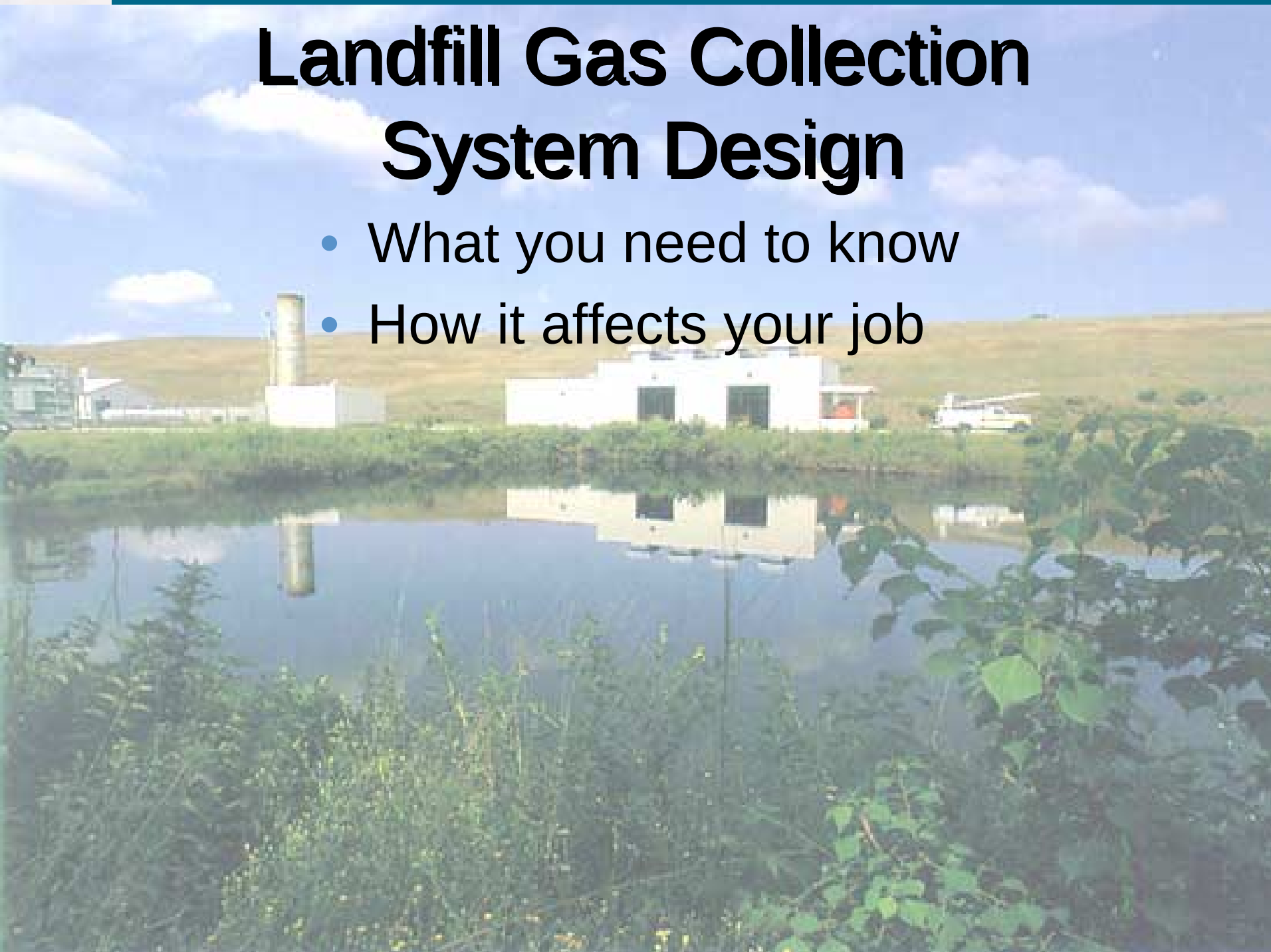
Landfill Gas Collection System Design

- What you need to know
- How it affects your job



Design Objectives

- Control migration
- Control emissions
- Control odors
- Maximize gas collection for energy recovery
- Comply with regulations

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Designing to Accommodate the Variable Nature of Landfills

- MSW
- C&D
- Waste Age
- Method of Filling
- Location
- Climate

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Types Of Systems

- Passive
- Active

Passive System

- System that relies on pressure or concentration gradients to function
  - Vertical vents, gravel trenches

Active System

- System that includes a prime mover that creates a vacuum on the landfill
  - Vertical gas wells
  - Horizontal collectors

Passive

- Pluses and Minuses
  - Low Operating cost
  - Low initial cost
  - Positive pressures
  - Gas collection inefficiencies
  - Condensate removal
  - Minimal capacity

Active

- Pluses and Minuses
  - Maximum capacity
  - Functions with various gas systems
  - Maintains vacuum on the landfill
  - Higher initial cost
  - Higher operating cost

What Goes into a Gas Collection System Design?

- Well Spacing
- Well Materials and Depth
- Non-Well Extraction Points
- Collection Piping
- Condensate
- Dual Gas/Leachate Extraction
- Flares

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Well Spacing

- ROI equation
  - Limitations of
- Landfill design
- Permeability
- Waste type
- Operating pressure/vacuum

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Well Spacing

- Typical ranges of ROI
  - Passive Wells
  - Active Wells

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Well Spacing

- Gas venting layer beneath final cover
  - Waste Hauling and Bath Examples
  - Sand vs. Geosynthetic

Well Design

- Pipe vs. Pipeless vs. non-gravel pack wells
- Well diameter
- Materials of construction
- Well heads
- Well Lifecycle
- Design Limitations

Well Design

- Pipe vs. Pipeless vs. non-gravel pack wells
  - Depth
  - Packing
  - Surface seal
  - Geomembrane Boots
  - Connection to header
  - Header design

Well Design

- Well diameter
  - Implications
    - Flow
    - Pressure
  - Cost

Well Design

- Well Design / Materials of construction
- Typically HDPE or PVC
- Stainless Steel
  - (rarely)

Well Design

- PVC
  - Rigid
  - Higher temperature
  - Structurally functional when slotted
  - Easy to extend
  - Higher cost
  - Variety of manufactured fittings

Well Design

- HDPE
  - Low cost
  - Very flexible
  - Temperature affects
- Stainless Steel
- Other materials

