ABSTRACT

BORIS BRGLEZ: Disposal of Poultry Carcasses In Catastrophic Avian Influenza Outbreaks: A Comparison of Methods
(Under the direction of Dr. Louise M. Ball)

Catastrophic outbreaks of low pathogenic avian influenza (LPAI) occurred in 1984 and again in 2002 in the U.S.A. Whole poultry operations required complete depopulation. The sudden accumulation of thousands of tons of diseased poultry carcasses necessitated quick, sanitary disposal. In 1984, the diseased carcasses were mainly buried on site; in 2002, they were primarily buried in local landfills.

It is the aim of this paper to provide a review of the major methods of mass disposal of diseased poultry carcasses and a framework for establishing the most efficient disposal method. This paper will examine several disposal methods, discussing the cost, and their positive and negative effects on the environment and public perception. The various disposal methods that will be reviewed are onsite burial, landfills, composting, incineration, rendering, alkaline hydrolysis, and in-situ plasma vitrification system.

Models were made based on the total tonnage of poultry that was disposed of in the Virginia (VA LPAI) outbreak of 2002. Each disposal method was modeled on its capacity to dispose of 188 tons per day of diseased poultry carcasses daily for a period 90 days. Results indicated that rendering was the method of choice.

I dedicate this manuscript to my wife, Lisa Lynn, who has supported and nurtured our marriage throughout veterinary school, graduate school and military deployments.

To my only daughter, Chloe Lynaura, all my love and admiration.

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LIST OF ABREVIATIONS

Ag-Bag	Compost Company name
AI	Avian Influenza
AITF	Avian Influenza Task Force
BSE	Bovine Spongiform Encephalopathy
BTU	British Thermal Unit
CDC	Centers for Disease Control
CO^2	Carbon Dioxide
COD	Chemical Oxygen Demand
DEQ	Department of Environmental Quality
DWM	Department of Waste Management
ENCD	Exotic New Castle Disease
FMD	Foot and Mouth Disease
GA	Georgia
HA	hemagglutinatin
HPAI	High Pathogenic Avian Influenza
ISVP	In-situ plasma vitrification
LPAI	Low Pathogenic Avian Influenza
MSW	Municipal Solid Waste
NA	neuraminidase
NH_3	Ammonia
OIE	Organization International Epizootics
SWCB	State Water Control Board
TKN	Total Kieldahl Nitrogen
TOC	Total Organic Carbon
UK	United Kingdom
USA	United States of America
USDA	United States Department of Agriculture
VA	Virginia

Chapter 1 – INTRODUCTION

In the last 20 years, there have been two large outbreaks of Low Pathogenic Avian Influence (LPAI) in Rockingham County, Virginia, requiring the complete depopulation of the poultry farms in the county. In 1984, more than 65 commercial poultry operations yielded 5,700 tons of carcasses; in 2002, more than 195 depopulated operations yielded 16,900 tons. On both occasions, the Avian Influenza Task Force (AITF) was confronted with a potential public health disaster, and with no strategic plan in place to combat it. It is the purpose of this paper to examine and compare all existing catastrophic poultry disposal methods, and to contribute to just such a strategic plan.

At this time, there appear to be seven methods of disposal, three of which have not been yet applied in the United States. These methods, and their applicability in the U.S., are as follows:

I. Routine Methods:

1. On-site burial (applied in the U.S.);
2. Landfill burial (applied in the U.S.);

II. Complex Methods:

3. Composting (applied sparingly in the U.S.);
4. Incineration (applied sparingly in the U.S.);
5. Rendering (not applied in the U.S., but widely used in Europe);

III. Experimental Methods:

6. Alkaline Hydrolysis (in the experimental stage); and,
7. "In-situ" plasma vitrification (in the experimental stage).

In comparing disposal methods, the determining factors are cost, ease and speed of disposal, and possible community objections over and above disease transmission and water contamination. Among the variables of disposal cost are transportation, labor, materials, land-use fees, and equipment usage, and also whether these costs can be offset by some saleable byproduct of the disposal method. In 1984, the AITF handled disposal primarily through burial on site; in 2002, the county landfill was chosen as the location for the bulk of disposal. In neither case, however, were the responses prepared ahead of time. That the outbreaks were, indeed, successfully contained by the respective disposal methods is a tribute to our mastery over avian influenza, and to the diligent efforts of those on the ground searching for a solution under the time constraints imposed by the outbreaks.

The United States is the world's largest producer and exporter of poultry products. Annual cash receipts of $93 billion from livestock and poultry products account for about half of all commerce in agricultural products. According to recent USDA statistics, 34% of all poultry in the world is produced by the United States, and our share of the world export market is 40%. According to the USDA agricultural baseline projections:
U.S. livestock, 2003-2012 (www.ers.usda.gov/briefing/baseline/livstk03), consumption of poultry in the United States is considerably higher than of either beef or pork.
The commercial production of poultry, and its attendant wastes, is increasing yearly in order to keep up with the demand. Naturally, the increase in poultry production should also give rise to an increase in the outbreaks of disease, of which there is a wide range. The survival characteristics of the most common, and most lethal, poultry pathogenic microbes are shown in Table 1.

Table 1: Common infectious diseases of poultry. (Adapted from Nathaniel L. Table 1 in "Biosecurity: A vital key to poultry disease prevention" published in Poultry Perspectives, vol 2, No. 1, Spring 2000 (University of Maryland)

Disease	Poultry's Health Effects	Survival in the Environment	Zoonotic
Virus			
Infectious Bursal disease (Birnavirus)	Lowered resistance	Months to other diseases	No
Marek's disease (Herpesvirus)	Wasting, paralysis	Weeks	No
♠Influenza type A (Orthomyxovirus)	Severe fever, death	Days to weeks	Yes
♠Newcastle disease (Paramyxovirus)	Colds, paralysis	Days to weeks	Yes
Duck plague (Herpesvirus)	Diarrhea, death	Days	No
Infectious laryngotracheitis (Herpesvirus)	Choking, death	Days	No
Bacteria			
Mycobacterium avian (tuberculosis)	Fatal wasting	Years	Yes
Fowl coryza (Bordetella avium)	Swelling around eyes, nasal discharge	2 days to 6 months	No
♣ Chlamydophila psittaci	Respiratory distress	Weeks to Months	Yes
♣ Fowl typhoid (Salmonella gallinarum)	Deaths in growing poultry	Weeks to Months	Yes
Campylobacter jejunum	Avian vibrionic hepatitis	Weeks to Months	Yes
Fowl cholera (Pasturella multocida)	Fatal pneumonia	Weeks	Yes
Mycoplasmosis (M. gallisepticum)	Low egg production, respiratory disease	Hours to days	No
Protozoa			
Eimeria acervulina (Poultry Coccidia)	Diarrhea, death	Months	No

♠ OIE List A Diseases: transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that are of serious socio-economic or public health consequence and that are of major importance in the international trade of animals and animal products.

♣ OIE List B Diseases: "Transmissible diseases that are considered to be of socio-economic and/or public health importance within countries and that are significant in the international trade of animals and animal products".

The diseases currently posing the gravest threats to poultry stock and to human health are Avian Influenza (AI), Exotic New Castle Disease (ENCD), Campylobacter and Salmonella. Since 1983, there have been frequent outbreaks of AI in the U.S., which has resulted in millions of birds being depopulated. Since September 2002, the west coast states have been affected by a huge wide outbreak of ENCD, which has resulted in over 15 million birds being depopulated there to date. Among the human populations, the two most common food borne illnesses attributed to poultry are Campylobacter and Salmonella bacteria among people, where the Centers for Disease Control (CDC) reports several thousands of Americans are affected yearly. According to the Canada Safety Data Sheets (http://www.hc-sc.gc.ca/pphb-dgspsp/msds-ftss/msds29e.html), both Salmonella and Campylobacter are sensitive to moist heat (121°C or 250°F, for at least 15 minutes) and to dry heat (160-170°C or 320°F- 338°F, for at least 1 hour). John Snell's article, "The Role of Temperature in the Garbage Composting Process" (Compost Science, Vol. 1, 1960, pg 28-31), summarizes that all Salmonella species die when subjected to 1 hour at 55°C (131°F), or 20 minutes at 60°C (140°F). ENCD is destroyed rapidly by dehydration and by the ultraviolet rays of the sun, or by one minute's exposure to 100°C or 212°F temperature. AI is vulnerable in temperatures of 56°C (133°F), for a period of 30 minutes. A study conducted in Ames, Iowa, on composting carcasses infected with AI demonstrated that the virus could not be cultured after only 10 days of composting. The researchers calculated that compost had maintained temperatures between 100°F and 140°F throughout the composting period. (D.A. Senne, B. Panigrahy, R.L. Morgan, 1994: Effect of composting poultry carcasses on survival of exotic avian viruses: HPAI virus and adenovirus of egg drop syndrome-76. Avian Diseases 38:733-737).

Poultry microbial pathogenic contamination of the environment can occur during carcass disposal arising from infectious disease outbreaks. However, there is very limited research available that has examined soils for the presence of pathogenic microbes when unprocessed poultry carcasses are simply buried. To some extent, commercial composting companies do such tests, in order to make certain that their compost is free of harmful microbes. Moreover, while poultry diseases are of great concern to the commercial industry, poultry operations also generate a natural microflora that may well contain organisms potentially harmful to humans, such as Salmonella and Campylobacter.

In 2001, a total of 13,705 cases of 10 food-borne diseases were laboratory-diagnosed by the Center for Disease Control; (Preliminary FoodNet Data on the Incidence of Foodborne Illnesses --- Selected Sites, United States, 2001 http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5115a3.htm#tab1). Thirty-eight percent of these cases were due to Salmonella, and 35% were due to Campylobacter. Prior to 2001, the percentage of Campylobacter was slightly higher than that of Salmonella. The CDC asserts that probably 50% of all Campylobacter food poisoning, and 25% of all Salmonellosis can be traced to poultry, specifically chicken. Commercial poultry operations attempt to reduce the shedding of the both Salmonella and Campylobacter through probiotics by competitive exclusion. Some poultry farmers have had some success by vaccinating their flocks against Salmonella.

The most widespread and lethal poultry diseases are High Pathogenic Avian Influenza (HPAI) and Exotic New Castle Disease (ENCD). Both HPAI and ENCD are Foreign Animal Diseases

(FAD), and are zoonotic. The former is a more lethal—in fact, an extremely lethal—variant of Low Pathogenic Avian Influenza (LPAI), and while LPAI displays variable and mild symptoms, often regarded as sub-clinical, it has been shown to mutate into HPAI. Indeed, the 1984 outbreak of LPAI in Rockingham County, Virginia, was an offshoot of an outbreak that began in Pennsylvania. Due to complacency and the lack of clear reporting guidelines with respect to LPAI, the Pennsylvania outbreak not only migrated to Virginia, but also mutated in Pennsylvania into HPAI, the first reported outbreak of this virulent strain in 54 years.

Avian Influenza (AI), both high pathogenic and low, is an RNA-virus, and belongs to the Orthomyxovirus family. The virus is spherical, 80 to 100 nm in diameter. According to Canada's Material Safety Data Sheet, a very low dose of virus particles can cause infection in poultry. The virus particle has an envelope with glycoprotein projections, and contains two surface antigens, hemagglutinatin (HA), and neuraminidase (NA). The composition of the envelope gives the virus its high infectivity, but it also makes AI more fragile than non-enveloped viruses, thus rendering it susceptible to harsh conditions and disinfectants. The two surface antigens, HA and NA, are the basis for describing the serologic identity of all influenza viruses, using the letters H and N with the appropriate numbers in the virus designation. "There are now 15 hemagglutinin and 9 neuraminidase antigens described among the Type A influenza viruses. The type designation (A, B, or C) is based upon the antigenic character of the M protein of the virus envelope and the nucleoprotein within the virus particle. All influenza viruses affecting domestic animals (equine, swine, avian) belong to Type A, and Type A influenza virus is the most common type producing serious epidemics in humans. Types B and C do not affect domestic animals." (Part IV. Foreign Animal Diseases. http://www.vet.uga.edu/vpp/gray_book/FAD/avi.htm.)

Swine have the capability to aerosolize large quantities of AI into the air just as they do Foot and Mouth Virus. "Pigs are the most important source of air dissemination of the virus; once infected, they excrete vast quantities of the virus. Thus pigs can be described as an amplifying host. (Javier M. Ekboir; http://aic.ucdavis.edu/pub/EkboirFMD-part1.pdf.; Potential Impact of Foot-and-Mouth Disease in California; Agricultural Issues Center Division of Agriculture and Natural Resources University of California1999). Hence, when pigs become infected with avian influenza—which is the case in the current HPAI outbreak in the Netherlands—the risk for human infection is great. The danger of the pig becoming infected with AI is that the virus can mutate to a more virulent form of the virus which then can re-infect poultry and cause higher mortality losses and even human death. "In the 1983-1984 "Swine Flu" outbreaks in Pennsylvania, the transfer was made by pigs feeding on garbage and dead avian carcasses under the chicken coops... After transmission to the pigs, the transmission to humans or other species was mainly through respiratory transmissions such as coughs, snorts and sneezes" (The Flu Is For the Birds; http://www.feelbest.com/article_17.cfm).

The incubation period for the AI virus is 3 to 14 days. Poultry in the United States are not vaccinated for AI because of the changing nature of the virus. LPAI is endemic in wild waterfowl, although it does not affect them clinically unless it converts to HPAI, which can then cause large die-offs. Therefore, water from ponds upon which wild fowl are observed to aggregate should not be used as drinking water for poultry houses.

In huge outbreaks of AI at commercial poultry operations, where birds numbering in the millions must be euthanized and immediately disposed of, there are three natural disposal methods of land application: burial on site, burial in landfills and composting. Of these, composting appears to be the most effective way to ensure that harmful pathogenic poultry microbes are deactivated. Composting can maintain temperatures over 140°F for several weeks, unlike on-site burial or landfills. Due to the extreme heat produced in the course of incineration, rendering, alkaline hydrolysis and in-situ plasma vitrification, there is no doubt that all poultry pathogens are destroyed by way of these disposal methods. Incineration heat can be produced by wood, oil, or fossil fuels. Rendering and alkaline hydrolysis both utilize pressurized steam ranging from 25 to 75 PSI (200-300°F) to break the carcass down into a protein particles. The rendering process first mechanically crushes the whole carcass into 2 inch cubic chunks of tissue, cooks the tissue for an hour under steam, and then removes the moisture for the proteinacious particles into a dry animal feed which weighs a third of the original weight of the raw product. Alkaline Hydrolysis, like rendering, uses steam heat in combination with NaOH. Unlike rendering, there is no mechanical crushing of the tissue. The NaOH dissolves the tissue into an amino acid like soup with pH exceeding 11. The water is not removed from the final product as it is in rendering. In in-situ plasma vitrification (ISVP), heat is generated directly from electricity which then ionizes compressed air to exceed temperatures of 7000°C and can thus vaporize all the water from the carcass. The final product from ISVP is a rock like substance with 97% reduction from the original weight.

However, cost and quick access to a particular disposal method will likely be the most important factors influencing selection of the treatment to be used to dispose of catastrophic amounts of highly infectious poultry within the shortest amount of time. Of the seven possible disposal options, composting, rendering and alkaline hydrolysis generate renewable sources of energy. Environmental concerns arise with use of on-site burials, landfills and incineration. If properly done, landfill leachate can be safely collected and treated. Similarly, proper on-site burial methods can limit environmental contamination to within acceptable levels. There is, however, somewhat less control over environmental effects produced by the combustion of poultry carcasses with wood.

There have been a number of outbreaks of AI in the United States. Recently, an outbreak of LPAI was eradicated in Virginia. This particular virus strain (H7N2) endured 3 months, and resulted in the destruction of about 4 million birds (a yield of 19,000 tons). This same disease but a different strain (H5N2) had previously emerged in the same area, Rockingham County, in January of 1984, for about 6 months, but with only 1.5 million birds destroyed. This earlier outbreak of AI (H5N2) in Virginia had actually originated in 1983 in Pennsylvania, where it had led to the destruction of 15 million birds. (This is the outbreak that was originally diagnosed, in April 1983, as LPAI, but which subsequently converted to HPAI in October, resulting in 90% mortality of infected birds in the area.) On April 11, 2003, the website of the Organization of International Epizootics (OIE) reported a diagnosis of LPAI in 4 million layer-hens in Connecticut. To date the infected hens have not been euthanized and are being closely monitored. Poultry can overcome LPAI infection, just as humans get well from the flu. The danger in letting LPAI fester is that it can convert to HPAI, as it did in Pennsylvania in 1983

(H5N2), in Italy in 1999 (H7N1), and recently in the Netherlands in February of 2003 (H7N7). To prevent huge poultry mortality losses, the farmers, industry, and state and federal veterinarians need to humanely euthanize all surrounding flocks within a three mile radius of the infected HPAI flocks by CO_2 poisoning.

On April 19, 2003, a 57 year-old Dutch veterinarian died from HPAI, and of the 66 workers involved in the Dutch AI eradication program, some have contracted conjunctivitis and others mild symptoms of the flu. To my knowledge this is the first reported human death from HPAI in Europe. To date, there have not been any deaths due to HPAI in United States. In China, in February of 2003, a death was attributed to the Hong Kong Avian Influenza (H5N1), which was the first reported case of death there since 18 people died from the virus in 1987.

The principal objectives of this paper are as follows:

1) The cost of all the seven listed disposal methods, which includes labor, transportation, and raw materials.

2) The environmental impact of the seven disposal methods on ground water and soil.

3) The public perception of all the seven disposal methods. The methods the public would most likely support in times of crises where entire flocks need to be disposed of. The odor emissions produced by the various disposal methods is a major decision factor in which disposal method the community is most receptive.

4) The complexity of the various diposal methods is also a major factor needed to be considered. The least complex disposal method is the most desirable choice, all other factors being equal

This paper will discuss the potential harmful effects of disposing of thousands of tons of carcasses via the least expensive methods of disposal, on-site burial, landfills and composting, for it is clear that no microbes can survive incineration, alkaline hydrolysis, "in-situ" plasma vitrification and rendering, due to the extreme heat generated in the course of each. In both incineration and "in-situ" plasma vitrification, there is a complete alteration in the physical matter of the carcass, from protein to ashes in the case of incineration, and from protein to an inert solid rock-like substance with in-situ plasma vitrification. In both rendering and alkaline hydrolysis, the carcasses are subjected to extreme heat and pressure, which not only deactivate all known pathogens and natural microflora, but also alter the bird's physical structure. The addition of NaOH in alkaline hydrolysis causes complete separation of the carcass protein in an amino acid soup-like material, which can be either sprayed as fertilizer or sent to a waste-water treatment facility. In rendering, the carcass is altered into dry, pelleted matter that can be re-utilized as an alternative feed for aquaculture or as fertilizer. These pellets can also be safely disposed of in a landfill, with no chance of disease transmission or environmental contamination.

Composting, on-site burial and landfills are natural forms of carcass destruction. In all cases, bacteria, fungi, insects and earthworms are involved in the natural decomposition. In such decomposition, the microbes can be classified as mesophiles, which can grow from 15°C to 43°C (59°F to 109°F). In composting, thermophilic bacteria dominate and grow from 25°C to 85°C (77°F to 185°F). Thus the rate at which all poultry pathogens are killed is much higher in composting than in either on-site burial or landfills, due to aerobic decomposition and the heat produced (140-160°F) from the right combination of carbon source (straw, poultry litter, etc.) and nitrogen source (poultry carcasses). Composting temperatures of 140-160°F will remain constant for months. Total decomposition of a carcass will occur within 6 months by composting, whereas it will take several years for total carcass decomposition to occur in either landfills or on-site burials. Landfills and on-site burials undergo anaerobic decomposition and decompose at significantly slower rates.

More studies need to be on conducted on the rate at which complete destruction of pathogens can occur in on-site burials and at landfills. Several studies of composting have demonstrated that all poultry pathogens are destroyed within 10 days, if not sooner. Also of concern in landfills and on-site burials is the effect of the leachate on the ground water supply. In today's landfills, this leachate can be disposed of through waste-water treatment, but such cannot be said for burials on site. Even then there is room for concern over ground-water contamination.

