

**An Evaluation of Health Concerns  
in Milford, Utah  
and the Possible Relationship of Circle Four Farms  
to Those Concerns**

**Southwest Utah Board of Health  
Southwest Utah Public Health Department**

**February 2001**

## **Executive Summary**

At the request of the Beaver County Commission and by assignment of the Southwest Utah Board of Health, the Southwest Utah Public Health Department began an evaluation of health concerns in the Milford valley as they might be impacted by Circle Four Farms, a large swine operation. The concerns centered around air quality, water quality, and a perceived higher than expected rate of symptoms, clinical illness and hospitalizations for respiratory and diarrheal illnesses.

One of the many roles of a local health department in the State of Utah is to investigate the causes of morbidity and mortality. However, the Southwest Utah Public Health Department is not a research institution. While extensive research has been conducted on the health of employees of concentrated animal feeding operations, limited research has been completed to date on the potential public health impacts of concentrated animal feeding operations on non-employees. This report details the steps taken and information gathered by the Department to evaluate this issue, relying primarily on the findings of other government (State of Utah) agencies and independent researchers and research institutions.

The purpose of public health is to promote and protect health and prevent disease. The recommendations presented herein are made with that purpose in mind and the desire to have the most current scientific knowledge on which to base current and future recommendations and actions. It is hoped that this report of the health issues in the Milford valley will assist decision makers and regulators at the State and local level as they continue to grapple with this significant problem.

## **I. History/Background**

The Southwest Utah Public Health Department has received complaints from residents of the Milford, Utah area concerning odor since Circle Four Farms (CFF) began raising hogs in 1995. According to Utah law, “A local health department may abate nuisances or eliminate sources of filth and infectious and communicable diseases affecting the public health and bill the owner or other person in charge of the premises upon which this nuisance occurs for the cost of abatement” (Utah Code, 2000). It has been, and continues to be, the position of the Department that while odors may be a “nuisance,” until components of the odors can be identified and quantified, with quantities at such a level to negatively impact public health, they are not a “public health nuisance.”

In some respects, the CFF operation is unique when compared to other swine intensive livestock operations. The total operation has approximately 600,000 animals at any one time. The animals are housed in numerous barns, approximately 10,000 to 12,000 animals to a barn. These barns are spread out over a path about five miles wide and 18 miles long, running from the southwest to the northeast. That amounts to approximately 6,667 animals per square mile over a 90 square mile area. For the majority of the barns, waste is handled in open lagoons with a primary and secondary cell at each site. The operation is actually divided into two “complexes,” Skyline and Blue Mountain. The northern most barns of the Skyline Complex are closest to residents and the town, approximately 2.5 miles from the nearest residence and 12 miles from the town of Milford. Skyline covers approximately 40 mi<sup>2</sup>, about 10 mi<sup>2</sup> of which are developed with barns and waste lagoons. This area houses over 340,000 animals, which amounts to 8,500 animals per mi<sup>2</sup> or 34,000 animals per developed mi<sup>2</sup>. While the distance of the operation from the nearest

residence is farther than the norm in other swine intensive operation locations around the country, the concentration of animals appears to be greater in the Milford valley than in other locations.

In November of 1998, the Department received two letters from an attorney representing a resident of the Milford flats (an unincorporated area south of Milford City limits and north of CFF). These letters expressed concern for contamination of the ground water aquifer underlying Milford and the flats. Since ground water contamination could affect public health, the Department enlisted the support of the Utah Department of Environmental Quality (DEQ), with their expertise in and jurisdiction over ground water, to evaluate this issue. Results to date of ground water studies are discussed in Section IV of this report.

In June of 1999, the Department received another letter from the same attorney expressing concern that poor health of Milford residents may be the result of poor air quality. The letter indicated there is “verified documentation that animal feeding operations cause serious health risks.”

As a result of that letter, the Department again sought assistance from DEQ and the Utah Department of Health (DOH) to evaluate the claims. Two members of the Utah State Legislature met with the Beaver County Commission and encouraged them to deal with this situation locally. They indicated that at that time neither the Legislature nor state agencies would adopt laws and/or rules to solve this problem. With that understanding, the Beaver County Commission asked the Southwest Utah Public Health Department to evaluate the situation from a public health standpoint and recommend what could/should be done. On August 10, 1999, the Southwest Utah Board of Health formally assigned the Department the responsibility to evaluate the health status of Milford residents and try to determine if CFF or any other entity may be negatively impacting public health in the area.

In order to accomplish this task, the Department developed a five phase project. The phases consisted of:

Best Management Practices--to determine if the current practices employed by CFF are consistent with “best management practices” for odor control (see section V).

Historical Surveillance--to describe the incidence of past hospitalizations for respiratory and diarrheal illnesses of Milford residents (see section II a).

Sentinel Surveillance--to describe the incidence of newly diagnosed respiratory and diarrheal illnesses occurring in Milford residents (see section II b).

Air Monitoring--to determine the level of selected compounds in the ambient air (see section III).

Veterinary Surveillance--to better understand the causes of death in the hog population and determine if those causes pose a threat to human health.

(In addition to the above activities, the DEQ has been continuing with various ground water studies to determine if the ground water is contaminated and if so what the source of contamination may be.)

In June 2000, based on a review of the scientific literature and other information gathered by the Department, and realizing that many questions remained unanswered, the Southwest Utah Board of Health requested that the DEQ delay issuing additional permits requested by CFF until the Department could gather additional information or until October 31, 2000. Although the DEQ issued additional permits in September 2000, this report updates what is known to date that may relate to the current situation in the Milford valley.

## **II. Human Health and Concentrated Animal Feeding Operations**

Many studies have documented that employees of concentrated animal feeding operations

(CAFO) experience higher rates of selected illness, however, little research has been completed on the impacts of CAFOs on the health status of non-employees that may reside near a CAFO. Limited evidence suggests risks to physical health downwind of CAFOs (University of North Carolina, 1998). Interest in this subject has been generated nationally over the past 24 months although only preliminary results are available. The following is a brief synopsis of what is known.

