National Waste & Recycling Association℠

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# MSW Landfills

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# Subtitle D Requirements

- Location restrictions
- Composite liner requirements
- Leachate collection & removal systems
- Operating practices
- Groundwater monitoring requirements
- Corrective action provisions
- Closure & Post-closure care requirements
- Financial assurance mechanisms

# Location restrictions

Ensures that landfills are built in suitable geological areas:

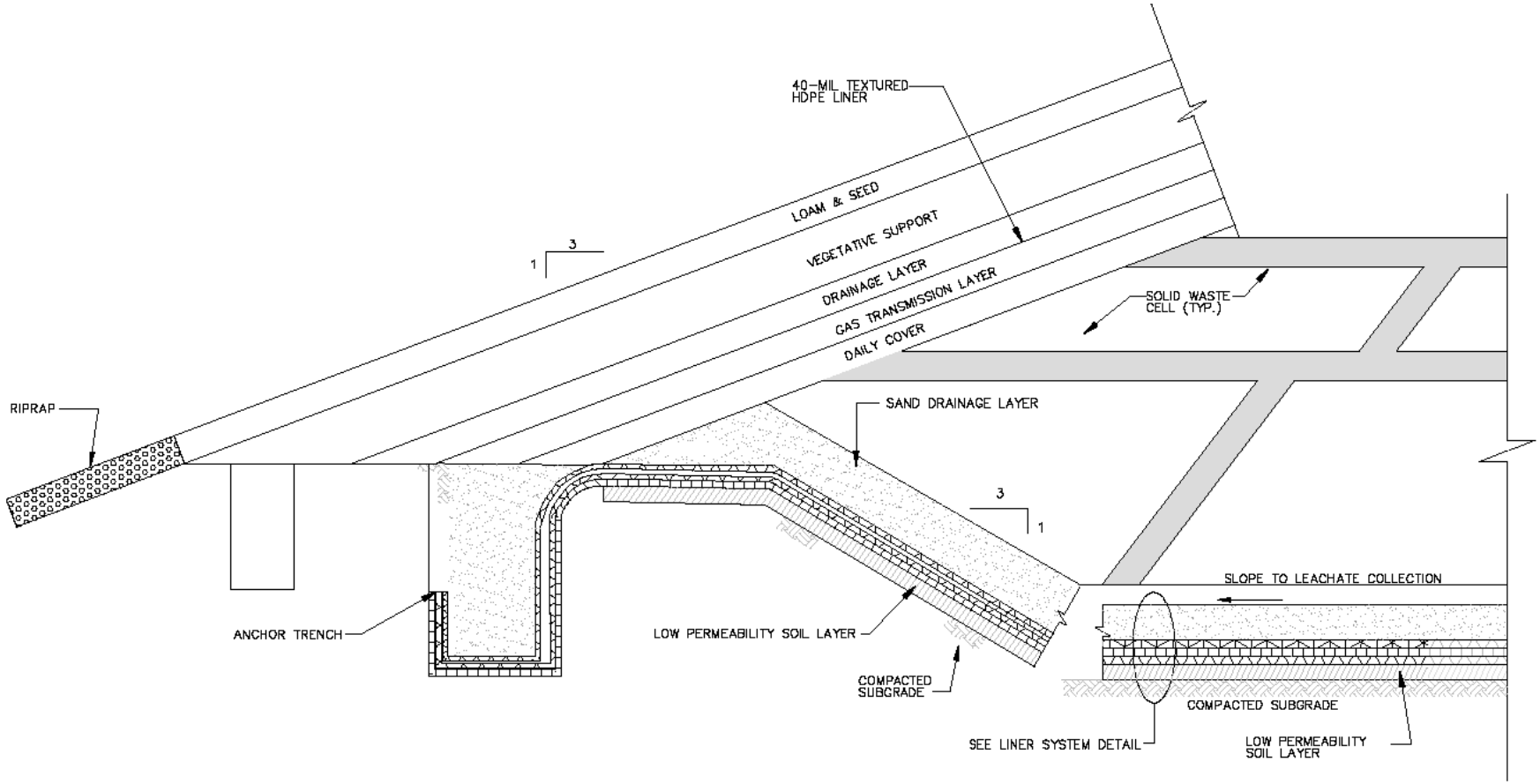
- ✓ Away from wetlands
- ✓ Away from floodplains
- ✓ Away from faults
- ✓ Away from unstable areas
- ✓ Away from airports
- ✓ Away from seismic impact areas

# Composite liner and leachate collection & removal system requirements

Ensures that landfills are built in a manner protective of the environment.

