

Carcass Disposal: A Comprehensive Review

National Agricultural Biosecurity Center Consortium
USDA APHIS Cooperative Agreement Project
Carcass Disposal Working Group

August 2004

Chapter

10

Historical Documentation

Authors:

James Ehrman	Institute for Military History and 20 th Century Studies, Kansas State University
Jack Holl	Institute for Military History and 20 th Century Studies, Kansas State University

Supporting Authors/Reviewers:

Justin Kastner	Agricultural Security, Kansas State University
----------------	--

Table of Contents

Section 1 – Key Content.....	1	Florida.....	10
Section 2 – Historical Studies	2	Hawaii.....	10
Section 3 – Historical Experiences	3	Illinois.....	10
3.1 – Survey Methods.....	4	Arizona	10
3.2 – Preliminary Survey Results.....	4	Arkansas.....	11
North Carolina	4	Missouri.....	11
California	5	Oregon.....	12
North Dakota.....	5	Washington	12
Texas.....	6	3.3 – Preliminary Survey Conclusions	12
Pennsylvania.....	6	Section 4 – Critical Research Needs	13
Georgia	7	References	13
Maryland.....	8	Appendices.....	16
Indiana.....	8	Appendix A – HIDA Fields.....	16
Michigan	9	Appendix B – CDWG Historical Incidents Questionnaire.....	16
Idaho.....	9		
Maine	10		
Iowa.....	10		

Abbreviations

APHIS	USDA Animal and Plant Health Inspection Service	FMD	foot and mouth disease
CDWG	carcass disposal working group	HIDA	Historic Incidents Database and Archive
DOE	US Department of Energy	HPAI	highly pathogenic avian influenza
DEP	Pennsylvania Department of Environmental Protection	LPAI	low pathogenic avian influenza
END	exotic Newcastle disease	NPAI	nonpathogenic avian influenza
		USDA	United States Department of Agriculture

Section 1 – Key Content

The objectives of this research were to examine the state of historical documentation relative to past carcass disposal events within the United States, and explore the potential for developing a Historic Incidents Database and Archive (HIDA). Based on research into past incidents of catastrophic losses of livestock and their associated large-scale disposal efforts, deficiencies were observed to exist in historical documentation, with significant variances occurring among states relative to planning, experience, and preparation for a catastrophic event. There was also an evident problem in sharing information, expertise, and experiences among the states in regard to handling a catastrophic carcass disposal event.

Research indicated that California, Georgia, Indiana, Maryland, North Carolina, North Dakota, Pennsylvania, and Texas have accumulated a great deal of experience and expertise in catastrophic animal disposal incidents. The most frequent causes of carcass disposal events included avian influenza, pseudorabies, and natural disasters. The states of Florida, Hawaii, Idaho, Iowa, Maine, Michigan, Missouri, Oregon, and Washington have had experience with relatively small carcass disposal incidents due to avian influenza, accidents, or natural disasters. Other states have indicated they have had no recent experience with large-scale carcass disposal operations but have provided information on their states' carcass disposal regulations. All the officials contacted in the course of this research expressed enthusiasm for opportunities to communicate and exchange information, experience, and expertise on carcass disposal with officials in other states.

During the course of this research it became evident that US officials concerned with managing a catastrophic animal disposal incident could benefit from a rigorous historical program. A historical team dedicated to issues of agricultural biosecurity and carcass disposal could provide officials on both the state and federal level with information that would be invaluable for emergency planning and incident management. A historical program for agricultural biosecurity and carcass disposal would also help to

assure both the media and the general public that the carcass disposal methods used in dealing with any future catastrophe are both necessary and effective. A well-documented history of both past and emerging catastrophic carcass disposal incidents would also provide additional credibility to emergency management officials when dealing with governors, state legislatures, and the US Congress.

Although documentation of past large-scale animal disposal events is limited, a number of incidents were investigated that yield important lessons for emergency management officials concerned about the possibility of a catastrophic event (see Section 3). While the lessons from these experiences should serve as guides for other states and localities preparing for a catastrophic event, dissemination of these lessons is hampered by the almost total absence of historical records documenting catastrophic animal disposal events. Large-scale animal disposal events caused by natural disasters or epidemics are certainly nothing new, and states and localities have encountered these problems in the past; however, interviews and correspondence with officials from various states confirm that state agencies dealing with this problem generally have no institutional memory. The documents that do exist provide only rudimentary data, and states often purge what are deemed as inconsequential records at five- or ten-year intervals. As a result, detailed information about carcass disposal incidents that occurred more than ten years ago can be very difficult, if not impossible, to obtain.

As a consequence of the generally inadequate historical documentation of animal disposal events, a majority of the information that can be gleaned about past events has to be obtained from interviews of the persons involved in such events. Although information obtained from interviews can certainly be useful and the knowledge and experience of those involved in past events is worthy of documentation and distribution, oral history can have significant shortcomings. Human memory can be problematic and hard facts concerning numbers of livestock lost, economic losses, disposal expenses, and the exact location of disposal sites can be difficult or even

impossible to obtain. In addition, the death, retirement, or career changes of those individuals with the most knowledge of past incidents means that the ability to learn lessons from past incidents dissipates with each passing year. The absence of any institutional memory or written history of past incidents robs current government officials of a useful pool of knowledge concerning how best to handle any future large-scale animal disposal emergency.

Another major deficiency lies in communicating and distributing current information concerning carcass disposal technologies, planning, problem solving, and historic incidents. It appears that the various states and localities operate as independent islands with each one attempting to plan and prepare for potential emergencies as if in a vacuum. Communication is lacking among officials in various state agencies involved in regulating or directing animal disposal

projects, academics involved in the study of carcass disposal, and the various federal agencies that might provide assistance. Consequently, evaluation of opportunities and means to facilitate communication between state and federal officials, producers, and academics is warranted. Possible means include virtual forums—or other electronic formats—that could provide an inexpensive and effective channel to share past experiences and problems and to distribute information on carcass disposal technologies, emergency planning, laws and regulations, logistics, and a variety of other relevant topics. Information from these forums could then be captured for further development. Many officials attending an August 2003 Midwest Regional Carcass Disposal Conference expressed great interest and enthusiasm for opportunities to increase communication with outside experts or other experienced individuals.

