Improving the Quality of Science/Engineering in Superfund Site Investigation & Remediation II

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TAG Advisor

DOE/UCD LEHR Superfund Site, Davis, CA

Lava Cap Mine Superfund Site, Nevada City, CA

Constraints

- Regulatory Agency Staff Constraints in Superfund Site Investigation/Remediation
  - Workload/Funding
  - Interpretation of Minimum Guidance
  - Academic Background & Experience in All Relevant Areas
  - Political Pressure
- Constraints Lead to Less-Than-Optimum Site Investigation & Remediation

Participation in First National TAG Meeting

At the Nashville National TAG Meeting, Discussed:

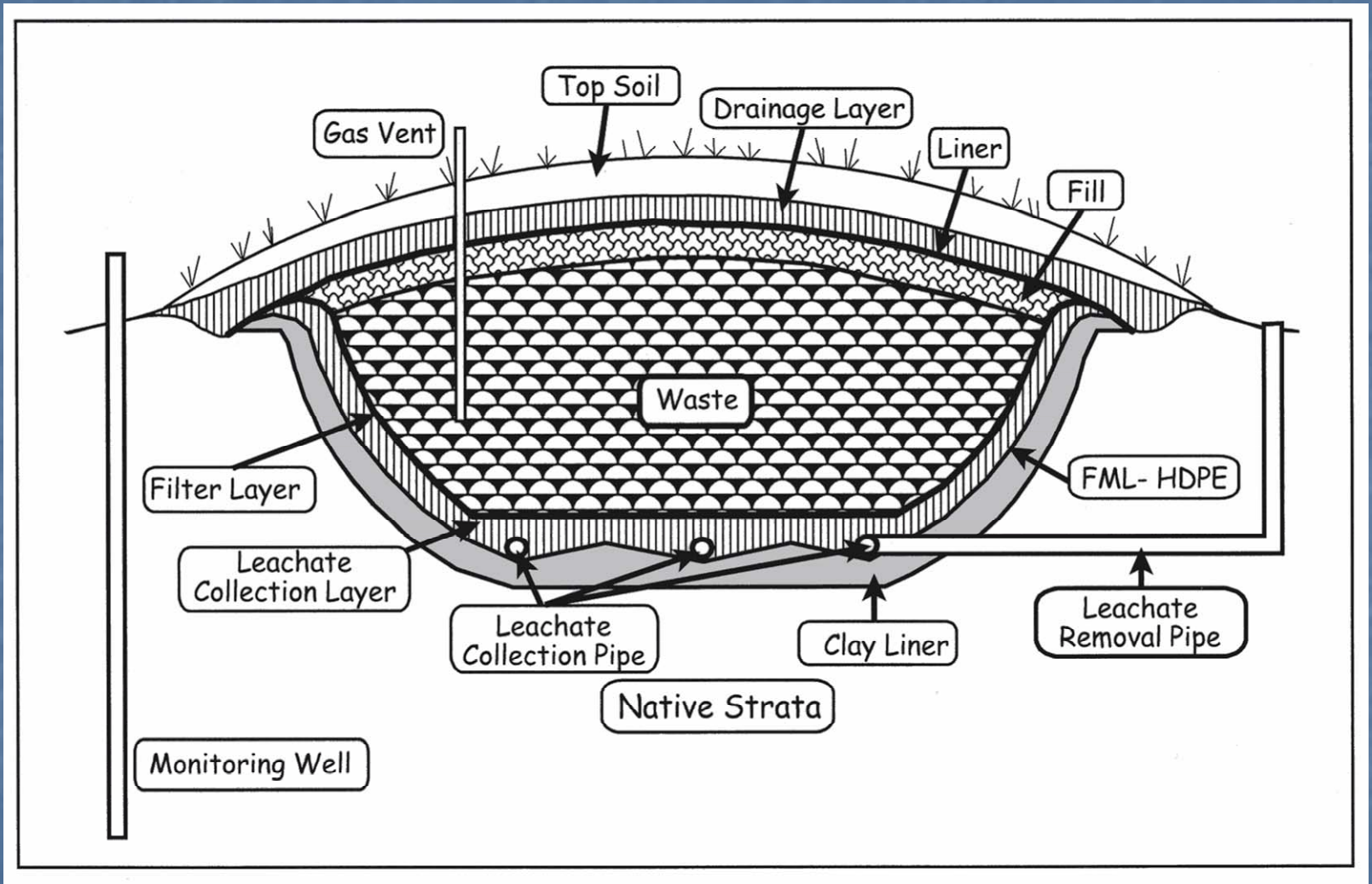
- Inadequacies in Definition of Constituents of Concern
- Inadequacies in Consideration of "Non-Hazardous" Chemicals
- Deficiencies in Stormwater Runoff Monitoring
- Failure to Address Translocation of Pollutants from Subsurface Soils to Surface through Vegetation
- Unreliability of Vadose Zone Modeling
- Inadequacies in Evaluation of Extent of Groundwater Pollution
- Inadequacies in Long-Term Groundwater Monitoring
- Problems with Reliability of Data Reports
- Site Remediation by On-Site Landfilling

