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

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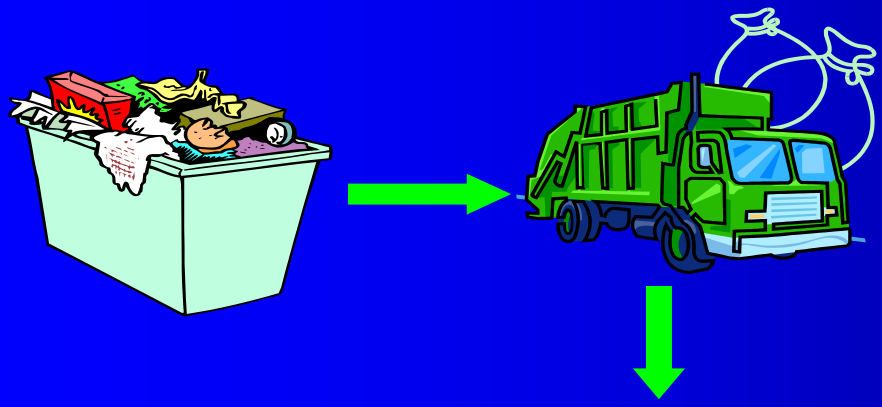
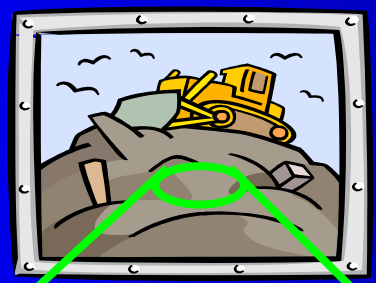
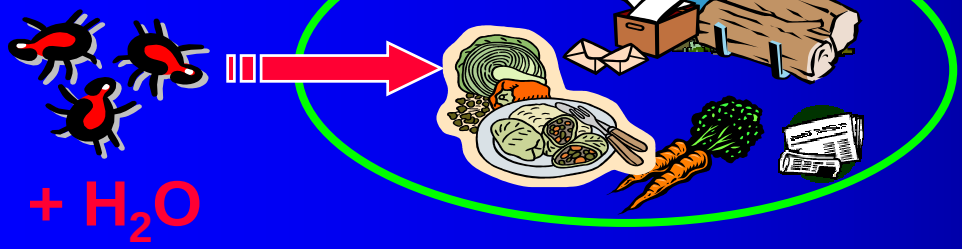
Background







$CO_2 + NH_3 + CH_4$

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

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

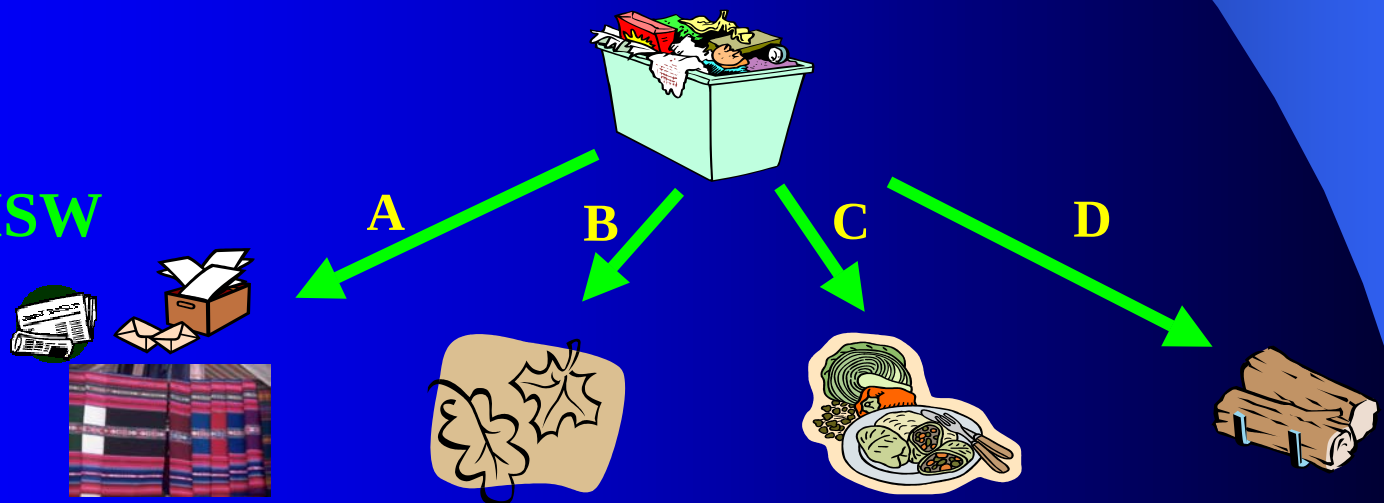
- Methane correction factor (MCF)
  - 1 Managed landfills
  - 0.8 Unmanaged landfills (d>5)
  - 0.4 Unmanaged landfills (d<5)
  - 0.6 Unknown quantity of disposed MSW
- Factors reflect lower methane generating potential for unmanaged sites (less favorable conditions for anaerobic decomposition)

