Evaluating and Controlling Landfill Odors and Other Advancements in Landfill Technologies

Lindsay E. James, R.G.
Senior Project Manager
Blackstone Environmental, Inc.
9153 West 133rd Street
Overland Park, Kansas 66213
Direct: 913.956.4160
ljames@blackstone-env.com

Austin Quick, E.I.T.
Project Engineer
Blackstone Environmental, Inc.
9153 West 133rd Street
Overland Park, Kansas 66213
Direct: 913.815.6180
aquick@blackstone-env.com

BLACKSTONE ENVIRONMENTAL

Objectives

- Characterizing Odors from Solid Waste Facilities
- Potential Odor Sources
- Dynamics of Odor Movement and Dilution
- Air Modeling
- Odor Evaluation Techniques
- Odor Mitigation Techniques
- Landfill Advancements

What is Odor?

- Odor refers to the perception experienced when one or more chemicals in the air (i.e. odorants) come into contact with human sensory systems.
- Ambient air contains a mixture of chemicals from activities occurring all around us.
- Odors can be classified as fugitive or point source.
- Odors can be transient or steady-state.
- Odors can be described by their character, frequency, intensity, duration, and offensiveness.

Community Odor Sources

- Industrial and manufacturing activities
- Landfills
- Waste Water Treatment Plants
- CAFOs
- Many others!

Nature of Odors from Solid Waste Facilities

- People react to odors in different ways and landfill odors are often transient and fugitive.
- Components of a Typical Odor Study
  - Identification of major odor sources and receptors
  - Site inspection and facility operations review
  - Review of odor complaint history
  - Inspection of other potential odor sources
  - Resident interviews
  - Atmospheric analysis/Air Modeling
  - Field evaluation/monitoring

Typical Odor Sources at Solid Waste Facilities

- Gas Collection Control System
- Active Face
- Odorous Loads (i.e. biosolids, restaurant wastes, animal processing waste, etc.)
- Composting Operations
- Leachate Management System

Meteorological Evaluation of Landfill Odors

Meteorology plays an essential role in the assessment of landfill odors

- Accumulation/dispersion of air pollutants
- Biological breakdown of organic waste
- Predict and mitigate odor episodes

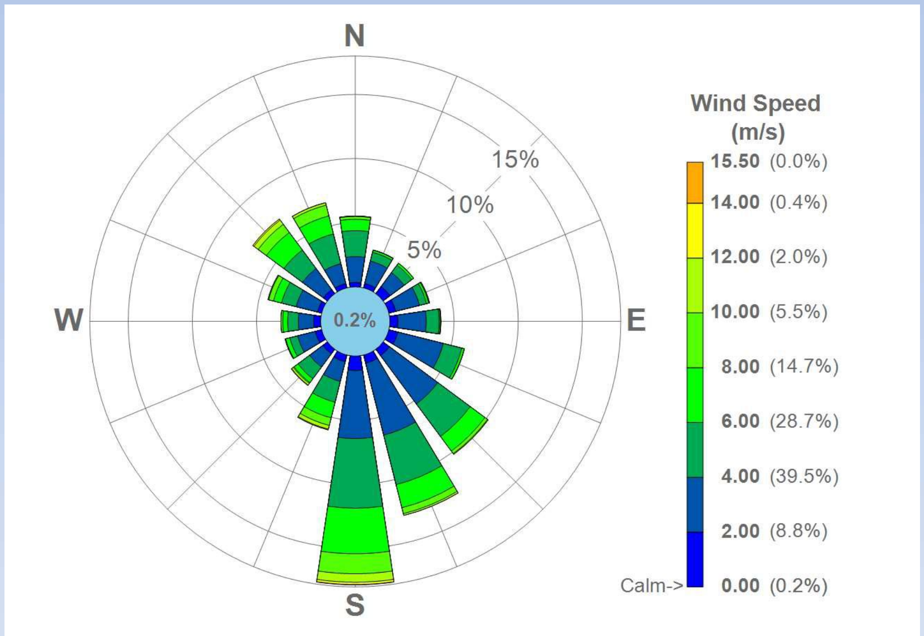
Two primary areas of consideration:

1. Odor transport:
    - Wind speed & direction → Horizontal transport
    - Atmospheric stability → Vertical dispersion
    - Boundary layer turbulence → Convective and/or mechanical diffusion
2. Meteorological Conditions affecting organic decomposition
    - Precipitation & Temperature → Conditions for aerobic vs. anaerobic breakdown

Odor Transport - Wind Speed & Direction

The transport of odors by mean wind (advection) is a principal transport mechanism in the atmosphere.

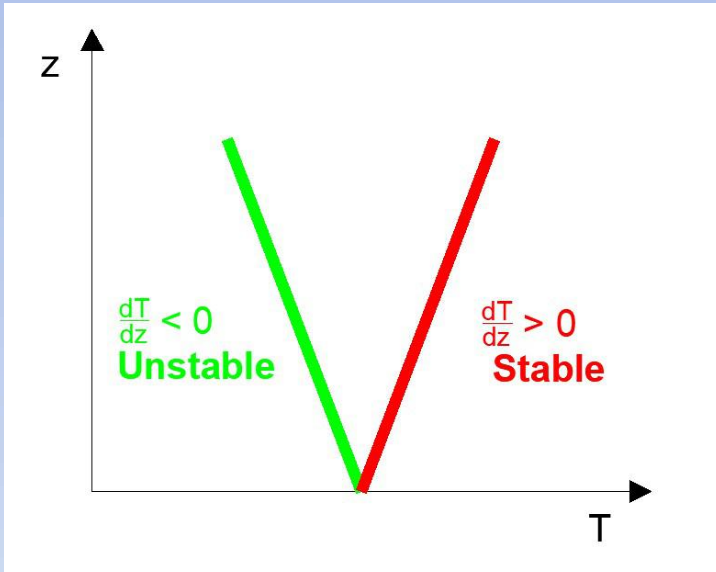
- Odor complaints from downwind of odor source
- Higher winds = lower concentrations
- Lower winds = higher concentrations, complaint potential



Odor Transport – Atmospheric Stability

Unstable atmosphere

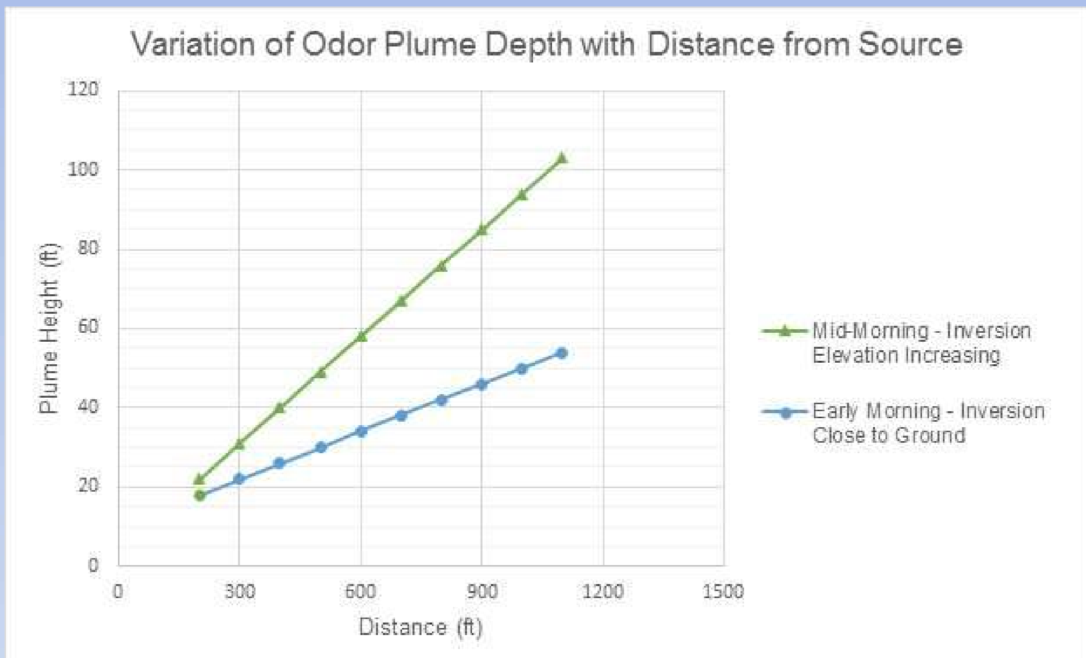
- Afternoon is typically most unstable time of day
- Associated with low pressure systems & clouds
- Vertical mixing = lower pollutant surface concentrations

