

Cheaper Than Real-Cost Landfilling

G. Fred Lee, PhD, PE, DEE & Anne Jones-Lee, PhD

G. Fred Lee & Associates

El Macero, CA

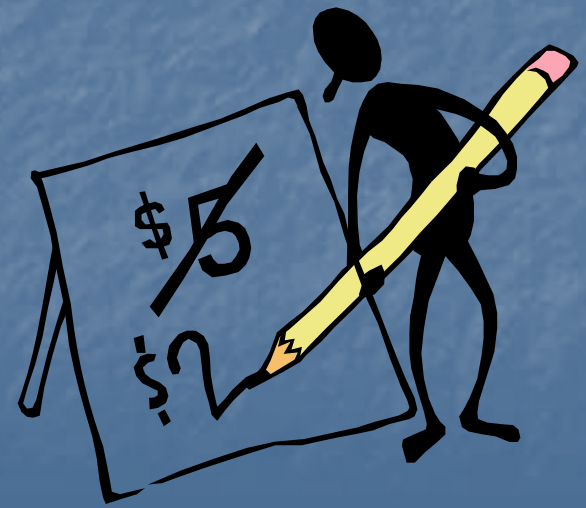
ph: 530-753-9630

gfredlee@aol.com  www.gfredlee.com

Topics

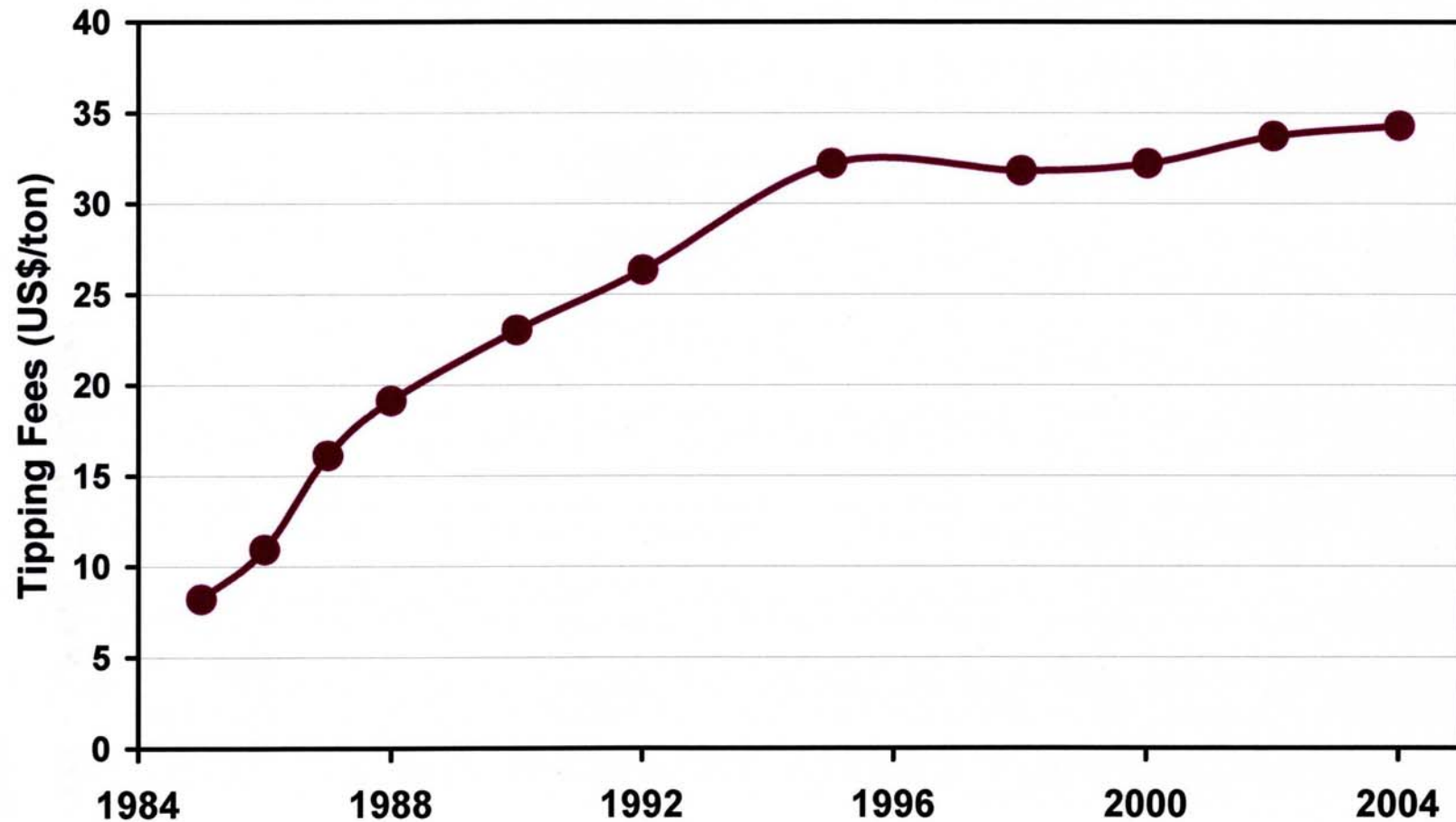
Aspects of MSW Landfilling Done
for Less-Than-Real Costs

*Prepared for presentation to Northern California Recycling
Association (NCRA) meeting, Oakland, CA, March 27 (2007)*