Geomembrane Boot Around Well

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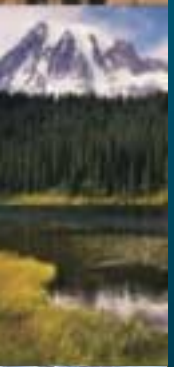
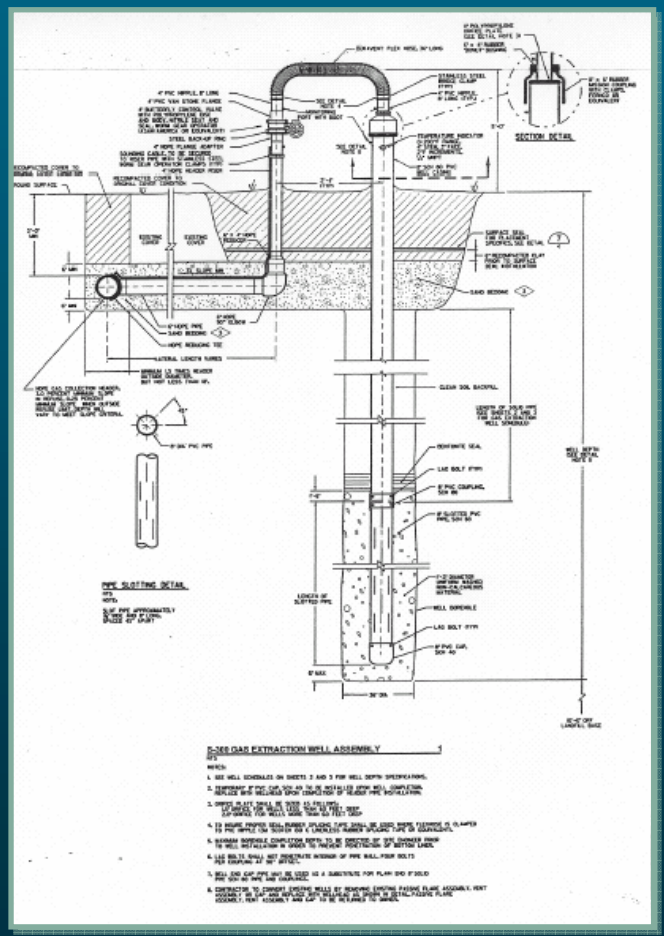
Well Design

- Well heads
  - Monitoring capability
  - Liquid level accessibility
  - Resistance to environmental affects
  - Versatility after installation



Well Design - A



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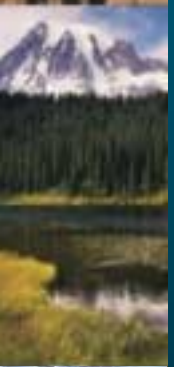
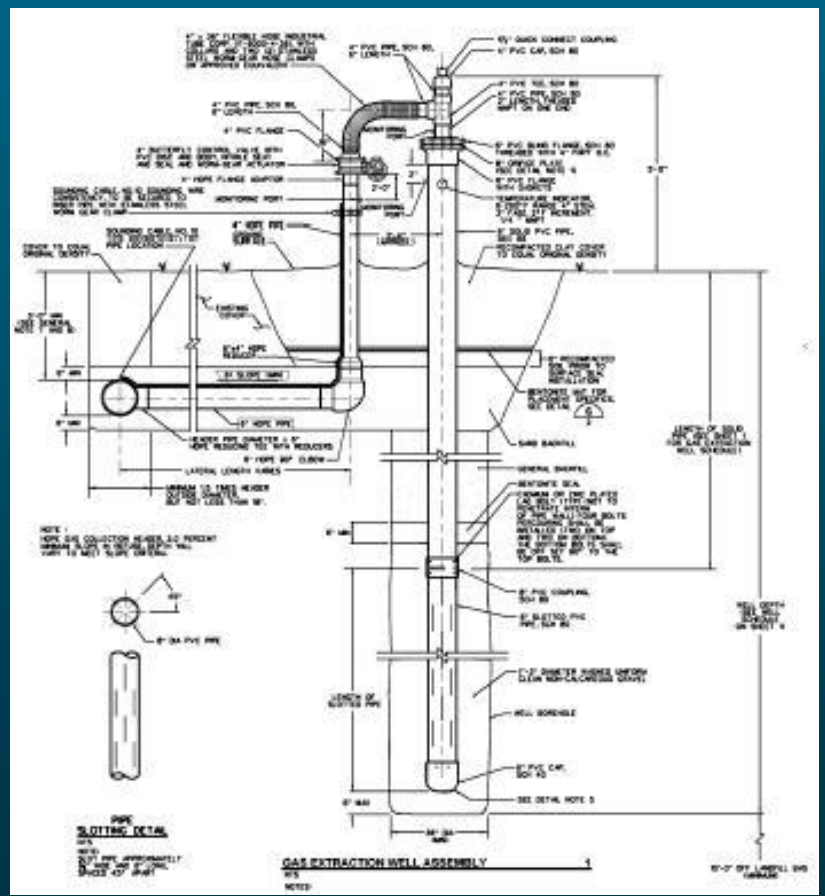


Well Design - B



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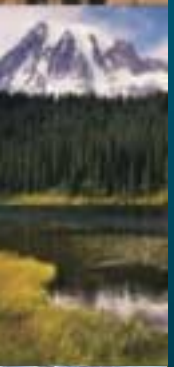
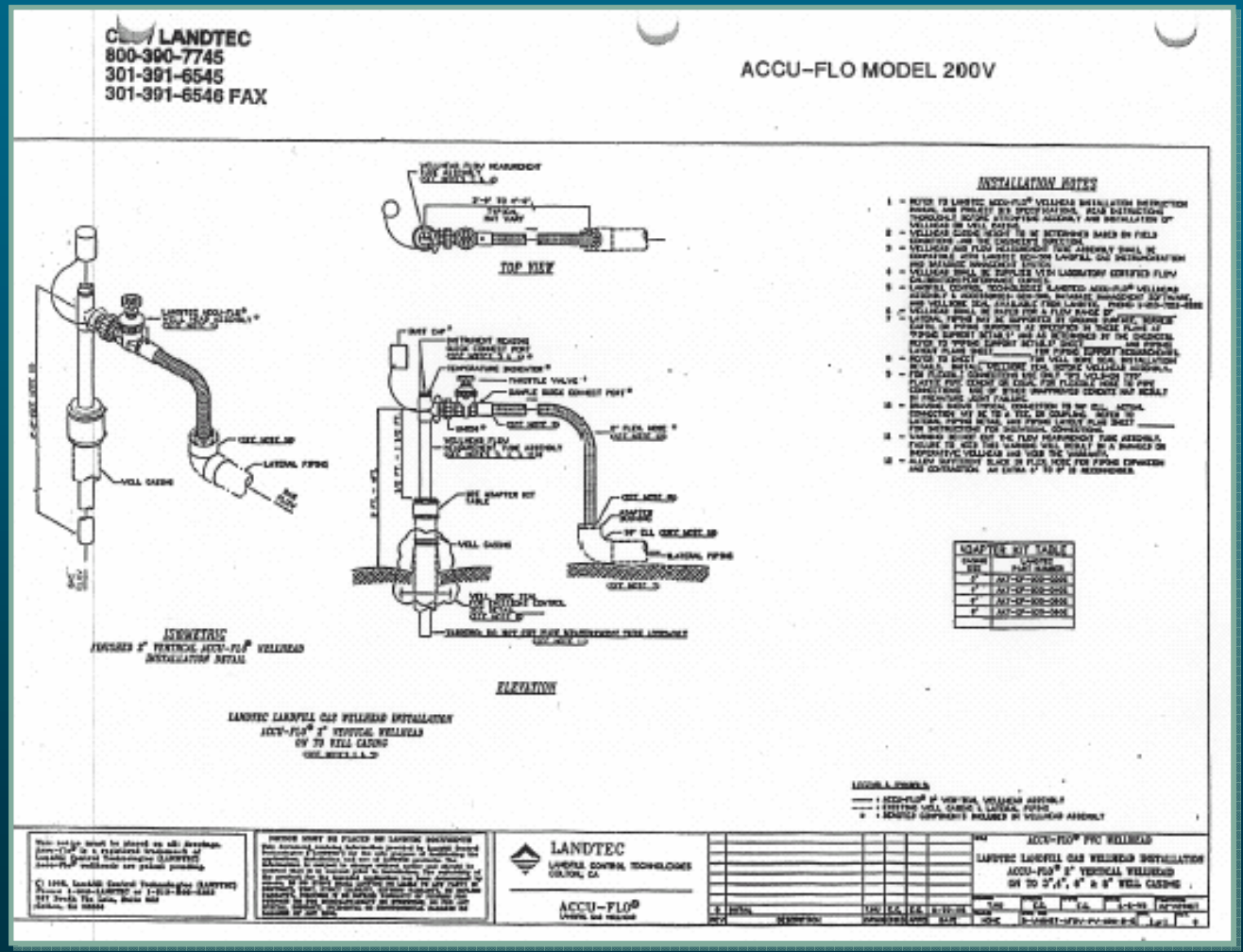