Chapter 2 - ON SITE BURIAL

On-site burial was the primary disposal method used during the 1984 Avian Influenza outbreak in Rockingham County. Eight-five percent of a total of 5700 tons of carcasses were disposed of in this manner; the remaining 15% went to the Rockingham County land fill. Other options were contemplated, including rendering, composting and incineration. At that time, the rendering plants feared that they would lose the poultry feed industry if they processed infected poultry. Composting was not used because the technology at the time was not well established. Incinerator boxes were not widely available as they are today, and open burning was not acceptable to the community. A small experimental open-pit burning occurred with 1,000 tons of carcasses at the landfill site, but the bad odor along with the difficulty of fueling the fire sufficiently to incinerate the birds caused the experiment to cease. The burned carcasses were then buried in the landfill. Landfills were generally not utilized because of the availability of on-site burial (disposal) in 1984 and landfills did not have clay and plastic liners with leachate collection. The Rockingham county landfill cells were not lined until 1998.

Burial of birds on site was the only widespread option available in 1984 to the poultry industry in the Shenandoah Valley. The outbreak ran from January to June. Various designs and burial methods were attempted. It was not until May of 1984 that burial methods became standardized. The width and depth of the pit were predetermined at 20 feet and 10 feet. The length was then calculated based on the tonnage of birds. It was determined that 800lbs of birds would take up 20 cubic feet.

Of great concern at the time was leachate from the carcasses contaminating the ground water supply. "The major factors determining the suitability of a waste disposal site [were] the soils, geology, and hydrology of the site. The distances to surface water, ground water, springs, wells, sinkholes, bedrock and rock outcrops [were] criteria for site selection." (From VA State Water Control Board (SCWB) On-Site Disposal Criteria For Poultry Waste, 26 January 1984 Memorandum). The burial pits were located a minimum of 500 ft from streams, springs, sinkholes, and wells. The set back from drainage ways and rock outcrops was 100 feet.

Through several designs during the first few months, an established model was set as described in Figure 1 and Figure 2. The depth of 10-feet into which depopulated carcasses were placed consisted of the following layers from the bottom to top. The disposal pit had to be 5 feet from the water table, and have at least 2 feet of clay. On top of this was placed 0.5 feet of gravel to serve as drainage for any leachate from the carcasses. The birds were then piled no more than 2 feet high with a layer of loose fill of around 3 feet. Then came 2.5 feet of compacted dirt, and then the ground was compacted by a bulldozer. The last layer consisted of compacted clay. A 3-foot wide ventilation strip of loose fill was put into place across the center length of the pit to relieve pressure from decaying carcasses. Good-quality clay was often not readily available and had to be transported to the burial site.

Figure 1 (cross section of on-site burial pit) (From 1984 AITF On-Site Disposal Memorandums)

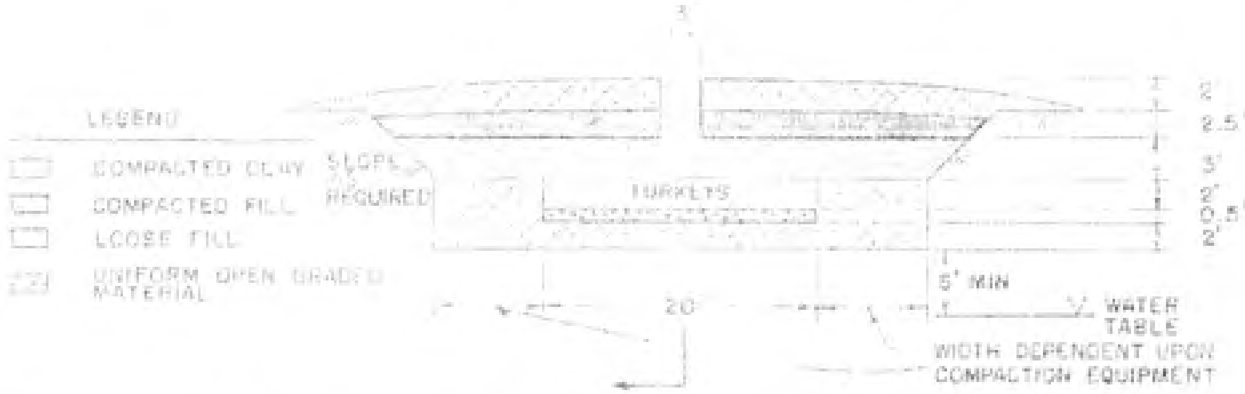
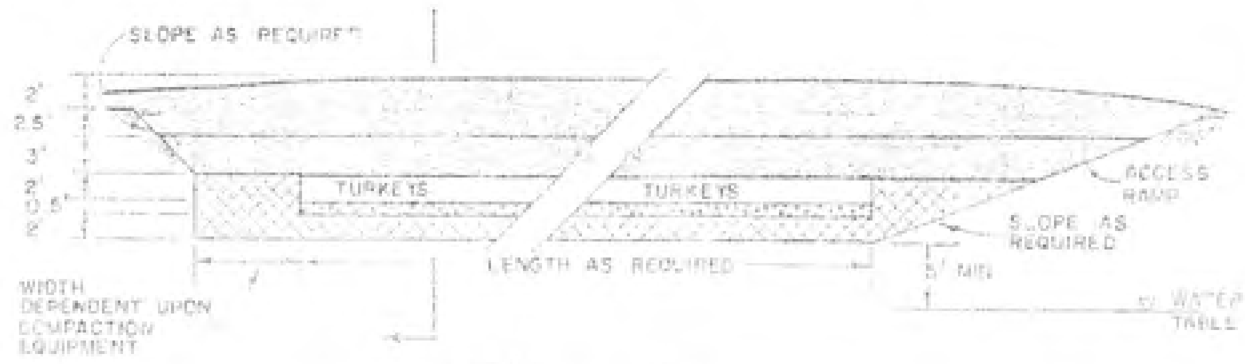


Figure 2 (longitudinal section of on-site burial pit) (From 1984 AITF On-Site Disposal Memorandums)



Initially, due to the concern over ground and surface water contamination, the Avian Influenza Task Force (AITF) recommendations were that the burial pits should be lined with plastic to prevent contamination. However, it was observed that because the leachate was both trapped and growing more than expected, it would tend to perculate to the surface. Plastic lining of the burial pit lining was therefore discontinued. "The plastic contained the carcasses to the point that [when heated as part of the decomposition process], gasses were produced, the burial structure broke down and burial liquids rose to the surface with settling on the surface" (written comments from Dr. W.W.Buish, AITF director in a letter written 23 April 84 to the Executive Director of the VA State Water Control Board).

Only 23 farms of the 57 on-site burials were lined with plastic. The pits were also not lined with quicklime because the VA State Dept of Agriculture, through a brochure, indicated that liming should not be used as the natural acidic conditions of decomposition will inactivate the virus. Quicklime has been used in the past to mask the odor of decomposing carcasses to retard their decomposition and to keep the flies away. The contaminants of concern to the ground water were nitrates and bacteria. However since nitrate production was an aerobic process, the AITF determined that buried birds would be enveloped in an anaerobic environment and that minimal nitratification would be produced from burial. To assure the residents that their well water was safe, the water was tested weekly. The following tests were routinely done to measure changes in well water, pH, total kieldahl nitrogen (TKN) and ammonia (NH_3).

Not all birds were able to be buried on site. The land of the infected farms was all surveyed prior to digging a burial pit. Only half of the farms had suitable burial sites. Thus half of the infected farms had their birds buried on infected farms whose land was certified as safe for burial. Had the outbreak been greater, the ATIF was issued a permit from the Bureau of Solid Waste Management to use a designated 3.35 acre site in the George Washington National Forest. Many people were against clearing land in the forest for a burial site. Fortunately, the outbreak was contained to 70 of the 600 farms in Rockingham County and extra burial sites were not needed.

The AITF selected ground-water pH measurement was the easiest and most reliable surrogate metric for ground-water pollution in the environment. Unlike surface waters, ground water does not move quickly and contamination will occur only from contaminated soil. If the pH was not within the 6.5 to 7.5 range, a water sample would then be sent to the lab for further testing. Ground water pH was measured at access points such as nearby wells. It was determined that the decomposition of poultry generates water soluble organic acids which have a pH less than 4. According to Mr. Ray Tesh from the VA Department of Environmental Quality (DEQ); the pH is expressed in a logarithmic manner and thus the effects of dilution are seen much more slowly than with parameters such as chemical oxygen demand (COD), total organic carbon (TOC), or ammonia.

From the 1984 DEQ AITF farm logs, at total of 15 farms wells were tested, of those, only 5 records were available for review. None of the farms ground-waters indicated any measurement of contamination from the burial sites. Air contamination from on-site burials or landfills was negligible.

Table 2 is an example of what tests were routinely conducted from the wells:

		normal range			normal range
PH (Laboratory)	7.4	6.5-7.5	Arsenic, Total W1		
Alkalinii /Acidity (mg/l asCaCo3)	259	25-200	Cadmium, Total Wl		
Total Solids, Total (m /1)	783		Calcium, Total, pil		
Volatile	121		Chromium, Total, W1		
Fixed	662		Copper, Total g1l		
Suspended Solids, Total (mg/1)	0.5		Iron, Total 1111		
Volatile	0.5		Lead, Total Wl		
Fixed	500	200-300	Magnesium, Total]1/./		
Dissolved Solids, Total (mg/1)			Manganese, Total dge		
Settleable Solids (mg/1)			Mercurv. Total U11		
Chloride (mgll)	21		Zinc, Total MA		
Hardness, EDTA (mg/l as CaC0-j)	504		Sodium Total u/l		
Nitrogen, Total Kieldahl (mg/1)	0.4		Potassium, Total MA		
Phosphorus, Total (mg/1)	0.1		Nickel. Total MA		
Phosphorus Ortho (mg/1)	0.02				
Ammonia (mqjl as N)	0.1		Total Coliform/100 ml - MF		
Nitrate (mg/l as N)	0.07	<10	Fecal Coliform/100 ml - MF		
Nitrite (mg/l as N)	0.01	<10	Total Coliform/100 ml - MPN	16	<5
Sulphate (mg/1)	318.2	<20	Fecal Col if orm/1 00 ml - MPN	2.2	0
Freon extractibles					
BOD5 (mg/ml)		x	Conductivity (micro - mhos/cm)	882	
COD (mg/ml)			Turbidity- NTU		
Total Organic Carbon (mg/1)	5	<5	Pesticides. to in water		
Fluoride (mg/1)	0.12		Herbicide Wl in water		

The cost for on-site burial disposal and landfill charges in 1984 were approximately $25/ton or approximately $142,000. The total cost of the LPAI outbreak in 1984 for the destruction of about 1.4 million birds was approximately $40 million dollars. Disposal costs account for less than 0.5% of the overall cost of the LPAI from 1984. The cost of the outbreak was mainly due to the loss of the poultry flocks.

Chapter 3 - LANDFILLS

Landfilling is the most popular waste disposal method of municipal solid wastes (MSW). It has also been around for the longest time and has evolved from on-site burial methods. The ancient Greeks began landfilling when they required citizens to take their trash outside the city gates and dispose of it. Landfills have since slowly evolved into a sophisticated engineering science. No longer is a big hole dug into the ground and filled with trash. Now they are lined on the bottom with clay, special plastic, or a combination of both. Since 1993, VA law required that all new landfill cells have leachate management systems built into them and gas management systems to handle the methane gas produced as the waste decays. (Virginia Waste Management Act, http://www.deq.state.va.us/waste/wastereg2000st.html, Chapter 10.1-1413.2). Every day, the garbage is crushed and covered by a layer of soil to keep out pests and to reduce bugs and odors. These facilities are regulated by state and federal laws and must meet certain criteria or face closure. It was not until 1997 that Rockingham County Landfill became a true sanitary landfill.

In 1984, the VA Department of Environmental Quality (DEQ), was divided into three unique agencies. It was not until 1993 that these three agencies, State Water Control Board (SWCB), the VA Air Pollution Control, and the Department of Waste Management (DWM) were combined to form the DEQ. The 1984 outbreak merged all three agencies together to work on the environmental impacts of carcass disposal.

On 29 March, 1984, water sampling was performed at the two domestic wells nearest the Rockingham County Landfill. According to a Memorandum written on 2 April, 1984, by the State Water Control Board (SWCB), to their knowledge, the water sampling from the

Rockingham County landfill was the first time an agency investigated a landfills impact on the surrounding ground and surface-waters. The site was in operation before the DWM-SWCB Memorandum of Understanding pertaining to landfill approvals went into effect. "No engineering plans or specifications are known to exist for this landfill." According to the memorandum, the site was not the most suitable for a landfill from the standpoint of impact upon state waters. The site was originally used as an unregulated dump. "Part of the landfill has been placed in two natural ravines that drain to Blacks Run. There [was little protection] for controlling surface runoff over or from the landfill. Numerous gullies have been cut over the recently filled area and there is some ponding. During periods of heavy precipitation, as observed on 29 March 1984, uncontrolled runoff left the landfill via two ravines which drain toward Blacks Run. [The SWCB] viewed the run off as a direct threat to surface water. [They also saw] evidence of leachate emanating from the site during low flow periods." The SWCB was also very concerned of the landfill's geologic formation which consisted of primarily limestone and dolomite with solution cavities. They determined the maximum depth of soil to be about 30 feet.

The first burial of AI-infected poultry in 1984 went into a recently constructed landfill trench where domestic waste was being disposed. A large outcrop of limestone was exposed in the trench which extended to within 250 feet of two domestic wells (#701 and #702) just outside the landfill property. The current law stated that all on-site burials be 300 feet away from wells and 500 feet away from surface waters. It was soon apparent to the AITF that the Rockingham Landfill did not meet the code of waste treatment. Wells numbered 701 and 702 were sampled. From then on, the SWCB observed the other 13 carcass pits that were dug at the landfill but strongly advised against further landfill burials and strongly urged the AITF to find better means of disposal. From that point on, accurate records were maintained at the Rockingham County landfill.

The lab results from well 701 and 702 showed no indication of ground water contamination. However heavy fecal coliform contamination was found on nearby surface waters (ponds). The 240-fold increase in fecal coliform measured at surface waters near the landfill on April 24, 1984 were likely due to the 655 tons of carcasses that were placed in the landfill.

This map of the Rockingham County landfill and table illustrate the locations and measurements performed during the 1984 AI outbreak.

Figure 3: 1984 Map of Rockingham Landfill

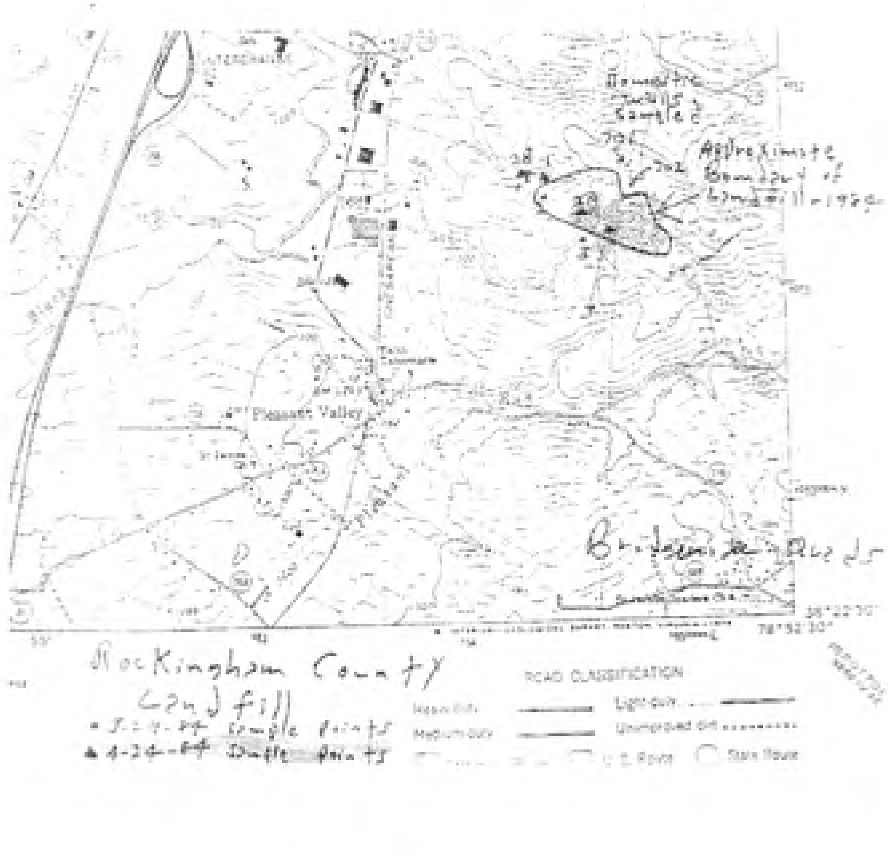


Table 3: Well and surface water sampling results at the landfill site

Rockingham County Landfill	Selected Parameters (mg/1)													Fecal
	pH	TDS	Cl	TKN	NH_3	NO_3	SO_4	COD	TOC	Fe	Na	K	Zn	Coliform
Surface Points Sampled -3-29-84														
1*	8.0	870	70	24	16.5	0.25	114.5	963	365	10.0	72	28.0	1.8	100-
[illegible]	5.6	465	15	90	55.0	0.75	[illegible]	1328	435	0.6	12	15.0	0.0	100-
3	8.9	791	59	11	9.5	0.50	90.2	556	215	11.0	58	22.0	1.0	Nor
*Drainage from sludge pond														
**Drainage from recent AI Burial														
														Fecal
Wells Sampled 3-29-84	pH	TDS	Cl	TKN	NH_3	NO_3	SO_4	COD	TOC	Fe	Na	K	Zn	Coliform
701	7.7	251	2	0	0.1-	1.20	1-	1-	1-	0.0	6	1.2	1.0	2.2-
702	7.7	245	1	0	0.1	0.26	1-	1-	1-	0.1	5	1.6	1.0	2.2-
Surface Points														Fecal
Sampled -4-24-84	pH	TDS	Cl	TKN	NH_3	NO_3	SO_4	COD	TOC	Fe	Na	K	Zn	Coliform
1	7.0	570	41	6	1.6	0.05-	1.0	316	115	6.6	33	9.5	0.6	24000
[illegible]	5.3	6730	440	125	--	0.08	700.0	8171	2720	157.0	410	175.0	13.8	24000
2B	5.6	1833	129	47	35.0	0.05-	81.0	2132	760	44.8	115	44.0	0.6	11000
3	7.0	4632	335	85	--	0.05-	90.0	3529	1320	126.0	300	130.0	3.6	3

In the United States, the most common route of poultry carcass disposal has been by either land fill or on-site burial. Landfilling is common and is often used in disposing of entire flocks of condemned poultry. In the 2002 AI VA outbreak, 85% of 16,900 tons of poultry carcasses went to landfills. In the 1984 AI VA outbreak only 15% of the 5700 tons of poultry carcasses went to the landfill since the risk of ground and surface water contamination was serious due to poorly constructed landfills which had no capacity for the carcass fluids contaminated with avian influenza virus, Salmonella and Campylobacter. Currently, in the outbreak Exotic New Castle Disease (ENCD) on the west coast affecting such states as California, Texas, Nevada and Arizona which started in September 2002, the USDA's primary method of disposal is by landfills. ENCD has not been fully eradicated and the danger of further flock infections is very serious.

Landfilling is an easy option but the rate of decomposition and destruction of bird pathogens requires tens of years. For good decomposition to occur, soil or a good carbon source such as hay used in composting is needed along with constant adequate moisture. The tightly compacted earth at the landfill can deprive aerobic bacteria of oxygen. The chemicals that are in landfills also might be toxic to the bacteria that are essential in carcass decomposition. More studies are needed to determine the effectiveness of carcass disposal in landfills. Also, the leachate that is collected at the landfill may contain viable pathogenic viruses and bacteria and therefore must be treated and disinfected completely.

When the outbreak avian influenza occurred in 2002, the VA DEQ contacted all landfills equipped with leachate collection facilities. There are currently about 70 active landfills in Virginia accepting Municipal Solid Waste, however not all of them meet the current definition of "sanitary landfills". Although improvements had been made greatly to the Rockingham County Landfill, due to its small size and to keep the odor from becoming a problem, it did not accept more that 3,400 tons of carcasses. The next closest landfill was about 40 miles in Page County and due to its small size it accepted no more than 951 tons of carcasses. Other surrounding counties which were closer and had larger landfills did not want to accept any infected carcasses because of their concern about spreading the disease to uninfected poultry farms nearby. Frederick County, VA, accepted the least tonnage because they were not sure the waste treatment plant on-site could not handle the leachate from the birds. These concerns were proven correct. Although it accepted only 842 tons of carcasses, the amount of ammonia produced from the carcasses threaten to overwhelm their waste water-treatment system which consisted simply of water holding ponds followed by release into surface waters. From April 16 to May 19 2002, Frederick County received approximately 42 truckloads of carcasses. The total amount of ammonia tripled from normal levels of 57 mg/l to 157 mg/ml and fecal coliform nearly doubled. To eliminate the possibility of contaminating the local surface water supply with leachate rich in ammonia and fecal matter, regulations were enacted to contain the pond water. The pond water's ammonia levels measured in March, 2003, are currently too high for release into the local surface waters. Frederick County landfill is the only landfill that is required to measure its leachate because it does not go directly into a waste-water treatment facility. Apparently, the waste-water treatment plants are large enough that the leachate need not be measured at the other landfills. Below are measurements made from the Frederick County leachate.