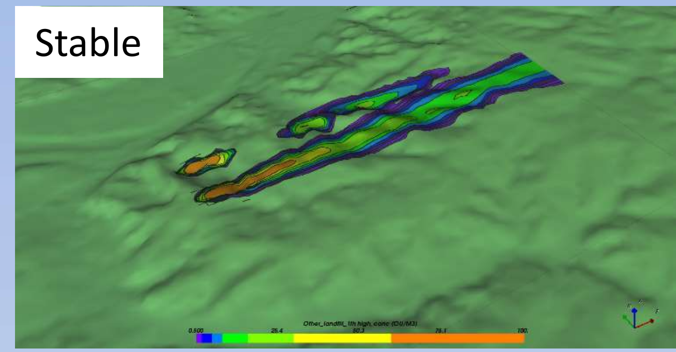


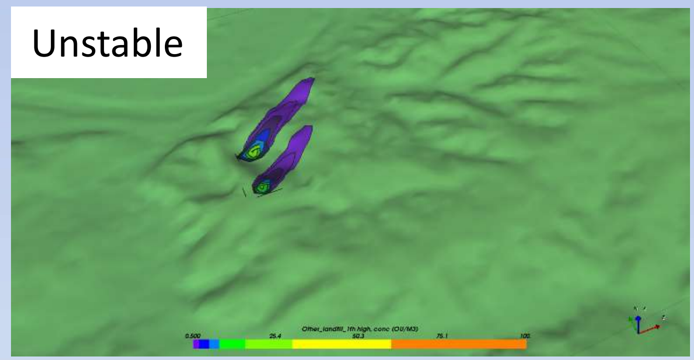
Stable atmosphere

- Typical overnight
- Associated with high pressure systems & clear skies
- Inhibited vertical mixing = higher pollutant surface concentrations
- Trapping temperature inversion → very stable