Accu-flo Model



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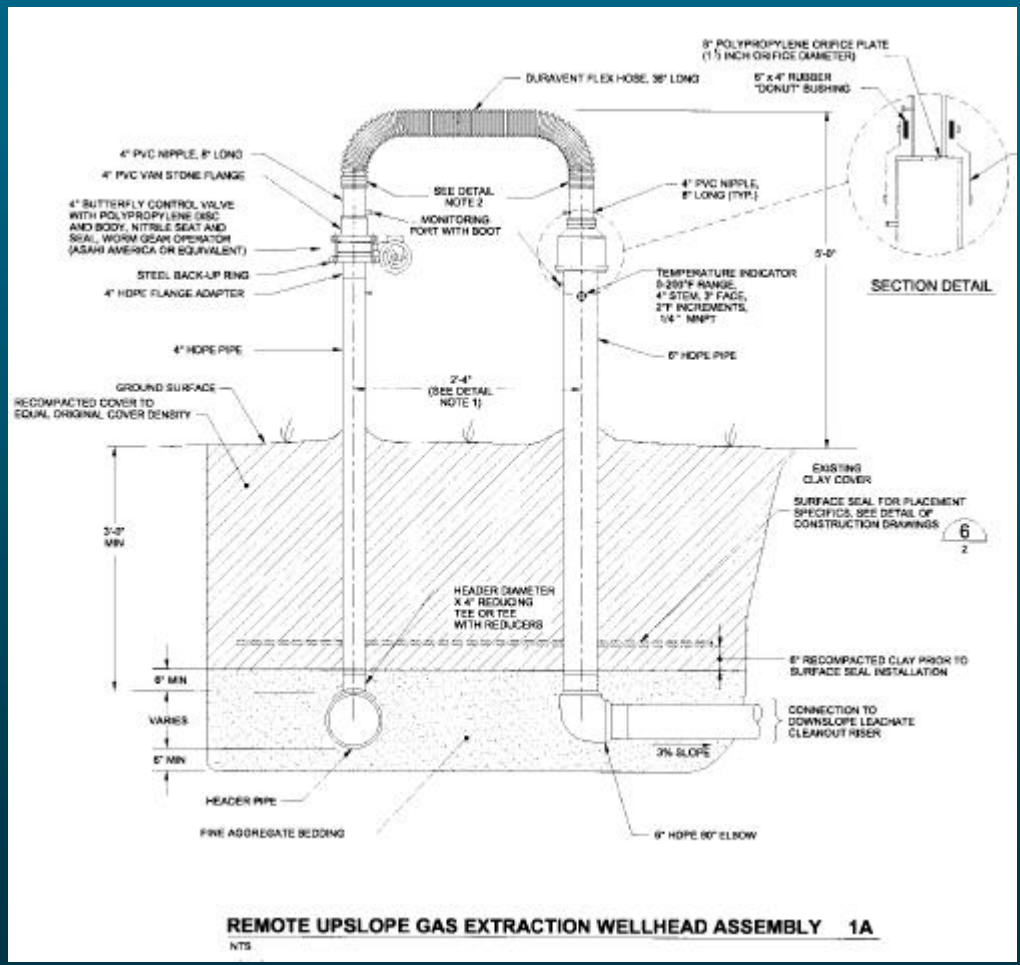
Remote Up-slope Wellhead

- Used when header is upslope of well
- Prevents lateral from filling with condensate
- Typical lateral/wellhead will become blocked with condensate in this configuration

Remote Up-slope Wellhead



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Well Design

- Well Life Cycle
  - Life expectancy
  - Causes for decline in well performance
    - liquids
    - silt
    - pipe crushing
- Design Limitations

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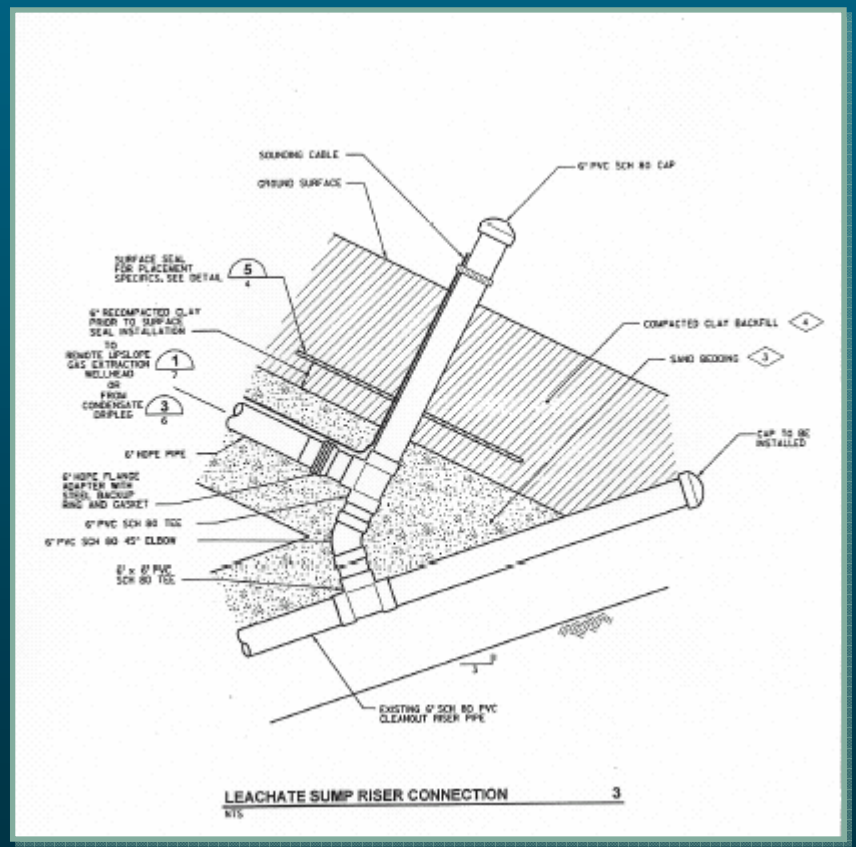
Non-Well Extraction Points