Table 4: Frederick County Landfill Leachate Measurements

			mg/l	mg/l			N/CML
	pH	**TSS**	**TKN**	**NH_3**	**BOD**	**COD**	**Fecal Coliform**
Apr-02	7.4	83	286	174	135	624	>1601
Jun-02	7	136	182	158	101	456	>1602
Jul-02	7	95	178	157	295	711	>1603
Oct-02	7.3	384	457	414	360	1212	>1604
Mar-03			65	57			895

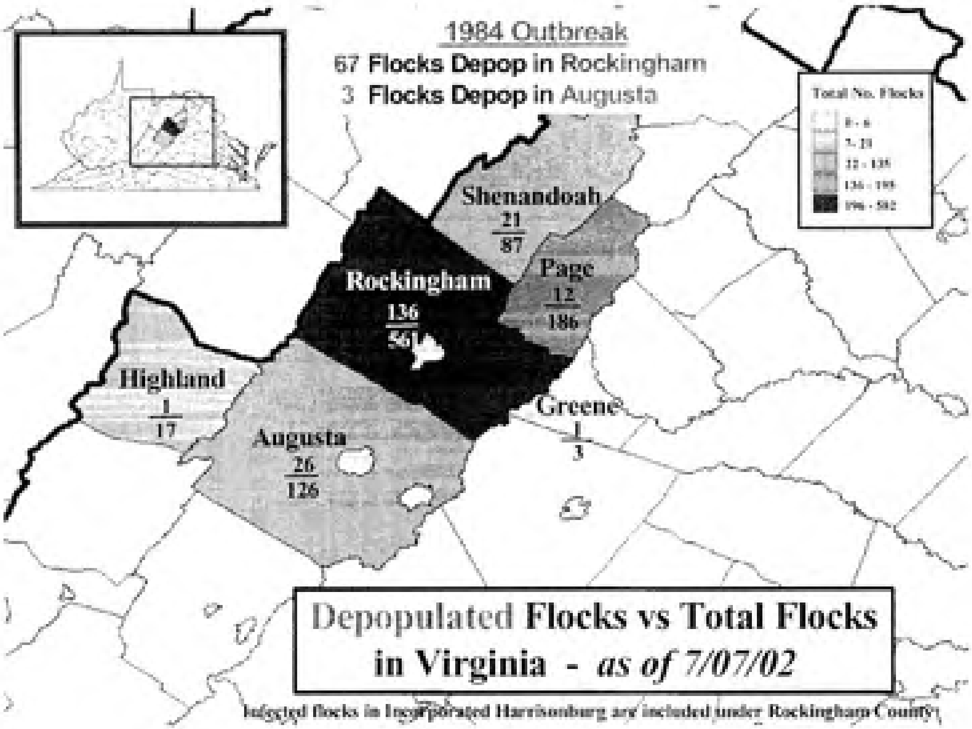
Due to the lack of local landfill space, the remaining 64% of total carcass tonnage was then shipped at great distances, over 160 miles, to two very large landfill sites, in Charles City and Sussex County. Although Charles City received only 4,610 tons and Sussex County received slightly more at 4,625 tons, both landfill sites were prepared to receive up to 10,000 tons. The AITF had at least 60 days, if the outbreak were to continue at a disposal rate of 188 tons of carcasses per day to look for other additional landsites further away. Almost 1 million dollars was paid for the use of both landfill sites, and had the outbreak lasted 60 more days, it would have cost another million dollars. The major cost was not due to landfill expenses which charged $45/ton, about the same as in Rockingham County but was due to 16 times the distance needed to travel to the landfill one way. The most a truck could hope to do in a day was 2 loads. Each truck traveled, on average, 4 hours back and forth from the infected poultry farm to either the Sussex County or Charles City landfills. This was extremely time consuming. An average of 10 trucks a day were on the road hauling 20 tons of carcasses. There was no more than 14 trucks readily available. The trucks had to meet special requirements to haul carcasses. They needed to have a special rubber seal on the rear latches that was leak proof and a hood that could be tightly sealed on top to prevent from feathers and debris from the carcasses from aerolizing which can easily occur when a vehicle is moving at 65 miles an hour down a major highway.

To try and curb the risk of transmission from the trucks, the carcasses were loaded initially into the truck beds in a large bag that was sealed with duct tape. The truck beds were also lined with saw dust to absorb any carcass juices that had leaked through any tears in the plastic. The bag was then dumped into small box-like cells of various dimensions dug out of the trash. The cell sites that were selected for disposal of the carcasses were far removed from the landfill's daily operations. Trenches were dug into old existing trash sites. Usually a 6-foot deep by 4-foot wide trench was dug, then filled with carcasses to a depth of 4 feet with the existing garbage used to refill the trench. A cover of compacted soil was placed on top.

Landfills were limited. Had the outbreak spread to more farms within Rockingham or the surrounding counties, better methods of carcass disposal would have been needed. Only 69% of the 197 depopulated flocks were from Rockingham County. Overall, the county lost 24% of its

561 poultry farms due to Avian Influenza. The remaining five counties hit by the outbreak, Augusta, Shenandoah, Page, Highland, and Green suffered poultry losses much less in comparison. Bellow is a map showing the extent of both the 1984 and 2002 outbreaks.

Figure 4: Map of 2002 and 1984 AI Outbreaks in VA



However, in about a year's time, there would have been enough new garbage and top soil layers covering the garbage, that the same landfills could be used if a similar outbreak of the same magnitude of the 2002 outbreak were to occur. The limiting factor is the size of a particular outbreak. In both AI outbreaks, the AITF were able to successfully stop the outbreaks from spreading and infecting further flocks.

Chapter 4 INCINERATION

Incineration or the burning of municipal solid wastes is an old concept. Open-pit burnings of trash in holes in the ground is routinely done in third world countries especially of medical wastes. However in addition to costs of transportation and digging a hole, fuel to burn carcasses is expensive and not always available on site. The cheapest fuel is often used, such as unwanted pieces of forest wood or commercial wood which is no longer of re-sale value, very low british thermal unit (BTU) value due to higher moisture content.

Carcasses have combustibility of 1000 BTU/lb. The very low combustibility of carcasses is due to their 70% moisture content. There are five combustible classifications of waste. On a scale of 0 to 4, 0 (< 10% moisture such as very dry wood or paper) is the best and 4 (> 70% moisture such as carcasses) is the worst (http://www.cmtsproduct.com/Products/FAQ.asp; How to Choose an Incinerator). The greater the percentage of animal fat, the more efficient a carcass will burn. Ruminants and swine have more body fat than poultry. Animal fat has a BTU value of 17,000 BTU/lb and is considered an excellent fuel source. For example, rendering can abstract animal fats and re-sell them as excellent grade-two fuel. Therefore, some animals will burn more efficiently than others based on their fat content.

Incineration was attempted at the Rockingham County landfill as a pilot project. However, the heat generated by fire wood at the trash site did not incinerate carcasses at a decent controllable rate. Freshly cut wood or wet wood has a 20% moisture content, which lowers its BTU value of 8500 to 6500 BTU/lb. Thus open-pit burning requires the addition of gasoline which has a BTU value of roughly 18,000 BTU/lb. to heat the wood enough where it can evaporate its moisture and burn efficiently.

At the beginning of the 2002 AI outbreak, on-site burial was attempted, but farmers were denied a burial permit from the state, unless the farmer would agree to record these events into the property deed. Earlier in 2002, this state law was quickly passed as a result of construction of a new school on land where carcasses had been buried in 1984. Eighteen years later, to the shock of the community, it was discovered that very little decomposition had occurred to the birds as they had mummified. The 18 year-old poultry carcasses were tested for AI and results were negative. No farmer wanted to devalue his land with burial sites listed on their deed and they no longer wanted to bury the carcasses as they so readily did quickly in 1984. This turn of events was not expected by the AITF who were in favor of burial to eradicate the disease.

Landfills were still under negotiation and could not be used when the outbreak first occurred. Desperately seeking another alternative to burial, a company that specializes in the clearing of woods for land development was called upon to dispose of the birds with their open-flame incinerator boxes. These same boxes were effectively used to dispose of thousands of dead pigs that drowned when Hurricane Fran completely submerged hog farms along the east coast. The next day, 4 incinerators where promptly delivered to a chosen incineration site, an active rock quarry, that was determined to be far enough away from residential areas so that the stench of burning carcasses would be minimal.

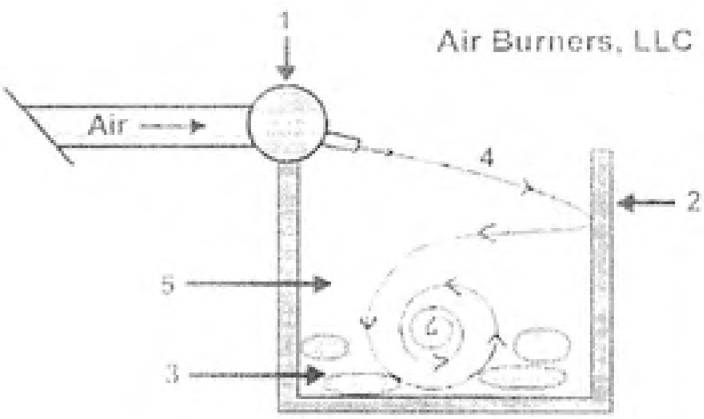
The incinerator boxes used wood as a fuel source and gasoline was also used at the outset to get the wood to burn. Initially, poor grade wood from the Rockingham County landfill was transported to the quarry. After a few days, there was sufficient amount of wood to begin burning the carcasses. In the mean time, several tons of carcasses had accumulated on site to be burned and liquid from the carcasses leached out and contaminated a small pond located at the quarry. The pond was then quickly sterilized with a thousand pounds of chlorine to ensure total destruction of the AI virus. "It has been shown that the virus when shed into water, it remains viable for days or weeks depending on water temperature" (Webster, R.G., et. Al., 1977. Influenza Viruses from Avian and Porcine Sources and their Possible Role in the Origin of Human Pandemic Strains. Dev. Biol. Stand. 39: 461-468).

AI has been documented to survive up to 6 months in cold water. The pond was spring fed and the water extremely cold. The concern of dosing the water with chlorine was the total destruction of plant life, which would normally serve to oxygenate the water. The water could not be released into the local streams without sufficient oxygen levels. Many aerators were brought in to pump the water to safe oxygen levels. This was an unexpected event and clean up was costly.

After burning several tons of carcasses at an extremely slow rate, it was quickly determined that wood from the landfill was not a good fuel source due to its high moisture content. The boxes are specially designed with electric fans to blow air onto wood to make the wood burn faster and also smokeless. The diagram below illustrates how the fans oxygenate the wood. However, due to the high content of moisture, the birds created a terrible stench that could be smelled miles away. People living nearby had to be moved into hotels.

Diagram 1: Picture from www.airburners.com website. "Continued air flow over-oxygenates the fire keeping temperatures high. Higher temperatures provide a cleaner and more complete burn."

Figure 5: Diagram of box incinerator



It was determined by trial and error that the best method of burning the carcasses was by layering the birds on top of wood pallets. This allowed sufficient air circulation to burn the birds efficiently. Thus, a combination of forest wood and pallets were used. The only draw back in using pallets was the nails that remained in the ash. The nails were required to be removed by a power screener when the ash was to be re-applied to land as a rich source of nutrients.

An average of 76 tons of birds were burned per day at the quarry for 29 days. A total of 2,268 tons of birds was incinerated in 29 days from 23 April to 11 May 2002. The total tonnage of wood burnt was 3023 tons. Total cost of the wood was $317,616.16 ($105/ton), including transportation costs. The total cost of transport of the carcasses from the farms to the quarry was estimated to be $ 267,908. One truck load weighs 20 tons, and a total of 113 trucks loads were needed to transport 2268 tons of poultry carcasses a distance on average of 15 miles and a cost of $2.5 /mile. Trucks normally rent at $45/hour and worked an average of 1.5 hours. The rental costs of four incinerators, along with the cost of labor to maintain the fires, to place carcasses into the fire boxes, and then to remove the ashes was $810,389. The rental of the power screener and its operation for several weeks of screening ash cost an additional $75,283. A total of 4080 tons of strained ash was then removed as fertilizer to nearby farms at a cost of $173,466. Thus it approximately cost $477 to burn one ton of carcasses. Based on the figures, it takes 1.35 tons of wood to incinerate 1 ton of carcasses. Due to the high costs of incineration and community complaints from the stench, incineration was terminated.

In order for incineration of carcasses to be practical and efficient, a better fuel source needs to be used with a higher BTU, such as propane which can incinerate carcasses at a faster right as well as not contribute to the formation of added ash weight. The ratio of carcasses to propane is 3.1 to 1. Thus 1 ton of propane could incinerate 3 tons of carcasses (www.ces.ncsu.edu/depts/poulsci/techinfo/4Fact25.html, A Cost Comparison and Incineration as Methods for Mortality Disposal, Poultry Science Facts). Clearly, more ash was generated in burning wood and will add to the extra cost of its removal. Although pallets seem to make the burning of carcasses more efficient, a power strainer will need to be used to remove all of the nails.

Chapter 5 – Composting

Composting is a year-round on-farm carcass management option that greatly reduces weather-related complications. Composting can be managed successfully on nearly any scale as long as the basic needs of the microbes—moisture, food, oxygen, and temperature—are maintained. In the United States, the composting of entire flocks has been undertaken, for a limited few flock disease outbreaks, but landfills are still much more widely utilized.

In 1984, during the time of the first AI outbreak in Rockingham County, composting was mainly used to control small losses of animals on individual farms. The technology is still evolving, and has not been used as a means of disposal in the U.S. during major disease depopulations. Since then, however, composting has become increasingly efficacious, and has grown fashionable as an alternate source of garbage disposal.

Recent research indicates that composting has widespread agricultural benefits, above and beyond waste disposal. Compost-enriched soil can suppress plant diseases that attack root systems, and ward off pests such as specific types of nematodes (http://www.epa.gov/epaoswer/non-hw/compost/disease.pdf., Innovative Uses of Compost Disease Control for Plants and Animals, EPA530-F-97-044, October 1997).

In controlled studies, compost administered on fields has shown to increase crop yields. Thus, the beneficial uses of compost can help growers save money, reduce their use of pesticides, and conserve natural resources.

In 2002, in response to the AI outbreak in Rockingham County, the AITF had several proven designs for in-house composting of entire depopulated flocks. One mortality study, undertaken by the Maryland Agriculture Extension Service, demonstrated that in-house composting would successfully dispose of birds infected with AI. However, when the AITF approached the poultry industry and farmers, there was scant interest in this method of disposal. Most were reluctant to tie up their poultry houses with compost, which demands several months of curing, and then only further entails applying it to the land in order to reap its wide benefits. Having suffered sudden massive losses due to the outbreak and depopulation, commercial poultry operations wanted simply to decontaminate their houses as soon as possible. Even though raising new flocks is what poultry farmers do best, there was surprisingly little regard given to a method that offered the prospect of offsetting their flock losses. Nevertheless, in the initial phases of the outbreak, one farmer did agree to compost his 50 tons of diseased turkeys in house. Due to neglect and mismanagement, however, the lone farmer's compost pile completely dried out within a month.

Perceiving that the industry's negative perception of composting was tied to the in-house method, the AITF investigated other forms of composting, particularly one that could be used outdoors with minimal impact upon on-going operations. The AITF located a company whose product, the Ag-Bag (www.ag-bag.com) (1), can compost 50 tons of carcasses inside a huge plastic bag that is essentially sealed except for a few vent holes. Composting is an aerobic process, and requires a constant supply of oxygen to maintain high temperatures. The Ag-Bag is fitted with plastic pipes that run along the inside of the apparatus into which air is forced every few minutes by a timed electric fan. When this technology was introduced to the farmers and poultry industry, again, few embraced it. They were concerned about the stigma that might attach to having diseased carcasses in close proximity to their million-dollar poultry operations. There were two takers, however: the turkey farmer who had previously failed at in-house composting agreed to remove his dried up compost to the Ag-Bag; and a Mennonite egg-layer farmer, who had suffered chicken losses of 25 tons. Given a second chance, the turkey farmer learned the lesson of moisture in composting.

"Moisture is the most critical factor in composting. Bacteria need water to help dissolve organic matter and transport vital nutrients through their cell walls." (Tom Glanville, "Composting saves time, money, and nutrients.") "Moisture determines whether the process will be 'aerobic' (with oxygen) or 'anaerobic' (without oxygen). For animal carcass disposal, aerobic composting is preferred because it is faster and produces less odors. Ideal moisture content for aerobic composting is about 40 - 50 percent. When the moisture content reaches 65 percent, the process begins to go anaerobic." (http://www.ecochem.com/t_acdisposal.html, article: Composting - An Effective Option for Animal Carcass Disposal.) Moisture content below 35 percent starves composting bacteria because their food source literally dries up.

Subsequent tests of both the turkey and egg-layer composts revealed important information. (See Table 1) First, early tests for any lingering incidence of AI were negative. Samples were taken one year later to measure the nutrient levels in the respective composts. After harvest of the material from the Pods, further tests will be run to track any changes to the nutrients and compost. The moisture content of both composts exceeded 65%, which is higher than recommended and could have been helped by adding additional shavings to the mix. Once the Ag-Bags were opened, additional effort would be required to finish the curing process. Had the AITF more experience with composting, or had they hired an experienced composter, the compost would have been of better quality. Both composts should have been better monitored for their moisture content. Only the temperature was tracked and monitored. In order for composting to work effectively, temperatures must be maintained between 120-140°F. Bacteria begin to die when temperatures increase above 160°F.