Section 2 – Historical Studies

The September 11th attacks in Washington, DC, New York, and Pennsylvania offer dramatic examples of "asymmetric warfare." Small groups of highly organized and highly motivated irregulars can move undetected in American society and, with minimal resources, execute attacks that simultaneously inflict enormous loss of human life and billions of dollars worth of economic damage. Given the open nature of American society, targets for terrorist cells are abundant. Possibly one of the United States' most vulnerable targets is its food supply system. An attack by terrorist cells deliberately infecting American livestock with highly pathogenic agents could threaten the food supply and impose significant economic losses on producers. The vulnerability of the nation's food supply to terrorist attack or even accidental infection is greatly magnified by the fact that current livestock operations concentrate very large numbers of cattle, chickens, turkeys, and swine in feedlots or confinement systems. The rapid transit of livestock to slaughter facilities simply magnifies an already enormous vulnerability. The accidental infection of livestock in the United Kingdom with foot and mouth disease (FMD) in 2001, and the highly problematic containment and disposal effort that

followed, provides an example of the enormous economic damage that can be inflicted by highly contagious diseases regardless of whether livestock are deliberately or accidentally infected.

In preparing for the possibility of a terrorist attack on the US food supply or even the possibility of the US food supply becoming accidentally contaminated by some infectious agent, state, local, and federal agricultural officials can realize some important returns on a modest historical/scientific research effort in past large-scale animal disposal incidents. The historical programs of the US armed forces and the US Department of Energy (DOE) offer excellent examples of the usefulness of historical studies for the successful execution of their particular mission as well as effective models that officials concerned with agricultural biosecurity can imitate. The US Armed Forces devote significant resources to documenting and analyzing past operations, campaigns and conflicts as well as preserving historically important materials for future research. For example, the US Army has highly trained civilian command historians who actively document the activities of each US Army command. The US Army Center of Military

History, which is staffed by active duty personnel and highly trained civilian historians, documents and writes a variety of campaign studies and analyses and researches, composes, and publishes the US Army's official histories. The US Army also utilizes Military History Detachments, small units of active duty soldiers who enter combat zones and theaters of active military operations. These soldier-historians conduct subject, after-action, and exit interviews of commanders and troops, photograph and film combat operations, and document all aspects of military operations that can be used to compile important "lessons learned," campaign analysis, and official histories (Gough, 1996; Wright, 1985, pp. 3-6).

The US DOE, like the US Armed Forces, also realized the benefit of a vigorous historical research program. In the aftermath of the nuclear reactor accident at Three Mile Island, Pennsylvania, in March 1979, the DOE discovered it possessed no systematic institutional memory concerning nuclear accidents whether civilian or military. There existed a good deal of information concerning laboratory mishaps, reactor accidents, military "broken-arrows," and other nuclear incidents, but the data, while voluminous, was uncollated, non-uniform, unverified, incomplete, inaccessible, contradictory and, frequently, self-serving. In addition, the historical information was not centralized, but rather was scattered among headquarters and field offices, laboratory archives, military commands, and contractor records. Much of the data was security classified. Consequently, the DOE had great difficulty in providing Congress, the White House, cooperating federal agencies, state and local officials, and the press accurate and reliable historical information concerning the department's experience in dealing with nuclear accidents.

In addition to writing the report of the DOE's response to Three Mile Island (*Crisis Contained: The*

Department of Energy at Three Mile Island), the History Division, under the leadership of Chief Historian Jack M. Holl, was tasked to develop a centralized, comprehensive nuclear incidents database and archives for the DOE. The nuclear incidents database would contain standardized information on all nuclear and non-nuclear reactor accidents; nuclear mishaps at all DOE laboratories and contractor facilities; military "broken-arrows" and nuclear incidents in the armed forces; and unauthorized, illegal, criminal, and terrorist use of nuclear materials or devices. The computerized nuclear incidents database would be supplemented by an archive of reports, hearings, investigations, articles, books, press releases, newspaper and video coverage, and other printed, pictorial, and evidentiary material pertinent to the database. The nuclear incidents database, while centralized in the DOE History Division, was designed to be searchable from the field.

The nuclear incidents database and archives provided the DOE an invaluable management tool and public relations asset. Public policy rests to some degree on the assessment and understanding of historical precedent. DOE officials in command of accurate and pertinent data stand on firm historical ground in developing and promulgating national policy relative to nuclear accidents and terrorism. In concert with providing the department a useable institutional memory, the History Division also augmented the nuclear incidents database with a "current history project" which actively collected data and records of current nuclear incidents worldwide to the extent that the information was available. Thus the nuclear incidents database and archives was kept up-to-date with a proactive, ongoing data collection and analysis project (Holl, 2004).

Section 3 – Historical Experiences

The objectives of this research included examining historical incidents of catastrophic losses of livestock and their associated large-scale disposal efforts, and designing and populating a Historic Incidents

Database and Archive (HIDA). This database is intended to become a searchable, Web-based database documenting past incidents of catastrophic livestock losses and their associated disposal efforts.

HIDA will also store bibliographic material, images and files related to carcass disposal, and historic carcass disposal events. The various fields that HIDA will feature are outlined in Appendix A. Progress in building the first version of a HIDA is well advanced, as is the identification of historic events to populate this database.

3.1 – Survey Methods

Research into the history and magnitude of past large-scale carcass disposal incidents within the United States was initially conducted using traditional, library-based research with the intent of developing bibliographies of materials concerning catastrophic animal disposal efforts. Although some useful materials were obtained through library research, it was discovered that catastrophic animal disposal incidents are largely undocumented. Some library resources offer journalistic reports that indicate the approximate scope of agricultural losses due to natural disaster or disease but do not provide any significant details on carcass disposal efforts, numbers of various species lost, economic losses sustained, disposal methods and protocols used, disposal effort expenses, or long-term problems associated with a massive disposal operation (i.e. environmental impacts). Needless to say, these sources are inadequate for the purposes of fully developing the HIDA.

Given the dearth of detailed historic information relative to carcass disposal events, efforts were then turned to contacting all state departments of agriculture to request information on past carcass disposal incidents within their states, the availability of documentation regarding past incidents, current regulations concerning animal disposal, and current planning. Requests were mailed to all fifty states, and the quality and quantity of responses varied. The responses received are summarized in the following paragraphs. Responses were followed up with additional telephone calls, e-mails, and the dispatch of a carcass disposal questionnaire (see appendix B) about the specific incidents that were reported.

Correspondence with and telephone interviews of various state officials who responded to the mailing yielded some interesting information regarding past

carcass disposal efforts that should be of great interest to all involved with the Carcass Disposal Working Group (CDWG) project. In addition, correspondence and interviews with respondents revealed that state records of carcass disposal events are at best fragmentary and incomplete. A great deal of information had to be obtained from correspondence and interviews of persons with firsthand knowledge of these events.