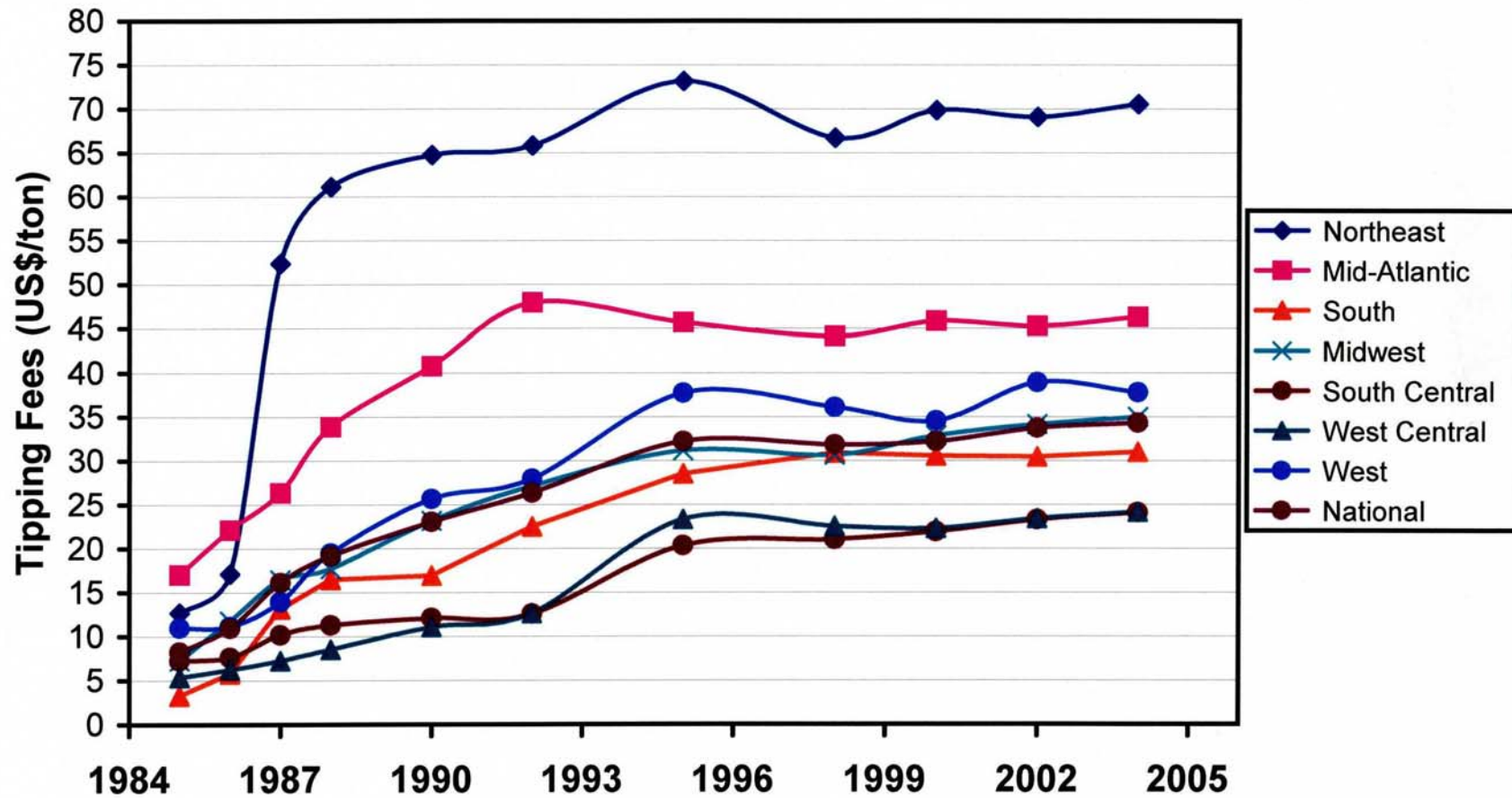
US National Tipping Fees (US\$/ton)

Source: Repa, E., "NSWMA's 2005 Tip Fee Survey," NSWMA (National Solid Wastes Management Association) Research Bulletin 05-3, Washington, D.C., March (2005).

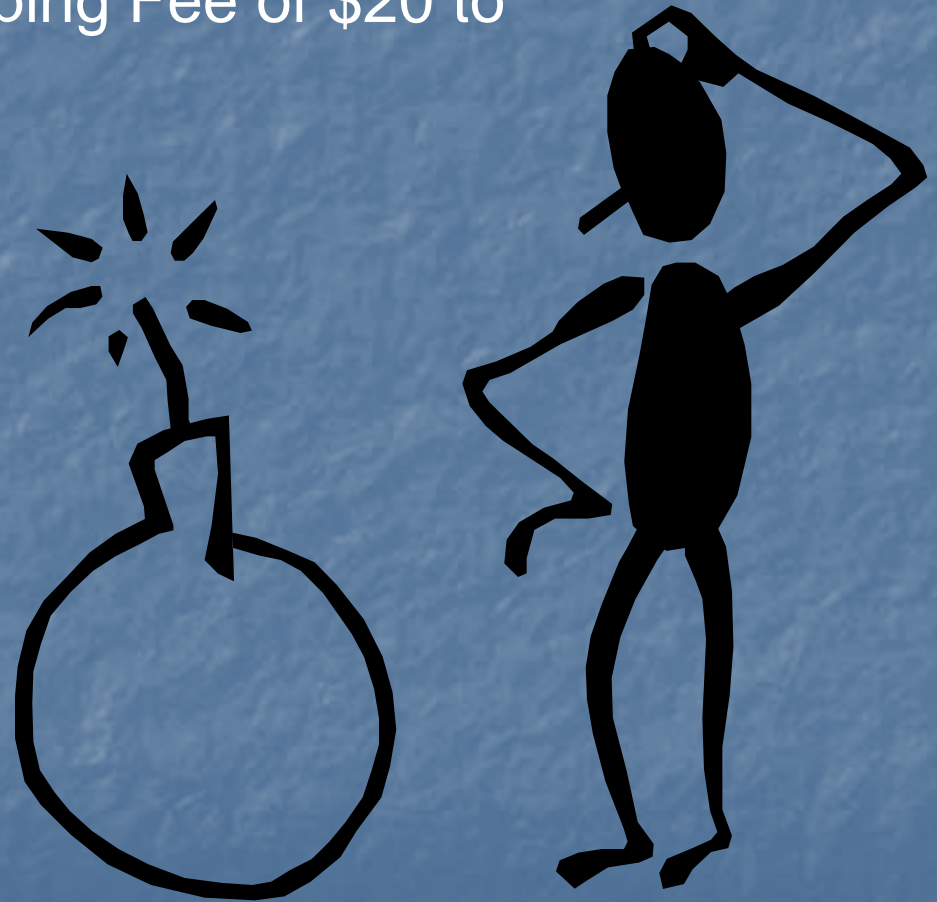


US Tipping Fees by Region (US\$/ton)

Source: Repa, E., "NSWMA's 2005 Tip Fee Survey," NSWMA (National Solid Wastes Management Association) Research Bulletin 05-3, Washington, D.C., March (2005).