- ✓ Provides for the construction of a composite liner system (barrier) between waste and subsurface consisting of:
  - ✓ Flexible membrane
  - ✓ Compacted clay
- ✓ Provides for the construction of a drainage system above the composite liner to collect any liquids (leachate) drained from the waste.

# Typical Landfill Design Detail




TYPICAL CROSS SECTION THROUGH LANDFILL

(NOT TO SCALE)

# Operating practices

Ensures that landfills are operated in a manner that is protective of public health and minimizes nuisances. Requires landfill operations include:

- ✓ Waste receipt control
- ✓ Daily cover
- ✓ Vector control
- ✓ Gas control
- ✓ Stormwater & surface control
- ✓ Recordkeeping

# Groundwater monitoring requirements & Corrective action

Ensures that landfills are monitored to verify that in-place measures are operating

- ✓ Provides for routine monitoring of groundwater
- ✓ Provides mechanism for corrective action

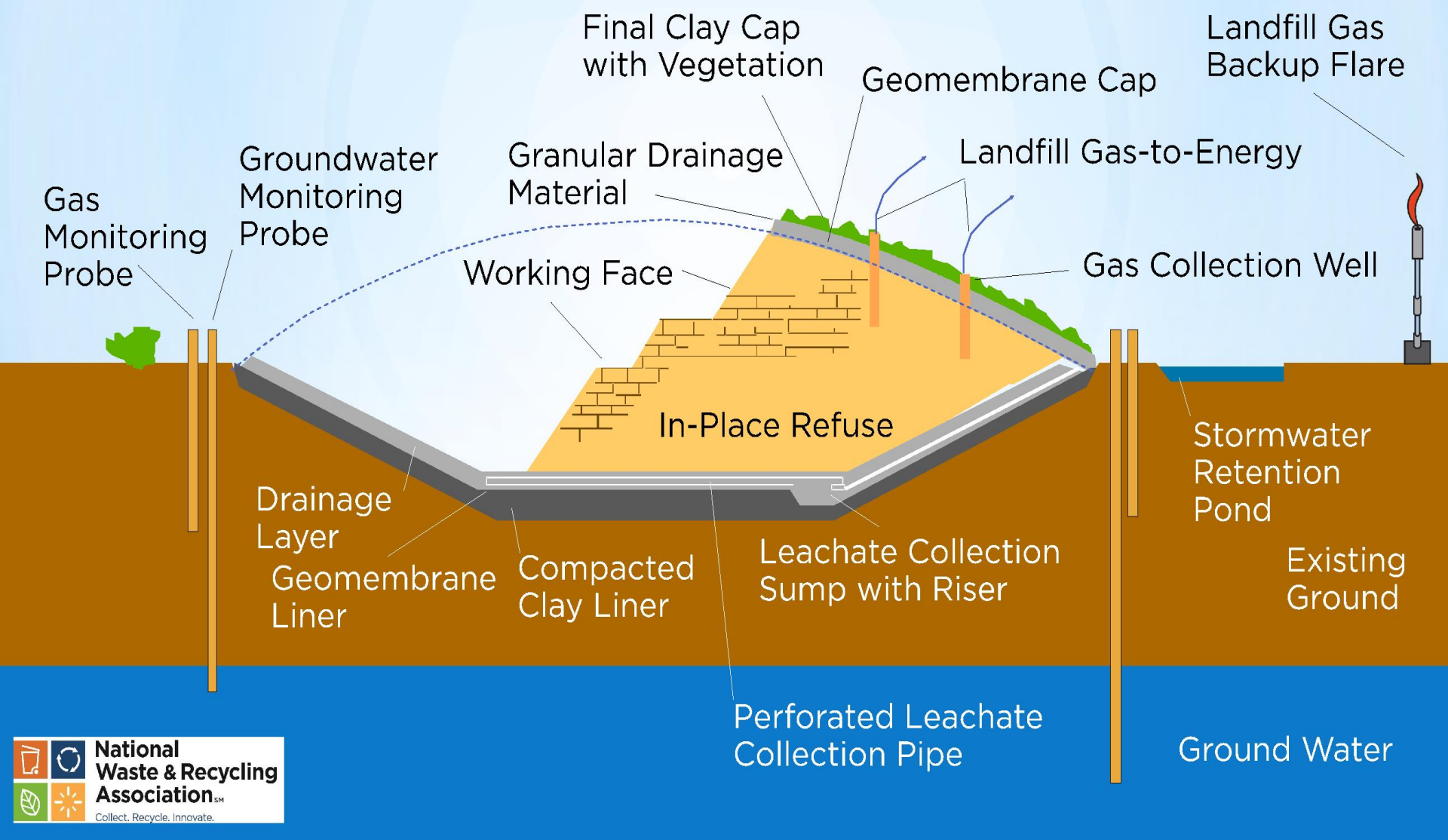
# Closure & Post-closure Care & Financial Assurance