Expand on Discussion of Problems with On-Site Landfilling as a Site Remediation Approach

G. Fred Lee's Background for Discussion of Problems of Using On-Site Landfills as Superfund Site Remediation Approach

- BA, San Jose State College, Environmental Health Sciences, 1955
- Master of Science in Public Health, University of North Carolina, 1957
- PhD, Harvard University, Environmental Engineering, 1960
- Expertise in Aquatic Chemistry, Water Quality, Public Health, Environmental Engineering
- 30 Years of University Graduate-Level Environmental Engineering Teaching & Research at Several US Universities
  - Conducted >$5million in Research on Landfill Liners
  - Published 850 Professional Papers & Reports
- Full-Time Consultant for >13 yrs
  - Investigated >20 Superfund/Hazardous Chemical Sites
  - Investigated Impacts of >75 Landfills

Single-Composite-Lined Landfill



Issue
Inability of Minimum Subtitle D Landfills to Protect Public Health & Environment for as Long as Landfilled Wastes Are a Threat

Liner Integrity

Key to Waste Containment Is Ability of HDPE Liner to Prevent Leachate Migration through It for as Long as the Wastes in Landfill Are Threat

US EPA Stated, as Part of Developing Subtitle D Regulations (Federal Register, August 1988)

"First, even the best liner and leachate collection system will ultimately fail due to natural deterioration, and recent improvements in MSWLF (municipal solid waste landfill) containment technologies suggest that releases may be delayed by many decades at some landfills."

Liner Integrity

US EPA Criteria for Municipal Solid Waste Landfills (US EPA, 1988) Stated:

> *"Once the unit is closed, the bottom layer of the landfill will deteriorate over time and, consequently, will not prevent leachate transport out of the unit."*

US EPA (2002) Propaganda:

- Municipal Solid Waste Will Only Be a Threat for 200 Years
- High Density Polyethylene Liners Effective for 1000 yrs

US EPA Analysis of Duration of Threat in Error

- **Some Waste Components Will Be a Threat Forever**
- **Assessment of Effectiveness of HDPE Liners Based on Inappropriate Extrapolation Using Arrhenius Equation**

Bottom Line:

1. **A Single Composite Liner Will Eventually Fail, Leading to Groundwater Pollution**

2. **Duration of Effective Protection Provided by Liner Depends on *Quality of Design* and, Especially, *Construction***

Geosynthetic Liners as Substitute for 2 ft of Clay

- Clay Liner: Thin Layer of Bentonite Clay Sandwiched between Matting Material
  - Low Advective Permeability
  - Low Structural Strength
    - Subject to Failure if Not Properly Constructed
  - Diffusion through Bentonite Layer Is Rapid

