

**Presentation to the Pottstown Landfill Closure
Committee**

**Pottstown Landfill Current Conditions
Implications for Closure**

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Purpose of Peer Review Study:

- 1. To inform Pottstown Closure Committee on key environmental and public health issues, current and future**
- 2. To inform Closure Committee on strengths and weaknesses of Closure/Post-Closure Plans and regulations**
- 3. To provide the Closure Committee with recommendations aimed at enhancing Closure Plans and Post-Closure Care**

KEY FOCUS: THE WESTERN **LANDFILL - CLOSED**

The Original Landfill

- Site was used as a dump as early as 1932
- The Rinehart family (1948-1972)
- 40 acres original landfill is unlined
- 15-acre asphalt and clay liner (1972-1984) – SCA ownership

WASTE MANAGEMENT ERA

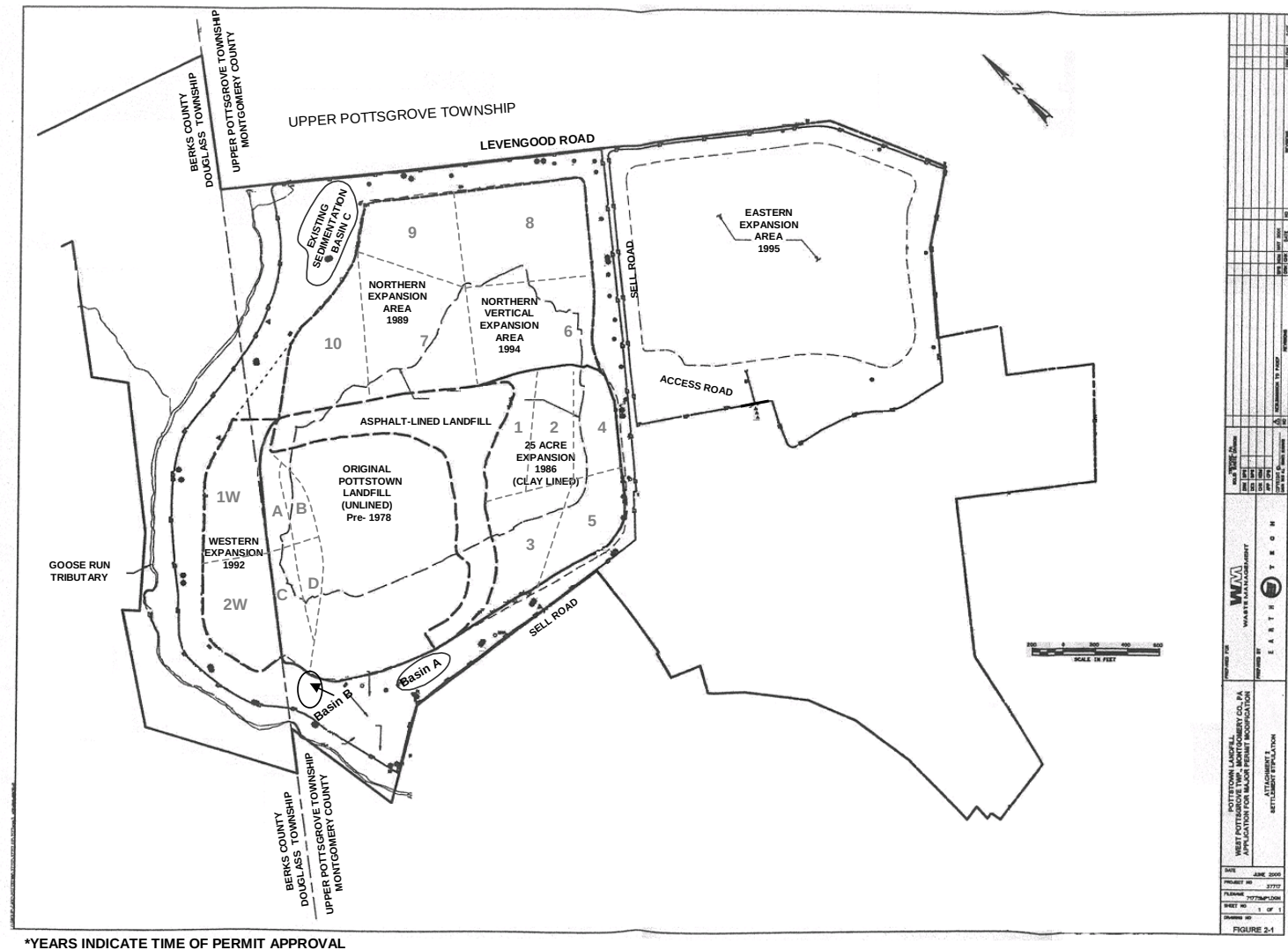
SCA became a subsidiary of Waste Management in 1984. The following expansions were installed Waste Management:

