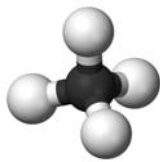


# LANDFILL GAS MONITORING: A Primer on Methane & City of Tucson Landfill Ordinance



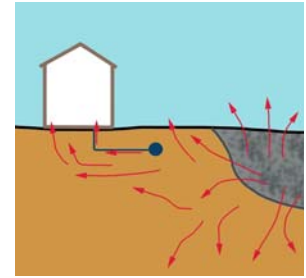
## Methane is:

- ▶ colorless
- ▶ odorless
- ▶ naturally occurring
- ▶ explosive at atmospheric concentrations of 5% to 15%



## Landfill Gas Facts:

- ▶ Most landfills are in varying phases of decomposition, and all phases may be found simultaneously in a landfill.
- ▶ Landfill gases expand and “migrate” through the available pore spaces, principally following the path of least resistance.
- ▶ Migration of gases is influenced by the concentrations of the gases, the pressure from the accumulation of gases, and the permeability of the surrounding soils.
- ▶ Wet soil conditions from rain and moisture may prevent landfill gases from migrating through the top of the landfill.
- ▶ Rain and moisture may seep into pore spaces and “push” gases out of these spaces.
- ▶ Added moisture encourages bacterial decomposition and increases gas production.
- ▶ Temperature increases within the landfill also increase bacterial activity and gas production.



Routes of migration for gases.

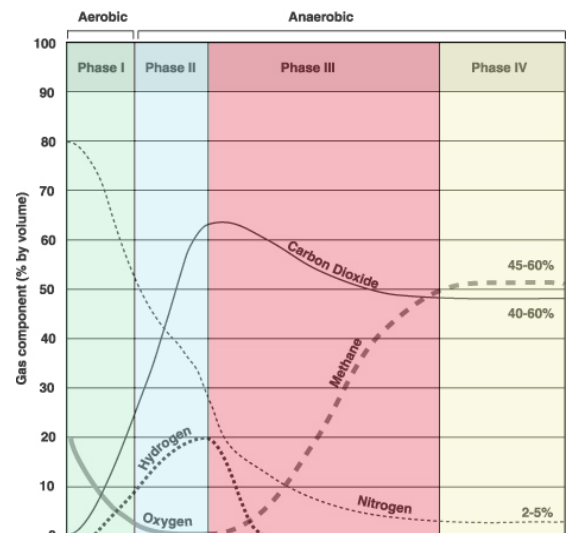
## Phases of Decomposition of Landfill Waste

**Phase I:** Aerobic bacterial decomposition produces the landfill gases carbon dioxide, hydrogen, sulfides, and other non-methane organic compounds, typically within 5-10 years after burial of the waste.

**Phase II:** As oxygen is depleted, acids formed by aerobic decomposition mix with moisture making nitrogen and phosphorus available to anaerobic bacteria.

**Phase III:** Once oxygen is depleted and acetate is formed from the anaerobic decomposition process, methanogenic bacteria consume the acetate and carbon dioxide producing methane.

**Phase IV:** As the anaerobic bacterial decomposition stabilizes, methane and carbon dioxide are produced at a constant rate, and production and releases of gases may continue for several decades.



Source: EPA 1997

## City of Tucson Landfill Ordinance

The landfill ordinance is designed to protect the public health and safety from the adverse affects of methane. To provide this protection, development within 100 feet of a designated landfill requires a Landfill Methane Development Plan. The plan includes: measures to monitor methane production and migration, construction specifications for structures, properly engineered drainage, and as appropriate, the design and installation of methane controls. To assess the production and migration of methane, the following measures are typically implemented for landfill gas monitoring:

Atmosphere		Soil (native)		Landfill	
Nitrogen (N <sub>2</sub> )	79%	Nitrogen (N <sub>2</sub> )	78-79%	Nitrogen (N <sub>2</sub> )	2-5%
Oxygen (O <sub>2</sub> )	21%	Oxygen (O <sub>2</sub> )	18-20%	Oxygen (O <sub>2</sub> )	0.1-15%
Carbon dioxide (CO <sub>2</sub> )	0.04%	Carbon dioxide (CO <sub>2</sub> )	0.25-2%	Carbon dioxide (CO <sub>2</sub> )	5-65%
Methane (CH <sub>4</sub> )	0.0002%	Methane (CH <sub>4</sub> )	<0.0002%	Methane (CH <sub>4</sub> )	0.1-80%

Typical atmospheric, soil, and landfill gas concentrations.

- ▶ Subsurface monitoring probes are placed around the perimeter of the landfill. The probes typically range in depth from 5 to 20 feet below the surface.
- ▶ Monitoring of the soil gas concentrations is completed on a regular schedule that is dependent on the methane conditions for the landfill.
- ▶ The operating condition of the system and monitoring results, including methane, oxygen, and carbon dioxide concentrations, are required to be reported to the Tucson Fire Department.
- ▶ Methane concentrations at the monitoring locations in excess of 5% must be reported to the proper authorities and a plan developed to correct the problem.