HDPE Permeation

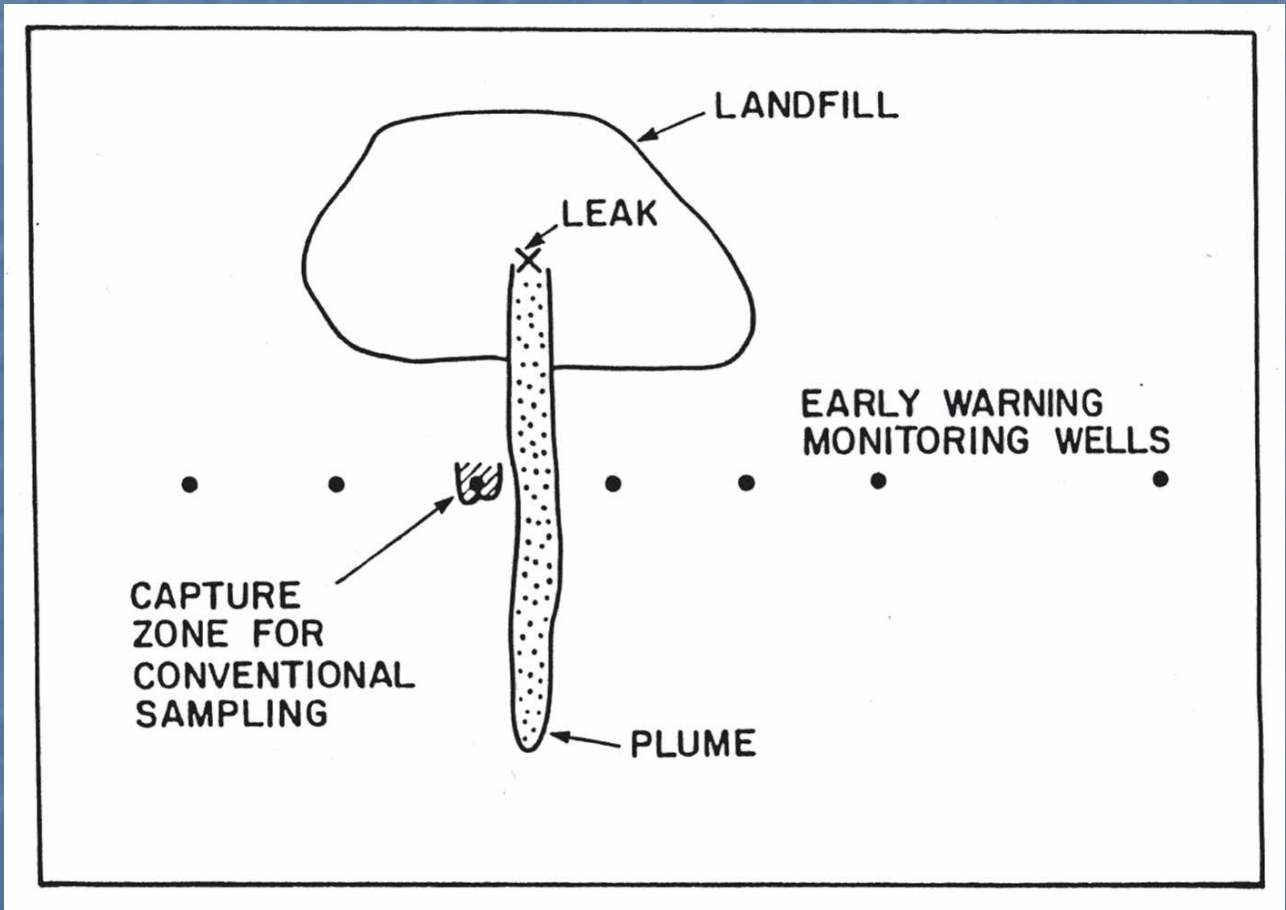
- **Solvents Pass through HDPE Rapidly**
  - Dilute Solvent Solutions Dissolve into HDPE and Pass through It in a Few Days
  - Well-Documented But Regulatory Agencies Ignore Permeation of Solvents through HDPE Liners

Issue:
Reliability of Groundwater Monitoring

- While US EPA Recognizes Eventual Failure of the Liner, It Assumes That Failure Will Be Detected with High Degree of Reliability at Point of Compliance for Groundwater Monitoring
  - Point of Compliance Must Be < 150 m from Edge of Waste Disposal
- Typical Landfill Monitoring Approach: Place Monitoring Wells **Hundreds of Feet Apart** along Line at Point of Compliance – **BUT:**
  - Each Well Captures Water Only from within **~1 ft** of Well
  - Initial Liner Failure Will Produce Finger-Like Plumes of Groundwater Pollution, Which, at Point of Compliance, Could Be ☯ **10 – 20 ft** Wide