- Leachate collection risers
- Trench systems

- Regulatory Implications

Leachate Sump Riser Connection



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Sump Tie-in

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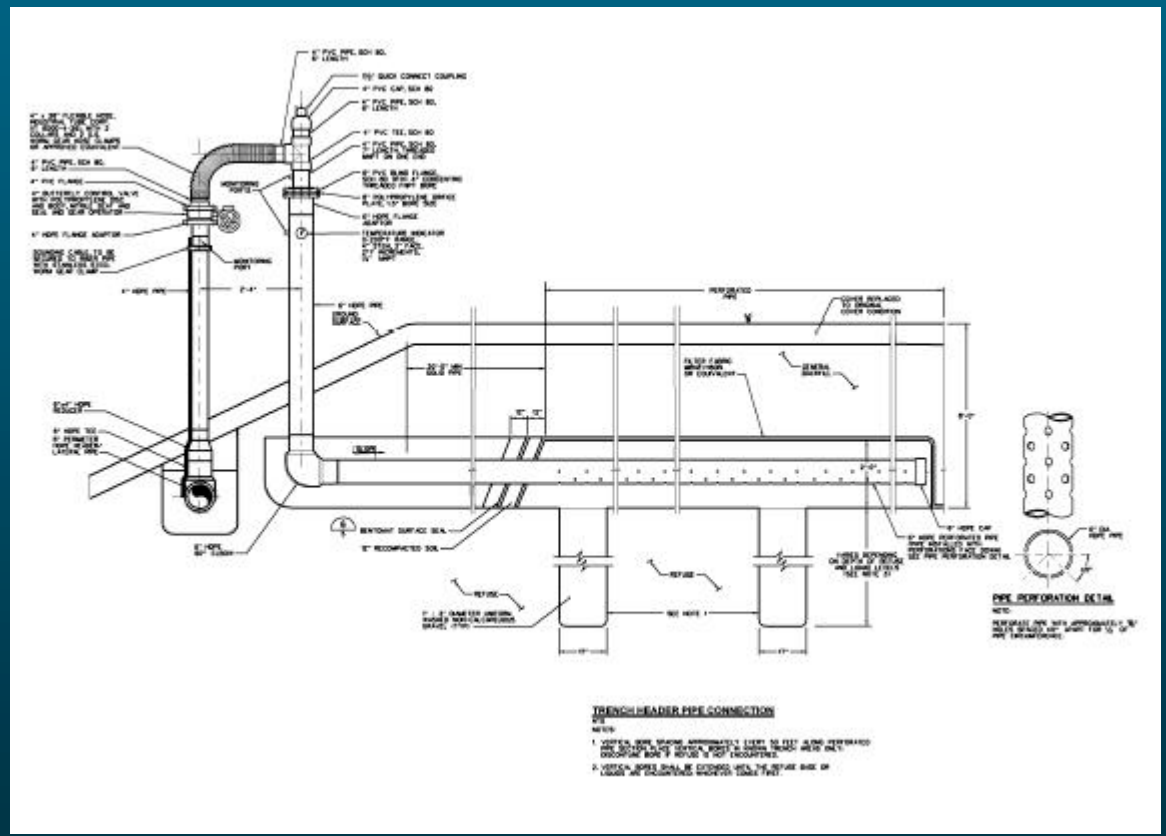
Horizontal Trench Design



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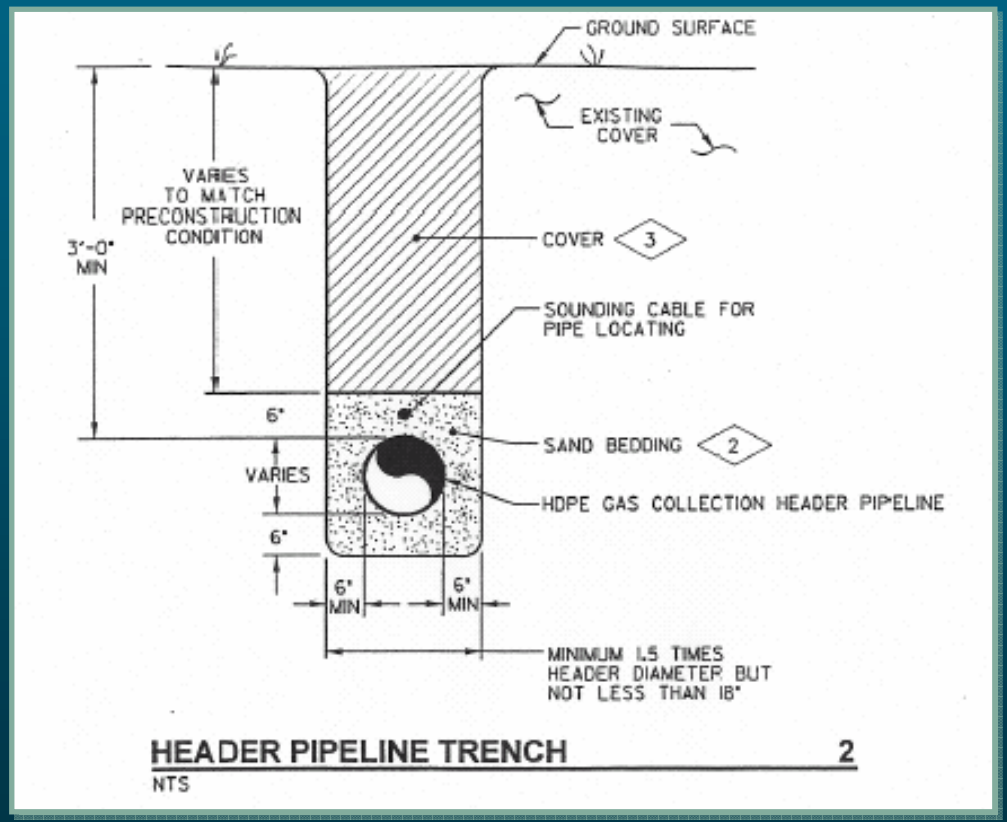
Collection Piping

- How to:
  - Get the vacuum to the wells
  - Get the gas from the well to the flare
    - Or the power plant

Collection Piping

- Looping systems
- Pipe slope
- Pipe diameter
- Valves
- Pipe Lifecycle
- Condensate

Header Pipe Trench



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Collection Piping

- Looping systems
  - Benefits vs. costs
  - Designed to be redundant
  - Accepts expansions

Collection Piping

- Pipe slope
  - Implications associated with settlement
    - Bellies
    - Sedimentation
    - Shearing
  - Design Options
  - Design Limitations

