# Potential CDM Project for a Landfill in Egypt
# Application of the Approved Methodology AM002

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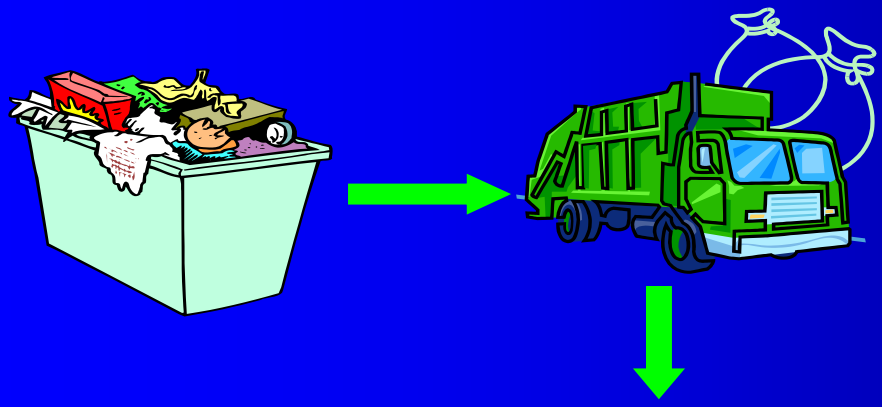
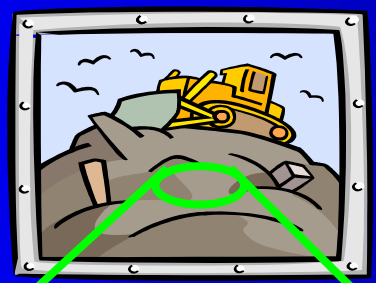
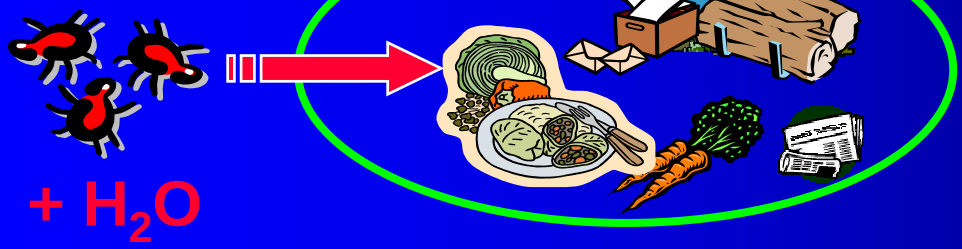
# Background







$CO_2 + NH_3 + CH_4$

# Potential Project in Egypt

- Landfill serves 4 districts in Greater Cairo
- Annual MSW approximately 400,000 t/yr
- Contract between Egyptian government and an international company for the collection and final disposal of SW
- Contract Duration = 15 years

# Approved Baseline Methodology

- Applicability
- Emission Reduction
- Baseline
- Additionality
- Leakage

# Applicability

- There exists a contractual agreement where the operator is responsible for all aspects of the landfill
- Contract awarded through competitive bidding
- Contract stipulates amount of landfill gas to be flared → performance among top 20% in the previous 5 years
- No generation of electricity using captured methane occurs or planned

# Applicability – Egyptian Landfill

- Contractor responsible for all aspects of the landfill
- Contract awarded through competitive bidding
- A passive collection system is proposed by the contractor → Quantity of LFG can be estimated. The contract mandates flaring if $CH_4$ generation rate is greater than 20 $m^3$/hr
- Only 2 governorates out of 26 use controlled landfills, others use open dumping. $CH_4$ recovery system pilot projects are being implemented
- No electricity generation is planned

# Emission Reduction

$CH4_{flared,y}$

Project

$CH4_{baseline,y}$

Baseline

$$ER\_CH4_y = CH4_{flared,y} - CH4_{baseline,y}$$

$$ER_Y = ER\_CH4_y * CF * GWP\_CH4$$

| | |
|---|---|
| $ER_y$: | GHG reduction in t $CO_{2e}$ |
| $ER\_CH4_y$: | Methane emission reduction in $m^3$ |
| CF: | 0.000662 t $CH_4/m^3$ $CH_4$ |
| GWP_CH4: | 21 (Global warming potential for $CH_4$) |

