BIOREACTOR BENEFITS

PRESENTATION BY

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ANAEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

RAPID ORGANIC WASTE STABILIZATION

(almost complete within 5 to 10 years of initializing bioreactor process)

- **Rapid settlement; mostly complete during landfill operation**
- **Increased gas unit yield, total yield and flow rate during active operational period; mostly occurs during landfill operation**
- **Landfill land use possible during landfill operation; remainder within 5 to 10 years of closure**

ANAEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

MAXIMIZATION OF LANDFILL GAS CAPTURE FOR ENERGY PROJECTS

- **Significantly increased total gas available within relatively short time period (landfill operating period plus 5 to 10 years after closure) for energy use-provides entrepreneurial opportunities**
- **Significant economy of scale advantage and potential increase in total landfill gas extraction efficiency (due to high generation rate enabled over shorter generation period)**
- **Greatly increased greenhouse gas reduction from lessened emission and consequent fossil fuel offsets**
- **Revenues can help defray landfill gas system from otherwise mandated non-funded environmental costs**

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ANAEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

LEACHATE TREATMENT AND DISPOSAL

(almost complete stabilization within 5 to 10 years of initializing bioreactor process)

- **Low cost partial or complete reduction of organic constituents in leachate**
- **Low cost partial removal of some salts and metal by precipitation, chemical transformation, filtration, sorption, etc.**
- **Retention of leachate within landfill available up to field capacity significantly reduces of eliminates off-site transport of leachate for treatment and/or disposal**

AEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

POST-CLOSURE CARE AND MAINTENANCE REDUCTION

(almost complete stabilization of gas and settlement within 1 to 3 years of closure; almost complete stabilization of leachate within 2 to 4 years of closure)

- **After reaching stabilization, minimizes future environmental risk and liability related to gas, settlement and leachate**
- **After reaching stabilization, significant reduction in landfill operation and maintenance activities**
- **After reaching stabilization, significant reduction in landfill monitoring activities**

AEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

RAPID ORGANIC WASTE STABILIZATION

(almost complete within 1 to 3 years of initializing bioreactor process)

- **Rapid settlement; mostly complete during landfill operation**
- **Increased gas unit yield, total yield and flow rate during active operational period; mostly occurs during landfill operation; operated to generate mostly carbon dioxide and little if any methane gas**
- **Landfill land use possible during landfill operation; remainder within 1 to 3 years of closure**

AEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

LEACHATE TREATMENT AND DISPOSAL

(almost complete stabilization within 2 to 4 years of initializing bioreactor process)

- **Low cost partial or complete reduction of organic constituents in leachate**
- **Low cost partial removal of some salts and metal by precipitation, chemical transformation, filtration, sorption, etc.**
- **Retention of leachate within landfill available up to field capacity significantly reduces of eliminates off-site transport of leachate for treatment and/or disposal**

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POTENTIAL GOALS AND BENEFITS

LANDFILL SPACE CAPACITY REUSE AS RESULT OF RAPID SETTLEMENT

- During operational period allows the placement of more tonnage into the permitted landfill airspace
- During operational period allows significant increase in landfill life; this leads to defraying capital cost of acquiring new landfill during the life extension period
- Significant increase in realized waste disposal revenues as result of additional waste placed during the extended landfill life

ANAEROBIC BIOREACTOR LANDFILL
POTENTIAL GOALS AND BENEFITS

POST-CLOSURE CARE AND MAINTENANCE REDUCTION

(almost complete stabilization of gas and settlement within 5 to 10 years of closure; almost complete stabilization of leachate within 3 to 5 years of closure)

- **After reaching stabilization, minimizes future environmental risk and liability related to gas, settlement and leachate**
- **After reaching stabilization, significant reduction in landfill operation and maintenance activities**
- **After reaching stabilization, significant reduction in landfill monitoring activities.**

LANDFILL GAS GENERATION FROM MUNICIPAL SOLID WASTE

MSW Organic	Wet Weight	Biodegradability	Gas Generation	Biodegradation Time of LFG Generation
	% of MSW		% (Barlaz)	yrs
Food	9	fast	9 to 12	1 to 5
Vegetation	19	fast to moderate	9 to 11	1 to 80
Paper	33	moderate	71 to 76	5 to 80
Subtotal	**61**			
Wood	7	slow	5 to 6	5 to >100
Subtotal	**7**			
Plastic		refractory		
Rubber	5	refractory		
Textiles	3	refractory		
Subtotal	**15**			
TOTAL	**83**			

