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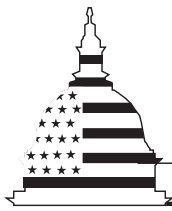
Report to Congressional Requesters

September 2008

CONCENTRATED ANIMAL FEEDING OPERATIONS

EPA Needs More Information and a Clearly Defined Strategy to Protect Air and Water Quality from Pollutants of Concern



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GAO-08-944

September 2008

CONCENTRATED ANIMAL FEEDING OPERATIONS

EPA Needs More Information and a Clearly Defined Strategy to Protect Air and Water Quality from Pollutants of Concern

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Highlights

Highlights of GAO-08-944, a report to congressional requesters

Why GAO Did This Study

Concentrated Animal Feeding Operations (CAFO) are large livestock and poultry operations that raise animals in a confined situation. CAFOs can improve the efficiency of animal production but large amounts of manure produce can, if not properly managed, degrade air and water quality. The Environmental Protection Agency (EPA) is responsible for regulating CAFOs and requires CAFOs that discharge certain pollutants to obtain a permit.

This report discusses the (1) trends in CAFOs over the past 30 years, (2) amounts of waste they generate, (3) findings of key research on CAFOs' health and environmental impacts, (4) EPA's progress in developing CAFO air emissions protocols, and (5) effect of recent court decisions on EPA's regulation of CAFO water pollutants. GAO analyzed U.S. Department of Agriculture's (USDA) data from 1982 through 2002, for large farms as a proxy for CAFOs; reviewed studies, EPA documents, laws, and regulations; and obtained the views of federal and state officials.

What GAO Recommends

To more effectively regulate CAFOs, GAO recommends that EPA complete its inventory of permitted CAFOs, reassess the current nationwide air emissions monitoring study, and establish a strategy and timetable for developing a process-based model for measuring CAFO air emissions. EPA partially agreed with GAO's recommendations.

To view the full product, including the scope and methodology, click on GAO-08-944. For more information, contact Anu Mittal (202) 512-3841, mittala@gao.gov.

What GAO Found

Because no federal agency collects consistent, reliable data on CAFOs, GAO could not determine the trends in these operations over the past 30 years. However, using USDA data for large farms that raise animals as a proxy for CAFOs, it appears that the number of these operations increased by about 230 percent, going from about 3,600 in 1982 to almost 12,000 in 2002. Also, during this 20-year period the number of animals per farm had increased, although it varied by animal type. Moreover, GAO found that EPA does not have comprehensive, accurate information on the number of permitted CAFOs nationwide. As a result, EPA does not have the information it needs to effectively regulate these CAFOs. EPA is currently working with the states to establish a new national data system.

The amount of manure generated by large farms that raise animals depends on the type and number of animals raised, but large operations can produce more than 1.6 million tons of manure a year. Some large farms that raise animals can generate more raw waste than the populations of some U.S. cities produce annually. In addition, according to some agricultural experts, the clustering of large operations in certain geographic areas may result in large amounts of manure that cannot be effectively used as fertilizer on adjacent cropland and could increase the potential of pollutants reaching nearby waters and degrading water quality.

Since 2002, at least 68 government-sponsored or peer-reviewed studies have been completed that examined air and water quality issues associated with animal feeding operations and 15 have directly linked air and water pollutants from animal waste to specific health or environmental impacts. EPA has not yet assessed the extent to which these pollutants may be impairing human health and the environment because it lacks key data on the amount of pollutants that are being emitted from animal feeding operations.

As a first step in developing air emissions protocols for animal feeding operations, in 2007, a 2-year nationwide air emissions monitoring study, largely funded by industry, was initiated. However, as currently structured, the study may not provide the scientific and statistically valid data it was intended to provide and that EPA needs to develop air emissions protocols. Furthermore, EPA has not established a strategy or timetable for developing a more sophisticated process-based model that considers the interaction and implications of all emission sources at an animal feeding operation.

Two recent federal court decisions have affected EPA's ability to regulate water pollutants discharged by CAFOs. The 2005 *Waterkeeper* case required EPA to abandon the approach that it had proposed in 2003 for regulating CAFO water discharges. Similarly, the 2006 *Rapanos* case has complicated EPA's enforcement of CAFO discharges because EPA believes that it must now gather significantly more evidence to establish which waters are subject to the Clean Water Act's permitting requirements.

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Abbreviations

CAFO	Concentrated Animal Feeding Operation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
NAS	National Academy of Sciences
NPDES	National Pollutant Discharge Elimination System
USDA	U.S. Department of Agriculture

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United States Government Accountability Office
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September 4, 2008

Congressional Requesters

Over the last 40 years, diversified, independent, family-owned-and-operated farms that produce a variety of crops and a few animals are becoming a smaller share of the agricultural sector and are being replaced by fewer, much larger farms. For animal production, this change has meant a movement to significantly larger operations that can raise, for example, as many as 2 million chickens or 800,000 hogs at one facility at one time.

These large-scale livestock and poultry operations are generally referred to as animal feeding operations. An animal feeding operation is one that (1) raises animals in a confined situation for a total of 45 days or more during a 12-month period and (2) brings feed to the animals rather than having the animals graze or seek feed in pastures and fields or on rangeland. Concentrated animal feeding operations (CAFO) are a subset of animal feeding operations and usually operate on a much larger scale. Generally, a CAFO is an animal feeding operation that raises enough animals to meet or exceed certain minimum thresholds, depending upon the type of livestock being raised. For example, as defined in Clean Water Act regulations, an animal feeding operation would be considered a CAFO if it raised 1,000 or more beef cattle, 2,500 hogs weighing more than 55 pounds, or 125,000 broiler chickens.[1] In addition, an animal feeding operation of any size can be designated a CAFO if it meets certain conditions, such as being a significant contributor of pollutants to federally regulated waters.[2]

While CAFOs may have improved the efficiency of the animal production industry, they have also raised environmental and health concerns because of the large amounts of manure they produce. Generally, to minimize potential environmental problems, these operations retain the manure that they produce in storage facilities onsite and periodically dispose of it by spreading it on nearby or adjacent cropland as fertilizer. If the manure is properly contained and managed, it can benefit crop production; if improperly contained and managed, it can degrade air and

[1]40 C.F.R. § 122.23(b).

[2]Federally regulated waterways include waters of the United States as defined in 33 C.F.R. § 328.3(a)(1)-(7) and may include rivers, wetlands, impoundments, the territorial seas, and waters used in interstate commerce.

water quality, thereby potentially impairing human health and damaging the environment. Specifically, these operations can potentially degrade air quality because large amounts of manure may emit unsafe quantities of ammonia, hydrogen sulfide, and particulate matter,[3] and they can potentially degrade water quality because pollutants in manure such as nitrogen, phosphorus, bacteria, and organic matter could enter nearby water bodies.

Several federal laws provide the Environmental Protection Agency (EPA) with the authority to regulate water and air pollutants from CAFOs. The Clean Water Act specifically addresses CAFOs by requiring EPA to consider CAFOs like any other industry if they discharge pollutants into federally regulated waters. As a result, CAFOs that have such discharges must obtain a permit that establishes design standards and management practices for retaining and disposing of manure in such a way as to limit the amounts and types of pollutants from manure that are released into federally regulated waters. EPA, or the states that have been authorized by EPA to administer the Clean Water Act, are responsible for issuing these permits. In contrast, three other acts provide EPA with certain authorities related to air emissions from these operations, although they do not specifically cite CAFOs as regulated entities. Under the Clean Air Act, any animal feeding operation, regardless of size, that exceeds established air emission thresholds for certain pollutants can be regulated. For example, pollutants such as particulate matter that are emitted by animal feeding operations are regulated under the Clean Air Act and other pollutants such as hydrogen sulfide or ammonia may be regulated under the act in certain circumstances. Similarly, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) do not specifically mention CAFOs, but they do require owners or operators of these facilities to report to federal or state and local authorities when a "reportable quantity" of certain hazardous substances, such as hydrogen sulfide or ammonia,[4] is released into the environment. Together, CERCLA's and EPCRA's reporting requirements provide government authorities, emergency management agencies, and citizens the ability to

[3]Particulate matter is a complex mixture of extremely small particles and liquid droplets. Particulate matter can be made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

[4]Each of these hazardous substances has a reportable quantity of 100 pounds in a 24-hour period.

know about the source and magnitude of hazardous releases into the environment.

In light of the growing concerns regarding the potential human health and environmental impacts of CAFOs, you asked us to determine the (1) trends in CAFOs over the past 30 years; (2) amount of waste they generate; (3) findings of recent key academic, industry, and government research on the impacts of CAFOs on human health and the environment, and the extent to which EPA has assessed the nature and severity of such impacts; (4) progress that EPA and the states have made in regulating and controlling the emissions of, and in developing protocols to measure, air pollutants from CAFOs that could affect air quality; and (5) extent to which recent court decisions have affected EPA and the states' ability to regulate CAFO discharges that impair water quality.

In conducting our work, we reviewed laws and regulations and federal and state agencies' documents; met with officials from EPA and the U.S. Department of Agriculture (USDA), industry, citizen and environmental groups, and academia. We also spoke with state officials and visited CAFOs in eight states. These states were Arkansas, California, Colorado, Iowa, Maryland, Minnesota, North Carolina, and Texas. We chose these states because they were geographically dispersed and contained numerous CAFOs representing various animal types. In addition, to determine trends in CAFOs over the past 30 years, from 1974 through 2002, we obtained the most recent data available from USDA on large farms that raise animals to use as a proxy for CAFO data. However, because of limitations in USDA's data for 1974 through 1982, we could not determine from these data which farms prior to 1982 would meet EPA's minimum size thresholds for CAFOs. Consequently, our analysis of trends in CAFOs focuses on the 20-year period between 1982 and 2002. We also obtained and reviewed the data that EPA compiled over the last 5 years from each of its regions on the number of CAFOs that were issued a permit. To identify the amount of waste CAFOs generate, we estimated the amounts of manure generated by various size farms that raise animals. To provide a perspective of the amount of waste that large farms that raise animals can generate, we selected certain cities based on their population and estimated the amount of sanitary waste generated by the human population and compared these amounts with the amount of waste generated by three different sizes of large farms.[5] To report on key research on the impacts of CAFOs on human health and the environment,

[5]Human sanitary waste includes feces and urine but does not include wastes such as water from showers, washing dishes and clothes, and flushing toilets.

we reviewed EPA's 2003 Rule regulating discharges from CAFOs under the Clean Water Act and the National Academy of Sciences study on air emissions from animal feeding operations.[6] We also conducted library and Internet searches to identify key studies completed since 2002 on air and water pollutants from waste generated by animal feeding operations. We compared the findings from these studies with EPA assessments to date and interviewed EPA officials regarding these assessments. To assess the progress that EPA and the states have made in regulating and controlling the air emissions of, and in developing protocols to measure, air pollutants from CAFOs, we reviewed relevant documents and interviewed EPA officials, as well as officials responsible for an ongoing national air emissions monitoring study. In addition, we contacted state officials in all 50 states to determine which states had developed air emission regulations applicable to CAFOs. Finally, to determine the extent to which recent court decisions have affected EPA and the states' ability to regulate CAFO discharges that impair water quality, we reviewed the results of recent federal and state court decisions. We also interviewed EPA and state officials on how the court decisions have affected their ability to regulate CAFOs. A more detailed description of our scope and methodology is presented in appendix I.

We conducted this performance audit between July 2007 and August 2008, in accordance with generally accepted government auditing standards. These standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

No federal agency collects accurate and consistent data on the number, size, and location of CAFOs. However, according to USDA officials, the data USDA collects for large farms that raise animals can serve as a proxy in estimating trends in CAFOs nationwide from 1982 through 2002. Using these data, we found that the number of large farms that raise animals has increased 234 percent, from about 3,600 in 1982 to almost 12,000 in 2002. We found that the number of animals raised on these large farms had also increased, but the rate of increase varied greatly by animal type. For example, the average number of hogs raised on large farms increased by 37 percent, from about 3,400 in 1982 to nearly 4,600 in 2002. In contrast,

[6]National Academy of Sciences, *Air Emissions from Animal Feeding Operations: Current Knowledge, Future Needs* (Washington, D.C.: National Academies Press, 2003).

during the same time period, the average number of broiler chickens raised on large farms only increased by about 3 percent, from approximately 155,000 to nearly 160,000. Furthermore, almost half of the livestock and poultry raised in the United States in 2002, about 43 percent, were raised on large farms. Over the last 5 years, EPA has been compiling data from its regions in an effort to develop information on the number of permitted CAFOs nationwide. However, we determined that these data are inconsistent and inaccurate and do not provide necessary information on the characteristics of these CAFOs. Without a systematic and coordinated process for collecting and maintaining accurate and complete information on the number, size, and location of permitted CAFOs, EPA does not have the information that it needs to effectively regulate these operations. EPA has indicated that it is working with the states to develop and implement a new national system to collect and maintain these data.

The amount of manure that a large farm raising animals can generate depends on the types and numbers of animals being raised at a specific operation; such farms can produce from over 2,800 tons to more than 1.6 million tons of manure annually. For example, a layer farm that meets EPA's minimum large CAFO threshold of 82,000 laying hens could produce more than 2,800 tons of manure a year, while a farm with 10,000 beef cattle (cattle fattened with feed) could produce about 117,000 tons of manure a year. In fact, some large farms can produce more raw waste than the human population of a large U.S. city. For example, a very large hog farm, with as many as 800,000 hogs, generates more than 1.6 million tons of manure annually—more than one and a half times the sanitary waste produced by the about 1.5 million residents of Philadelphia, Pennsylvania in 1 year. Furthermore, while manure is a valuable resource often used as fertilizer, agricultural experts and government officials have raised concerns about the large amounts of manure produced by animal feeding operations that are increasingly clustered within specific geographic areas within a state. For example, five contiguous North Carolina counties had an estimated hog population of over 7.5 million hogs in 2002 and the hog operations in these counties could have produced as much as 15.5 million tons of manure that year. According to agricultural experts and government officials that we spoke to, such clustering of operations raises concerns that the amount of manure produced could result in the overapplication of manure to croplands in these areas and the release of excessive levels of some pollutants that could potentially damage water quality.

At least 68 government-sponsored or peer-reviewed studies have been completed on air and water quality issues associated with animal waste since 2002 and 15 of these studies have directly linked pollutants from

animal waste to specific health or environmental impacts. Of the remaining 53 studies, 7 found no impacts, 12 made indirect linkages between these pollutants and health and environmental impacts, and 34 of the studies focused on measuring the amount of water or air pollutants emitted by animal feeding operations. However, EPA has not yet assessed the extent to which air and water pollution from CAFOs may be impairing human health and the environment because it lacks key data on the amount of pollutants that CAFOs are discharging. Of the 15 studies we found directly linking pollutants from animal waste to human health or environmental impacts, 8 focused on water pollutants and 7 on air pollutants. Most of the water studies found that nutrients or hormones released from animal feeding operations were causing environmental harm, such as reproductive disorders in fish and degraded water quality. One water study found that animal feeding operations were causing pathogens such as *E. coli* to contaminate drinking water, which were then causing gastrointestinal illnesses in humans. Similarly, all seven air studies linked air emissions from animal feeding operations to adverse human health effects. Specifically, six found exposure to these emissions caused respiratory inflammation and one found an increased incidence of headaches, eye irritation, and nausea in people working at or living near these operations. According to EPA officials, although the agency has long recognized the potential impacts that water pollutants from CAFOs can have on human health and the environment, it has not yet assessed these impacts because it lacks information on the extent to which water pollutants are actually being discharged by CAFOs. According to other officials at EPA, the agency does not have the resources needed to conduct a study that would provide this information. Likewise, EPA has not yet assessed the air quality impacts from animal feeding operation emissions because, according to agency officials, it lacks key data on the extent to which these operations are emitting pollutants. To gather this information, EPA entered into a series of agreements with animal feeding operations to implement a national air emissions monitoring study that is currently ongoing and is being funded by the industry and will measure and quantify air emissions from animal feeding operations.

The ongoing national air emissions monitoring study is considered a first step in EPA's efforts to develop protocols for measuring and quantifying air contaminants from animal feeding operations; however, it is not clear if the study will provide EPA the data that it needs to develop these protocols. EPA believes that this 2-year study, initiated in 2007, will provide a scientific basis for estimating air emissions from animal feeding operations so that the agency can develop protocols that these operations can use to more quickly determine if they exceed regulatory thresholds. However, concerns have been raised that the animal feeding operations

being monitored in the study do not represent a valid sample of all animal feeding operations and that the data collected during the early phases of the study may be incomplete. As a result, it is uncertain whether the study will ultimately provide data of sufficient quantity and quality that will enable the agency to develop its planned protocols. In addition, it is uncertain if and when EPA will develop a process-based model that considers the interaction and implications of all sources of emissions at an animal feeding operation. Furthermore, other EPA actions make it unclear at this time how the agency intends to regulate air emissions from animal feeding operations once the data collection effort is complete. For example, EPA has not yet decided if it will aggregate the emissions occurring on an animal feeding operation or if the emissions from barns and manure storage areas will be considered separately when determining if an operation has exceeded air emissions thresholds. Moreover, in December 2007, EPA proposed a rule to exempt releases to the air of hazardous substances, such as ammonia and hydrogen sulfide, from manure at farms, including animal feeding operations, which meet or exceed their reportable quantity from both CERCLA and EPCRA notification requirements. EPA stated that, in all instances, the source and nature of the release make emergency responses unnecessary, impractical, and unlikely for these operations, and hence it found notifications to be unnecessary. It is unclear to us how EPA made this determination when it has not yet completed its data collection effort and does not yet know the extent to which animal feeding operations are emitting these pollutants. In the absence of federal guidance on how to regulate air emissions from animal feeding operations, officials in six states told us that they are regulating some emissions covered under the Clean Air Act, CERCLA, and EPCRA. For example, Minnesota has established state emissions thresholds for hydrogen sulfide that apply to CAFOs and the state requires CAFO operators to develop an air emissions plan specifying how they will control these emissions.

Two recent federal court decisions have affected EPA's and some states' ability to regulate CAFOs for pollutants that may impair water quality. Specifically:

- In 2005, in *Waterkeeper Alliance Inc. v. EPA* (*Waterkeeper*), the U.S. Court of Appeals for the Second Circuit set aside key provisions of a CAFO rule EPA had issued in 2003. This rule would have provided EPA with comprehensive information on the universe of CAFOs and their operations and would have subjected large numbers of previously unregulated CAFOs to monitoring and reporting requirements, as well as periodic inspections. However, the court concluded that EPA did not have the authority under the Clean Water Act to require CAFOs that were not discharging pollutants

into federally regulated waters to apply for permits. As a result, CAFO operators currently determine for themselves whether they need to apply for a federal permit, and EPA must rely on other means of acquiring information about CAFOs that are illegally discharging pollutants, such as through citizens' reports. EPA has developed proposed revisions to its 2003 rule in response to the court's ruling. The resulting rule is currently awaiting the Office of Management and Budget's approval, but EPA is not certain when that review will be completed and the final rule issued. The *Waterkeeper* decision has had mixed impacts on states' regulation of CAFOs. Some states have not been affected by the *Waterkeeper* decision because they have used their own authorities to adopt regulations more stringent than federal regulations. As a result, these states, such as Minnesota, have continued to require all CAFOs to obtain state permits. In contrast, officials in those states, such as Colorado, that base their regulations on the Clean Water Act and federal regulations told us that their programs will remain in limbo until EPA issues its final revised rule.

- The Supreme Court's 2006 decision—*Rapanos v. United States* (*Rapanos*)—has also complicated EPA's enforcement of CAFO regulations. The Court's decision has raised questions that have not yet been resolved about which "waters" are considered federal waters and, therefore, fall under the jurisdiction of the Clean Water Act. According to EPA enforcement officials, the agency may be less likely to seek enforcement against a CAFO that it believes is discharging pollutants into a water body because it is now more difficult to prove that the water body is federally regulated. Congress is considering legislation that seeks to clearly define the scope of the Clean Water Act and resolve the questions raised by the *Rapanos* decision.

To more effectively regulate CAFOs, we are recommending that the Administrator of EPA direct the agency to complete its efforts to develop a comprehensive national inventory of permitted CAFOs that incorporates appropriate internal controls to ensure the quality of the data collected. To ensure that the national air emissions monitoring study will provide the scientific and statistically valid data that EPA needs for developing its air emissions protocols, we are recommending that EPA reassess the current data collection efforts, including its internal controls. We are also recommending that EPA establish a strategy and timetable for developing a process-based model that will provide more sophisticated air emissions estimating methodologies for animal feeding operations. In commenting on a draft of this report, EPA partially agreed with our recommendations.

Background

The livestock and poultry industry is vital to our nation's economy, supplying meat, milk, eggs, and other animal products; however, the past several decades have seen substantial changes in America's animal production industries. As a result of domestic and export market forces, technological changes, and industry adaptations, food animal production that was integrated with crop production has given way to fewer, larger farms that raise animals in confined situations. These large-scale animal production facilities are generally referred to as animal feeding operations. CAFOs are a subset of animal feeding operations and generally operate on a larger scale. While CAFOs may have improved the efficiency of the animal production industry, their increased size and the large amounts of manure they generate have resulted in concerns about the management of animal waste and the potential impacts this waste can have on environmental quality and public health.