Pattern of Landfill Leakage – Groundwater Contamination from Lined Landfills

(after Cherry, 1990)



Reliability of Groundwater Monitoring

- Initial Liner Leakage Would Not Likely Be Detected by Typical Groundwater Monitoring Approach
  - Current Groundwater Monitoring Largely Cosmetic & Fundamentally Flawed
  - Groundwater Pollution Will Be "Detected" by Off-Site Production Wells
- As Part of Permitting, Landfill Advocates Should Be Required to Demonstrate Capability of Proposed Groundwater Monitoring System to Detect Groundwater Pollution by Landfill-Derived Waste Constituents When Pollution First Reaches Point of Compliance for Groundwater Monitoring
- Groundwater Pollution Monitoring Should Be Based on Use of Double Composite Liner
  - With Leak Detection System between the Two Composite Liners
  - Approach Used by State of Michigan & 8 Other States

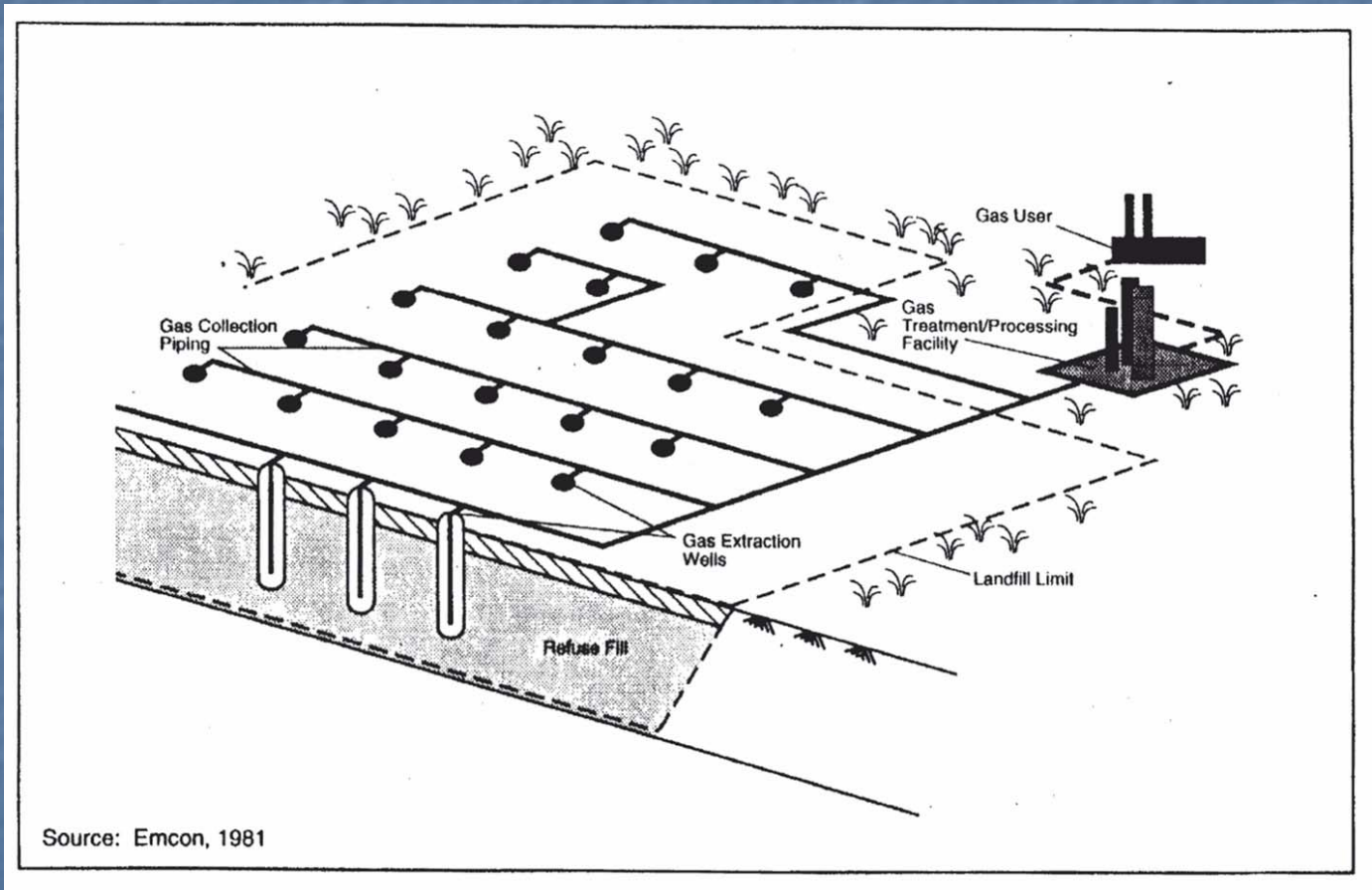
Single Composite Liner

- Proponents of Single Composite Liners Claim No Evidence That Single-Composite-Lined Landfills Have Failed
  - Misleading & Distorted
  - Time Too Short
    - Can Take 25 yrs for Leachate to Get through Clay Layer
    - Groundwater Monitoring Unreliable for Detecting Failure

Issue:
Leachate Removal

- **Keep the Head (Depth of Leachate) above the Liner as Low as Possible**
  - Reduces Rate of Leakage
- **Leachate Removal Systems Tend to Plug**
  - Increases Head on the Liner
- **Leachate Treatment and Disposal Must Be Done in Manner to Protect Public Health & Environment**
  - Typical Approach – Disposal in Publicly Owned Treatment Works (POTW)
    - Often "Disposal by Dilution"
    - May Not Be Protective

Example of an Interior Gas Collection/Recovery System



Issue:
Landfill Gas Releases

- Typical Approach for Collection of Landfill Gas Collects Only Part of the Gas
- Long-Term Problems with Operation & Maintenance of Gas Collection Systems

Classification of Wastes "Hazardous" vs. "Non-Hazardous"

