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Landfill Biogas Collection System Design, Construction, and Operational Considerations

GMI ALL-PARTNERSHIP MEETING

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Overview

- Purpose of Presentation
- Objectives of Landfill Biogas Collection and Control Systems
- Design Considerations
- Construction Considerations
- Biogas Collection System Operations

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Purpose of Presentation

- To Improve Landfill Biogas Recovery and Project Success By:
  - Identification of common issues with collection system design, construction, and operation
  - Increasing technical capacity of landfill biogas system designers and operators
  - Responding to issues observed by GMI at landfill biogas projects

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Objectives of Biogas Collection System

- Recover and utilize landfill biogas
- Minimize potential environmental impacts
  - Fugitive emissions
  - Off-site migration
  - Odors
- Comply with regulatory requirements

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Elements of a Landfill Biogas Collection System

- Biogas Extraction Points
  - Vertical wells
  - Horizontal collectors
  - Connection to existing leachate piping system
- Network of interconnecting piping
- Condensate control management
- Blower and flare
- Monitoring systems

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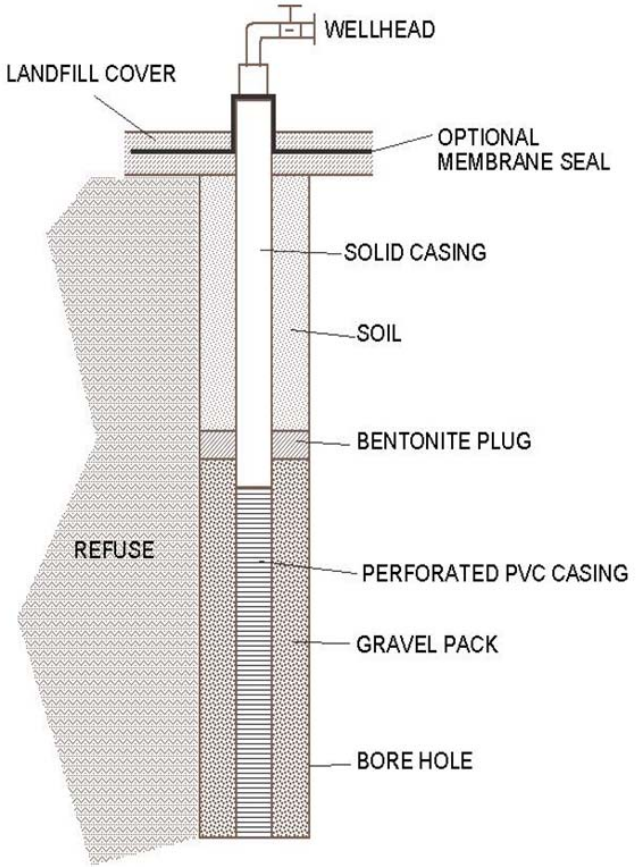
Vertical Extraction Wells

- Most common approach for recovering landfill biogas
- Wellhead is used to control vacuum and provide a monitoring point



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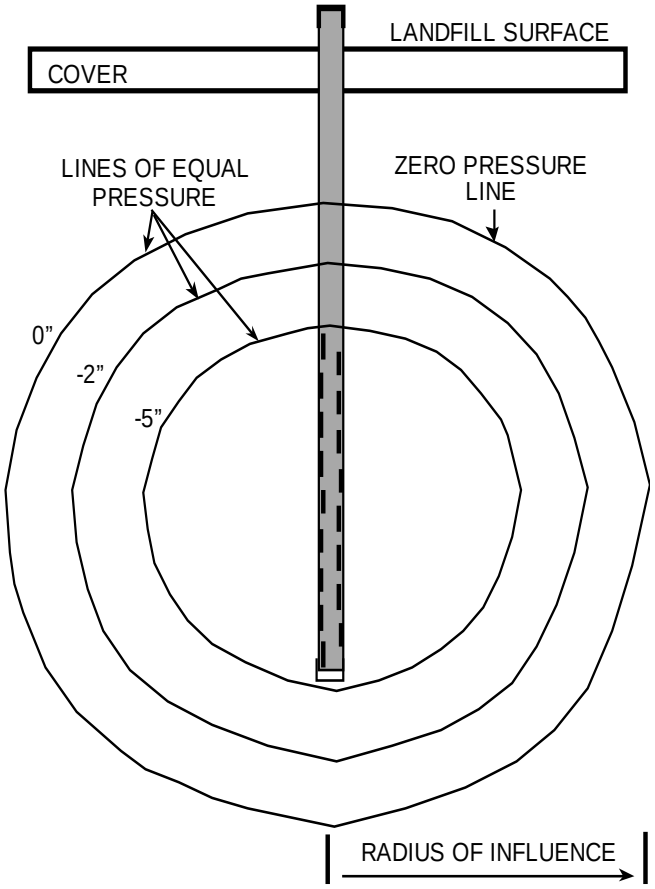
Theoretical Radius of Influence of a Vertical Gas Well