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

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

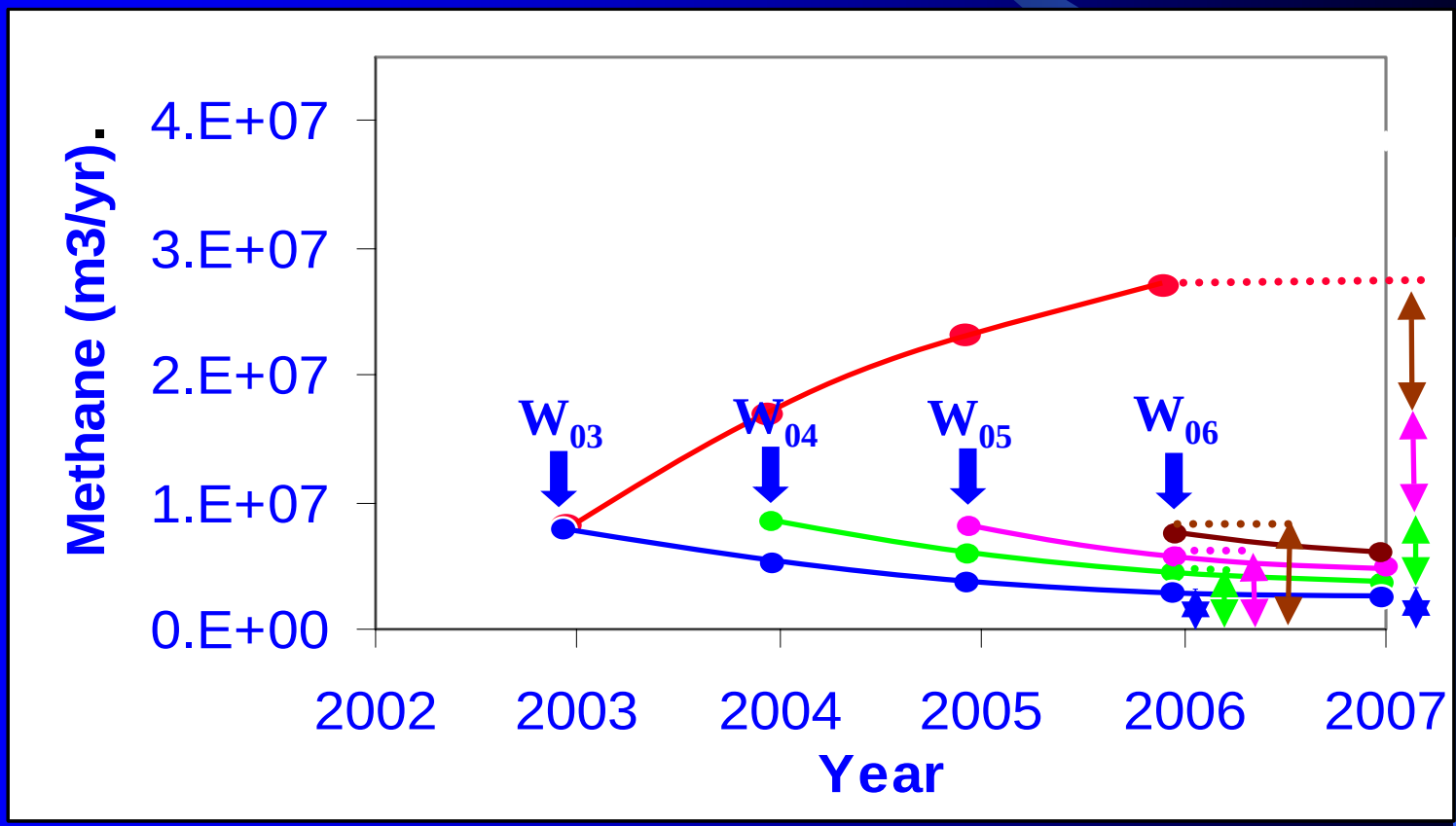
- **Fraction of carbon converted to LFG (DOC_f)**
  - **Function of temperature in anaerobic zone**