Animal manure can be, and frequently is, used beneficially on farms to fertilize crops and to restore nutrients to soil. However, if improperly managed, manure and wastewater from animal feeding operations can adversely impact water quality through surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, and leaching into the soil and groundwater. Excess nutrients in water can result in or contribute to low levels of oxygen in the water and toxic algae blooms, which can be harmful to aquatic life. Improperly managed manure can also result in emissions to the air of particles and gases, such as ammonia, hydrogen sulfide, and volatile organic compounds, which may also result in a number of potentially harmful environmental and human health effects.

Most agricultural activities are considered to be nonpoint sources of pollution because the pollution that occurs from these activities is in conjunction with soil erosion caused by water and surface runoff of rainfall or snowmelt from diffuse areas such as farms and rangeland. However, section 502(14) of the Clean Water Act specifically defines point sources of pollution to include CAFOs, which means that under the act, CAFOs that discharge into federally regulated waters are required to obtain a federal permit called a National Pollutant Discharge Elimination System (NPDES) permit. These permits generally allow a point source to discharge specified pollutants into federally regulated waters under specific limits and conditions. These permits are issued by EPA or a state agency authorized by EPA to implement the NPDES program for that state. Currently, 45 states are authorized to administer the NPDES permit program, and their programs must be at least as stringent as the federal

program.[7] In 1976, in accordance with the Clean Water Act's designation of CAFOs as point sources, EPA defined which poultry and livestock facilities constituted a CAFO and established permitting regulations for CAFOs. According to EPA regulations issued in 1976, to be considered a CAFO a facility must first be considered an animal feeding operation. Animal feeding operations are agricultural operations where the following conditions are met:

- animals are fed or maintained in a confined situation for a total of 45 days or more in any 12-month period, and
- crops, vegetation, forage growth, or post harvest residues are not sustained during normal growing seasons over any portion of the lot.

If an animal feeding operation met EPA's criteria and either met or exceeded minimum size thresholds based on the type of animals being raised, EPA considered the operation to be a CAFO. For example, an animal feeding operation would be considered a CAFO if it raised 1,000 or more beef cattle, 2,500 pigs weighing more than 55 pounds, or 125,000 chickens. In addition, EPA could designate an animal feeding operation of any size as a CAFO under certain circumstances. For example, if an animal feeding operation was a significant contributor of pollutants to federally regulated water, EPA could designate the operation as a CAFO. Appendix II lists the full text of EPA's current CAFO definition, including the size thresholds established for small, medium, and large CAFOs.

Under EPA's 1976 CAFO regulations, certain animal feeding operations did not require permits. These included (1) those animal feeding operations that only discharged during a 25-year, 24-hour storm event—which is the amount of rainfall during a 24-hour period that occurs on average once every 25 years or more and (2) chicken operations that use dry manure-handling systems—systems that do not use water to handle their waste. In addition, EPA generally did not regulate animal waste that was applied to cropland or pastureland.

In January 2003, we reported that although EPA believed that many animal feeding operations degrade water quality, it had placed little emphasis on its permit program and that exemptions in its regulations allowed as many as 60

[7]EPA has retained program authority for Alaska, Idaho, Massachusetts, New Hampshire, and New Mexico. Oklahoma has been authorized to issue permits for most sources but not for CAFOs.

percent of the largest operations to avoid obtaining permits.[8] In its response to our 2003 report, EPA acknowledged that the CAFO program was hampered by outdated regulations and incomplete attention by EPA and the states. EPA pointed out that it had revised its permitting regulations for CAFOs to eliminate the exemptions that allowed most animal feeding operations to avoid regulation. The revisions, issued in February 2003 and known as the 2003 CAFO rule, resulted, in part, from the settlement of a 1989 lawsuit by the Natural Resources Defense Council and Public Citizen, in which these groups alleged that EPA had failed to comply with the Clean Water Act. EPA's 2003 CAFO rule included the following key provisions:

- *Duty to apply*. All CAFOs were required to apply for an NPDES permit unless the permitting authority determined that the CAFO had no potential to discharge to federally regulated waters.

- *Expanded CAFO definitions to include all poultry operations and stand-alone operations raising immature animals.* The previous rule had applied only to poultry operations that used a liquid manure-handling system. The 2003 rule expanded the CAFO definition to all types of poultry operations, and EPA officials estimated that this revision could result in almost 2,200 additional poultry operations requiring a permit.

- *More stringent design standard for new facilities in the swine, poultry, and veal categories.* Under the previous rule, facilities were to be designed, constructed, and operated to contain runoff from a 25-year, 24-hour rainfall event; this continues to be the rule for existing facilities. For new facilities, the 2003 rule established a no-discharge standard that can be met if the facilities are designed, constructed, and operated to contain the runoff from a 100-year, 24-hour storm event.

- *Best management practices*. Operations would be required to implement best management practices for applying manure to cropland and for animal production areas. The rule required, among other things, specified setbacks from streams, vegetated buffers, depth markers in lagoons, and other impoundments for production areas to prevent or reduce pollution from the operation.

- *Nutrient management plans.* CAFO operations would be required to develop a plan for managing the nutrient content of animal manure as well

[8]GAO, *Livestock Agriculture: Increased EPA Oversight Will Improve Environmental Program for Concentrated Animal Feeding Operations*, GAO-03-285 (Washington, D.C.: Jan. 16, 2003).

as the wastewater resulting from CAFO operations, such as water used to flush manure from barns.

- *Compliance schedule*. The 2003 rule required newly defined CAFOs to apply for permits by April 2006 and existing CAFOs to develop and implement nutrient management plans by December 31, 2006.[9]

According to EPA officials, the 2003 rule was expected to ultimately lead to better water quality because the revised regulations would extend coverage to more animal feeding operations that could potentially discharge and contaminate water bodies and subject these operations to periodic inspections.

Three laws provide EPA with certain authorities related to air emissions from animal feeding operations: the Clean Air Act,[10] the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA).[11] Although these laws provide EPA with authority related to air emissions from various sources, they do not expressly identify animal feeding operations as a regulated entity. Specifically:

- The Clean Air Act authorizes EPA to regulate stationary and mobile sources of air pollution and emphasizes controlling sources that emit more than threshold quantities of regulated pollutants. Livestock producers and other agricultural sources whose emissions meet or exceed specific statutory or regulatory thresholds are therefore subject to Clean Air Act requirements. Although EPA has authorized states and local governments to carry out certain portions of the act, EPA retains concurrent enforcement authority.

- Taken together, CERCLA and EPCRA require owners or operators of a facility to report to federal or state authorities the release of hazardous substances that meet or exceed their reportable quantities so as to alert federal, state, and local agencies, as well as the public, to the release of these substances. Section 103 of CERCLA requires that the person in charge of a facility notify the National Response Center of any non-permitted release of "hazardous

[9]In July 2007, EPA extended these deadlines to February 27, 2009.

[10]The Clean Air Act, 42 U.S.C. §§7401-7671q.

[11]CERCLA, Pub. L. No. 96-510, 94 Stat. 2767 (codified as amended at 42 U.S.C. §§9601-9675) and EPCRA, Pub. L. No. 99-499, Tit. III, 100 Stat. 1728 (codified as amended at 42 U.S.C. §§11001-11050).

substances" in a reportable quantity as soon as he or she has knowledge of that release. Section 304 of EPCRA requires that the owner or operator of a facility at which a hazardous chemical is produced, used, or stored give immediate notice of a release of any "extremely hazardous substance" to the community emergency coordinator. Among the reportable substances that could be released by livestock facilities are hydrogen sulfide and ammonia. The reportable quantity for each of these hazardous substances is 100 pounds in a 24-hour period. Under these acts, EPA can assess civil penalties for failure to report releases of hazardous substances or extremely hazardous substances that equal or exceed their reportable quantities—up to $32,500 per day or $32,500 per violation for first time offenders.

EPA is also working with USDA to address the impacts of animal feeding operations on air and water quality and public health. In 1998, EPA entered into a memorandum of understanding with USDA that calls for the agencies to coordinate on air quality issues relating to agriculture and share information. In addition, in 1999, the two agencies issued a unified national strategy aimed at having the owners and operators of animal feeding operations take actions to minimize water pollution from confinement facilities and land application of manure and in 2001 adopted an agreement to develop a process for working together constructively. To help minimize water pollution from animal feeding operations and meet EPA's regulatory requirements, USDA, through its Natural Resources Conservation Service, provides financial and technical assistance to CAFO operators in developing and implementing nutrient management plans.

The Number of Large Farms Raising Animals Has Increased, but Specific Data on CAFOs Are Not Available

Because no federal agency collects accurate and consistent data on the number, size, and location of CAFOs nationwide, it is difficult to determine precise trends in CAFOs over the last 30 years. According to USDA officials, the data USDA collects for large farms raising animals can be used as a proxy for estimating trends in CAFOs nationwide. Using these data, we determined that between 1982 and 2002, the number of large farms raising animals has increased sharply, from about 3,600 to almost 12,000. Moreover, EPA has compiled some data from its regions on the number of CAFOs that have been issued permits; however, these data are inconsistent and inaccurate. As a result, EPA does not have a systematic way of identifying and inspecting all of the CAFOs nationwide that have been issued permits.

Since 1982 the Number of Large Farms Raising Animals Has Increased as Has the Average Number of Animals on Farms

We found that the number of large farms raising animals for all animal types increased by 234 percent between 1982 and 2002. Table 1 shows the changes in the number of large farms by animal type for 1982 through 2002.

Table 1: Nationwide Trends in the Number of Large Farms Raising Animals for All Animal Types, 1982 through 2002

Type of animal farm	1982	1987	1992	1997	2002	Percentage change, 1982-2002
Beef cattle[a]	966	1,014	1,004	958	982	2
Dairy cow	541	712	1,009	1,445	1,939	258
Hog[b]	916	1,257	2,061	4,170	5,571	508
Layer	720	808	788	788	706	(2)
Broiler	173	357	737	1,331	2,227	1,187
Turkey	278	437	504	577	570	105
Total of all animal types[c]	**3,594**	**4,585**	**6,103**	**9,269**	**11,995**	**234**

Source: GAO analysis of USDA data.

Notes: The phrase "all animal types" refers to the following animals: beef cattle, dairy cows, hogs, layers, broilers, and turkeys.

The criteria for a large farm varied by animal type, consistent with EPA's CAFO thresholds, and represent the average number of animals on a farm per day.

[a]Beef cattle includes only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more.

[b]Hogs include swine of all sizes from birth to market size.

[c]The number of large farms for all animal types is the total of large farms for each animal type and may include some farms multiple times if they were considered large for more than one animal type.

As table 1 shows, large broiler and hog farms experienced the largest increase, with large farms raising broilers increasing by 1,187 percent and large farms raising hogs increasing by 508 percent. Large farms raising layers and large farms raising beef cattle remained relatively stable over these 20 years, while layer farms were the only farms that experienced an overall decrease in number over the period, declining by 2 percent. In contrast, while the number of large farms raising animals has increased, the number of all farm raising animals has decreased. Appendix III presents trends in the number of all farms raising animals, from 1982 to 2002.

Just as the number of large farms for almost all animal types increased between 1982 and 2002, so did the size of these farms as illustrated by the

median number of animals raised on each farm.[12] Table 2 shows the trends in the median number of animals raised on large farms for all animal types from 1982 through 2002.

Table 2: Median Number of Animals Raised on Large Farms, by Animal Type, 1982 through 2002

Animal type	1982	1987	1992	1997	2002	Percentage change, 1982-2002
Beef cattle[a]	2,820	2,950	2,919	3,308	3,424	21
Dairy cows	910	988	1,020	1,100	1,200	32
Hogs[b]	3,350	3,500	3,778	4,334	4,588	37
Layers	131,530	146,383	155,319	168,000	180,000	37
Broilers	154,830	168,593	159,840	161,820	159,840	3
Turkeys	80,000	79,500	81,000	79,697	80,491	1

Source: GAO's analysis of USDA data.

Note: We used the median number of animals raised on large farms to represent the average concentration of animals raised on large farms per day.

The criteria for a large farm varied by animal type, consistent with EPA's CAFO thresholds, and represent the average number of animals on a farm per day.

The median is the point above and below which half of the cases exist. For large animal farms, half of the farms of a particular animal type have more animals than the median farm and half have fewer animals. For example, in the table above, half of large layer farms in 2002 have more than 180,000 layers and half have less than 180,000 layers.

[a]Beef cattle includes only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more.

[b]Hogs include swine of all sizes from birth to market size.

The layer and hog sectors had the largest increases in the median number of animals raised per farm, both growing by 37 percent between 1982 and 2002. Specifically, for layers, large farms increased the number of birds they raised from 131,530 in 1982 to 180,000 in 2002 and for hogs, large farms increased the number of animals they raised from 3,350 in 1982 to 4,588 in 2002. In contrast, large farms that raised either broilers or turkeys only increased slightly in size with an overall increase of 3 and 1 percent, respectively, from 1982 to 2002.

[12]The median is the point above and below which half of the cases exist. For large farms that raise animals, half of the farms of a particular animal type have more animals than the median farm and half have fewer animals.

The increases in the number of large farms for almost all animal types, as well as the increases in the median number of animals raised on these farms, are also reflected in the percentage of animals raised on large farms as compared with animals raised on all farms. Specifically, the number of animals raised on large farms increased from over 257 million in 1982 to over 890 million in 2002—an increase of 246 percent. In contrast, the number of animals raised on all farms increased from over 1,145 million in 1982 to 2,072 million in 2002—an increase of 81 percent. This is particularly noteworthy because the number of animals raised on large farms only accounted for 22 percent of animals raised on all farms in 1982; yet, the number of animals raised on large farms accounted for 43 percent of animals raised on all farms in 2002. Table 3 shows the trends in the number of animals raised on large farms and the number of animals raised on all farms from 1982 to 2002.

Table 3: Nationwide Trends in the Number of Animals Raised on Large Farms as a Proportion of the Number of Animals Raised on All Farms, by Animal Type, 1982 and 2002

Animal type	Number of animals raised on all animal farms		Percent change, 1982-2002	Number of animals raised on large farms		Percent change, 1982-2002	The number of animals raised on large farms as a percentage of the number of animals raised on all animal farms	
	1982	2002		1982	2002		1982	2002
Beef cattle[a]	11,064,096	11,264,122	2	6,601,928	8,677,892	31	60	77
Dairy cows	10,849,880	9,103,959	(16)	632,583	3,183,086	403	6	35
Hogs[b]	45,944,318	66,318,763	44	4,176,477	47,789,951	1,044	9	72
Layers	386,638,856	420,742,205	9	160,005,126	304,500,225	90	41	72
Broilers	612,092,410	1,440,501,856	135	52,140,827	457,461,691	777	9	32
Turkeys	78,550,564	124,152,525	58	33,443,754	68,417,853	105	43	55
Total of all animal types[c]	**1,145,140,124**	**2,072,083,430**	**81**	**257,000,695**	**890,030,698**	**246**	**22**	**43**

Source: GAO analysis of USDA data.

Note: The phrase "all animal types" refers to the following animals: beef cattle, dairy cows, hogs, layers, broilers, and turkeys.

A farm was included in all farms, for a particular animal type, only if it had one or more animals of that type. For example, if a farm had broilers only, it would not be counted in all farms for other animal types. If a farm raised no animals of any type, then it would also not be included in all farms.

Reported percentages have been rounded to the nearest whole number but calculations involving percentages used non-rounded percentages.

[a]Beef cattle includes only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more.

[b]Hogs include swine of all sizes from birth to market size.

[c]The number of large farms for all animal types is the total number of large farms for each animal type and may include some farms multiple times if they were considered large for more than one animal type.

As table 3 shows, most of the beef cattle, hogs, and layers raised in the United States in 2002 were raised on large farms. Specifically, 77 percent of beef cattle and 72 percent of both hogs and layers were raised on large farms.

EPA Does Not Have a Systematic Means of Identifying Permitted CAFOs Because It Lacks Accurate Data

EPA does not have its own data collection process to determine the number, size, and location of CAFOs that have been issued permits nationwide. Since 2003, the agency has compiled quarterly estimates from its regions on the number of permits that have been issued to CAFOs. These data are developed by EPA's regional offices or originates with the state permitting authority. However, we determined that these data are inconsistent and inaccurate and do not provide EPA with the reliable data that it needs to identify and inspect permitted CAFOs nationwide. For example, according to EPA some uncertainty in the data exists because some states may be using general permits to cover more than one operation. In addition, EPA has not established adequate internal controls to ensure that the data are correctly reported. For example, officials from 17 states told us that data reported by EPA for their states were inaccurate. In one case, when we asked a state official for the number of CAFOs in his state, the official realized that the CAFO numbers reported by EPA's regional office were incorrect because of a clerical error, which resulted in some CAFO statistics for the state being doubled. After the state official discovered this error the state's data were corrected and resubmitted to EPA. Without a systematic and coordinated process for collecting and maintaining accurate and complete information on the number, size, and location of permitted CAFOs nationwide, EPA does not have the information it needs to effectively regulate these operations.

In commenting on a draft of this report, EPA stated that the information from permit files is available to EPA upon request; however, the information is currently not readily compiled in a national database. EPA is currently working with the states to develop and implement a new national data system to collect and record operation-specific information. As part of this effort, the agency plans to develop national requirements for data that should be collected and entered into the database by the states. According to EPA, it may require the states to provide data that identifies operations that have been issued or applied for a CAFO permit

as well as operations that should have applied for a permit based on an inspection or enforcement action.

Large Farms That Raise Animals Can Produce Thousands of Tons of Manure Each Year, and Regional Clustering of Farms Can Exacerbate Manure Management Problems

The amount of manure a large farm that raises animals can generate primarily depends on the types and numbers of animals raised on that farm, and the amount of manure produced can range from over 2,800 tons to more than 1.6 million tons a year. To further put this in perspective, the amount of manure produced by large farms that raise animals can exceed the amount of waste produced by some large U.S. cities. In addition, multiple large farms that raise animals may be located in a relatively small area, such as two or more adjacent counties, which raises additional concerns about the potential impacts of the manure produced, stored, and disposed of by these farms.

Table 4 shows the estimated number of animals and the typical amounts of manure produced each year, by type of animal, for three different sizes of large farms: (1) large farms that meet EPA's thresholds for each animal type, (2) large farms that raise the median number of animals according to our analysis of USDA farm census data, and (3) large farms that fell into the 75th percentile based on our analysis. As table 4 shows, a dairy farm that meets the minimum threshold of 700 dairy cows could produce almost 17,800 tons of manure a year; a median-sized dairy farm with 1,200 dairy cows could produce about 30,500 tons of manure a year; and a larger dairy farm with 1,900 dairy cows could produce almost 48,300 tons of manure a year.

Table 4: Estimated Typical Manure Production for Three Different Sizes of Large Farms That Raise Animals, 2002

Animal type	EPA's minimum thresholds for large CAFOs[a]	Estimated tons of manure produced annually by large CAFOs meeting EPA's minimum threshold	Median number of animals raised on large farms[b]	Estimated tons of manure produced annually by large farms that raised median number of animals	Number of animals raised on large farms in the 75th percentile[c]	Estimated tons of manure produced annually by large farms in the 75th percentile
Beef cattle[d]	1,000	11,690	3,424	40,025	10,000	116,895
Dairy cows	700	17,793	1,200	30,502	1,900	48,295
Hogs[e]	2,500	5,100	4,588	9,360	7,700	15,708
Layers	82,000	2,843	180,000	6,242	400,000	13,870
Broilers	125,000	4,125	159,840	5,275	195,383	6,448
Turkeys	55,000	3,633	80,491	5,317	124,500	7,719

Source: GAO analyses based on EPA CAFO definitions, USDA data, and standards for manure production cited by the American Society of Agricultural and Biological Engineers, "Manure Production and Characteristics," March 2005.

Note: The amounts of manure reported are estimates. The actual amount of manure produced by an animal will vary based on, among other things, feeding programs, feeds used, climatic conditions, production techniques, and animal genetics.

EPA reports its minimum thresholds for large CAFOs in terms of inventory data for all the animal types included in table 4. To be able to compare the annual manure estimates for EPA's thresholds, the median, and 75th percentile animal counts, we used USDA data on animal sales, inventories, and production cycles, and adjusted these to determine typical inventory during a year.

The criteria for a large farm varied by animal type, consistent with EPA's CAFO thresholds, and represent the average number of animals on a farm per day.

[a]This category captures the minimum inventory threshold that an animal feeding operation must meet to be designated as a large CAFO by EPA and the Clean Water Act.

[b]This column represents the median-sized animal farm in 2002, for each animal type. The median is the point above and below which half of the cases exist. For large farms that raise animals, half of the farms of a particular animal type have more animals than the median farm and half have fewer animals. For example, in table 4, half of large layer farms have more than 180,000 layers and half have less than 180,000 layers.

[c]This column represents the farms ranked in the 75th percentile for the amount of animals raised per farm in 2002, for each animal type. The 75th percentile is the point where 25 percent of the cases are larger and 75 percent are smaller. For large farms that raise animals, the 75th percentile indicates the larger of the large farms. The 75th percentile gives a more complete picture of how big a large farm can be. For example, for beef cattle the 75th percentile farm is about 3 times larger than the median-size farm and 25 percent of the beef cattle farms are larger than 10,000 cattle.

[d]Beef cattle includes only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more. The beef cattle manure estimates are for cattle fed from about 700 pounds to about 1,200 pounds.

[e]Hogs include swine of all sizes from birth to market size. The hog manure estimates are for hogs fed from about 27 pounds to about 260 pounds.