- **The Northern Expansion (permit issued in April 1988)**
- **The Western Expansion (permit issued June 1992)**
- **The Vertical Expansion in the Northern Expansion area (July 1994)**
- **Total area of 3 Expansions: About 100 acres**

WASTE MANAGEMENT ERA

Landfill Components

- **Waste Management began using an HDPE double-liner system below the waste cells and compacted clay cap for cover in 1985.**
- **In 1989 the company began using an HDPE geosynthetic-lined cap system for closures.**



Note that the original (unlined) + asphalt-lined landfill = about 55 acres. This is about the same size as the Eastern Expansion.

Wastes and Chemicals

- Municipal Solid Wastes
- Wastewater treatment sludges
- Industrial sludges (including arsenic, chromium, chlorinated pesticides, aromatic hydrocarbons and other hazardous constituents)
- Pharmaceutical manufacturing wastes
- Paint wastes
- Incinerator ash
- Ammunition wastes
- Asbestos

Source for Western Landfill: NUS, "Site Inspection of Pottstown Landfill" NUS Corp Report to the US EPA August 16, 1991

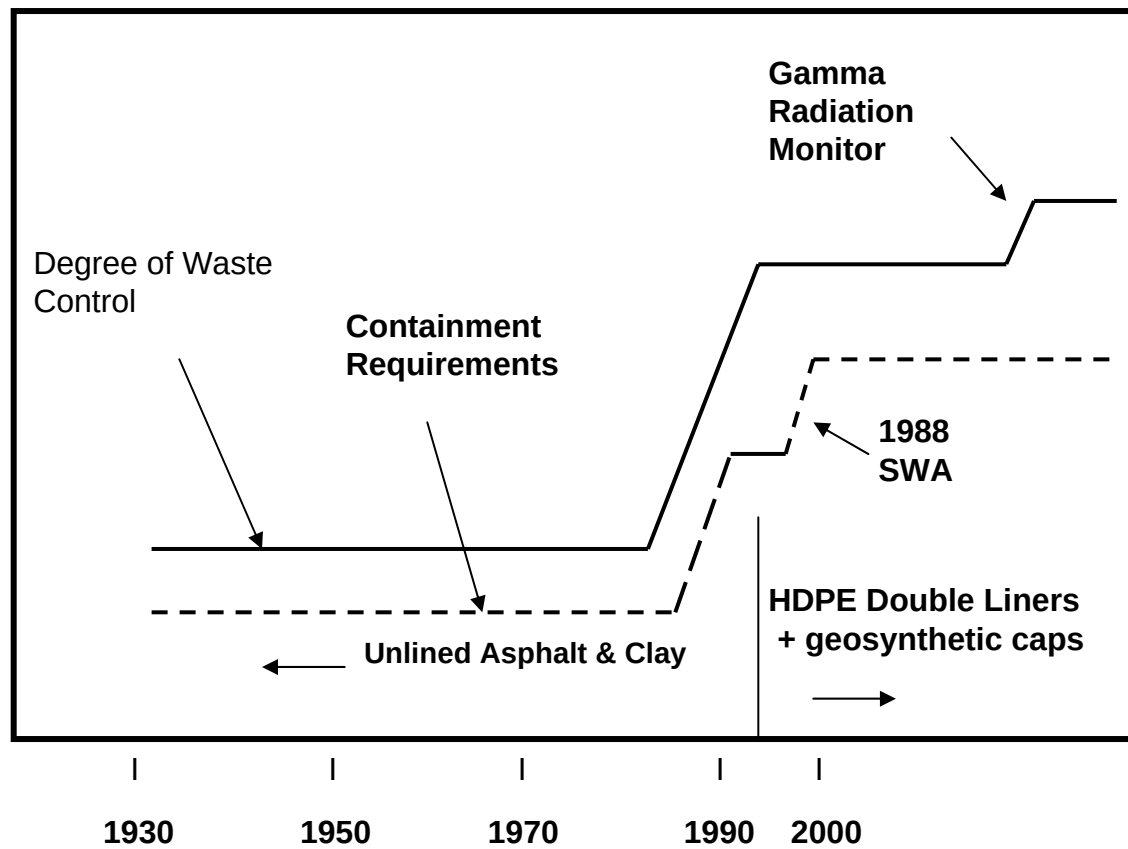
Wastes and Chemicals

- Many of these wastes would probably be classified as hazardous wastes under RCRA today
- Certain wastes contain deleterious chemicals though non-hazardous cause odors.
- Wastes containing radioactive materials: Includes industrial, commercial and medical wastes.
 - Examples: uranium and thorium bearing industrial wastes from Cabot Corp., tritium, probable source is self-luminous signs

Municipal waste includes many toxic & deleterious chemicals, Examples:

- **Batteries (lead, mercury)**
- **Used paints, oils and solvents**
- **Pesticides**
- **Treated wood discards (arsenic, chromium)**
- **Discarded electronic equipment (variety of toxic metals)**
- **Wall board discards: sulfate to hydrogen sulfide gas**

Conceptual Relationship between Control of Waste, regulatory era and period of operation:



Key Issues:

1. State of the Western Landfill -- especially oldest portions

Older portions not closed according to today's standards for liners and caps. Will not result in "dry tomb" conditions.