Odor Transport – Atmospheric Stability



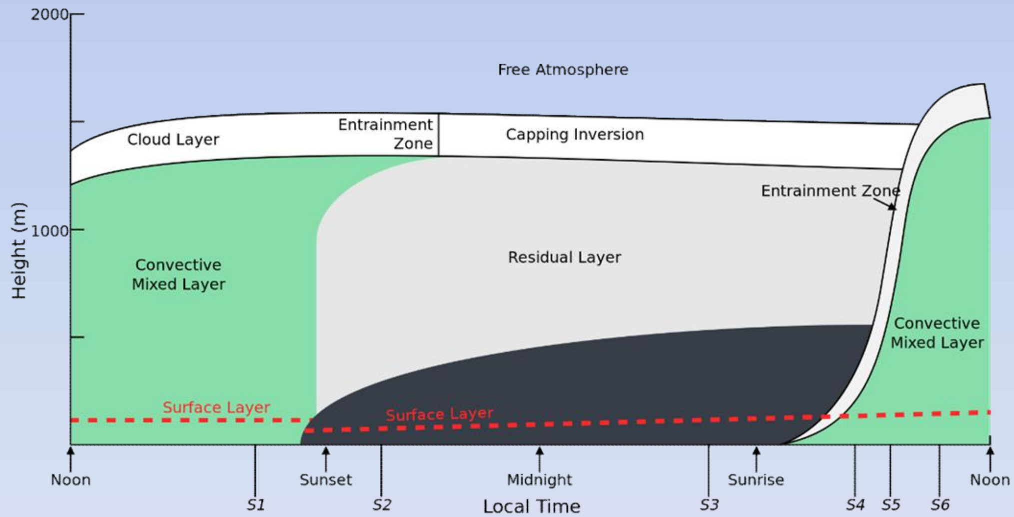




Odor Transport – Boundary Layer Turbulence

Atmospheric Boundary Layer (ABL) – The region of the atmosphere where the Earth's surface strongly influences wind, temperature, and moisture through the turbulent transfer of air mass

- Lowest part of atmosphere
- Daily cycle – unstable by day, stable by night
- Turbulent eddies disperse odor
- Created through convection and/or mechanics
- Odors detected elsewhere than downwind of source