- Cannot Site, Construct, Operate, Close, & Provide Postclosure Monitoring and Maintenance for Protective Landfill with Tipping Fee of \$20 to \$50/ton
- Leads to Inadequately Developed Landfills
- Not Protective of
 - Public Health
 - Groundwater Resources
 - Interests of Those in Sphere of Influence of Landfill



Real Cost of Landfilling: ~ \$100/ton

- Issues Not Addressed in Current US EPA Minimum Subtitle D Landfilling
 - Active-Life Impacts
 - Releases of Waste-Derived Chemicals & Components during Period of Waste Deposition
 - Postclosure Impacts
 - Releases after Landfill Is Closed



Active-Life Impacts

- Justified NIMBY Issues
 - Releases of Waste-Derived Components Adverse to Those in Sphere of Influence of Landfill
 - Current Landfilling Regulations Allow Landfilling Essentially to Landfill Property Line
 - Trespass of Airborne Chemical Releases to Adjacent Properties
 - Nearby Property Owners/Users Adversely Impacted by Airborne Landfill Emissions
 - Odors (Health Threat; Nuisance)
 - Landfill Gas (Methane – Explosive; Greenhouse Gases)
 - Hazardous Chemicals (Health Threat)



MSW

- Contains Myriad Hazardous & Deleterious Chemicals
- Threat to Human Health & Environment

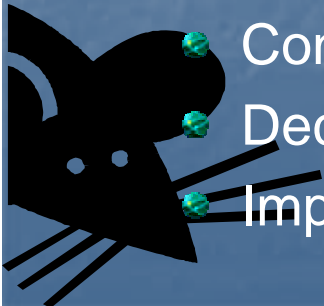


NIMBY Issues

Adverse Impacts of “Dry Tomb” Landfills on Owners/Users of Adjacent/Nearby Property

[from Lee et al. (1994) and Lee and Jones-Lee (2007)]

- Public Health, Economic & Aesthetic Aspects of Groundwater & Surface Water Quality
- Methane and VOC Migration – Public Health Hazards, Explosions, Toxicity to Animals and Plants
- Illegal Roadside Dumping & Litter near landfill
- Truck Traffic
- Noise
- Dust & Wind-Blown Litter
- Odors
- Vectors, Insects, Rodents, Birds
- Condemnation of Adjacent Property for Future Land Uses
- Decrease in Property Values
- Impaired View



Health Impact Studies

- Known for Years – Greater Incidence of Illness Among Those near Landfills & Other Hazardous Chemical Sites
- Epidemiology Needs Large Populations to Reliably Define Relationship between Potential Source & Those Potentially Impacted
- Two Large-Population Studies:



Health Impacts of Landfills

- Elliott, P.; Briggs, D.; Morris, S.; de Hoogh, C.; Hurt, C.; Jensen, T.; Maitland, I.; Richardson, S.; Wakefield, J.; Jarup, L., “Risk of Adverse Birth Outcomes in Populations Living near Landfill Sites,” *British Medical Journal* **323**:363-368, August (2001).
- Kouznetsova, M.; Huang, X.; Ma, J.; Lessner, L. and Carpenter, D., “Increased Rate of Hospitalization for Diabetes and Residential Proximity of Hazardous Waste Sites,” *Environmental Health Perspectives* **115**(1):75-79, January (2007).

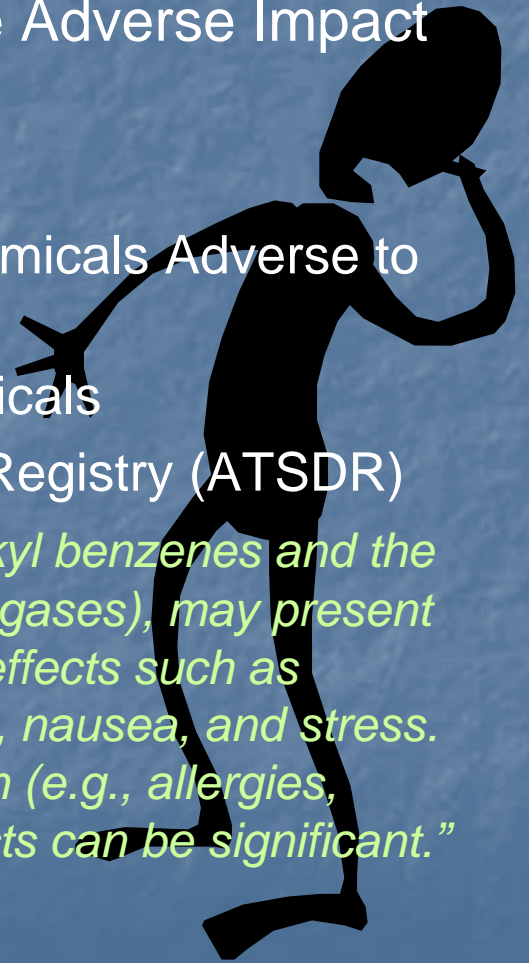
Also:

- “Association between Hazardous Chemical Sites and Illness,” Report of G. Fred Lee & Associates, El Macero, CA, January (2007). This review is available at:
<http://www.members.aol.com/annejlee/HazChemSites-Illness.pdf>.

Odors Can Be Detected Several Miles from Some Landfills

- If Landfill Odor Detected, It's Likely to Have Adverse Impact on Health of Nearby Property Users
- Landfill Odors – More Than “Nuisance”
 - Landfill Odors Due to “Non-Hazardous” Chemicals Adverse to Health of Some Individuals
 - Odors Can Be Indicator of Hazardous chemicals
 - Agency for Toxic Substances and Disease Registry (ATSDR)

“Many of the typical landfill gases, notably the alkyl benzenes and the sulfur compounds (both organosulfides and acid gases), may present an odor problem that can cause adverse health effects such as mucous membrane irritation, respiratory irritation, nausea, and stress. If an individual has a pre-existing health condition (e.g., allergies, respiratory illness), these additional health impacts can be significant.”