# Emission Reduction – Egyptian Landfill

618,628,267 $m^3$ $CH_4$

Project

154,657,067 $m^3$ $CH_4$

Baseline

Corrected by monitoring $CH_4$ flar ed

Corrected by monitoring actual waste and % $CH_4$ in LFG

$$ER\_CH4_{y=1to15} = 618,628,267 - 154,657,067 = 463,971,200 \quad m^3 CH_4$$

$$ER_{y=1to15} = 463,971,200\ m^3\ CH_4 * 0.00066 \frac{t\ CH_4}{m^3\ CH_4} * 21 \frac{t\ CO_{2e}}{t\ CH_4} = \mathbf{6,450,128\ t\ CO2e}$$

# Baseline

- First order decay model
- Applied to a single batch (either a layer or a year), then results are summed for all batches

$$CH4_{projected,y} = k * L_o * \sum_{t=0 \text{ to } y} Waste_{contract,t} * e^{-k(y-t)}$$

| | |
|---|---|
| $CH4_{projected,y}$: | Methane projected to be generated during a given year |
| K: | Decay rate |
| $L_o$: | $m^3$ CH4 / t MSW |
| $Waste_{contract,t}$: | Waste projected to be lanfilled at year t |

# Baseline

- K depends on local conditions e.g. temp., moisture content of MSW, pH, and nutrients.

- $L_o$ ($m^3$ $CH_4$ / t MSW)

$$L_o = MCF * DOC * DOC_f * F * \frac{16}{12}$$

| | |
|---|---|
| MCF | Methane correction factor |
| DOC | Degradable organic carbon |
| $DOC_f$ | Fraction of organic carbon converted to landfill gas |
| F | Fraction of $CH_4$ in landfill gas (Default = 0.5) |

# Baseline

$$L_o = \boxed{MCF} * DOC * DOC_f * F * \frac{16}{12}$$

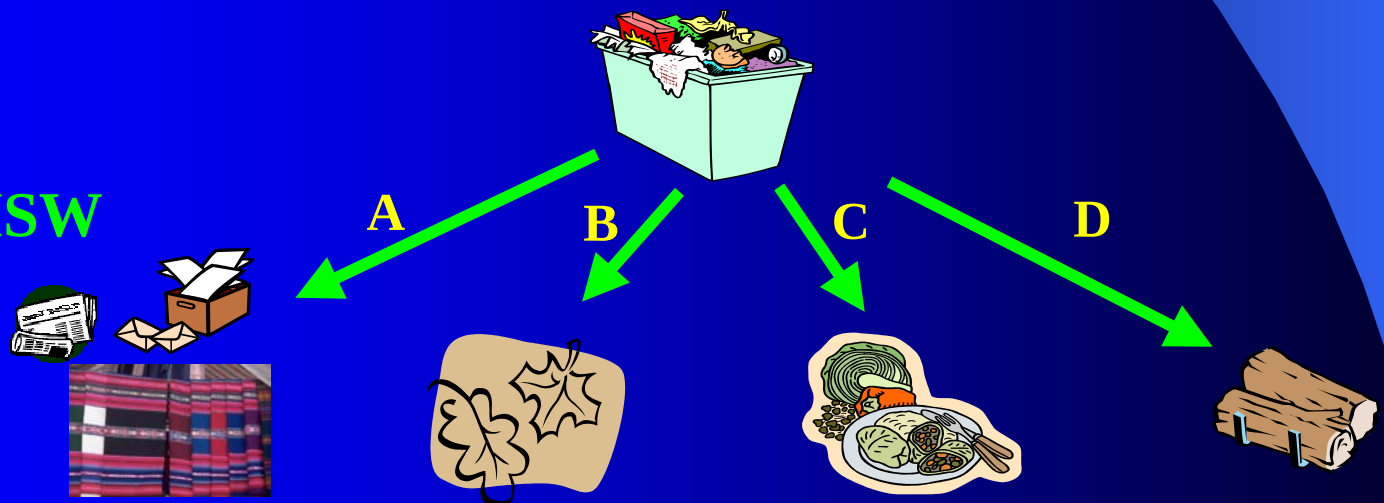
- Methane correction factor (MCF)
  - 1 Managed landfills
  - 0.8 Unmanaged landfills (d>5)
  - 0.4 Unmanaged landfills (d<5)
  - 0.6 Unknown quantity of disposed MSW
- Factors reflect lower methane generating potential for unmanaged sites (less favorable conditions for anaerobic decomposition)