$$DOC_f = 0.014T + 0.28$$

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

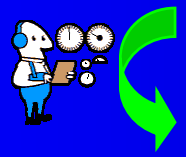
Baseline

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



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

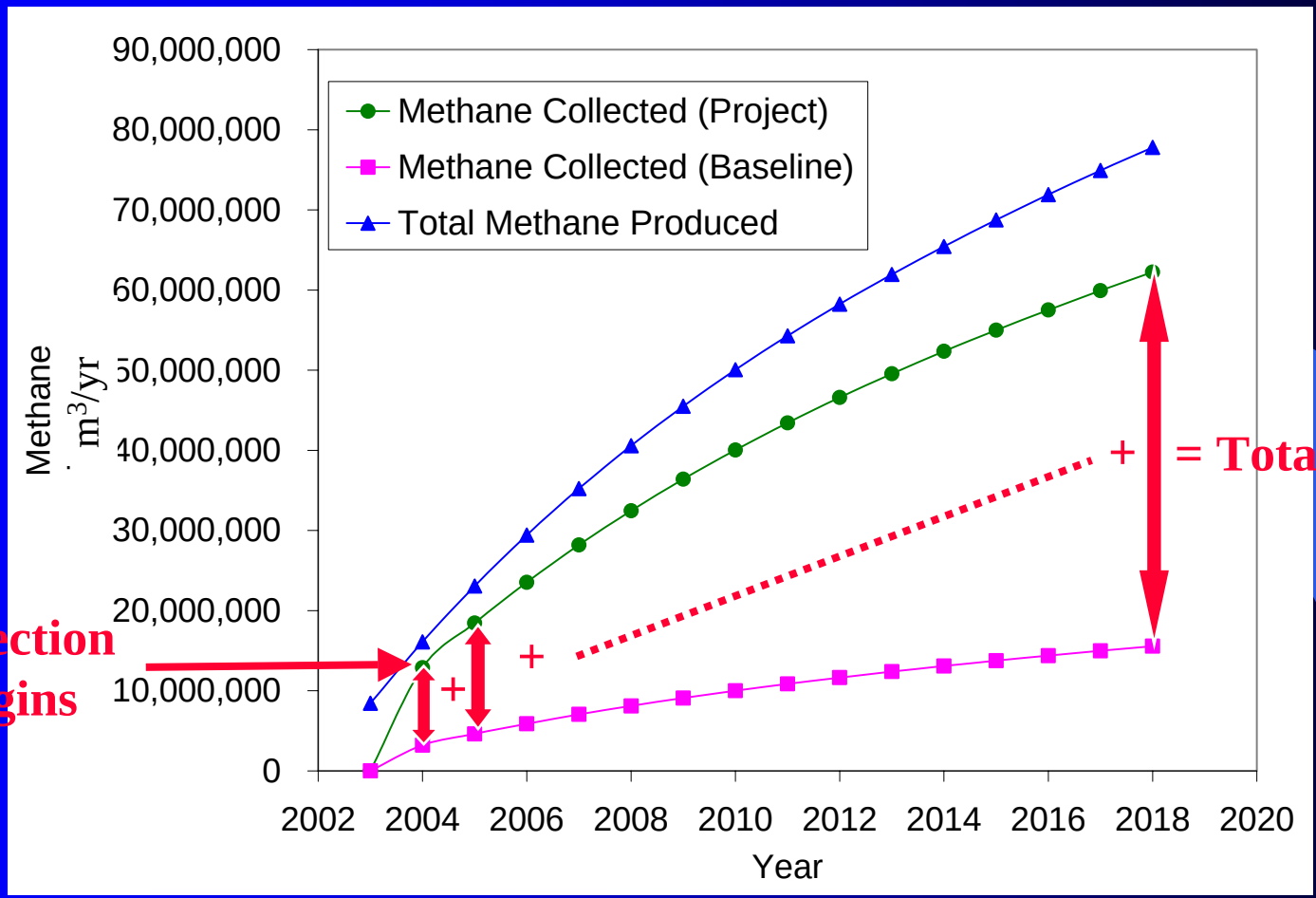
2% annual increase

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

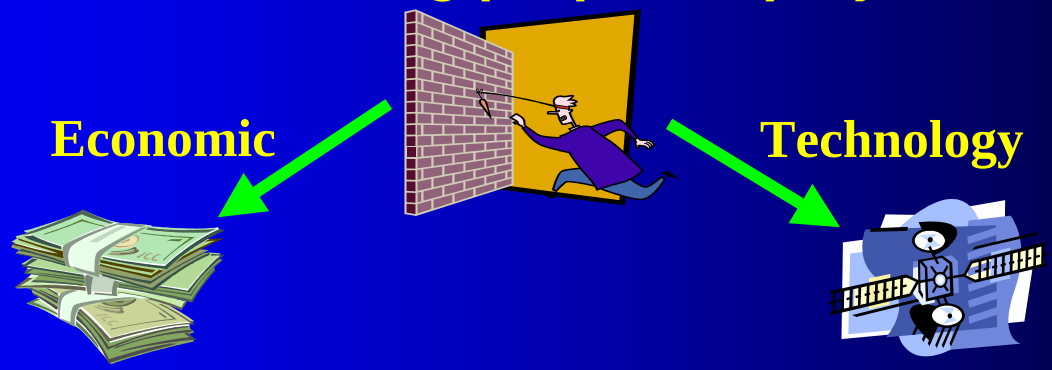


- Assumed Baseline collection efficiency = 20%
- Assumed project collection efficiency = 80%