Controlling Landfill Odors

- Absence of Odors Does Not Mean That No Health Effects Are Occurring
- Require Landfill Developers to Acquire Sufficient Buffer Lands to Enable Dissipation/Control of Odors on Landfill-Owner's Property
 - Should Be **No Trespass** of Landfill Odors across Property Line
 - Will Typically Require Buffer of Several Miles of Landfill-Owner-Owned Land between Deposition Area & Adjacent Property Line
 - In Some Landfill Settings, May Require Greater Amount of Buffer Land
 - e.g., Landfills in Valleys; Account for Inversions, etc.
 - Do Not Allow Use of Odor-Masking Agents to Hide Odors
 - Does Not Address Problems



Buffer Lands

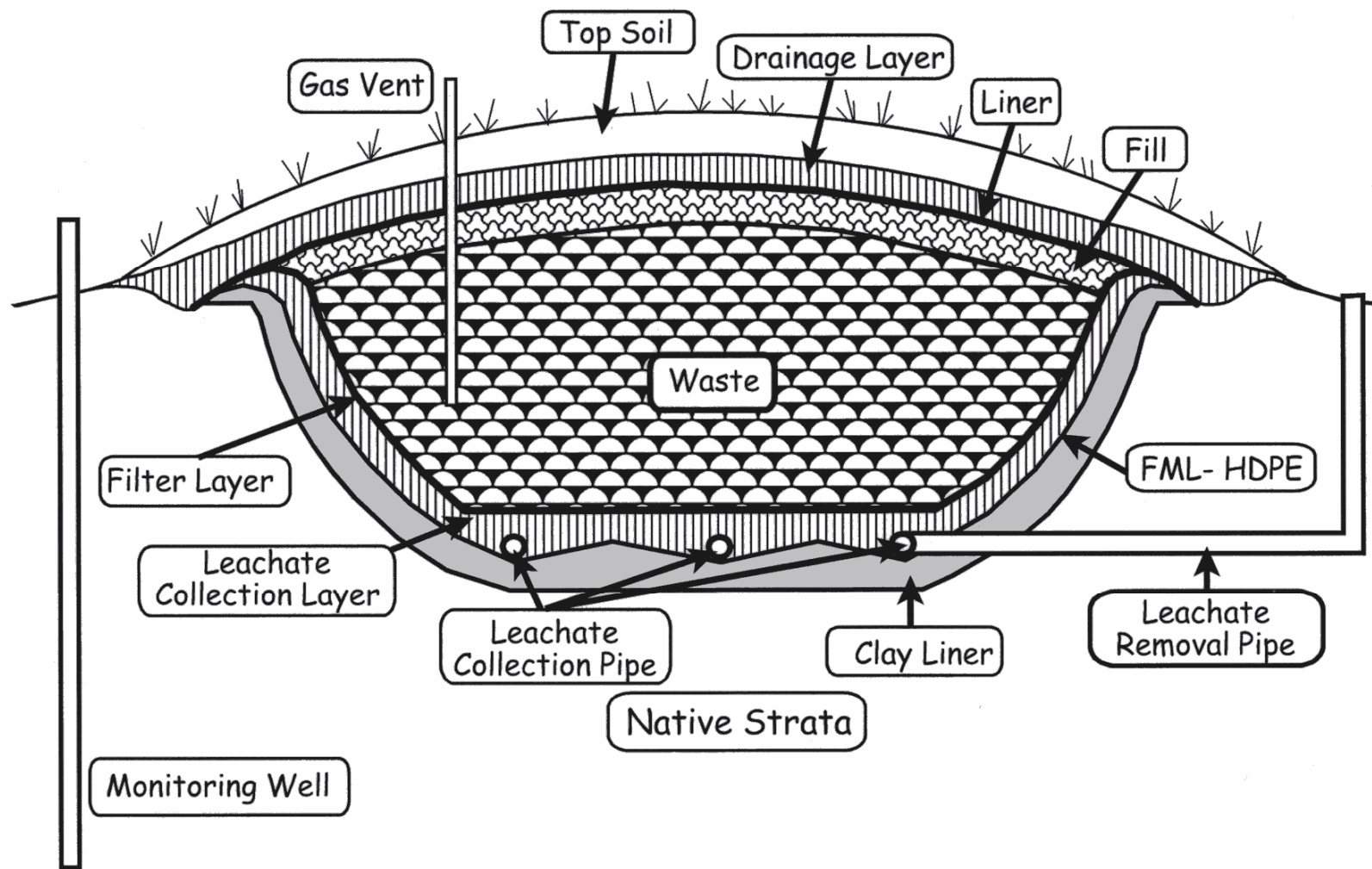
- Adequate Buffer Lands Would Help Address Justified NIMBY
- Cost of Adequate Landfill-Owned Buffer Land is Part of True Cost of Landfilling



Groundwater Quality Protection

- Minimum-Design Subtitle D Landfill with Single Composite Liner Will Eventually Pollute Groundwater with Landfill Leachate
 - Will Lead to Need for “Superfund”-Like Remediation
 - Lost Groundwater Resources
 - Threat to Health of People, Animals, Other Uses
 - Can Extend for a Mile or More from Landfill
- “Flawed Technology of Subtitle D Landfilling of Municipal Solid Waste,” Report of G. Fred Lee & Associates, El Macero, CA, December (2004). Updated January (2007). Available on Internet at:
<http://www.members.aol.com/apple27298/SubtitleDFlawedTechnPap.pdf>