3.2 – Preliminary Survey Results

Of the states that responded to the inquiries, some have accumulated a great deal of knowledge and experience in handling catastrophic animal losses due to both natural disaster and disease. California, Georgia, Maryland, North Carolina, North Dakota, Pennsylvania, and Texas North Carolina, Texas, California, North Dakota, Pennsylvania, Georgia, Maryland and Indiana appear to have accumulated the most experience in dealing with catastrophic losses of animals and their disposal. The incidents these states handled offer the richest areas for the study of past catastrophes and important lessons in planning for future events.

A number of other states revealed they had accumulated some experience with relatively modest animal disposal incidents. Other states indicated they had no experience with such catastrophes but did provide information on their state regulations governing animal disposal or potential problems should an animal catastrophe occur within their state.

North Carolina

North Carolina's experience in disposing of approximately 3 million animals as a result of Hurricane Floyd in 1999 makes it one of the nation's leaders in handling carcass disposal in the wake of a catastrophe. The vast majority of the animals lost in Hurricane Floyd were poultry and therefore North Carolina officials were not faced with the disposal of hundreds of thousands of large animals, nor a massive disposal effort made more complex by protocols necessary for the containment and eradication of an epidemic. However, the destruction left in the wake of Hurricane Floyd did create an enormous carcass disposal incident. Flooding led to

the loss of 752,970 turkeys, 2,107,857 chickens, 21,474 swine, 619 cattle, 125 goats, 23 horses, and 10,000 cases of eggs. The disposal effort was also inhibited by impaired transportation and widespread electrical power outages. As a result of the power failures, rendering facilities were not able to operate. North Carolina law requires rendering, burial, or incineration of carcasses, but given the emergency the North Carolina State Veterinarian authorized the composting of avian carcasses in open areas. The compost piles were required to have a bed of hay or plastic and the carcasses were required to be covered with bulking material and covered by plastic sheeting and located at least 300 feet from flowing streams, bodies of water, or wells. Any runoff from the compost sites was to be controlled by berms and all the location of all the compost piles were to be reported to the State of North Carolina.

Air curtain incineration was used to dispose of cattle, swine, and some poultry carcasses, but this technology was utilized under less than ideal conditions. Obtaining dry wood for fuel and the abundance of waterlogged carcasses inhibited the efficiency of this disposal technology. The advanced state of decay of some carcasses also inhibited efficient incineration.

North Carolina also utilized burial as a carcass disposal technology but this option was also problematic. North Carolina statutes require carcasses to be buried at least 3 feet below the ground surface and at least 300 feet from a flowing stream, well, or body of water. Severe flooding limited access to potential burial sites and the rapid decomposition of carcasses created difficulties in handling and transport.

In reviewing and evaluating the carcass disposal effort in the wake of Hurricane Floyd, North Carolina officials were able to discern a number of important lessons. The first is that the most effective way to handle any disaster situation is to let local officials be in charge of their own disaster relief efforts. Local officials know the local population and the disposition and location of local resources better than anyone on the state or federal level. North Carolina also determined that any delay can be extraordinarily costly and it is best to have contracts in place long before a disaster strikes. Extended contact and coordination between state, local, and federal officials

before an urgent animal disposal event emerges also facilitates the disposal effort (Kirkland, 2003).

North Carolina's experience and use of a variety of disposal technologies, planning, and "lessons learned" from Hurricane Floyd offer an outstanding template for other states and localities concerned with the possibility of catastrophic animal losses.

California

The poultry industry in southern California recently experienced an outbreak of exotic Newcastle disease (END) that resulted in the destruction of 3.6 million birds. END was first discovered in October 2002 and infected the first commercial egg farm by November 2002. By January the disease had spread throughout Riverside County, California, and infected 21 commercial flocks and 899 backyard flocks. State and local officials quarantined over 18,340 premises in an effort to check the disease and discovered that 920 of the quarantined premises had been infected. California's disposal effort was made more complicated by a fire that destroyed a local rendering facility. As a result all the birds were disposed of via landfill. Birds were euthanized using carbon dioxide gas then loaded into sealed trucks wrapped in thick-ply plastic for transport to Riverside County landfills. Decontamination of the vehicles occurred on site as well as at the landfill (Hickman, 2003a; Hickman 2003b; Riverside County Waste Management Department, 2003).

The END incident in California is well documented but, at time of publication, minimal detailed information from the University of California Extension Service is publicly available.

North Dakota

A severe winter and a major flood in the winter/spring of 1996 and 1997 destroyed approximately 110,000 cattle in North Dakota. In North Dakota's case only 14,000 animal carcasses were actually documented as buried. Although local authorities and producers buried many carcasses, in some cases burial or other means of disposal was not possible due to the carcasses being inaccessible and subsequently in an advanced stage of decay. The North Dakota carcass disposal effort provides

excellent opportunities for further study. Obviously logistical problems, planning, and limited state resources all played a part and these aspects warrant deeper examination (Carlson, 2003; North Dakota Department of Agriculture).

Texas

Texas Floods in 1998 provided carcass disposal experience. Dee Ellis of the Texas Animal Health Commission reviewed the disasters, collected data and performed numerous personal interviews.

In October 1998, torrential downpours in south central Texas resulted in the flooding of the San Marcos, Guadalupe, San Antonio, and Colorado River Basins. Over 23,000 cattle were drowned or lost, in addition to hundreds of swine, sheep, and horses. The Texas Animal Health Commission (TAHC) worked with state emergency personnel from the Governor's Division of Emergency Management, the Texas Department of Transportation, and the Texas Forest Service to manage the disposal of animal carcasses. Local emergency response personnel played integral roles in the actual disposal process. Most animal carcasses were buried (where found if possible) or burned in air curtain incinerators. Two air curtain incinerators were utilized. One difficulty that arose was finding a burn site selection that was not located on saturated ground. Some carcasses were inaccessible and began to decompose before actual disposal could take place. According to Ellis, the main carcass disposal issues were 1) lack of prior delineation or responsibilities between agencies, 2) non-existent carcass disposal plans and pre-selected disposal sites, 3) a short window of time to complete disposal, 4) minimal pre-disaster involvement between animal health and local emergency officials, and 5) and inaccessibility of some carcasses (Ellis, 2001).

Pennsylvania

The State of Pennsylvania has been extremely cooperative and has shared a great deal of information on their large-scale animal disposal incidents. Pennsylvania officials have dealt with two outbreaks of low pathogenic avian influenza, one incident of highly pathogenic avian influenza, and one outbreak of pseudorabies.