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



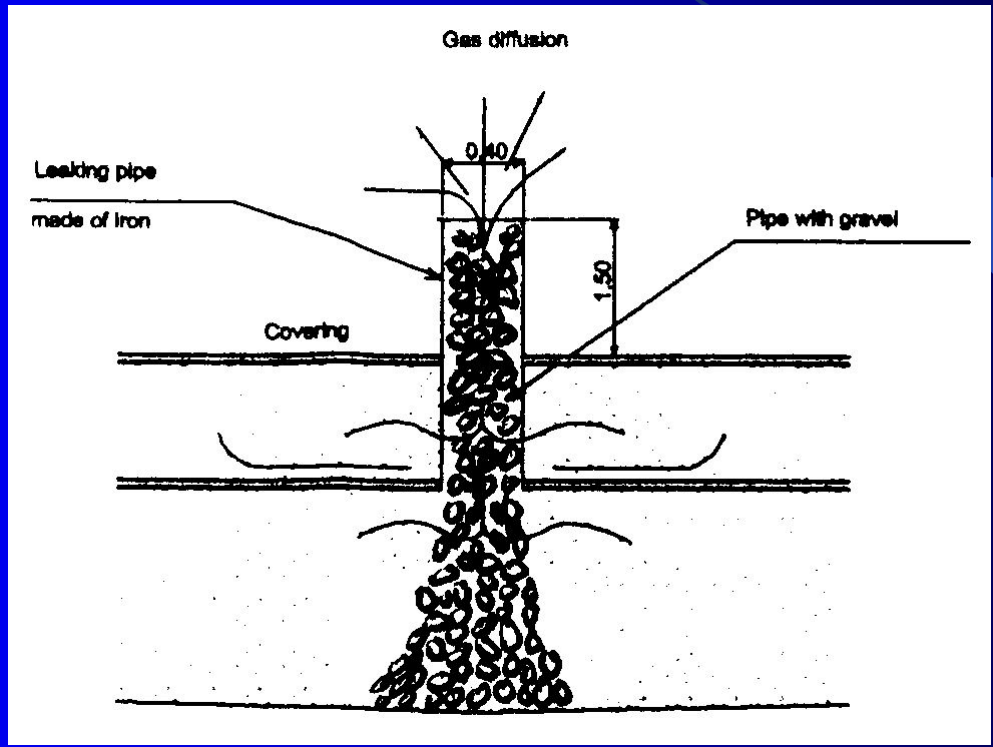
  - An indication that the project type is not common practice in the proposed area of implementation