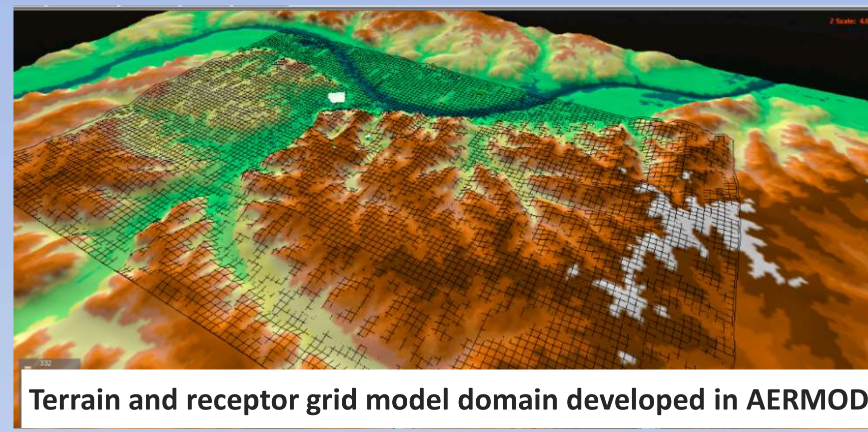


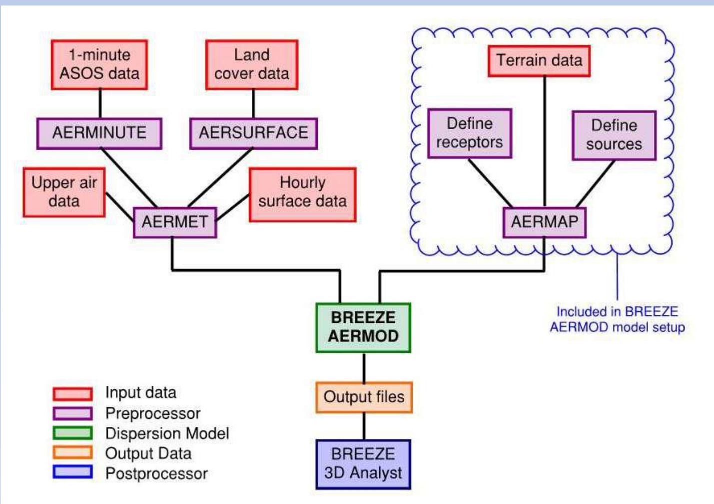
Source: NikNaks

Modeling Landfill Odors with AERMOD

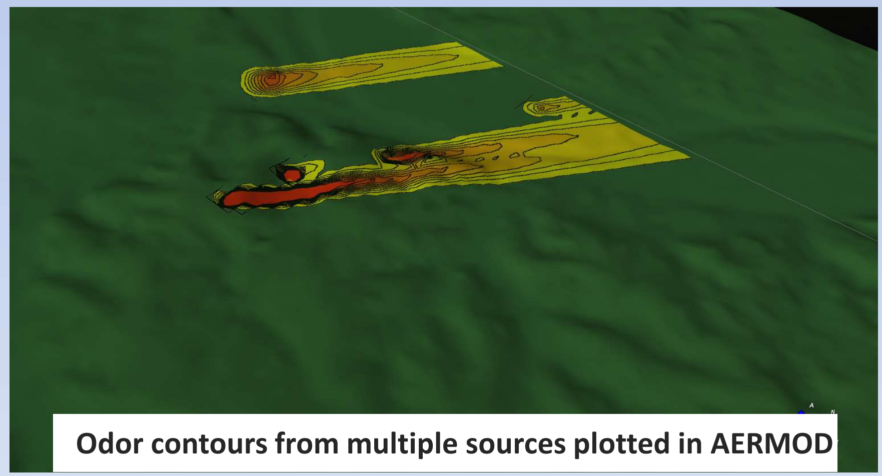
AERMOD – A steady-state Gaussian plume dispersion model up to 50 km for industrial pollutant emissions

- An EPA preferred regulatory model
- Incorporates boundary layer physics (stability)
- Models the effects of local topography on pollutant concentrations


