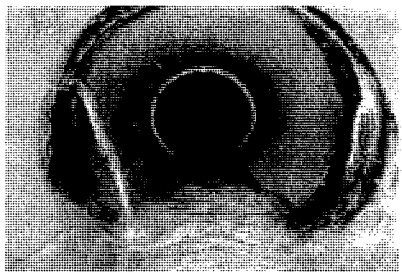


Typical sewer cleanout with properly installed plug.

5. **"WASTEWATER TREATMENT PLANT"** or **"WASTEWATER RECLAMATION FACILITY"**. These are facilities where organic matter, bacteria, viruses and solids are removed from sewage through physical, biological and chemical processes. The treated wastewater (called effluent) may be disposed of by discharging it to water bodies (mainly the ocean in Hawaii), injecting it into the ground, or

reusing it for irrigation or other beneficial non-potable (non-drinking) uses.

6. **"INFILTRATION."** This refers to groundwater (water found below the ground surface) that enters sewer pipes through cracks, pipe joints, and other system leaks. Because sewers in coastal areas are typically buried deep, they are often located below the water table. Since most sewer lines do not flow full (under pressure), groundwater "infiltrating" into the sewer line is actually more of a problem than sewage leaking out of the line. Storm events can raise groundwater levels and increase infiltration of groundwater into sewer pipes. The highest infiltration flows are observed during or right after heavy rain. Too much infiltration will overload the sewers and cause spills!

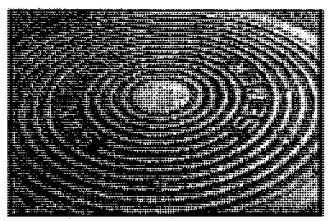


Water infiltrating into a sewer line.

7. **"INFLOW."** This is rainwater that enters the sewer system from sources such as yard and patio drains, roof gutter downspouts, uncapped cleanouts, pond or pool overflow drains, footing drains, cross-connections with storm drains, and even holes in manhole covers. Inflow is greatest during heavy rainfall and like infiltration, can cause excessive flows and sewage spills.

8. **"PATHOGENS."** These are harmful germs in raw sewage that cause diseases such as cholera, dysentery, hepatitis and gastroenteritis.

9. **"MANHOLES."** Sewer manholes are underground structures used to provide access to underground sewer lines and are usually found in a street, parking area or sidewalk. Access is required to periodically inspect and clean the lines. Sewer manholes typically have heavy round covers with the words "Sanitary Sewer" on the cover.



10. **"SANITARY SEWER OVERFLOW."** Sewage spills are technically called "sanitary sewer overflows" since it involves the overflow of sewage from the sanitary sewer system. The word "sanitary" is used only because the overflow is from the sanitary sewer system, and not because the raw sewage is sanitary! (See definition of sanitary sewer above). For simplicity, we will use the term "sewage spill" or "sewage overflow."

Sewage overflows often occur from sewer manholes in the streets. Sewage can also backup into homes through your toilets, showers and floor drains. Sewage spills are caused by sewage filling the sewer pipes behind the clog to the point where it spills out of an opening in the system (generally the lowest manhole, shower drain or other plumbing fixture).

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EPA United States Environmental Protection Agency
Office of Water

OFFICE OF WASTEWATER MANAGEMENT

Sanitary Sewer Overflows

Sanitary Sewer Overflows
What are they and how can we reduce them?

EPA 832-K-96-001 - Summer 1996

What are Sanitary Sewer Overflows?

A sanitary sewer overflow can spill raw sewage into basements or out of manholes and onto city streets, playgrounds and into streams, before it can reach a treatment facility.

Why are SSOs a problem?

EPA has found that Sanitary Sewer Overflows (SSOs) caused by poor sewer collection system management pose a substantial health and environmental challenge in some parts of our nation. The response to this challenge varies considerably from state to state. Many municipalities have asked fo national consistency in the way permits are considered for wastewater discharges, including SSOs, and in enforcement of the law prohibiting unpermitted discharges.