- Current US EPA & State Waste Classification System Allows Large Amounts of Hazardous Chemicals in "Non-Hazardous" Waste Landfills
- Classification Approach Based on Limiting Magnitude of Hazardous Waste Stream That Has to Be Managed as "Hazardous Waste"
- Leaching Tests, Such as TCLP, Not Reliable for Waste Classification
- Must Also Consider Impact of So-Called "Non-Hazardous" Chemicals on Water Quality
  - e.g., Total Salts, Taste & Odor Compounds Can Cause Abandonment of Water Supply Well

Issue: Landfill Cover

- Purpose of Landfill Cover – Keep Wastes Dry
  - If No Water Infiltration into Waste, No Leachate Generation & No Pollution of Groundwater
- Subtitle C & D Landfill Covers (If Properly Designed & Constructed) Can Keep Initial Infiltration Close to Zero
  - Over Time, Cover's Low Permeability Properties Deteriorate
  - Cannot Inspect Low-Permeability Layer in Cover
- Use Leak-Detectable Covers
  - Not Used Because No Regulatory Support
  - Require Operation & Maintenance of Leak Detection System Forever

Issue:
Landfill Siting

- US EPA Allows Siting (Locating) Landfills at Geologically Unsuitable Sites
  - Underlying Geological Strata Do Not Provide Natural Protection
    - Sand & Gravel – High Permeability
    - Fractured Rock, Clay Layers, Limestone – Impossible to Monitor
    - Sandy Lenses – Pathways for Rapid Migration
  - Areas Having High Groundwater Table

Inadequate Funding for Closure & Post-Closure Care

- Key to Providing Long-Term Protection of Public Health & Environment Is Adequate Funding for Operation & Maintenance of Closed Landfill for as Long as the Wastes Are Threat
  - 30-yr Post-Closure Care Funding Inadequate for Proper Maintenance during Mandatory Post-Closure Care Period
  - No Assurance That Funding Will Be Available after That Period
  - Need Post-Closure Care Funding Forever
  - Who Will Fund Monitoring & Maintenance, & Provide Groundwater Remediation for as Long as the Wastes in the Landfill Are Threat?