In 1983-84 Pennsylvania was forced to deal with an outbreak of highly pathogenic avian influenza (HPAI) that required the destruction and disposal of more than 16,000,000 birds and cost more than \$70 million. A 1997-98 outbreak of low pathogenic avian influenza (LPAI) resulted in the destruction and disposal of 1,565,000 birds and another outbreak of LPAI in 2001 required the state to dispose of 170,500 birds. The 1997-98 LPAI incident indemnity and carcass disposal cost \$2,000,000 while the 2001 LPAI incident indemnity and disposal cost \$150,000. In all three incidents the Pennsylvania Department of Agriculture officials used a combination of disposal technologies that included burial, composting, and landfill in order to accommodate the disposal of such large numbers of birds. Burial of birds on site created a number of problems. First, some carcasses were pushed to the surface due to decomposition gasses and inadequate soil coverage. Soil subsidence of the burial pits was also a problem. In addition, burial of enormous numbers of chickens created a perception problem about the possibility of groundwater contamination. Despite the fact frequent testing revealed no groundwater contamination has occurred, the concerns of those who live in the vicinity of the burial pits persist.

In-house composting is perhaps Pennsylvania's preferred carcass disposal technology though this option, in Pennsylvania's experience, also presents some problems. The first problem is an economic one due to the fact that there is an inconvenience cost associated with keeping the farm under quarantine but not in production as well as concerns about the biosecurity of this procedure for the disposal of diseased carcasses. Composting was also found to be impractical for the disposal of layer flocks due to the layout of the poultry houses.

Landfill disposal, in Pennsylvania's experience, also presented a number of concerns and was, at times, problematic. The landfill option poses biosecurity concerns surrounding the transport of carcasses, as well as additional labor in lining trucks with thick plastic and sanitizing vehicles at both the farm and landfill. The limited hours of operation for landfills also made the timing of flock depopulation and transport to the landfill a constant challenge. Finally, the use of landfills for the disposal of diseased

animals also required clearances from the Pennsylvania Department of Environmental Protection (DEP).

Incineration of the diseased poultry was never considered and Pennsylvania has never attempted air curtain incineration. In the incidents listed above, the Pennsylvania DEP provided follow-up monitoring of all burial and landfill sites. No complications or significant problems have yet been encountered.

In 2002 Pennsylvania faced a pseudorabies outbreak that required the disposal of 15,000 hogs within a six-day period. The majority of the infected hogs were initially scheduled to go to rendering facilities. At the last moment this disposal option could not be utilized due to the fact that Pennsylvania rendering facilities refused to handle diseased animals and had a processing rate that was too slow to accommodate the needs of the carcass disposal team. Instead the Pennsylvania carcass disposal team decided to dispose of the hogs via landfills and a small percentage of the hogs were buried on site.

In managing the Pennsylvania pseudorabies incident the carcass disposal team developed very efficient means of handling the large number of infected animals. The swine were loaded into refrigerated trucks (reefers) and euthanized using carbon dioxide gas for 12-18 minute cycles. This resulted in 100% mortality. Captive bolt guns were available as a backup but were rarely used. Carcasses were unloaded from the refrigerated truck using a skid-steer payloader operating from two flatbed trailers parked adjacent to one another. The only bottleneck in the carcass disposal system was created by the time required to unload the reefers. Pennsylvania received expert advice and assistance in the euthanasia operation from a US Department of Agriculture (USDA) team under the direction of Dr. Frank Wilson.

Once the swine were euthanized, the carcasses were loaded onto dump trucks and hauled to area landfills. On the second to the last day of the disposal operation two truckloads of carcasses, approximately 80,000 pounds, arrived at the local landfill a few minutes after closing and were refused entry and permission to park overnight on the landfill premises so as to facilitate the prompt unloading of the trucks the following day. As a result of this development

the carcass disposal team recalled the trucks to the farm so that the carcasses could be buried on site. A bulldozer operator was located and a pit was excavated. The Pennsylvania DEP supervised the burial. The DEP provided follow-up monitoring of both the landfill and burial site and has reported no complications from the disposal technologies utilized (Knepley, 2003; Pennsylvania Department of Agriculture).

Georgia

Dr. Nelwyn Stone, a veterinarian with the Georgia Department of Agriculture, provided information on four catastrophic carcass disposal incidents that occurred in Georgia. The first occurred in 1994 when Hurricane Alberto hit Georgia. Forty counties in Georgia were affected and hundreds of thousands of livestock perished. Many of the carcasses washed into rivers and were eventually swept out to sea. The destruction of so much livestock and the resulting flooding led to significant public health problems for human beings. Hardest hit was Dougherty County where all the livestock in a feeding operation drowned. The county sewer system flooded and the well around the feeding operation became contaminated with coliform bacteria and high nitrate levels from animal waste and decomposing carcasses. As a result, local residents in Dougherty County were compelled to boil their drinking water for several years following Hurricane Alberto.

Hurricane Alberto also hit Macon County, Georgia, very hard and necessitated the burial of 100,000 birds. The Georgia Department of Agriculture, Department of Transportation, and the Georgia National Guard assisted in the burial of the birds on site.

The problems Georgia encountered in the wake of Hurricane Alberto led to the adoption in 1995 of the Emergency Support Function Plan 14 which attempted to better coordinate state resources to train personnel and plan, respond, and mitigate animal health emergencies caused by disease or natural disaster.

In 1999 tornadoes struck Mitchell County in Southwest Georgia and destroyed 3 farms resulting in 900 tons of dead chickens. The Georgia

Department of Agriculture incinerated the carcasses and then buried the ashes on site. In 2001 tornadoes again struck the same farms and resulted in 450 tons of dead chickens. Incineration of the carcasses and burial of the ashes on site was again used to dispose of the chickens. Dr. Stone indicated that, as a result of the emergency management system now in place in Georgia, the disposal of the chicken carcasses in these operations cost \$300,000 or about 15 cents per pound. Outsourced bids for carcass disposal in these operations ran to \$1.5 million or approximately 80 cents per pound.

In 2002 Georgia also dealt with a relatively rare man-made carcass disposal incident. In Wayne and Pierce County, Georgia, the operator of a poultry layer farm abandoned 1,171,000 chickens with no food. Consequently many thousands of chickens died of starvation. Of the 1,171,000 that the State of Georgia discovered on the farm, 705,000 were determined to be in good enough condition to sell to other companies. Georgia had to bury 103,000 on site, render 233,000, dispose of 90,000 in landfills, and sent the remaining 40,000 to slaughter.