Collection Piping

- Pipe diameter
  - sizing for gas and condensate flow

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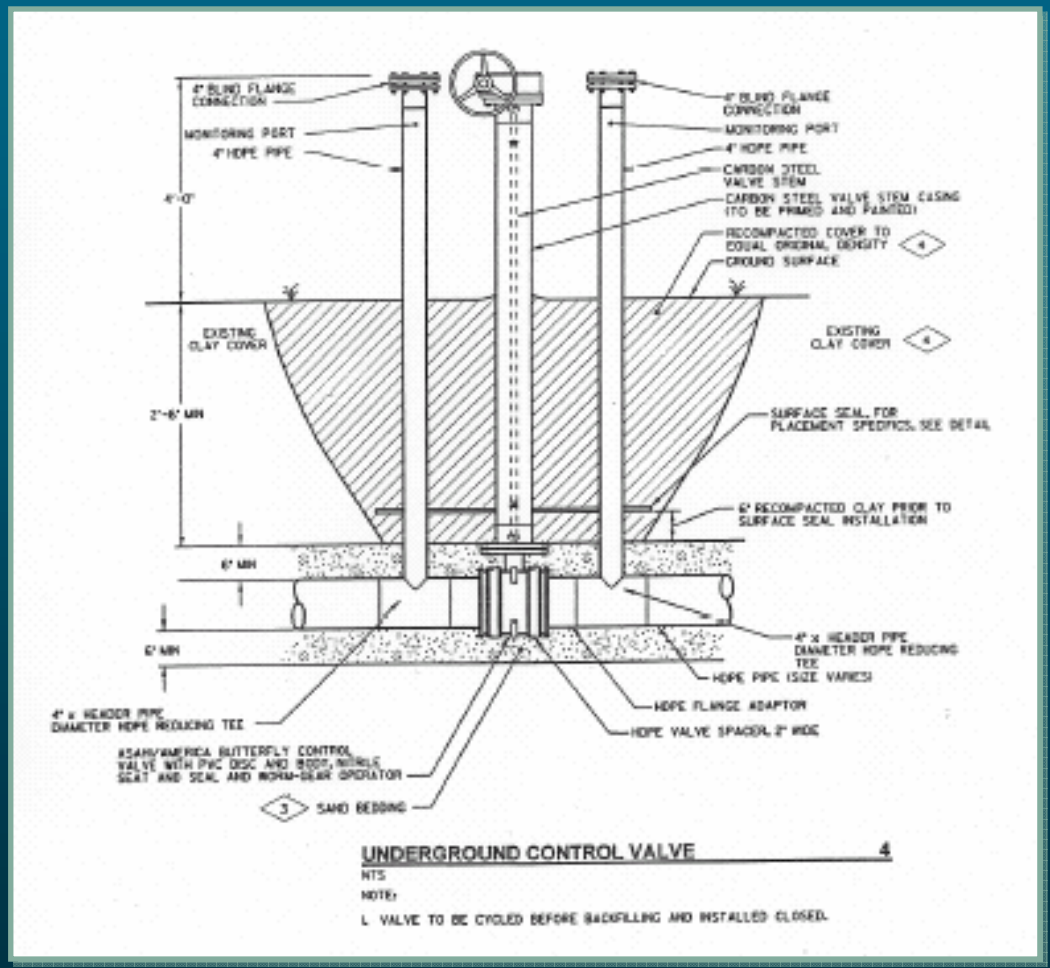
Collection Piping - Valves

- Control valves at strategic locations in header system
- Purpose
  - Isolation portions of the system for maintenance, etc
- Not used for balancing the wellfield
  - Use valves at wellheads for that

Collection Piping - Valves

- Types
  - Butterfly
  - Gate
  - Others
- Materials of construction

Underground Control Valve



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Collection Piping - Valves

- Monitoring ports on both sides of valve for troubleshooting

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Collection Piping

- Pipe Life Cycle
  - Life expectancy
  - Causes for decline in flow capacity
    - Landfill settlement
    - Pipe crushing
  - Design Limitations

Condensate

- HOW DID ALL THIS LIQUID GET IN MY GAS HEADER PIPES?

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Condensate

- What is it?
- Where does it come from?
- Can’t we make it go away?
  - No!
- How do we manage it?
- What if we don’t manage it?

Condensate

- What is it?
  - Warm gas from within the landfill
  - Saturated with water vapor
  - Flows into a cooler area
    - Wellhead above ground at ambient temperature
  - Voila - Condensate!

Condensate

- Managing it
- Need to size headers to carry it, along with the gas

Condensate

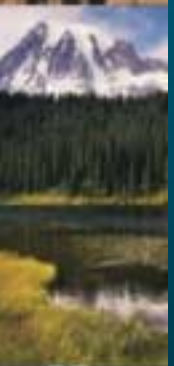
- Headers need to be sloped so condensate doesn't pool in them!
- NEED TO MAKE SURE HEADERS DON'T HAVE UNDRAINED LOW POINTS!!!

Condensate

- Estimating quantities of condensate
  - Gas flow estimates
  - Humidity change
  - System design and gas temperature

Condensate

- Condensate Management Structures
  - Knock-outs
  - Lift stations
  - Barometric drip legs
  - Transfer stations
  - Drip legs
    - Potential for air intrusion
  - Pneumatic vs. Electric



Sump

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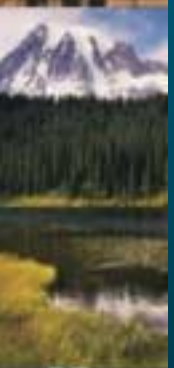
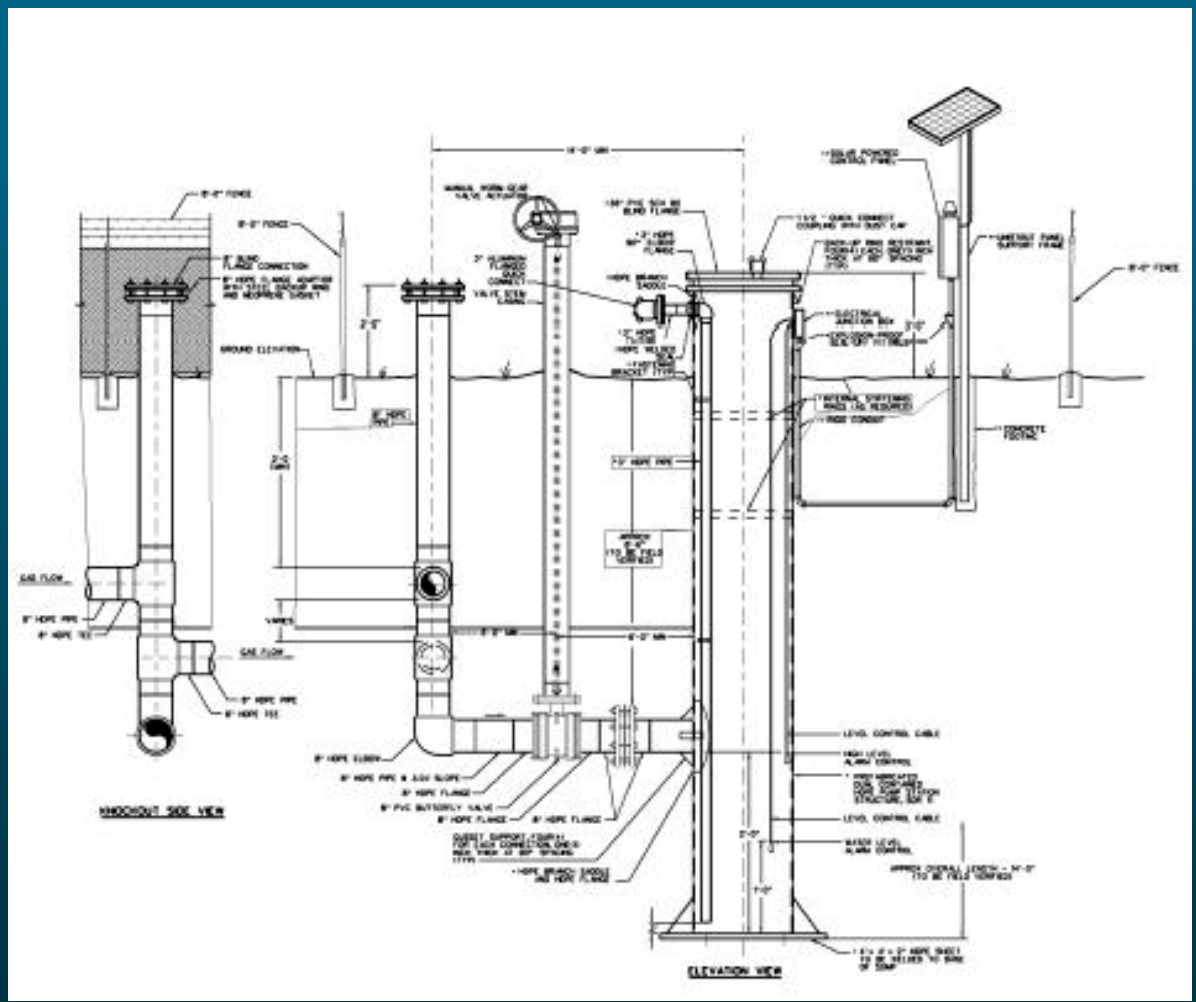