Ensures that landfills are closed in a manner protective of the environment.

- ✓ Provides for the construction of a final cover system
- ✓ Provides for site monitoring for 30-years after the facility is closed

Ensures that landfills maintain financial mechanisms in place sufficient to meet the requirements associated with closing and post-closure care of the facility.

# Typical Modern Landfill Cross Section

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# Federal and State Requirements

- Federal New Source Performance Standards & Emission Guidelines
  - Establishes requirements for the collection and management of landfill gas
  - Monitoring and reporting requirements for verification
- Proposed changes pending
- PA Best Available Technology
  - Imposes more stringent requirements for control of gas
  - Touted by DEP Secretary Quigley in a recent letter to US EPA as being more stringent than proposed federal requirements in several aspects

# Landfill Gas Generation

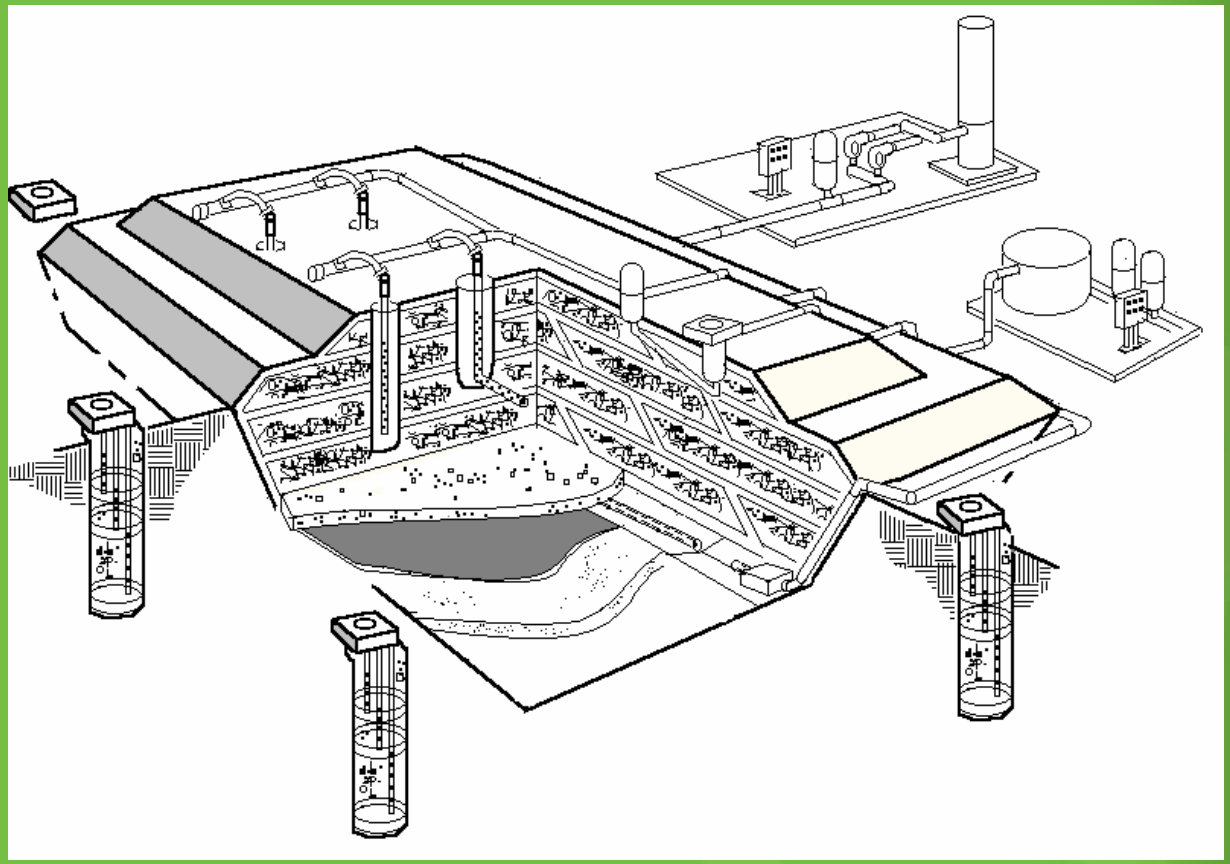
- No emissions from inorganics materials that do not contain carbon (metals, glass)
- No emissions from carbon sources that do not biodegrade in landfills (plastics, carpet, tires)
- Landfill gas generated from a portion of the biodegradable fraction of waste (paper, food waste, yard trimmings)