- C The current status of the understanding of the potential threat to human health from hog operations is better described as what appears to be a problem or potential problem, versus what is clearly understood (Okum, 1999).
- C Most health research has focused on the workers employed in the confinement houses and processing plants (Okum, 1999).
- C The health issues for workers are well-documented. They include: scratchy throat, morning phlegm, cough, burning eyes, wheezing, shortness of breath, toxic organic dust syndrome, occupational asthma, and chronic bronchitis (Okum, 1999; Chapin, 1998; University of North Carolina, 1998).
- C Studies in the United States, Sweden, Canada, the Netherlands and Denmark indicate that approximately 50 percent of swine production workers experience one or more of the following health conditions: bronchitis, toxic organic dust syndrome, hyper-reactive airway disease, chronic mucous membrane irritation, occupational asthma and hydrogen sulfide intoxication (Chapin, 1998).
- C It is difficult to distinguish health effects possibly caused by swine CAFO versus other human or agricultural activities (Swinker, 1998).
- C Few studies have been conducted to determine the health effects for residents living near

swine intensive livestock operations (Chapin, 1998). Two recent preliminary studies have looked at the impacts on the physical and mental health of nearby residents. These studies need to be conducted with larger study populations to validate their preliminary findings.

**N** A preliminary health study in Iowa suggested that there were physical health effects for neighbors of hog intensive livestock operations. The study indicated that symptoms for near-by residents are similar, however less severe and less frequent, than those found for workers in the confinement houses. Residents living within two miles of the operation reported significantly higher rates of four types of respiratory problems, including toxic or inflammatory effects (Thu, 1997).

**N** A recently completed study in North Carolina reports increased incidence of self reported respiratory and gastrointestinal symptoms among residents within two miles of a 6,000 head hog operation when compared to (1) residents within two miles of two large cattle operations and (2) residents in a rural agricultural area where no livestock operations used liquid waste management systems (Wing, 1999).

**C** Unpleasant odors can produce impaired mood and increased stress which may influence health through biological mechanisms that include changes in immune system function (University of North Carolina, 1998).

**C** Further research is needed to determine the exact impact of the industry on human health (Okum, 1999).

**C** Many differences exist when comparing conditions and factors surrounding hog operations in Iowa and North Carolina to the CFF operation in Milford (i.e. proximity to residences, waste disposal methods, climatology, concentration of animals) that make it irresponsible

to assume that what happens in those locations will also happen in Milford.

C On October 2, 2000, a request was made of the Centers for Disease Control and Prevention (CDC) to conduct an evaluation of health concerns in the Milford valley. The CDC declined, indicating that they are currently involved in four very large population studies looking at the public health impact of CAFOs which will apply to the concerns in Milford. The results of these studies will not be available for at least 18 months. The CDC also expressed the belief that the projects undertaken by the Department were appropriate steps to better understand the situation in the Milford valley.

**a. Respiratory and Diarrheal Hospitalizations in the Milford Population**

During the spring and summer of 1999, numerous residents of the Milford area complained of perceived high rates of respiratory and diarrheal illnesses. The Department requested assistance from the Bureau of Epidemiology, Utah Department of Health in evaluating this concern. An evaluation of hospital discharge data was undertaken to determine if Milford residents experienced a higher than expected rate of hospitalizations for respiratory and diarrheal illnesses. The following describes the process, findings and conclusions of this evaluation (Keller et al., 2000)

C Hospital discharges for Milford residents during the time period of 1992 through 1998 were compared to discharges for Parowan residents, Panguitch residents, and the State of Utah. (Milford's population is older than Utah and Panguitch populations. Of the three comparison populations, Parowan is the most demographically similar.) These are the years for which computerized discharge data are available. These data provide some pre and post hog production



information since CFF began operation in 1994. Ideally, we would like to have several more years previous to the establishment of CFF in order to have a good baseline.

- C The data were limited to hospital discharges. Emergency room data were not included in the analysis. The zip code of patient (not hospital of discharge) was used to determine residence.
- C Respiratory illness was found to be elevated and statistically significant in Milford during each year from 1992 through 1998 in contrast to the State of Utah. The rate was elevated and statistically significant in Milford compared to Panguitch during the years 1993 through 1994 and 1996 through 1998. Rates were elevated and statistically significant in 1994 and 1996 through 1998 when compared to Parowan.
- C Diarrheal illness was found to be statistically significantly elevated in Milford in contrast to Parowan and the State of Utah from 1992 through 1998, with the exception of 1994. A statistically significant difference was not found during 1994 between Milford and any of the comparison populations. Diarrheal illness rates were also elevated in Milford when compared to Panguitch although the differences were not statistically significant for the years 1992, 1994, and 1995.
- C Causes of the diarrheal and respiratory illness cases included in the study are unknown.
- C Typically the young and older segments of a population are the most susceptible to these illnesses. The respiratory illness rates for Milford and the comparison populations follow this pattern. The diarrheal illness rates do not follow a consistent pattern.

- C Numerous factors that were not measured could be confounders to the data and may account for some or all of the variation, i.e. health care practice, personal lifestyle practices of Milford residents, existing chronic diseases in the population, other environmental considerations.

While this study was not designed to identify the cause of elevated illnesses, it did validate the perception of residents that illness rates (as identified by hospitalization) are significantly higher (i.e., not due to chance) in Milford than would be expected. With elevated rates of this magnitude the Department determined further evaluation into the possible cause of such high rates was warranted.