Additionally, individual large farms that raise animals can generate as much waste as certain U.S. cities.[13] For example, a dairy farm meeting EPA's large CAFO threshold of 700 dairy cows can create about 17,800 tons of manure annually, which is more than the about 16,000 tons of sanitary waste per year generated by the almost 24,000 residents of Lake Tahoe, California. Likewise, a median-sized beef cattle operation with 3,423 head of beef cattle can produce more than 40,000 tons of manure annually, which is more than the almost 38,900 tons of sanitary waste per year generated by the nearly 57,000 residents of Galveston, Texas. Similarly, some larger farms can produce more waste than some large U.S. cities. For example, a large farm with 800,000 hogs could produce over 1.6 million tons of manure per year, which is one and a half times more than the annual sanitary waste produced by the city of Philadelphia, Pennsylvania—about 1 million tons—with a population of almost 1.5

[13]Human sanitary waste includes urine and feces only; it does not include any other household sewage wastes such as water from washing dishes or clothes or water used for showers or flushing.

million.[14] Moreover, a beef cattle farm with 140,000 head of cattle could produce over 1.6 million tons of manure annually, more than the almost 1.4 million tons of sanitary waste generated by the more than 2 million residents of Houston, Texas.[15]

Although manure is considered a valuable commodity, especially in states with large amounts of farmland, like Iowa, where it is used as fertilizer for field crops, in some parts of the country, large farms that raise animals are clustered in a few contiguous counties. This collocation of large farms that raise animals has resulted in a separation of animal production from crop production because many of these operations purchase feed rather than grow it on adjacent cropland. As a result, there is much less cropland on which the manure can be applied as fertilizer. This clustering of large farms that raise animals has occurred because of structural changes in the farming sector. According to agricultural experts and USDA officials, the overall decrease in the number of farms and increase in the average number of animals raised on a farm may have occurred because these operations wanted to achieve economies of size. To achieve these economies, operators often need significant amounts of capital, which they obtain through production contracts with large processing companies.

A USDA report identified this concern as early as 2000 when it found that between 1982 and 1997 as livestock production became more spatially concentrated that when manure was applied to cropland, crops were not fully using the nutrients in manure and this could result in ground and surface water pollution from the excess nutrients.[16] According to the report, the number of counties where farms produced more manure nutrients, primarily nitrogen and phosphorus, than could be applied to the land without accumulating nutrients in the soil increased. Specifically, the numbers of counties with excess manure nitrogen increased by 103 percent, from 36 counties in 1982 to 73 counties in 1997. Similarly, the number of counties with excess manure phosphorous increased by 57 percent, from 102 counties in 1982 to 160 counties in 1997. As a result, the potential for runoff and leaching of these nutrients from the soil was high, and water quality could be impaired, according to USDA. Agricultural

[14]EPA officials told us that the agency has identified a hog farm of this size.

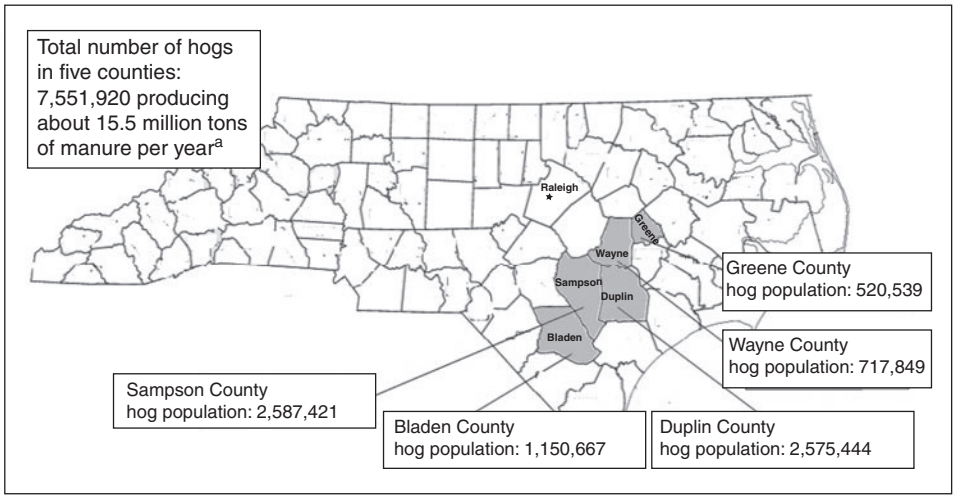
[15]EPA officials told us that the agency has identified a cattle farm of this size.

[16]R. L. Kellogg, C.H. Lander, D. C. Moffitt, and N. Gollehon. *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States*. (Washington, D.C.: December 2000).

experts and government officials who we spoke to during our review echoed the findings of USDA's report and provided several examples of more recent clustering trends that have resulted in degraded water quality, including the following:

- As a result of adopting the poultry industry's approach of developing close ties between producers and processors,[17] North Carolina experienced a rapid growth in the number of hog CAFOs, primarily in five contiguous counties. Based on our analysis of 2002 USDA data, we estimated that the hog population of the five North Carolina counties was more than 7.5 million hogs in 2002 and that hog operations in these counties produced as much as 15.5 million tons of manure that year. Figure 1 shows the geographic concentration of hog farms in North Carolina in 2002.

Figure 1: Geographic Concentration of Hogs in Five Contiguous North Carolina Counties, 2002



Source: GAO analysis of USDA data.

Note: Hog populations are the number of hogs on a typical day per county in 2002. The number of hogs was estimated by dividing hogs-to-market sales by two production cycles and adjusting for inventory on hand at the end of the year.

[17]GAO, *Animal Agriculture: Information on Waste Management and Water Quality Issues*, GAO/RCED-95-200BR (Washington, D.C.: June 1995).

[a]This is the amount of manure that would be produced if all of these hogs were in the feeder-finish production phase where they start at about 27 pounds and are marketed at about 260 pounds. The amount of manure would be less if a large percentage of these hogs were nursery pigs (up to about 27 pounds). Although we were unable to determine what percentage of hogs in these counties was not in the feeder-finish production cycle, we adjusted our estimates based on 1997 USDA data that showed that 25 percent of swine sold were not in the feeder-finish production cycle.

According to North Carolina agricultural experts, excessive manure production has contributed to the contamination of some of the surface and well water in these counties and the surrounding areas. According to these experts, this contamination may have occurred because the hog farms are attempting to dispose of excess manure but have little available cropland that can effectively use it. According to state officials, partly out of concern for the potential contamination of waterways and surface water from manure, in 1997, North Carolina placed a moratorium on new swine farms and open manure lagoons, which was subsequently continued through 2007. While the moratorium included exceptions that could allow a new swine farm to begin operations in this area, according to state officials, the requirements for these exceptions are so stringent that they effectively have prevented the construction of new swine operations or the expansion of existing operations.

- Similarly, a California water official told us that the geographic clustering of large farms that raise animals is causing concern in his state as well. Our analysis of USDA data shows that in 2002 two counties in the San Joaquin Valley in California had 535,443 dairy cows that produced about 13.6 million tons of manure that year. According to the official, because of the limited flow of water through the Valley, once pollutants reach the water, they do not dissipate, resulting in a long-term accumulation of these pollutants.

- Regional clustering is also occurring in Arkansas. Two counties in northwest Arkansas, located on the Arkansas-Oklahoma border, raised 14,264,828 broiler chickens that produced over 471,000 tons of manure that year. According to EPA Region 6 officials, the Arkansas-Oklahoma border is an area of concern due to the number of poultry operations (primarily broilers, but also turkeys and layers) within this area. Furthermore, region 6 officials identified numerous water bodies in northwest Arkansas and northeast Oklahoma that have been impaired by manure from animal feeding operations and identified these locations as "areas of general ground water concern."

  While USDA officials acknowledge that regional clustering of large animal feeding operations has occurred, they told us that they believe the nutrient management plans that they have helped livestock and poultry producers develop and implement have reduced the likelihood that pollutants from manure are entering ground and surface water. They also believe that as a

result of new technologies such as calibrated manure spreaders, improved animal feeds, and systems that convert manure into electricity, large animal feeding operations are able to more effectively use the manure being generated. However, USDA could not provide information on the extent to which these techniques are being utilized or their effectiveness in reducing water pollution from animal waste.

Studies Have Identified Impacts of Pollutants from Animal Waste, but EPA Has Not Assessed the Extent of Such Impacts

Since 2002, at least 68 government-sponsored or peer-reviewed studies have been completed on air and water pollutants from animal feeding operations. Of these 68 studies, 15 have directly linked pollutants from animal waste generated by these operations to specific health or environmental impacts, 7 have found no impacts, and 12 have made indirect linkages between these pollutants and health and environmental impacts. In addition, 34 of the studies have focused on measuring the amount of certain pollutants emitted by animal feeding operations that are known to cause human health or environmental impacts at certain concentrations. Appendix IV presents information, including the sponsor, the pollutants, and impacts, identified for each of the 68 studies we reviewed.[18] Although EPA is aware of the potential impacts of air and water pollutants from animal feeding operations, it lacks data on the number of animal feeding operations and the amount of discharges actually occurring. Without such data, according to EPA officials, the agency is unable to assess the extent to which these pollutants are harming human health and the environment.

Some Recent Studies Directly Link Pollutants from Animal Waste to Health and Environmental Impacts

Of the 15 studies completed since 2002 that we reviewed that directly link pollutants from animal waste to human health or environmental impacts, 8 focused on water pollutants and 7 on air pollutants. Academic experts and industry and EPA officials told us that only a few studies directly link CAFOs with health or environmental impacts because the same pollutants that CAFOs discharge also often come from other sources including smaller livestock operations; row crops using commercial fertilizers; and wastes from humans, municipalities, or wildlife, making it difficult to distinguish the actual source of pollution. Table 5 shows the eight government-sponsored or peer-reviewed studies completed since 2002 that found direct links between water pollutants from animal waste and impacts on human health or the environment.

[18]Sponsors are agencies, organizations, or universities responsible for conducting the study and not necessarily the group funding the study.

Table 5: Studies Completed Since 2002 Linking Water Pollutants from Animal Feeding Operations with Impacts on Human Health or the Environment

Study title	Sponsor[a]	Pollutant(s) studied	Impact identified
Effects of the Feedlot Contaminant 17α-Trenbolone on Reproductive Endocrinology of the Fathead Minnow	EPA	Hormones	Adverse effects to reproductive system of aquatic life
Endocrine-Disrupting Effects of Cattle Feedlot Effluent on an Aquatic Sentinel Species, the Fathead Minnow	University of Florida, St. Mary's College of Maryland, University of Nebraska, EPA, Tufts University	Hormones	Adverse effects to reproductive system of aquatic life
Effects of the Androgenic Growth Promoter 17ß-Trenbolone on Fecundity and Reproductive Endocrinology of the Fathead Minnow	EPA, University of Minnesota	Hormones	Adverse effects to reproductive system of aquatic life
In Vitro and in Vivo Effects of 17ß-Trenbolone: A Feedlot Effluent Contaminant	EPA	Hormones	Reproductive malformations in laboratory rats and human cells
Characterization of Waterborne Outbreak-associated *Campylobacter jejuni*, Walkerton, Ontario	Health Canada	Bacteria	Gastrointestinal illness and death in humans
Impact of Animal Waste Application on Runoff Water Quality in Field Experimental Plots	Jackson State University, National Institutes of Health-Center for Environmental Health, Louisiana State University	Nutrients, bacteria	Water degradation
Nutrient Loading Patterns on an Agriculturally Impacted Stream System in Huntingdon County Pennsylvania over Three Summers	Juniata College	Nutrients	Water degradation; unable to sustain aquatic life
Concentrated Animal Feeding Operations, Row Crops, and Their Relationship to Nitrate in Eastern Iowa Rivers	University of Iowa	Nutrients	Water degradation

Source: GAO's analysis of identified studies.

[a]Sponsor refers to the organization under whose auspices the research was conducted or with whom the primary researchers were affiliated.

As table 5 shows, EPA sponsored four of the water quality studies that identified reproductive alterations in aquatic species caused by hormones in discharges from animal feeding operations. Two of these studies found that hormones from these discharges caused a significant decline in the fertility of female fish in nearby water bodies. Similarly, three other studies found water bodies impaired by higher nitrogen and phosphorus levels from manure runoff from animal feeding operations. For example, the study by Juniata College found that the runoff resulted in nutrient

concentrations in the water that were too high to sustain fish populations. Only one of the eight water pollutant studies linked pollutants from animal feeding operations to human health effects. This study, conducted by Health Canada, directly linked water discharges from a cattle farm to bacteria found in nearby waters. These bacteria, which included *Campylobacter* and *E. coli*, caused gastrointestinal illnesses in more than 2,300 residents and 7 deaths in a nearby community.

Table 6 shows the seven government-sponsored or peer-reviewed studies completed since 2002 that we reviewed that directly link air pollutants from animal feeding operations with human health effects.

Table 6: Studies Completed Since 2002 Directly Linking Air Pollutants from Animal Feeding Operations to Impacts on Human Health

Study title	Sponsor[a]	Pollutant(s) studied	Impact identified
Feedlot Dust Stimulation of Interleukin-6 and 8 Requires Protein Kinase C-Epsilon Human Bronchial Epithelial Cells	Nebraska Medical Center, Department of Veterans Affairs Medical Center, Texas A&M	Dust	Respiratory inflammation
Farm Residence and Exposures and the Risk of Allergic Diseases In New Zealand Children	University of Otago, New Zealand	Dust	Greater prevalence of allergies in children living on farms
Exhaled Nitric Oxide and Bronchial Responsiveness in Healthy Subjects Exposed to Organic Dust	National Institute of Environmental Medicine, Sweden	Dust	Respiratory inflammation (occupational)
Hog Barn Dust Extract Augments Lymphocyte Adhesion to Human Airway Epithelial Cells	Department of Veterans Affairs Medical Center, University of Nebraska Medical Center	Dust	Respiratory inflammation (occupational)
Hog Barn Dust Extract Stimulates IL-8 And IL-6 Release in Human Bronchial Epithelial Cells Via PKC Activation	Department of Veterans Affairs Medical Center, University of Nebraska Medical Center	Dust	Respiratory inflammation (occupational)
Experimental Human Exposure to Inhaled Grain Dust and Ammonia: Towards a Model of Concentrated Animal Feeding Operations	University of Iowa	Dust, ammonia	Tightening of airway in asthmatics (occupational)
Symptomatic Effects of Exposure to Diluted Air Sampled from a Swine Confinement Atmosphere on Healthy Human Subjects	Duke University	Hydrogen sulfide, ammonia, endotoxin, dust, odor	Headaches, eye irritation, nausea

Source: GAO's analysis of identified studies.

[a]Sponsor refers to the organization under whose auspices the research was conducted or with whom the primary researchers were affiliated.

As table 6 shows, six of these studies identified airway inflammation or wheezing in people working at or living on an animal feeding operation.

For example, the studies conducted by the Department of Veterans Affairs show that the dust of hog confinement facilities induces airway inflammation in workers. The seventh study, completed by Duke University in a laboratory setting, exposed healthy volunteers to air emissions consistent with those that would occur downwind from animal feeding operations. These volunteers reported headaches, eye irritation, and nausea following this exposure. According to experts who we spoke with, the effects of air emissions from animal feeding operations on workers are well known, but the impacts of these emissions on nearby communities are still uncertain, and more research is needed to identify these impacts. Additionally, experts said it is difficult to determine which specific contaminant or mixture of contaminants causes particular health symptoms. For example, while hydrogen sulfide causes respiratory and other health problems, other contaminants emitted from animal feeding operations, such as ammonia, can also cause similar symptoms.

Some Studies Found No Links between Pollutants from Animal Feeding Operations and Harm to Human Health or the Environment

We found seven government-sponsored or peer-reviewed studies that have been completed since 2002 that found no impact on human health or the environment from pollutants released by animal feeding operations. These seven studies are shown in table 7.

Table 7: Studies Completed Since 2002 Finding No Links between Pollutants from Animal Feeding Operations and Impacts on Human Health or the Environment

Study title	Sponsor[a]	Pollutant(s) studied	Finding(s)
Prevalence of *Escherichia coli O157:H7* Bacterial Infections Associated with the Use of Animal Wastes in Louisiana for the Period 1996-2004	Grambling State University, Louisiana State University, Jackson State University	*Escherichia coli*	No clear indication that any cases of *E. coli* infection are related to animal waste
Prevalence of Selected Bacterial Infections Associated with the Use of Animal Waste in Louisiana	Jackson State University, Louisiana State University	*Escherichia coli*	No clear indication that any cases of *E. coli* infection are related to animal waste
Impacts of Swine Manure Pits on Groundwater Quality	Illinois State Geological Survey, University of Illinois, Illinois Department of Agriculture	Chloride, ammonium, phosphate, potassium, nitrate, bacteria	Manure seepage from swine facilities has had limited impacts on groundwater

Study title	Sponsor[a]	Pollutant(s) studied	Finding(s)
Ground-Water Quality and Effects of Poultry Confined Animal Feeding Operations on Shallow Ground Water, Upper Shoal Creek Basin, Southwest Missouri, 2000	U.S. Geological Survey	Nutrients, bacteria	The results do not indicate that poultry CAFOs are affecting the shallow ground water with respect to nutrients and fecal bacteria
Environmental Exposure to Endotoxin and Its Relation to Asthma in School-Age Children	Institute of Social and Preventive Medicine (Switzerland), Children's Hospital (Austria), Philipps University (Germany), Ruhr University (Germany), University Children's Hospital (Switzerland), University of Munich (Germany	Dust	Decreased risk of hay fever, asthma, and wheeze in children exposed to high levels of endotoxin in dust
Ecological Associations between Asthma Prevalence and Potential Exposure to Farming	University of North Carolina	Farm air	Farm exposures may be protective against childhood asthma.
Atmospheric Pollutants and Trace Gases: Atmospheric Ammonia, Volatile Fatty Acids, and Other Odorants near Beef Feedlots	Research Centre, Agriculture and Agri-Food Canada	Ammonia, odor, organic compounds, dust	Odorants from feedlots were effectively dispersed. Emitted ammonia was deposited to the soil downwind.

Source: GAO's analysis of identified studies.

[a]Sponsor refers to the organization under whose auspices the research was conducted or with whom the primary researchers were affiliated.

As table 7 shows, the results of a U.S. Geological Survey study did not indicate that poultry animal feeding operations were causing an increase of nutrient concentrations and fecal bacteria in groundwater. Similarly, another study by Agriculture and Agri-Food Canada found that odorants, including ammonia and dust emitted by animal feeding operations, never exceeded the established irritation threshold. According to EPA and academic experts we spoke with, the concentrations of air pollutants and water pollutants emitted by animal feeding operations can vary, which may account for the differences in the findings of these studies. These variations may be the result of numerous factors, including the type of animals being raised, feed being used, and manure management system being employed, as well as the climate and time of day when the emissions occur.

Some Recent Studies Indirectly Link Pollutants from Animal Feeding Operations with Human Health and Environmental Impacts

We also identified 12 government-sponsored or peer-reviewed studies completed since 2002 that indirectly link pollutants from animal feeding operations to human health or environmental impacts. While these studies found that animal feeding operations were the likely cause of human health or environmental impacts occurring in areas near the operations, they could not conclusively link waste from animal feeding operations to the impacts, often because other sources of pollutants could also be contributing. For example, 5 of these 12 studies found an increased incidence of asthma or respiratory problems in people living or attending school near animal feeding operations, compared with a control group. These studies hypothesized that the pollutants emitted from animal feeding operations were likely the cause of the increased incidence of asthma, but some of these studies acknowledged that pollutants from other sources could also be contributing to the increased incidence. Table 8 lists the 12 studies that have been completed since 2002 that made indirect links between emissions from animal feeding operations and human health and environmental impacts.

Table 8: Studies Completed Since 2002 That Found an Indirect Link between Pollutants from Animal Feeding Operations and Human Health or Environmental Impacts

Study title	Sponsor[a]	Impact(s)
Associations between Indicators of Livestock Farming Intensity and Incidence of Human Shiga Toxin-Producing *Escherichia coli* Infection	University of Guelph; Université de Montréal; Centre for Infectious Disease Prevention and Control – Health Canada	The strongest associations with human *Escherichia coli* infection were the ratio of beef cattle to human population and the application of manure to the surface of agricultural land by a solid spreader and by a liquid spreader.
The Potential Impact of Flooding on Confined Animal Feeding Operations in Eastern North Carolina	University of North Carolina	Flood events have a significant potential to degrade environmental health because of dispersion of wastes from industrial animal operations in areas with vulnerable populations.
Odor from Industrial Hog Farming Operations and Mucosal Immune Function in Neighbors	University of North Carolina, Duke University	This study suggests that malodor from industrial swine operations can affect the secretory immune system, although the reduced levels reported are still within normal range.
Environmental Stressors, Perceived Control, and Health: The Case of Residents Near Large-Scale Hog Farms in Eastern North Carolina	University of North Carolina Wilmington	Residents living near large-scale hog farms in eastern North Carolina report symptoms related to respiratory, sinus, and nausea problems.