# Baseline

$$L_o = MCF * DOC * DOC_f * F * \frac{16}{12}$$

- **Degradable organic carbon (DOC)**
  - **Weighted average of carbon content in each waste component**

$$DOC = 0.4(A) + 0.17(B) + 0.15(C) + 0.3(D)$$



# Baseline

$$L_o = MCF * DOC * \boxed{DOC_f} * F * \frac{16}{12}$$

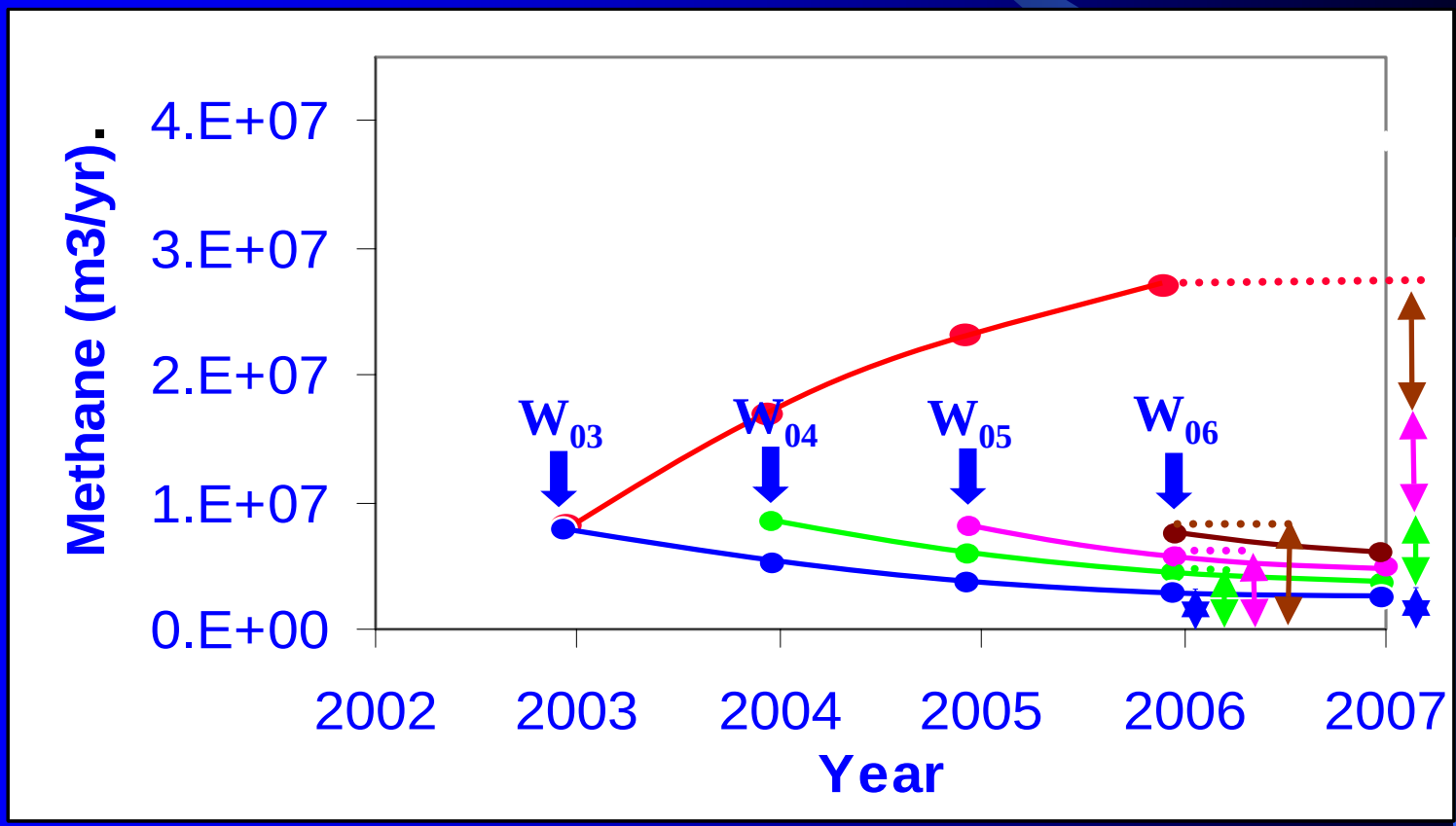
- **Fraction of carbon converted to LFG ($DOC_f$)**
  - **Function of temperature in anaerobic zone**