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

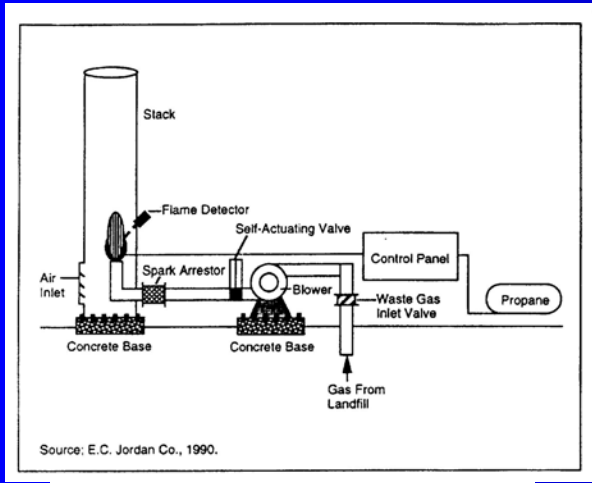
Additionality -- Egyptian Landfill

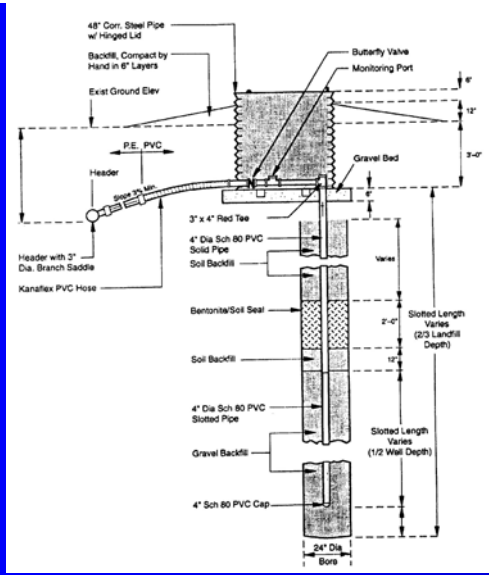
Baseline

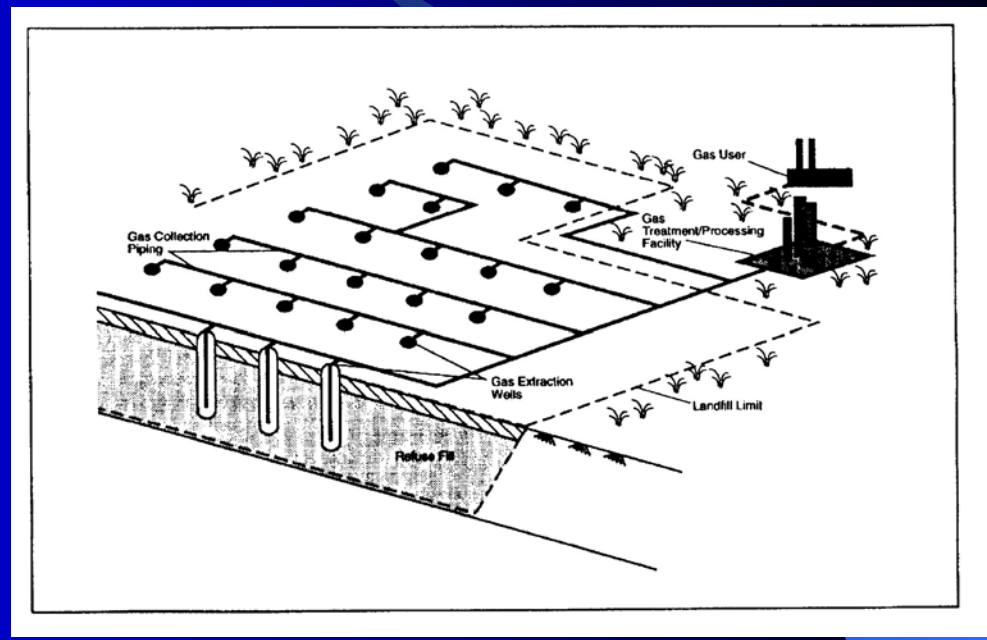


- Passive venting system