- Radius of influence 2 to 2.5 times well depth
- Increase vacuum to increase the radius of influence
- Actual spacing will depend on landfill conditions and project goals

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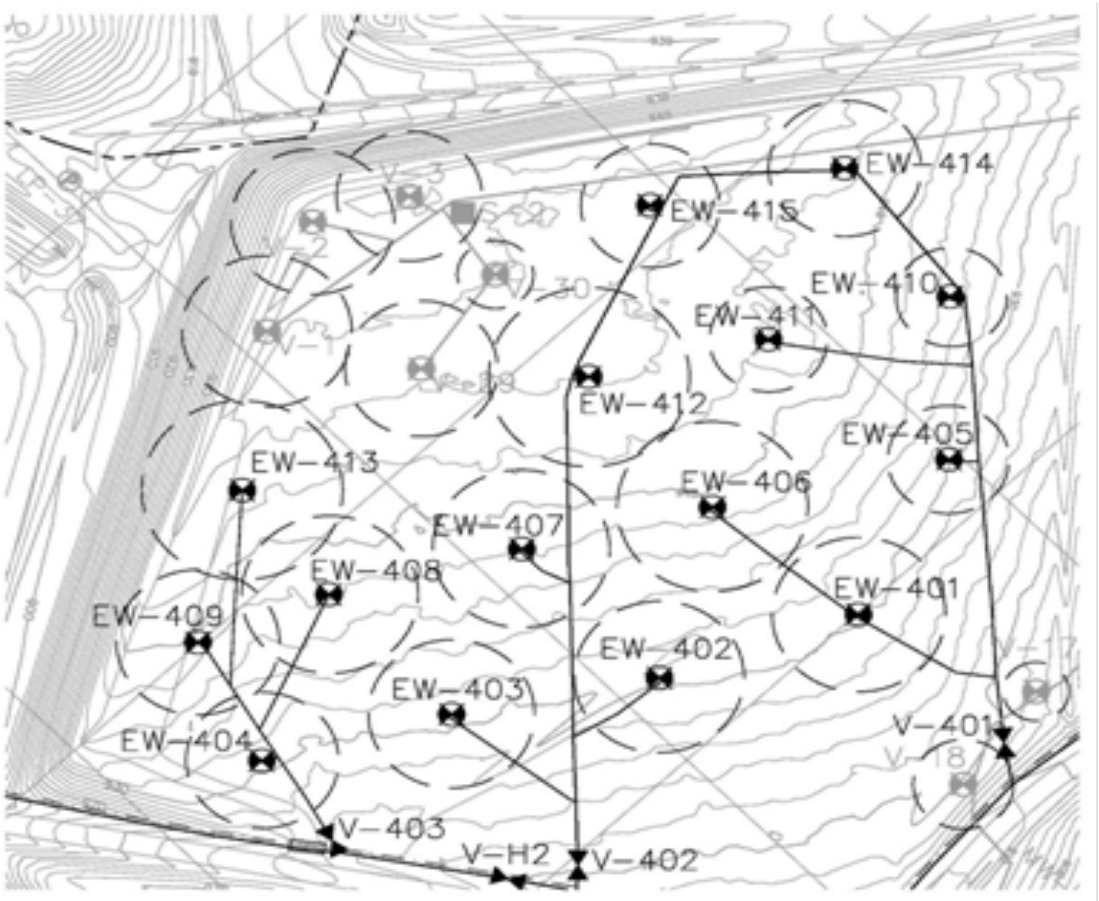
Vertical Well Placement