# Landfill Gas Generation

- Phase I – Aerobic degradation
  - Carbon dioxide ($CO_2$)
  - Water
- Phase II – Anaerobic degradation
  - 50% Methane ($CH_4$) – natural gas
  - 50% Carbon dioxide
  - <1% non-methane organic compounds (NMOC)

# Landfill Gas Management

- Collection
- Destruction
- Beneficial use



# Calculated Landfill Gas Generation

- Landfill gas generation estimated using EPA LandGem model

- Based on studies of actual data at landfills, the models have overestimated generation by a factor of 2 – 4.

# Methane Oxidation

- Microbial process carried out by bacteria called methanotrophs
- Converts methane to carbon dioxide
- Generally occurs in soil layers where methane is available
- The oxidized methane is neither collected nor emitted—its destroyed in the soil layer
- Developing area of understanding over last 5-10 years

# Methane Oxidation at Landfills

- Default value was 10%
- Based on research, range for oxidation is between 10 – 100%
- Mean percent oxidized based on analysis at 90 landfills - 38%
- Varies by cover type, highest mean percent oxidized occurs in sand covers (54%), lowest in clay covers (30%)
- Based on research data, EPA changed allowable 10% oxidation to a new range of between 10-35%

# EPA's Framework for Biogenic $CO_2$ Emissions Accounting

Biogenic accounting factor for landfills:

"The SAB concurs with the *Framework* that the $CO_2$ released from the decomposition of biogenic waste in landfills, compost facilities or anaerobic digesters could reasonably be assigned a BAF of 0."

Source: EPA's Science Advisory Board on Biogenic Carbon Emissions 9/28/12 letter

# Landfill Carbon Storage

- Organics made up of cellulose, hemicellulose (readily degradable in anaerobic conditions) & lignin (recalcitrant in anaerobic conditions)
- Therefore, carbon storage potential for materials higher in lignin:
  - High potential: newspapers, phonebooks, branches, dimensional lumber and medium density fiberboard
  - Medium potential: yard trimmings