$$DOC_f = 0.014T + 0.28$$

- **T is usually assumed 35° in anaerobic zone → $DOC_f$ = 0.77**

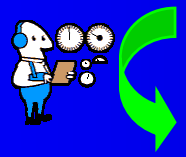
# Baseline

$$CH4_{projected,y} = k * L_o * \sum_{t=0 \text{ to } y} Waste_{contract,t} * e^{-k(y-t)}$$



# Baseline

Correct →



$$CH4_{contract,y} = CH4_{projected,y} * FD_y$$

$$CH4_{baseline,y} = CH4_{contract,y} * \frac{Waste_{actual,y}}{Waste_{contract,y}} * \frac{R_{actual}}{R_{contract}}$$

**$CH4_{contract,y}$:** Methane required to be flared each year as per contract

**FD:** Fraction of methane collected in baseline

**$CH4_{baselinr,y}$:** Methane specified in contract adjusted by actual waste and actual % CH4 in LFG

**R:** Fraction of CH4 in LFG

# Project

Correct →

$$CH4_{project,y} = CH4_{projected,y} * FP_y$$

$$CH4_{flared,y}$$

**FP:** Fraction of methane collected in project

**CH4flared,y** Actual methane flared during year y

# Baseline – Egyptian Landfill

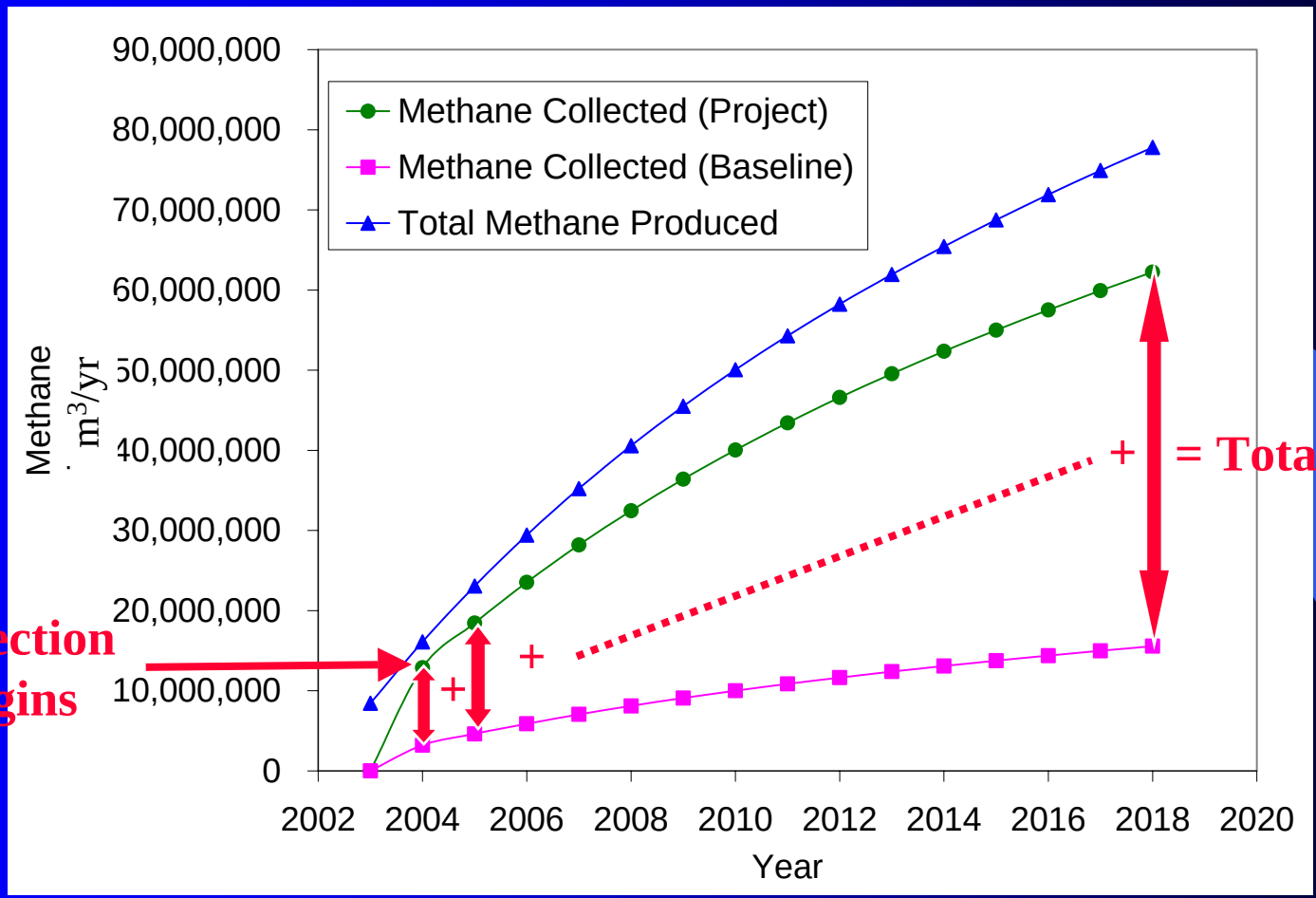
2% annual increase

| Yr | 2003 | 2004 | 2005 | 2006 | …….. | 2018 |
|---|---|---|---|---|---|---|