- Portions of the Western Landfill allow rainfall to penetrate.**
- Significant quantities of leachate are generated.**
- Original two areas: unlined or poorly lined.**
- Landfill contaminants have entered groundwater below and downgradient of site.**

Western Landfill, cont.

- **Pump and treat system installed in 1991, modified in 1997, additional extraction well to be installed. Hydro-fracturing needed in past and may be required in future. Will have to operate for a long time.**
- **Methane generation continues due to water infiltration. Methane decline in Western Landfill quite gradual.**
- **Deficiencies in cover likely to contribute to odors and fugitive air emissions.**
- **Permeability of covers may increase the potential for air to mix with methane in cells (fire hazards).**

Western Landfill, cont.

Current Efforts by Waste Management

- Focused on reducing infiltration in drainage channels. Good first step, however,
- We are not certain that these efforts will be sufficient to reduce leachate formation or to provide protection against continued erosive forces of nature.

RECAPPING PROBLEM PORTIONS OF WESTERN LANDFILL WOULD PROVIDE MULTIPLE BENEFITS

- Reduced leachate and methane generation
- Less potential for odor and air emissions
- Less potential for air infiltration and fire/explosion potential

Key Issues:

2. Air / Oxygen Infiltration:

Fire and Explosion Potential

- Methane is explosive at concentrations of 5-15 percent with air
- Fires or explosion require an ignition source
- Ignition sources include sparks (from equipment, spontaneous ignition)
- Landfill fires are difficult to control
- Landfill fires generate air emissions including inhalable particulates and toxic chemicals (e.g. PAHs, dioxins/furans).

Federal Clean Air Act Regulations:

- Objective: to prevent landfill fires and explosions
- Limit oxygen content in landfill cells (measured at extraction well head) to 5 %
- Exceedances must be corrected within 15 days
- Applicants may apply to EPA for allowable deviations or may request DEP permission to remove gas extraction wells (that are pulling in oxygen).