Study title	Sponsor[a]	Impact(s)
Asthma Prevalence and Morbidity Among Rural Iowa Schoolchildren	University of Iowa, EPA	Among children who wheeze, farm and nonfarm children were equally likely to have been given a diagnosis of asthma and had comparable morbidity. Asthma in rural schoolchildren was comparable to schoolchildren in large cities.
Occupational Asthma in Newly Employed Workers in Intensive Swine Confinement Facilities	Institute of Agricultural Rural and Environmental Health, University of Saskatchewan, Laval University	Newly employed workers in intensive swine confinement facilities reported development of acute onset of wheezing and cough suggestive of asthma.
Asthma and Farm Exposures in a Cohort of Rural Iowa Children	University of Iowa, EPA, Colorado State University, Kaiser Permanente	There was a high prevalence of asthma health outcome among farm children living on farms that raise swine and raise swine and add antibiotics.
Asthma Symptoms among Adolescents Who Attend Public Schools That Are Located Near Confined Swine Feeding Operations	University of North Carolina, RTI International	Estimated exposure to airborne pollution from confined swine feeding operations is associated with adolescents' wheezing symptoms.
Airway Responses of Healthy Farmers and Nonfarmers to Exposure in a Swine Confinement Building	National Institute of Environmental Medicine (Sweden), National Institute for Working Life (Sweden)	Altered lung function and bronchial responsiveness was found in nonfarming subjects. Only minor alterations were found in the farmers.
Environmental Exposure to Confined Animal Feeding Operations and Respiratory Health of Neighboring Residents	Institute for Occupational and Environmental Medicine (Germany), National Research Centre for Environment and Health (Germany), Boston University, Municipal Health Service Amsterdam	Respiratory disease was found among residents living near confined animal feeding operations.
School Proximity to Concentrated Animal Feeding Operations and Prevalence of Asthma in Students	University of Iowa Carver College of Medicine, University of Iceland	Children in the study school, located one-half mile from a CAFO, had a significantly increased prevalence of physician-diagnosed asthma.
Lung Function and Farm Size Predict Healthy Worker Effect in Swine Farmers	University of Saskatchewan (Canada)	Some swine workers are less affected by swine air and continue in the profession. Other workers are more affected.

Source: GAO's analysis of identified studies.

[a]Sponsor refers to the organization under whose auspices the research was conducted or with whom the primary researchers were affiliated.

Many Recent Studies Have Measured the Level of Pollutants Emitted by Animal Feeding Operations

Thirty-four government-sponsored or peer-reviewed studies completed since 2002 have focused on measuring the amounts of water or air pollutants emitted by animal feeding operations that are known to cause harm to humans or the environment. Specifically:

- Nineteen of the 34 studies focused on water pollutants. Four studies found increased levels of phosphorus or nitrogen in surface water and groundwater near animal feeding operations. According to EPA, excessive amounts of these nutrients can deplete oxygen in water, which could result in fish deaths, reduced aquatic diversity, and illness in infants. The other 15 studies measured water pollutants such as pathogens, hormones, and antibiotics.

- Fifteen of the 34 studies focused on measuring air emissions from animal feeding operations. Seven of the 15 studies found high levels of ammonia surrounding animal feeding operations. EPA considers ammonia a hazardous substance that may harm human health or the environment, and that must be reported when emissions exceed its reportable quantity. The other eight studies measured the levels of other air pollutants, such as hydrogen sulfide, particulate matter, and carbon dioxide.

Appendix IV provides additional details about each of the 34 studies.

EPA Has Not Yet Assessed the Extent of the Human Health and Environmental Impacts of Pollutants from Animal Feeding Operations

While EPA recognizes the potential impacts that water and air pollutants from animal feeding operations can have on human health and the environment, it lacks the data necessary to assess how widespread these impacts are and has limited plans to collect the data it needs.

Water quality. EPA has long recognized the impacts of pollution from CAFOs on water quality. For example, almost a decade ago, in its 1998 study on feedlot point sources, EPA documented environmental impacts that may be attributed to these operations.[19] This report identified pollutants from animal feeding operations and listed about 300 spills and runoff events that were attributable to animal feeding operations from 1985 through 1997. More recently when developing the 2003 CAFO rule, EPA documented the potential water quality impacts from CAFOs. It reported that contaminants in manure will have an impact on water quality if significant amounts reach surface water or groundwaters. Moreover, as discussed above, numerous studies completed since 2002 have provided

[19]EPA, Office of Water, *Feedlots Point Source Category Study* (Washington, D.C.: 1999).

additional information on the direct and indirect impacts of discharges from animal feeding operations on human health and the environment, and many more studies have been completed that have measured the amounts of pollutants being discharged.

EPA officials we spoke with acknowledged that the potential human health and environmental impacts of some CAFO water pollutants, such as nitrogen, phosphorus, and pathogens, are well known. They told us that the agency has recently focused its research efforts on obtaining more information on emerging pollutants, such as hormones and antibiotics, and on how the concentrations of nutrients and pathogens differ among the various types of animal feeding operations. However, these officials also stated that EPA does not have data on the number and location of CAFOs nationwide and the amount of discharges from these operations. Without this information and data on how pollutant concentrations vary by type of operation, it is difficult to estimate the actual discharges occurring and to assess the extent to which CAFOs may be contributing to water pollution. According to agency officials, because of a lack of resources, the agency currently has no plans for a national study to collect information on CAFO water discharges. However, the agency has recently taken the following three steps that may help gather additional data on CAFO pollutants that affect water quality:

- EPA has begun research to determine (1) how the concentration of pathogens and nutrients vary in manure on the basis of certain characteristics, such as animal type and animal feed, and (2) how manure management techniques can reduce the amount of pathogens and nutrients in runoff.

- EPA has set a long-term research goal, as part of its *Multi-Year Plan for Endocrine Disruptors (FY2007-2013)*, to characterize the magnitude and extent of the impact of hormones released by CAFOs and to determine the impact of management strategies on the fate and effects of hormones. At the time of our review, according to an EPA official, the agency had only limited preliminary findings because it has just recently begun this work.

- EPA and the U.S. Geological Survey have discussed a joint project to identify (1) the location of CAFOs nationwide and (2) those watersheds where many CAFOs might be located. According to EPA officials, this project is still in the discussion phase.

Air quality. More recently, EPA has recognized concerns about the possible health impacts from air emissions produced by animal feeding operations. Prompted in part by public concern, EPA and USDA

commissioned a 2003 study by the National Academy of Sciences (NAS) to evaluate the scientific information needed to support the regulation of air emissions from animal feeding operations.[20] The NAS report identified several air pollutants from animal feeding operations and their potential impacts. For example, the study identified ammonia and hydrogen sulfide as two air pollutants emitted from animal feeding operations that can impair human health. According to the study, ammonia can cause eye, nose, and throat irritation at certain concentrations, and hydrogen sulfide can cause respiratory distress. While such effects are known to occur, the study noted that additional research is warranted to determine if air emissions from animal feeding operations are occurring in high enough concentrations to cause these effects. The NAS report also concluded that in order to determine the human health and environmental effects of air emissions from animal feeding operations, EPA and USDA would first need to obtain accurate estimates of emissions and their concentrations from animal feeding operations with varying characteristics, such as animal type, animal feed, manure management techniques, and climate.

Since the NAS report was issued, EPA has conducted one hypothetical assessment of the impacts of air emissions from animal feeding operations. In 2004, EPA updated a preliminary analysis to estimate the levels of emissions of ammonia and hydrogen sulfide that occur downwind from a manure lagoon and that could pose a risk to human health. EPA found that ammonia would not reach levels associated with respiratory irritation if emitted at the reportable quantity of 100 pounds per day.[21] On the other hand, the agency found that hydrogen sulfide could cause respiratory irritation and central nervous system effects about one mile downwind if emitted at the reportable quantity of 100 pounds per day.[22] EPA officials who conducted this analysis told us that there have been no documented cases of hydrogen sulfide emissions from animal feeding operations exceeding the reportable quantity. However, other officials noted that the agency does not know exactly what type of species and what size of operations are likely to have emissions above the reportable quantity, and, as noted in the NAS report, accurate measurements of the

[20]National Academies of Sciences, *Air Emissions from Animal Feeding Operations: Current Knowledge, Future Needs* (Washington, D.C.: National Academies Press, 2003).

[21]Section 302.4 of title 40 of the Code of Federal Regulations notes that the reportable quantity for ammonia is 100 pounds per 24 hours.

[22]Section 302.4 of title 40 of the Code of Federal Regulations notes that the reportable quantity for hydrogen sulfide is 100 pounds per 24 hours.

air pollutants being emitted by animal feeding operations are currently not known.

In 2007, a national air emissions monitoring study to collect data on air emissions from animal feeding operations was undertaken as part of a series of consent agreements EPA entered into with individual animal feeding operations. This study, funded by industry and approved by EPA, is intended to help the agency determine how to measure and quantify air emissions from animal feeding operations. The data collected will in turn be used to estimate air emissions from animal feeding operations with varying characteristics, and, according to EPA officials, it is only the first step in a long-term effort to accurately quantify air emissions from animal feeding operations. According to agency officials, until EPA can determine the actual level of emissions occurring, it will be unable to assess the extent to which these emissions are affecting human health and the environment. Progress in conducting the national air emissions monitoring study is discussed in greater detail in the following section.

It Is Unclear If EPA's Efforts to Develop Air Emissions Protocols for Animal Feeding Operations Will Be Effective and How EPA Intends to Regulate These Emissions in the Future

The National Air Emissions Monitoring Study—a 2-year effort to collect data on air emissions from animal feeding operations—is intended to provide a scientific basis for estimating air emissions from these operations. The results of this study were intended to help EPA develop protocols that will allow it to determine which operations do not comply with applicable federal laws. As currently structured, however, the study may not provide the quantity and quality of data needed for developing appropriate methods for estimating emissions. Furthermore, it is uncertain if and when EPA will develop a process-based model that considers the interaction and implications of all sources of emissions at an animal feeding operation. Also, other more recent decisions suggest that the agency has not yet determined how it intends to regulate air emissions from animal feeding operations. In the absence of federal guidance on how to regulate air emissions from animal feeding operations, a few states have developed their own regulations.

A National Air Emissions Monitoring Study Has Begun, but the Study May Not Provide the Data EPA Needs to Develop Air Emissions Protocols

According to EPA, although it has the authority to require animal feeding operations to monitor their emissions and come into compliance with the Clean Air Act on a case-by-case basis, this approach has proven to be time and labor intensive. As an alternative to the case-by-case approach, in January 2005, EPA offered animal feeding operations an opportunity to sign a voluntary consent agreement and final order, known as the Air Compliance Agreement. To participate in the agreement, animal feeding operations were required to take the following actions:

- Pay a civil penalty ranging from $200 to $1,000 per animal feeding operation, depending on the number of animals at the operation and the number of operations that each participant signed up.[23]
- Pay up to $2,500 per farm to help fund a nationwide emissions monitoring study and make their facilities available as a monitoring site for emissions testing.
- Once emission protocols are published, apply for all applicable air permits and comply with permit conditions, if deemed necessary.
- Once emission protocols are published, report any releases of ammonia and hydrogen sulfide above the threshold levels established by CERCLA and EPCRA.[24, 25]

[23]The total penalty is capped at $10,000 for a participant having 10 or fewer farms to $100,000 for a participant having over 200 farms.

[24]Since announcing the Air Compliance Agreement, EPA has proposed exempting such releases from the CERCLA and EPCRA reporting requirements. The exemption, proposed in December 2007, has not been finalized.

[25]Any farm more than 10 times larger than EPA's established size thresholds for CAFOs must, within 120 days of receiving an executed copy of the agreement, provide the National Response Center with a written statement noting the facility's location, estimating air emissions of ammonia, and stating that it will notify the Center of reportable releases when emission rates are determined by the monitoring study.

In return for meeting these requirements, EPA agreed not to sue participating animal feeding operations for certain past violations or violations occurring during the emissions monitoring study.[26]

Almost 13,900 animal feeding operations were approved for participation in the agreement, representing the egg, broiler chicken, dairy, and swine industries. Some turkey operations volunteered but were not approved because there were too few operations to fund a monitoring site, and the beef cattle industry chose not to participate. EPA collected a total of $2.8 million in civil penalties from participating animal feeding operations and deposited these funds into the U.S. Treasury. An additional $14.8 million was collected by a nonprofit, industry-established organization to fund the national air emissions monitoring study. Industry groups representing the participating operations provided the funding for the study as was called for under the agreement. Table 9 shows the level of participation by type of operation and the amount of funding provided by different industry groups for the national air emissions monitoring study.

Table 9: Number of Participants in the Air Compliance Agreement, Funding Provided by Animal Type, and Source of the Funding for the National Air Emissions Monitoring Study

(Dollars in millions)

	Air Compliance Agreement		National Air Emissions Monitoring Study	
Animal type	Number of participants	Number of animal feeding operations	Funding provided	Funding source
Swine	1,878	4,865	$6.0	National Pork Board
Dairy	474	573	5.0	National Milk Producers Council
Layers	218	2,693	2.8	United Egg Producers
Broilers	41	5,752	1.0	National Chicken Council
Total	**2,611**	**13,883**	**$14.8**	

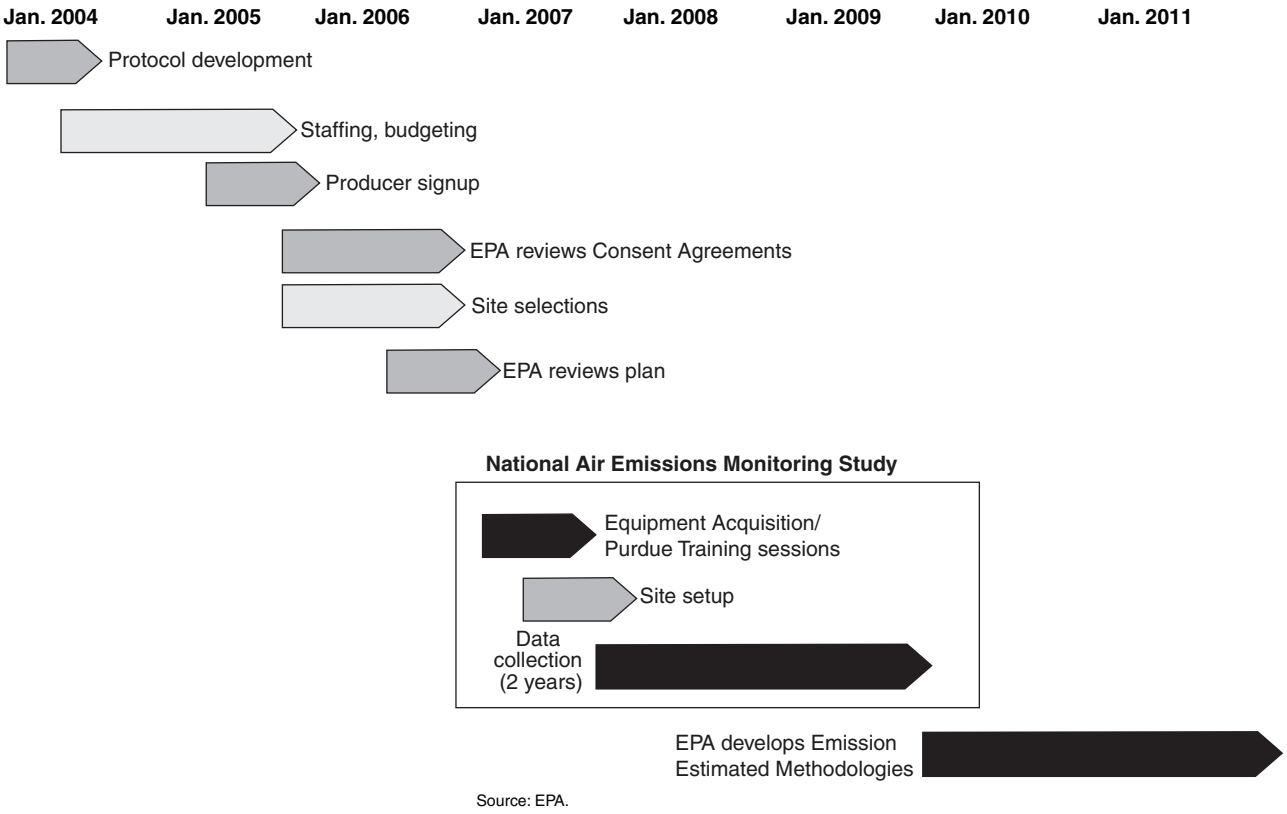
Source: EPA.

The purpose of the National Air Emissions Monitoring Study is to collect data that will provide a scientific basis for measuring and estimating air

[26]EPA placed certain conditions and limits on its agreement not to sue animal feeding operations participating in the Air Compliance Agreement. For example, EPA can continue to pursue cases that present an imminent and substantial endangerment to public health, welfare, or the environment. In addition, EPA's agreement not to sue only covers emissions from agricultural livestock and livestock waste and does not extend to generators or land application of animal waste.

emissions from animal feeding operations and will help EPA to determine operations' compliance status. To provide a framework for the monitoring study and develop a sampling plan that was representative of animal feeding operations in the United States, in 2003 EPA convened a panel of industry experts, university and government scientists, and other stakeholders knowledgeable in the field. In 2004, the nonprofit organization founded by the various livestock sectors selected an independent science adviser to oversee the data collection at 20 of the 13,883 animal feeding operations that were selected to participate in the study. Their selection was submitted to and approved by EPA. Data collection began in May 2007. Once 2 years of data has been collected, EPA will use these data to develop air emissions protocols. Figure 6 shows EPA's expected timeline for the development of air emissions protocols.

Figure 2: EPA Timeline for Development of Air Emission Protocols for Animal Feeding Operations



Source: EPA.

However, the National Air Emissions Monitoring Study may not provide the data that EPA needs to develop comprehensive protocols for quantifying air emissions from animal feeding operations for a variety of reasons. First, the monitoring study does not include the 16 combinations of animal types and geographic regional pairings recommended by EPA's expert panel. The panel recommended this approach so that the study sample would be representative of the vast majority of participating animal feeding operations, accounting for differences in climatic conditions, manure-handling methods, and density of operations. However, EPA approved only 12 of the 16 combinations recommended by the expert panel, excluding southeastern broiler, eastern layer, midwestern turkey, and southern dairy operations. Second, site selection for the study has been a concern since the plan to select monitoring sites for the monitoring study was announced in 2005. At that time, many agricultural experts, environmental groups, and industry and state officials disagreed with the site selection methodology. In commenting on EPA's *Federal Register* notice of the Animal Feeding Operation Consent

Agreement and Final Order, these experts and officials stated that the study did not include a sufficient number of monitoring sites to establish a statistically valid sample. Without such a sample, we believe that EPA will not be able to accurately estimate emissions for all types of operations. More recently, in June 2008, the state of Utah reached an agreement with EPA to separately study animal feeding operations in the state because of the state's continuing concerns that the National Air Emissions Monitoring Study will not collect information on emissions from operations in Rocky Mountain states and therefore may not be meaningful for those operations that raise animals in arid areas. Finally, agricultural experts have raised concerns that the National Air Emissions Monitoring Study does not include other sources that can contribute significantly to emissions from animal feeding operations. For example, these experts have noted that the monitoring study will not capture data on ammonia emissions from feedlots and manure applied to fields. According to these experts, feedlots and manure on fields, as well as other excluded sources, account for approximately half of the total ammonia emissions from animal feeding operations.

Furthermore, USDA's Agricultural Air Quality Task Force has also recently raised concerns about the quantity and quality of the data being collected during the early phases of the study and how EPA will eventually use the information.[27] In particular, the task force expressed concern that the technologies used to collect emissions data were not functioning reliably. For example, according to data provided by EPA, almost one-third of the preliminary data from one site were incomplete during a 2-month data collection period. The task force was also concerned about EPA's plans to extrapolate the data across a variety of CAFO operating configurations. At its May 2008 task force meeting, the members requested that the Secretary of Agriculture ask EPA to review the first 6 months of the study's data to determine if the study needs to be revised in order to yield more useful information.

EPA acknowledged that emissions data should be collected for every type of animal feeding operation and practice, but EPA officials stated that such an extensive study is impractical. According to EPA officials, the industry identified those monitoring sites that they believed best represented the type of operations and manure management practices that

[27]The Agricultural Air Quality Task Force, created in accordance with the 1996 farm bill, is charged with advising the Secretary of Agriculture with respect to providing oversight and coordination related to agricultural air quality, and consists of leaders in farming, industry, health, and science.

are in their various animal sectors. EPA reviewed and approved these site selections. According to EPA, it believes that the selected sites provide a reasonable representation of the various animal sectors. EPA has also indicated that it plans to use other relevant information to supplement the study data and has identified some potential additional data sources. For example, a study conducted at two broiler facilities in Kentucky has been accepted as meeting the emissions study's requirements. However, according to agricultural experts, until EPA identifies all the supplemental data that it plans to use, it is not clear if these data, together with the emissions study data, will enable EPA to develop comprehensive air emissions protocols.

Furthermore, EPA has also indicated that completing the National Air Emissions Monitoring Study is only the first step in a multiyear effort to develop a process-based model for predicting overall emissions for animal feeding operations. A process-based model would capture emissions data from all sources and use these data to assess the interaction of all sources and the impact that different manure management techniques have on air emissions for the entire operation. For example, technologies are available to decrease emissions from manure lagoons by, among other things, covering the lagoon to capture the ammonia. However, if an operation spreads the lagoon liquid as fertilizer for crops, ammonia emissions could increase on the field. According to NAS, a process-based model is needed to provide scientifically sound estimates of air emissions from animal feeding operations that can be used to develop management and regulatory programs. Although EPA plans to develop a process-based model after 2011, it has not yet established a timetable for completing this model and, therefore, it is uncertain when EPA will have more sophisticated approaches that will more accurately estimate emissions from animal feeding operations.