Terrain and receptor grid model domain developed in AERMOD



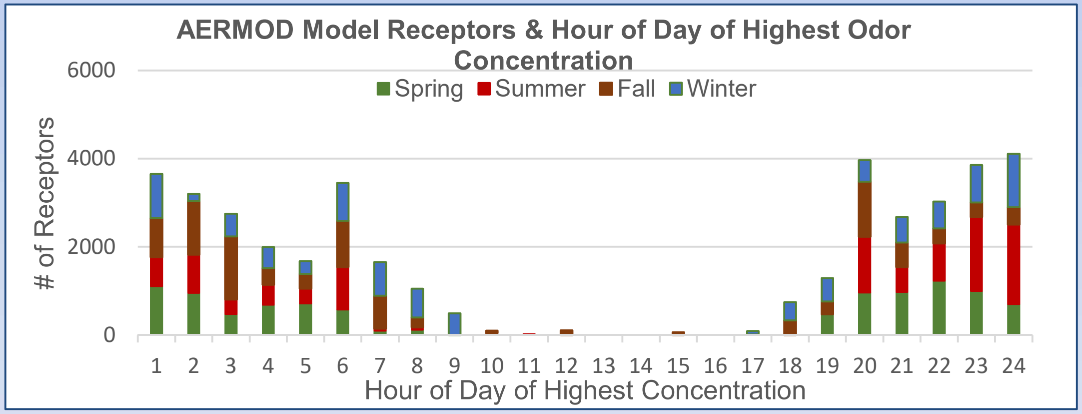
Schematic of the AERMOD modeling system


Odor contours from multiple sources plotted in AERMOD

Modeling Landfill Odors with AERMOD

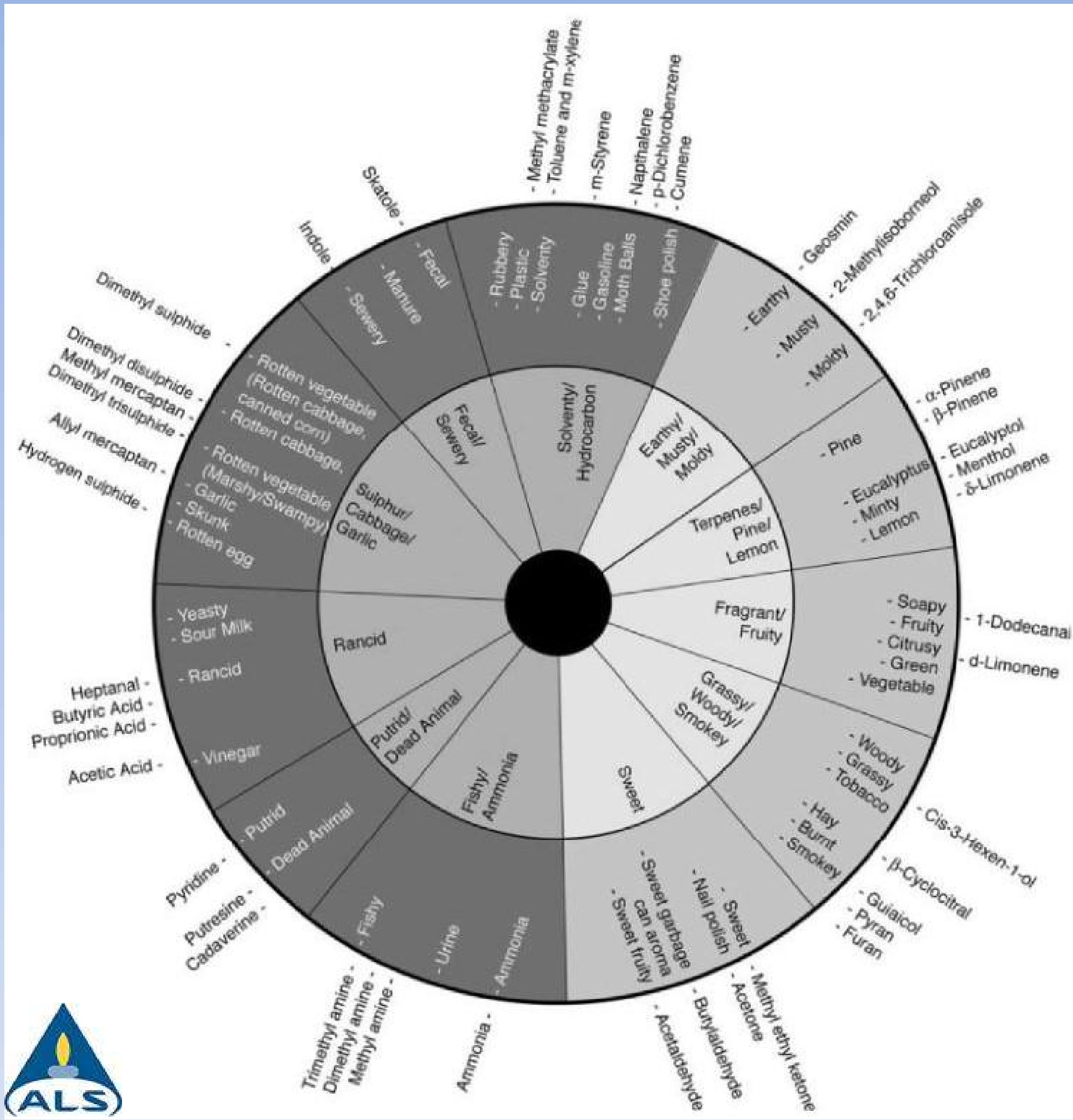
Advantages:

- Investigate the effects of atmospheric stability on odor dispersion
- Investigate the effects of local topography on odor dispersion
- Pinpoint the meteorological conditions which contribute to odor episodes & predict when future episodes will occur
- Locate topographic areas of concern regarding odor migration off-site



Disadvantages:

- Odor sources at landfill are constantly changing – requires meticulous emissions input data to accurately represent
- Smallest temporal resolution = 1 hour – not fine enough to model fluctuations occurring within an hour
- Odor complaints occur on the order of seconds, odors modeled on the order of hours – not currently suitable for odor complaint investigation
- Requires substantial set-up and run time



Odor Wheel Image courtesy of ALS Environmental

Nature of Odors from Solid Waste Facilities and the Odor Wheel

The character of an odor is a unique, innate quality of an odor that does not vary with intensity.

Four Primary Characteristics of an Odor – FIDO

- Frequency
- Intensity
- Duration
- Offensiveness

Methods of Evaluation

Nasal Ranger® Field Olfactometer – Portable and precise odor strength measuring device.