At the time of this report, Dr. Stone is continuing to gather information for the CDWG and has indicated that he and his colleagues in the Georgia Department of Agriculture are enthusiastic about participating in any carcass disposal forum that might be created (Stone, 2003).

Maryland

Maryland's documented experience with large-scale carcass disposal involves the loss of poultry to nonpathogenic avian influenza (NPAI) and natural disaster. In November 1993 Maryland Department of Agriculture officials mandated the destruction of 18,000 game birds (pheasants, chuckers, quail, mallards, and turkeys) due to NPAI. Maryland opted to destroy the carcasses via burial and incineration. The birds were euthanized with firearms or carbon dioxide gas. Maryland officials indicated that during this incident the appropriate knowledge and equipment for gassing the birds was deficient and constituted a deficiency in their planning. The burial sites were not recorded nor were they subject to long-term monitoring.

In 2001 the Maryland Department of Agriculture was again faced with a large-scale disposal effort, this time emanating from the collapse of a poultry house after a very heavy snow. Approximately 10,000 birds were either killed in the collapse or had to be euthanized with carbon dioxide gas.

Unfortunately, Maryland does not keep records of their carcass disposal efforts; however, according to Dr. J. Casper, DVM, the Maryland Department of Agriculture's emergency planning has improved substantially as a result of these incidents (Casper, 2003a; Casper 2003b).

Indiana

Correspondence with Dr. John A. Johnston, DVM, and Director of the Swine Health Division of the Indiana State Board of Animal Health revealed that Indiana had a relatively recent experience in a large-scale animal disposal event. Between February 15, 1999, and May 15, 2000, the Indiana Board of Animal Health in cooperation with producers and USDA Animal and Plant Health Inspection Service (APHIS) participated in the Accelerated Pseudorabies Eradication Program. This program depopulated over 100 swine herds (244,822 animals) infected with the pseudorabies virus.

Indiana's experience is interesting in that the nature of the emergency did not mandate the immediate destruction and disposal of the animals. As a result the disposal operation could be well managed and planned. The number of carcasses at no time overwhelmed Indiana's ability to process and dispose of them rapidly. In addition, Indiana's experience also required a large-scale euthanasia program.

In disposing of the carcasses the Indiana and USDA/APHIS authorities opted to use rendering. Dr. Johnson indicated that in future emergencies caused by a foreign animal disease, Indiana probably will not be able to rely on rendering as a disposal technology.

Indiana arranged to conduct the euthanasia process using the facilities of a recently closed meat packing plant. Appropriate modifications were made to the stockyard facilities, namely the construction of special chutes, an electrical shock system and a conveyor system to move the deceased animals to semi-trailers for transport to the rendering facilities.

Most pigs were destroyed using electrical shock. Smaller pigs were destroyed with carbon dioxide gas and nursing pigs were euthanized with lethal injections. Trucks hauling live pigs to the euthanasia facilities and trucks hauling carcasses to the rendering plant were washed and disinfected before being allowed to return to the farms. During the 15-month operation 25 trucking companies and six rendering companies were employed.

Dr. Johnston also indicated that Indiana permits carcass disposal via rendering, composting, incineration, and burial. On-site burial is permitted in a pit at least 4 feet deep. Animals must also be covered by at least 4 feet of earth. Disposal via landfill is permitted only if state and local regulations do not prohibit it. Landfill operators in Indiana are by no means required to accept carcasses (Johnston, 2003; Wilson, 2003).

Michigan

Michigan, according to Dr. Joan Arnoldi, the Michigan State Veterinarian, has had the rare experience of dealing with a catastrophic carcass disposal incident caused by a feed mixing accident that occurred in the fall of 1973. In this incident animals were poisoned as a result of a chemical called "Firemaster" or polybrominated biphenyls being mixed into livestock and poultry feed rather than "Nutrimaster." The incident affected 557 premises and caused the death of approximately 30,000 animals of various species.

In dealing with this disaster the State of Michigan elected to bury the carcasses in remote locations near Kalkaska and Oscoda, Michigan. The Kalkaska pit consisted of trenches 12 feet deep in sandy soil and was approximately 80–90 feet above the water table. The pit had a bentonite cover over the trenches and monitoring wells. The Kalkaska trenches accommodated 22,691 cattle, 3,707 swine, 1,371 sheep, 573 poultry, 2 goats, 2 horses, and 32 rabbits.

The Oscoda pit was built with the same dimensions and boasted 20-foot-thick clay walls. The Oscoda pit accommodated 921 cattle and 1,789 barrels of carcasses. Monitoring wells at both sites have revealed only slightly higher level of nutrients from the decomposition of the animal carcasses. Dr. Arnoldi indicated that the incident cost over \$40

million for indemnity, labor, equipment, lawsuits, and other legal matters (Arnoldi, 2003).

Idaho

Idaho officials have reported their only catastrophic carcass disposal event occurred in 1976 when the Teton Dam broke and resulted in the deaths of more than 5,000 cattle. Idaho's carcass disposal effort offers a rare case of a problematic disposal effort. Idaho elected to bury the animals, but too many cattle were placed in the pits. Despite being covered with 3 feet of earth, gasses associated with carcass decomposition pushed many carcasses to the surface. The pits had to be recovered with earth each week for six weeks before the problem subsided.

In addition to the experience associated with the Teton Dam incident, the Idaho Department of Agriculture indicated that in any future large-scale animal disposal event, landfills might not be a viable option due to public pressure and reluctant county commissioners. Idaho did provide a copy of their newest animal disposal regulations, which were implemented in March 2002. Idaho regulations permit rendering, composting, landfill, and digestion.

Idaho regulations mandate that burial can be utilized as long as the carcasses are covered by at least 3 feet of earth, and the pit is located at least 300 feet from public or private water supply, 300 feet from residences, 50 feet from property lines, 100 feet from roadways, and 200 feet from lakes or streams. Burial sites are also not permitted in areas subject to flooding or with a high water table.

Incineration is permitted only in an approved incineration facility or with a mobile air curtain incinerator approved by the State of Idaho. Open burning of animal carcasses is not allowed except as authorized by the State of Idaho.

Idaho also permits the open decomposition of animals that die from causes other than contagious disease if the carcass is located 1,320 feet from public and private water supplies, springs, streams, lakes, or sinkholes. The carcass must also be 1,320 feet from roadways and residences.

Idaho regulations also have dead animal emergency provisions that permit extraordinary disposal

measures in the event of contagious disease or the sudden loss of a sizable number of animals. In the event of such an emergency Idaho regulations permit open burning, pit burning, burning with accelerants, pyre burning, air curtain incineration, mass burial, and natural decomposition (Simunich, 2003; Idaho Administrative Code).