**b. Clinic Visits for Respiratory and Diarrheal Illness of Milford**

**Residents**

In November 1999, Milford residents were asked to voluntarily report any health care practitioner diagnosed cases of respiratory and diarrheal illness to the Department. Only one such case was reported during the subsequent six months. Since anecdotal reports continued to be received by the Department that there were numerous illnesses occurring, and the Department believed this information was important as a follow-up to the hospital discharge data reported above (section II a), the Department proposed a mandatory health care provider respiratory and diarrheal reporting requirement for patients that are Milford residents. The regulation was adopted by the Southwest Utah Board of Health on June 13, 2000 and implemented July 1, 2000. The following is a brief description of the diagnoses submitted through October 26, 2000. The Milford Clinic is the only provider to submit such information to date.

- C Numerous cases of pharyngitis, sinusitis, bronchitis and other upper respiratory conditions have been reported. In discussing these numbers with local family

practice providers, the numbers are not excessive for the time period covered.

C Eight cases of clinical pneumonia were reported. According to other family practice providers, this number may be of concern for the time period covered.

C The number of cases of diarrhea and other digestive system disorders were not unusual according to local family practice providers.

**c. Survey of Health Related Symptoms in the Milford Population**

In July 1999, a survey was mailed to half of the residents in Milford, Panguitch and Parowan. The purpose of the survey was to quantify the presence of selected self reported symptoms (similar to those used in other studies, IE. Wing, 1999; Thu, 1997) in these populations in an attempt to determine whether Milford residents reported a different rate than the other two populations. The following is a preliminary analysis of the data. (Also, see Appendix I.)

C For 25 of the 29 symptoms surveyed, a greater percentage of Milford residents reported having experienced the symptom “sometimes, often or very often” over the past six months than Panguitch residents. For 14 of the 29 symptoms, Milford residents were at least 1.5 times more likely to report having experienced the symptom “sometimes, often or very often” over the past six months as compared to Panguitch residents. The symptom with the greatest variance between these two communities was “burning nose/sinuses” for which Milford residents were 2.9 times more likely to report “sometimes, often or very often” than Panguitch residents. Upper respiratory symptoms appear to have the greatest variance between these two communities.

C For 19 of the 29 symptoms surveyed, a greater percentage of Milford residents reported having experienced the symptom “sometimes, often or very often” over the

past six months than Parowan residents. For three of the 29 symptoms, Milford residents were at least 1.5 times more likely to report having experienced the symptom “sometimes, often or very often” over the past six months as compared to Parowan residents. The symptom with the greatest variance between these two communities was “burning nose/sinuses” for which Milford residents were 1.7 times more likely to report “sometimes, often or very often” than Panguitch residents. Upper respiratory symptoms appear to have the greatest variance between these two communities.

- C The prevalence of chronic diseases in the communities may influence the prevalence of various symptoms. There does not appear to be great differences in rates of chronic illness among the three communities.
- C Milford residents were over twice as likely to report being hospitalized during the past six months for a chronic illness than either Parowan or Panguitch residents (12.6% for Milford compared to 6.1% for Parowan and 5.0% for Panguitch).
- C Thirty-nine percent of Milford residents surveyed reported visiting a health care provider during the past six months for a sudden or acute illness, compared to 27.8 percent of Parowan residents and 22.9 percent of Panguitch residents.
- C It is not yet known if the differences between the communities are statistically significant.

### **III. Odors, Gases and Emissions Associated with Circle Four Farms and Swine CAFOs in General**

Much research has been done to identify the gases associated with swine CAFOs. The following describes what is currently known about the gases and compounds produced in these operations, and what is known about their ability to impact odors.

- C There is a difference between odors and gases. The correlation between odors and gases is weak. The term “odor” refers to the complex mixture of gases, vapors and dust that result from the anaerobic decomposition of swine manure (Chapin, 1998; Swine Odor Task Force, 1995).
- C Although all livestock operations generate smell, odors are more intense from the large hog intensive livestock operations. These operations are wet-based waste management systems with water used to flush the waste periodically from the growing houses (Okum, 1999).
- C Typically, odors from swine operations originate from one or more of the following sources: building and holding facilities; manure storage and treatment; land application; carcass disposal (Chapin, 1998; Swine Odor Task Force, 1995).
- C Research in North Carolina indicates that odors outside swine farms are intermittent and often result from barely detectable levels of compounds--often in the parts-per-billion range.
- C There are no reliable chemical indicators for odors caused by complex biological materials such as manure (Swine Odor Task Force, 1995).
- C The combination of several odorous compounds may create a unique odor and not several odors perceived independently (Swine Odor Task Force, 1995).
- C Research has shown that it may not be practical or feasible to eliminate odor emissions from farms where animals are raised. However, research has demonstrated that it is

possible to manage, or mitigate, odor from farms (University of North Carolina, 1998).

- C Thousands of gases and/or particles are emitted from intensive swine operations. The primary gases and particles emitted are: ammonia, carbon monoxide, carbon dioxide, hydrogen sulfide, methane, dust, organic dust, and endotoxins. These gaseous emissions are of particular concern for workers at such facilities (Okum, 1999; Chapin, 1998)
- C Over 400 gaseous compounds have been found in the air, manure and lagoons on hog farms. Most gases are emitted in small amounts, well below Threshold Limit Values (occupational limits based on exposures during a typical 8 hour day/40 hour work week).  
The component gases associated with the air emissions from swine CAFOs are individually well below many federal standards (Okum, 1999).
- C Federal and state standards are set for exposure to one gas, not a combination of gases. Some researchers suggest that a synergistic effect of the component parts of numerous gases working together may be important (Okum, 1999).
- C The inhalation of gases, known as volatile organic compounds (VOCs), can cause smell sensations (odors) in humans. There are four primary ways in which odors can affect human health (Schiffman, 1998)
  - N the VOCs can produce toxic neurological effects;
  - N the odorant compounds can cause irritations in the eye, nose and throat;
  - N the VOCs can stimulate sensory nerves that can cause potentially harmful health effects;
  - N the exposure to perceived unpleasant odors can stimulate negative cognitive and emotional responses based on previous experiences with such odors.
- C Twenty-one different VOCs have been identified in the air above the surface of swine

manure lagoons in Iowa. Emission rates of methane, ammonia, and VOCs are dependent upon manure loading rates and indirectly by animal numbers (Hatfield, 2000).