Table 5: Results of Compost testing collected on March 2003

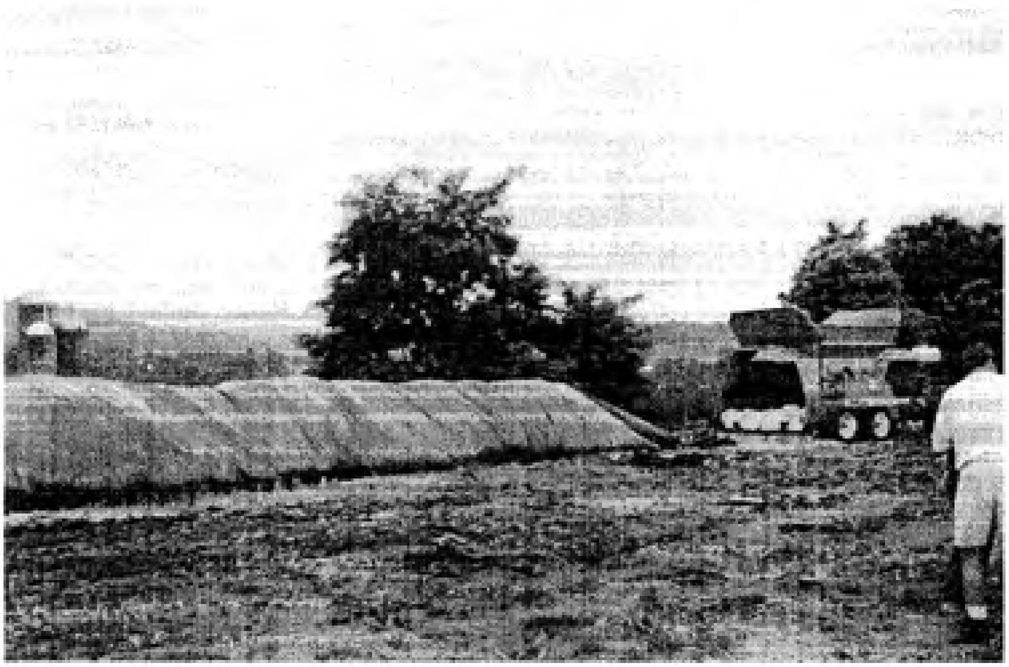
	Chicken		**lbs/ton**	**Tukey**		**lbs/ton**
Ammonium Nitrogen	1.06	%	21.20	1.06	%	21.20
Total Nitrogen	1.99	%	3,968	1.99	%	3,968
Available Nitrogen			30.29			30.29
Available Surface Nitrogen			21.81			21.81
Phosphorus as P20S	1.99	%	39.82	1.01	%	36.14
Potassium as x2o	1.01	%	20.29	0.51	%	10.13
Calcium	1.45	%	29.12	146	%	29.15
magnesium	0.29	%	6	0.20	%	4.00
Sulfur	0.24	%	4.79	0.12	%	2.48
zinc	283.86	ppm	D.57	200.16	ppm	0.40
Copper	259.89	ppm	0.52	116.80	ppm	0.23
Manganese	349.29	ppm	0.70	220.17	ppm	0.44
Sodium	1542.16	ppm	3.08	987.49	ppm	1.97
Aluminum	471.56	ppm	3.94	1882.97	Ppm	3.77
Moisture	69.28	%		65.54	%	

Another important factor neglected in both turkey and the egg-layer composts was the proper mix of carbon and nitrogen, for the bacteria need a balanced diet of both. "The carbon/nitrogen ratio (C:N) directly affects the composting process. C:N ratios of 15:1 to 30:1 are acceptable. If the C:N ratio is less than 25:1, the microorganisms cannot metabolize all of the available nitrogen and it is lost as ammonia. This may result in unpleasant odors, and loss of fertilizer value. When the C:N ratio exceeds 30:1, the composting process slows down." (Composting - An Effective Option for Animal Carcass Disposal, internet source) Improper ratios are most often attributable to uneven mixing of poultry and litter, and in both cases of turkey and egg-layer composts, there are reasons for believing that the compost components were loaded into their Ag-Bags in a non-uniform manner. Using a mixer would produce a more uniform product going into the Ag-Bag. At the turkey farm, the dried, transplanted in-house compost constituted an unknown mix. At the egg-layer facility, the only equipment available on site was one front-end loader. The euthanized birds were piled on the ground on top of a layer of litter, with a subsequent layer of litter covering the poultry pile. The front loader then scooped up all three layers and dumped them into the Ag-Bag machine, which slowly filled the 200-foot bag.

The cost of composting was calculated to be approximately $60.00 per ton. The way to success in composting is for an outside agency, specializing in the compost process be utilized to monitor the moisture, temperature, carbon and nitrogen contents on a continual basis. As the tended compost matures, it will yield a valuable by-product to offset the cost. Other important advantages to proper composting is that it is biosecure, requires no transport of shedding carcasses, and it can be undertaken without local government approval or state permits.

Keeping in mind that the poultry industry elected quick removal of the infected carcasses from their property, composting also offers a middle-ground disposal option. While in-house composting yields its valuable by-product only after a considerable period of time, the AITF has shown that it does destroy the AI virus in a relatively short time, perhaps within two weeks. Thereafter, the compost can be safely transported to another site for further composting, or for burial, or for land application.

Figure 6: Photo of the "pod" or Ag-Bag



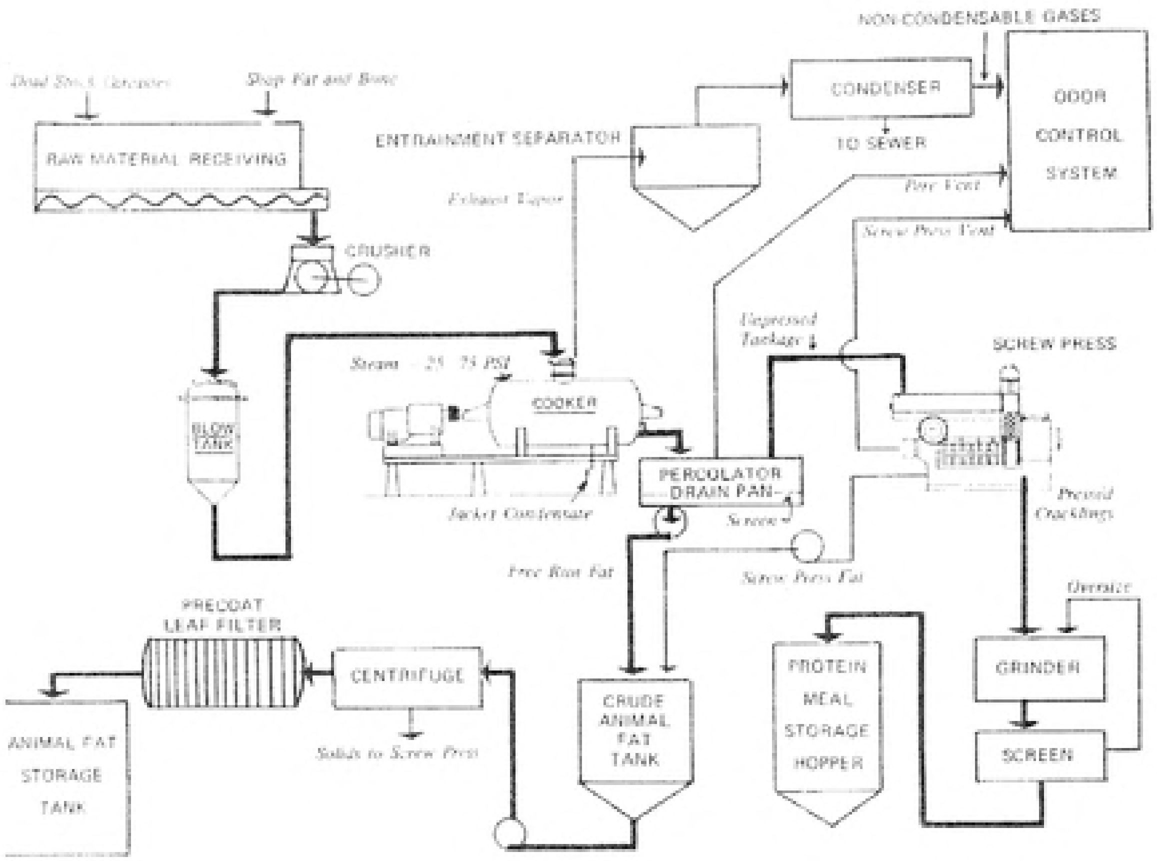
Chapter 6 – Rendering

Rendering is another form of recycling. Rendering plants "recycle dead animals, slaughterhouses waste, and supermarket and restaurant rejects into various products known as recycled meat, bone meal, and animal fat. These products are used as a source of protein and other nutrients in the diets of dairy animals, poultry, swine, pet foods, cattle feed, and sheep feed. Animal fat is also mixed in animal feeds as an energy source. A 1991 USDA report states that rendering plants produced approximately 7.9 billion pounds of meat, bone meal, blood meal, and feather meal in 1983. Of that amount, 34 percent was used in pet food, 34 percent in poultry feed, 20 percent in pig food, and the rest (12 percent) in dairy and beef cattle feed." (Pravin K. Shah, http://www.jaina.org/education_material, Recycling of Slaughterhouses Waste). Rendering plants also have in place systems to recycle the air and water wastes generated from rendering their products and very little odor is emitted from the plants processes.

The plants are equipped with devices to crush whole carcasses into 2 inch cubed pieces which allows for efficient cooking. Infected tissues are steam cooked between 250 to 275 degrees Fahrenheit (121-132 Celsius) for 90 to 120 minutes. This temperature range has been scientifically proven to sufficiently kill most infectious microorganism agents such as Salmonella and Campylobacter, common natural flora of poultry. This temperature will easily destroy less hardier microbes such as Avian Influenza and New Castle Viruses. Avian influenza is destroyed at 133°F in 30 min. Prions are the only infectious agents that the rendering process cannot inactivate adequately. Prions are not an infectious microbe, but a faulty protein which are the responsible agents of "Mad Cow Disease" or "Bovine Spongiform Encephalopathy" (BSE).

"Health authorities consider it to be the most likely cause of a new variant of Creutzfeldt-Jakob disease, a fatal brain disease that recently killed several young people in Britain." (http://www.pcrm.org/health/Preventive_Medicine/mad_cow_disease.html, Mad Cow Disease and the risk of Infection to US). Prions reside in nervous tissue and are especially concentrated in the brain. Since its discovery, the USDA has prohibited U.S. plants from rendering neural tissues such as brains. As an additional precaution, ruminant rendered by products are not fed to other ruminants. BSE disease is believed to have risen from rendering scrapie-infected nerve tissues and then feeding the rendered by-product to cattle.

Figure 7: A flow chart describing the rendering process from raw to final product. (Don A. Franco and Winfield Swanson, The Original Recyclers, 1996).



In 1984, the rendering plant in the Shenandoah Valley,VA, did not want to render infected carcasses for concern of the vpoultry industry not purchasing rendered animal proteins from its plants. In 2002, the new President of the same rendering plant approached the AITF and offered its rendering services to help in the disposal of carcasses by rendering them. The AITF elected not to render and chose to landfill the majority of the carcasses. At the time, the AITF were not familiar with rendering methods and believed it might be costly since they were at the mercy of the plant owner charges. Maintaining acceptable biosecurity at the rendering plant was also an AITF concern. Rendering plants are busy facilities. There is a constant flux of large trucks moving in and out of the plant coming from various types of farms. Plants dispose of recently dead swine, domestic ruminants and poultry that is not fit for human consumption, but edible when processed as good rich proteinacious feed to dogs, cats, birds and domestic ruminants. The feed is completely sterile. However, there is a danger of feed becoming re-infected with Salmonella during the cooling down phase of the feed after it leaves the cookers. Flies have been known to seed the feed with Salmonella, despite the plants measures from keeping the pests out.

For many years, rendering of infected carcasses has now been an on going process in Europe. On Friday March 16, 2001, a rendering plant was opened in Widnes, Cheshire, England to assist with the destruction of livestock during the Foot and Mouth disease outbreak. Its sole purpose was to boil down carcasses 24 hours a day, seven days a week. (Paul Brown, http://www.guardian.co.uk/footandmouth/story/0,7369,457597,00.html
Slaughter policy brings fresh problems, Special report: Foot and mouth disease). The dead animals were chopped and subsequently boiled, leaving bone meal and tallow - a form of hard

fat. Even though heat inactivates the virus, the animal feed (rendered carcasses) was burned at local incinerators. This is an excellent example of the tremendous capabilities rendering plants have to dispose of catastrophic amounts of animal carcasses in an efficient, sterile manner.

When Germany was diagnosed with Classical Swine Fever (CSF) on 17 October, 2001, they rendered 2054 animals of 651 confirmed cases in order to control and eradicate the outbreak. The majority of the pigs were disposed of at rendering plants.
(http://www.oie.int/eng/info/hebdo/AIS_22.HTM, Classical Swine Fever in Germany)

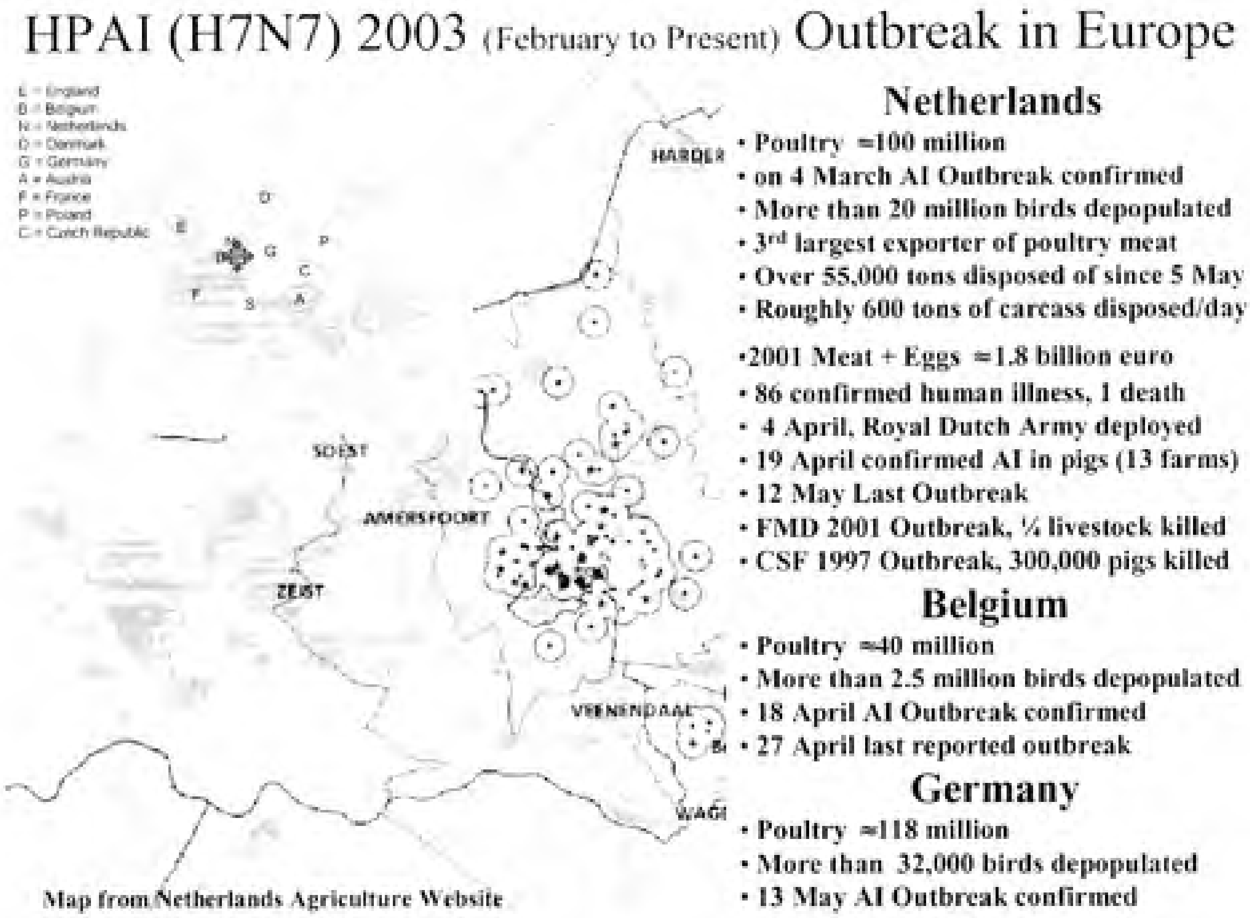
In May 23, 1997, the Netherlands also used rendering as an option to dispose of infected pig carcasses with CSF. (ProMed website, CSF - Europe: Update (05)
May 23, 1997).

Currently, the Netherlands, Belgium, and Germany are dealing with an outbreak of high pathogenic avian influenza (HPAI). The outbreak first began in the Netherlands in April and within a month, spread to Belgium and as of 13th May, 2003, spread to Germany (http://news.bbc.co.uk/2/hi/europe/3024509.stm, Germany has confirmed that it has uncovered its first case of the highly contagious bird flu that has ravaged farms in Belgium and the Netherlands, 13 May, 2003). As of 8 May, 2003, over 25 million birds have been euthanized in Europe. The Netherlands have euthanized over 20 million birds, which is roughly 20% of their country's poultry. As of 30 April 2003, more than 54,000 tons of poultry and 6000 tons of eggs have been processed. Forty-six thousand tons have been processed within the rendering plant. The end-products of this rendering process are incinerated at an energy plant and not as used feed products. Due to the concerns of BSE, the Europeans do not want to feed previously virus-infected carcasses to other animals, even if the AI virus has been deactivated. One thousand tons have been sent to an incineration plant directly, and 5,500 tons were stored in cold storage for eventual rendering. In addition 1,500 tons have been transported to a landfill site.

In the Netherlands, the poultry carcasses are being rendered at a temperature of 133°C (271°F)for 20 minutes. All high risk or specific risk material is processed into meat-and-bone meal (MBM) and tallow. The MBM and tallow is then incinerated at energy (incineration) plants. Rendering plant capacity is not sufficient to maintain the demand. Therefore, Dutch are using additional methods. The non-infected farms have killed their poultry and stored them in freezing rooms until there is sufficient rendering capacity. The freezers can store the carcasses up to one year. Carcasses from non-infected farms are being directly incinerated at local house hold garbage-incineration plants. Some of the carcasses have also been transported to landfills at enclosed in bags which can hold approximately 1000 kg.

In the Netherlands there are two rendering plants, one in Son (Noord-Brabant) and one in Bergum (Friesland). The total capacity of Son is 8,500 tons of high risk or specific risk material processed per week. The total capacity of Bergum is 600 tons of high risk or specific risk material and 5,900 tons of low risk material processed each week. To keep up with the demand of rendering infected carcasses, the Dutch have considered enlarging the capacity of the two rendering plants by expanding the amount of workable hours from 108 hours each week to 143 hours each week and by sending low risk material to rendering plants in foreign countries.

Figure 8: Map of 2003 AI Outbreak in Europe



During the 2002 outbreak of AI in VA, two rendering plants were located nearby in which the AITF could have used the Linville Plant, located in Rockingham County. This plant has 2 cookers. One of these cookers could have been used and solely dedicated for the purpose of infected carcass disposal without disrupting the plant's operations. The capacity of the cooker is 7.5 tons per hour or 1.8 million pounds on a 120 hour workweek. The Winchester Plant, in Frederick County, is 75 miles away from the major poultry operations in Rockingham County. The capacity of the cooker at the Frederick County plant is 20 tons per hour or 4.8 million pounds on a 120 hour workweek. Had the USDA contracted out the rendering plant Winchester Plant in Frederick County, then all remaining normal processing of products would have been transported to other rendering plants. This would allow the USDA complete control and monitoring of the Franklin County Plant to insure 100% biosecurity within minimal movement. The plant owner has agreed to accept the infected carcasses at a fee of $80/ton. If the total tonnage of the 2002 outbreak had been processed at the Frederick County Winchester rendering plant, the total cost to the USDA, with all other operations temporary suspended at the plant and displaced else where, would have been $ 2,820,206. This also included the cost of disposal of the animal feed to the local landfill site. The total weight of the animal feed to be disposed of from the initial total weight of 16,920 tons would have been approximately 5,640 tons due to the reduction in weight from the elimination of all the water from the carcasses. An average bird weight is 70% water.

The rendered poultry feed, instead of being placed into a landfill, could be alternately used for fuel at a local coal burning electric plant or cement plant. The BTU value of the animal feed is roughly 8500, which is higher than wood and slightly lower than anthracite coal (13500 BTU). Currently plants in Europe are utilizing animal feed as a fuel source at various cement plants. By combining the animal feed with coal. On average, it takes 2 kg of animal feed to burn at the same rate of 1 kg of coal. Should the animal feed from the rendering plant be used as a fuel source, the USDA would then save the additional cost of paying the landfill for disposing the feed. The total adjusted cost of the rendered product would only be $ 1,565,006. If the USDA were to allow the plant to resale the poultry feed as an alternative feed source to local trout farms , the total cost to the USDA would be approximately $ 662,606.

There is also a proposal submitted to the USDA by a privately owned company to construct mobile rendering plants based on its proprietary technologies. The proposal suggests 16.5 tons an hour at 212°F of processing. It is estimated that the energy costs of such a boiler would be $450 per hour. The private company is willing to proceed with the development of the project if it can be funded for 2 million dollars. Such a mobile plant would be ideal as it would eliminate the risk of biosecurity that is involved with transportation of the dead animals. The USDA needs to further explore the usage of both fixed and mobile rendering plants.

Chapter 7 – ALKALINE HYDROLYSIS

Although the concept of Alkaline Hydrolysis is not new, the machines recently designed are new forms of technology to aid in the safe removal of highly infectious material ranging from birds infected with avian influenza to cows infected with bovine spongiform encephalopathy (BSE). The company that markets these machines is Waste Reduction by Waste Reduction, Inc., or ***WR²***. They are based in Europe and in the US. The recent purchase of the machines by state and federal agencies demonstrates an acknowledgement that the threat of animal disease outbreaks is real and that a plan needs to be implemented where there is equipment and technology available to contain, control and eliminate out an outbreak.

The term alkaline hydrolysis refers to the process of thermally sterilizing under pressure and using an alkali solution (KOH, NaOH) to dissolve animal carcasses into an amino acid/peptide solution. The only solid remaining structure of the carcass is bone "shadows", composed of calcium phosphate that no longer contain collagen and can be easily crushed by hand to form powder. Various animal labs across the nation have these machines to dispose of their infectious and non-infectious carcasses.