In response, EPA has convened representatives of states, municipalities, health agencies, and environmental advocacy groups to advise the Agency on how to best meet this challenge. This *Federal Advisory Subcommittee* examines the need for national consistency in permitting and enforcement, effective sewer operation and maintenance principles, public notification for SSOs wit potential health or environmental dangers, and other public policy issues.

EPA carefully considers the Subcommittee recommendations for regulatory and nonregulatory actions to reduce SSOs nationally.

Why Do Sewers Overflow

SSOs occasionally occur in almost every sewer system even though systems are intended to collect and contain all the sewage that flows into them. When SSOs happen frequently, however, it means something is wrong with the system.

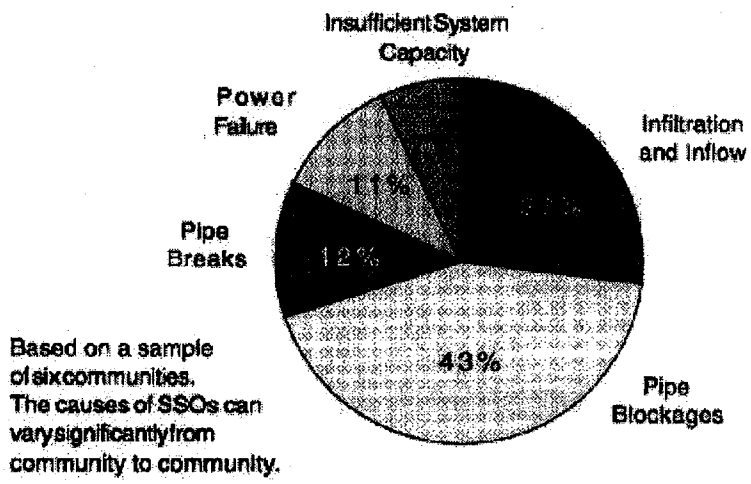
Problems that can cause chronic SSOs include:

- Too much rainfall or snowmelt **infiltrating** through the ground into leaky sanitary sewers,

which are not intended to hold rainfall or to drain property. Excess water can also **inflow** through roof drains connected to sewers and broken or badly connected sewer service lines

- Sewers and pumps too small to carry sewage from newly-developed subdivisions or commercial areas
- Blocked, broken or cracked pipes and other equipment or power failures that keep the system from doing its job. Tree roots can grow into the sewer. Sections of pipe can settle or shift so that pipe joints no longer match. Sediment and other material can build up and cause pipes to break or collapse. This can also happen to sewer service connections to houses and other buildings. Some cities estimate that as much as 60 percent of the water over-filling their sewer systems comes from service lines. The chat below shows major types of problems that cause SSOs most frequently.
- A deteriorating sewer system. When sewers are not properly installed or maintained, widespread problems that can be expensive to fix develop over time. Some municipalities have found severe problems, necessitating billion-dollar correction programs. Often, communities have had to curtail new development until problems are corrected or system capacity is increased.

Estimated Occurence of Sanitary Sewer Overflows by Cause



What Health Risks Do SSOs Present

Because SSOs contain raw sewage they can carry bacteria, viruses, protozoa (parasitic organisms), helminths (intestinal worms), and borroughs (inhaled molds and fungi). The diseases they may cause are shown in the table below and range in severity from mild gastroenteritis (causing stomach cramp and diarrhea) to life-threatening ailments such as cholera, dysentery, infections hepatitis, and severe gastroenteritis.

PATHOGENS IN RAW SEWAGE(6)

ORGANISMS	DISEASES AND SYMPTOMS
Bacteria	Chlorea, salmonellosis (food poisoning),

	typhoid fever, bacillary dysentery, gastroenteritis (including diarrhea and abdominal pain)
Viruses	Hepatitis, meningitis, pneumonia, fever, common colds, paralysis, encephalitis, gastroenteritis, diarrhea, respiratory infections
Protozoa	Gastroenteritis, acute enteritis, giardiasis (including diarrhea, abdominal cramps, and weight loss), dysentery, toxoplasmosis, crypotosporidiosis
Helminths	Digestive and nutritional disturbances, abdominal pain, vomiting, restlessness, coughing, chest pain, fever, abdominal pain, diarrhea, anemia, weight loss, fever, muscle aches, nervousness, insomnia, anorexia, hookworm disease, taeniasis
Bioaerosols	Allergic reactions (such as asthma), Legionnaire's disease