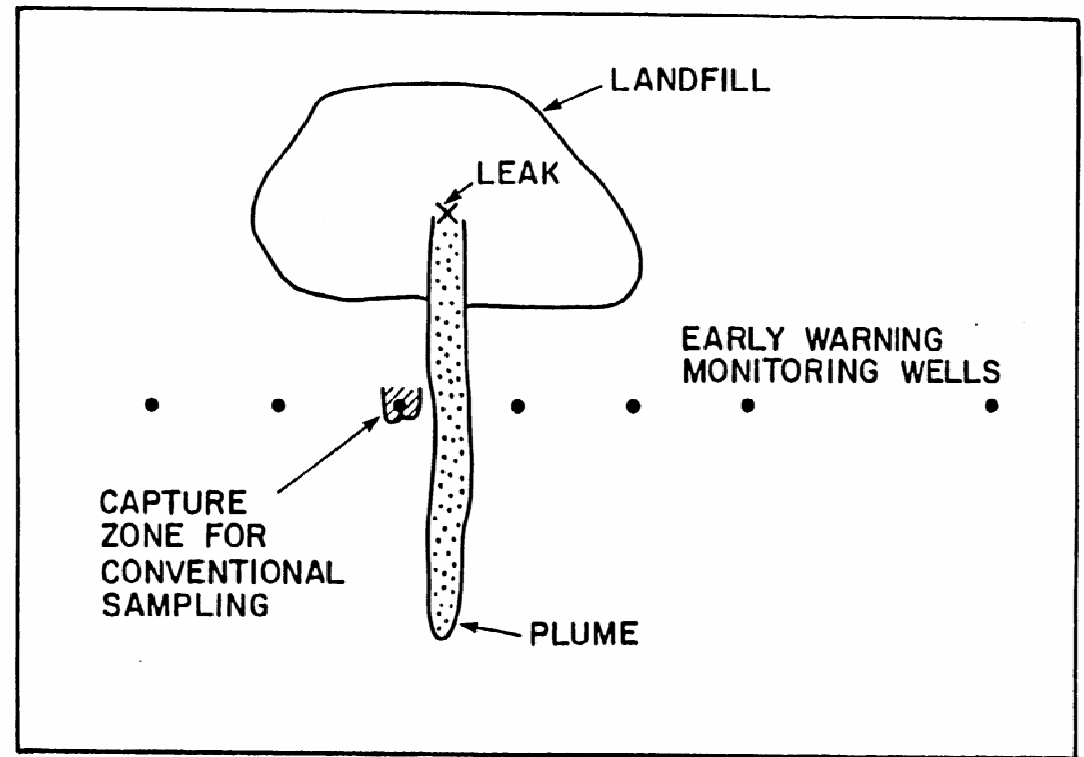
Single-Composite-Lined Landfill Schematic » **Flawed Technology**



Leakage from Plastic-Lined Landfills

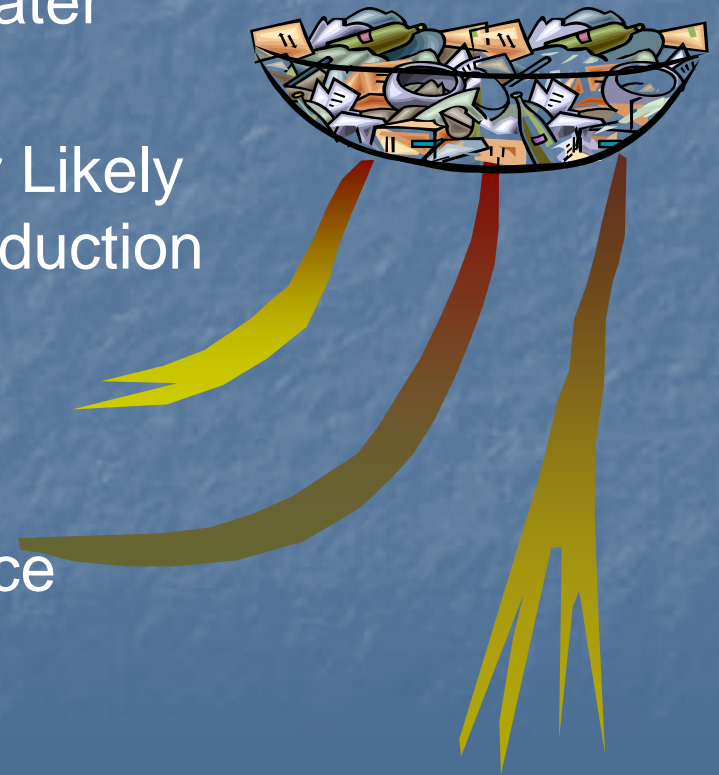
(after Cherry, 1990)

- Initial Leakage Expected from “Finger Plumes”
Originating from Tears, Holes, Other Imperfections in Liner
- Zone on Capture of Typical Monitoring Wells – a Few Feet
- Typical Monitoring Well Spacing too Great to Be Relied upon to Intercept Finger Plumes



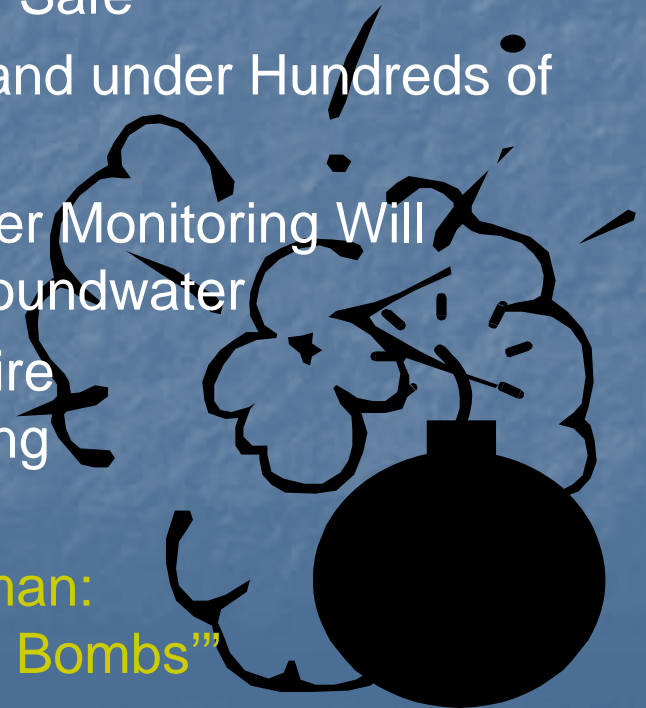
Unreliable Groundwater Pollution Detection