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Horizontal Collectors

- Alternative approach for biogas
- May be a better financial option depending on landfill conditions
- Install in existing or operational disposal areas
- Install at a spacing of approximately 30 to 40 meters

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Laterals and Headers

- Pathway for biogas from wells to blower/flare
- Pipe size based on flow rate and pressure drop
- May be constructed on the landfill surface or below the landfill surface
- Laterals and headers should be sloped to promote condensate drainage to sumps
  - Should consider future landfill settlement
- Evaluate different types of system designs
  - Individual lateral per well
  - Header system with shorter laterals to wells

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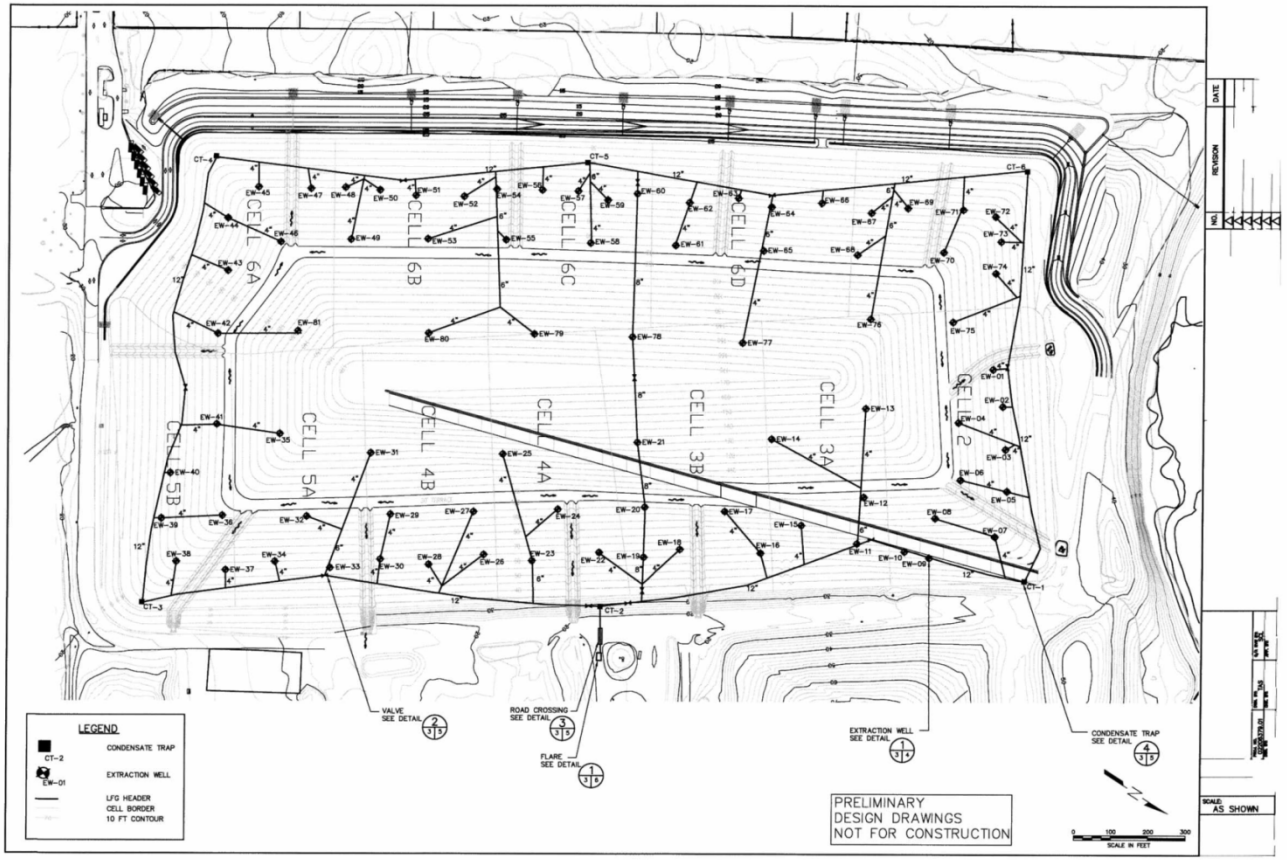
Collection System with Headers and Laterals