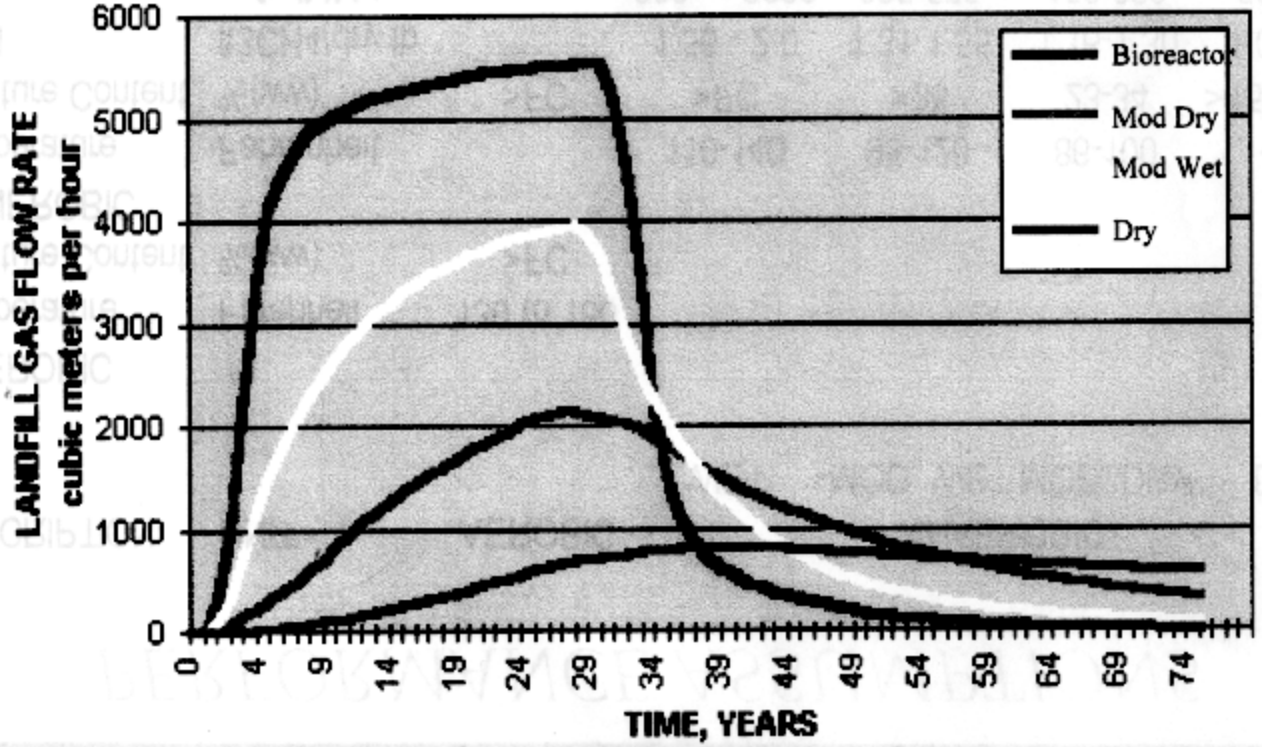
PERFORMANCE RESULTS

DESCRIPTION	UNIT	ANAEROBIC			
		WET	MOD.WET	MOD.DRY	DRY
LFG Yield					
Food	ft3CH4/dry lb	0.18	0.13	0.11	0.09
Vegetation	ft3CH4/dry lb	0.41	0.32	0.25	0.21
Paper	ft3CH4/dry lb	1.41	1.07	0.86	0.73
Other	ft3CH4/dry lb	0.03	0.02	0.02	0.02
Total	ft3CH4/dry lb	2.03	1.54	1.24	1.05
Rapid	ft3CH4/dry lb	0.33	0.24	0.20	0.17
Moderate	ft3CH4/dry lb	1.60	1.23	0.98	0.83
Slow	ft3CH4/dry lb	0.10	0.07	0.06	0.05
Total	ft3CH4/dry lb	2.03	1.54	1.24	1.05
LFG Energy	ft3CH4/dry lb				
Total Yield	%	100	75	61	52
Energy Project	%	100		40	

PERFORMANCE ASSUMPTIONS

DESCRIPTION	UNIT	AEROBIC	ANAEROBIC			
			WET	MOD. WET	MOD. DRY	DRY
LFG						
AEROBIC						
Temperature	Farenheit	130 to 150				
Moisture Content	%(ww)	>FC				
ANEROBIC						
Temperature	Fahrenheit		110-140	95-120	86-100	<86
Moisture Content	%(ww)	>FC	>FC	>35	23-34	>15 to <22
Yield	ft3CH4/dry lb		1.56 - 2.0	1.31-1.55	1.16-1.30	1.0-1.15
Rate	scfm/MM tons		600 - >3000	325-575	150-320	50-145
Stabilization Time	yrs	1 to 2	5 to 10	15-25	30-45	>50
Waste settlement	%	22-27	20-25	15-19	14-10	<10

LANDFILL GAS GENERATION VS TIME



POTENTIAL ENERGY PROJECT