- Flaring if CH_4 rate > 20 m^3/hr
- 20% collection efficiency

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)

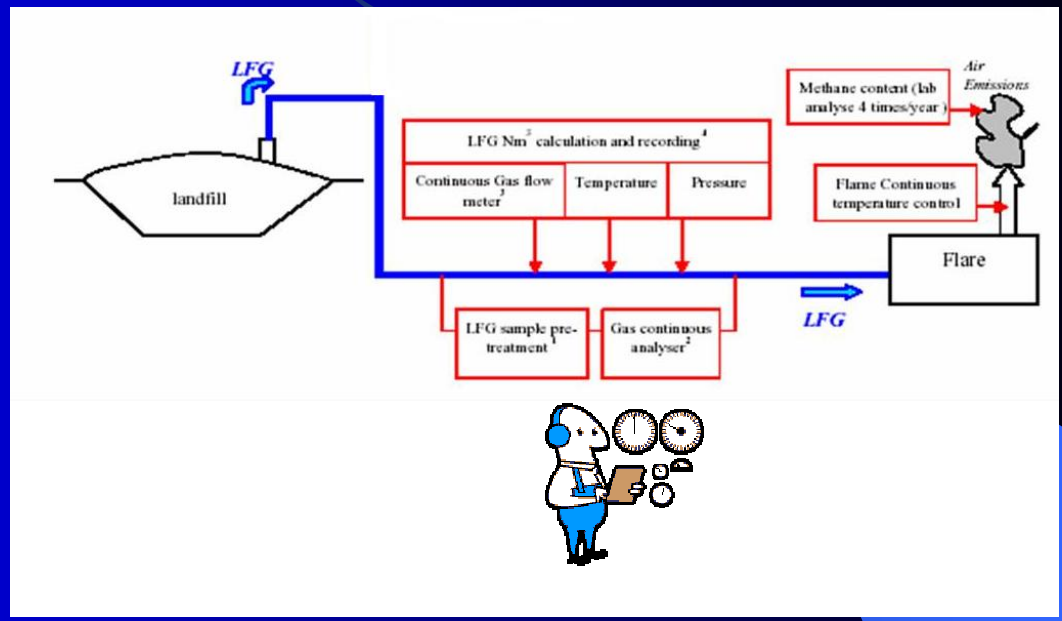
EP_y Electricity consumption (Kwh/yr)

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