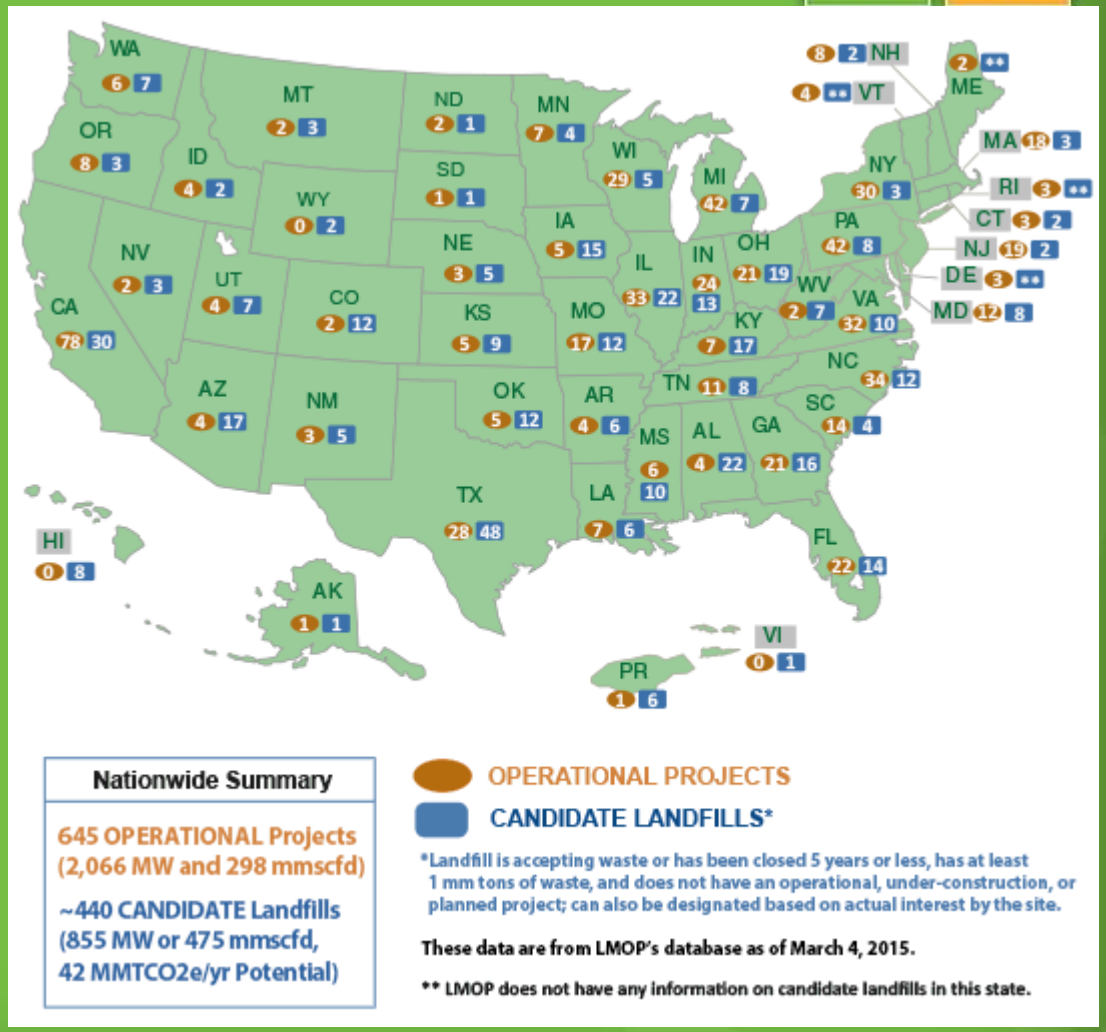
Source: EPA's Waste Reduction Model (WARM)

# LFG is Green Power

- Dual benefit - destroys methane and other NMOCs
- Offsets use of nonrenewable energy resources reducing emissions of $SO_x$, $NO_x$, PM, $CO_2$
- LFG is recognized as a renewable energy resource by EPA, 31 states, EDF

# State of the LFG Industry

- 645 operational projects in 48 states
  - 2,066 MW electricity
  - 298 mmscfd gas
- Pennsylvania
  - Ranked 2nd (tied with Michigan)
  - Only CA has more projects




Source: LMOP database

# Pennsylvania's Landfill GHG Emissions

As mandated by Act 70 of 2008, each year DEP calculates statewide GHG emissions by sector.