| MSW (t) | 395,660 | 403,573 | 411,645 | 419,878 | …….. | 532,506 |
| CH4 (m3/yr) from waste in 2003 | 8,445,125 | 7,490,154 | 6,643,171 | 5,891,964 | …….. | 1,395,970 |
| CH4 (m3/yr) from waste in 2004 | | 8,614,028 | 7,639,957 | 6,776,034 | …….. | 1,605,431 |
| CH4 (m3/yr) from waste in 2005 | | | 8,786,308 | 7,792,756 | …….. | 1,846,320 |
| CH4 (m3/yr) from waste in 2006 | | | | 8,962,035 | …….. | 2,123,355 |
| ……. | | | | | | |
| CH4 (m3/yr) from waste in 2018 | | | | | | 11,366,027 |
| Total CH4 (m3) | 8,445,125 | 16,104,182 | 23,069,437 | 29,422,789 | …….. | 77,812,347 |
| Baseline Flared (m3 CH4) | 1,689,025 | 3,220,836 | 4,613,887 | 5,884,558 | …….. | 15,562,469 |
| Project Flared (m3 CH4) | 6,756,100 | 12,883,346 | 18,455,549 | 23,538,231 | …….. | 62,249,877 |
| Emission Reduction (m3 CH4) | 5,067,075 | 9,662,509 | 13,841,662 | 17,653,674 | …….. | 46,687,408 |
| Emission Reduciton (t CH4) | 3,354 | 6,397 | 9,163 | 11,687 | …….. | 30,907 |
| Emission Reduction (t CO2e) | 70,442 | 134,328 | 192,427 | 245,421 | …….. | 649,048 |