We examined 4 years of well head gas measurements 2001-2004:

- **2004: We found 20 measurements where oxygen exceeded 5 % and methane was in the explosive range of 5-15 %**
- **2004 the only year for which we had both oxygen and methane readings**
- **Waste Management not required to report on methane levels**
- **2001-2004: Dozens of wells in Western Landfill had exceedances of 5 percent oxygen level in each year**
 - **Average exceedance duration about 2 months (where full years data available)**
 - **Some wells had exceedances lasting nearly a year (not brought into compliance)**

Recent Development:

- Last 9 months: Waste Management has brought oxygen levels into compliance (DEP)

Concern:

- This potential hazard could reoccur in the future; methane generation likely to continue for several decades under current conditions.

Recommendations:

1. Long-term monitoring of landfill gas conditions (as long as degradable organic materials remain in landfill).
2. Monthly reports to DEP containing all gas data including methane
3. Upgrade of landfill cover as necessary to:
 - Reduce water infiltration and methane generation
 - Reduce air infiltration and fire potential

The Eastern Expansion

Issue 1: Open Face Issue

- More than 40 acres without permanent cover despite near-filled condition of cells
- Probably contributes to increased water penetration and leachate formation
- May have contributed to greater than anticipated landfill gas generation due to increased moisture
- Less effective barrier to air emissions and odors

These concerns will diminish once Waste Management installs permanent cover as required within a year of closure.

The Eastern Expansion

Issue 2: Gas generation and potential migration

Potential for offsite gas migration

- Potential hazard: fire and explosion offsite (e.g. in residential basements, crawl spaces, or sewers)
- Landfill gas if not controlled can migrate hundreds of feet
- State regulations require perimeter probes and limit allowable level to less than 5 percent methane

Source of Concern

- Repeated exceedances of 5 % methane level at perimeter gas probe PE-04 from 2000 to 2003.
- Greater than anticipated gas migration may have contributed to this problem
- Located north of the Eastern Expansion
- Waste Management maintains that methane levels not related to landfill
- However, data available insufficient to rule out landfill source.
- Exceedances have not been observed over past year.