C One study that simulated atmospheric dispersion of VOCs included data collected at CFF. This study demonstrated that for the VOC acetic acid (the only compound that could be detected in sufficient levels away from buildings and lagoons), the gaseous plume remains fairly narrow. At a distance of 300 meters the concentration of acetic acid was less than one percent of the concentration at the source. After 5000 meters (3.1 miles) acetic acid was still detectable and the plumes from multiple sources had begun to interact as one single plume (Hatfield, 2000).

C It is unlikely that the concentrations of individual VOCs from livestock operations are toxic to neighbors downwind because the concentrations are too low (Schiffman, 1998; University of North Carolina, 1998).

C Dust particles absorb odorous compounds. As the dust particles are carried by the wind, so is odor. Odorous dust can cause intense odor sensation if particles settle in the nose on the olfactory organ (University of North Carolina, 1998).

C It is not yet known whether the mixture of multiple low level VOCs can result in health consequences that a single low-level VOC would not cause (Schiffman, 1998).

C Minimal data is available concerning the public health effects of odor because most odor studies investigate the impact of specific gases on human health rather than the responses or outcomes elicited from the presence of malodorous air in general (Chapin, 1998).

As was mentioned earlier in this section, thousands of gases and/or particles are emitted from swine intensive livestock operations. Over 400 gaseous compounds have been found in the air, manure and lagoons on hog farms. These gaseous emissions are of particular concern for

workers at hog farms due primarily to the concentration of the gases in the confinement houses.

To date, little air quality and air monitoring has been done at CFF or down wind from the facility. In May 2000, some air samples were collected at various farm sites using a hand held instrument (Draeger) which pumps air into a tube that contains a substance that will change color in the presence of ammonia or hydrogen sulfide. The following briefly describes the results of this test.

- C There was a strong odor coming from the lagoons the day the samples were taken.
- C Samples were taken at edge of five anaerobic lagoons; two nursery lagoons, two finisher lagoons and one sow lagoon were sampled. The temperature was estimated at 65 to 70 FE and the wind was strong, estimated at 20 to 25 mph. Samples were taken downwind. Each lagoon collected waste from approximately 12,000 animals.
- C For comparison, the Utah Division of Air Quality's Toxic Screening Level for ammonia is 25 ppm and for hydrogen sulfide is 10 ppm.
- C The two nursery lagoons produced the smallest amount of ammonia (.25 - .5 ppm) and hydrogen sulfide (none detected at one, a trace at the other) in comparison to the other lagoon air samples taken that day. The sow lagoon tested produced .5+ ppm ammonia and a trace of hydrogen sulfide. The two finisher lagoons produced 1.5+ and 2+ ppm ammonia with a trace of hydrogen sulfide at each location.
- C At the sow facility, air coming from a pit fan was also tested and produced a result of 3+ ppm ammonia and a trace of hydrogen sulfide. Ten yards away from the same fan no ammonia could be detected.
- C At the finisher facility with the highest ammonia reading, an ammonia sample was



also taken at the property line downwind (estimated at 100 yards distance). The test produced .25 ppm ammonia.

- C Tests were also taken at the experimental BION facility at the Blue Mountain pyramid (a finisher facility). Three separate locations at this facility were sampled. Both the west primary cell (servicing 20,000 animals) and the west secondary cell produced readings of one ppm ammonia and no hydrogen sulfide. The third cell which collects the combined waste from the previous two cells and two other adjacent cells (40,000 animals) had readings of nearly 2 ppm ammonia and no hydrogen sulfide.

These observations confirm that there was odor coming from the lagoons and that ammonia and hydrogen sulfide were being emitted from the CFF sites sampled on this particular day. According to the University of North Carolina (1998), “When properly sized and managed, an anaerobic lagoon can be operated with a minimum of disagreeable odor. . . . An anaerobic lagoon that is operating properly will have a pH ranging from 7 to 8. The pH in new lagoons without adequate dilution water or in overloaded lagoons can be reduced to 6.5 or less, thereby causing odor problems. . . . Many lagoons exhibit a reddish color in the liquid. . . . The red color is a good indicator of a lagoon working optimally.” While the pH of the lagoons sampled on this day was not measured, the odor was strong and a reddish color was not evident. CFF is not required by any of its permits to monitor lagoon pH.

The question of whether these gases or other compounds that may be emitted from CFF facilities impact human health at comparatively low quantities remains to be answered. As reported earlier in this document, tests at other CAFOs have revealed that the gasses emitted are well below the levels known to cause human illness. Some researchers suggest that a synergistic

effect of the component parts of numerous gases working together may be of importance. Also, low concentrations of multiple VOCs can result in health consequences that a single low-level VOC would not cause. Further research is needed to determine what the public health impact of the gases and VOCs from CFF facilities may be on the residents down wind.

At least two air quality studies are being conducted in the Milford area. CFF and the National Pork Producers Council are conducting continuous monitoring of selected sites (including the BION facility) to determine the concentration of selected emitted gases over time and various meteorologic conditions (since this report was first drafted, the Department has learned that this study has been canceled). The Rocky Mountain Center for Occupational and Environmental Health (University of Utah) will be collecting air samples for VOCs in the vicinity of various CFF manure lagoons and at the properties of residents who have registered complaints. Air samples will also be collected near some dairy/cattle feed lots. The samples will be analyzed for VOCs via gas chromatography/mass spectroscopy. This analytical method will allow identification and quantification of up to 275,000 individual chemicals at very low concentrations. It is hoped that chemical fingerprints of the odors from the monitoring near the lagoons can be developed to determine: 1) if these chemicals can be detected at the tested residential properties; and, 2) if these chemicals are present at appreciable levels to cause a health concern.