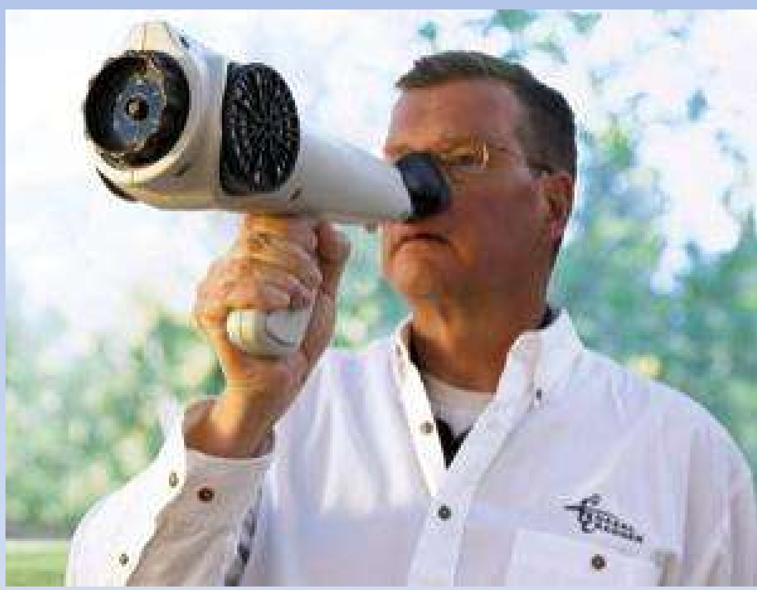
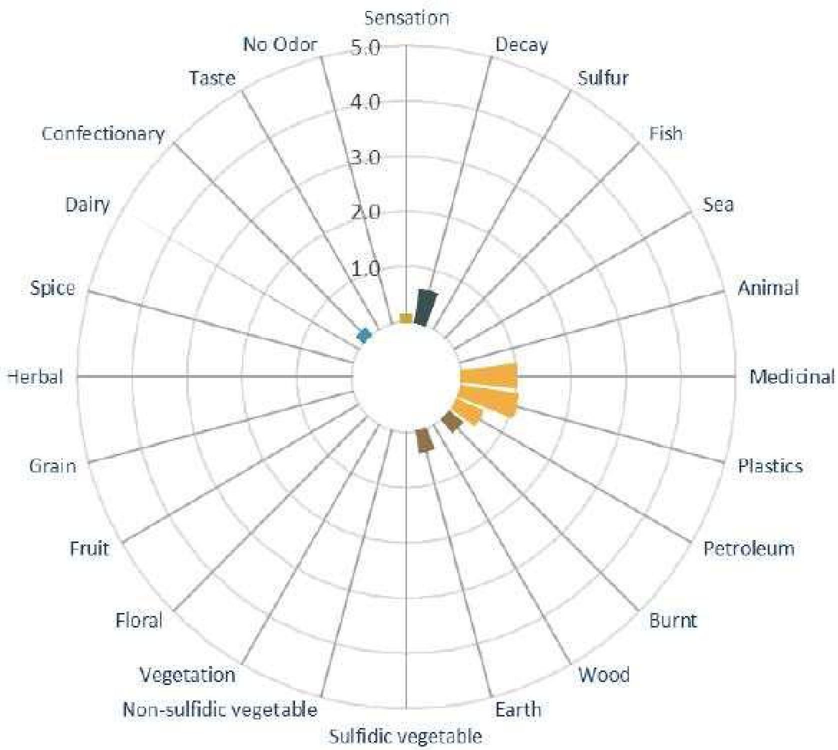