- Typically Allowed Approach:
 - Can Not Be Relied upon for Detection of When Leachate-Polluted Groundwater Reaches Point of Compliance
 - Leachate-Pollution of Groundwater Likely to Be First Detected in Off-Site Production Wells
 - Vertical Monitoring Wells Spaced Hundreds of Feet Apart at Point of Groundwater Monitoring Compliance

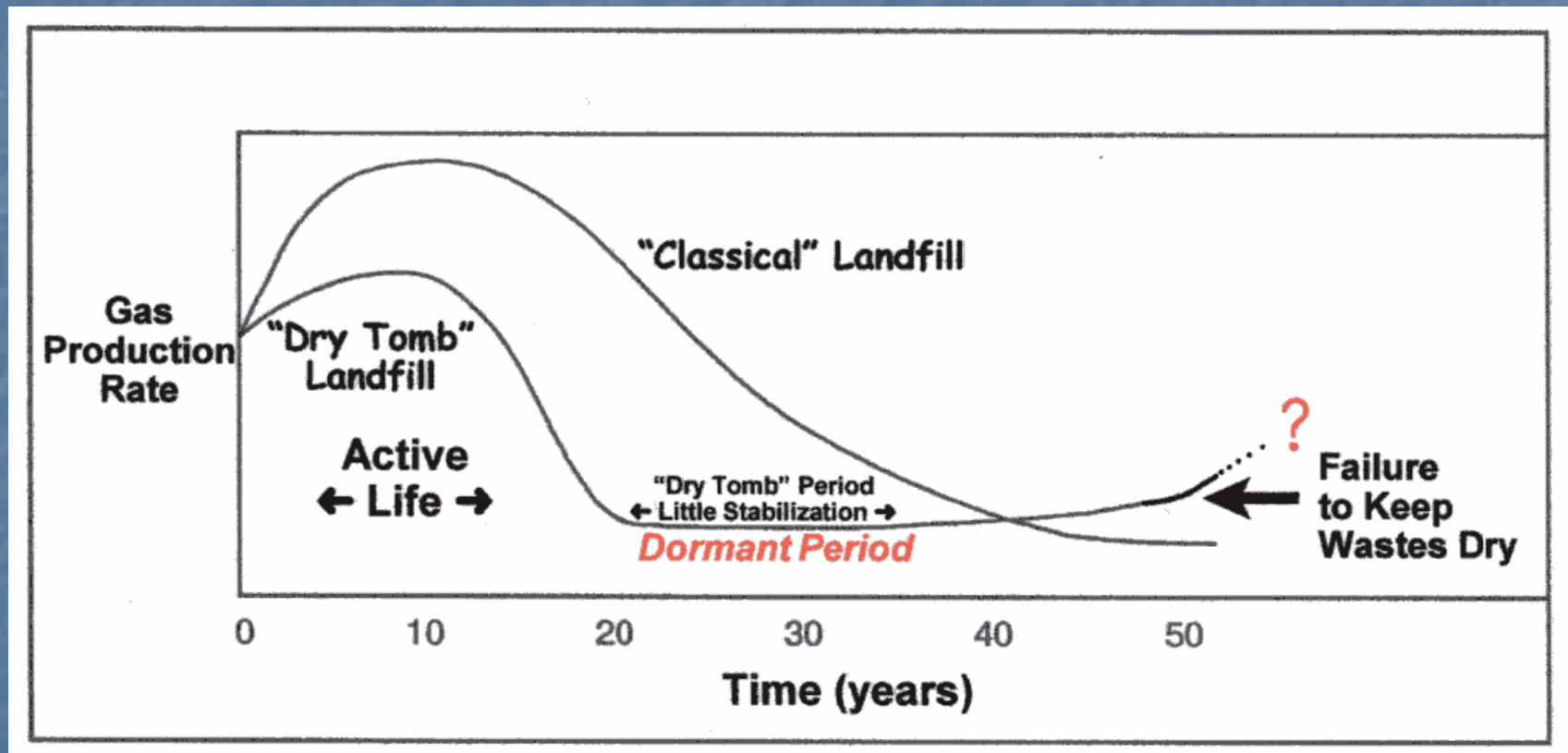


Key Problems with “Dry Tomb” Landfilling

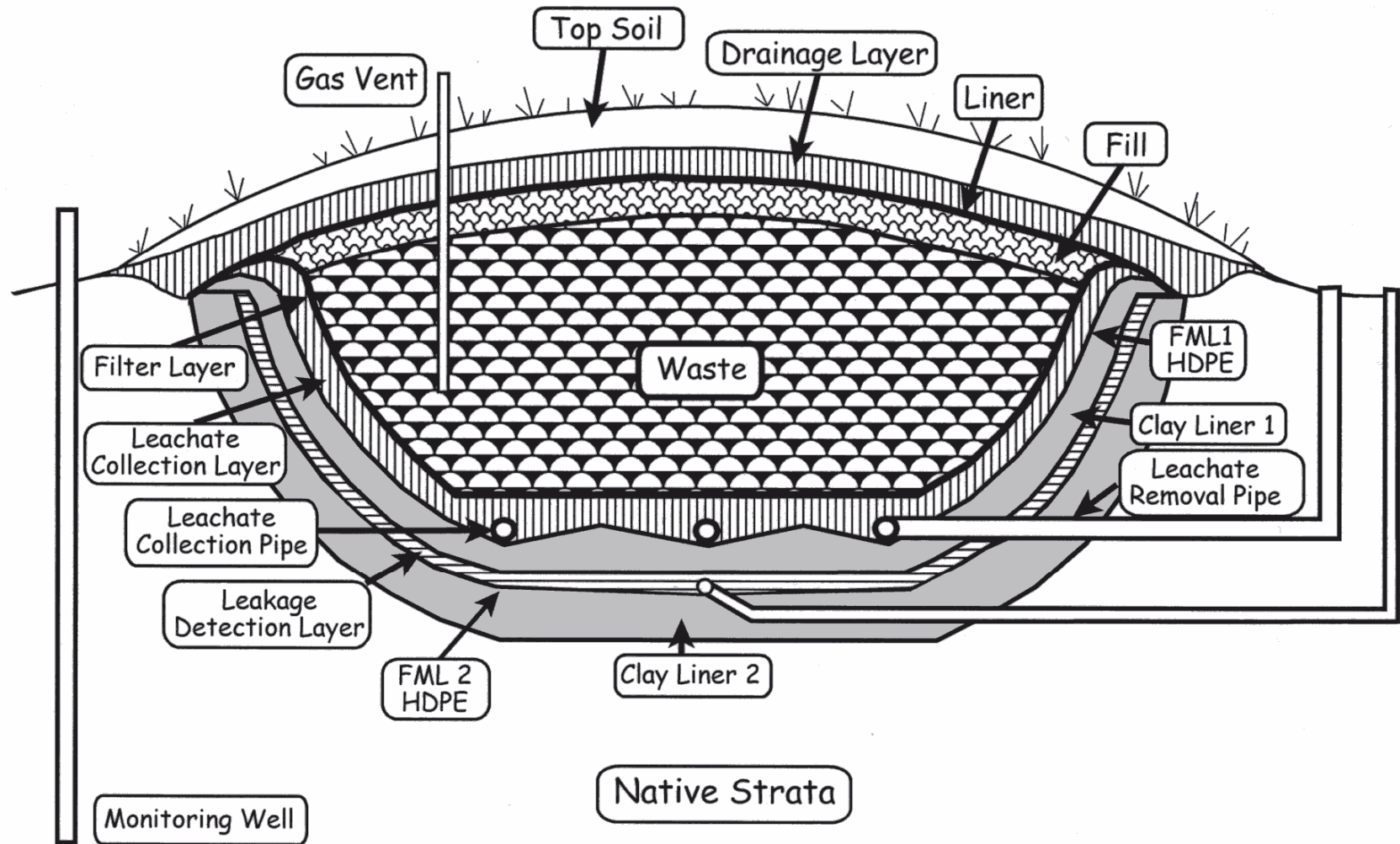
- Integrity Relies on Keeping Wastes Dry Forever
- Presumes Wastes “Detoxify” and Become “Non-Deleterious” within Decades While Buried & Dry
 - With Little or No Landfill Gas & Leachate Generation, Landfill Becomes “Dormant”
 - Not Synonymous with “Innocuous” or “Safe”
- Presumes Systems Buried under Cover and under Hundreds of Feet of Garbage Will Not Deteriorate
- Presumes That Conventional Groundwater Monitoring Will Detect Incipient Leachate Pollution of Groundwater
- US EPA & Many States Currently Require Only 30 yrs of Limited Postclosure Funding
 - Groundwater Quality Problems Likely Not Manifested for Decades -- Hickman: “Dry Tomb Landfills Are ‘Ticking Time Bombs’”



Comparison of Pattern of Landfill Gas Generation over Time: Classical Sanitary Landfill vs “Dry Tomb” Landfill



Double-Composite-Lined Landfill Schematic

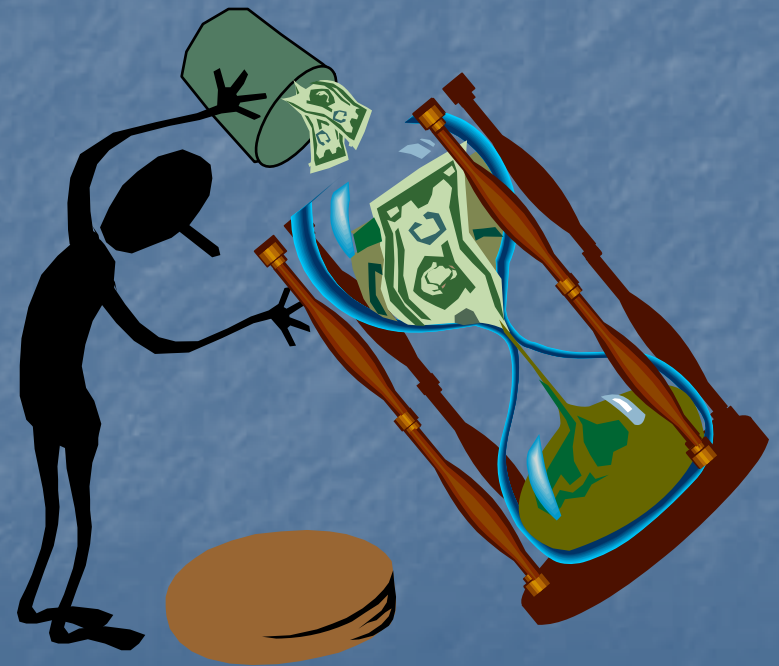


Elements of Improved Landfill Design