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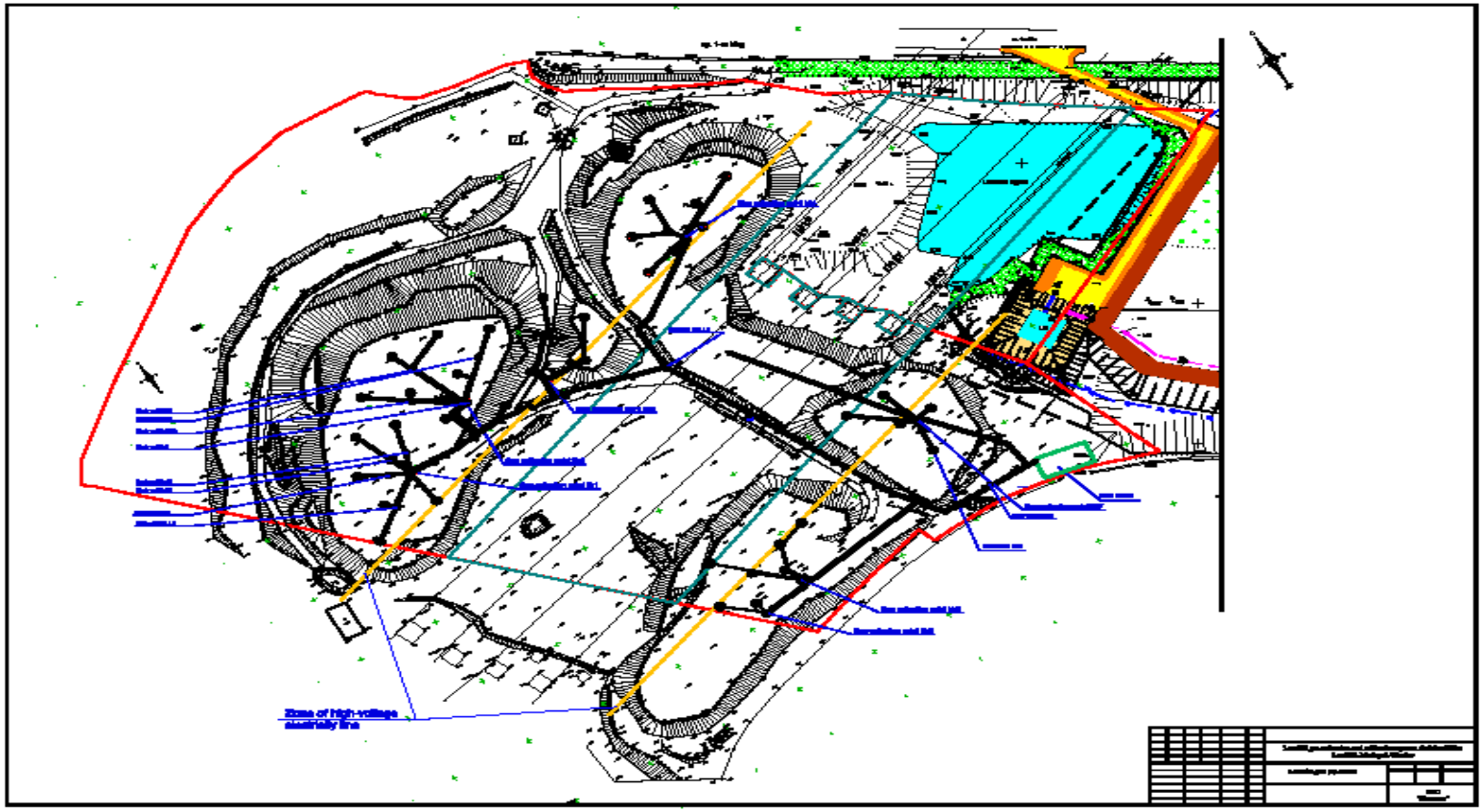
Collection System with Headers and Laterals