X 20%
X 80%
X 0.00066
X 21

- K = 0.12, Lo = 178 m3 CH4 / t MSW, MCF=1, DOC=0.21, DOCf = 0.77, CH4/LFG = 0.55

# Baseline – Egyptian Landfill

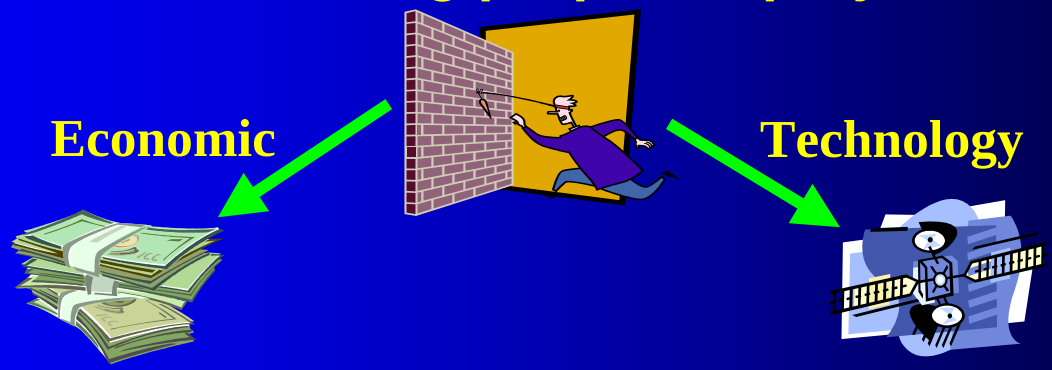



- Assumed Baseline collection efficiency = 20%
- Assumed project collection efficiency = 80%

# Additionality

- Emission reductions that are additional to any that would occur in the absence of the project

- How to demonstrate:
  - Qualitative or quantitative assessment of one or more barriers facing proposed project



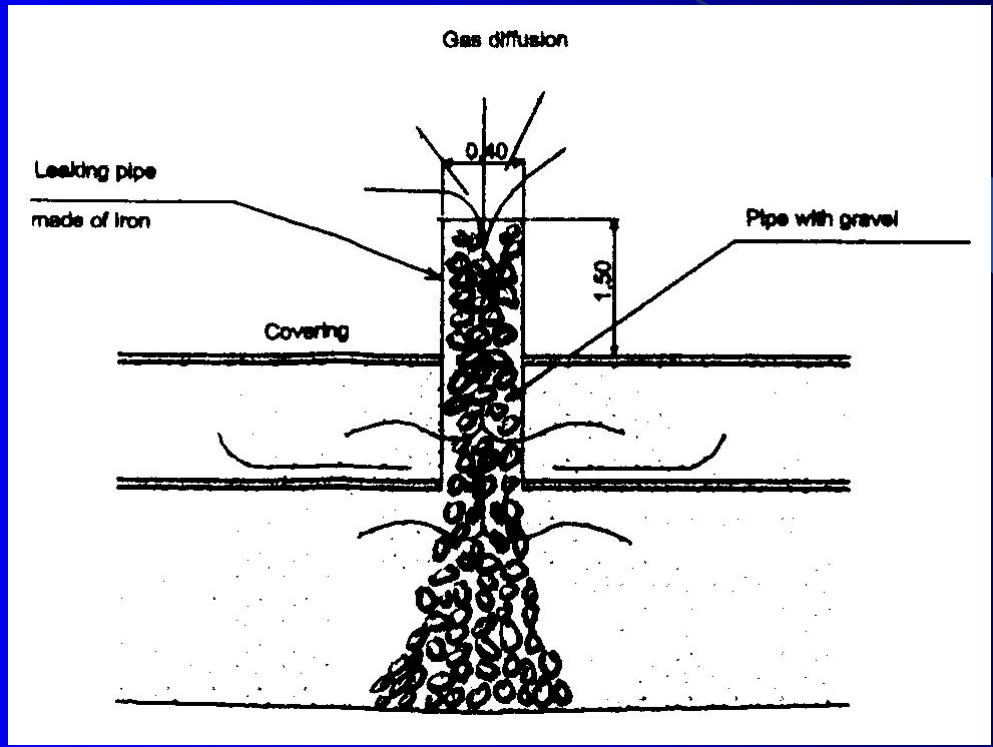

  - An indication that the project type is not common practice in the proposed area of implementation