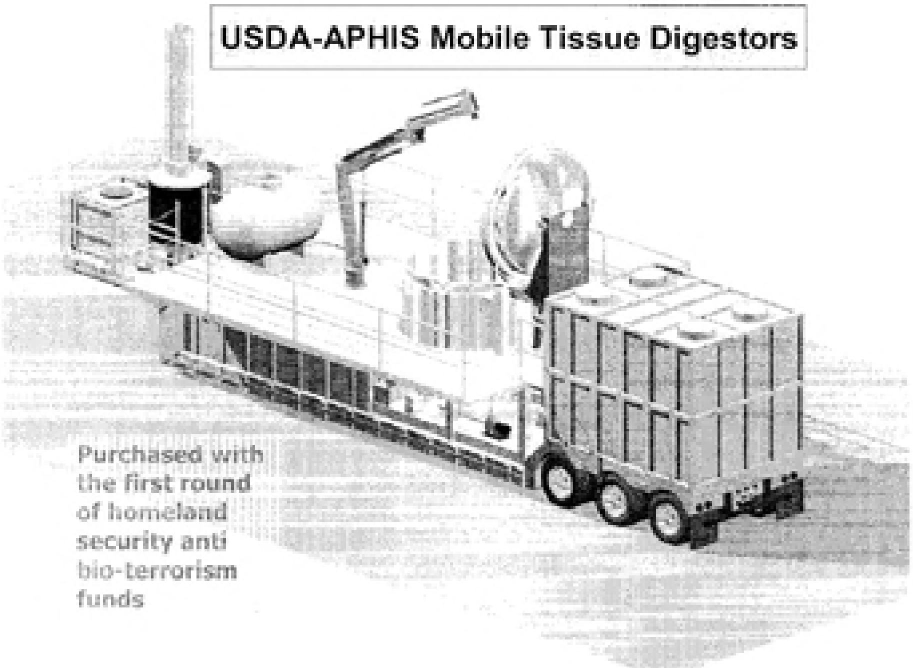
Recently, ***WR²*** develped a mobile unit designed especially for the USDA known as the USDA Mobile Tissue Digestor (MTD). This year, the USDA has made two purchases, one digestor to deal with the Chronic Wasting Disease problem in deer in Wisconsin and another other to deal with outbreaks of disease along the West Coast, such as the Exotic New Casthle Disease, whic currently affects Texas, Nevada, Arizona, and California, representing a significant threat to neighboring states. More purchases are expected as their MTD product proves its worth, ease of use, cost, efficiency and reliability.

The MTD has the capacity to process 2 tons of cattle carcasses in 3 hours and the same amount of poultry carcasses in less than 3 hours. The necessary ingredients to process the tissue are 2 tons of water and 560 lbs of dry chemical, if KOH is used, or 400 lbs of NaOH (24% by weight of 45% solution of KOH; 20% by weight of 50% solution of NaOH). The energy required per cycle is 10,199,000 BTUs, utilizing 78 gallons of oil costing $141. It also requires 115 KWhrs of electricity at a cost of $7. The total cost of water and sewage disposal will be less than 3 dollars. However, the amino acid rich solution need not be wasted and could be land applied as a fertilizer once the pH of the solution is lowered. Note, however, that the 3 hour processing time was derived from digestions of bovine, porcine, and ovine carcasses. Studies conducted in the UK with poultry (turkey) carcasses have determined that half of that time (1.5 hours) is adequate for this waste stream. Thus, the output of the system could be doubled and the cost per pound (or ton) processed halved.

If the MTD were utilized exclusively to control the VA outbreak of AI in 2002, 12 such machines would have been needed. Each machine would have been able to operate on a 24-hour basis with just one skilled operator attending the machine which runs on a computer system and is fully automated. The operator is needed only for loading and starting the cycle, so a single operator can easily operate as many as the 12 machines if they were in one location. These twelve machines placed at the various sites of the outbreaks could each handle 15 tons of carcasses a day for a total of 188 tons a day, which is approximately the daily amount of poultry carcasses that were disposed of for 90 days in the 2002 AI outbreak. The total operational cost for 90 days would be $ 1,636,567 or $ 97/ton.

These costs are reasonable and comparable to the total amount of money that was invested on disposal during the 2002 AI outbreak using landfill, incineration and composting disposal options. However, the only limiting factor of the operation of the machines in such a huge outbreak would be the disposal of the effluent, if it were not re-cycled as a fertilizer and released into the sewage. A total amount of 8,531,092 gallons of effluent extremely rich in amino acids with a high pH may easily overwhelm the capacity of the local waste treatment plant, especially if it is already running at full capacity. It is essential therefore, that the local waste water treatment plants across the nation report to the USDA at least yearly their under-used capacity so that the dispersal of MTD effluent in large quantities during an outbreak can be well-managed and environmentally safe.

Figure 9: The 4000lbs USDA Alkaline Hydrolyzer mobile appears. Photo from WR2 (www.wr2.net)



Chapter 8 – IN-SITU PLASMA VITRIFICATION

"In-situ" plasma vitrification is a new technology that has evolved from technology developed in the 1960s that enabled man to take his first step on the moon. NASA developed a plasma torch which produces a flame that exceeds 7,000°C, or three times hotter than any fossil fuel. This torch is generated from electricity, much in the same way as lightning. By using DC current, enough voltage can be generated to ionize the air to produce this remarkable extremely hot flame in an efficient and cost-effective manner.

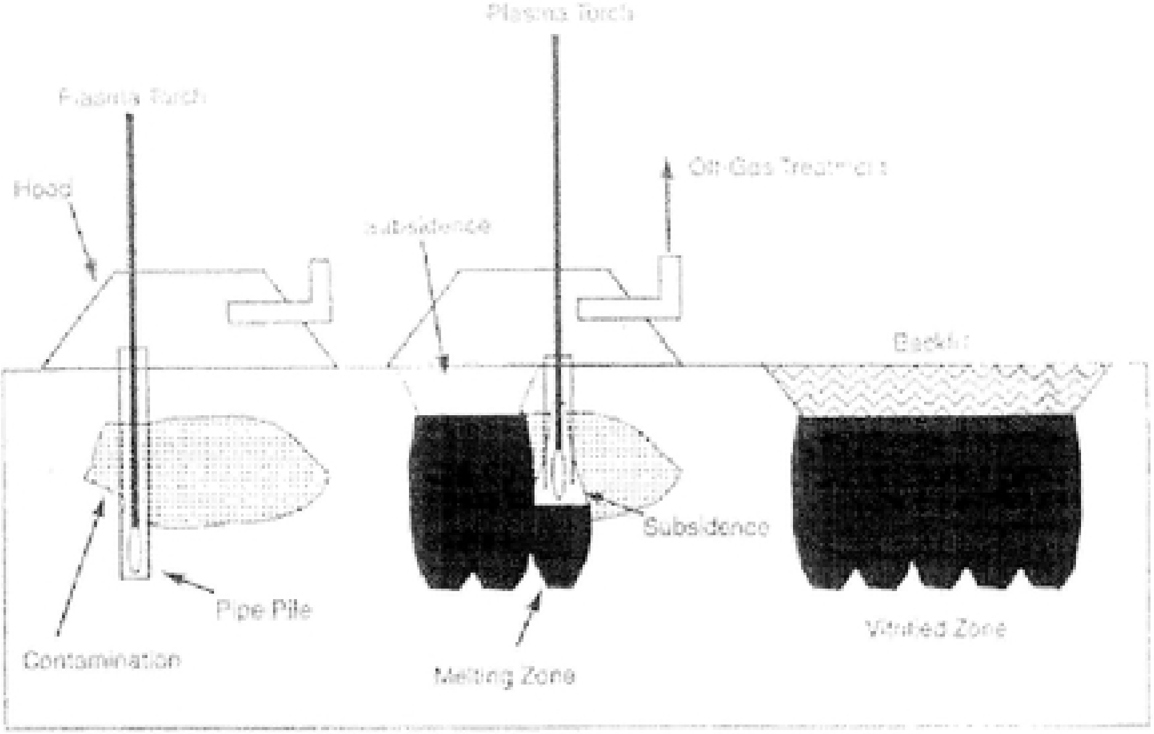
In the 1980s, it was realized that the torch cannot only be used to test heat shields made for the NASA space shuttles but also used to dispose of municipal solid waste (MSW) through a pyrolysis process. This special type of waste treatment does not produce the environmentally unsafe gasses that are generated when burning fossil-based fuels. The technology developed for pyrolysis of MSW is known as "ex-situ" plasma processing; that is, destroying MSW in a plasma-fired furnace. It has been determined that by treating MSW by "ex-situ" plasma processing, more energy is developed in the form of hydrogen and carbon monoxide gas which can then be used to sustain the electrical power required by the torch, and, in addition, generate enough electricity for re-sale. At a plant in Japan, the pyrolyzed MSW, which leaves the furnace stream, is then allowed to cool into a rock-like or sand-like residue which can be sold as road gravel or processed into brick. The operating costs of the plant are offset by three income streams: the MSW tipping fees, the sale of the gas or electricity, and the sale of the rock or sand residue.

There is virtually no leachate from the residue and thus plasma technology has tremendous potential, ranging from the elimination of extremely hazardous chemicals to the destruction of hog waste.

The technology that can be used to dispose of volumes of carcasses in the field is "in-situ" plasma vitrification which was developed several years ago by Dr. Louis J. Circeo, inventor and Principal Researcher Scientist at the Georgia Institute of Technology in Atlanta GA. "In-situ" plasma vitrification could be used to safely dispose of extremely large outbreaks of diseased animals in a timely, efficient, and safe manner with no harm to the environment. The process of disposal is by burial and then the plasma torch pyrolize the carcasses in the soil to generate gaseous effluent. (Figure 10).

"In-situ" plasma vitrification could have been used to eradicate the daily disposal of 188 tons of infected poultry carcasses on site at a farm by the use of up to four 2.4MW Mark II torches made by Westinghouse Plasma Corporation. The plasma torches would be inserted into the ground to destroy the buried carcasses at a total operational expense of about $71.60/ton. Each torch is priced at about $2 million dollars, thus an $8 million dollar investment is needed by the government, to have mobile system that can be powered by generators or directly from a local electrical power line to respond with hours to a disease outbreak. A collection hood would be used to neutralize harmful gasses escaping from the earth. Such a gas collection hood has already been developed by the Department of Energy. Should the hood be unavailable, the government has the designs to build a similar hood for approximately $500,000. This collection hood is designed to hold up to 4 torches which could be lowered in unison into the ground and

Figure 10: Diagram of in-situ plasma vitrification system



Chapter 9 – METHOD OF COMPARATIVE ANALYSIS

Each of the current methods for disposing of depopulated poultry entails varying degrees of monetary cost, environmental hazard, public and industry perception and process complexity. These four factors can be used to compare each disposal method by weighing each independently on a point scale as follows: "good" (1 point); "average" (2 points); or "poor" (3 points). Upon summing weighted factors, the disposal method with the fewest total points may be declared the best disposal method. The point scale is described as follows:

1. "Poor" means that the costs are extremely high, perhaps transportation cost are greater than disposal; the environment will be contaminated to the point where there will be public health concerns; public perception will be negative; the disposal method requires a lot of raw materials, will generate waste to be further disposed and additional clean up is likely involved.

2. "Average" means that the costs are acceptable; the impact on the environment is not sufficient to cause damage or impact health; the public will not object; the disposal method is efficient but may require some time.

3. "Good" means that the costs are low or that the disposal method will generate a product that is re-sellable to discount the cost; there is little impact on the environment; public perception is favorable; and the disposal method is a simple and quick.

The four factors used to compare each disposal method may be broken down into further components:

A) Cost includes actual processing costs, raw materials needed for processing, equipment, labor, transportation of carcasses to the disposal site and energy needed to dispose of the carcasses.

B) Environment factors considered in the various disposal methods are to maintain strict biosecurity with little or no contamination of ground water, surface water, and air.

C) Perception of the public and industry need to be considered when choosing a disposal method. People are heavily influenced by odor and the industry is sensitive to public criticism.

D) Complexity of the disposal process will influence the amount of potential problems that can occur. Some of the disposal methods generate a re-saleable by-product.. Also, some of the disposal methods produce unwanted waste that needs to be further processed prior to disposal.

Comparative analysis of each of the four factors in this way is a subjective decision making tool based on actual experience, oral histories, and the literature, whereby a case-by-case method may be assessed differently.

Chapter 10 – CONCLUSION

Based on the summary of the comparative analysis table shown below, it can be safely said that no one process demonstrates optimal results for cost, environment, perception and complexity. The poultry carcass disposal method that has the best score is rendering. The disposal method with the worst score by a wide margin is incineration. The other technologies are fairly consistent together in total scores.

Table 1: Summary of Comparative Analysis

	Disposal Scale: 4 = best and 12 = Worst				
	Cost	Environment	Perception	Complexity	Total Score
On-site Burial	2	2	1	3	8
Landfills	3	2	2	1	8
Incineration	3	2	3	3	11
Composting	1	1	1	3	6
Rendering	1	1	2	1	5
Alkaline Hydrolysis	3	2	2	2	9
In-situ Plasma Vitrification	3	1	2	1	7

However, both alkaline hydrolysis and "in-situ" plasma vitrification technology need to be further funded by the U.S. government or the private sector. Should either of those technologies be used, total cost of per ton of carcasses would be approximately $ 73/ton for "in-situ" plasma vitrification, and $97/ton for alkaline hydrolysis. To be able to dispose of 188 tons of AI infected carcasses in 90 days in the future, the U.S. government would need to spend $8.5 million dollars for the 4 plasma torches and gas collection hood (ISVP technology) or $12 million dollars for twelve 4000 lb capacity mobile alkaline hydrolysis machines. Both of these technologies would be the most effective of combating serious infected carcasses that were infected with prions such as cattle. The other technologies processes could not deactivate the prions. Indeed, ISVP can eliminate the most toxic of substances known to man, such as radioactive materials. However, all the other technologies would be able to destroy avian influenza and exotic new castle disease.

The cost that appears the greatest in general is the transportation of carcasses. By reducing the amount of transportation involved, the risk of a biosecurity breach decreases as well. The most environmental safe, and with the highest re-sale value of the residue, is composting. There is virtually no anthropogenic energy requirement. The destruction of avian influenza and the carcasses occurs entirely due to natural processes. Public perception would be most favorable if on-site composting was done. The government needs to invest in at least 6 months following an outbreak, for the proper management of the curing process of the compost. The least complex method of disposal is on-site burial. The hole is dug, the carcasses are buried and no more work is required. However, due to the recent requirement of notating on the deed of the land, the potential stigma attached to the burial of the carcasses would lower the re-sale value of the land. Also, the conditions of the soil greatly influence the rate of decomposition. If the soil was very dry and rich in clay, it may take tens of years for the birds to completely decompose.

To be better prepared for future livestock or poultry disease outbreaks, the U.S. government should consider all the options and create a disposal team within the USDA whose sole purpose would be to assess all the technologies. Indeed there is already a commitment by the USDA in the purchase and utilization of alkaline hydrolysis machines. A method to utilize the effluent of the alkaline hydrolysis needs to be explored. The amino acid-like soup has tremendous energy capabilities which could be potentially developed into a renewable form of energy, such as fertilizer. Monitoring should be done of the under-used capacity of waste-treatment facilities so that large amounts of alkaline hydrolysis effluent could be released into the waste treatment plants without damaging the bacteria of the plant. Rendering plants need to have contracts established and contingency plans in place with the USDA in case of further outbreaks of animal diseases. Clearly this has already been done in Europe. The USDA needs to decide also how they will dispose of the rendered products effectively. A great potential of energy is available in processed animal feed either as an alternative source of fuel, feed for a different species of animals, or perhaps may be incorporated into a type of fertilizer. Contract and programs must also determined with landfills prior to outbreaks. Incineration should be a last resort since it is the most costly process, very labor intensive and not at all accepted by the public.

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Table 7: List Definitions of Abbreviations used in Table 2

Abbreviations	
A =	Augusta County
Burial =	On-Site Burial (only one farm), listed at bottom of Table 2
C =	Chicken
C =	Chicken Layer
CB =	Chicken Breeder
G =	Greene County
H =	Highland County
P =	Page County
R =	Rockingham County
S =	Shenandoah County
T =	Turkey
TB =	Turkey Breeder
F =	Farms
CTY =	County
LF =	Landfill: 1000s of birds
SL =	Slaughtered 1000s of birds
VI =	Virus Isolation
RFD =	Reason For Depop
DD =	Depopulation Date
I =	Incineration: 1000s of birds
CPT =	Composting: 1000s of birds
AGE =	Age in Weeks

TABLE 8: Number of Birds Depopulated / farm in VA 2002

F	CTY	C	CB	CL	T	TB	AGE	VI	RFD	DD	LF	I	CPT	SL
1	R					1		H7N2	symptoms	3/15		14		
2	R	1					7	H7N2	Pre-slaughter	3/20				133
3	R				1		14	H7N2	at slaughter	3/22		22		
4	R				1		12	H7N2	symptoms	3/22		16	18	
5	P	1					8	H7N2	at slaughter	3/29				40
6	R				1		13	H7N2	Pre-slaughter	4/4				20
7	R				1		13	H7N2	Pre-slaughter	4/5	23			
8	R				1		13	H7N2	symptoms	4/5	22			21
9	R		1				33	H7N2	symptoms	4/5	22			
10	R				1		15	H7N2	symptoms	4/5	32			
11	S				1		17	H7N2	symptoms	4/5	31			
12	R				1		13	H7N2	symptoms	4/8	14			14
13	R					1		H7N2	symptoms	4/8				15
14	R					1	52	H7N2	symptoms	4/8				11
15	R				1		8	H7N2	symptoms	4/9	22			
16	S				1		14	H7N2	symptoms	4/9				16
17	R					1	14	H7N2	proximity	4/9				17

Continuation of **Table 8:** Number of Birds Depopulated / farm in VA 2002

F	CTY	C	CB	CL	T	TB	AGE	VI	RFD	DD	LF	I	CPT	SL
18	R		1				47	H7N2	symptoms	4/9	15			
19	R				1		12	H7N2	Pre-slaughter	4/9	11			12
20	R					1	43	H7N2	symptoms	4/9				15
21	R					1	26	H7N2	symptoms	4/9				17
22	R				1		10	H7N2	symptoms	4/10	13			
23	R	1					7	H7N2	pre-slau	4/10	14			
24	A					1	49	H7N2	symptoms	4/10	7			
25	R					1	13	H7N2	symptoms	4/10	15			
26	R				1		13	H7N2	symptoms	4/10	15			
27	R				1		13		slaughter	4/10				18
28	R				1		7	H7N2	symptoms	4/11	20			
29	R		1				57	H7N2	symptoms	4/11	11			
30	P		1				57	H7N2	symptoms	4/11	25			
31	R					1	70	H7N2	symptoms	4/11	7			
32	R				1		13	H7N2	symptoms	4/11				48
33	S	1					8	H7N2	pre-slaughter	4/12	78			
34	S				1		7	H7N2	symptoms	4/12	25			
35	R				1		17	H7N2	symptoms	4/12				18
36	R				1		13	H7N2	pre-slaughter	4/12				22
37	R				1		10	H7N2	symptoms	4/12				22
38	R				1		18	H7N2	symptoms	4/12	30			
39	R				1		8	H7N2	symptoms	4/13	30			
40	R		1				60	H7N2	symptoms	4/13	14			
41	R				1		13	H7N2	symptoms	4/13	30			
42	S				1		12	H7N2	symptoms	4/14	36			
43	R				1		9	H7N2	symptoms	4/15	22			
44	R					1	27	H7N2	symptoms	4/15				13
45	S				1		13	H7N2	symptoms	4/15	24			
46	A				1		13	H7N2	pre-slaughter	4/15	11			12
47	S				1			H7N2	symptoms	4/16	21			
48	S				1		13	H7N2	symptoms	4/16	10			
49	R				1		44	H7N2	symptoms	4/17				13
50	S				1		13	H7N2	proximity	4/17				24
51	R				1		14	H7N2	surveillance	4/17	23			
52	S				1		19	H7N2	surveillance	4/17	24			
53	R				1		11	H7N2	proximity	4/17	22			
54	A					1	10		proximity	4/18	45			
55	A				1		8	H7N2	symptoms	4/18	12			
56	R				1		10	H7N2	symptoms	4/18	23			
57	R				1		8	H7N2	symptoms	4/18	11			
58	R					1	33		symptoms	4/18	10			
59	R		1				46	H7N2	symptoms	4/18	22			
60	G				1		13	H7N2	pre-slaughter	4/19	50			
61	R				1		7		special	4/19	12			
62	P				1		12		symptoms	4/19	47			