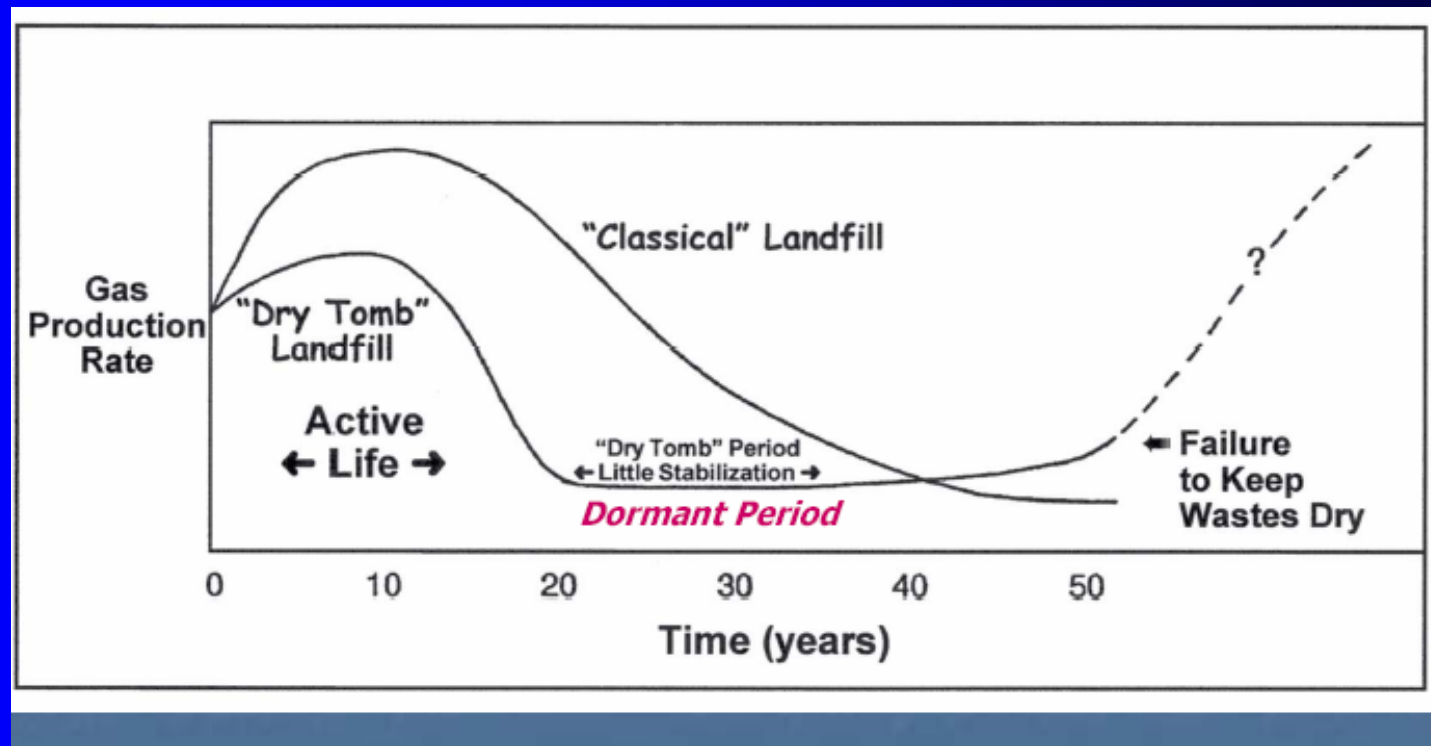
Concern: Possibility of recurrence

- Permanent cover required October 2006 (within 1 year of closing).
- May temporarily increase gas pressures until waste dries and methane generation diminishes

Recommendations:

- Expanded gas investigation in PE-04 area to determine source and whether is continued potential for exceedances.
- Perimeter probe monitoring should continue so long as there is degradable organic material in landfill.

Eastern (Dry Tomb) vs. Older Western Sections (continued moisture supply)



(From Lee et al. 2005)

Air Emissions

Two principal sources:

- Stack emissions (turbines and flares)
- Fugitive emissions (VOC emissions from landfill surface)
- Difficult to obtain reliable data for both

Stack Emissions:

- 2004 DEP NOV cites Waste Management for violations of air emissions and combustion efficiency limits.
- Based on DEP's recent stack tests (cited in NOV) yields an annual emission rate of about 45 tons of NMOC (non-methane organic compounds).
- Waste Management's estimate about 8 tons per year.
- Waste Management and DEP negotiating stack test protocol acceptable to both parties. This NOV is still open.

Stack Emissions cont.

- Stacks also generate NO_x (oxides of nitrogen): ~ 40 tons per year according to Waste Management estimates (2003).
- Some NMOC and NO_x are photochemically active (generate ground level ozone).
- Fugitive and unburned stack NMOC/VOC contain variety of Hazardous Air Pollutants.
- Other contaminants: Sulfur oxides, fine particulates, products of incomplete combustion (no estimates).

Fugitive Air Emissions:

- Federal regulations based on surface scans for methane (proxy for NMOC/ VOCs). Limit is 500 ppm. Exceedance requires corrective action.
- Reviewed reports from 2002 (EPA) and 2004 (Waste Management). These reports showed initial exceedances (on the order of several thousand ppm)
- For both years Waste Management corrected exceedances within 15-30 days compliance periods.