People can be exposed through:

- Sewage in drinking water sources.
- Direct contact in areas of high public access such as basements, lawns or streets, or to waters used for recreation. At least one study has estimated a direct relationship between gastrointestinal illness contracted while swimming and bacteria levels in the water(1).
- Shellfish harvested from areas contaminated by raw sewage. One study indicates that an average of nearly 700 cases of illness per year were reported in the 1980s from eating shellfish contaminated by sewage and other sources. The number of unreported cases is estimated to be 20 times that(2).

Some cases of disease contracted through inhalation and skin absorption have also been documented (3).

What Other Damage Can SSOs Do?

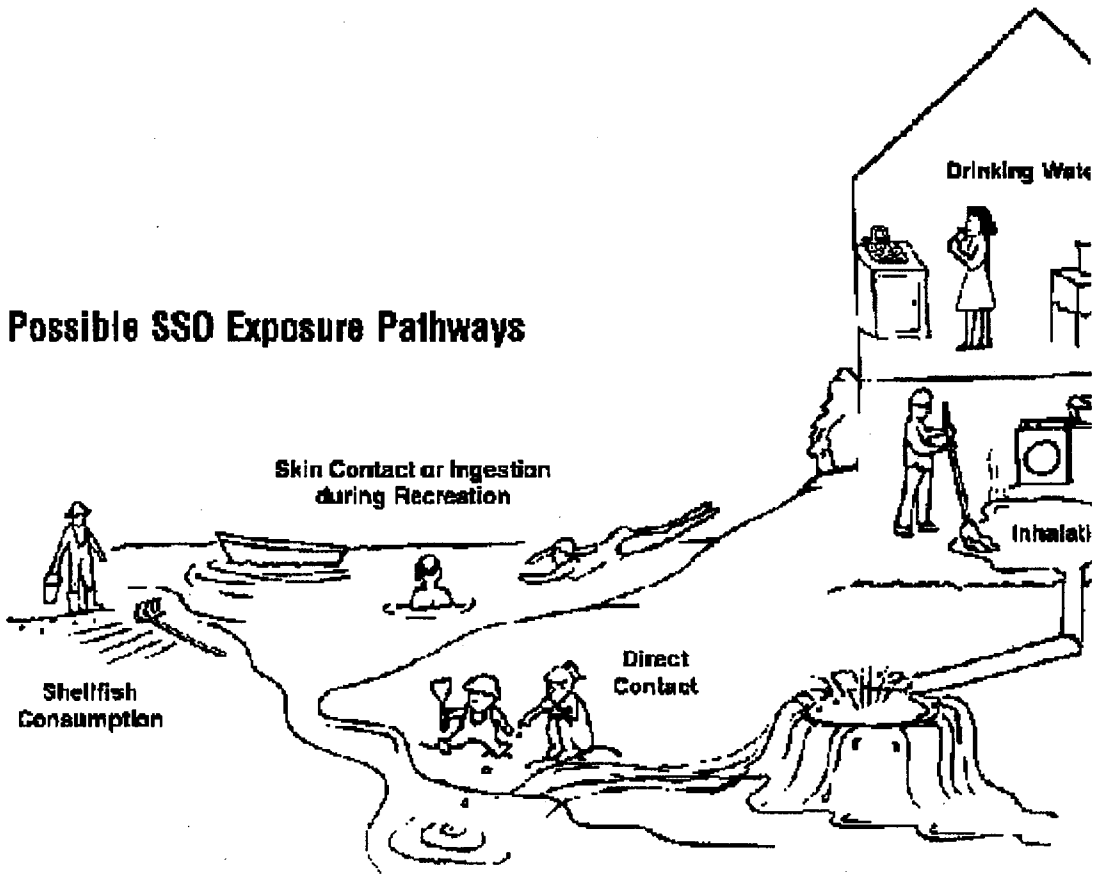
SSOs also damage property and the environment. When basements flood, the damaged area must be thoroughly cleaned and disinfected to reduce the risk of disease. Cleanup can be expensive for homeowners, and municipalities. Rugs, curtains, flooring, wallboard panels, and upholstered furniture usually must be replaced.

