

## Critical Thinking Questions - Landfill Gas Generation

### I. Landfill Gas Fundamentals

1. Why is the first-order reaction rate higher in regions that receive more precipitation than in those with lower precipitation?
2. How does the waste composition affect gas production – for example how would a gas rates be different from a construction and demolition landfill than a municipal waste landfill?
3. Why are methane and carbon dioxide the main components in landfill gas?
4. Compare the changes in leachate quality to landfill gas composition during the various phases of landfill gas generation.
5. Describe the factors that affect landfill gas generation the most.

### II. Landfill Gas Production Mechanisms and Modeling

1. A landfill cell is open for three years, receiving 165,700 Mg of waste per year. Calculate the peak gas production if the landfill gas emission constant is 0.0307 yr<sup>-1</sup>, the methane generation potential is 140 m<sup>3</sup>/Mg. Assume prior to final closure methane oxidation in the cover is 20% of the uncollected methane. Use the table below. Assume Years 1-3 have only daily cover (50% collection efficiency), years 3-5 have intermediate cover (75% collection efficiency), and after year 5 a geosynthetic cover is in place (98% collection efficiency).

Year	Gas Generation, m <sup>3</sup>	Collection Efficiency, fraction	Uncollected Methane, m <sup>3</sup>	Uncollected and Unoxidized Methane, m <sup>3</sup>
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
Total				

2. Calculate the metric tons of methane generated over 20 years, assuming the ideal gas law applies and the gas is at standard pressure and temperature. Calculate the CO<sub>2</sub> equivalent in metric tons.
3. Using the GHG Equivalencies Calculator, calculate the equivalent number of barrels of oil and passenger vehicles for methane generation from a landfill over 20 years.

## **VII. Landfill Gas Collection System Design**

1. After reviewing LMOP's Landfill Gas Energy Project Development Handbook Chapter 3. Project Technology Options, list the gas to energy approaches and find examples on the web which utilize each type. Briefly describe these examples including the type of technology, capacity of the system, and the justification for their use.
2. Using the gas collected from the landfill analyzed in Critical Thinking Question 1 from Activity 2, determine how many vertical wells would be required. Assume an average depth of 25 m, a waste density of 10 kN/m<sup>3</sup>, and a well radius of influence of 30 m.
3. After reading Sections 3.5-3.8 in the US Army Corp of Engineers Landfill, Gas Collection and Treatment Systems, Manual No. 200 1-22 analyze the gas collection system shown in the LFG Collection System Drawing. Discuss the major components needed and the information you need to complete the design the system (size of pipes, valves, well heads, and pressure drop