The June 15, 1999 issue of *National Hog Farmer* focused on odor control and air quality. A table in that issue which summarized odor control technologies was introduced with the statement: “The means by which to control odorous compounds and gases emanating from hog barn pits, flush systems, pull-plugs, lagoons and other manure storage basins has become almost endless.” (*National Hog Farmer*, 1999). Twenty different technologies are presented in the table. No doubt CFF has tried and implemented at least some of these technologies. However, it

may be advantageous to try others that hold the most promise for success.

In summary, the only conclusions concerning odor and air quality related to CFF and the Milford valley the Southwest Utah Board of Health and the Department have been able to reach are:

1. At least some of CFF facilities have been shown to release ammonia and hydrogen sulfide.
2. At this time it remains unknown whether the quantities of ammonia and hydrogen sulfide (and any other gases and/or compounds that may be emitted) are at levels away from CFF property that would negatively impact public health. The rapid dissipation within 100 yards of the lagoon suggests only low levels of hazardous chemicals, well below toxic screening levels.
3. It is unknown what aspect of CFF operation (lagoons, barns, other) may be contributing most to the odor and air quality concerns.

Therefore, the Southwest Utah Board of Health and the Department suggest the following:

1. Current and future air quality studies at CFF and in the Milford area should attempt to identify and quantify additional gases and VOCs being emitted from the operation.
2. Air quality studies currently being conducted in the Milford area need to be completed and the results evaluated to assess public health impact.
3. Additional research needs to be conducted on the individual effect of various gases and VOCs emitted from the CFF operation on public health as well as the synergistic effect of these gases and VOCs.
4. Although emission studies are valuable, the potential downwind impact of

emissions on public health must be evaluated and documented.

5. The DEQ, which permits the CFF lagoons, should require a lagoon management plan that would include, at a minimum, the addition of adequate fresh dilution water and maintaining waste lagoons at an appropriate pH level.
6. CFF should try additional odor control techniques to reduce odors from both lagoons and barns.

#### **IV. Ground Water Studies in the Milford Flats**

As a result of complaints that bacteria were present in Milford flats private drinking water wells in the fall of 1998, the DEQ began a process to determine the extent of contamination and other factors concerning ground water in the flats. In December 1998 and January and February 1999, samples were collected from 25 private wells, the Beaver River and associated canals, and CFF lagoons, shallow monitoring wells and deep water supply wells. Analyses were conducted by the State Health Laboratory. A description of the results from six different analyses follows (Utah Department of Environmental Quality, 1999).

1. The first analysis identified bacteria from samples collected from the private wells, Beaver River, and CFF locations. The purpose was to determine the type of bacteria, if the bacteria were harmful to humans, and if the bacteria were the same between the three locations (private wells, lagoons, river/canal system).
  - C Twenty of the 24 private drinking water wells sampled in December 1998 were positive for total coliforms. The coliforms isolated from the wells included the following organisms: *Enterobacter cloacae*, *Citrobacter freundii*, *Enterobacter agglomerans*, *Klebsiella ozonea*, *Enterobacter amnigenus*, *Serratia plymuthica*, *Citrobacter farmeri*, *Serratia fonticola*, *Rahnella aquaticus*, *Citrobacter braakii*, *Hafnia alevi*, *Serratia liquefaciens*, *Enterobacter intermedius*, and *Enterobacter cancerogen*. None of these organisms is considered pathogenic in normally healthy humans. Only one well contained *Escheria coli*. This organism is rarely pathogenic in humans, but is considered a possible indicator of fecal contamination of water.
  - C Nine drinking water wells tested positive for the presence of fecal streptococcus

(*Enterococcus gallinarium*, *Enterococcus durans*, *Enterococcus faecium*, and *Enterococcus faecalis*). These organisms are generally non-pathogenic. Though they have been regarded as potential indicators of fecal pollution, fecal streptococci have been recovered from polluted wells and springs in which fecal coliforms were absent.

- C The only organism from the total coliform test that was able to be isolated from the CFF sewage lagoon samples was *E. coli*. However, *Enterococcus durans* and *Enterococcus faecalis* were identified from the fecal streptococcus test.
- C Total coliform tests on the samples from the Beaver River/canal system identified *Serratia fonticola*, *Enterobacter amnigenus*, *Rahnella aquaticus* and *E. coli*. From the fecal streptococcus test *Enterococcus gallinarium*, *Enterococcus durans*, and *Enterococcus faecium* were isolated.
- C While this test identified the coliforms and fecal streptococcus-like organisms present in collected samples, the presence/absence of organisms from the private wells to the sewage lagoons to the Beaver River/canal system proved not sufficient in determining the source of bacteria. Only two bacteria were common from the three collection points (private wells, lagoons, river), namely *E. coli* (found in only one of the 24 private wells tested) and *Enterococcus durans*. There were some common organisms between the wells and the river, and some common organisms between the wells and lagoons.

2. The second analysis was the retesting of most of the private drinking water wells following a sodium hypochlorite (Chlorox®) decontamination of the wellheads. If ground water was contaminated with bacteria, wellhead decontamination would only remove bacteria present

as a biofilm in the pipes of the well.

C Twenty previously positive wells were retested in January 1999. Of those 20 wells, 18 showed a significant decrease in total coliform and fecal streptococcus counts following the decontamination. Only five of the tested wells still contained any bacteria, and only two had significant numbers of bacteria. (Anecdotal information provided to DEQ suggests that only one of the two wells with significant bacteria had actually been decontaminated). There was no residual chlorine in any of the samples.

C The combined results from the first and second analyses suggest that the tested wells may have a biofilm contamination problem. Had the ground water been contaminated, the number of wells showing bacteria present before and after wellhead decontamination would not have changed.