Knock-out Station



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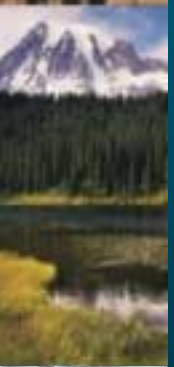

Drip Legs

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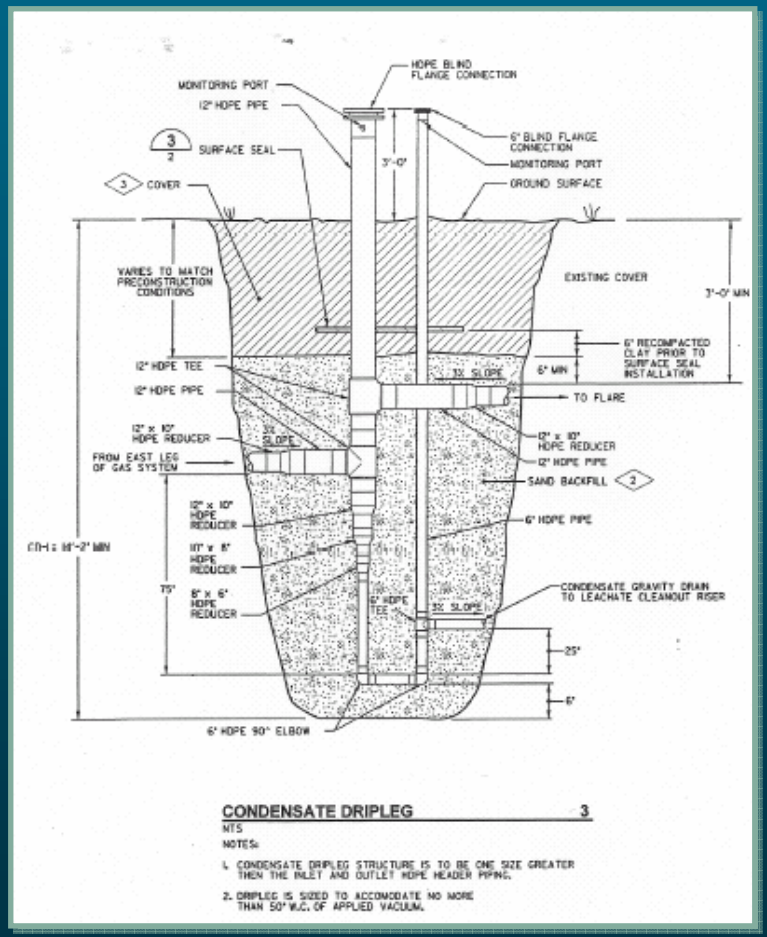
Condensate Drip Leg



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Condensate

- Consequences of inadequate condensate management
  - Flooded headers
  - Low vacuum at well heads
  - Effectively reduces pipe diameter
  - Increased operating cost

Condensate Knock-out and Pump

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Condensate Knock-out and Pump

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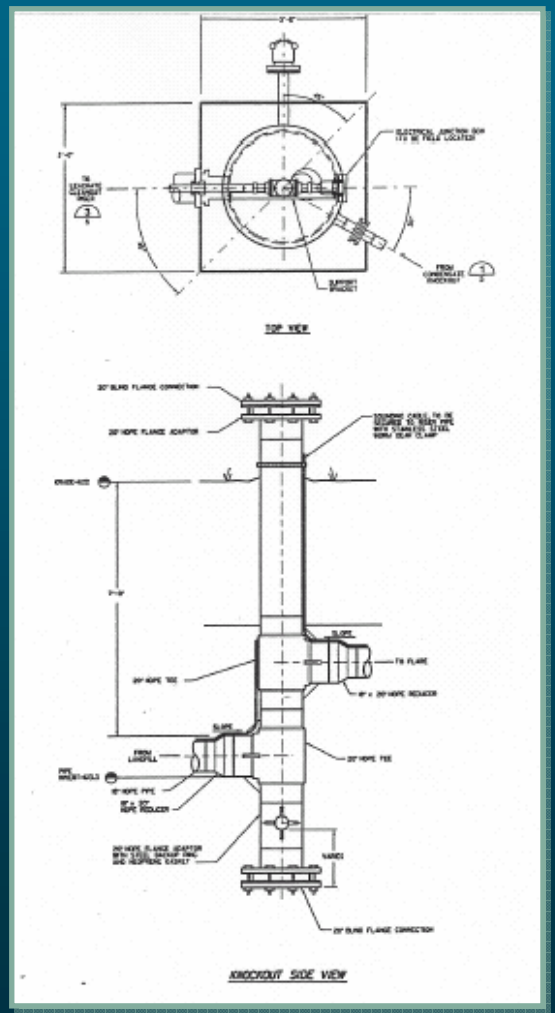
Inline Knock-out



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Dual Leachate/Gas Extraction

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Flares

- What do we do with the gas once we collect it?

Flares

- Enclosed vs. open
- Sizing
- Capacity ranges
- Interconnection with gas recovery project

Flares

- Enclosed vs. open
  - Destruction efficiency
  - Cost
  - Simplicity of operation

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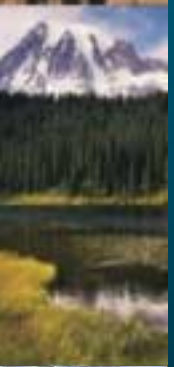
Flares

