RESEARCH ABSTRACT

ENVIRONMENT

Title: Chemical Characterization of both particulates and gaseous emissions from impacted and non-impacted areas associated with swine feeding operations - **NPB #06-114** **REVISED**

Investigator: Steven L. Trabue

Institution: USDA-ARS, National Soil Tilth Laboratory

Date Submitted: October 13, 2009

Scientific Abstract:

The purpose of this study was to measure both gaseous and PM sorbed odorants emitted from a swine facility in central Iowa and compare those compounds to background levels associated with rural environments. Gaseous VOCs were captured in the field using sorbent tubes while gaseous VSCs were captured in the field using canisters (both glass and fused silica lined) and continuous monitoring of total reduced sulfur using pulsed fluorescence detection. Samples were taken at an active swine facility (impacted) and at either a site 10 miles from any animal feeding operation (non-impacted) or upwind from the facility (control). Sorbent tubes sampled in the field were analyzed by GC-MS using a thermal desorption (TDS) inlet system, and canisters samplers were also analyzed using a GC-MS system equipped with both a canister inlet system and pulsed flame photometric detector (PFPD, a highly sensitive sulfur detector). Particulate matter was sampled using HiVol particulate sampler (PM_{10} sampling head) equipped with quartz particulate filter paper. Filter samplers were analyzed for sorbed VOCs by extracting VOCs from filters in a heated tube apparatus purged with humidified nitrogen. VOCs extracted from the filters were captured on sorbent tubes for later TDS-GC-MS analysis. Filter samplers were analyzed for elemental C, N, and S using a tube combust instrument that quantifies gases by thermal conductivity detector.

Key VOCs associated with odor from the swine facility included: volatile fatty acids (VFA), phenol and indole compounds. Odorants in the swine housing areas had elevated levels of VFAs with some 4-methylphenol, while in pit fan areas levels of phenol and indole compounds were elevated. In terms of concentration in air, total VFAs averaged 325 $\mu g\ m^{-3}$, total phenols 62.4 $\mu g\ m^{-3}$ and total indoles 1.6 $\mu g\ m^{-3}$. However, if concentrations are adjusted to odor activity value (= conc. of odorant in air/odor threshold concentration) total VFAs, phenols, and indole compounds averaged 6.8, 6.5, and 5.0, respectively. Daily concentrations of odorants had a diurnal pattern with early morning and late evening having the highest levels. Odor profiles changed with distance with VFAs, phenols, and indole compounds all above their odor threshold at the facility, but indole and phenol compounds being detected up to 1 mile north offsite. Concentrations of the most odorous compounds were all below their odorous thresholds values for samples taken at the control/non-impacted site. Compounds typically above odor threshold concentrations included butanonic acid, 3-methylbutanoic acid, 4-methylphenol, 4-ethylphenol, indole, and 3-methylindole.

Volatile sulfur compounds, hydrogen sulfide (H_2S), methanethiol, and dimethyl sulfide were generally detected above their odor threshold values at the pit fan; however, during pumping of the deep pits levels of H_2S rose rapidly to over 1000 ppbv from the building and over 800 ppbv 46 m downwind (approximately 50 times odor threshold) from the facility, but rapidly declined when pumping ceased. There was little to no rise in levels of the other VSC during pumping.

Levels of PM_{10} between buildings and 46 m downwind averaged 60.5 and 49.7 $\mu g\ m^{-3}$, respectively, but levels were not significantly different. Control and non-impacted sites averaged 18.3 $\mu g\ m^{-3}$, which were significant lower ($p<0.05$) than PM_{10} measured near buildings. There was little difference between levels of PM_{10} collected in the spring, summer or fall, but winter PM_{10} was significantly lower ($p < 0.05$) than the other seasons. Levels of VFA were enriched compared to both phenol and indole compounds when comparing PM sorbed to vapor phase concentrations. Elemental analysis of PM showed significant higher levels ($p < 0.05$) of nitrogen compared to samples taken from non-impacted areas; however, carbon and sulfur levels were not significantly different.