Fugitive Air Emissions:

- **EPA study found correlation between unvegetated “bare spots”**
- **EPA report notes that exceedances were located in older part of the landfill in areas without geotextile material as part of the cap.**
- **Typical corrective action: increased rate of gas pumping, adding layers of soil to surface.**

WM 2003 Estimates

Source Area	NMOC (tons/yr)
Western Landfill	17.29
Eastern Landfill	7.4

- Result is consistent with gas generation estimates showing about 2:1 ratio WLF:EE gas generation.
- Waste Management's estimates of fugitive air emissions are based on modeling rather than measurement.
- Waste Management's modeling applications tend to underestimate leachate and gas generation.
- A detailed evaluation of air emissions modeling was outside the scope of our work.

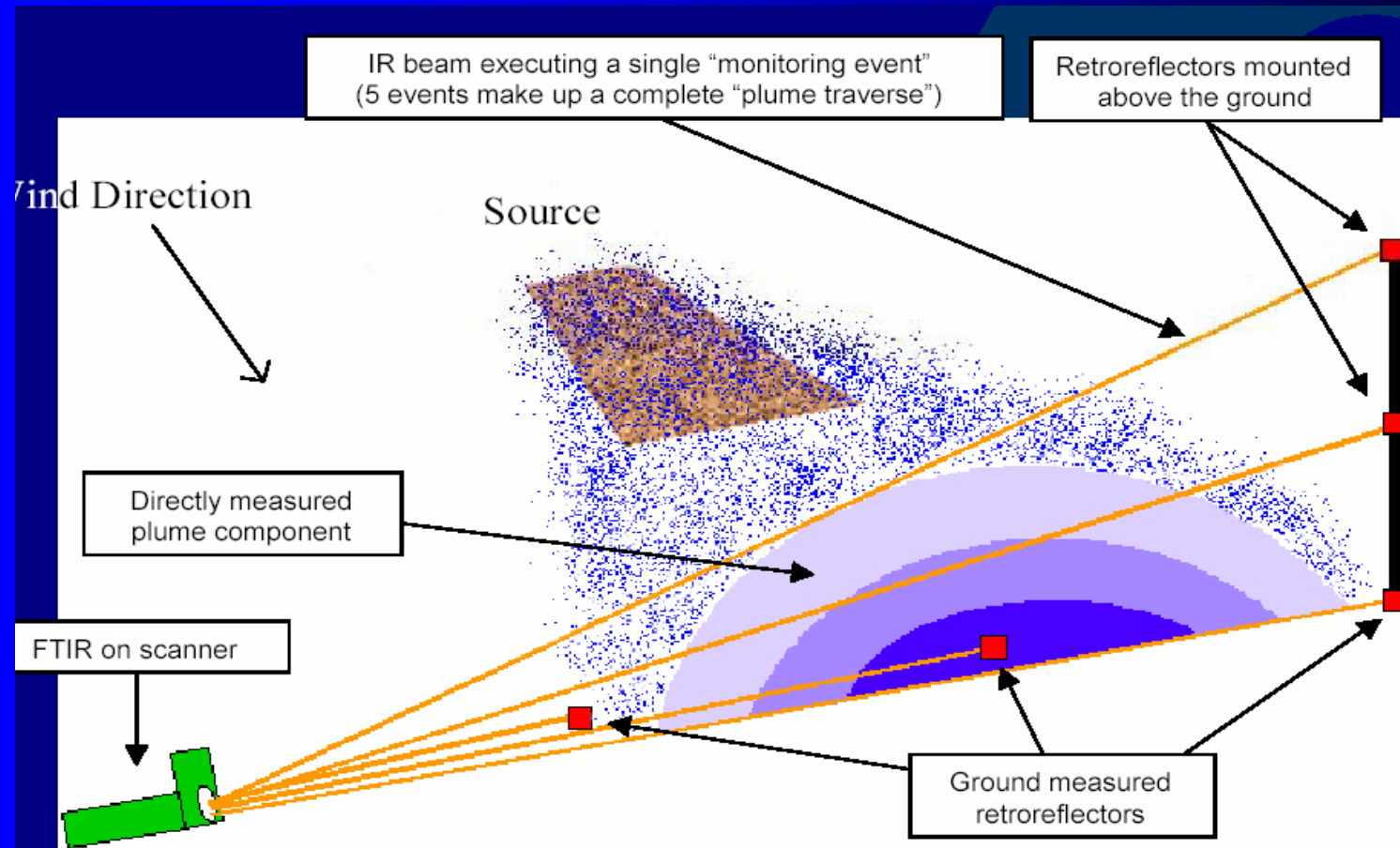
Corrective Measures Fugitive Emissions

- Although Waste Management has taken appropriate corrective action to reduce methane emissions, the an upgrade to cover material in older portions of the landfill is likely to reduce current and future air emissions.
- Upgrading cover would have multiple benefits including reducing the potential for odors, air emissions, water infiltration, methane generation and air infiltration.

Approaches to Emission Estimates:

1. Flux box measurements + air quality modeling
2. Remote sensing coupled with mobile monitoring

Remotely sensed Fourier Infrared Spectroscopy



TCE Contamination / Farmington Avenue area

- **More than 100 residential wells found to have TCE in excess of the drinking water standard (MCL) of 5 ppb.**
- **Maximum concentrations were on the order of 200 ppb.**
- **PA DEP proposed public water to homes with contaminated wells.**
- **Have seen no evidence indicating that landfill is source of TCE.**

TCE Contamination, cont.

Several lines of evidence indicate that landfill is not the source, e.g.

- **Little or no landfill leachate found in leak detection zone below Eastern Expansion.**
- **Highest TCE concentrations found to east of Wolf Run, concentrations decrease toward the landfill and are non-detect near perimeter of landfill.**
- **However, available information made it difficult to determine actual groundwater gradients / flow between Eastern Expansion and TCE contamination zone**