Continuation of **Table 8:** Number of Birds Depopulated / farm in VA 2002

F	CTY	C	CB	CL	T	TB	AGE	VI	RFD	DD	LF	I	CPT	SL
63	S				1		11		symptoms	4/19	29			
64	R				1		11	H7N2	pre-slaughter	4/19	11			
65	S	1					7		symptoms	4/19	43			
66	S				1		17	H7N2	surveillance	4/19				15
67	R					1	57	H7N2	symptoms	4/19	1			
68	R					1	58	H7N2	symptoms	4/19	4			
69	R				1		16	H7N2	pre-slaughter	4/19	23			
70	A				1		12	H7N2	pre-slaughter	4/19	8			
71	R		1				33			4/19	28			
72	R				1		10		symptoms	4/19	23			
73	R					1	12	H7N2	symptoms	4/20	5			
74	R				1		11		pre-slaughter	4/20	19			
75	R				1		11	H7N2	symptoms	4/20				21
76	A				1		24	H7N2	symptoms	4/20				30
77	S				1		13		symptoms	4/20	19			
78	R				1		12	H7N2	symptoms	4/21	31			
79	R				1		9		symptoms	4/21	11			
80	R					1	50	H7N2	symptoms	4/22				4
81	S				1		14	H7N2	symptoms	4/22				13
82	S					1	50	H7N2	symptoms	4/22				8
83	R					1	18	H7N2	symptoms	4/22				14
84	A					1	34	H7N2	symptoms	4/22				11
85	A					1	25	H7N2	symptoms	4/22				5
86	R				1		12		symptoms	4/23		26		
87	A				1		8		symptoms	4/23		19		
88	R				1		13	H7N2	pre-slaughter	4/23	30			
89	R				1		12	H7N2	pre-slaughter	4/23	13			
90	R		1				33	H7N2	symptoms	4/23	14			
91	R				1		9	H7N2	symptoms	4/23		20		
92	R				1		12	H7N2	symptoms	4/23		21		
93	S				1		9	H7N2	symptoms	4/24		20		
94	A					1	25	H7	symptoms	4/25	14			
95	R				1		10	H7N2	symptoms	4/25	22			
96	R					1	59	H7N2	symptoms	4/25	5			
97	S				1		6	H7N2	proximity	4/25		15		
98	S				1		5	H7N2	proximity	4/25		15		
99	R		1				9	H7N2	symptoms	4/25	19	9		
100	R				1		13		signs	4/25	4	18		
101	R	1					6	H7	pre-slaughter	4/26	84			
102	R				1		11	H7	symptoms	4/26	15			
103	R				1		12	H7N2	symptoms	4/26	15			
104	R		1				56		surveillance	4/26		29		
105	A					1	52		surveillance	4/26		15		
106	R	1					6		high mortality	4/27		40		
107	S				1		8	H7N2	symptoms	4/27		30		

Continuation of **Table 8:** Number of Birds Depopulated / farm in VA 2002

F	CTY	C	CB	CL	T	TB	AGE	VI	RFD	DD	LF	I	CPT	SL
108	R		1				28		signs	4/27		40		
109	R					1	7		signs	4/27		6		
110	R				1		7	H7N2	signs	4/28	49			
111	P				1		8		surveillance	4/28		20		
112	R	1					27	H7N2	surveillance	4/28	19			
113	R				1		12		surveillance	4/28	22			
114	P		1				45		surveillance	4/29	31			
115	R		1				15	H7N2	surveillance	4/30	29			
116	R				1		12		surveillance	4/30	30			
117	A				1		11	H7N2	slaughter	4/30				20
118	R				1		14	H7N2	surveillance	4/30	9			
119	A				1		5		slaughter	5/2	11			
120	R				1		9		surveillance	5/2	15			
121	S		1				7	H7N2	surveillance	5/2	19			
122	R				1		9	H7N2	symptoms	5/2	9			
123	R				1		11	H7N2	symptoms	5/3	22			
124	P				1		11	H7N2	symptoms	5/3	22			
125	R				1		7	H7N2	symptoms	5/3	22			
126	H				1		20	H7N2	symptoms	5/3	15	5		
127	A		1				49	H7N2	surveillance	5/3	17			
128	R				1		7	H7N2	signs	5/4		24		
129	P				1		9	H7N2	signs	5/6	24			
130	R				1		12	H7N2	surveillance	5/6		15		
131	A				1		14	H7N2	surveillance	5/6		18		
132	A				1		12		proximity	5/6		18		
133	A					1	29	H7N2	high mortality	5/7	4			
134	R				1		12		surveillance	5/8		19		
135	R				1		12		surveillance	5/8	10			
136	R				1		9	H7N2	signs	5/8	23			
137	R				1		13		surveillance	5/9				11
138	R					1		H7N2	surveillance	5/9	5			
139	A				1		11	H7N2	surveillance	5/9	21	22		
140	R		1				7		surveillance	5/9		14		
141	R				1		12	H7N2	surveillance	5/9		22		
142	A				1		13	H7N2	pre-slaughter	5/9	33			
143	A					1	22	H7N2	surveillance	5/11	14	2		
144	A				1		11	H7N2	suspect	5/13	44			
145	R				1		10	H7N2	suspect	5/14	22			
146	R		1				48		surveillance	5/14	7			
147	A				1		10	H7N2	proximity	5/15	22			
148	R				1		14	H7N2	pre-slaughter	5/15	18			
149	R				1		6		surveillance	5/16	11			
150	R				1		6	H7N2	surveillance	5/16	22			
151	A				1		10	H7N2	proximity	5/16	11			
152	R				1		10	H7N2	symptoms	5/17	28			

Continuation of **Table 8:** Number of Birds Depopulated / farm in VA 2002

F	CTY	C	CB	CL	T	TB	AGE	VI	RFD	DD	LF	I	CPT	SL
153	R				1		13		pre-slaughter	5/17	15			
154	R				1		7	H7N2	surveillance	5/17	36			
155	P		1				52	H7N2	surveillance	5/17	25			
156	A		1				40		surveillance	5/17	9			
157	R	1					7	H7N2	pre-slaughter	5/19	50			
158	R				1		18	H7N2	pre-slaughter	5/20				0
159	R				1		9	H7N2	surveillance	5/20	11			
160	R				1		16		surveillance	5/20				
161	R				1		14		surveillance	5/20	22			
162	R				1		13	H7N2	surveillance	5/21	20			
163	P	1					7	H7N2	pre-slaughter	5/21	120			
164	R				1		16	H7N2	surveillance	5/21	8			
165	R		1				63	H7N2	surveillance	5/22	4			
166	R				1		13	H7N2	pre-slaughter	5/22	44			
167	R		1				34		surveillance	5/22	27			
168	R				1		10	H7N2	surveillance	5/22	13			
169	R		1				60		surveillance	5/23	6			
170	R		1				31		surveillance	5/24	8			
171	R				1		12	H7N2	symptoms	5/24	24			
172	R				1		13	H7N2	pre-slaughter	5/24	46			
173	R				1		12	H7N2	slaughter	5/24				11
174	R		1				66		pre-slaughter	5/25	15			
175	A			1			72	H7N2	surveillance	5/25	70			
176	R				1		13		pre-slaughter	5/27	7			
177	R		1				41		surveillance	5/28	13			
178	R				1		14		survelliance	5/28	19			
179	R				1		11		Surveillance	5/29	10			
180	R				1		8		survelliance	5/30	14			
181	R	1						H7N2	slaughter	5/30				37
182	R				1		9		surveillance	5/31	11			
183	R				1		8		survelliance	5/31	9			
184	P	1					6		surveillance	5/31	44			
185	R				1		15		survelliance	6/3	40			
186	P	1					7		survelliance	6/4	80			
187	R				1		11		survelliance	6/4	20			
188	R				1		12	H7N2	pre slaughter	6/4				8
189	P		1				60		survelliance	6/5	13			
190	R		1				52		survelliance	6/5	7			
191	R			1			57		surveillance	6/7			14	
192	R				1		12	H7N2	survelliance	6/9	12			
193	A				1		11	H7N2	survelliance	6/10	11			
194	R				1		8	H7N2	surveillance	6/11	7			
195	R		1				25	H7N2	surveillance	6/22	6			
196	R				1		10	H7N2	symptoms	6/27	12			
197	R		1				52	H7N2	survillance	7/3	6			

Continuation of **Table 8:** Number of Birds Depopulated / farm in VA 2002

TOTAL		C	CB	CL	T	TB				Burial	LF	I	CPT	SL
197		13	29	2	126	27				15	3009	551	32	590
											TOTAL			
											4197	X 1000 birds		

TABLE 9: Total Tonnage Recorded at Disposal Sites in VA 2002

Site of Disposal	Birds	Tonnage	%
Rockingham County Landfill	709,080	3,400	20.1%
Page County Landfill	198,334	951	5.6%
Fredrick County Landfill	175,601	842	5.0%
Charles City County Landfill	961,428	4,610	27.2%
Sussex County County Landfill	964,557	4,625	27.3%
Incineration at Rockingham Quarry	551,000	2,268	13.4%
Composting	32,000	75	0.4%
On-Farm Burial	15,000	128	0.8%
Slaughter	590,000	21	0.1%
TOTAL Tons	**4,197,000**	**16,920**	100%

APPENDIX 2

Table 10: List Definitions of Abbreviations used in **Table 10**

Abbreviations	
A =	Augusta County
CTY =	County
F =	Farms
ILF =	Incineration at Landfills: Tons of birds
LF =	Landfills: Tons of birds
NOB =	New On-site Burial (original land unsuitable for burial): Tons of birds
OB =	On-site Burial (original land suitable for burial): Tons of birds
PLOB =	Plastic Lined Onsite Burial Sites
R =	Rockingham County
S =	Spring Water Sampled for ground water contamination
W =	Wells Sampled for ground water contamination

Table 11: Total Tonnage of Birds Depopulated per farm in VA 1984

F	CTY	ILF	LF	NOB	OB	PLOB	W	S
1	R				51.80			
2	R		0.00		0.00			
3	R				140.00		1	
4	R				204.50			
5	R				86.70			
6	R		44.70					
7	R				49.00		1	
8	R		38.50					
9	R				25.30		1	
10	R		51.50					
11	R		0.00		0.00			
12	R				66.00	1	1	1
13	R		20.40					
14	R				72.00	1	1	
15	R				200.00	1		
16	R				49.70	1		
17	R				25.00	1		
18	R				58.10	1	1	
19	R				447.60	1		
20	R				93.50	1		
21	R				135.50	1		
22	R				77.70	1		
23	R		45.00					
24	R				50.90	1		
25	R				293.40	1		
26	R				473.00			
27	R				26.70	1	1	
28	R				48.60	1	1	

Continuation of **Table 11:** Total Tonnage of Birds Depopulated per farm in VA 1984

29	R				54.50			
30	R				86.70	1		
31	A				48.40	1	1	
32	R				119.00	1		
33	R				69.20	1	1	
34	R				63.00	1		
35	R			42.80				
36	R				25.20	1		
37	R				114.90	1	1	
38	R				26.90	1		
39	R		9.10					
40	R				167.80			
41	R		159.50					
42	R				42.30			
43	R		49.80					
44	R				164.50	1	1	
45	R		0.00		0.00			
46	R				53.50			
47	R				17.00			
48	R				45.50			
49	A				114.50			
50	R		187.00					
51	R				44.50			
52	R		39.40					
53	R				33.30			
54	R				48.00			
55	R			340.40				
56	R				212.00			
57	R			25.50				
58	R			43.50				
59	R			18.00				
60	R			11.00				
61	R			49.40				
62	R			34.00				
63	R			9.90			1	
64	A				36.80		1	
65	R			17.50				
66	R			81.70				
67	R			11.10				
68	R	10.70			21.40			
69	R			40.40				
70	R			33.00				
TOTALS		**10.70**	**644.90**	**758.20**	**4283.90**	**23**	**14**	**1**
		ILF	**LF**	**NOB**	**OB**	**PLOB**	**W**	**S**
Total Tonnage = 5697.7 from 70 Farms								

APPENDIX 3 – Calculations for On-Site Burial

Table 12: List Definitions of Abbreviations used in Table 13

Abbreviations	
C =	Constant, used in calculating length of Burial Pits
D =	The average depth of the on-site burial pit
DP =	Pile Depth of Poultry Carcasses
F =	Farms
ft^{3} =	cubic feet of land dug up to creat burial pit
L =	Length of on-site burial pit
LF =	Landfill; not all birds were buried on-site
OB =	On-site Burial on Farm Land
W =	Width for all the burial pits were 20 feet wide

Table 13: Rough calculations that were used to determine the size of the on-site burial pits.

F	OB	D	C	L	W	D	ft^3
1	51.80	2	800	65	20	10	12,950
2	LF						
3	140.00	2	800	175	20	10	35,000
4	204.50	2	800	256	20	10	51,125
5	86.70	2	800	108	20	10	21,675
6	LF						
7	49.00	2	800	61	20	10	12,250
8	LF						
9	25.30	2	800	32	20	10	6,325
10	LF						
11	LF						
12	66.00	2	800	83	20	10	16,500
13	LF						
14	72.00	2	800	90	20	10	18,000
15	200.00	2	800	250	20	10	50,000
16	49.70	2	800	62	20	10	12,425
17	25.00	2	800	31	20	10	6,250
18	58.10	2	800	73	20	10	14,525
19	447.60	2	800	560	20	10	111,900
20	93.50	2	800	117	20	10	23,375
21	135.50	2	800	169	20	10	33,875
22	77.70	2	800	97	20	10	19,425
23	LF						
24	50.90	2	800	64	20	10	12,725
25	293.40	2	800	367	20	10	73,350
26	473.00	2	800	591	20	10	118,250
27	26.70	2	800	33	20	10	6,675
28	48.60	2	800	61	20	10	12,150
29	54.50	2	800	68	20	10	13,625

Continuation of **Table 13:**

F	OB	D	C	L	W	D	ft^3
30	86.70	2	800	108	20	10	21,675
31	48.40	2	800	61	20	10	12,100
32	119.00	2	800	149	20	10	29,750
33	69.20	2	800	87	20	10	17,300
34	63.00	2	800	79	20	10	15,750
35	42.80	2	800	54	20	10	10,700
36	25.20	2	800	32	20	10	6,300
37	114.90	2	800	144	20	10	28,725
38	26.90	2	800	34	20	10	6,725
39	**LF**						
40	167.80	2	800	210	20	10	41,950
41	**LF**						
42	42.30	2	800	53	20	10	10,575
43	LF						
44	164.50	2	800	206	20	10	41,125
45	**LF**						
46	53.50	2	800	67	20	10	13,375
47	17.00	2	800	21	20	10	4,250
48	45.50	2	800	57	20	10	11,375
49	114.50	2	800	143	20	10	28,625
50	**LF**						
51	44.50	2	800	56	20	10	11,125
52	**LF**						
53	33.30	2	800	42	20	10	8,325
54	48.00	2	800	60	20	10	12,000
55	340.40	2	800	426	20	10	85,100
56	212.00	2	800	265	20	10	53,000
57	25.50	2	800	32	20	10	6,375
58	43.50	2	800	54	20	10	10,875
59	18.00	2	800	23	20	10	4,500
60	11.00	2	800	14	20	10	2,750
61	49.40	2	800	62	20	10	12,350
62	34.00	2	800	43	20	10	8,500
63	9.90	2	800	12	20	10	2,475
64	36.80	2	800	46	20	10	9,200
65	17.50	2	800	22	20	10	4,375
66	81.70	2	800	102	20	10	20,425
67	11.10	2	800	14	20	10	2,775
68	21.40	2	800	27	20	10	5,350
69	40.40	2	800	51	20	10	10,100
70	33.00	2	800	41	20	10	8,250
	Total Tons						
	5042.10				Total Cubic Feet =		1,260,525
				1 acre feet = 43560 cubic feet			
				Total Acreage of Land used = 29 acres			

Table 14: List the Formulas used to calculate the length of the on-site burial pits and explains the various layers used in constructing the burial pit to ensure no ground water contamination would occur.

During the 1984 Avian Influenza Outbreak approximately 29 acres was used to bury 5032.1 tons of birds

Birds buried on-site could not be stacked more than 2 feet high

Birds buried in Landfills could be stacked 4-6 feet

Formula used to calculate length of the burial pit, developed by DEQ

$$\frac{\text{total weight (lbs)}}{\text{depth of poultry(2 ft)} \times 800} = \text{length of pit}$$

The following layers were used to bury birds on-site from top to bottom

compacted clay	2	feet
compacted fill	2.5	feet
loose fill	3	feet
poultry carcasses	2	feet
gravel	0.5	feet
Total Depth	10	feet

Appendix 4 – Landfills

Table 15: List Definitions of Abbreviations used in **Table 16**

Abbreviations:	
AT =	Available Space at the Landfill after the AI 2002 Outbreak
Charles =	Charles City Landfill
DTM =	Total number of Days Till Landfill Space is Maxed Out
FTL =	Total # of Future Truck Loads needed if Outbreak continued until landfill space maxed
LF =	Landfill
MT =	Maximum Tonnage allowed to be buried at the buiral pit
Sussex =	Sussex County Landfill
T/D =	Total Tonnage per day of birds needed to be disposed of during the 2002 AI Outbreak
TL =	Average truck load of carcasses in tons
TU =	Total Tonnage Used at the landfill site

Table 16: Shows the calculation for maximum number of days both Sussex County Landfill and Charles City Landfill could be used for poultry carcass disposal:

2002 Outbreak was dependent on available space of landfills							
LF	**TU**	**MT**	**AT**	**TL**	**FTL**	**T/D**	**DTM**
Charles	4610	10000	5390	20	269.5	188	28.67021277
Sussex	4625	10000	5375	20	268.75	188	28.59042553
			TOTAL AT		**Tot FTL**		**TOTAL TDM**
			10765		538.25		57.2606383

Appendix 5 – Incineration

Table 17: List Definitions of Abbreviations used in **Table 17**

Abbreviations	
Days =	Number of days birds are being incinerated
Date =	Actual date birds were incinerated
F =	Farm being depopulated
T =	Trucks of loads of carcasses from farm to incinerators
TONS =	Tonnage of birds transported per truck
DEPT =	Departure time of truck from farm to incinerators
ARR =	Arrival time of truck to incineration site
TT =	Departure to Arrival of Trucks from the farm to the incineration site in hrs and min

Table 18: List the amount of tonnage of birds incinerated

Days	Date	F	T	TONS	DEPT	ARR	TT
1	23-Apr	1	1	24	1600		
2	24-Apr	2	2	24	1208	1315	**1.07**
	24-Apr	2	3	24	1219	1320	**1.01**
	24-Apr	2	4	32	1335	1500	**1.65**
	24-Apr	2	5	27	1430	1610	**1.80**
	24-Apr	2	6	25	1401	1645	**2.44**
	24-Apr	3	7	32	530		
	24-Apr	3	8	26	535		
3	25-Apr	4	9	22	1620	1645	**0.25**
	25-Apr	4	10	29	1405	1440	**0.35**
	25-Apr	4	11	29	1235	1315	**0.80**
	25-Apr	4	12	32	1101	1203	**1.02**
	25-Apr	5	13	24	1040	1130	**0.90**
	25-Apr	5	14	17	1040	1115	**0.75**
	25-Apr	5	15	11	1150	1220	**0.70**
	25-Apr	6	16	30	900	925	**0.25**
	25-Apr	6	17	30	845	850	**0.05**
4	26-Apr	7	18	28	715	830	**1.15**
	26-Apr	7	19	23	820	930	**1.10**
	26-Apr	7	20	39	945	1055	**1.10**
	26-Apr	7	21	28	1145	1300	**1.55**
	26-Apr	7	22	27	1230	1345	**1.15**
	26-Apr	7	23	26	1445	1620	**1.75**
	26-Apr	7	24	22	1600	1700	**1.00**
	26-Apr	7	25	27	1645	1800	**1.55**
	26-Apr	7	26	20	1830	1945	**1.15**
	26-Apr	8	27	25	600	610	**0.10**
	26-Apr	8	28	26	600	630	**0.30**