A key concern with SSOs which enter rivers, lakes, streams, or brackish waters is their effect on water quality. When bodies of water cannot be used for drinking water, fishing, or recreation, society experiences an economic loss. Tourism and water front home values may fall. Fishing and shellfish harvesting may be restricted or halted. SSOs can also close beaches. One 1994 study claims that SSOs closed beaches across the nation that year for more than 300 days(4).

How Big Is The Problem?

The total number of SSOs that occur nationwide each year is not known. In some areas, they might not be reported or are underreported to EPA and state environmental agencies. Two surveys, however, hep to define the size of the problem:

- In a 1994 survey of 79 members of the Association of Metropolitan Sewerage Agencies, 65 percent of the respondents reported wet weather SSOs(5). They reported that between 15 and 35 percent of their sewers were filled above capacity and/or overflowed during wet weather. However, municipal respondents with SSOs had only limited information about them. Only 6C percent had estimated the annual number. half of those had estimated the amount of sewerage discharged, and 17 percent had determined what pollutants were in their overflows.
- A 1981 survey conducted by the National Urban Institute indicated an average of 827 backups and 143 breaks per 1,000 miles of sewer pipe *(about 1,000 miles of sewer pipe are needed to serve 250,000 people.)* per year. Breaks occurred most often in the young, growing cities of th South and West. The report authors suggested that cities with the most collection system problems were doing the least to correct them---even cleaning pipes at a very low rate.



How Can SSOs Be Reduced Or Eliminated

Many avoidable SSOs are caused by inadequate or negligent operation or maintenance, inadequate system capacity, and improper system design and construction. These SSOs can be reduced or eliminated by:

- Sewer system cleaning and maintenance
- Reducing infiltration and inflow through system rehabilitation and repairing broken or leaking service lines.
- Enlarging or upgrading sewer, pump station, or sewage treatment plant capacity and/or reliability.
- Construction wet weather storage and treatment facilities to treat excess flows.

Communities also should address SSOs during sewer system master planning and facilities planning, or while extending the sewer system into previously unsewered areas.

A few SSOs may be unavoidable. Unavoidable SSOs include those occurring from unpreventable vandalism, some types of blockages, extreme rainstorms, and acts of nature such as earthquakes or floods.

What Costs Are Involved?

Sanitary sewer collection systems are a valuable part of the nation's infrastructure. EPA estimates

that our nation's sewers are worth a total of more than $1 trillion. The collection system of a single large municipality is an asset worth billions of dollars, and that of a smaller city could cost many millions to replace. Sewer rehabilitation to reduce or eliminate SSOs can be expensive, but the cost must be weighed against the value of the collection system asset and the added costs of this asset is allowed to further deteriorate. Ongoing maintenance and rehabilitation adds value to the original investment by maintaining the system's capacity and extending its life.

The costs of rehabilitation and other measures to correct SSOs can vary widely by community size and sewer system type. Those being equal, however, costs will be highest and ratepayers will pay more in communities that have not put together regular preventive maintenance or asset protection programs in place.

Assistance is available through the Clean Water Act State Revolving Fund for capital projects to control SSOs. State Revolving Funds in each state and Puerto can help arrange low-interest loans. For the name of your State Revolving Fund contact, please call the EPA Office of Water Resource Center, (202)260-7786.

Identifying SSO Problems and Finding Solutions

Cabool, Missouri(7)

In 1990 the sewer system for this city of 5,000 exceeded its capacity, causing overflows and backups at several locations. Breaks in drinking water mains lowered the water pressure, allowing contamination from nearby SSOs to enter the drinking water system.

Researchers linked these overflows with a pathogenic strain of *Escherichia coli* which killed 4 people, hospitalized 32 and caused diarrhea and other problems in 243 people.