DEP uses US EPA's official State Inventory Tool.

In 2015, DEP calculated statewide emissions for 2012 (most recent year all data was available)

Results for 2012:

Statewide emissions = 287.38 MMCO2e

Statewide emissions w/ Forestry Sinks = 253.12 MMCO2e

- Landfills emissions ($CH_4$) total = **(**0.415 $MMCO_2e$)
- WTE emissions ($CO_2$, $N_2O$, $CH_4$) = 2.328 $MMCO_2e$
- WWTP emissions ($CH_4$ and $N_2O$,) = 1.726 $MMCO_2e$

**Net Landfill GHG emissions are negative!**

Source: PADEP Draft 2015 Climate Change Action Plan Update

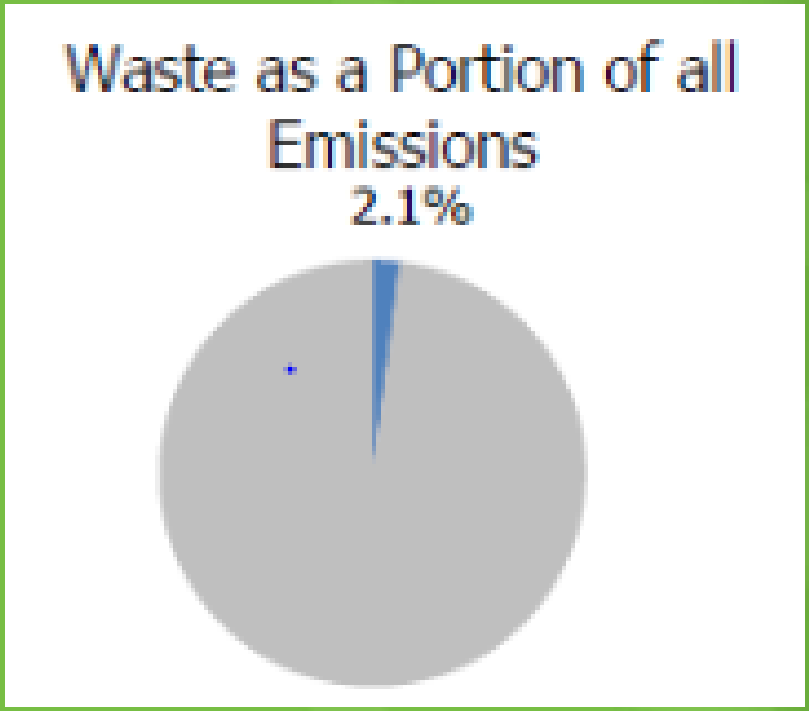
# Net GHG Emissions

- Net Pennsylvania GHG Emissions includes:
  - Fugitive and point source emissions
  - Offset emissions due to electricity generation
  - Exemption for biogenic $CO_2$ from landfills

Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2013

# US Greenhouse Gas Emissions

- Total US GHG Emissions: 5,791.2 MMT $CO_2Eq$
- Landfills US GHG Emissions: 114.6 MMT $CO_2Eq$
  - Includes both MSW & Industrial landfills
  - 38% lower than 1990
  - Gas-to-energy – 2361% increase since 1990




Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2013

# Facts Behind the US Numbers

| | US Emissions 1990* | US Emissions 2013* | PA LF Emissions 2012* |
|---|---|---|---|
| Landfills (MSW & Industrial) | 219.2 | 351.7 | 10.632 |
| LFG control & energy use | (12.2) | (224.2) | (11.093) |
| Methane oxidation through cover | (20.7) | (12.7) | (0.046) |
| Subtotal | 186.2 | 114.6 | (0.415) |
| Sequestration | (26.0) | (12.6) | Not addressed |
| Net emissions | 160.2 | 102.0 | (0.415) |

*GHG Emissions in MMT $CO_2$Eq

Sources: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2013
Pennsylvania Greenhouse Gas Inventory 12/9/14

# Contact information:

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