Continuation of **Table 18:**

Days	Date	F	T	TONS	DEPT	ARR	TT
	26-Apr	8	29	26	610	640	**0.30**
	26-Apr	8	30	28	630	700	**0.70**
	26-Apr	8	31	26	630	645	**0.15**
5	27-Apr	9	32	27	940	1200	**2.60**
	27-Apr	9	33	29	905	1210	**3.05**
	27-Apr	9	34	23	1040	1215	**1.75**
	27-Apr	10	35	24	1420	1440	**0.20**
	27-Apr	10	36	24	1515	1540	**0.25**
	27-Apr	10	37	24	1550	1614	**0.64**
	27-Apr	10	38	25	1430	1450	**0.20**
	27-Apr	11	39	24	1430	1515	**0.85**
	27-Apr	11	40	24	1550	1625	**0.75**
	27-Apr	11	41	24	1650	1730	**0.80**
6	28-Apr	12	42	28	1213	1400	**1.87**
	28-Apr	12	43	25	1020		
	28-Apr	12	44	26	1415	1525	**1.10**
7	2-May	13	45	34	1430	1730	**3.00**
	2-May	13	46	27	1430	1740	**3.10**
	2-May	13	47	19	1500	1750	**2.50**
	2-May	13	48	30	1140	1810	**6.70**
	4-May	14	49	24	1620	2145	**5.25**
	4-May	15	50	11	900	1015	**1.15**
	4-May	15	51	24			
	4-May	16	52	15	1400		
	4-May	16	53	8	1500		
8	6-May	16	54	31	1150	1325	**1.75**
	6-May	16	55	28	1105	1325	**2.20**
	6-May	16	56	26	1245	1355	**1.10**
	6-May	16	57	26	1340	1500	**1.60**
	6-May	16	58	23	1420	1545	**1.25**
	6-May	16	59	7	1440	1550	**1.10**
9	7-May	17	60	24	845	1010	**1.65**
	7-May	17	61	29	1000	1110	**1.10**
	7-May	17	62	26	1050	1245	**1.95**
	7-May	17	63	19	1545	1630	**0.85**
	7-May	18	64	30	930	1040	**1.10**
	7-May	18	65	19	1045	1205	**1.60**
	7-May	18	66	22	1200	1315	**1.15**
	7-May	18	67	30	1415	1530	**1.15**

Continuation of **Table 18:**

Days	Date	F	T	TONS	DEPT	ARR	TT
10	8-May	19	68	23	959	1115	**1.56**
	8-May	19	69	23	1040	1220	**1.80**
	8-May	19	70	27	1145	1245	**1.00**
	8-May	19	71	28	1245	1350	**1.05**
	8-May	19	72	13	1410	1545	**1.35**
11	9-May	20	73	36	145	750	**6.05**
	9-May	20	74	26	920	1020	**1.00**
	9-May	21	75	28	846	1045	**1.99**
	9-May	21	76	25	922	1055	**1.33**
	9-May	21	77	30	1120	1320	**2.00**
	9-May	21	78	22	1140	1330	**1.90**
12	10-May	22	79	17	1245	1430	**1.85**
	10-May	22	80	21	1140	1253	**1.13**
	10-May	22	81	25	845	1015	**1.70**
	10-May	22	82	24	945	1110	**1.65**
	10-May	22	83	29	1055	1219	**1.64**
	10-May	23	84	28	1011	1115	**1.04**
	10-May	23	85	12	1022	1126	**1.04**
13	11-May	24	86	15	1240		
	11-May	24	87	24	1055	1240	**1.85**
	11-May	24	88	24	1035	1228	**1.93**
	11-May	24	89	24	950	1056	**1.06**
	11-May	24	90	26	840	949	**1.09**
	11-May	24	91	22	825	935	**1.10**
	11-May	24	92	26	710	848	**1.38**
				Total Tons			**Average hrs.min**
				2,268			**1.44**

Table 19: Describes cost of wood and incineration costs

Unit: Tons	21 - 27 April Cost of Wood includes transport costs	Unit Price	Amount
325.38	compined hardwood & pines	$ 46.00	$ 14,967.48
91.20	wood pallets, including trans. (6080 pallets)	$ 1.18	$ 7,174.40
	28 April - 4 May Cost of Wood include transport costs		
1340.76	compined hardwood & pines	$ 46.00	$ 61,674.96
13.20	wood pallets, including trans. (880 pallets)	$ 1.18	$ 1,038.40
	5-11 May Cost of Wood include transport costs		
286.14	compined hardwood & pines	$ 46.00	$ 13,162.44
8.70	wood pallets, including trans. (580 pallets)	$ 1.18	$ 684.40
22.55	wood pallets, delivered (1503 pallets)	$ 0.59	886.77
	12-19 May Cost of Wood include transport costs		
817.18	compined hardwood & pines	$ 46.00	$ 37,590.28
13.43	wood pallets, including trans (895 pallets)	$ 1.18	$ 1,056.10
	May Cost of Wood include transport costs		
104.60	compined hardwood & pines	**$ 46.00**	**$ 4,811.60**
Total Tons	**Over all cost per ton of wood**	**Total Cost of Wood**	
3023.1	$47.32 / ton		$143,046.83
Unit: Hrs	**Cost of Moving and Cutting Wood at the incineration site**	**Unit Price**	**Amount**
	Cost of Hauling Free Wood Billed 21 MAY 02		
119.0	tractor and dump trailer w/operator	$ 65.00	$ 7,735.00
91.0	tractor and dump trailer w/operator	$ 65.00	$ 5,915.00
10.0	tandem triaxle dump w/operator	$ 50.00	$ 500.00
20.5	tandem triaxle dump w/operator	$ 50.00	$ 1,025.00
50.0	tractor and dump trailer w/operator	$ 65.00	$ 3,250.00
37.0	tractor and dump trailer w/operator	$ 65.00	$ 2,405.00
34.5	tractor and dump trailer w/operator	$ 65.00	$ 2,242.50
78.0	tractor and dump trailer w/operator	$ 65.00	$ 5,070.00
52.0	tractor and dump trailer w/operator	$ 65.00	$ 3,380.00
492.0		**Total**	**$ 31,522.50**
	Local Private Contractors		
21.0	International Tractor and Dump Trailer (5-7May)	$ 65.00	$ 1,365.00
28.5	Mac Tractor & Dump Trailer (3-7 May)	$ 65.00	$ 1,852.50
31.0	Freightline Tractor & Dump (3-7 May)	$ 65.00	$ 2,015.00
10.0	KW Tractor (3 May)	$ 65.00	$ 650.00
25.5	KW Tractor & Trailer	$ 65.00	$ 1,657.50
28.5	KW Tractor & Trailer	$ 65.00	$ 1,852.50
144.5		**Total**	**$ 9,392.50**

Continuation of **Table19:**

	Local Private Contractors		
98.0	April 24 to May 5 Tractor Trailer	$ 65.00	$ 6,370.00
62.5	April 25 to May 2 Tractor Trailer	$ 65.00	$ 4,062.50
10.0	April 28 Tractor Trailer	$ 50.00	$ 500.00
20.50	April 25-27	$ 50.00	$ 1,025.00
47.00	April 29 to May 2	$ 65.00	$ 3,055.00
23.50	May 1-2	$ 65.00	$ 1,527.50
37.00	April 30 to May 2	$ 65.00	$ 2,405.00
24.50	April 30 to May 1	$ 65.00	$ 1,592.50
24.50	April 30 to May 1	$ 65.00	$ 1,592.50
347.50		**Total**	**$ 22,130.00**
Total Hrs	**Over all total costs of Local Private Contractors Total Costs**		**Total Cost**
984.00			**$ 31,522.50**
Unit: Hrs	**Incineration Contract Costs (equipment [4 incinerators] and work crew)**	**Unit Price**	**Amount**
24.00	mobilization		$ 22,050.00
24.00	21-Apr-03		$ 1,560.00
24.00	22-Apr-03		$ 3,480.00
24.00	23-Apr-03		$ 14,640.00
24.00	24-Apr-03		$ 19,481.00
24.00	25-Apr-03		$ 19,481.00
24.00	26-Apr-03		$ 22,241.00
24.00	27-Apr-03		$ 25,361.00
24.00	28-Apr-03		$ 25,361.00
24.00	29-Apr-03		$ 28,481.00
24.00	30-Apr-03		$ 33,341.00
24.00	1-May-03		$ 33,341.00
24.00	2-May-03		$ 33,341.00
24.00	3-May-03		$ 33,341.00
24.00	4-May-03		$ 33,341.00
24.00	5-May-03		$ 33,341.00
24.00	6-May-03		$ 33,341.00
24.00	7-May-03		$ 33,341.00
24.00	8-May-03		$ 33,341.00
24.00	9-May-03		$ 33,341.00
24.00	10-May-03		$ 33,341.00
24.00	11-May-03		$ 33,341.00
24.00	12-May-03		$ 33,341.00
24.00	13-May-03		$ 33,341.00
24.00	14-May-03		$ 33,341.00
24.00	15-May-03		$ 27,101.42
24.00	16-May-03		$ 26,521.00
24.00	17-May-03		$ 24,881.42
24.00	18-May-03		$ 24,881.42

Continuation of **Table 19:**

24.00	19-May-03		$ 2,711.42
24.00	demobilization		$ 22,050.00
	Total Cost on Incineration Contract		**$810,397.68**
	Over all total costs for total operation of incinerations (wood and contracts)		**$984,967.01**
	Over all cost ($984,967) per incinerating 1 ton of carcasses (2,268 tons)		**$434.29**

Table 20: Costs of removal of Ashes

Unit: Hrs	**Power screener**	**Unit Price**	**Amount**
1.00	rental of Trommel 720 Double Screen Sifter/month	$ 11,000.00	$ 11,000.00
1.00	Freight for delivery and pickup of power sifter	$ 1,200.00	$ 1,200.00
1.00	finance charge	$ 183.00	$ 183.00
40.00	operate 40hrs/week	$ 100.00	$ 4,000.00
20.00	labor	$ 27.50	$ 550.00
	Total cost of operation of powerscreener		$ 16,933.00
Quantity (tons)	**Farmer Hauling of Ash to be utilized on Fields (farmer paid $10/ton)**	**Unit Price/ton**	**Amount**
445.48	8/9/2002 to 9/03/2002 (includes costs of weight scales, for 13 loads, $5/weighing)	$ 10.00	$ 4,519.80
159.34	8/22/2002 (includes costs of weight scales, for 8 loads, $5/weighing)	$ 10.00	$ 1,633.40
239.23	8/19/2002 (includes costs of weight scales, for 11 loads, $5/weighing)	$ 10.00	$ 2,447.30
270.56	8/15/2002 (includes costs of weight scales, for 11 loads, $5/weighing)	$ 10.00	$ 2,760.60
419.06	Sept 30, (includes costs of weight scales, for 19 loads, $5/weighing)	$ 10.00	$ 4,285.60
1912.79	Aug 20, (includes costs of weight scales, for 121 loads, $5/weighing)	$ 10.00	$ 38,627.00
	Independent Contractor Hauling of Ash ($85 / truck load)		
110.04	8/15/2002 (includes costs of weight scales, for 9 loads, $5/weighing)	$ 85.00	$ 765.00
205.49	8/8/2002 (includes costs of weight scales, for 14 loads, $5/weighing)	$ 85.00	$ 1,190.00
55.45	8/7/2002 (includes costs of weight scales, for 4 loads, $5/weighing)	$ 85.00	$ 340.00
262.41	8/16/2002 (includes costs of weight scales, for 14 loads, $5/weighing)	$ 85.00	$ 23,435.70

Continuation of **Table 20:** Costs of removal of Ashes

	Total Amount of Ash Produced in Tons as result of burning wood and birds		**4079.85**
	Total Cost of Ash Removal from incineration site		**$ 84,084.25**
	Average Cost of removing 1 ton of Ash		**$ 20.61**
	Over all total costs for total operation of incinerations including Ash disposal		**$1,069,051.26**
	Over all cost ($1,069,051.26) per incinerating 1 ton of carcasses (2,268 tons)		**$ 471.36**
	Ratio of Wood (3023.1 tons) needed to burn poultry carcasses (2,268 tons)		**1.33**

Table 21: Average Cost Breakdown per item of Incineration Contract

	Equipment	Hourly Rate
1	foreman with pick up & phone	$ 60.00
2	front end loader fully operated	$ 115.00
3	rubber tired backhoe fully operated	$ 95.00
4	skid steer loader fully operated	$ 85.00
5	dump truck (tandem or tri-axle fully operated	$ 70.00
6	tractor trailer dump (40cy or larger) fully operated	$ 95.00
7	grapple truck with dump bed fully operated	$ 145.00
8	laborer with transportation	$ 38.00
9	sawman with transporation saw	$ 55.00
10	track excavator fully operated #1	$ 130.00
11	track excavator fully operated #2	$ 130.00
12	truck and lo-boy fully operated	$ 120.00
13	refractory incinerator #1	$ 130.00
14	refractory incinerator #2	$ 130.00
15	refractory incinerator #3	$ 130.00
16	refractory incinerator #4	$ 130.00
17	mechanic truck and mechanic	$ 75.00
18	fuel, oil, grease service truck with operator	$ 75.00
19	environmental technician	$ 75.00
20	in-ground air curtain burner	$ 75.00
21	project manager	$ 65.00
22	safety gear	$ 11.73
23	light plants, disel generated	$ 10.00
24	mobilization to site	$ 22,000.00

Table 22: Conservative costs of clean up required to disinfected pond water

	Disinfection of local pond water contaminated with infected carcasses juices		
	Cost of chlorinating the pond water (1000lbs of chlorine)	**$ 1,250.00**	
Quantity	**Aerators Pumps Purchase plus hook up costs**	**Unit Price**	**Amount**
3.00	High Voltage Aeration System	$ 3,304.81	$ 9,914.43
50.00	12/3 cable	$ 2.05	$ 102.50
1.00	rush shippment	$ 250.00	$ 250.00
1.00	drop shipment	$ 50.00	$ 50.00
1.00	charges for wiring aerators by trumbo electric	$ 2,998.11	$ 2,998.11
1.00	credit card service charge	$ 157.80	$ 157.80
	Total conservative approximate costs involved in the pond clean up		**$ 13,472.84**

Appendix 6 – Composting

Table 23: Cost of Ag-Bag CT-10 to dispose of 16,920 tons of poultry carcasses

AG-Bag CT-10 Compost Encapsulator, with two 10 x 200 PODS; Cost =	$ 129,000
Electric Fan / Bag cost =	$ 1,000
Additional pods will be billed at $2000/POD while machine is on site	$ 2,000
Total tonnage capacity of Ag-Bag CT-10 =	200
Total space capacity of Ag-Bag = 200L ft x 10 ft in acreage is (1 acre = 43560 ft^{2}) in acreage =	0.05
Tonnage of carcasses per bag: 4 to 1 ration (Poultry litter:carcasses)	50
Total Tonnage of Litter needed / bag =	150
Cost / tonnage = $3000 / 50 tons of carcasses	$ 60
Average time needed to compost 50 tons of birds carcasses with proper mixture in Hours =	8
Total number of bags needed for 188 tons/day of carcasses =	4
Total cost per day with litter on-site =	$ 12,000
Total cost for 90 days (16,920 tons of carcasses) with litter on-site =	**$1,080,000**
Total Acerage space needed for 360 bags (16,920 tons of carcasses) or 4 bags x 90 days =	17
Cost of poultry litter per ton is $15	$ 15
Cost of poultry litter needed per bag is $2,250 for 150 tons of poultry litter	$ 2,250
Total cost per day for 4 bags plus cost of litter	$ 21,000
Total cost for 90 days (16,800 tons of carcasses) plus cost of litter =	**$1,890,000**
Resale potential value of compost per ton =	$ 25
Resale value of 1 bag of compost =	$ 5,000
Resale value of 360 bags if 188/tons x 90 days were place in each bag (360 bags)	$ 450,000
Total cost of 16920 tons of carcasses with litter on-site with re-sale value =	$ 630,000
Total cost of 16920 tons of carcasses with litter purchase with re-sale value =	$1,440,000

Appendix 7 – Rendering

Table 24: Costs of Rendering 16,920 tons of poultry carcasses at Winchester Rendering Plant

Winchester normally receives 3 million lbs of product a week = 1500 tons/week or 75 truck loads/week or 11 trucks/day	**1,500**	**75**
Winchester normally receives 1.7 million lbs of product from local suppliers in the area = 850 tons/week or 43 tuck loads/week or 6 truck loads / day	850	42.5
To divert local products in Winchester area to go to other plants it will cost per ton	$ 10.00	
Approximate cost of hauling good product to other plants would be per week is $8,500	$ 8,500.00	
Tons of carcasses per tractor trailer load is 20	20	
Winchester would need to divert 42.5 trailer loads to other surrounding rendering plants	42.5	
Cost per week to divert 43 trailer loads is $ 85	$ 8,500.00	
Cost per day to divert 43 trailer loads $12.14	$ 1,214.29	
Total cost for 90 days to divert 43 trailer loads is $1,092.86	$ 109,285.71	
Cost per Ton to receive poultry carcasses at Winchester Plant is $80 per ton	$ 80	
Total Cost to receive poultry 16,920 tons of carcasses at Winchester Plant is $1,353,600	$ 1,353,600	
Cost per mile for regular dump truck to haul waste to landfill is $1.70 per mile	$ 1.70	
Cost per mile for special waste disposal dump truck to haul waste to landfill is $2.50 per mile	$ 2.50	
Winchester has a total of 6 special waste disposal dump trucks on site to haul waste	6	
The average total miles from Shannadoah valley poultry houses to Winchester Plant is 75 miles	75	
Each truck could make 2 trips a day to Shannadoah valley poultry houses	2	
Rental of 9 special waste disposal trucks per day costs $3,375	9	$ 3,375
Rental of 9 special waste disposal trucks per week costs $23,625	9	$ 23,625
Rental of 9 special waste disposal trucks for 90 days costs $303,750	9	$ 303,750.00
VA AI 2002 Outbreak resulted in the destruction of approximately 16920 tons of birds	16,920	
Outbreak on average lasted for 90 days.	90	
The amount of birds per ton destroyed daily was 188 tons daily or 1,316 per week	188	1,316

Continuation **Table 24:** Winchester Plant

9 trucks daily would be needed to haul the destroyed birds	9	
Total tonnage of finished product needed to be hauled away is 5,640 tons	5,640	
Number of trucks to haul finished product away is 282 trucks	282	
Total cost of hauling finished product 25 miles away is $23,800	25	$ 23,970
Cost of landfill per ton is $ 65 thus total cost for finished product is 366,000	65	$ 366,600
Price to sell as a feed product per ton is $200	-200	
Thus total profit for finished product is of rendered (16920 tons) is $1,128,000	$ (1,128,000)	
Perhaps the animal feed could be sold as an alternate fuel source for $40 per ton	-40	
Thus the total profit for fuel could be $224,600	$ (225,600)	
Winchester normally receives 3 million lbs of product a week = 1,500 tons	1,500	
The amount of birds per ton destroyed daily during the AI 2002 was 188 tons	188	
Total cost of using Winchester Plant for disposal is $2,157,206	**$ 2,157,206**	
Total cost of re-utlizing protein as feed is $662,606	**$ 662,606**	
Total cost of burning protein is $ 1,565,006	**$ 1,565,006**	
Total cost of Winchester Plant + displacement of personnel is $2,820,206	**$ 2,820,206**	
30 employees needed to be relocated weekly	30	
$ 500 per dieum (75room + 25 food) per 5 day work week	500	
$100 Travel a week for travel	100	
$ 100 A week per bonus per person	100	
A total of $21,000 expense is needed a week to relocate 30 people	21,000	
30 trucks will have to be relocated	30	
Distance trucks need to travel will cost $ 2 per mile	2	
On average each truck will have to travel $100 miles a day further than normally	100	
To run the trucks per day on satelite location 6,000 tons/ day will need to be relocated	6,000	
To run the trucks per week on satelite location 30,000 tons/week will need to be relocated	30,000	
Total cost of displacement of 30 trucks and 30 workers per week	51,000	
Total cost of displacement of 30 trucks and 30 workers for 90 days	663,000	

Table 25: Costs of Rendering 16,920 tons of poultry carcasses at Linville Rendering