Maine

Maine has had some limited experience with carcass disposal. In February 2002 low pathogenic avian influenza was detected by producer of ducks, geese, quail, and pheasant. The farm was quarantined and approximately 5,000 birds were euthanized with carbon dioxide gas. Burial was an unsuitable alternative given the frozen ground and characteristics of Maine's terrain. Instead, all 5,000 birds were composted on site with excellent results. The producers were also paid the market value of the 5,000 birds to compensate for their losses (Rourque, 2003; Associated Press, 2002a; Associated Press, 2002b).

Iowa

Contact was established with personnel from the Iowa Department of Natural Resources at the Midwest Regional Carcass Disposal Conference at Kansas City. Kathryne Clark provided some information on the disposal of 60 cattle carcasses killed by a fire in the early summer of 2003. Half of the carcasses were disposed of via landfill and the remaining 30 were rendered (Clark, 2003).

Alison Manz provided some details of a much larger carcass disposal incident occurring the summer of 2003. As a result of a lightning strike that simultaneously shut down the ventilation system and sparked the fire of a large hog confinement building, approximately 800 hogs were lost. Because the source of the fire was not immediately known, the disposal of the carcasses could not proceed until the completion of the Fire Marshal's investigation. Several days passed and given the summer heat the carcasses were in an advanced state of decay. The Department of Natural Resources decided to bury the carcasses and constructed a burial pit on top of a ridge on the producer's farm. Monitoring wells were also constructed around the pits so any

contamination resulting from the burial pits could be quickly detected. Ms. Manz indicated that although composting of the carcasses might have been the best disposal option, the Iowa Department of Natural Resources is ambivalent about using or encouraging the use of this technology because of doubts that producers will do it properly (Manz, 2003).

Florida

Florida's acting State Veterinarian, Dr. William C. Jeter, indicated that he had no recollection of any large-scale animal disposal incident within Florida. Dr. Jeter indicated that small-scale carcass disposal incidents occurred within the Florida poultry industry when birds were killed as a result of heat or flooding. In these circumstances local county officials and producers dispose of the carcasses via on site burial (Jeter, 2003).

Hawaii

The State Veterinarian of Hawaii, Dr. Jim Fobboli, indicated that Hawaii has no experience in performing mass animal depopulations. The largest incident to date is the disposal of 167 head of swine that was disposed of via landfill. Dr. Fobboli did not indicate the reason for the depopulation. According to Dr. Fobboli, Hawaii has no laws or regulations that specifically address carcass disposal (Fobboli, 2003).

Illinois

Dr. Colleen O'Keefe, DVM, of the Illinois Department of Agriculture, reported that Illinois has not had a disaster that resulted in a large-scale animal disposal problem. Dr. O'Keefe indicated that Illinois did have experience with several incidents of large-scale animal deaths that were resolved by a combination of on-site burial and rendering (O'Keefe, 2003).

Arizona

Arizona indicated it had no information on large-scale disposal incidents occurring within its borders. Dr. Rick Willer, the Arizona State Veterinarian, indicated that the State of Arizona is currently addressing an antiquated law that mandates disposal of dead livestock by rendering if the carcass is

removed from a premise. Dr. Willer indicated that only one rendering plant exists in Arizona and does not serve most of the rural areas of the state. Price gouging has occurred and the state legislature has revised the law to allow for the disposal of dead livestock at licensed landfills unless the State Veterinarian determines a disease risk warrants an alternative means of disposal (Willer, 2003).

Arkansas

Dr. Jack Gibson, director of the Arkansas Livestock and Poultry Commission, provided a copy of Arkansas regulations, dated June 17, 1993, concerning the disposal of large animal carcasses. According to these regulations Arkansas permits rendering, burial, incineration, extrusion, cooking of carcasses for swine food, and composting unless the State Veterinarian mandates a specific manner of disposal. Rendering in Arkansas is permitted if the carcass is transported to rendering facilities in a sealed, leak-proof vehicle. Burial is permitted if a site is at least 100 yards from a well and situated where streams cannot be contaminated. Carcasses infected with anthrax are, according to Arkansas regulations, to be covered with 1 inch of lime and all carcasses are to be covered with at least 2 feet of earth. All animals that expire as a result of anthrax must be buried on site. The disposal of any carcass via a landfill is not permitted. According to Arkansas regulations carcasses may be cooked for swine food if the internal temperature reaches 212° F for 30 minutes. This method of carcass disposal is only permissible with a federal permit issued by USDA-APHIS. Curiously, Arkansas regulations mandate that carcasses can only be composted if the carcasses or portions of carcasses are no heavier than 60 lbs. The only regulation concerning incineration is that the carcasses must be reduced to ash. No detailed information on large-scale animal disposal incidents within Arkansas was available(Gibson, 2003).

Missouri

Missouri reported some limited experiences with carcass disposal disasters. Correspondence with Jack Sifford of the Animal Health Division of the Missouri Department of Agriculture indicated that

Missouri has had a few useful experiences in large-scale carcass disposal and revealed some potential difficulties should any future disaster affect Missouri. All of Missouri's experiences, to Mr. Sifford's knowledge, involve the loss of animals due to natural disaster, accident, or neglect. Mr. Sifford did not have any knowledge of any incident during his 15-year tenure with the Missouri Department of Agriculture resulting from a highly pathogenic disease.

In 2001 the curtains of a hog confinement operation failed to operate and killed 290 hogs. The majority of the carcasses were disposed of via rendering while 70 carcasses were composted on site.

An accident involving the collapse of poultry houses resulting in the death of 40,000 birds created another large-scale carcass disposal incident. In this case the producers relied on their own rendering facility to dispose of all the carcasses.

A case of criminal neglect resulted in the death of 80 head of cattle in 2001. The cattle died from a combination of pneumonia and poor nutrition. The State of Missouri arranged to excavate three burial pits on site and buried all the carcasses.

An accidental poisoning left 25 cattle dead in southeast Missouri 2001. Problematic conditions surrounded this particular incident since landfills in that area of Missouri would not accept carcasses, no incinerators existed, and burial was not permitted due to a high water table. Composting was also ruled out as an impractical method given the number of cattle involved. Due to the extenuating circumstances surrounding the incident the state permitted the owner to build pyres, burn the carcasses, and then bury the ashes.