- **Double-Composite Liner with Leak Detection Layer**
 - Leak Detection Layer under Upper Composite Liner
 - Used in at Least 6 States
 - Enables Detection of Failure of Upper Composite Liner
- **Control Landfill Cover Failure** That Allows Water to Enter Landfill and Generate Leachate & Landfill Gas
 - Maintain/Repair Cover to Stop Leachate Generation
- **Postclosure Funding Needed Forever** to
 - Monitor Leachate Generation
 - Maintain Leachate Collection System
 - Repair Cover

Postclosure Funding

- Adequate, Reliable Postclosure Funding Is Part of True Cost of Landfilling of MSW
- Beginning:
 - Begins after Closure of Landfill – Cessation of MSW Deposition
- Duration:
 - Lasts for as Long as Wastes Will Be a Threat
 - Forever, With Today's "Dry Tomb" Approach



Assurance of Adequate Postclosure Funding

- US EPA & Most States
 - Not Provided Mechanism to Ensure Adequate Postclosure Funding for as Long as Wastes in Landfill Will Be Threat
- CA Integrated Waste Management Board Currently Working to Develop Adequate Postclosure Funding
- Lee, G. F. and Jones-Lee, A., “Comments on the CIWMB Staff Efforts to Gain Assured Postclosure Funding for Landfills for as Long as the Wastes in the Landfill Are a Threat to Public Health and the Environment,” Comments Submitted to California Integrated Waste Management Board by G. Fred Lee & Associates, El Macero, CA, January (2007).