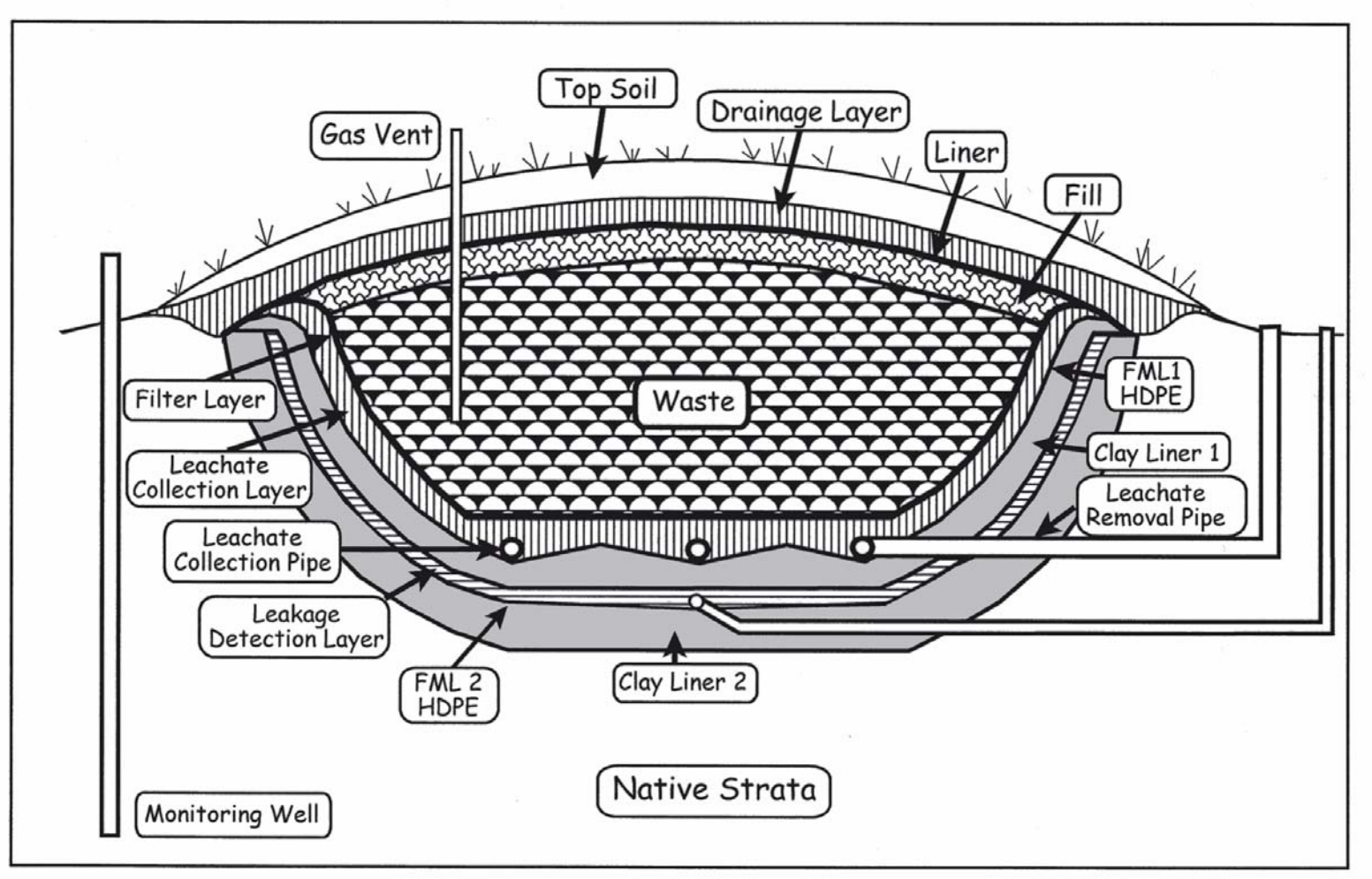
Inadequate Funding for Closure & Post-Closure Care

- Should Require
  - Plausible Worst-Case Failure Evaluation as Part of Landfill Permitting
  - Establishment of Dedicated Trust Fund That Will Be Available for as Long as the Wastes Are Threat
  - Dedicated Trust Fund of Sufficient Magnitude to Address All Plausible Worst-Case Failure Scenarios at Landfill

Effectiveness of US EPA's Periodic 5-yr Review

This Review Will Not Be Effective in Detecting Incipient Failure of Landfill Liner or Cover in Subtitle D Landfills

Double-Composite-Lined Landfill



What Can Be Done to Improve Superfund Site Landfill Waste Disposal?