3. The third analysis was to perform molecular fingerprinting on the isolates obtained in the first analysis. Molecular fingerprints show if two organisms are closely related.

C Three isolates of *Enterococcus durans* matched. All three were obtained from different sites in the river/canal system. No other isolates of this organism matched.

C Two isolates of *Enterococcus gallinarium* matched. Both were isolated from the same private well collected on different dates.

C There were no isolates in the wells that matched any isolates in either the Beaver River/canal system or the lagoons.

4. The fourth analysis looked at the antibiotic resistance of fecal streptococci, with the assumption that if the organisms were from the same source, they would be equally or

similarly resistant to antibiotics.

C For *Enterococcus durans* and *Enterococcus faecalis* (the two organisms common to the wells and sewage lagoons), the isolates from the sewage lagoons were significantly more resistant to the antibiotics than the organisms from the private wells.

C For *Enterococcus faecium* and *Enterococcus gallinarium* (the two organisms common to the wells and the river/canal system), there was no difference in the resistance patterns found from isolates in the wells versus the river/canal.

C The data from this analysis suggest that the organisms in the private wells are not the same as the organisms in the CFF sewage lagoons. The data do not differentiate the organisms from the wells and the river/canal.

5. The fifth analysis was to identify caffeine and surfactants (commonly found in detergents) in the private wells. Presence of these substances would suggest possible ground water contamination from septic systems.

C Analysis of water samples for caffeine did not produce results that would suggest bacteria found in private drinking water wells were from septic systems.

C Though four of 14 well samples collected in January 1999 had detectable levels of surfactant, the concentrations were below levels that would indicate contamination from septic systems (and may actually be false positives).

C The data from this analysis support the assumption that the ground water is not being impacted by septic systems.

6. The final analysis compared total nitrogen values for the wells sampled in January 1999 to total nitrogen values reported by the United States Geological Service (USGS). Since



animal (including human) waste is high in nitrogen, increasing levels could indicate that ground water might be contaminated by such waste.

C The USGS reported levels in the Milford flat area generally in the 3 to 6 mg/L range. Samples collected in January 1999 ranged from .01 to 5.94 mg/L. Though this is a wider range of values than that reported by the USGS, it does not exceed the levels reported by the USGS.

C This wide range of values could suggest the aquifer is vulnerable to land-use practices.

Two additional studies were conducted in the Milford flats during the spring and summer of 2000.

1. The first sought to identify all bacteria in two well samples since it is believed that 99 percent of bacteria present in the environment cannot be grown on standard microbiological media and to match them by DNA.

C Three samples were obtained from each of two wells; one private residential well and one CFF well. The researcher/author of the study concluded that the data are insufficient to either define the frequency or the source(s) of the potentially or opportunistic pathogenic bacteria observed in the examined water wells.

C The DEQ solicited numerous researchers to review the report, its methodologies, findings and conclusions. Those reviewers consisted of individuals from academia as well as government agencies. The researchers all agreed that the data did not identify the source of the contamination. There was some disagreement concerning whether the

organisms present in the samples were harmful to human health. However, the organisms present were not quantified so it made it impossible to determine if any of the organisms present might be in great enough number to present an imminent threat. (Some of the researchers commented they would not drink the water.)

2. The second study which evaluated ground water movement and rate in the Milford valley has not yet been completed.

In summary, the Southwest Utah Board of Health and the Department have reached the following conclusions on ground water in the Milford flats based on data presented to date:

1. Private wells have experienced some contamination with both total and fecal coliforms.
2. Molecular fingerprinting and antibody resistance tests indicated the contaminants identified in the private wells, CFF lagoons and/or the Beaver River/canal system, were not from the same source.
3. The contamination identified in the private wells was significantly reduced or eliminated by chlorination.
4. The contamination identified in the private wells was not related to septic system effluent.
5. A private residential well and a CFF well did test positive for contamination with numerous identical organisms, however, the source and the amount of the contamination is not known.

Based on these findings and conclusions, the Southwest Utah Board of Health and Department suggest the following:

1. Wells should be routinely sampled and tested to determine if contamination returns to all or the majority of the wells or whether it is isolated to specific wells.
2. Wells should be routinely sampled and tested to determine if contamination is seasonal.
3. If contamination persists, further attempts should be made to determine whether the contaminants in the wells are identical to contaminants in lagoon effluent.
4. Residences served by wells with any contamination should chlorinate, boil, or mechanically treat the water prior to human consumption.

## **V. Best Management Practices**

The purpose of this portion of the project was to determine if CFF was implementing practices in its daily operation which had the greatest potential to reduce odors. On November 2, 1999, representatives of the Department and DEQ toured three CFF barn sites; one sow, one nursery, and one finisher. All barns toured were part of the Skyline Complex. Observations of CFF operations were compared to written documents which describe “. . . all known [feasible] methods and practices that may reduce odor nuisance from swine production units.” (Heber et al., 1999).

Based on a review of the literature, it is estimated that 35 percent of the odor from a swine CAFO originates from barns (Chapin, 1998). Accordingly, specific questions were asked about the barn ventilation systems which are not the same for each barn. We learned that the design of the barns has not been static and that each of the three major developments within the Skyline pyramid had slightly different design. The existing and proposed sites at the Blue Mountain complex are also different.

Primary and secondary lagoons for each farm site visited were also observed. As expected, the odor was significant at the edge of each primary lagoon. Odor at the secondary lagoon and outside the barns was obvious but not overbearing.