Recent EPA Decisions Suggest That the Agency Has Not Yet Determined How It Plans to Regulate Air Emissions from Animal Feeding Operations

Two recent decisions by EPA suggest that the agency has not yet determined how it intends to regulate air emissions from animal feeding operations. EPA's first decision in this context was made in December 2007. At that time EPA proposed to exempt releases to the air of hazardous substances from manure at farms that meet or exceed the reportable quantities from both CERCLA and EPCRA notification requirements. According to EPA, this decision was in response to language that was contained in congressional committee reports related to EPA's appropriations legislation for 2005 and 2006. EPA was directed to promptly and expeditiously provide clarification on the application of these laws to poultry, livestock, and dairy operations. In addition, the agency received a petition from the National Chicken Council, the

National Turkey Federation, and the U.S. Poultry and Egg Association seeking an exemption from the CERLA and EPCRA reporting requirements for ammonia emissions from poultry operations. The petition argued that ammonia emissions from poultry operations pose little or no risk to public health, and emergency response is inappropriate. In proposing the rule, EPA noted that the agency would not respond to releases from animal wastes under CERCLA or EPCRA nor would it expect state and local governments to respond to such releases because the source and nature of these releases are such that emergency response is unnecessary, impractical, and unlikely. It also noted that it had received 26 comment letters from state and local response agencies supporting the exemption for ammonia from poultry operations. However, during the public comment period ending on March 27, 2008, a national association representing state and local emergency responders with EPCRA responsibilities questioned whether EPA had the authority to exempt these operations until the agency had data from its monitoring study to demonstrate actual levels of emissions from animal feeding operations. This national association further commented that EPA should withdraw the proposal because it denied responders and the public the information necessary to protect themselves from dangerous releases.[28] The timing of this proposed exemption, before the National Air Emissions Monitoring Study has been completed, we believe calls into question the basis for EPA's decision.

The second decision that EPA has recently made that calls into question how the agency intends to regulate air emissions from animal feeding operations involves the timing of key regulatory decisions. EPA has stated that it will not make key regulatory decisions on how federal air regulations apply to animal feeding operations until after 2011, when the monitoring study is completed. According to EPA, the agency will issue guidance defining the scope of the term "source" as it relates to animal agriculture and farm activities. As a result, EPA has not decided if it will aggregate the emissions occurring on an animal feeding operation as one source or if the emissions from the barns, lagoons, feed storage, and fields will each be considered as a separate source when determining if an operation has exceeded air emissions' reportable quantities. Depending on the approach EPA takes, how emissions are calculated could differ significantly. For example, according to preliminary data EPA has received from an egg-laying operation in Indiana, individual chicken barns may

[28]The National Association of SARA Title III Program Officials. The Superfund Amendments and Reauthorization Act (SARA) amended CERCLA on October 17, 1986, after the first 6 years of the program.

exceed the CERCLA reportable quantities for ammonia. Moreover, if emissions from all of the barns on the operation are aggregated, they might be more than 500 times the CERCLA reportable quantities. In addition, EPA does not intend to issue guidance to address emissions, and sources of emissions, that cannot reasonably pass through a stack, chimney, or other functionally equivalent opening, i.e., fugitive emissions, until after the conclusion of the monitoring study.

EPA has already been asked to clarify what it considers a source on an animal feeding operation but has declined to do so. In a 2004 ruling on an appeal of a civil suit against a swine operation, the U.S. Court of Appeals for the 10th Circuit overturned a 2002 federal district court ruling that a farm's individual barns, lagoons, and land application areas could be considered separate "sources" for purposes of CERCLA reporting requirements.[29] The Court of Appeals ruled that the whole farm site was the proper entity to be assessed for purposes of CERCLA reporting. The Court invited EPA to file a friend-of-the-court brief in order to clarify the government's position on this issue, but EPA declined to do so within the court-specified time frame.[30] Another court reached similar conclusions in 2003.[31] Despite these court rulings, EPA has indicated that it will not decide on what it considers a source until the National Air Emissions Monitoring Study is completed.

Lacking Federal Guidance, Some States Have Begun to Regulate Air Emissions from Animal Feeding Operations

In the absence of federal guidance on how to regulate air emissions from animal feeding operations, officials in 6 states, out of the 47 states that responded to our survey, are regulating some emissions covered under the Clean Air Act, CERCLA and EPCRA. As table 10 shows, state officials in California, Idaho, Minnesota, Missouri, Nebraska, and North Dakota reported that they have developed state air regulations for certain pollutants that are emitted by CAFOs.

[29]*Sierra Club v. Seaboard Farms Inc.*, 387 F.3d 1167 (10th Cir. 2004).

[30]In commenting on a draft of this report, EPA noted that it had a very limited time to respond to the court's request.

[31]*Sierra Club v. Tyson Foods, Inc.*, 299 F. Supp. 2d 693 (W.D. Ky. 2003).

Table 10: States That Reported Having Regulations for Air Emissions from Animal Feeding Operations, 2008

	Hydrogen sulfide	Ammonia	Particulate matter	Volatile organic compounds
California	X	X	X	X
Idaho		X		
Minnesota	X			
Missouri	X		X	
Nebraska	X			
North Dakota	X			

Source: State officials, as reported to GAO.

Specific examples of the types of regulations that the states have developed include the following:

- Minnesota has established state emissions thresholds for hydrogen sulfide that apply to CAFOs. CAFO operators in the state must develop an air emissions control plan and must implement it if the Minnesota Pollution Control Agency detects elevated levels of hydrogen sulfide. According to state officials, once an operator reduces emissions, the agency re-monitors to ensure the emission levels remained below the state-established threshold.[32] Minnesota may take legal action against CAFO operators violating this standard. For example, in June 2008, monitoring by the Minnesota Pollution Control Agency at a dairy operation recorded hydrogen sulfide levels above the state threshold and in cooperation with the State Attorney General, the agency, using state authorities, filed a lawsuit against the dairy's operator.

- In 2003, California passed a law that authorized the state and local air districts to require animal feeding operations above a certain size to apply for clean air permits and develop a plan to decrease air emissions. For example, one air district in California—the San Joaquin Valley Air Pollution Control District with large clusters of animal feeding operations—developed a rule in 2006 to implement the law that required large animal feeding operations to apply for a permit that includes a plan for mitigating their emissions. According to air district officials, the district

[32]The standard is: 50 ppb average over 1/2 hour not to be exceeded more than two times per year; 30 ppb average over 1/2 hour not to be exceeded more than two times in any 5 consecutive days.

has implemented specific regulations for dairy animal feeding operations that require these operations to obtain five separate permits for components of their operations, including barns and land application of manure. The officials told us that these regulations were put in place, in part because the area is designated as a severe nonattainment area under the Clean Air Act and they are required to regulate a broader range of emission sources. According to state officials we spoke with, as a result of these more stringent state regulations, CAFOs in California may be relocating to other states—such as Texas and Iowa.

Two Federal Court Decisions Have Affected EPA's and Some States' Ability to Regulate Water Pollutants Discharged by CAFOs

Two federal court decisions have affected EPA and some states' abilities to regulate CAFOs for water pollutants. The 2005 *Waterkeeper Alliance Inc. v. EPA* decision forced EPA to revise its 2003 rule for permitting CAFOs and abandon its approach of requiring all CAFO operators to obtain a permit. Although this court decision affected EPA's ability to regulate CAFOs, states' reaction to the *Waterkeeper* decision has varied: some states such as Minnesota continue to require all CAFOs to obtain permits while others such as Colorado have delayed developing new rules until EPA issues its final revised rule. In addition, the Supreme Court's 2006 decision—*Rapanos v. United State*s—has made determination of Clean Water Act jurisdiction over certain types of waters more complex. According to EPA, this has required the agency to gather significantly more evidence to establish Clean Water Act jurisdiction in some enforcement cases.

The *Waterkeeper* Decision Has Impacted EPA's Ability to Regulate CAFOs, but Has Not Had a Similar Impact on Some States

In its 2005 *Waterkeeper* decision, the U.S. Court of Appeals for the Second Circuit set aside a key provision of EPA's 2003 CAFO rule requiring every CAFO to apply for a NPDES permit. Under the 2003 rule, large numbers of previously unregulated CAFOs were required to apply for permits and would have been subject to monitoring and reporting requirements imposed by the permit as well as periodic inspections. According to EPA, the 2003 rule would have expanded the number of CAFOs requiring permits from an estimated 12,500 to an estimated 15,300, an increase of about 22 percent. According to EPA officials, when fully implemented, this requirement for all CAFOs with a potential to discharge to apply for permits would have provided EPA with more comprehensive information on the number and location of CAFOs and how they are operated and managed, thus allowing EPA to more effectively locate and inspect CAFOs nationwide.

However, in 2003, both environmental and agricultural groups challenged EPA's 2003 rule. In the *Waterkeeper* case, environmental groups argued,

among other things, that EPA's 2003 rule did not adequately provide for (1) public review and comment on a CAFO's nutrient management plan and (2) permitting authorities to review the CAFO's nutrient management plan. The court agreed with the environmental groups and instructed EPA to revise the rule accordingly. The agricultural groups challenged the 2003 rule's CAFO permitting requirement, arguing that the agency exceeded its authority under the Clean Water Act by requiring CAFOs that were not discharging pollutants into federally regulated waters to apply for permits or demonstrate that they had no potential to discharge. The court also agreed with the agricultural groups and set aside the permitting requirements for CAFOs that did not actually discharge. Following the court's decision, many aspects of the 2003 rule remained in effect, including EPA's revised regulatory definition of CAFOs and the expansion of the number of CAFOs needing permits by deleting a significant exception.

In effect, the *Waterkeeper* decision returned EPA's permitting program to one in which CAFO operators are not required to apply for a NPDES permit unless they discharge, or propose discharging, into federally regulated waters. As a result, EPA must identify and prove that an operation has discharged or is discharging pollutants in order to require the operator to apply for a permit. To help identify unpermitted discharges from CAFOs, EPA officials stated that they have to rely on other methods that are not necessarily all-inclusive, such as citizens' complaints, drive-by observations, aerial flyovers, and state water quality assessments that identify water bodies impaired by pollutants associated with CAFOs. According to EPA officials, these methods have helped the agency identify some CAFOs that may be discharging as well as targeting inspections to such CAFOs.

In response to the *Waterkeeper* decision, EPA proposed a new rule in June 2006 requiring that (1) only CAFO operators that discharge, or propose to discharge, apply for a permit; (2) permitting authorities review CAFO nutrient management plans and incorporate the terms of these plans into the permits; and (3) permitting authorities provide the public with an opportunity to review and comment on the nutrient management plans. According to EPA officials, the final rule is currently being reviewed by the Office of Management and Budget before it is formally published in the *Federal Register*. These officials said it is uncertain when the OMB review will be completed and the final rule issued. Estimates vary on how this rule, when implemented, will affect the number of CAFOs that will obtain a permit. EPA estimates that 25 percent fewer CAFOs will need to apply for a permit under the new rule than would have been required to apply for a permit under the 2003 rule. In contrast, an association representing

state water program officials believes that many fewer CAFOs than EPA estimates will voluntarily apply for a permit under the new 2006 rule, when it is finalized.

The need to develop and implement a new rule that meets the *Waterkeeper* requirements has also resulted in delays in implementing the provisions of the 2003 rule that the Court upheld. Specifically, EPA has not yet implemented, among other things the expanded CAFO definitions, which cover operations such as dry-manure poultry operations. This is particularly significant since, according to a USDA official with extensive knowledge of the poultry industry and another agricultural expert that we spoke to, at least 90 percent of poultry operations use a dry-manure management system. An EPA Region 6 official told us that in Texas alone this expanded definition would result in about 1,500 additional dry-manure poultry operations being covered under the new CAFO definition.

Although the *Waterkeeper* decision has affected EPA's ability to regulate CAFOs' water pollutant discharges, this decision has not had the same impact on the ability of some of the states to regulate these operations. According to officials in the 47 states responding to our survey, the impact of the *Waterkeeper* decision on their ability to regulate water pollution from CAFOs has been mixed. As table 11 shows, the impacts of the *Waterkeeper* decision ranged from having little impact on state regulation of CAFOs to impairing state CAFO programs.

Table 11: State Officials' Views of the Impact of the *Waterkeeper* Decision on Their CAFO Programs

Impact of *Waterkeeper*	Number of states reporting impact
Waterkeeper had little or no impact	16
Reduced the number of CAFOs with permits	15
Impaired state program	10
Waiting for EPA to issue revised rule	9
Prompted state legislation to require permits for CAFOs	1

Source: GAO analysis of state official responses.

Note: Some state officials identified more than one impact.

Officials from several of the states that told us that the *Waterkeeper* decision had little impact on their regulation of CAFOs, saying that this was primarily because their states had implemented CAFO regulations that were more stringent than those required under the Clean Water Act. For example, Minnesota officials stated that the *Waterkeeper* decision had

no impact on their state's regulations because the state used its own authority to adopt regulations more stringent than EPA's regulations. Moreover, according to Minnesota officials, even after the *Waterkeeper* decision, the state has continued to require all CAFOs to obtain permits from the state environmental agency. Similarly, Kansas officials stated that the *Waterkeeper* decision had only minimal effects because the state has regulated CAFOs since the 1960s.

However, 34 states indicated that the *Waterkeeper* decision directly affected their state programs. Officials from 15 states told us that the number of CAFOs that had obtained permits since the *Waterkeeper* decision had decreased although none provided us with numbers on what this decrease had been. Similarly, officials in 10 states told us that the *Waterkeeper* decision had impaired their state's ability to regulate CAFOs because it discredited the program, created confusion or uncertainty, or made it difficult for them to determine which operations needed a permit. For example, according to the state official responsible for Indiana's CAFO permitting program, although the state has had a CAFO permitting program since 1971, it adopted EPA's 2003 CAFO Rule because the rule was more protective. However, when the *Waterkeeper* decision set aside portions of the 2003 rule, this official told us that the decision, in effect, discredited the state's regulatory program. In addition, officials from nine states who are responsible for their state's permitting program told us that their programs remain in limbo while they wait for EPA to issue its final revised rule. These state officials, including officials in Colorado, said that they will update their state rules once EPA's final rule is issued.

Finally, state water pollution control officials have expressed some concerns that EPA's new 2006 rule will place a greater administrative burden on states than the 2003 rule would have. In an August 2006 letter to EPA, the Association of State and Interstate Water Pollution Control Administrators noted that the "reactive" enforcement that EPA will now follow will require permitting authorities to significantly increase their enforcement efforts to achieve the level of environmental benefit that would have been provided by the 2003 rule. These officials believe that requiring EPA and the states to identify CAFOs that actually discharge pollutants into federally regulated water bodies will consume more resources than requiring all CAFOs to apply for a permit.

The *Rapanos* Decision Has Affected EPA's Overall Ability to Regulate Pollutants Entering Federally Regulated Waters

The Supreme Court's 2006 *Rapanos* decision has also affected EPA's enforcement of the Clean Water Act because the agency believes that it must gather significantly more evidence to establish which waters are subject to the act's permitting requirements. At issue in the *Rapanos* decision was whether the Clean Water Act's wetlands permitting program applied to four specific wetlands that were adjacent to non-navigable tributaries of traditional navigable waters. The Court rejected the standards applied by the lower courts in determining whether wetlands at issue fell under the act's jurisdiction and, therefore, could be subject to permitting requirements. Although a majority of the justices rejected the standards applied by the lower courts, a majority could not agree on how to determine which waters would fall under the act's jurisdiction, and thus how far EPA could reach to regulate discharges of pollutants under the act.

Although the *Rapanos* case arose in the context of a different permit program, the scope of EPA's pollutant discharge permit program originates in the same Clean Water Act definition that was discussed in the decision. According to EPA enforcement officials, the agency may now be less likely to seek enforcement against a CAFO that it believes is discharging pollutants into a water body because it may be more difficult to prove that the water body is federally regulated. According to EPA officials, as a result of the *Rapanos* decision, the agency must now spend more resources developing an enforcement case because the agency must gather proof that the CAFO not only has illegally discharged pollutants, but that those discharges ultimately entered a federally regulated water body. These officials told us that the farther a CAFO is from a regulated water body, the more evidence they will need to prove that the discharges entered that water body. To ensure "nationwide consistency, reliability, and predictability in their administration of the statute," EPA has issued national guidance to clarify the agency's responsibilities in light of the Supreme Court's decision. However, in a March 4, 2008, memorandum, EPA's Assistant Administrator for Enforcement and Compliance Assurance stated that the *Rapanos* decision and EPA's guidance has resulted in significant adverse impacts to the clean water enforcement program. According to the memorandum, the *Rapanos* decision and guidance negatively affected approximately 500 enforcement cases, including as many as 187 cases involving NPDES permits. In May 2007, Members of Congress, in both the House and Senate, introduced a bill entitled the Clean Water Restoration Act of 2007 to clearly define the scope of the Clean Water Act. As of August 2008, neither bill had been reported out of committee.

Conclusions

For more than 30 years, EPA has regulated CAFOs under the Clean Water Act and during this time it has amassed a significant body of knowledge about the pollutants discharged by animal feeding operations and the potential impacts of these pollutants on human health and the environment. Despite its long-term regulation of CAFOs, EPA still lacks comprehensive and reliable data on the number, location, and size of the operations that have been issued permits and the amounts of discharges they release. As a result, EPA has neither the information it needs to assess the extent to which CAFOs may be contributing to water pollution, nor the information it needs to ensure compliance with the Clean Water Act. More recently, EPA has also begun to address concerns about air pollutants that are emitted by animal feeding operations. The Nationwide Air Emissions Monitoring Study, along with EPA's plans to develop air emissions estimating protocols, are important steps in providing much needed information on the amount of air pollutants emitted from animal feeding operations. However, questions about the sufficiency of the sites selected for the air emissions study and the quantity and quality of the data being collected could undermine EPA's efforts to develop air emissions protocols by 2011 as planned. Finally, while the study and resulting protocols are important first steps, a process-based model that more accurately predicts the total air emissions from an animal feeding operation is still needed. While EPA has indicated it intends to develop such a model, it has not yet established a strategy and timeline for this activity.

Recommendations for Executive Action

In order to more effectively monitor and regulate CAFOs, we recommend that the Administrator of the Environmental Protection Agency should complete the agency's effort to develop a national inventory of permitted CAFOs and incorporate appropriate internal controls to ensure the quality of the data.

In order to more effectively determine the extent of air emissions from animal feeding operations, the Administrator of the Environmental Protection Agency should

- reassess the current data collection efforts, including its internal controls, to ensure that the National Air Emissions Monitoring Study will provide the scientific and statistically valid data that EPA needs for developing its air emissions protocols;
- provide stakeholders with information on the additional data that it plans to use to supplement the National Air Emissions Monitoring Study; and

- establish a strategy and timetable for developing a process-based model that will provide more sophisticated air emissions estimating methodologies for animal feeding operations.

Agency Comments and Our Evaluation

We provided a draft of this report for review and comment to the EPA and the Secretary of USDA. We received written comments from EPA. USDA did not provide written comments, but did provide technical comments and clarifications, which we incorporated, as appropriate.

EPA partially concurred with our conclusions and recommendations. In its written comments, EPA acknowledged that currently no national inventory of permitted CAFOs exists. The agency stated that it is currently working with its regions and the states to develop and implement a new national data system to collect and record facility-specific information on permitted CAFOs. We have revised our recommendation to reflect the actions that EPA has underway. In response to our recommendations that EPA reassess the current data collection effort, EPA stated that the agency has developed a quality assurance plan for the study and is continuously evaluating the National Air Emissions Monitoring Study. We are aware that EPA has developed a quality assurance plan for the data collected during the study. However, our recommendation also reflects other concerns with the study. For example, the monitoring sites selected may not represent a statistically valid sample or animal feeding operations that account for the differences in climatic conditions, manure-handling methods, and density of operations; and the study does not address other sources that can contribute significantly to emissions from animal feeding operations. EPA did not address these issues in its comments. Therefore, we continue to believe that EPA should reassess the ongoing effort to ensure that the study, as currently structured, will provide the data that EPA needs.

In response to our recommendation that the agency identify the information that it plans to use to supplement the National Air Emissions Monitoring Study, EPA stated that it cannot yet identify the data that it will use to augment the data collected during the monitoring study. However, the agency indicated that it has begun discussions with USDA to identify ongoing research that is focused on agricultural air emissions and gaps that may still exist, but did not provide any additional information on when it plans to identify the supplemental data that it plans to use to augment the monitoring study. Until it does so, neither EPA nor stakeholders can be assured that these data, in combination with the emissions study data, will enable EPA to develop the planned protocols. The agency also agreed with our recommendation to establish a strategy

and timetable for developing a process-based model and said that it has begun to evaluate what is needed to develop such a model. However, the agency did not provide any information on when it expects to complete plans for developing a process-based model. EPA also provided technical comments, which we have incorporated, as appropriate. EPA's written comments are provided in appendix V.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to interested congressional committees, the Administrator of the Environmental Protection Agency, the Secretary of the United States Department of Agriculture and other interested parties. We also will make copies available to others upon request. In addition, the report will be available at no charge on GAO's Web site at http://www.gao.gov.

If you or your staff have any questions regarding this report, please contact me at (202) 512-3841 or mittala@gao.gov. Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix VI.