Image from www.nasalranger.com

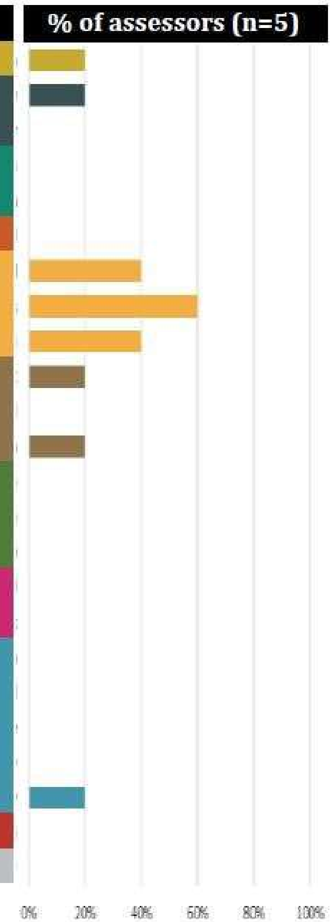
- Dilution to Threshold (D/T) – A measure of the number of dilutions needed to take the odorous air to its sensory threshold. D/T = Volume of Carbon-Filtered Air / Volume of Odorous Air
- Carbon filtered air is mixed with specific volumes of odorous ambient air. Standard D/T ratios include 2, 4, 7, 15, 30, 60.
- Missouri 10 CSR 10-6.165 specifies 7 D/T for 2 separate trials not less than 15 minutes apart within the period of 1 hour.

Methods of Evaluation

Odor Panel



Strength	Descriptor
0.2	Sensation
0.6	Decay
	Sulfur
	Fish
	Sea
	Animal
1.0	Medicinal
1.1	Plastics
0.5	Petroleum
0.3	Burnt
	Wood
0.4	Earth
	Sulfidic vegetable
	Non-sulfidic vegetable
	Vegetation
	Floral
	Fruit
	Grain
	Herbal
	Spice
	Dairy
0.2	Confectionary
	Taste
	No Odor



Methods of Evaluation

Field Screening for compounds such as hydrogen sulfide can be performed using a Jerome hydrogen sulfide meter.

- Capable of measuring hydrogen sulfide from a concentration of 0.003 to 50 ppm.
- Recognition threshold for H2S is 0.0047 ppm.

Other field instruments are available but many such as a PID measure total VOCs or do not measure down to the recognition threshold.

Jerome 631-X H^{2}S Analyzer

MiniRAE Photoionization Detector (PID)

Methods of Evaluation

Whole air sampling using Tedlar bags, SUMMA canisters, and sorbent tubes. Provides compound specific information, concentrations, and can be compared to recognition thresholds.

Due to the chemical and physical nature of odorous compounds, a single method often will not adequately address all of the compounds of concern.

Nitrogenous Compounds
Sulfur Containing Compounds
Volatile Organic Compounds (VOCs)
    Carboxylic Acid (volatile fatty acids)
Alcohols
Aldehydes

Key Odor Factors

- Meteorological Conditions
  - Precipitation
  - Wind Speed
  - Wind Direction
  - Atmospheric stability
- Distance to Receptors
- Odor Characteristics
  - Frequency
  - Intensity
  - Duration
  - Offensiveness

Obviously solid waste facilities cannot control the weather or land development. But, what we can do is understand how these factors impact odor transport and use this information to make operational changes to control odors at the source.

Mitigation Methods

- Determine the source(s)
- Monitor meteorological conditions and plan activities such as feedstock/yard waste grinding or LFG system maintenance to avoid times with high odor potential
- Restrict odorous loads during times of stable atmosphere such as overnight hours
- Perform routine odor monitoring/surveys on and off-site
- Keep active face as small as possible

Mitigation Methods

- Cover odorous loads immediately
- Control odors near the source – not just at the perimeter
- Use air modeling and meteorological conditions to predict localized odor movement and optimal placement of odor control systems
- Respond to citizen odors complaints and communicate with the community

QUESTIONS

Lindsay E. James, R.G.
Senior Project Manager
Blackstone Environmental, Inc.
9153 West 133rd Street
Overland Park, Kansas 66213
Direct: 913.956.4160
ljames@blackstone-env.com

Austin Quick, E.I.T.
Project Engineer
Blackstone Environmental, Inc.
9153 West 133rd Street
Overland Park, Kansas 66213
Direct: 913.815.6180
aquick@blackstone-env.com