- Sizing
  - Gas rate
  - Operating temperature
  - Ignition source

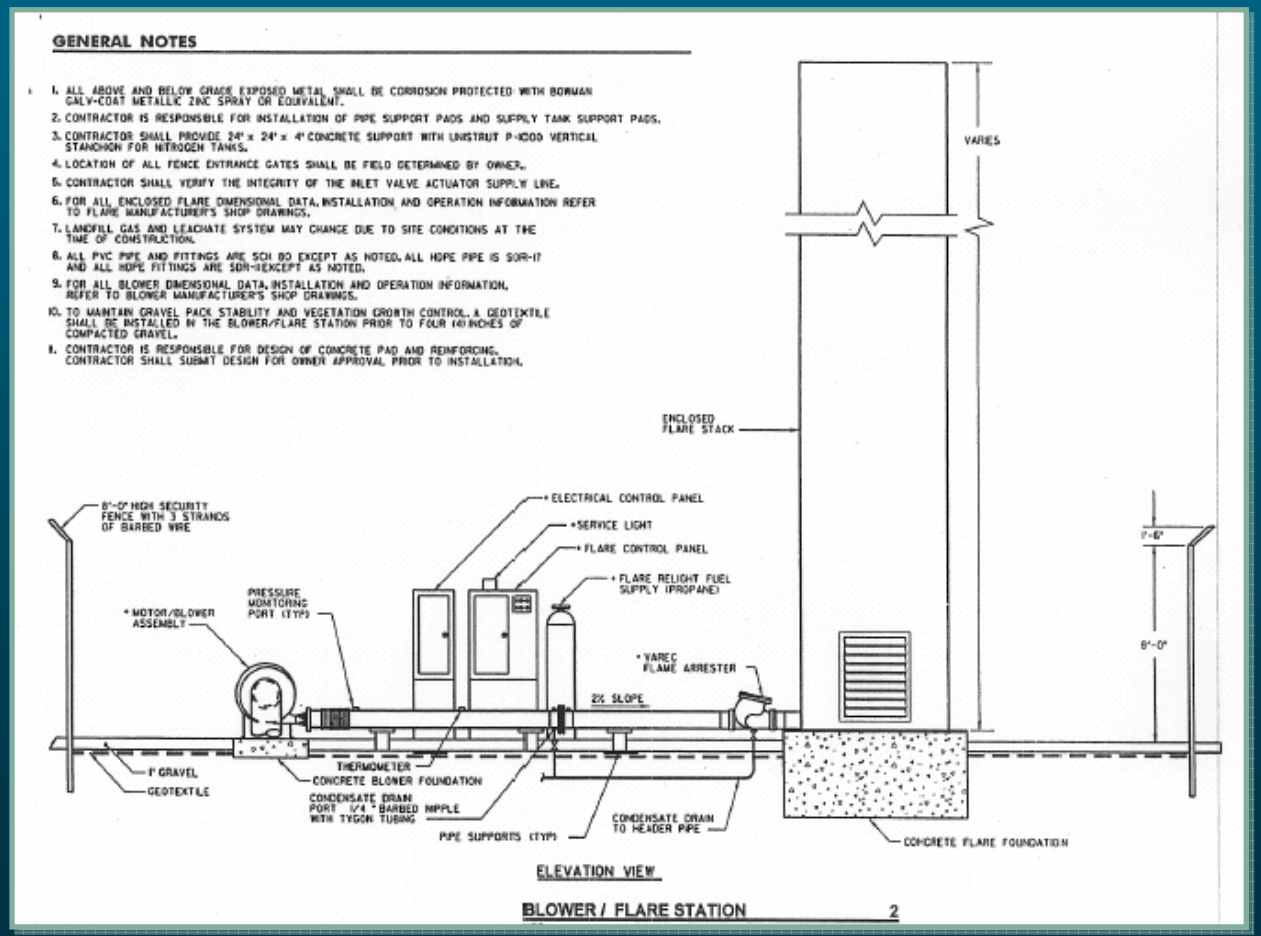
Flares

- Capacity ranges (turndown capability)
  - May be important for some of the closed sites with very little gas






Blower and Flare Station



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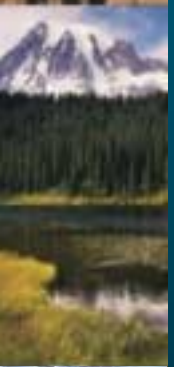
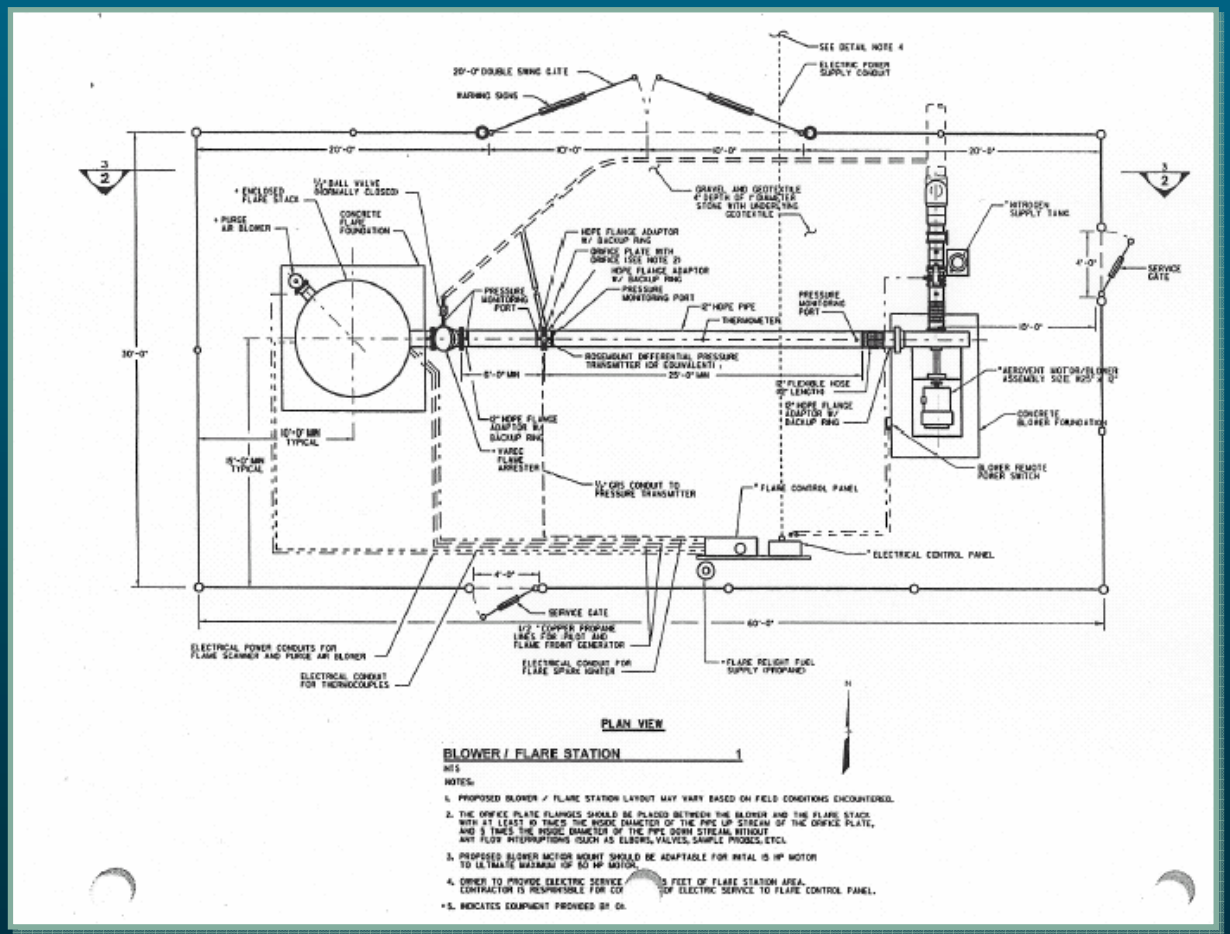


Blower and Flare Station



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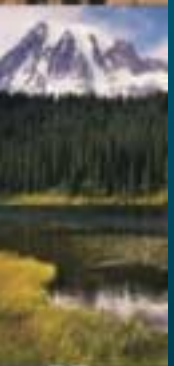

Flare Drain

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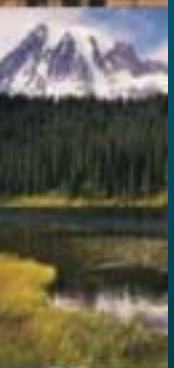


Open Flare

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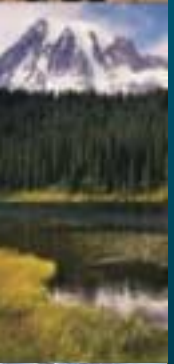
Controls

- Emission safety interlock
  - Flare Off
    - Blower Off
    - Valve Closes
- Pneumatic Valves
- PLC