Anu Mittal
Director, Natural Resources
and Environment

List of Requesters

The Honorable John D. Dingell
Chairman
Committee on Energy and Commerce
House of Representatives

The Honorable James L. Oberstar
Chairman
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Gene Green
Chairman
Subcommittee on Environment and Hazardous Materials
Committee on Energy and Commerce
House of Representatives

The Honorable Eddie Bernice Johnson
Chairwoman
Subcommittee on Water Resources and Environment
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Hilda L. Solis
House of Representatives

Appendix I: Objectives, Scope, and Methodology

For this report we were asked to determine the (1) trends in concentrated animal feeding operations (CAFOs) over the past 30 years; (2) amount of waste they generate; (3) findings of recent key academic, industry, and government research of the potential impacts of CAFOs on human health and the environment, and the extent to which the Environmental Protection Agency (EPA) has assessed the nature and severity of these identified impacts; (4) progress that EPA and states have made in regulating and controlling the air emissions of, and in developing protocols to measure, air pollutants from CAFOs that could affect air quality; and (5) extent to which recent court decisions have affected EPA and the states' ability to regulate CAFO discharges that impair water quality.

In conducting our work, we reviewed laws and regulations and federal and state agencies' documents. We met with officials from EPA, the U.S. Department of Agriculture (USDA), the National Pork Producers Council, the National Pork Board, the National Cattlemen's Beef Association, the Environmental Integrity Project (a nonpartisan, nonprofit environmental advocacy group), the Sierra Club, California Association of Irritated Residents, Waterkeeper Alliance, Iowa Citizens for Community Improvement, Environmental Defense, National Association of Clean Air Agencies, Association of State and Interstate Water Pollution Control Administrators, as well as state officials. The National Chicken Council did not respond to our requests for information. Additionally, we visited CAFOs in eight states: Arkansas, California, Colorado, Iowa, Maryland, Minnesota, North Carolina, and Texas. We chose these states because they were geographically dispersed and contained numerous CAFOs representing multiple types of animals.

For our analysis of trends in CAFOs over the past 30 years, we used USDA's Census of Agriculture data. We assessed the reliability of these data by reviewing USDA's documentation on the development, administration, and data quality program for the Census of Agriculture. We also electronically tested the data used in this study to determine if there were any missing data or anomalies in the dataset. Furthermore, we compared the results of our nationwide results for each year by animal sector to USDA's published reports. On the basis of these assessments, we determined the data to be sufficiently reliable for the purposes for which it was used in this report. In addition, respecting USDA's requirement to protect the privacy of individual farmers responding to the Census of Agriculture surveys, we conducted these analyses at USDA and worked

with USDA to review our results and verify that no single operation could be identified from our analysis.[1]

From USDA's Census of Agriculture data, we analyzed the most recent data available for large farms raising animals from 1974 through 2002.[2] We used these data on large farms as a proxy for CAFOs because no federal agency collects consistent data on these types of operations. USDA has periodically collected data on farms nationwide using the Census of Agriculture survey. Prior to 1982, these surveys were conducted every four years; whereas since 1982, the agency has administered the survey every five years (the most recent survey results, conducted in 2007, will not be available until February 2009). In analyzing Census data prior to 1982, we found that the categories reported by USDA were not consistent with EPA's minimum size threshold for large CAFOs: 2,500 hogs, 700 dairy or milk cows, 55,000 turkeys, 1,000 beef cattle, 82,000 layers, and 125,000 broilers.[3] For instance, the largest farm categories USDA reported for broilers prior to 1982 was farms with sales of 100,000 and more. Since sales data must be converted to an inventory number, we had to make adjustments for production cycles to determine the number of animals on a farm per day.[4] Broiler farms complete six production cycles per year therefore, when we divided the USDA provided number of 100,000 in broiler sales by 6 to account for the total number of possible production cycles, the USDA reported broiler sales represent a farm with an inventory of about 17,000 broilers. Farms of this size are much smaller than the

[1]In order to adjust the data for survey undercoverage and nonresponse, we used the official USDA statistical weights. However, we were unable to calculate the confidence intervals around the reported estimates because the Census of Agriculture's documentation does not provide the necessary information to determine the statistical error associated with subpopulation estimates.

[2]We included a farm, for the purposes of calculating the number of farms overall and for each animal type, only when it reported, on the Census of Agriculture survey, either sales or inventory numbers for a particular animal type.

[3]By minimum size threshold, we mean the minimum number of animals required for classification as a large CAFO without consideration of other factors, such as whether the animal feeding operation is a significant contributor of pollutants to federally regulated waters, or whether pollutants are discharged into federally regulated waters from the operation through a manmade ditch.

[4]A production cycle is the length of time an animal is fed before being sold plus time between "crops." For example, the feeding period for a broiler is about 48 days. Including time for cleaning barns between cycles, restocking, etc., a broiler farm has about 6 production cycles per year. We used the number of cycles per animal type provided in "Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients," USDA, December 2000.

125,000 broiler CAFO threshold defined by EPA. Similarly, categories for farms raising other types of animals, in the pre-1982 USDA data, were also different than the EPA CAFO definitions for these types of operations. As a result, we used the time frame of 1982 through 2002 because USDA could provide us with detailed electronic data that allowed us to apply EPA's CAFO thresholds to determine the trends in the overall number of large farms that raised animals and could be potentially considered a CAFO. For broilers and layers/pullets,[5] we used EPA's CAFO minimum size threshold for dry-litter manure handling systems because these systems represent the majority of poultry operations. These thresholds are larger than for those poultry operations that have liquid manure handling systems.

Because USDA does not report the average number of animals on a farm, we used USDA Census of Agriculture inventory, sales, and inventory plus sales data for this purpose. The choice of using inventory only, sales only, or inventory and sales data for a particular animal type depended on the wording of Census survey questions during the years we analyzed. When only sales data or inventory plus sales data were used, we adjusted these data using the appropriate USDA formulas to determine the average number of animals on a farm.[6] When both inventory and sales were used for an animal type, we applied an approved USDA approach to determine the average number of animals on a farm. As a result, we made the following adjustments for each animal type:

- For beef cattle, USDA only collected sales data for 1982 through 1997. As a result, for beef cattle, we used sales of cattle on feed (2002 survey) or sales of fattened cattle (1982 through 1997 surveys) adjusted for the number of production cycles. This increased the likelihood that we were including cattle raised on CAFOs instead of operations that allow the cattle to graze on pastureland.

- For dairy cows, we used the inventory of animals as of December 31 for each Census year since these animals are maintained to produce milk and not specifically for slaughter. For dairy cows, we included the categories: lactating and nonlactating cows.

[5]A pullet is a replacement hen for laying eggs that is less than 1 year of age.

[6]"Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients," USDA, December 2000.

- For hogs, the Census of Agriculture reported both inventory and sales data for hogs and pigs.[7] These data were not reported by either the weight or age, so we used the total for all hogs and pigs of all ages. We used both the inventory and sales data for hogs and adjusted for the number of production or finish cycles. Hogs may be sold more than once because of the practice of selling feeder pigs at about 10-12 weeks of age to producers to be grown to typical slaughter size. For example, in 1997, about 25 percent of all hog and pig sales reported on the Census of Agriculture were feeder pigs.[8] We adjusted the hog data to factor out these multiple sales.

- For layers, we used survey responses of inventory as of December 31 for layers 20 weeks old and older plus pullets for laying flock replacement.

- For broilers, we used inventory and sales data from the categories: broilers, fryers, capons, roaster and other chickens raised for meat.

- For turkeys, both inventory and sales data were used and included both hens and tom turkeys.

We also reviewed EPA's data on the number of CAFOs that had been issued permits—these data are either collected by EPA's regional offices or from the states—for the period 2003 to 2008. We assessed the accuracy and reliability of these data by interviewing officials in 47 states and we asked them to verify the information that EPA had for the numbers of CAFOs permitted in their state.[9] Based on the information we obtained from the state officials, we determined that EPA's data for permitted CAFOs was not reliable and could not be used to identify trends in permitted CAFOs over the 5-year period.

To identify the amount of manure, including urine, a large CAFO is estimated to generate for each animal type, we used EPA's thresholds for the minimum number of animals that constitute a CAFO. To illustrate the size of a "typical" large farm for each animal type, we used the median for

[7]The term "hogs" includes all production stages unless otherwise stated.

[8]1997 was the last Census of Agriculture survey that asked for sales of feeder pigs. The 2002 survey asked for hogs "sold or moved from this operation, including feeder pigs." In many hog contract operations, the farmer does not own the pigs being fed. GAO did not determine what effect changing the survey wording had on the change in total hogs sold between 1997 and 2002 nor whether the sales of feeder pigs as a percentage of total swine sales changed from 1997 to 2002.

[9]The three states that did not provide information on their state CAFO programs were Connecticut, Nevada, and Vermont.

a large-sized farm. We used the median instead of the mean because we believe it provides a more representative measure for a typical large farm. We also present information on farms at the 75th percentile of all large farms for a particular animal type to represent larger farms.[10]

To estimate the amount of manure produced by each type of animal, we used engineering standards for manure production cited by the American Society of Agricultural and Biological Engineers (ASABE).[11] These standards report the total amount of manure over the production cycle for hogs, beef cattle, turkeys, and broilers. In order to estimate the average pounds of manure per day, we divided the total manure produced over the production cycle by the number of days in the production cycle. Further, we converted the pounds of manure into tons of manure per farm per year. We adjusted the manure calculations for the following animal types:

- For layers, the standards provided the average daily pounds of manure produced by layers. We multiplied the average pounds of manure per day times the average number of animals times 365 days to get manure produced per year.
- For broilers, we determined the average daily pound of manure from the information provided in the standards. We multiplied the average pound of manure per day times the average number of animals times 365 days to get manure per year.
- For dairy cows, the standards provided the average daily pounds of manure produced by dairy cows. We multiplied the average pounds of manure per day times the average number of animals times 365 days to get manure per year. However, we adjusted the data to take into account the typical percentage of cows that are either lactating or dry (nonlactating) and applied the different amounts of manure produced by each type of dairy cow.
- For turkeys, we adjusted the turkey statistics based on the ratio of hens to tom turkeys raised on farms and applied different amounts of manure due to the different sizes of the animals.

[10]We do not report the largest farm for each particular animal type to avoid disclosing information that would allow the identification of the person who supplied the particular information to USDA. Federal law prohibits such disclosure.

[11]"Manure Production and Characteristics" (St. Joseph, Mich.: March 2005). Manure is "as-excreted" and excludes bedding, waste feed, dilution water, biochemical degradation of solids, or dissipation of gases.

- For hogs, the manure standards report manure produced by hogs covering a specific stage of production: feeder-pig-to-finish pigs—beginning with a pig weighing on average about 27 pounds and resulting in a hog weighing 154 pounds. Estimates for other hog operation types such as nursery, farrow to feeder, and farrow to finish would therefore differ. Census of Agriculture data for 2002 indicate that about a third of all hogs sold were from the grow-to-finish (called finish only on the survey) operation type. The ASABE manure standards for this type of operation use 154 pounds as the finish weight. However, USDA reports that typical hog finish (slaughter) weights at the time of the 2002 Census were about 260 pounds. For hogs only, we adjusted the ASABE manure estimates by 1.7 to account for the larger finish weights reported by USDA. We believe this is a conservative adjustment because manure produced by hogs weighing 154 to 260 pounds will be the maximum amount per day that ASABE used to calculate the average pounds produced for the hogs growing from about 27 pounds to 154 pounds.

- For beef cattle, we used the manure standard for "beef-finishing cattle." This standard is for cattle fattened from about 740 pounds to about 1,200 pounds at marketing. Beef cattle (listed as cattle on feed) data from the Census are for cattle sold for slaughter and thus similar in weight to those for the standard. The reported manure results for beef cattle are for operations of this type only.

  In addition, the number of days on feed for hogs, turkeys, and broilers used for the ASABE manure standards does not take into account time between herds or flocks entering and leaving an operation; therefore, we adjusted the manure generated to account for the time between cycles.

  We recognize that all amounts of manure reported are estimates because amounts of manure per animal type vary by feeding programs, feeds used, climatic conditions, production techniques, and animal genetics, among other things. As feeds, animal genetics, and production techniques change in the future, these estimates might change—and may have changed since 2002—but USDA did not provide specific information on what changes have occurred and how those changes may have impacted the manure production on farms. We did not estimate the ability of the farm or surrounding farms to assimilate the manure if applied to pastures and crop land nor did we take into account various technologies to process and/or convert manure. Reported estimates of manure are for amounts produced. We did not determine whether these amounts were discharged into the air or streams and wetlands. Manure harvested from CAFOs for application to land might be less than that excreted by animals because of shrinkage due to evaporation.

To provide a perspective of the amount of wastes generated by these large farms, we compared them with the amount of human sanitary waste generated in various cities. We selected certain cities on the basis of their population, as reported by the U.S. Census Bureau's Population Estimates for 2002, and calculated the amount of sanitary waste generated by the human population of those cities by applying estimates for human sanitary waste production. Human sanitary waste includes feces and urine but does not include wastes such as water from showers, washing dishes and clothes, and flushing toilets. We found two sources of information for average daily human sanitary waste.[12] Because these sources provided different estimates (2.68 and 4.76 pounds per person per day), we averaged the two amounts to use in our calculations of human sanitary waste produced for cities (3.72 pounds per person per day). All amounts of human sanitary waste reported are estimates because amounts will vary based on differences in age, dietary habits, activity levels, and climatic conditions, among other things. Human sanitary waste is a small portion of human discharge into sewage systems. Our reported estimates of human sanitary waste for a city are illustrative only and are not intended to be estimates of actual human sanitary waste entering a particular city's waste treatment system. These estimates are for a population the size of selected cities assuming that the residents do not commute outside the city boundaries and that nonresidents do not enter the city for work or other reasons.

To identify the findings of recent key academic, industry, and government research on the potential impacts of CAFOs on human health and the environment, and the extent to which EPA has assessed the nature and severity of such impacts, we reviewed EPA's 2003 CAFO rule (for water impact studies) and the findings and supporting documents of the National Academy of Sciences study on air emissions from animal feeding operations (for air impact studies).[13] In addition, we

- conducted library, online journal and Internet searches to identify recent studies;

[12]Metcalf and Eddy, Inc., "Wastewater Engineering: Treatment, Disposal, and Reuse," 3rd Edition, (New York, N.Y..: 1991) and Parker, D. and Gallagher, S. K., "Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space," in "Second Conference on Lunar Bases and Space Activities of the 21st Century," Volume 2 (NASA Conferences Publication 3166: 1992).

[13]National Academy of Sciences, *Air Emissions from Animal Feeding Operations: Current Knowledge, Future Needs* (Washington, D.C.: National Academies Press, 2003).

- consulted with EPA, USDA, state agencies, industry groups, environmental groups, and academia to help identify additional studies; and
- identified studies through citations in previously identified studies.

We only included in our review studies that (1) were peer-reviewed or produced by a federal agency, (2) were new and original research completed since 2002, (3) had a clearly defined methodology, and (4) identified pollutants found in animal waste and/or their impacts. Through this effort, we found over 200 studies and identified 68 studies that examined air and water quality issues associated with animal waste and met our criteria. We also classified these studies according to whether they

- found a direct link between pollutants from animal waste and impacts on human health or the environment;
- did not find any impacts on human health or the environment from pollutants from animal waste;
- found an indirect link between animal waste and human health or environmental impacts; or
- measured pollutants from animal waste otherwise known to cause human health or environmental impacts.

The classification for each study involved two reviewers. If the reviewers disagreed on the classification, they turned to a third reviewer for resolution. Finally, we compared the findings from these studies with EPA assessments to date and interviewed EPA officials regarding these assessments.

To determine the progress that EPA and states have made in regulating and controlling the air emissions of, and in developing protocols to measure, air pollutants from CAFOs, we reviewed relevant documents, interviewed officials responsible for the ongoing air monitoring study and visited several National Air Emissions Monitoring Study sites in North Carolina. Additionally, we interviewed industry and environmental groups, the umbrella association for state and local clean air agencies, and citizen groups about how EPA air emissions protocols affect them. Finally, we contacted state CAFO officials in all 50 states to determine which states had developed air emission regulations applicable to CAFOs. Officials in

47 states responded.[14] These 47 states account for an estimated 99 percent of large animal feeding operations that could be defined as CAFOs under EPA's 2003 rule.

Finally, to determine the extent to which recent court decisions have affected EPA and the states' ability to regulate CAFO discharges that impair water quality, we examined recent federal decisions, including the *Waterkeeper Alliance Inc. v. EPA* (*Waterkeeper*), and the Supreme Court's 2006 decision in *Rapanos v. United State*s. We interviewed EPA officials about how these court decisions have affected their regulations. To better understand the bases for the lawsuits and what has occurred since the court decisions, we contacted plaintiffs and defendants involved in *Waterkeeper* and other court cases, including industry and environmental groups. To identify the impact of these cases on states regulations, we contacted state CAFO officials in all 50 states to determine how the *Waterkeeper* decision affected their regulations. We asked the states if the *Waterkeeper* decision had affected their state's CAFO program. Using the responses we received from 47 states, we conducted content analyses and classified them into six categories, including if the decision (1) had little impact on the state program, (2) caused the state to wait for EPA guidance (3) impaired the state program, (4) proactively changed legislation, (5) reduced the number of CAFOs with permits, or (6) other. Some officials identified more than one impact. The responses in the "other" category included such responses as "not applicable," "because the state does not have delegated authority," and "we have spent a large amount of time studying the ruling and commenting on EPA proposed rules that were developed to satisfy the ruling."

We conducted this performance audit between July 2007 and August 2008, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[14]The three states that did not provide information on their CAFO programs were Connecticut, Nevada, and Vermont.

Appendix II: EPA's Definition of Concentrated Animal Feeding Operations

EPA's National Pollutant Discharge Elimination System (NPDES) permit program regulates the discharge of pollutants from point sources to waters of the United States. The Clean Water Act defines point sources to include CAFOs. To be considered a CAFO, a facility must first be defined as an animal feeding operation, which is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period.
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Generally CAFOs must meet the above definition of an animal feeding operation and stable or confine a certain minimum number of animals at the operation. EPA classifies CAFOs as large, medium, or small, based on size. Table 12 shows the number of animals at a farm that meet EPA's definition of a large, medium, and small CAFO.

Table 12: EPA Designation of Large, Medium, and Small CAFOs for Various Size Thresholds by Animal Type

	Size thresholds (number of animals)		
Animal type	**Large CAFOs**	**Medium CAFOs[a]**	**Small CAFOs[b]**
Cattle or cow/calf pairs	1,000 or more	300 - 999	less than 300
Mature dairy cows	700 or more	200 - 699	less than 200
Veal calves	1,000 or more	300 - 999	less than 300
Swine (weighing over 55 pounds)	2,500 or more	750 - 2,499	less than 750
Swine (weighing less than 55 pounds)	10,000 or more	3,000 - 9,999	less than 3,000
Horses	500 or more	150 - 499	less than 150
Sheep or lambs	10,000 or more	3,000 - 9,999	less than 3,000
Turkeys	55,000 or more	16,500 - 54,999	less than 16,500
Laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000 - 29,999	less than 9,000
Chickens other than laying hens (other than a liquid manure handling system)	125,000 or more	37,500 - 124,999	less than 37,500
Laying hens (other than a liquid manure handling system)	82,000 or more	25,000 - 81,999	less than 25,000
Ducks (other than a liquid manure handling system)	30,000 or more	10,000 - 29,999	less than 10,000
Ducks (liquid manure handling systems)	5,000 or more	1,500 - 4,999	less than 1,500

Source: EPA.

[a]Must also meet one of two "method of discharge" criteria to be defined as a CAFO or may be designated.

[b]May be designated as a CAFO on a case-by-case basis.

In addition to size, EPA uses the following criteria to determine if a CAFO operator needs to apply for a NPDES permit.

- A large CAFO confines at least the number of animals described in table 12.
- A medium CAFO falls within the size range in table 12 and either:
  - discharged pollutants into federally regulated waters through a manmade ditch, flushing system, or similar manmade device;
  - discharged pollutants directly into federally regulated waters that originate outside of and pass over, across, or through the facility or otherwise come into contact with animals confined in the operation; or
  - is designated as a CAFO by the permitting authority as a significant contributor of pollutants.
- A small CAFO confines the number of animals described in table 12 and has been designated as a CAFO by the permitting authority as a significant contributor of pollutants.

Appendix III: Nationwide Trends in the Number of All Animal Farms and the Number of Animals Raised on Large Farms, 1982-2002

This appendix provides our analysis of USDA's data for trends on the number of all animal farms and the number of animals raised on large farms per day for all animal types for the period from 1982 through 2002.

Table 13: Nationwide Trends in the Number of All Farms That Raise Animals for All Animal Types, 1982 through 2002

Type of animal farm	1982	1987	1992	1997	2002	Percentage change, 1982-2002
Beef cattle[a]	215,465	173,961	133,795	99,654	98,061	(54)
Dairy cow	277,762	202,068	155,339	116,874	91,989	(67)
Hog[b]	347,699	256,595	202,811	114,289	89,542	(74)
Layer	218,114	146,056	89,507	74,073	104,974	(52)
Broiler	52,890	41,097	31,427	30,979	41,572	(21)
Turkey	24,701	19,195	13,767	12,129	16,999	(31)
Total of all animal farms[c]	**1,136,631**	**838,972**	**626,646**	**447,998**	**443,137**	**(61)**

Source: GAO analysis of USDA data.