Radioactive materials in the Landfill

Currently allowed:

- Naturally occurring radioactive material (e.g. soils, ores) (NORM)
- Waste from nuclear medicine patients after released from treatment facilities
- Consumer products such as smoke detectors
- Natural materials that are processed including coal ash or processed metal ores. (TENORM)

Controlled/Licensed radioactive wastes may not be disposed at Pottstown Landfill

- Unless specifically exempted from disposal restrictions by applicable state or federal statute or regulation.
- According to DEP, no exemptions other than blanket permission for list on previous slide.

Radiation Detector at Gate: July 2004

- Responds to gamma radiation (but not to pure alpha or beta emitters)
- Alarm triggers requirement to properly characterize and manage waste in accord with state/federal regulations. Prohibited wastes would be turned away according to the approved radiation protection action plan.

Significant volumes of radioactive waste have been buried in the landfill for more than 30 years.

- **Cabot Corporation:** Landfill has received residual wastes from Cabot's tantalum ore processing facilities since the 1970's (15,000 – 20,000 tons/yr)
- **Sludge from Royersford laundry (INS).** Sludge from Interstate Nuclear Services in Royersford was shipped to Pottstown LF (1980's-90's). Residual containing low levels of radioactivity from washing of Limerick clothes.

Radionuclides, cont.

Limerick Nuclear Power Plant. Wastes from non-controlled areas of plant. The Landfill received this kind of waste in 1998 and 1999.

- **NRC Violation:** five bags of waste that were clearly labeled “radioactive waste” were inadvertently sent to the Pottstown Landfill.
- Shows that what goes into a landfill is not always consistent with restrictions, especially in past.

Wastes in older landfill areas

- Industrial wastes disposed prior to mid-1980's buried in the oldest, unlined or poorly lined and capped sections of the landfill.
- This would include industrial, commercial or government wastes containing radionuclides
- Level of control over waste contents likely to have been less than today's.