In discussing Missouri's experience with large-scale animal disposal, Mr. Sifford indicated that future events would be more problematic given the fact that rendering companies stopped making free on-farm pickups of fresh deaths. In addition, Mr. Sifford indicated that Missouri's carcass disposal laws are poorly written and create many problems for those in charge of enforcing the statutes (Sifford, 2003).

Oregon

Rodger Huffman, administrator for Animal Health and Identification, Oregon Department of Agriculture, indicated that Oregon has had two incidents involving large-scale carcass disposal in the past ten years. In each case the animals were euthanized and transported to landfills for disposal. Mr. Huffman indicated that in 1999 Oregon passed a law that gives the Oregon Department of Agriculture broad powers to deal with an animal health emergency. Under this statute the diseased or deceased animals will be disposed of on site and either burned or buried (Huffman, 2003).

Washington

The State of Washington indicated that they have had large-scale carcass disposal incidents but due to the fact that the incidents occurred more than ten years ago, the records associated with these incidents have been destroyed. Dr. Kathleen Connell, DVM, did provide a copy of Washington's regulations regarding animal disposal. These regulations indicate that burial and incineration are the only approved means of animal disposal (Connell, 2003; Washington Administrative Code).

3.3 – Preliminary Survey Conclusions

While the lessons from these experiences should serve as guides for other states and localities preparing for a catastrophic event, dissemination of these lessons is hampered by the almost total absence of historical records documenting catastrophic animal disposal events. Large-scale animal disposal events caused by natural disasters or epidemics are certainly nothing new, and states and localities have encountered these problems in the past; however, interviews and correspondence with officials from various states confirm that state agencies dealing with this problem generally have no institutional memory. The documents that do exist provide only rudimentary data, and states often purge what are deemed as inconsequential records at five- or ten-year intervals. As a result, detailed information about carcass disposal incidents that

occurred more than ten years ago can be very difficult, if not impossible, to obtain.

As a consequence of the generally inadequate historical documentation of animal disposal events, a majority of the information that can be gleaned about past events has to be obtained from interviews of the persons involved in such events. Although information obtained from interviews can certainly be useful and the knowledge and experience of those involved in past events is worthy of documentation and distribution, oral history can have significant shortcomings. Human memory can be problematic and hard facts concerning numbers of livestock lost, economic losses, disposal expenses, and the exact location of burial sites can be difficult or even impossible to obtain. In addition, the death, retirement, or career changes of those individuals with the most knowledge of past incidents means that the ability to learn lessons from past incidents dissipates with each passing year. The absence of any institutional memory or written history of past incidents robs current government officials of a useful pool of knowledge concerning how best to handle any future large-scale animal disposal emergency.

Another major deficiency lies in communicating and distributing current information concerning carcass disposal technologies, planning, problem solving, and historic incidents. It appears that the various states and localities operate as independent islands with each one attempting to plan and prepare for potential emergencies as if in a vacuum. Communication is lacking among officials in various state agencies involved in regulating or directing animal disposal projects, academics involved in the study of carcass disposal, and the various federal agencies that might provide assistance. Consequently, evaluation of opportunities and means to facilitate communication between state and federal officials, producers, and academics is warranted. Possible means include virtual forums -- or other electronic formats -- that could provide an inexpensive and effective channel to share past experiences and problems and to distribute information on carcass disposal technologies, emergency planning, laws and regulations, logistics, and a variety of other relevant topics. Information from these forums could then be captured for further development. Many officials

attending the August 2003 Midwest Regional Carcass Disposal Conference expressed great interest and enthusiasm for opportunities to increase

communication with outside experts or other experienced individuals.

Section 4 – Critical Research Needs

- Rectify the general inadequacy of documentation regarding historical, large-scale animal disposal incidents and the lack of institutional memory. The development of a pool of historical knowledge of past incidents will offer useful lessons to current officials and credibility to those handling an urgent animal disposal incident. Development of a HIDA and documentation of past incidents may require significant travel and a significant number of interviews.
- Conduct follow-up research on past animal disposal incidents in the areas of policy, planning, lessons learned, and the scientific evaluation of past disposal methods.
- Compile and review states' emergency plans for a catastrophic animal disposal effort. Copies of plans have been requested, although not yet provided. It is suspected that emergency planning is deficient or in some cases nonexistent.
- Explore opportunities and means to facilitate communication among academic, state, and federal authorities and producers concerning all aspects of carcass disposal. Conferences, virtual forums, and electronic formats are all possibilities that merit exploration.
- Create Web-based tools that would include a HIDA as well as planning, policy, and communications advice. Although it is a daunting task, it is indeed possible, based on exploratory development of a HIDA, that a central, Web-based archive of incidents and bibliographic sources could be developed to facilitate planning, policy development, and communication among all interested parties. Such a database would be central to capturing the history and important lessons learned from past events and would serve as a repository for bibliographic material on carcass disposal issues.

References

- Arnoldi, J. (2003, 11 December). Personal communication to James Ehrman: Joan Arnoldi, DVM (State Veterinarian and Division Director Animal Industry Division, State of Michigan).
- Associated Press. (2002a, 8 February). Associated Press State & Local Wire.
- Associated Press. (2002b, 12 February). Associated Press State & Local Wire.
- Carlson, W.R. (2003, 22 August). Personal communication to James Ehrman: Wayne R. Carlson (North Dakota Department of Agriculture).
- Casper, J. (2003a, 8 September). Personal communication to James Ehrman: J. Casper, DVM (Maryland Department of Agriculture).
- Casper J. (2003b, 26 October). Carcass Disposal Incident Questionnaire, completed by J. Casper.
- Clark, K. (2003, 20 October). Personal communication to James Ehrman: Kathryne Clark (Iowa Department of Natural Resources).
- Connell, K.M. (2003, 28 August). Personal communication to James Ehrman: Kathleen M. Connell, DVM (Acting State Veterinarian, Washington Department of Agriculture).