Notes: The phrase "all animal types" refers to the following animals: beef cattle, dairy cows, hogs, layers, broilers, and turkeys.

The criteria for a large farm varied by animal type, consistent with EPA's CAFO thresholds, and represent the average number of animals on a farm per day.

[a]Beef cattle includes only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more.

[b]Hogs include swine of all sizes from birth to market size.

[c]The number of large farms for all animal types is the total of large farms for each animal type and may include some farms multiple times if they were considered large for more than one animal type.

Table 14: Nationwide Trends in the Number of Animals Raised on Large Farms per Day for All Animal Types, 1982 through 2002

Type of animal farm	1982	1987	1992	1997	2002	Percentage change, 1982-2002
Beef cattle[a]	6,601,928	7,368,109	7,533,708	8,598,508	8,677,892	31
Dairy cow	632,583	860,878	1,300,616	2,049,814	3,183,086	403
Hog[b]	4,176,477	6,275,200	12,133,231	32,412,839	47,789,951	1,044
Layer	160,005,126	212,871,326	229,959,901	263,660,262	304,500,225	90
Broiler	52,140,827	102,198,894	170,873,560	298,222,567	457,461,691	777
Turkey	33,443,754	52,905,796	62,042,552	73,029,156	68,417,853	105
Total of all animal types[c]	**257,000,695**	**382,480,203**	**483,843,568**	**677,973,146**	**890,030,698**	**246**

Source: GAO analysis of USDA data.

Notes: The phrase “all animal types” refers to the following animals: beef cattle, dairy cows, hogs, layers, broilers, and turkeys.

The criteria for a large farm varied by animal type, consistent with EPA’s CAFO thresholds, and represent the number of animals on a farm per production day.

[a]Beef cattle include only cattle on feed, not grazing on pasture, and sold weighing 500 pounds or more.

[b]Hogs include swine of all sizes from birth to market size.

[c]The number of large farms for all animal types is the total of large farms for each animal type and may include some farms multiple times if they were considered large for more than one animal type.

Appendix IV: Government-Sponsored or Peer-Reviewed Studies Completed Since 2002 on the Impacts of Pollutants from Animal Waste

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Studies showing a direct impact				
Ankley, Gerald T., Kathleen M. Jensen, Elizabeth A. Makynen, Michael D. Kahl, Joseph J. Korte, Michael W. Hornung, Tala R. Henry, Jeffrey S. Denny, Richard L. Leino, Vickie S. Wilson, et al. "Effects of the Androgenic Growth Promoter 17β-trenbolone on Fecundity and Reproductive Endocrinology of the Fathead Minnow." Environmental Toxicology and Chemistry. Vol. 22, no. 6 (2003):1,350–1,360.	EPA, University of Minnesota	Water	Hormones	Fertility of fish was significantly reduced by hormones and female fish developed male sex characteristics.
Clark, Clifford G., Lawrence Price, Rafiq Ahmed, David L. Woodward, Pasquale L. Melito, Frank G. Rodgers, Frances Jamieson, Bruce Ciebin, Aimin Li, and Andrea Ellis. "Characterization of Waterborne Outbreak–Associated Campylobacter jejuni, Walkerton, Ontario." Emerging Infectious Diseases. Vol. 9, no. 10 (2003):1,232-1,241.	Health Canada, Ontario Ministry of Health	Water	Bacteria	Cattle manure from a nearby farm entered the groundwater system and caused gastrointestinal illness and death in residents.
Diesel, Elizabeth A., Melissa L. Wilson, Ryan Mathur, Evan Teeters, David Lehmann, and Caitlan Ziatos. "Nutrient Loading Patterns on an Agriculturally Impacted Stream System in Huntingdon County Pennsylvania Over Three Summers." Northeastern Geology & Environmental Sciences. Vol. 29, no. 1 (2007):25-33.	Juniata College	Water	Nutrients	Excess nutrients from CAFO manure contributed significantly to impaired water quality and resulted in the inability to sustain fish populations.
Hill, Dagne D., William E. Owens, and Paul B. Tchounwou. "Impact of Animal Application on Runoff Water Quality in Field Experimental Plots." International Journal of Environmental Research and Public Health. Vol. 2, no. 2 (2005):314–321.	Jackson State University, NIH-Center for Environmental Health, Louisiana State University	Water	Nutrients, bacteria	Nutrients from manure spread on fields contributed to water pollution.
Jensen, Kathleen M., Elizabeth A. Makynen, Michael D. Kahl, and Gerald T. Ankley. "Effects of the Feedlot Contaminant 17α-Trenbolone on Reproductive Endocrinology of the Fathead Minnow." Environmental Science & Technology. Vol. 40, no. 9 (2006): 3,112-3,117.	EPA	Water	Hormones	Fertility of fish was significantly reduced by hormones and female fish developed male sex characteristics.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Orlando, Edward F., Alan S. Kolok, Gerry A. Binzcik, Jennifer L. Gates, Megan K. Horton, Christy S. Lambright, L. Earl Gray, Jr., Ana M. Soto, and Louis J. Guillette, Jr. "Endocrine-Disrupting Effects of Cattle Feedlot Effluent on an Aquatic Sentinel Species, the Fathead Minnow." Environmental Health Perspectives. Vol. 112, no. 3 (2004):353–358.	University of Florida; St. Mary's College of Maryland, University of Nebraska, EPA, Tufts University.	Water	Hormones	Male fish were demasculinized and there was defeminization of female fish.
Weldon, Mark B. and Keri C. Hornbuckle. "Concentrated Animal Feeding Operations, Row Crops, and Their Relationship to Nitrate in Eastern Iowa Rivers." Environmental Science & Technology. Vol. 40, no. 10 (2006): 3,168-3,173.	University of Iowa	Water	Nitrogen	High concentrations of nutrients in waters are a result of CAFO manure and degrade water quality.
Mathisen, T., S. G. Von Essen, T. A. Wyatt, and D. J. Romberger. "Hog Barn Dust Extract Augments Lymphocyte Adhesion to Human Airway Epithelial Cells." Journal of Applied Physiology. Vol. 96, no. 5 (2004):1,738–1,744.	Department of Veterans Affairs Medical Center, University of Nebraska Medical Center	Air	Dust	Dust from hog confinement facilities induces airway inflammation.
Romberger, D. J., V. Bodlak, S. G. Von Essen, T. Mathisen, and T. A. Wyatt. "Hog Barn Dust Extract Stimulates IL-8 And IL-6 Release in Human Bronchial Epithelial Cells Via PKC Activation." Journal of Applied Physiology. Vol. 93, no. 1 (2002):289–296.	Department of Veterans Affairs Medical Center, University of Nebraska Medical Center	Air	Dust	Dust from hog confinement facilities induces airway inflammation.
Schiffman, Susan S., Clare Studwell, Lawrence R. Landerman, Katherine Berman, and John S. Sundy. "Symptomatic Effects of Exposure to Diluted Air Sampled from a Swine Confinement Atmosphere on Healthy Human Subjects." Environmental Health Perspectives. Vol. 113, no. 5 (2005):567-576.	Duke University	Air	Hydrogen sulfide, ammonia, total suspended particulates, endotoxin, odor, dust	Short-term exposure to emissions expected downwind from a swine confinement facility can induce headaches, eye irritation, and nausea.
Sigurdarson, Sigurdur T., Patrick T. O'Shaughnessy, Janet A. Watt, and Joel N. Kline. "Experimental Human Exposure Inhaled Grain Dust and Ammonia: Towards a Model of Concentrated Animal Feeding Operations." American Journal of Industrial Medicine.Vol. 46, issue 5 (2004):345:348.	University of Iowa	Air	Dust, ammonia	Exposure to endotoxin-rich dust from CAFOs causes airflow obstruction in subjects with mild asthma.
Sundblad, B-M., B-M. Larsson, L. Palmberg, and K. Larsson. "Exhaled Nitric Oxide and Bronchial Responsiveness in Healthy Subjects Exposed to Organic Dust." European Respiratory Journal. Vol. 20, no. 2 (2002): 426–431.	National Institute of Environmental Medicine, Sweden	Air	Dust	Airway inflammation is induced by exposure to a farming environment.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Wickens, K., et. Al. "Farm Residence and Exposures and the Risk of Allergic Diseases in New Zealand Children." Allergy. Vol. 57, no. 12 (2002): 1,171-1,179.	University of Otago (New Zealand) Utrecht University (The Netherlands)	Air	Dust	There was a greater prevalence of allergic disease for children on farms.
Wilson, Vickie S., Christy Lambright, Joe Ostby, and L.E. Gray, Jr. "In Vitro and in Vivo Effects of 17β-Trenbolone: A Feedlot Effluent Contaminant." Toxicological Sciences. Vol. 70, no. 2 (2002): 202-211.	EPA	Water	Hormones	Hormones found in feedlot effluent caused reproductive malformations in laboratory rats and human cells.
Wyatt, Todd A., Rebecca E. Slager, Jane DeVasure, Brent W. Auvermann, Michael L. Mulhern, Susanna Von Essen, Tracy Mathisen, Anthony A. Floreani, and Debra J. Romberger. "Feedlot Dust Stimulation of Interleukin-6 And 8 Requires Protein Kinase C-Epsilon Human Bronchial Epithelial Cells." American Journal of Physiology-Lung Cellular and Molecular Physiology. Vol. 293, no. 5 (2007):1,163-1,170.	Nebraska Medical Center, Department of Veterans Affairs Medical Center, Texas A&M	Air	Dust	Dust extract from cattle feedlots stimulates airway inflammation at concentrations found downwind from the operation.
Studies indicating no impact				
Hill, Dagne D., William E. Owens, and Paul B. Tchounwou. "Prevalence of *Escherichia coli O157:H7* Bacterial Infections Associated With the Use of Animal Wastes in Louisiana for the Period 1996-2004." International Journal of Environmental Research and Public Health. Vol. 3, no. 1 (2006): 107-113.	Grambling State University, Louisiana State University, Jackson State University	Water	*Escherichia coli* (not measured)	Although some of the parishes surveyed had large amounts of animal waste generated each year, statistics did not show a correlations with *Escherichia coli 0157:H7* bacterial infections.
Hill, Dagne D., William E. Owens, and Paul B. Tchounwou. "Prevalence of Selected Bacterial Infections Associated with the Use of Animal Waste in Louisiana." International Journal of Environmental Research and Public Health. Vol. 2, no. 1 (2005): 84–93.	Jackson State University, Louisiana State University,	Water	*Escherichia coli* (not measured)	Although the four parishes surveyed had large amounts of animal waste generated, statistics does not show a correlation between this and bacterial infections.
Krapac, I.G., W.S. Dey, W.R. Roy, C.A. Smyth, E. Storment, S.L. Sargent, and J.D. Steele. "Impacts of Swine Manure Pits on Groundwater Quality." Environmental Pollution. Vol. 120, issue 2 (2002): 475-492.	Illinois State Geological Survey, University of Illinois, Illinois Department of Agriculture	Water	Chloride, ammonium, phosphate, potassium, nitrate, bacteria	Groundwater near swine CAFOs has not been significantly impacted.
Mugel, Douglas N. "Ground-Water Quality and Effects of Poultry Confined Animal Feeding Operations on Shallow Ground Water, Upper Shoal Creek Basin, Southwest Missouri, 2000." U.S. Geological Survey Water-Resources Investigations Report 02-4125 (2002).	United States Geological Survey	Water	Nutrients, bacteria	The results do not indicate that poultry CAFOs are affecting the shallow ground water with respect to nutrients and fecal bacteria.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Braun-Fahrlander, Charlotte, Josef Riedler, Udo Herz, Waltraud Eder, Marco Waster, Leticia Grize, Soyoun Maisch, David Carr, Florian Gerlach, Albrecht Bufe. "Environmental Exposure to Endotoxin and its Relation to Asthma in School-Age Children." The New England Journal of Medicine. Vol. 347, no. 12 (2002): 869-877.	Institute of Social and Preventive Medicine (Switzerland), Children's Hospital (Austria), Philipps University (Germany), Ruhr University (Germany), University Children's Hospital (Switzerland), University of Munich (Germany)	Air	Dust	Decreased risk of hay fever, asthma, and wheeze in children exposed to high levels of endotoxin in dust.
Elliott, L., K. Yeatts, and D. Loomis. "Ecological Associations Between Asthma Prevalence And Potential Exposure to Farming." European Respiratory Journal. Vol. 24, no. 6 (2004): 938–941.	University of North Carolina, Chapel Hill	Air	N/A	Findings are consistent with the hypothesis that certain farm exposures are protective against childhood asthma.
McGinn, S. M., H. H. Janzen, and T. Coates. "Atmospheric Pollutants and Trace Gases: Atmospheric Ammonia, Volatile Fatty Acids, and Other Odorants near Beef Feedlots." Journal of Environmental Quality. Vol. 32, no. 4 (2003):1,173–1,182.	Research Centre, Agriculture and Agri-Food Canada	Air	Ammonia, odor, organic compounds, total suspended particulates, dust	Odorants from feedlots were effectively dispersed. Emitted ammonia was deposited to the soil downwind.
Studies showing an indirect link between pollutants and impacts				
Valcour, James E., Pascal Michel, Scott A. McEwen, and Jeffrey B. Wilson. "Associations between Indicators of Livestock Farming Intensity and Incidence of Human Shiga Toxin-Producing *Escherichia coli* Infection." Emerging Infectious Diseases. Vol. 8, no. 3 (2002): 252-257.	University of Guelph; Université de Montréal; Centre for Infectious Disease Prevention and Control-Health Canada	Water	*Escherichia coli* (not measured)	The strongest associations with human *Escherichia coli* infection were the ratio of beef cattle to human population and the application of manure to the surface of agricultural land by a solid spreader and by a liquid spreader.
Wing, Steve, Stephanie Freedman, and Lawrence Band. "The Potential Impact of Flooding on Confined Animal Feeding Operations in Eastern North Carolina." Environmental Health Perspectives. Vol. 110, no. 4 (2002): 387–391.	University of North Carolina	Water	N/A	Flood events have a significant potential to degrade environmental health because of dispersion of wastes from industrial animal operations in areas with vulnerable populations.
Avery, Rachel C., Steve Wing, Stephen W. Marshall, and Susan S. Schiffman. "Odor from Industrial Hog Farming Operations and Mucosal Immune Function in Neighbors." Archives of Environmental Health. Vol. 59, no. 2 (2004): 101-108.	University of North Carolina, Duke University	Air	N/A	This study suggests that malodor from industrial swine operations can affect the secretory immune system, although the reduced levels reported are still within normal range.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Bullers, Susan. "Environmental Stressors, Perceived Control, and Health: The Case of Residents Near Large-Scale Hog Farms in Eastern North Carolina." Human Ecology. Vol. 33, no. 1 (2005): 1-16.	University of North Carolina Wilmington	Air/Water	N/A	Residents living near large-scale hog farms in eastern North Carolina report symptoms related to respiratory and sinus problems and nausea.
Chénard, Liliane, Ambikaipakan Senthilselvan, Vaneeta K. Grover, Shelley P. Kirychuk, Joshua A. Lawson, Thomas S. Hurst, and James A. Dosman. "Lung Function and Farm Size Predict Healthy Worker Effect in Swine Farmers." Chest. Vol. 131, no. 1 (2007): 245-254.	Institute of Agriculture Rural and Environmental Health, University of Saskatchewan (Canada), University of Alberta (Canada), Canadian Institute of Health Research	Air	N/A	Some swine workers are less affected by swine air and continue in the profession. Other workers are more affected.
Chrischilles, Elizabeth, Richard Ahrens, Angela Kuehl, Kevin Kelly, Peter Thorne, Leon Burmeister, and James Merchant. "Asthma Prevalence and Morbidity Among Rural Iowa Schoolchildren." Journal of Allergy and Clinical Immunology. Vol. 113, no. 1 (2004): 66-71.	University of Iowa, EPA	Air	N/A	Among children who wheeze, farm and nonfarm children were equally likely to have been given a diagnosis of asthma and had comparable morbidity.
Dosman, J.A., J.A. Lawson, S.P. Kirychuk, Y. Cormier, J. Biem, and N. Koehncke. "Occupational Asthma in Newly Employed Workers in Intensive Swine Confinement Facilities." European Respiratory Journal. Vol. 24, no. 6 (2004): 698–702.	Institute of Agricultural Rural and Environmental Health, University of Saskatchewan (Canada), Laval University (Canada)	Air	N/A	Newly employed workers in intensive swine confinement facilities reported development of acute onset of wheezing and cough suggestive of asthma.
Merchant, James A., Allison L. Naleway, Erik R. Svendsen, Kevin M. Kelly, Leon F. Burmeister, Ann M. Stromquist, Craig D. Taylor, Peter S. Thorne, Stephen J. Reynolds, Wayne T. Sanderson, and Elizabeth A. Chrischilles. "Asthma and Farm Exposures in a Cohort of Rural Iowa Children." Environmental Health Perspectives. Vol. 113, No. 3 (2005): 350-356.	University of Iowa, EPA, Colorado State University, Kaiser Permanente	Air	N/A	There was a high prevalence of asthma health outcome among farm children living on farms that raise swine and raise swine and add antibiotics.
Mirabelli, Maria C., Steve Wing, Stephen W. Marshall, and Timothy C. Wilcosky. "Asthma Symptoms Among Adolescents Who Attend Public Schools That Are Located Near Confined Swine Feeding Operations." Pediatrics. Vol. 118, no. 1 (2006): 66-75.	University of North Carolina, RTI International	Air	N/A	Estimated exposure to airborne pollution from confined swine feeding operations is associated with adolescents' wheezing symptoms.
Palmberg, Lena, Britt-Marie Larsson, Per Malmberg, and Kjell Larsson. "Airway Responses of Healthy Farmers and Nonfarmers to Exposure in a Swine Confinement Building." Scandinavian Journal of Work, Environment, and Health. Vol. 28, no. 4 (2002): 256-263.	National Institute of Environmental Medicine (Sweden), National Institute for Working Life (Sweden)	Air	N/A	Altered lung function and bronchial responsiveness was found in nonfarming subjects. Only minor alterations were found in the farmers.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Radon, Katja, Anja Schulze, Vera Ehrenstein, Rob T. van Strien, Georg Praml, and Dennis Nowak. "Environmental Exposure to Confined Animal Feeding Operations and Respiratory Health of Neighboring Residents." Epidemiology. Vol. 18, no. 3 (2007): 300-308.	Institute for Occupational and Environmental Medicine (Germany), National Research Centre for Environment and Health (Germany), Boston University, Municipal Health Service Amersterdam	Air	N/A	Respiratory disease was found among resident living near confined animal feeding operations.
Sigurdarson, Sigurdur T. and Joel N. Kline. "School Proximity to Concentrated Animal Feeding Operations and Prevalence of Asthma in Students." Chest. Vol. 129, no. 6 (2006):1,486–1,491.	University of Iowa Carver College of Medicine, University of Iceland	Air	N/A	Children in the study school, located one-half mile from a CAFO, had a significantly increased prevalence of physician-diagnosed asthma.
Studies measuring pollutants				
Anderson, M.E. and M.D. Sobsey. "Detection And Occurrence of Antimicrobially Resistant E. Coli In Groundwater on or Near Swine Farms In Eastern North Carolina." Water Science & Technology. Vol. 54, no. 3 (2006): 211-218.	University of North Carolina	Water	Antibiotics	Antibiotic-resistant *E. coli* strains are present in groundwaters of swine farms.
Batt, Angela L., Daniel D. Snow, and Diana S. Aga. "Occurrence of Sulfonamide Antimicrobials in Private Water Wells in Washington Country, Idaho, USA." Chemosphere. Vol. 64, issue 11 (2006): 1,963-1,971.	State University of New York at Buffalo, University of Nebraska	Water	Antimicrobials, nitrate, ammonium	All six sampled wells were contaminated by veterinary antimicrobials and had elevated concentrations of nitrate and ammonium. Three wells had nitrate levels exceeding EPA thresholds.
Campagnolo, Enzo R., Kammy R. Johnson, Adam Karpati, Carol S. Rubin, Dana W. Kolpin, Michael T. Meyer, J. Emilio Esteban, Russell W. Currier, Kathleen Smith, Kendall M. Thu, and Michael McGeehin. "Antimicrobial Residues in Animal Waste and Water Resources Proximal to Large-Scale Swine and Poultry Feeding Operations." The Science of the Total Environment. Vol. 299, no. 1 (2002): 89-95.	CDC, U.S. Geological Survey, Iowa Department of Public Health, Ohio Department of Health, University of Iowa	Water	Antimicrobials	Multiple classes of antimicrobial compounds were detected in surface and groundwater samples collected proximal to the swine and poultry farms.
Durhan, Elizabeth J., Christy S. Lambright, Elizabeth A. Makynen, James Lazorchak, Phillip C. Hartig, Vickie S. Wilson, L. Earl Gray, and Gerald T. Ankley. "Identification of Metabolites of Trenbolone Acetate in Androgenic Runoff from a Beef Feedlot." Environmental Health Perspectives. Vol. 114, supp. 1 (2006):65–68.	EPA	Water	Hormones	Whole-water samples from the discharge contained detectible concentrations of hormones.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Gessel, Peter D., Neil C. Hansen, Sagar M. Goyal, Lee J. Johnston, and Judy Webb. "Persistence Of Zoonotic Pathogens in Surface Soil Treated With Different Rates of Liquid Pig Manure." Applied Soil Ecology. Vol. 25, issue 23 (2004): 237-243.	University of Minnesota	Water	Pathogens	Manure application rate was correlated positively with the persistence of fecal indicators but did not relate to survival of indicators with short survival times.
Haggard, Brian E. , Paul B. DeLaune, Douglas R. Smith, and Philip A. Moore, Jr. "Nutrient and B17-Estradiol Loss in Runoff Water From Poultry Litters." Journal of the American Water Resources Association. Vol. 41, no. 2 (2005):245-256.	USDA, University of Arkansas	Water	Nutrients, hormones	In general, poultry litter applications increased nutrient and hormone concentrations in runoff water.
Hutchins, Stephen R., Mark V. White, Felisa M. Hudson, and Dennis D. Fine. "Analysis of Lagoon Samples from Different Concentrated Animal Feeding Operations for Estrogens and Estrogen Conjugates." Environmental Science & Technology. Vol. 41, no. 3 (2007): 738-744.	EPA, Shaw Environmental and Infrastructure	Water	Hormones	Estrogen conjugates contribute significantly to the overall estrogen load, even in different types of CAFO lagoons.
Koike, S., I.G. Krapac, H.D. Oliver, A.C. Yannarell, J.C. Chee-Sanford, R.I. Aminov, and R.I. Makie. "Monitoring and Source Tracking of Tetracycline Resistance Genes in Lagoons and Groundwater Adjacent to Swine Production Facilities over a 3-Year Period." Applied and Environmental Microbiology. Vol. 73, no. 15 (2007): 4,813-4,823.	University of Illinois, USDA, Illinois State Geological Survey, Rowett Research Institute (UK)	Water	Antibiotics	Antibiotic resistance genes in groundwater are affected by swine manure and also part of the indigenous gene pool.
Miller, David H. and Gerald T. Ankley. "Modeling Impacts On Populations: Fathead Minnow (Pimephales Promelas) Exposure to the Endocrine Disruptor 17ß-Trenbolone as a Case Study." Ecotoxicology and Environmental Safety. Vol. 59, issue 1 (2004): 1-9.	EPA	Water	Hormones	Model shows that if fathead minnow is exposed to continuous concentrations of hormone, there will be a risk of extinction.
Nelson, Nathan O., John E. Parsons, and Robert L. Mikkelsen. "Field-Scale Evaluation of Phosphorus Leaching in Acid Sandy Soils Receiving Swine Waste." Journal of Environmental Quality. Vol. 34, no. 6 (2005): 2,024-2,035.	USDA, North Carolina State University	Water	Phosphorus	The results show that substantial quantities of phosphorus can be leached through soils with low phosphorus sorption capacities.
Peak, Nicholas, Knapp, Charles W, Richard K. Yang, Margery M. Hanfelt, Marilyn S. Smith, Diana S. Aga, and David W. Graham. "Abundance of Six Tetracycline Resistance Genes in Wastewater Lagoons at Cattle Feedlots With Different Antibiotic Use Strategies." Environmental Microbiology. Vol. 9, no. 1 (2007): 143-151.	University of Kansas, Kansas State University, State University of New York at Buffalo	Water	Antibiotic resistant genes	CAFOs using larger amounts of antibiotics had significantly higher detected resistance gene levels.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Sapkota, Amy R., Frank C. Curriero, Kristen E. Gibson, and Kellogg J. Schwab. "Antibiotic-Resistant Enterococci and Fecal Indicators in Surface Water and Groundwater Impacted by a Concentrated Swine Feeding Operation." Environmental Health Perspectives. Vol. 115, no. 7 (2007):1,040–1,045.	Johns Hopkins Bloomberg School of Public Health; University of Maryland	Water	Antibiotic resistant bacteria, fecal indicators	Detected elevated levels of fecal indicators and antibiotic-resistant bacteria in water sources down gradient from a swine facility.
Soto, Ana M., Janine M. Calabro, Nancy V. Prechtl, Alice Y. Yau, Edward F. Orlando, Andreas Daxenberger, Alan S. Kolok, Louis J. Guillette, Jr., Bruno le Bizec, Iris G. Lange, and Carlos Sonnenschein. "Androgenic and Estrogenic Activity in Water Bodies Receiving Cattle Feedlot Effluent in Eastern Nebraska, USA." Environmental Health Perspectives. Vol. 112, no. 3 (2004):346–352.	Tufts University; Southwest Research Institute; St. Mary's College of Maryland; Universität München-Weihenstephan, Germany; University of Nebraska; University of Florida; Ecole Nationale Vétérinaire de Nantes, France	Water	Hormones	Feedlot effluents contain sufficient levels of hormonally active agents to warrant further investigation of possible effects on aquatic ecosystem health.
Thorsten, Christiana, Rudolf J. Schneider, Harald A. Farber, Dirk Skutlarek, Michael T. Meyer, and Heiner E. Goldbach. "Determination of Antibiotic Residues in Manure, Soil, and Surface Waters." Acta hydrochimica et hydrobiologica. Vol. 31, no. 1 (2003):36–44.	University of Bonn, Germany; U.S. Geological Survey	Water	Antibiotics	In each of the surface waters tested antibiotics could be detected.
Thurston-Enriquez, Jeanette A., John E. Gilley, and Bahman Eghball. "Microbial Quality of Runoff Following Land Application of Cattle Manure And Swine Slurry." Journal of Water and Health. vol. 3, no. 2 (2005): 157-171.	University of Nebraska	Water	Microbials	Large microbial loads could be released via heavy precipitation events and could have a significant impact on water bodies.
Toetz, Dale. "Nitrate in Ground and Surface Waters in the Vicinity of a Concentrated Animal Feeding Operation." Archives of Hydrobiology. Vol. 166, no. 1 (2006): 67-77.	Oklahoma State University	Water	Nitrogen	Drinking water was contaminated with CAFOs as the suspected source.
U.S. Department of Interior. U.S. Geological Survey. In cooperation with U.S. Environmental Protection Agency, National Exposure Research Laboratory. Geochemistry and Characteristics of Nitrogen Transport at a Confined Animal Feeding Operations in a Coastal Plain Agricultural Watershed, and Implications for Nutrient Loading in the Neuse River Basin, North Carolina, 1999-2002. Scientific Investigations Report 2004-5283, Reston, Va.: (2004).	U.S. Geological Survey, EPA	Water	Nitrogen	Large amounts of nitrogen moving in the estuary as a result of extreme events may potentially cause algal growths.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
United State Geological Survey in cooperation with Virginia Department of Health. Water-Quality Data from Ground- and Surface-Water Sites near Concentrated Animal Feeding Operations (CAFOs) and non-CAFOs in the Shenandoah Valley and Eastern Shore of Virginia, January-February, 2004. Reston, Va (2005).	United State Geological Survey in cooperation with Virginia Department of Health	Water	Bacteria, antibiotics, trace metals, biological oxygen demand, nitrogen	N/A
United States Geological Survey. Fractionation and Characterization of Organic Matter in Wastewater from a Swine Waste-Retention Basin. Scientific Investigations Report 2004-5217 (2004).	United States Geological Survey	Water	Organic matter	The bulk of the organic matter consists of microbial cellular constituents and their degradation products.
Chapin, Amy, Ana Rule, Kristen Gibson, Timothy Buckley, and Kellogg Schwab. "Airborne Multidrug-Resistant Bacteria Isolated from a Concentrated Swine Feeding Operation." Environmental Health Perspectives. Vol. 113, no. 2 (2005):137-142.	Johns Hopkins University	Air	Antibiotic resistant bacterial pathogens	Multidrug-resistant bacterial pathogens were detected in the air of a swine CAFO.
Donham, Kelley. J., Joung Ae Lee, Kendall Thu, and Stephen J. Reynolds. "Assessment of Air Quality at Neighbor Residences in the Vicinity Of Swine Production Facilities." Journal of Agromedicine. Vol. 11, no. 3-4 (2006): 15-24.	University of Iowa, Northern Illinois University, and Colorado State University	Air	Hydrogen sulfide, ammonia, carbon dioxide, particulate matter	Average concentration of hydrogen sulfide exceeded EPA recommended community standards in all three areas assessed.
Gibbs, Shawn G., Christopher F. Green, Patrick M. Tarwater, Linda C. Mota, Kristina D. Mena, and Pasquale V. Scarpino. "Isolation of Antibiotic-Resistant Bacteria from the Air Plume Downwind of a Swine Confined or Concentrated Animal Feeding Operation." Environmental Health Perspectives. Vol. 114, no. 7 (2006):1,032–1,037.	University of Texas, University of Cincinnati	Air	Antibiotic-resistant bacteria	Bacterial concentrations with multiple antibiotic resistances or multidrug resistance were recovered inside and outside to 150 m downwind of a facility, even after antibiotic use was discontinued.
Harper, Lowry A., Ron R. Sharpe, Tim B. Parkin, Alex De Visscher, Oswald van Cleemput, and F. Michael Byers. "Nitrogen Cycling through Swine Production Systems: Ammonia, Dinitrogen, and Nitrous Oxide Emissions." Journal of Environmental Quality. Vol. 33, no. 4 (2004): 1,189-1,201.	USDA, Ghent University (Belgium)	Air	Nitrogen	In contrast with previous and current estimates of ammonia emissions from CAFOs, this study found smaller ammonia emissions from animal housing, lagoons, and fields.
Hamscher, Gerd, Heike Theresia Pawelzick, Silke Sczesny, Heinz Nau, and Jörg Hartung. "Antibiotics in Dust Originating from a Pig-Fattening Farm: A New Source of Health Hazard for Farmers?" Environmental Health Perspectives. Vol. 111, no. 13 (2003):1,590–1,594.	School of Veterinary Medicine Hannover, Germany	Air	Antibiotics	Five different antibiotics were detected in dust samples swine feeding operation.