Ocoee, Florida(8)

Sewage overflows from November 1988 to April 1989 periodically flooded a mobile home park during heavy rains and caused occasional outbreaks of disease.

Thirty nine cases of hepatitis A were identified among residents. In addition, four infected food handlers living in the park were linked to 100 cases of hepatitis A in Ft. Lauderdale where they worked. Hepatitis A is a chronic liver disease that can lead to permanent health injury and shorten life expectancy. Using a special health analysis scale, health damages were measured at up to 20 years' lost life expectancy. Diarrhea and other symptoms continued for 2 years.

Washington Suburban Sanitary Commission, Maryland(9)

From 1990 to 1994 the number of SSO-related basement backups ranged from 484 to 659 per year, for a total of 2,960. Basement cleanups cost an average of $700 each, including removal and disposa of sewage; removal and cleaning or disposal of carpet, wallpaper, wallboard, insulation, and other materials; disinfection; and drying.

Overflows at sewage pumping stations and treatment plants occurred from 11 to 50 times per year.

The costs of upgrades to reduce the level of overflows in the system (which serves 1.4 million people and handles 180 million gallons of wastewater a day) include:

- Upgrades at pumping stations and sewage treatment plants: $38 million
- Collection System improvements: $22 million
- Sewer reconstruction: $6 million (annual)
- Maintenance program: $10 million (annual)

These upgrades costs system users about $50 per household per year.

Lynn, Massachusetts(10)

SSOs caused street flooding, basement flooding, and sewer house connection backups in low locations. Some homeowners had to install pumps to reduce basement flooding.

Some of the SSO problems were attributed to badly cracked pipes, blocked, damaged manholes, leaky pipe joints, and large debris in some sewer sections.

The city has undertaken sewer separation and rehabilitation projects that have reduced the number and frequency of SSOs at a cost of $2.6 million. Additional work will further reduce overflows. Costs are estimated at about $10 per household per year.

Louisville/Jefferson County, KY(11)

From 1989 to 1994, 165 overflows were reported in 80 different locations, 70 percent caused by wet weather infiltration and inflow.

The county began corrective actions to reduce the number and frequency of SSOs through sewer rehabilitation and preventive maintenance. Further work was planned to remove private infiltration and inflow source connections such as sump pumps, foundation drains, and other connections. Future SSO reduction projects were investigated.

The long-term budget plan for corrective actions totaled $14.6 million. This program costs each household about $40 per year.

Office of Wastewater Management

For more information about EPA's work to help reduce sanitary sewer overflows please write to:

SSO Program Manager
U.S. EPA Office of Waste Water Management
401 M Street, SW (4201)
Washington, DC 20460

For publications about U.S. EPA Office of Wastewater Management programs and policies, please consult these sources:

Office of Water Resources Center

RC- 4100 - 2615 OWM
401 M Street, SW
Washington, DC 20460
(202)260-7786
Fax: (202)260-0386
(U.S. EPA Office of Water publications including information about storm water and combined sewer overflows. Also available is a list of commonly-used technical references for managing sanitary sewer overflows.)

Center for Environmental Research Information (CERI)
26 West Martin Luther King
Cincinnati, OH 45268
(513)569-7566
(Technical information about all U.S. EPA regulatory programs.)

Education Resource Information Center
Clearinghouse for Science, Mathematics and Environmental Education (ERIC/CSMEE)
1929 Kenny Road
Columbus, OH 43210-1080
(800)276-0462 or (614)292-6717
Fax: (614)292-0263
(Comprehensive information about environmental education. Charge applies.)

U.S. Dept. of Commerce
National Technical Information (NTIS)
5285 Port Royal Road
Springfield,, VA 22161
(800)553-6847 (rush orders) or (703)487-4650
Fax: (703)321-8547
(Many U.S. government agency publications. Charge applies)

National Small Flows Clearinghouse
West Virginia University
P.O Box 6064
Morgantown, WV 26506-6064
(800)624-8301
Fax: (304)293-3161
(Small communities technical assistance and information. Charge applies.)

Also see the U.S. EPA Office of Water Internet Home Page at http://www.epa.gov/OW

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