Based on best management practices identified in the literature (Heber et al., 1999; Swine Odor Task Force, 1995) this site visit discovered that CFF is addressing or has included in their barn design a number of the recommended measures for odor reduction. These include but are not limited to:

1. Routine removal of waste from pit floors at least once every seven day.
2. Under floor ventilation in nursery farms.
3. Buildings are thoroughly cleaned after each group of pigs leaves.
4. Minimum depths of water are maintained in the under floor pits.
5. Use of split sex feeding to enhance nutrient efficiency and reduce nutrient excretions.
6. Use of synthetic proteins to increase feed conversion and reduce nutrient excretions.
7. Carcass disposal within 24 hours (except weekends).
8. Siting distances were probably appropriate based on best management practice recommendations.

The following best management practice recommendations for odor control had not been employed at the time of the site visit.

1. “Wet feeding” (3:1 water to feed ratio). May reduce odors from 23 to 31 percent (Heber et al., 1999).
2. Totally enclosed feed delivery to covered feeders to keep dust from feed handling

to a minimum (Heber et al, 1999; Swine Odor Task Force, 1995).

3. Under floor ventilation in sow and finisher sites.
4. Adding dilution water to lagoons had only recently been implemented (the ratio of water to manure was not reported). The regulation in Indiana is one part water to one part manure (Heber et al., 1999). (An appropriate ratio should be established as well as a plan to evaluate the effectiveness of this practice.)
5. Agitation and removal of sludge from a first stage lagoon every three to four years (Heber et al., 1999).
6. Use of surface aeration to increase aerobic digestion of wastes in lagoons. The amount of aeration required to control odor is much less than required for significant treatment of the manure to reduce organic matter. It is estimated that this may reduce odors by 80 percent (Heber et al., 1999; Swine Odor Task Force, 1995).

In addition to the above, it may be advantageous for CFF to implement training for barn ventilation and lagoon management as a best management practice.

The state of North Carolina is looking beyond “best management practices.” In July 2000, the state reached an agreement with Smithfield Foods (parent company of CFF) to phase out open air lagoons in the state over the next five years and replace them with “environmentally superior technologies.” These technologies will have to meet the following standards:

- C eliminate the discharge of animal waste to surface waters and ground water through direct discharge, seepage or runoff;
- C substantially eliminate atmospheric emissions of ammonia;
- C substantially eliminate the emission of odor that is detectable beyond the

- boundaries of the parcel or tract of land on which the seine farm is located;
- C substantially eliminate the release of disease-transmitting vectors and airborne pathogens;
- C substantially eliminate nutrient and heavy metal contamination of soil and ground water.
- C be economically viable.

This effort will likely further define best management practices for the industry. As a sub-unit of Smithfield Foods, CFF stands to benefit from this agreement.

## **VI. Summary and Conclusions**

- C The Southwest Utah Public Health Department has received numerous complaints and expressions of concern from the Milford area concerning air quality, water quality and the health of Milford residents as these things may be impacted by Circle Four Farms.
- C The Beaver County Commission requested that the Southwest Utah Public Health Department evaluate these issues. That request was approved by the Southwest Utah Board of Health in August 1999. A plan was developed to evaluate the public health impacts of concentrated animal feeding operations in general and Circle Four Farms specifically.
- C Limited research has been completed on the impacts of concentrated animal feeding operations on public health and only limited evidence suggests risks to physical health downwind. Studies that are currently being conducted by CDC may help answer questions concerning public health.
- C Hospital discharges for respiratory and diarrheal illnesses in Milford residents was higher than expected for most of the years of 1992 through 1998 as compared to Parowan,

Panguitch and the State of Utah. This time period includes years prior to Circle Four Farms beginning operation as well as after the operation began. Large increases have been reported since 1996.

C Milford residents may be experiencing rates of clinical pneumonia higher than would be expected.

C The cause(s) of higher than expected rates of hospitalization for respiratory and diarrheal illnesses as well as non hospitalized cases of clinical pneumonia and self-reported rates of selected respiratory and intestinal symptoms in the Milford population remains unknown.

C It is well established that odors and gases are emitted from concentrated swine operations. Over 400 gaseous compounds have been found in the air, manure and lagoons.

C Most gases are emitted in small amounts.

C The inhalation of gases known as volatile organic compounds (VOCs) can cause smell sensations (odors) in humans. Unpleasant odors can produce impaired mood and stress which may influence health through biological mechanisms that include changes in immune system function. However, researchers have not determined conclusively whether or not emissions from concentrated animal feeding operations are harmful to human health.

C One point-in-time sampling event of five Circle Four Farm lagoons revealed that ammonia and hydrogen sulfide were emitted from the lagoons.

C Emissions from concentrated animal feeding operations can travel significant distances with plumes from multiple sources combining and interacting as a single plume. It remains unknown whether the quantities of the gases and/or compounds that may be emitted from Circle Four Farms facilities are at levels off the farm property that would negatively impact public health.

- C Water quality studies conducted and/or coordinated by the Utah Department of Environmental Quality did reveal microbial contamination with several similar organisms, however, because of limited funding neither the source nor the amount of contamination is known.
- C Private wells in the Milford valley have experienced some contamination with both total and fecal coliforms.
- C While some contaminants identified in the private wells were the same as those found in Circle Four Farm lagoons and/or the Beaver River/canal system, molecular fingerprinting and antibody resistance tests indicate the contaminants were not identical. The contamination identified in the private wells was significantly reduced or eliminated by chlorination.
- C The contamination identified in the private wells was not related to septic system effluent.
- C A private residential well and a Circle Four Farm well did test positive for contamination with numerous identical organisms, however, the source and the amount of the contamination is not known.
- C No direct link between contaminated private wells and the Circle Four Farms operation or any other potential source of contamination has been established.
- C Circle Four Farms employs many “best management practices” in its daily operation. The literature discusses some “best management practices” which Circle Four Farms does not utilize at present. It may be advantageous for regulatory agencies to consider including best management practices as part of the permitting process.
- C The State of North Carolina and Smithfield Foods will be developing “environmentally superior technologies” for swine operations which must address surface and ground water



quality protection, air quality, odor and disease-bearing pathogens.