<http://www.members.aol.com/annejlee/CIWMBPostCloseFund.pdf>

Funding of Post-Closure Care

- Should Be Part of Cost of Landfilling
- Should Be Paid by Those Who Generate the Wastes Placed in the Landfill
- Dedicated Trust Fund of Sufficient Magnitude to Generate Sufficient Funds Needed for Monitoring and Maintenance for as Long as the Wastes in the Landfill Are a Threat
 - Threat Exists as Long as Adding Water to Wastes Leads to Landfill Gas and/or Leachate



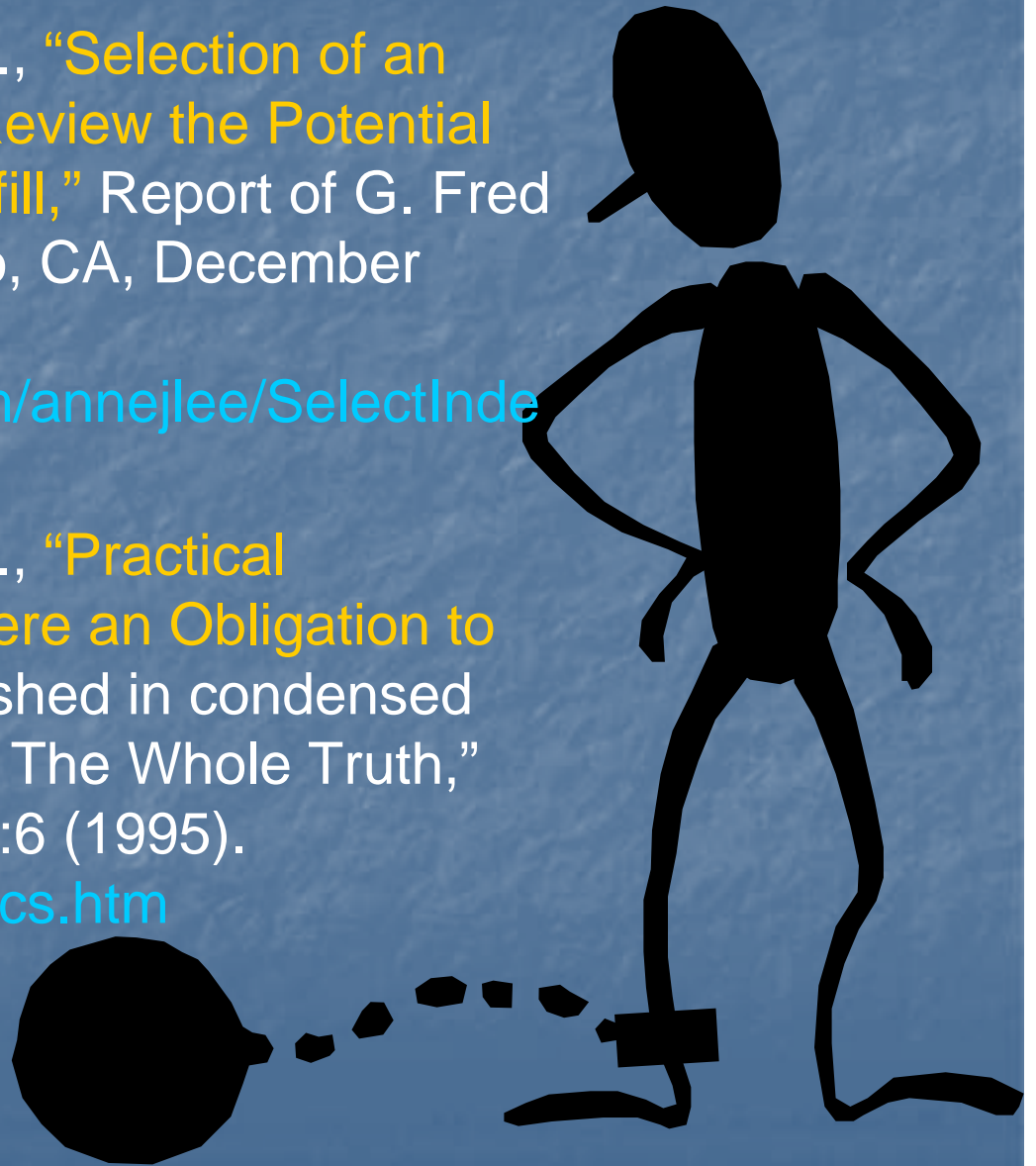
Ethics in Landfill Development

- Lee, G. F. and Jones-Lee, A., “Selection of an Independent Consultant to Review the Potential Impacts of a Proposed Landfill,” Report of G. Fred Lee & Associates, El Macero, CA, December (2006).

<http://www.members.aol.com/annejlee/SelectIndependentConsult.pdf>

- Lee, G. F. and Jones-Lee, A., “Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?” Published in condensed form “Environmental Ethics: The Whole Truth,” *Civil Engineering*, Forum, 65:6 (1995).

<http://www.gfredlee.com/ethics.htm>





Reduce

3 R's

Reuse

Recycle

Overall Findings

- Adoption of This Approach  Those Who Generate the Wastes Pay True Cost for Waste Management by Landfilling
- Increased Tipping Fees Will Increase Potential for Greater Waste Reduction, Reuse & Recycling  Reduce Need for Landfilling
 - More Cost-Competitive “3 R’s”

- Proper Siting, Design, Operation, Closure, Postclosure Care for as Long as Waste Will Be a Threat:

Doubles to Triples Cost of Landfilling of MSW

- Paying True Cost of Landfilling Up Front Promotes 3 Rs & Aids in
 - Conservation of Natural Resources
 - Protection of Human Health & the Environment
 - Addressing Justify NIMBY Concerns



Further Information
Consult Website of
Drs. G. Fred Lee and Anne Jones-Lee



<http://www.gfredlee.com>