Flare Valve

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Actuator

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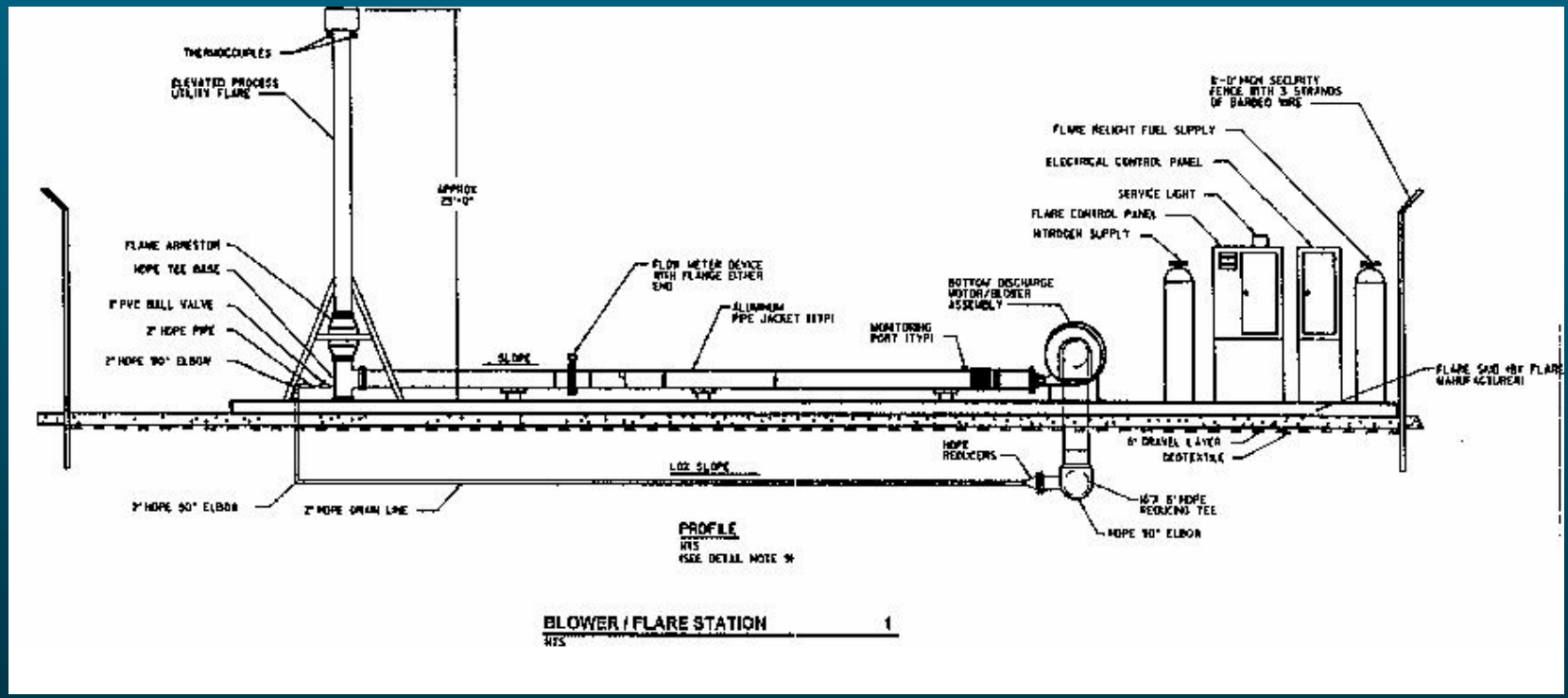
Flare Diagram



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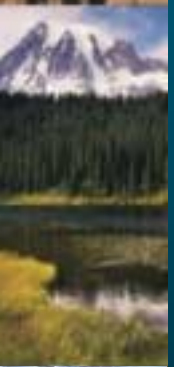
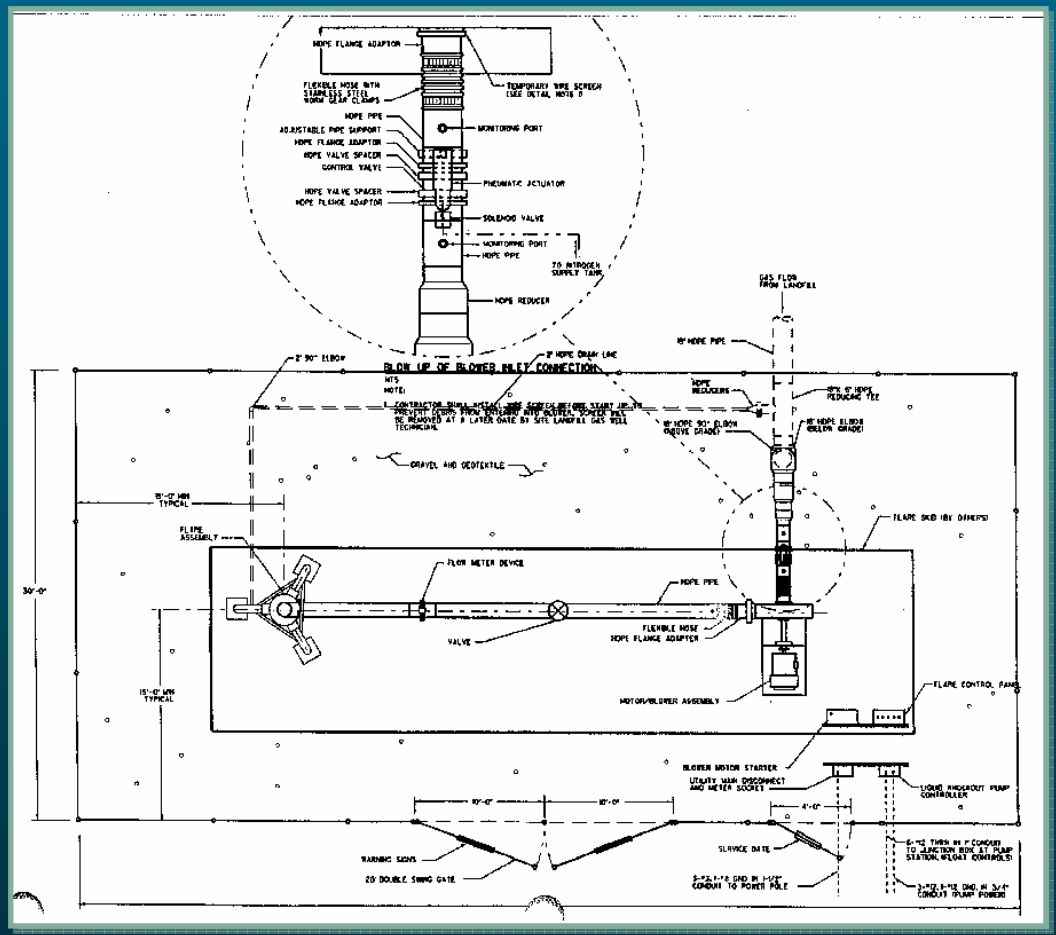



Blower Inlet



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Propane Tank

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Flame Arrestors

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Control Panel

Nitrogen Supply

Flares

- Interconnection with power plant operations
- Implications for NSPS/EG compliance

Construction Quality Assurance

- Documenting that the constructed system resembles the permitted system

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CQA

- Critical elements
- Well construction
  - Depth
  - Slotted pipe
  - Backfill
  - Seal and boots

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CQA

- Critical elements
- Header
  - Slope
  - Pipe size
  - Air tight
- Condensate Management
  - Pipe connections
  - Dripleg dimensions

CQA

- Critical elements
- Document what gets buried and can't be seen after the fact

Collection System Cost Comparison

- Active vs. passive
- Typical 1-10 well system
- Typical 10 – 20 well system
- Typical 20 – 50 well system

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