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Hoff, Steven J., Dwaine S. Bundy, Minda A. Nelson, Brian C. Zelle, Larry D. Jacobson, Albert J. Heber, Jinqin Ni, Yuanhui Zhang, Jacek A. Koziel, and David B. Beasley. "Emissions of Ammonia, Hydrogen Sulfide, and Odor before, during, and after Slurry Removal from a Deep-Pit Swine Finisher." Journal of the Air & Waste Management Association. Vol. 56, no. 5 (2006): 581-590.	Iowa State University, University of Minnesota, Purdue University, University of Illinois, North Carolina State University	Air	Ammonia, hydrogen sulfide, odor	Emissions of ammonia, hydrogen sulfide, and odor had large increases during slurry removal. A slurry removal even will result in acute exposure for animals and workers.
O'Connor, Rod, Mark O'Connor, Kurt Irgolic, Justin Sabrsula, Hakan Gurleyuk, Robert Brunette, Crystal Howard, Jennifer Garcia, John Brien, June Brien, and Jessica Brien. "Transformations, Air Transport, and Human Impact of Arsenic from Poultry Litter." Environmental Forensics. Vol. 6, no. 1 (2005): 83-89.	Chenard Consulting Services, Karl-Franzeas University (Austria), University of North Carolina, Frontier Geosciences, Aqua-Tech Laboratories	Air	Arsenic	Levels of arsenic found in homes. This could represent a significant health risk.
Radon, Katja, Brigitta Danuser, Martin Iversen, Eduard Monso, Christoph Weber, Jorg Hartung, Kelley J. Donham, Urban Palmgren, and Dennis Nowak. "Air Contaminants in Different European Farming Environments." Annals of Agriculture and Environmental Medicine. Vol. 9, no. 1 (2002): 41-48.	Ludwig-Maximilians-University (Germany), Swiss Federal Institute of Technology, Aarhus University Hospital (Denmark), Hospital Germans Trial I Pujol (Spain), School of Veterinary Medicine (Germany), University of Iowa, Pegasus Labor GmbH (Germany)	Air	Dust, endotoxin, fungi	The exposure level found in this study might put the farmers at risk from respiratory diseases.
Razote, E.B., R.G. Maghirang, B.Z. Predicala, J.P. Murphy, B.W. Auvermann, J.P. Harner III, and W.L. Hargrove. "Laboratory Evaluation of the Dust-Emission Potential of Cattle Feedlot Surfaces." Transactions of the ASABE. Vol. 49, no. 4 (2006): 1,117-1,124.	Kansas State University, Prairie Swine Center, Inc. (Canada), Texas A&M University	Air	Particulate Matter	N/A
Robarge, Wayne P., John T. Walker, Ronald B. McCulloch, and George Murray. "Atmospheric Concentrations of Ammonia and Ammonium at an Agricultural Site in the Southeast United States." Atmospheric Environment. Vol. 36, no. 10 (2002): 1,661-1,674.	North Carolina State University, EPA, URS Corporation, North Carolina Department of Environmental and Natural Resources	Air	Ammonia	Elevated ambient ammonia concentrations near an agricultural site.
United State Environmental Protection Agency. National Emission Inventory – Ammonia Emissions from Animal Husbandry Operations, Draft Report. Washington, D.C. (2004).	EPA	Air	Ammonia	N/A

Study	Sponsor[a]	Medium	Pollutant(s)	Impact
Walker, J.T., W.P. Robarge, Y. Wu, and T.P. Meyers. "Measurement of Bi-Directional Ammonia Fluxes Over Soybean Using Themodified Bowen-Ratio Technique." Agricultural and Forest Meteorology. Vol. 138, no. 1-4 (2006): 54-68.	EPA, North Carolina State University, NASA, NOAA	Air	Ammonia	In general, the net deposition flux was lower than expected.
Walker, John T., Wayne P. Robarge, Arun Shendrikar, and Hoke Kimball. "Inorganic Pm2.5 at a U.S. Agricultural Site." Environmental Pollution. Vol. 139, no. 2 (2006): 258-271.	EPA, North Carolina State University, North Carolina Department of Environment and Natural Resources	Air	Particulate matter	Model results show that reductions in atmospheric ammonia will have minimal effect on organic PM2.5 during summer and a moderate effect during winter.
Walker, J.T., Dave R. Whitall, Wayne P. Robarge, and Hans W. Pearl. "Ambient Ammonia and Ammonium Aerosol Across a Region of Variable Ammonia Emission Density." Atmospheric Environment. Vol. 38, no. 9 (2004): 1,235-1,246.	EPA, NOAA, North Carolina State University, University of North Carolina	Air	Ammonia, ammonium	Agricultural ammonia emissions influence local ambient concentrations of ammonia and PM2.5.
Wilson, Sacoby M. and Marc L. Serre. "Examination of Atmospheric Ammonia Levels Near Hog Cafos, Homes, and Schools In Eastern North Carolina." Atmospheric Environment. Vol. 41, issue 23 (2007): 4,977–4,987.	University of Michigan, Ann Arbor; University of North Carolina at Chapel Hill	Air	Ammonia	Distance to one or more CAFOs is the key variable in controlling atmospheric ammonia at the community level in Eastern N.C.
Muller-Suur, C., P.H. Larsson, K. Larsson, J. Grunewald. "Lymphocyte Activation After Exposure to Swine Dust: A Role Of Humoral Mediators and Phagocytic Cells." European Respiratory Journal. Vol. 19, issue 1 (2002): 104-107.		Air	Dust	About immune system response.
Charavaryamath, Chandrashekhar, Kyathanahalli S Janardhan, Hugh G Townsend, Philip Willson, and Baljit Singh. "Multiple Exposures to Swine Barn Air Induce Lung Inflammation and Airway Hyper-Responsiveness." Respiratory Research. Vol. 6, no. 1 (2005):50-66.	University of Saskatchewan, Canada	Air	Endotoxin	Does not address human impacts.
Eduard, Wijnand, Ernst Omenaas, Per Sigvald Bakke, Jeroen Douwes, and Dick Heederik. "Atopic and Non-atopic Asthma in a Farming and a General Population." American Journal of Industrial Medicine. Vol. 46, issue 4 (2004): 396-399.	National Institute of Ocupational Health (Norway), University of Bergen (Norway), University of Wellington (New Zealand)	Air	N/A	Protective effect of the farm environment on asthma.

Source: GAO's analysis of identified studies.

[a]Sponsor refers to the organization under whose auspices the research was conducted or with whom the primary researchers were affiliated.

Appendix V: Comments from the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 2 6 2008

OFFICE OF
AIR AND RADIATION

Ms. Anu K. Mittal
Director, Natural Resources and Environment
U. S. Government Accountability Office
Washington, DC 20548

Dear Ms. Mittal:

The U. S. Environmental Protection Agency (EPA) appreciates the opportunity to review and comment on the Government Accountability Office (GAO) draft report, "*Concentrated Animal Feeding Operations: EPA Needs More Information and a Clearly Defined Strategy to Protect Air and Water Quality from Pollutants of Concern*" (GAO-08-944). EPA agrees in part with the conclusions and recommendations in the draft report. Below I provide brief comments and clarification on EPA's position regarding the recommendations. Additional technical comments and clarifications on draft report language have been provided in a separate document.

Recommendation 1:

In order to more effectively monitor and regulate CAFOs, we recommend that the Administrator of the Environmental Protection Agency develop a comprehensive inventory of CAFOs nationwide and incorporate appropriate internal controls to ensure the quality of data. The inventory should be periodically updated to capture changes that have occurred in the animal production industry.

In Waterkeeper Alliance v. EPA, the Second Circuit Court of Appeals found that EPA did not have the authority to permit non-discharging CAFOs. EPA is finalizing amendments to a rule that would require CAFOs that discharge to apply for National Pollutant Discharge Elimination System (NPDES) permits. EPA's Office of Water has supported the Office of Enforcement and Compliance Assurance in working with EPA Regions and States to develop and implement a new national NPDES data system to collect and record facility-specific information on permitted CAFOs. This data system, called the Integrated Compliance Information System (ICIS), allows EPA to have an updated national inventory of permitted CAFOs, including number, location, size, and permitted discharges. National data on inspections, enforcement actions, and other NPDES program information will also be collected. Although this information is currently collected by permitting authorities for permitted CAFOs, there is no

comprehensive national database where the information is stored. While ICIS-NPDES has the functionality to provide complete data on the CAFO universe, the data must be consistently collected and entered into ICIS by states and EPA regions. Thus, EPA is developing a proposed rule package that would set national requirements for certain NPDES program information being provided by authorized states to ICIS. This information may include an obligation for authorized states to provide national data for identifying facilities that have been issued, or applied for, a CAFO permit, as well as facilities that should have applied for a CAFO permit based on an inspection or enforcement action.

Recommendation 2:

In order to more effectively determine the extent of air emissions from animal feeding operations, the Administrator of the Environmental Protection Agency should:

a. reassess the current data collection efforts, including its internal controls, to ensure that the national air emissions monitoring study will provide the scientific and statistically valid data that EPA needs for developing its air emissions protocols;

The Agency is continuously evaluating the national air monitoring study, both the data that are being collected, and the methods that are being used to collect these data. This continuous evaluation has resulted in changes being made and documented in numerous Standard Operating Procedures and also to the overall project Quality Assurance Plan. These changes range from items such as utilization of a different instrument than originally intended to changes in the maintenance schedule for certain items. All these changes have been identified through discussions with the monitoring contractor or through the audits described below.

The Agency is currently involved in a program of conducting Technical Systems Audits at each monitoring site to ensure the contractor is performing according to the approved Quality Assurance Project Plan. Each site is scheduled to be audited once during the first year of data collection and once during the second year. To date, the Agency has performed the first year audits at all but six of the monitoring sites with those remaining sites scheduled to be audited by the end of September 2008.

b. Provide information to stakeholders on the additional data that it plans to use to supplement the national air emissions monitoring study

With respect to the supplemental data that will be used to augment the data collected from the national air emissions monitoring study, we are not able to identify at this time which individual studies we plan to use. However, the Agency has been meeting with the Department of Agriculture (USDA), with representatives from their offices of Agricultural Research Service, Cooperative State Research, Education, and

Extension Service, and the Economic Research Service to help identify what research is ongoing and where gaps may still exist. We recently held a two-day workshop in Research Triangle Park, North Carolina with USDA representatives that focused on agricultural air emissions. Day 2 of the workshop focused exclusively on CAFO research.

c. Establish a strategy and timetable for developing a process-based model that will provide more sophisticated air emissions estimating methodologies for animal feeding operations.

The Agency has begun to evaluate what is necessary to develop a process-based model for estimating emissions from animal feeding operations. The emissions estimating methodology that will be developed from the monitoring study will assess the wide range of process information that is being collected in the monitoring study. To the extent that these parameters have a significant and logical impact on emissions, they will be included in the development of a process-based model. This will be performed through the use of a statistical software application that performs a multiple regression analysis of the process parameters and the measured emissions.

As part of the joint EPA/USDA workshop, there were several presentations on process based models that are currently being developed throughout the country and discussions on what data needs still exist to complete these models. These discussions with both USDA and modeling experts will continue as we flesh out our plans for developing a process based model.

Once again, thank you for the opportunity to respond.

Sincerely,

for Elizabeth Craig

Robert J. Meyers
Principal Deputy Assistant Administrator

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

Anu Mittal (202) 512-3841 or mittala@gao.gov

Staff Acknowledgments

In addition to the individual named above, Sherry L. McDonald, Assistant Director; Kevin Bray; Yecenia C. Camarillo; Wendy Dye; Paul Hobart; Cathy Hurley; Holly L. Sasso; James W. Turkett; and Greg Wilmoth made key contributions to this report. Also contributing to this report were Elizabeth Beardsley, Ben N. Shouse, and Carol Herrnstadt Shulman.

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