Tritium in leachate and landfill gas

- **Tritium found in both leachate and landfill gas.**
- **Substantial quantities in leachate (> 100,000 picocuries max)**
- **Certain cells (e.g. 7 in Western Landfill hottest – 1997 data)**
- **> Drinking water standards (20,000 picocuries/L)**

Tritium in leachate and landfill gas

- **More recent gross beta data show levels > drinking water standards in both east and west landfills (2004).**
- **DEP attributes the tritium to the disposal of self-luminous signs.**
- **Hypothesis consistent with articles in the literature.**
- **A report on Scottish landfills found that tritium from self-luminous devices becomes soluble and can contaminate leachate.**

Concerns:

- **Poor control of wastes containing radioactive substances in past**
- **Potential for disposal in older sections of landfill without proper liners and caps**
- **Mobility of certain radionuclides such as tritium**

Recommendations on Radiation:

- *Monitor for tritium in air in the wastewater treatment and turbine due to potential worker exposure*
- *Continue leachate monitoring for tritium, gross beta and gross alpha, with cell-specific monitoring to determine maximum levels.*

Recommendations on Radiation:

- *Upgrade cover systems in older portions of the Western Landfill, especially for areas that lack adequate bottom liners and also for areas where leachate contains elevated levels of radiation.*
- *Attempt to determine which landfill cells received largest quantities of radioactive materials. This can be done to some extent using records of waste disposal (including information on cells in use during specific time periods). This information should be part of the legacy repository for the closed landfill.*

Findings on Closure & Post Closure Recommendations

Western Landfill

- *We recommend measures sufficient to significantly reduce water penetration in problematic cells.*
- *This may include measures to bring these areas into compliance with standards for landfill cover systems.*
- *Such measures are especially important in portions of the landfill that are unlined or ineffectively lined.*

Findings on Closure & Post Closure Recommendations

Eastern Landfill

- Permanent cover required by October 2006
- This should greatly reduce water penetration, leachate formation, methane generation
- Should also reduce air emissions and potential for odor releases

Recommendations, cont.

Eastern Landfill

- Regulations designed to result in “dry tomb conditions” and dormant period
- However, so long as there are degradable organic wastes and hazardous and deleterious substances, the landfill will continue to pose the risk that such these substances will be released in ways that can harm public safety, health and the environment.
- Certain constituents will pose a risk for indefinitely long periods of time

Dr. Lee will discuss:

- **The longevity of hazardous materials in the landfill**
- **Evidence on the deterioration of landfill containment systems over time**
- **Pennsylvania Landfill Closing & Post-Closure Care regulations**
- **Contents of current closure plan (Form-28)**
- **Financial Assurance requirements**

Summary of Recommendations for Closure and Post-Closure

1. *Tie final certification of closure to a positive demonstration that releasable hazardous and deleterious materials are no longer present in the landfill.*
 - *Diminished levels of leachate and methane generation should not be used as the benchmark for final closure.*
 - *Require that key control systems are maintained so long as hazardous remain in the landfill.*

Recommendations, cont.

- *Gas and leachate collection systems should be maintained in an operable or stand-by condition, even during dormant periods.*
- *Ensure that critical monitoring and detection systems are maintained as long as the wastes in the landfill, in contact with water, have the potential to generate leachate and/or landfill gas.*
- *This policy will provide DEP long-term enforcement power to require corrective measures based on early detection rather than proof of adverse impact.*

Recommendations, cont.

2. *The landfill cover should be routinely inspected for areas of stressed vegetation (indicative of landfill gas migration and air emissions).*
 - *Renewed landfill gas and/or leachate generation is an indication that moisture has been entering the landfill.*
 - *Require owner to locate and repair the area of cover that is leaking. This process will have to be repeated as needed for as long as the wastes in the landfill are a threat.*

Recommendations, cont.

3. *DEP should renegotiate financial assurance terms to more adequately provide for long-term maintenance and monitoring and repairs and remedial measures. The need for financial assurance goes well beyond 30 years.*

Recommendations, cont.

4. *Waste Management should provide funds to enable PA DEP to develop a “legacy information system” on the Pottstown Landfill to include:*
 - *Critical information and easy electronic access and searching.*
 - *Ready access to the public.*
5. *The Pottstown Landfill Closure Committee should explore with PA DEP and Waste Management the development of funding that would provide for third-party independent monitoring of the landfill. Further information on this monitoring is provided in Attachment 2.*