# Additionality – Egyptian Landfill

- Contract approves passive collection system – Contractor will not spend money on increasing efficiency of collection
- Most economic course of action is the baseline (current approved passive collection system)
- Active collection system is not common practice in Egypt and is not required by legislation

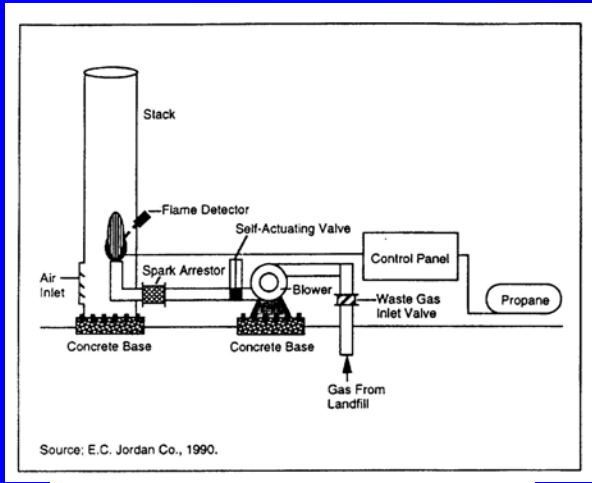
# Additionality -- Egyptian Landfill

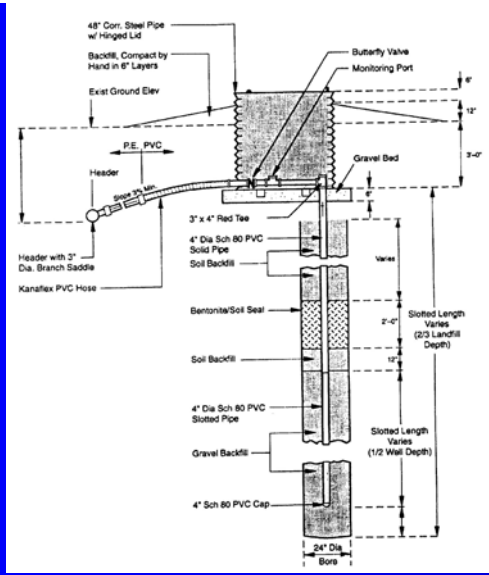
## Baseline

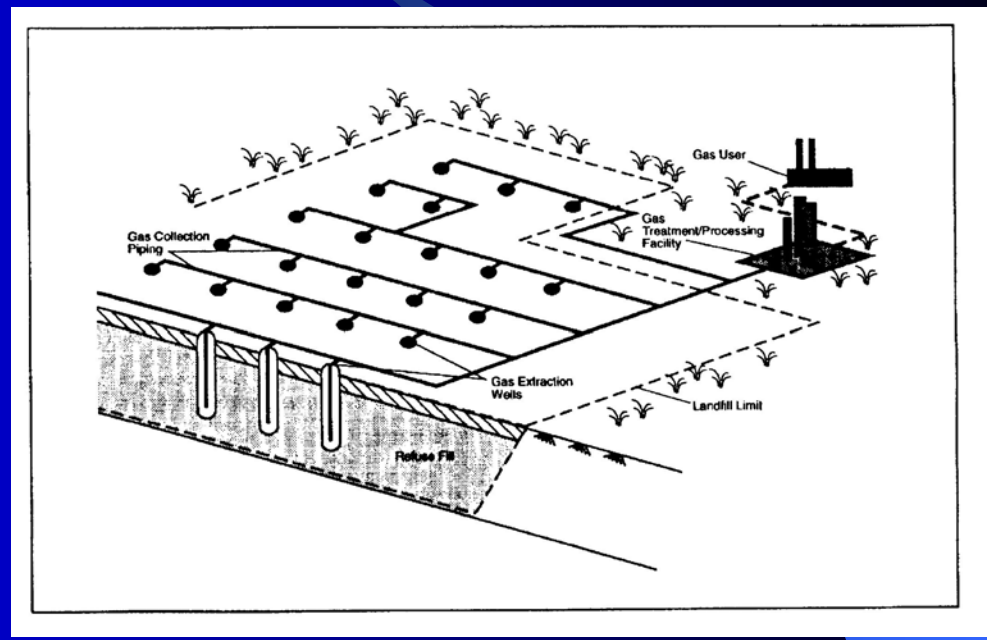



- Passive venting system
- Flaring if $CH_4$ rate > 20 $m^3$/hr
- 20% collection efficiency