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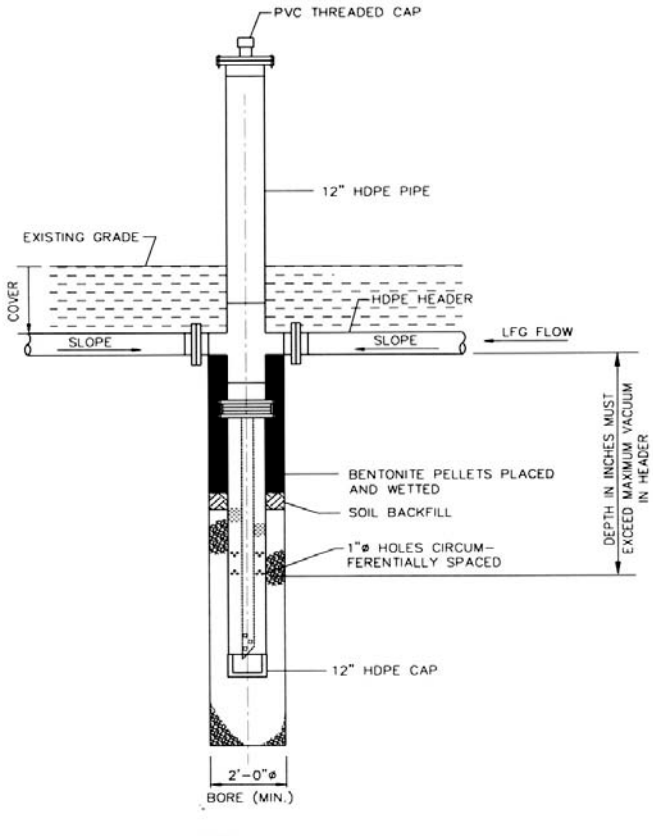
Condensate Removal

- As biogas cools, moisture condenses out into the piping
- Piping should be designed to allow condensate to drain to low points where sumps or traps are located
- Sumps collect condensate and pump it to a desired location or allow for drainage back into landfill by gravity



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Blower & Flare

- Provides vacuum to extraction points
- Combusts methane and other organic gases contained in the biogas
- May be used in combination with energy generation system
- Needed during energy system startup and downtime
- Design with flexibility to handle future biogas flows

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Blower & Flare – Typical Components

- Moisture separator
- Blowers
- Flow meter
- Methane analyzer (optional)
- Flame arrestor
- Flare (open or enclosed)
- Pilot fuel supply
- Control panel (controls both blower and flare)
- Auto shutoff valve

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Construction Considerations

- Good communication and understanding between design engineers and construction company
- Finding construction company with experience with landfills
- Safety of construction crew

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Construction Quality Assurance

- To make sure the construction firm builds a system that meets the proper design criteria
- Avoid drilling through landfill liner
- Address design changes in the field
- Provide “as-built” plan for system

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Biogas Collection System Operations

- Changes in landfill conditions will require changes in collection system operation
- Each landfill and collection system is different and requires a technician to develop a strong understanding of the system operations
- Periodic monitoring and adjustments are necessary

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Well Monitoring

- Typical parameters include:
  - Vacuum or pressure
  - Methane
  - Oxygen
  - Carbon dioxide
  - Balance gas (nitrogen)
  - Temperature
  - Flow rate
  - Liquid depth in well

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Biogas System Start-up

- Begin with low vacuum on system
- Adjust each well to have 0 vacuum or pressure
- Periodically increase vacuum on each well until:
  - Oxygen reaches 0.5 to 1 percent; or
  - Vacuum reaches 50 mmbar
- Vacuum increases should not exceed 10% during an adjustment

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Biogas System Operation

- Conduct periodic monitoring at each well
  - Minimum one time per month
- Maintain biogas characteristics:
  - Methane: 46-55%
  - Oxygen: Less than 1%
  - Nitrogen: 2-14%
  - Temperature: Less than 56-60^{O}C
- Note that each landfill is different and such ranges may not be possible at all sites

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Oxygen In the Biogas

- May occur through two routes:
  - Air intrusion through waste mass; or
  - Leaks in laterals, headers, piping
- If oxygen presence due to leaks, the ratio of nitrogen to oxygen would be ~ 4:1
- If due to air intrusion, the ratio could be much higher
  - Note that high nitrogen can be a concern as oxygen can be consumed in the waste mass during infiltration and may not be measured in the biogas

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Summary

- Biogas collection and control system design should be based on project goals
- Design should account for future operations, landfill settlement, and condensate management
- Construction management is important
- Biogas collection system operation requires constant monitoring and adjustment

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For More Information . . .

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