- Ellis, D. (2001). Carcass disposal issues in recent disasters, accepted methods, and suggested plan to mitigate future events (applied research project for Master of Public Administration). San Marcos, Texas: Texas State University–San Marcos (formerly Southwest Texas State University).
- Fobboli, J. (2003, 25 August). Personal communication to James Ehrman: James Fobboli, DVM (State Veterinarian, Hawaii Department of Agriculture).
- Gibson, J. (2003, 28 August). Personal communication to James Ehrman: Jack Gibson, DVM (Director, Arkansas Livestock and Poultry Commission).
- Gough, T.J. (1996, Spring). The US Army Center of Military History: A Brief History. *Army History*, PB-20-96-2(37).
- Hickman, M. (2003a). Presentation regarding carcass disposal. Kansas City, Missouri: Midwest Regional Carcass Disposal Conference.
- Hickman, M. (2003b). Personal communication to James Ehrman: Matthew Hickman (Program Coordinator, Riverside County Waste Management Department).
- Holl, J. (Chief Historian, US Department of Energy, 1980–1989). (2004). *Origins of the Department of Energy's Nuclear Incidents Database*.
- Huffman, R. (2003, 22 August). Personal communication to James Ehrman: Rodger Huffman (Administrator, Animal Health and Identification, Oregon Department of Agriculture).
- Idaho Administrative Code. Department of Agriculture, IDAPA 02.04.17–Rules Governing Dead Animal Movement and Disposal.
- Jeter, W. (2003, 3 December). Personal communication to James Ehrman: William C. Jeter, DVM (Acting State Veterinarian, Florida Department of Agriculture).
- Johnston, J.A. (2003, 2 September). Personal communication to James Ehrman: John A. Johnston, DVM (Director, Swine Health Division, Indiana State Board of Animal Health).
- Kirkland, C.F. (2003, 22 September). Personal communication to James Ehrman: C.F. Kirkland, DVM (North Carolina Department of Agriculture, Veterinary Division).
- Knepley, P.E. (2003, 4 December). Personal communication to James Ehrman: Paul E. Knepley, DVM (Pennsylvania Department of Agriculture, Bureau of Animal Health and Diagnostic Services).
- Manz, A. (2003, 20 August). Personal communication to James Ehrman: Alison Manz (Iowa Department of Natural Resources).
- North Dakota Department of Agriculture. State Agency After Action Report (obtained from C.F. Kirkland, North Carolina Department of Agriculture).
- O'Keefe, C. (2003, 22 December). Personal communication to James Ehrman: Colleen O'Keefe, DVM (Illinois Department of Agriculture).
- Pennsylvania Department of Agriculture, Bureau of Animal Health and Diagnostic Services. Depopulation and Disposal Summary Report (obtained from Paul E. Knepley, Pennsylvania Department of Agriculture).
- Riverside County Waste Management Department. (2003). Exotic Newcastle Disease DVD.
- Rourque, M. (2003, 10 October). Personal communication to James Ehrman: Michael Rourque (Maine Division of Animal Health and Industry).
- Sifford, J. (2003, 28 August). Personal communication to James Ehrman: Jack Sifford (Animal Health Division, Missouri Department of Agriculture).
- Simunich, M. (2003, 27 August). Personal communication to James Ehrman: Marilyn Simunich, DVM (Idaho Department of Agriculture).
- Stone, N.L. (2003, December). Personal communication to James Ehrman: Nelwyn L. Stone, DVM (Assistant State Veterinarian, Georgia Department of Agriculture).
- Washington Administrative Code. Revised Code of Washington 16.68, 246–203–120.

Willer, R. (2003, 16 December). Personal communication to James Ehrman: Rick Willer, DVM.

Wilson, F.R. (2003, 2 September). Accelerated Pseudorabies Eradication Program Summary

compiled 9/2/2003 by Frank R. Wilson,
USDA/APHIS.

Wright, R.K., Jr. (1985, Winter). Clio in Combat: The Evolution of the Military History Detachment. *The Army Historian*, (6), pp. 3-6.

Appendices

Appendix A – HIDA Fields

1. Cause of animal disposal event: (disease/natural disaster/accident/criminal act)
2. Location: state/province
3. Date of incident:
4. If disease-related, the pathway or suspected pathway of the pathogen
5. If a criminal act or accident, the method of destroying or infecting the animals
6. Total number of animals disposed
7. Number of animals disposed by species
8. Method of destruction of animals
9. Numbers euthanized (welfare killings)
10. Method(s) of carcass disposal
11. Economic losses inflicted on producers
12. Costs of disposal effort
13. Detailed incident summary. This summary will include available geographic information, images, spreadsheets, problems encountered, lessons learned, bibliographic information, and contact information for those officials providing the information to the History Task Group.

Appendix B – CDWG Historical Incidents Questionnaire

Name: _____

Agency: _____

Address: _____

Telephone: _____

Fax: _____

E-mail: _____

1. What caused the carcass disposal incident?
 - a. Natural disaster
 - b. Disease
 - c. Criminal act
 - d. Accident
2. Date of incident:
3. If the incident was caused by a disease, what type of disease was it?
4. If the incident was caused by a disease, what was the pathway or suspected pathway of the infectious agent?
5. If the incident was caused by a natural disaster, what type of disaster was it?
 - a. tornado
 - b. hurricane
 - c. flood
 - d. blizzard
 - e. other _____
6. If the incident was caused by a criminal act or accident, what was the method used to destroy the animals?
7. How many carcasses had to be disposed?

- a. cattle _____
- b. chickens _____
- c. turkeys _____
- d. swine _____
- e. sheep/goats _____
- f. deer _____
- g. other _____

8. Which method(s) of disposal were used? If multiple methods were used please give estimates of number disposed with each method.

- a. burial _____
- b. incineration _____
- c. composting _____
- d. landfill _____
- e. alkaline hydrolysis _____
- f. rendering _____

9. If burial was a method of disposal, were the graves marked or recorded and were they monitored for possible contamination? YES/NO

10. If yes, where are the graves located?

11. Are you aware if any follow-up investigation that has been done as to the effectiveness of the burial (i.e., the extent to which the animals have decomposed, etc.).

12. Did any animals have to be euthanized? YES/NO

If yes please indicate the method(s) used and approximate numbers euthanized with each method.

- a. firearm _____
- b. lethal injection _____

- c. electrocution _____
- d. carbon dioxide _____
- e. blunt trauma _____

- 13. Approximately how large were the economic losses sustained by livestock owners?
- 14. What were the approximate costs of the disposal effort?
- 15. What agencies (federal/state/local) or producers were involved in the disposal effort?
- 16. What sort of planning was done prior to the incident?
- 17. What deficiencies in planning were apparent during the incident?
- 18. What lessons were derived from the incident?
- 19. Does your state/company maintain records of catastrophic carcass disposal incidents? YES/NO
- 20. If yes, where are these records located?
- 21. Would your state be willing to provide copies of incident records to Kansas State University so they can be archived in Kansas State University's Hale Library? (Doing so would be extraordinarily helpful to others involved in carcass disposal research.)
- 22. Are there any other persons you know (state government employees, producers, or private industry) with intimate knowledge of this incident? If so would you please provide their contact information?
- 23. Is there any other information about this incident you would like to provide that has not been covered by the questions above? If so please provide your comments in the space below: