2007

Environmental Land Management, Inc.

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STUDY OF ODORS AT LONG-TERM STORAGE SITES

Study of odors generated at two long-term storage sites used by Environmental Land Management, Inc. in their Land Application of Industrial By-product Program.

Land application is an economical and environmentally sound method of disposal of the by-products of food manufacturing. The by-products are turned into fertilizer supplements and are then spread thinly (approximately one-eighth inch) on agricultural land. Land application, as practiced by Environmental Land Management, Inc. (ELM) of Boulder, Colorado, is successful with solid, semi-solid and liquid by-products throughout the United States. Industrial by-products that would otherwise be placed in a landfill or chemically treated are instead recycled and used to grow more food, significantly reducing disposal costs and minimizing environmental impact.

Since 1998, ELM has been regularly land applying a solid food by-product called "Nutrigrow" in Minnesota. Nutrigrow is generated by a food processing company. During the summer growing season, the Nutrigrow is stored outside in the form of a multiple-ton pile that changes in volume with numerous deliveries before eventually being spread. As much of the Nutrigrow as possible is spread as soon as we can do it, but sometimes farmers plan to spread it on land currently growing crops and it has to be stockpiled. We receive approximately one odor complaint every other year at one of the storage sites.

In an effort to better understand odors associated with land application and ascertain how far the odors traveled and how low or high the odor levels were, we conducted a study during the summer of 2006 to document odor strength, extent and duration at two of our long-term storage sites. The study was conducted while the by-products were being stored rather than after spreading because historically we have only received odor complaints during storage.

Odor strength for our study was determined by monitoring with a portable, hand-held, odor detecting and measuring device. We used the Nasal Ranger Field Olfactometer manufactured by St. Croix Sensory of Lake Elmo, Minnesota. It is a state-of-the-art device that measures and quantifies levels of odor strength. St. Croix Sensory trained our employees to confidently measure and quantify odor strength as well as measure their personal sensitivity to odor. The monitored levels were compared against the industry norm.

This field olfactometer dynamically dilutes the ambient air with carbon-filtered air in discrete "dilution ratios." The U.S. Public Health Service defines the dilution ratio (sometimes called dilution factor) as "Dilution-to-Threshold," or D/T. The ratio is a measure of the number of dilutions needed to dilute the odor to the threshold level. The method for calculating the ratio is:

D/T = Volume of odor free (filtered) air / Volume of odorous air

Nasal Ranger Field Olfactometer
for Measuring Odor Concentration

St.Croix Sensory Photo

The Nasal Ranger measures odor D/T values of 2, 4, 7, 15, 30, and 60. An air flow sensor allows the technician to use a standard inhalation rate that ensures that the volume of air used for each measurement is between 16 and 20 liters per minute.

Nasal Ranger DIAL

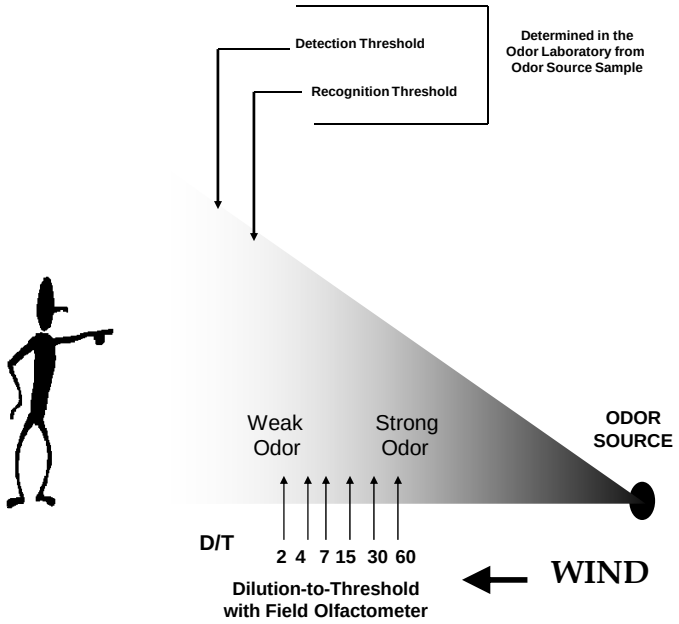
6 Dilution Settings: 60, 30, 15, 7, 4, and 2

6 Blank Air Settings Spaced Between the Dilution Settings

St.Croix Sensory Photo

Currently, several U.S. states regulate nuisance odors based on the field olfactometer method. For example, Colorado has Regulation No. 2, "Odor Emissions," in which Part A stipulates "…it is a violation if odors are detected after the odorous air has been diluted with seven (7) or more volumes of odor free air." This means that if the field technician detects the odor at position D/T = 7 or higher on the olfactometer while at or beyond the property line, then the facility is in violation of the odor rule. Although Minnesota does not have such regulations, other states that have a limit of D/T = 7 include: Connecticut (Reg. 22a-174-23); Illinois (Title 35, Subtitle B, Chap. 1, Part 245); Kentucky (Reg. 401 KAR 53:010); Missouri (several sections in Title 10); Nevada (NAC 445B.22087); and Wyoming (Ch. 2, Sec. 11).

Dilution of Odor in the Ambient Air

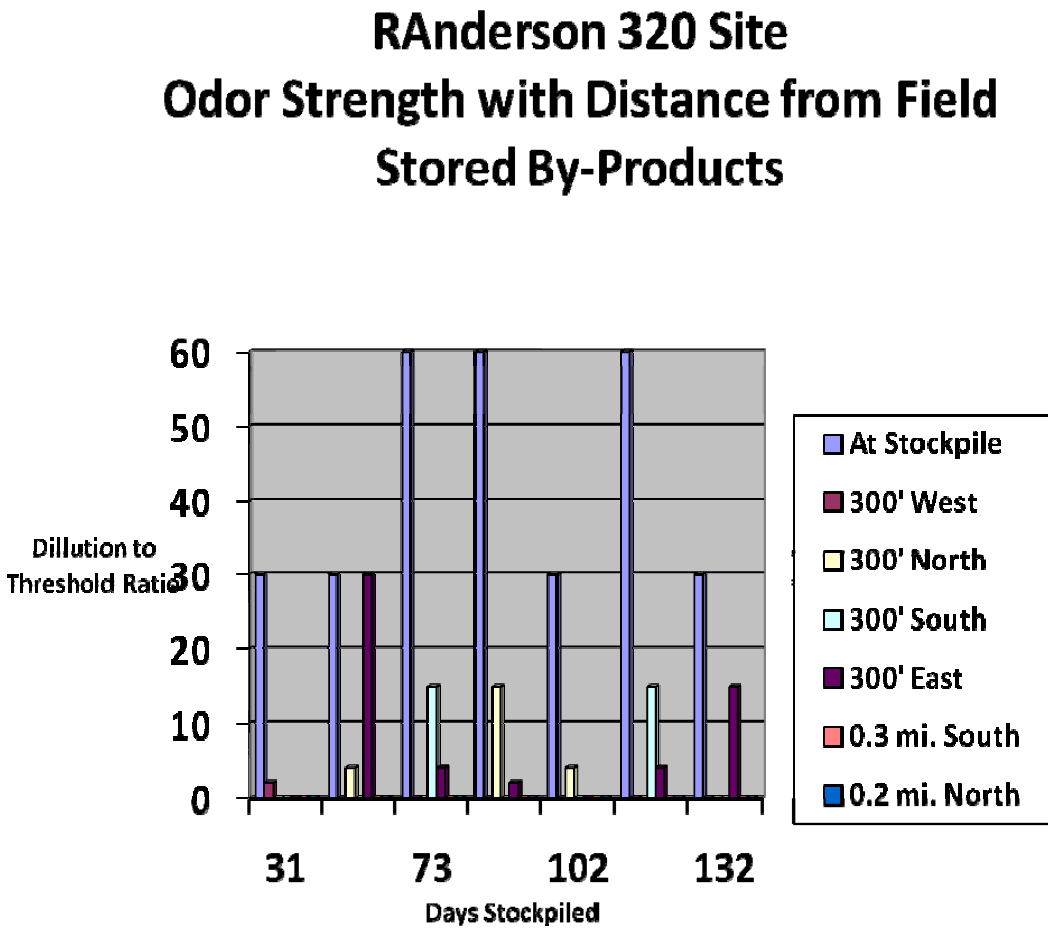


St.Croix Sensory Graphic

All of our technicians are trained to evaluate each sampling using a standard odor intensity scale and a standardized odor descriptor terminology that can provide measured, dependable and repeatable observation of the level of odor in ambient air. In order to determine the conditions that may generate odors from our long-term storage areas, we took samples at each storage site approximately every 15 days it was in use. The sampling was done at random time intervals during the day, and weather conditions did not influence the schedule. The amount of by-product at each site and other observations were noted.

Two long-term storage areas in Minnesota were monitored during this study. Sampling was done at each site in predetermined locations. These locations are highlighted on the attached aerial maps. The distances, in feet, from these locations to the actual stockpile areas are also noted. Each storage pile grew in size during the summer months. The RAnderson 320 site stored a total of 2,200 tons and the Franzen Decker site had a total of 2,600 tons. Both sites were selected for their remote locations, lack of near-by housing, geography, and proximity to the generating plant.

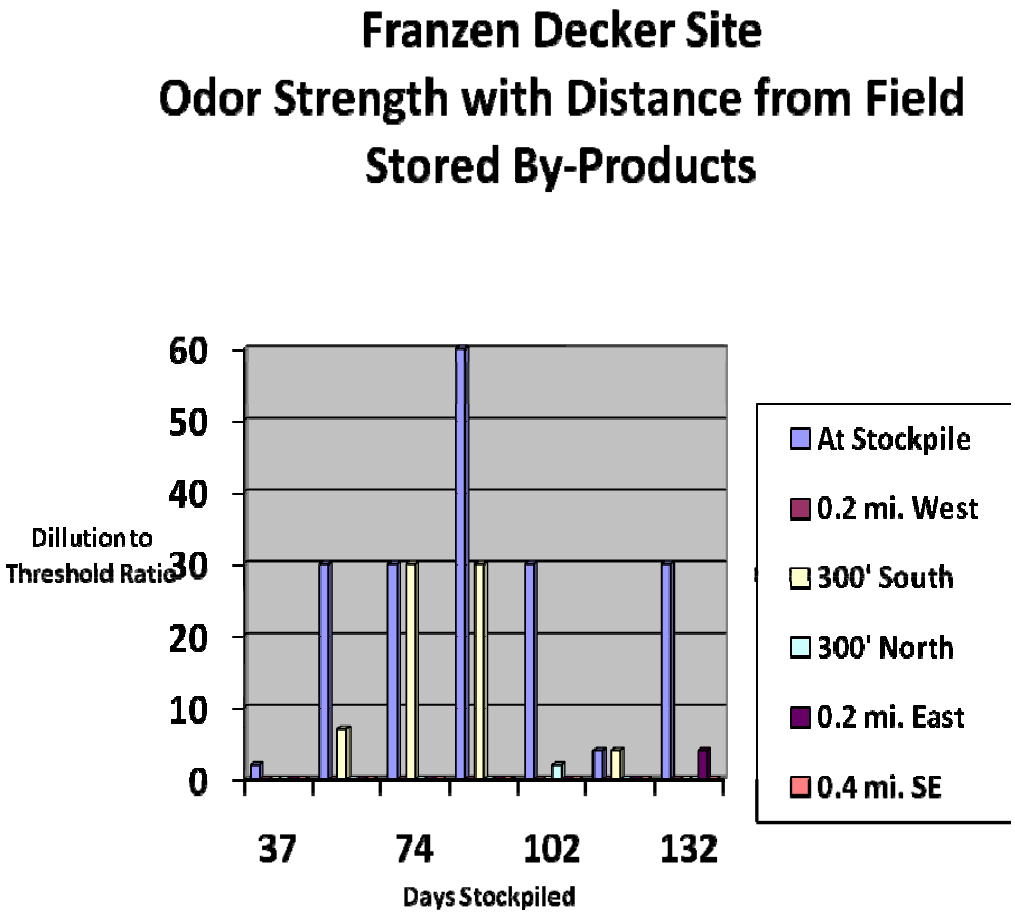
Twenty-cubic-yard roll-off boxes were used to transport the Nutrigrow from the plant to the storage sites. The trucks dumped each load as close to the previous load as possible. Several windrows of by-product were made next to each other and were usually approximately 3 to 4 feet in height. Once placed, the loads were not disturbed. Both storage sites were on level ground (less than a 2% slope) and a considerable distance from streams, waterways, wells, and other water sources. The crops surrounding the storage sites included corn, soybeans, alfalfa, and wheat. Both storage piles were spread on harvested crop land during September and October, 2006.



During this study, the odors at the RAnderson 320 storage site varied depending on distance from the storage pile. Nutrigrow was delivered to the site throughout the study timeframe but it did not appear to have any impact on odor, even as the number of tons stored increased over time. The odor strength at the stockpile varied from 30 D/T to 60 D/T. At 300 feet from the stockpile, the odor strength varied from 0 D/T to 30 D/T. All except one of the 28 readings from this distance were below 15 D/T. Only 5 of the 28 readings at the 300-foot distance were equal to or above 7 D/T. At the monitoring locations located 0.3 miles south (location of the nearest residence) and 0.2 miles north

(the landowner's residence) there was never a reading of 2 D/T or above. These readings were less than 2 D/T, the lowest possible odor dilution to threshold ratio.

Wind direction did have an effect on where the stronger odors were noticed. Usually, odor was more prevalent down wind from the storage area. Of the seven different days monitoring was done, on four days winds were from the northwest, on two days from the southeast, and on one day from the southwest.



The Nutrigrow was delivered to the Franzen Decker site from May 15th to July 30th. Fifteen days after delivery ended, the odor strength was at its highest level, measuring 60 D/T at the stockpile. In general, the odor at the stockpile was 30 D/T. The odor strength seems to be the highest 75 days after deliveries start and doesn't diminish until 30 days after deliveries stop. By 30 days after delivery ceased, the odor strength was dramatically less and measured in the 0 to 4 D/T levels. There was no drastic increase in odor as more Nutrigrow was delivered. At 300 feet from the stockpile, readings ranged from a D/T of 0 to 30. The readings were influenced by wind direction. They were more noticeable if standing down wind of the stockpile. At distances of 0.2 to 0.4 miles from the stockpile, odor strength was undetectable (less than 2 D/T) in all of the 18 readings except one occasion when it was measured at 4 D/T. The nearest residence is 0.4 miles southeast of the stockpile and at no time was odor strength measured to be 2 D/T or greater. Recent heavy rains and temperature increases did not seem to influence odor strength to any measurable degree. Slightly cooler temperatures in September (50's versus upper 70's Fahrenheit) may have reduced odor strength.

Conclusions

- At no time was odor measured to be over the critical level of less than 2 D/T at any residence near either of the long-term storage areas.
- 20% of the time, readings of 7 D/T or greater were measured 300 feet from the stockpiles.

- Only two percent of the time were readings of over 2 D/T measured 0.2 miles (or more) from the stockpiles.
- Being down wind of the stockpile increased the likelihood of obtaining a higher reading.
- Odor at the stockpile decreased significantly 30 days after delivery ceased.

Thus, we are confident that the odors from land application processes do not travel far and that the odor levels are low enough so as not to cause a nuisance.

For further information please contact Ray DeLong, Founder, Environmental Land Management, Inc. at raydelong@landspread.com or call 800-758-5050.