# Additionality -- Egyptian Landfill Project




- Active collection system (suction
- Collected gas flared
- 80% collection efficiency

# Leakage

- **Emissions resulting from generating electricity used to pump the landfill gas in the additional collection equipment**

$$EE_y = \left[ \frac{CH4_{flared,y} - CH4_{baseline,y}}{CH4_{baseline,y}} \right] * \frac{EP_y * EC_y}{1000}$$

**$EE_y$ Electricity emissions (t CO2/yr)**

**$EC_y$ Emission factor (kg CO2 / Kwh)**

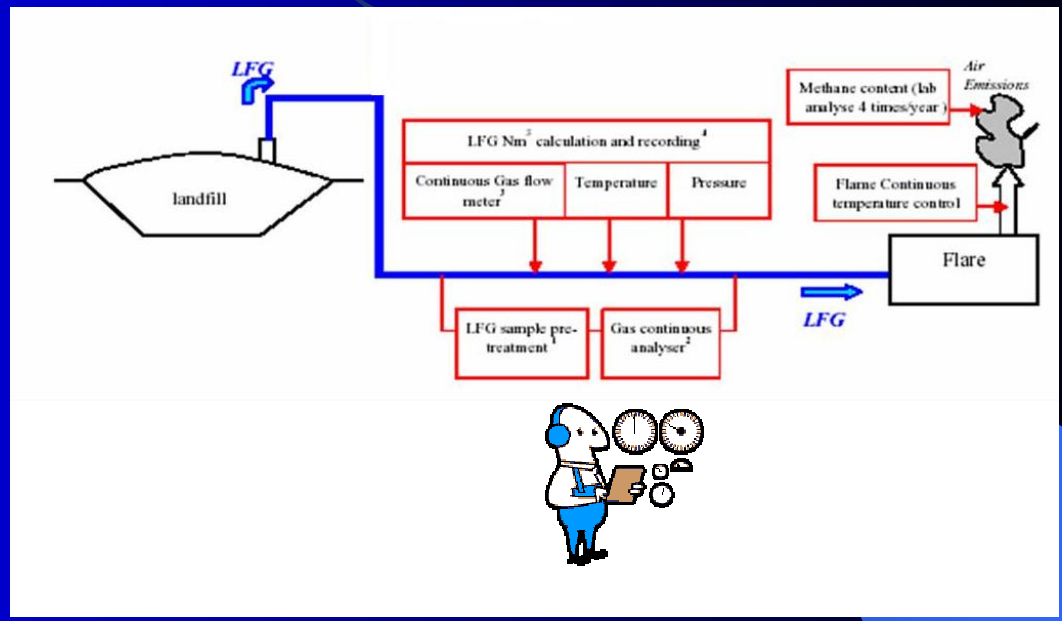
**$EP_y$ Electricity consumption (Kwh/yr)**

# Approved Monitoring Methodology

- Applicability
  - Project activities that reduce green house emissions through landfill gas capture and flaring
  - Baseline established by a public concession contract

# Approved Monitoring Methodology

- **Monitoring emissions from project activity**




  - **Measured**
    - **LFG (c)**
    - **% CH4 in LFG (c)**
    - **Temp. (c)**
    - **Pressure (c)**
    - **SW disposed (d)**
  - **Calculated**
    - **Amount of methane flaring for baseline (a)**
    - **Amount of methane collected in addition to baseline (a)**
    - **$CO_{2e}$ reduced (a)**

**a annual, d daily, c continuous**

# Approved Monitoring Methodology

- **Monitoring Leakage**
  - **Measured**
    - **Continuous monitoring of total electricity used to pump gas (kWh)**
  - **Calculated**
    - **Emissions factor ($CO_2$ / kWh)**

# Approved Monitoring Methodology

- Quality Control / Quality Assurance Procedures
  - Procedure for equipment calibration
  - ISO 9000/14000 certification