Linville normally receives 5 million lbs of product a week = 2500 tons/week or 125 truck loads/week or 18 trucks/day	2,500	125
Linville normally receives all product from local suppliers in the area = 2500 tons/week or 125 truck loads/week	2,500	125
To divert local products in Winchester area to go to other plants it will cost $10-25 per ton	$ 10.00	
Approximate cost of hauling good product to other plants would be per week is	$ 25,000.00	
Tons of poultry carcasses per tractor trailer load is 20	20	
Linville would need to divert 42.5 trailer loads to other surrounding rendering plants	42.5	
Cost per week to divert 43 trailer loads is $ 85	$ 8,500.00	
Cost per day to divert 43 trailer loads $1214.29	$ 1,214.29	
Total cost for 90 days to divert 43 trailer loads is $109,285.71	$ 109,285.71	
Cost per Ton to receive poultry carcasses at Linville Plant is $80 per ton	$ 80	
Total Cost to receive poultry 16,800 tons of carcasses at Linville Plant is $1,353,600	$ 1,353,600	
Cost per mile for regular dump truck to haul waste to landfill is $1.70 per mile	$ 1.70	
Cost per mile for special waste disposal dump truck to haul waste to landfill is $2.50 per mile	$ 2.50	
Linville has a total of 6 special waste disposal dump trucks on site to haul waste	6	
The average total miles from Shannadoah valley poultry houses to Linville Plant is 10 miles	10	
Each truck could make 4 trips a day to Shannadoah valley poultry houses	4	
Rental of 9 special waste disposal trucks per day costs $450	9	$ 450
Rental of 9 special waste disposal trucks per week costs $3,150	9	$ 3,150
Rental of 9 special waste disposal trucks for 90 days costs $40,500	9	$ 40,500

Continuation **Table 25:** Linville Plant

VA AI 2002 Outbreak resulted in the destruction of approximately 16920 tons of birds	16,920	
Outbreak on average lasted for 90 days.	90	
The amount of birds per ton destroyed daily was 188 tons daily or 1,316 per week	188	1,316
9 trucks daily would be needed to haul the destroyed birds	9	
Total tonnage of finished product needed to be hauled away is 5,640 tons (rendering reduces 1/3 of weight)	5,640	
Number of trucks to haul finished product away is 282 trucks	282	
Total cost of hauling finished product 25 miles away is $23,970	25	$ 23,970
Cost of landfill per ton is $ 65 thus total cost for finished product is $366,000	65	$ 366,600
Price to sell as a feed product per ton is $200	-200	
Thus total profit for finished product is of rendered (16920 tons) is $1,128,000	$ (1,128,000)	
Perhaps the animal feed could be sold as an alternate fuel source for $40 per ton	-40	
Thus the total profit for fuel could be $225,600	$ (225,600)	
Linville normally receives 5 million lbs of product a week =2500	2,500	
The amount of birds per ton destroyed daily during the AI 2002 was 188 tons / day	188	
Total cost of using Linville Plant for disposal is $1,932,656	**$ 1,932,656**	
Total cost of re-utlizing protein as feed is $483,056	$ 438,056	
Total cost of burning protein is $ 1,193,563	$ 1,193,563	
Total cost of Linville Plant + displacement of personnel is $2,701,556	**$ 2,701,556**	
30 employees needed to be relocated weekly	30	
$ 500 per dieum (75room + 25 food) per 5 day work week	500	
$100 Travel a week for travel	100	
$ 100 A week per bonus per person	100	
A total of $21,000 expense is needed a week to relocate 30 people	21,000	
30 trucks will have to be relocated	30	
Distance trucks need to travel will cost $ 2 per mile	2	

Continuation **Table 25:** Linville Plant

On average each truck will have to travel 100 miles a day further than normally	100	
To run the trucks per day on satelite location 6,000 tons/ day will need to be relocated	6,000	
To run the trucks per week on satelite location 30,000 tons/week will need to be relocated	30,000	
Total cost of displacement of 30 trucks and 30 workers per week is $51,000	51,000	
Total cost of displacement of 30 trucks and 30 workers for 90 days is $663,000	663,000	
Dedicated Entire Plant to Outbreak		
Weekly Feather Transportation		
Cost to re-locate Richmond feathers is $6000 ($400x15 trips)	$ 6,000	($400x15 trips)
Cost to re-locate Linville feathers (local feathers) is $21,000 ($1000x15 trips)	$ 21,000	($1000x15 trips)
Weekly Offal Transportation		
Cost to re-locate Richmond Offal is $12,000 ($400x30 trips)	$ 12,000	($400x30 trips)
Cost to re-locate Salem VA Offal is $2,400 ($300x18 trips)	$ 2,400	($300x8trips)
Cost to re-locate New Market Offal is $5,400 ($300x18 trips)	$ 5,400	($300x18trips)
Cost to re-locate Harrisonburg Offal is $9000 ($300x30 trips)	$ 9,000	($300x 30trips)
Cost to re-locate Bridgewater Offal is $4,500	$ 4,500	($300x15 trips)
Cost to re-locate Hatchery waste is $1,200 ($300x4 trips)	$ 1,200	($300x4 trips)
Cost to re-locate different Routes for Offal is $9000 ($300x30 trips)	$ 9,000	($300x30 trips)
Total cost to move raw material	**$ 70,500**	
Finished products		
Weekly Transportation Costs		
Fat from Winchester	$ 3,000	($300x10 trips)
Fat from Emporia	$ 5,000	($500x10 trips)
Meal from Winchester	$ 2,400	($300x8 trips)
Meal from Emporia	$ 5,000	($500x10 trips)

Continuation **Table 25:** Linville Plant

Meal from Fayetteville	$ 10,000	($1000x10 trips)
Total cost to return finished products	**$ 25,400**	
Loss of Blending capacity	**$ 10,000**	($10/tonx1000tons)
Total Week Cost of Relocation	**$ 105,900**	(relocating 30 drivers)
Dedicated one part of the Plant to Outbreak (1200 lb Cooker)		
Weekly Feather Transportation		
Cost to re-locate Richmond feathers is $6000 ($400x15 trips)	$ -	no trips
Cost to re-locate Linville feathers (local feathers) is $21,000 ($1000x15 trips)	$ -	no trips
Weekly Offal Transportation		
Cost to re-locate Richmond Offal is $12,000 ($400x30 trips)	$ 12,000	($400x 30 trips)
Cost to re-locate Salem VA Offal is $2,400 ($300x18 trips)	$ -	($300x8 trips)
Cost to re-locate New Market Offal is $5,400 ($300x18 trips)	$ -	($300x18 trips)
Cost to re-locate Harrisonburg Offal is $9000 ($300x30 trips)	$ -	($300x 30 trips)
Cost to re-locate Bridgewater Offal is $4,500	$ -	($300x 15 trips)
Cost to re-locate Hatchery waste is $1,200 ($300x4 trips)	$ -	($300x 4 trips)
Cost to re-locate different Routes for Grease ($300x30 trips)	$ 4,500	($300 x 30 trips)
Total cost to move raw material	**$ 16,500**	
Finished products		
Weekly Transportation Costs		
Fat from Winchester	$ 1,200	(300x4 trips)
Fat from Emporia	$ -	no trips
Meal from Winchester	$ -	no trips
Meal from Emporia	$ -	no trips
Meal from Fayetteville	$ 3,000	(1000x 3 trips)
Total cost to return finished products	**$ 4,200**	
Loss of Blending capacity	**$ -**	no loss

Continuation **Table 25:** Linville Plant

Total Week Cost of Relocation	**$ 20,700**	(relocating 3 drivers)
Protein Going to Landfill		
One time costs		
Will need to install special screw conveyers to remove partially rendered "sterile" product at a cost of $25,000	$ 25,000	(screw conveyers)
Will need to pave 200 yards of gravel road behind the plant to the special screw conveyers at a cost of $15,000	$ 15,000	(pave road)
Landfill or not will spend $18,000 for special knife rotaters to crush the birds once unloaded from trucks	**$ 18,000**	(knife rotaters system)

Appendix 8 – Alkaline Hydrolysis

Table 26: Cost of Alkaline Hydrolysis for disposal of a total of 16,920 tons of poultry carcasses

USDA-APHIS Mobile Tissue Digestors		
Estimation of services and cost for VA AI 2002 outbreak (16,920 tons)		
Conversion units:		
8.33 lbs/gal (density H20)	8.33	
USDA Mobile Tissue Digestor Capabilities		
Per cycle you will need:		
4000 lbs of carcasses	4000	
400 lbs of chemical NaOH or 560 lbs of chemical if KOH	400	
4000 lbs of water or 480 gallons of water	4000	
A total of 8600 lbs of effluent per cycle will be produced	8400	
A total of 1008 gallons of effluent will be produced	1,008	
Individual Item Costs		
What is the cost of water per gallon? (in $/gal)	**$ 0.0017**	
Estimated Alkali cost per pound. ($/lb) - purchased in bulk	**$ 0.1000**	
Electricity cost per KWH (in $/KWH)	**$ 0.0600**	
Steam cost per pound of 70 psi steam. ($/lb)	$ 0.0060	
Sewer cost ($/gal)	**$ 0.0012**	
Landfill cost ($/ton)	$ 20.00	
Hot rinse water usuage ($/gal)	0.000746	
MAXIMUM TONNAGE TO BE PROCESSED is 16920 Tons	**16,920**	
TIME FOR PROCESSING ABOVE WASTE is 90 days	**90**	
	Daily lbs	**90 Days**
POUNDAGE PER DAY needed to be processed is 376,000 lbs or 188 tons	**376,000**	**33,840,000**
Approximately 15.67 tons of carcasses will be processed with 12 machines	15.67	
MAXIMUM POUNDS PER LOAD processable per machine is 4000 lbs	4,000	
LOADS PER DAY TO PROCESS DAILY is 94	94	
HEAT UP TIME is 60 minutes for the machine	60	
PROCESS TIME is 60 minutes for the carcasses	60	
COOLDOWN TIME is 60 minutes before the cooker can be opened	60	

Continuation of **Table 26:** Cost of Alkaline Hydrolysis

TOTAL CYCLE TIME for poultry carcasses is 180 mintues or 3 hours	180	
NUMBER OF CYCLES PER UNIT/DAY is 8	8	
NUMBER OF UNITS needed is 12 (94 loads / 8 cycles)	**Daily**	**90 Days**
The total amount of effluent produced daily is 789,600 lbs	789,600	71,064,000
Amount chemical product (NaOH) needed for 12 units daily is 37,600	37,600	3,384,000
The cost of the chemical product (NaOH) for 12 units is $3,760	**$ 3,760**	**$ 338,400**
The total amount of effluent produced daily is 94,790gallons	94,790	8,531,092
The total amount of water needed per days is 45,120	45,120	4,060,800
The total cost of water is $76.70	**$ 76.70**	**$ 6,903.36**
The total cost for disposal into the sewage is $113.75	**$ 113.75**	**$ 10,237.31**
The total amount of RINSE WATER USED DAILY is 282,000 lbs	282,000	25,380,000
The total amount of RINSE WATER USED DAILY is 33,854 gallons	33,854	3,046,819
1.52gallons of propane = 1 gallon of No. 2 fuel oil		
The total amount of BTU required daily for 12 units is 1,002,416,000	979,104,000	88,119,360,000
(GAL OF OIL); $1.80/gal; 1 gallon = 139,500 BTUs (No.2 heating oil)	7,532	677,841
The total cost of oil for 12 units per day is $ $13,557	**$ 13,557**	**$ 1,220,114**
(GAL OF PROPANE) $1.18/gal; 1 gallon = 91,500 BTUs	8,092	$ 728,259.17
The total cost of propane for 12 units per day is $9,629	$ 9,629	$ 115,550.46
The total daily consumption of electricity for 12 units is 11,280 KW-HR	11,280	1,015,200
The total daily cost of electricity to power 12 units daily is $677	**$ 677**	**$ 60,912**
The total cost of 24 people (12 hr shifts, operators) at $30/hr is $8640.00	**$ 8,640.00**	**$ 777,600.00**
Electricity has 3,413 BTUs per kilowatt hour (kwh) and is 100% efficient		
propane has 91,500 BTUs per gallon and is 80% efficient		
	Daily	

Continuation of **Table 26:** Cost of Alkaline Hydrolysis

Cost per 1 unit (8 cycles/per/unit) in 24hrs, Max capacity/unit = 16 tons/day	32,000	
The total amount of effluent produced daily is 65,800 lbs per machine	65,800	
Amount chemical product (NaOH) needed for 1 units daily is 3,133	3,133	**% of Cost**
The cost of the chemical product (NaOH) for 1 unit is $ 313.33	**$ 313.33**	**20.68%**
The total amount of effluent produced daily is 7,899 gallons	7,899	
The total amount of gallons of water needed per days is 3,760	3,760	
The total cost of water is $6.39 / machine per day	**$ 6.39**	**0.42%**
The total cost for disposal into the sewage is $9.48 / machine	**$ 9.48**	**0.63%**
The total amount of RINSE WATER USED DAILY is 23,500lbs per machine	23,500	
The total amount of RINSE WATER USED DAILY is 2,821 gallons/machine	2,821	
1.52gallons of propane = 1 gallon of No. 2 fuel oil		
The total amount of BTU required daily for 1 unit is 81,592,000	81,592,000	
(GAL OF OIL); $1.80/gal; 1 gallon = 139,500 BTUs (No.2 heating oil)	628	
The total cost of oil for 1 unit per day is $1,129.74	**$ 1,129.74**	**74.55%**
(GAL OF PROPANE) $1.18/gal; 1 gallon = 91,500 BTUs	674	
The total cost of propane for 1 unit per day is $802.43	$ 802.43	
The total cost of labor per unit for a 24 hour period is $ 720	**$ 720.00**	**47.51%**
The total daily consumption of electricity for 1 units is 940 KW-HR	940	
The total daily cost of electricity to power 1 unit daily is $56.40	**$ 56.40**	**3.72%**
Total Cost/Day/1 unit to dispose of 16 tons is 1,515.34	**$ 1,515.34**	**100%**
Total Cost/Day/12 units to dispose of 187 tons / day is $ 18,184.08	**$ 18,184.08**	
Total Cost/90Days/12 units is $1,636,566.89	**$ 1,636,566.89**	
Total Cost / Ton is $96.72	**$ 96.72**	
Total Cost / lb is $.05	**$ 0.05**	
Costs of one unit (USDA Mobile Alkaline Hydrolyzer) is $975,000	**$975,000**	
Cost of 12 units is $11,700,000	**$11,700,000**	

Appendix 9 – In-Situ Plasma Vitrification

Table 27: Cost of In-Situ Plasma Vitrification to dispose of 16,920 tons of carcasses

One 2.4MW Torch can emit 2,400 KWH of electricity per hour	2400
Amount electricity needed to vitrify 1 ton of carcasses is 750 KWH	750
Total poultry carcass tonnage vitricated in 1 hour with a 2.4 MW Torch is 3.2 tons	3.2
1 KWH costs $0.06	0.06
2400 KWH costs	$ 144
A burial pit could be dug up in 1 day for a total cost of $3000	$ 3,000
Labor costs to operate 4 torches a day is $2000 (2 shifts @ 8hrs = 16 hrs/day; 4 workers/shift, $250/worker)	$ 2,000
Four 2.4 MW Torch can emit 9,600 KWH of electricity	9600
Amount electricity needed to vitricate 1 ton of carcasses is 750 KWH	750
Total poultry carcass tonnage vitrified with four 2.4 MW torches in 1 hour is 12.8 tons	12.8
Total poultry carcass tonnage vitrified in 24 hour with four 2.4 MW torches is 307.3 tons	307.2
Total cost of electricity of Four 2.4 MW Torch an hour is $ 576	$ 576
Total cost of electricity of Four 2.4 MW Torch in 24hrs is $13,824	$ 13,824
Total number of hours needed for operation of torches for 188 tons is 14.7 hrs	14.7
Total cost in electricity needed for operation of torches for 188 tons per day is $8,460	$ 8,460
Total cost in electricity needed for operation of torches for 16920 tons is $761,400	$ 761,400
Total cost to dig 1 burial pit per day for a total of 90 days is $ 270,000	$ 270,000
Total labor costs for operation of four torches per day for 90 days is $180,000	$ 180,000
Total operating cost of ISVP to dispose of 16920 tons of carcasses is $1,211,400	$ 1,211,400
Average operating cost per ton of ISVP technology is $71.60	$ 71.60
Costs are based on assuming purchasing of four 2.4 MW toches at $2,000,000 a piece	$ 8,000,000
Costs of purchasing a collection hood to neutralize escaping gases for all 4 torches costs $500,000	$ 500,000

Appendix – 10 Disposal Costs of AI 2002 Outbreak

Table 28: Abbreviations which explain **Table 29**

Abbreviations	
$/Ton =	Cost per ton
Burial =	On site-burial
Charl =	Charles City County Landfill
Comp =	Composting
Fred =	Frederick County Landfill
Haul $ =	Hauling costs of trucks at $2.5 a mile
Incin =	Incineration
Miles =	Distance Trucks travel one-way
Page =	Page County Landfill
Rental $ =	Truck Rental at $45/hour for an average of 10 hours / day
Rock =	Rockingham County Landfill
Slau =	Slaughtering done at Meat Plant
Sux =	Sussex County Landfill
T Cost =	Total cost for each individual method of disposal
Ton =	Tonnage of caracass disposal
Total $/ton =	Total cost / ton
Truck =	Number of trucks needed to transport 20 tons of carcasses
Trans$ =	Total Cost of Transportation = Rental plus Hauling

Table 29: Summary of approximate costs of AI 2002 Outbreak, costs do not reflect disinfection of premises or equipment.

	Ton	$/Ton	Total $/ton	Miles	Truck	Rental $	Haul $	T Cost
Rock	3,400	45	$ 153,000	10	170	$ 91800	$ 8,500	**$ 253,300**
Page	951	89	$ 84,639	40	48	$ 25677	$ 9,510	**$ 119,826**
Fred	842	65	$ 54,730	75	42	$ 22734	$ 15,788	**$ 93,252**
Charl	4,610	50	$ 230,500	160	231	$ 124470	$ 184,400	**$ 539,370**
Sux	4,625	45	$ 208,125	175	231	$ 124875	$ 202,344	**$ 535,344**
Incin	2,268	477	$ 1,081,836	30	113	$ 61236	$ 17,010	**$ 1,160,082**
Comp	75	60	$ 4,500	0	4	$ 2025	0	**$ 6,525**
Burial	128	30	$ 3,840	0	6	$ 3456	0	**$ 7,296**
Slau	20	0	0	30	1	$ 537	$149	**$ 687**
Totals	**16,919**		**$ 1,821,170**		**846**	**$ 456810**	**$ 437,701**	**$ 2,715,681**
						Trans$		**Cost / Ton**
						$ 894,511		**$ 160.51**

Appendix 11 – Overall Comparisons of Disposal Methods

Table 30: Abbreviations which are used in **Table 31**

Abbreviations	
$ of AI =	Total cost to dispose of 16,920 tons of poultry carcasses
$/T =	Cost/ton
24hrs =	Currently available within 24 hours
AH =	Alkaline Hydrolysis
B =	On-Site Burial
C =	Composting
DP =	Disposal of Processed Carcass
H$ =	Hauling Costs
I =	Incineration
IP =	In-Situ Plasma Vitrification
IU =	Immediate use of processed product with current technology
LF =	Landfill
MU =	Average cost/ton for disposal method used during AI Outbreak
PR =	Potential Re-usable agriculture product
R =	Rendering plant located ni Winchester 75 miles away
TR$ =	Truck rental costs
TT$ =	Total Cost which includes transportation and disposal
Note	Rendering changed from $80/ton to $149/ton due to additional costs of displacement of personnel. There is also "0" rental costs since the rendering plant owns their own trailers.

Table 31: Overall Comparisons of Disposal Methods based on the total tonnage disposed of during the VA AI 2002 Outbreak which was 16,920 tons (188 tons / day for 90 days)

	$/T	$ of AI	TR$	H$	TT$	24hrs	DP	PR	IU
B	30	507,600	0	0	507,600	yes	no	no	no
LF	55	930,600	380,700	274,950	1,586,250	yes	no	no	no
C	60	1,080,000	0	0	1,080,000	yes	yes	yes	yes
IP	72	1,221,400	0	0	1,221,400	no	no	yes	no
R	149	2,516,456	0	303,750	2,820,206	yes	yes	yes	yes
AH	97	1,636,567	380,700	274,950	2,292,217	no	yes	yes	no
MU	108	1,821,170	456,810	437,701	2,715,681	yes			
I	477	8,070,840	380,700	0	8,451,540	yes	yes	yes	yes
		Total Tons	# Trucks						
		16,920	846						