- C Despite the time that has been spent in evaluating concentrated animal feeding operations and their potential impact on public health, there remain more questions than answers. These questions include whether climatic differences and the large number of animals in one area might make the Milford situation worse than other situations studied in other states.

## **VII. Recommendations and Comments**

The information presented in this report is a summary of the current understanding (as of October 2000) of the public health situation in the Milford valley and the characteristics of a CAFO, in particular CFF, which may or may not contribute to the public health situation. The preceding information and following recommendations and comments may change as additional data become available.

- C Further evaluation of existing health concerns among Milford residents is warranted to attempt to determine possible causes.
- C Further research is needed to determine the cause of private well contamination in the Milford valley.
- C Further research is needed to determine the levels of gases, VOCs and other emissions from the Circle Four Farms operation, and whether these emissions are detrimental to public health. CFF, DEQ, and Beaver and Iron Counties should examine the value of BMPs for odor control that are not currently being utilized.
- C Entities involved in the regulation of CAFOs in southwest Utah should consider the information and recommendations contained in this report when determining the

appropriateness of a CAFO in a given location and in determining the requirements under which the CAFO must operate.

- C The Southwest Utah Board of Health remains concerned with the health problems reported in the Milford population. However, the Board does not believe there is enough scientific information at this time, locally or otherwise, to determine whether or not CFF and/or CAFOs cause public health problems. The Board feels strongly that this is a significant issue that deserves appropriate statewide attention and resources. While much work has been done by the DEQ and the DOH to assist the Southwest Utah Public Health Department in its evaluation of this situation, the Southwest Utah Board of Health believes the State Legislature and Governor should assume an active interest in this issue, as they would if it were occurring on the Wasatch Front, and provide the resources necessary to adequately address and resolve the situation.

## Appendix I

Percent of Respondents Experiencing Selected Symptoms  
Sometimes, Often or Very Often, by Community

Symptom	Milford	Parowan	Panguitch
Stuffy nose/sinuses	42.4	37.7	29.9
Runny nose	39.4	32.5	26.4
Burning nose/sinuses	25.5	15.0	8.9
Sore/scratchy throat	28.2	18.9	13.2
Plugged/popping ears	25.6	19.8	15.0
Mucus or phlegm	37.2	31.2	20.6
Excessive coughing	19.9	16.5	16.3
Shortness of breath	17.7	15.1	13.1
Wheezing	16.0	11.3	7.0
Tightness in chest	9.1	8.0	6.6
Chest pain	5.6	7.0	8.1
Nausea or vomiting	12.6	10.8	19.4
No appetite	12.6	11.8	5.4
Diarrhea	29.1	21.7	16.6
Heartburn/reflux	20.8	23.6	15.9
Burning eyes	26.8	21.2	10.5
Tearing eyes	29.5	20.8	10.8
Dry/scaly skin	25.6	28.8	21.3
Skin rash/irritation	18.2	15.6	13.9
Skin redness	10.4	7.1	5.8
Joint or muscle pain	32.5	33.5	30.2
Fevers or chills	10.0	6.6	5.0
Headache	30.7	33.9	24.0
Blurred vision	10.4	11.3	10.5
Hearing problems	15.6	17.4	11.2
Unexplainably tired	26.0	23.2	20.5
Dizzy or faint	9.1	12.7	5.4
Fainted	0.0	1.9	1.6
Disoriented/confused	3.1	5.7	3.5

## References

- Chapin, A., et al. *Controlling Odor and Gaseous Emission Problems from Industrial Swine Facilities*, Yale Environmental protection Clinic, Spring 1998.
- Heber, A.J., et al. "Methods and Practices to Reduce Odor from Swine Facilities," <<http://www.agcom.purdue.edu/AgCom/Pubs/AE/AQ-2.html>>, 1999.
- Hatfield, J.L., et al. *Air Flow and Microclimate Around Earthen Manure Storage Units*, Air Pollution from Agricultural Operations, Proceedings of the Second International Conference, American Society of Agricultural Engineers, October 2000, pp. 124-131.
- Keller, K.H. and Ball, R.W. *A Retrospective Study of Diarrheal and Respiratory Illness Incidence Rates in Milford, Utah 1992 - 1998*, Utah Department of Health, January 2000.
- National Hog Farmer*, June 15, 1999, pp. 44,46.
- Okum, M. *Human Health Issues Associated with the Hog Industry*, School of Public Health, University of North Carolina at Chapel Hill, January 1999.
- University of North Carolina, Board of Governors. "Control of Odor Emissions from Animal Operations," <[http://www.cals.ncsu.edu/waste\\_mgt/newodor.html](http://www.cals.ncsu.edu/waste_mgt/newodor.html)>, September 1999.
- Schiffman, S. "Livestock Odors: Implications for Human Health and Well-Being," *Journal of Animal Science*, 76, 1998, pp. 1343-1355.
- Swine Odor Task Force. "Options for Managing Odor," <<http://www.ces.ncsu.edu/whpaper/SwineOdor.html>>, March 1995.
- Utah Code, 26A-1-114(1)(f). <<http://www.le.state.ut.us/~code/TITLE 26A/htm/26A01016.htm>>, 2000.
- Utah Department of Environmental Quality. *Ground Water Bacterial Investigation in the Milford Valley, 1998-1999*. May 1999.
- Swinker, M. "Human Health Effects of Hog Waste," *North Carolina Medical Journal*, 59(1), 1998, pp. 16-18.
- Thu, K.M. "A Control Study of the Physical and Mental Health of Residents Living Near a Large-scale Swine Operation," *Journal of Agricultural Safety and Health*, 3(1), 1997, pp. 13-26.
- Wing, S. and Wolf, S. *Intensive Livestock Operations, Health and Quality of Life Among Eastern North Carolina Residents*, School of Public Health, University of North Carolina at Chapel Hill, May 1999.