Understand & Act on Deficiencies in Landfill Waste Containment Systems

- Siting – Natural Protection
- Design – Double Composite Liner with Leak Detection
- Closure – Leak-Detectable Cover
- Monitoring – Double Composite Liner
- Maintenance of Cover
  - Leak-Detectable Cover
  - Require Adequate Funding for Operation & Maintenance
- Funding – Provide for Plausible Worst-Case Failure for as Long as Wastes Are Threat

What Can Be Done to Improve Superfund Site Landfill Waste Disposal?

Restrict Land-Use within Sphere of Influence of Landfill

- Keep People Out of the Area
  - At Least 3-mi Buffer between Waste Disposal Areas & Adjacent Properties
    - Buffer Land Should Be Owned & Maintained by Landfill Owner
- Prevent Water Supply Wells:

For Landfills in:	No Production Wells within:
Homogeneous, Well-Defined Aquifer System	3 miles of Landfilled Wastes
Fractured Rock or Cavernous Limestone	5 miles of Landfilled Wastes

What Can Be Done to Improve Superfund Site Landfill Waste Disposal?

- For Existing Production Wells within Sphere of Influence of Landfill:
  - Provide Highly Reliable, Quarterly Monitoring of Groundwater Quality *ad infinitum*
  - Monitoring Funded by Landfill Owner
  - Monitoring Conducted and Reviewed by Independent, Third Party

Issue: Professional Ethics

- Problems with Subtitle D Landfills Well-Known in Landfill Community
  - Not Discussed by Professionals Who Depend on Future Landfill Development Work for Income
  - Need to Change the Permitting of Landfills from Current Adversarial Approach to Public Interactive, Peer Review Approach

Landfill and Related Publications of G. Fred Lee and Anne Jones-Lee

Lee, G. F., and Jones-Lee, A., "Evaluation of the Adequacy of Hazardous Chemical Site Remediation by Landfilling," IN: Remediation Engineering of Contaminated Soils, Marcel Dekker, Inc., New York, pp. 193-215 (2000).

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Lee, G. F., "Solid Waste Management: USA Lined Landfilling Reliability," Invited Submission for Publication in *Natural Resources Forum*, a United Nations Journal, New York, NY, Dec (2002).

Lee, G. F., and Jones-Lee, A., "Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches," Proc. Air & Waste Mgt. Assn. 91st Annual Meeting, San Diego, CA (Available on CD ROM as paper 98-WA71.04(A46), 40 pp. June (1998).

Lee, G. F., and Jones-Lee, A., "Deficiencies in Subtitle D Landfill Liner Failure and Groundwater Pollution Monitoring," Presented at NWQMC National Conference, "Monitoring: Critical Foundations to Protect Our Waters," US EPA, Washington, DC, July (1998).

Lee, G. F., and Jones-Lee, A., "Deficiencies in US EPA Subtitle D Landfills in Protecting Groundwater Quality for as Long as MSW Is a Threat: Recommended Alternative Approaches," Report of G. Fred Lee & Associates, El Macero, CA (1997).

Lee, G. F., and Jones-Lee, A., "Does Meeting Cleanup Standards Mean Protection of Public Health and the Environment?" IN: Superfund XV Conference Proceedings, Hazardous Materials Control Resources Institute, Rockville, MD, pp. 531-540 (1994).

Further Information

Consult Website of
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http://www.gfredlee.com

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EnviroQual

Publications on:

- Landfills-Groundwater
- Surface Water Quality
- Hazardous Chemical Sites
- Contaminated Sediment
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- Stormwater Newsletter

EnviroQual Surface and Groundwater Quality Evaluation and Management

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