

Session 1C

Oil & Gas/Environmental Geology

**Horizontal Environmental Drilling 101 –
An Introduction to the Means and
Methods for Horizontal Environmental
Well Installation**

History of Horizontal Environmental Wells

- **Innovative use of existing technology**
- **Horizontal/directional oil wells in the 1930s – present**
- **Directional “river crossings” in the 1970s**
- **Environmental applications for the Department of Energy in 1988**
- **Utilized for most remediation applications by 2014**

Environmental Applications

- **Sampling under obstructions**
- **Extraction techniques**
 - **Groundwater**
 - **Free phase product – NAPL and DNAPL**
 - **Vapors**
 - **Dual phase**
- **Injection techniques**
 - **ISCO**
 - **Nutrient injection**
 - **Air sparge**
 - **Bio sparge**
 - **Barriers – PRBs/HRx**

Environmental Applications

- **Thermal treatment**
 - Hot air/steam injection
 - Electrical resistance heating
- **Geotechnical**
 - Dewatering
 - Slope stability
- **Groundwater production**

Applications/ Advantages of Horizontal Wells

Access Areas Unreachable to Vertical Wells

- **Airports**
- **Rail Yards**
- **Landfills**
- **Pits/Ponds/Lagoons**
- **Chemical Plants**
- **Manufacturing Facilities**

Applications/ Advantages of Horizontal Wells

Allows screen placement in areas of concern

- **Most plumes are long and thin**
- **Well placement can mimic plume geometry**
- **Entire screen can be placed in free phase**

Fewer wells are required for remediation

- **Vertically fractured bedrock**
- **Greater ROI**

Applications/ Advantages of Horizontal Wells

Minimal Site Impact

- **Reduce amount of wells/well head required**
- **Well heads can be placed away from existing surface infrastructure**
- **Less construction time on site**

Directional Control/Steering

- The bit is navigated along a predetermined path
- The well need not be horizontal or straight
- Bore path is design is based on
 - Allowable bending radius of drill pipe and well materials
 - Geology
 - Treatment objective
 - Surface constraints

Directional Control/Steering

- The drill string is steered by pushing the drill pipe against an asymmetric bit with a hydraulic jet; “duck bill” or bent sub
- The force against the bit or sub forces the drill pipe in direction of the bit orientation
- When the entire assembly is rotated, the drill string goes straight
- A sensor behind the bit sends the direction/orientation of the bit to the surface



Locating Technologies

- **Several Options Available**
 - Induced magnetic field
 - Earth's magnetic field and gravitational force
 - Gyroscope
- **Selection based on bore path, interference risk, depth and cost**

Drilling Fluids are Required

- **Maintain hole stability**
- **Remove cuttings**
- **Limit drilling fluid loss to the formation**
- **Cool bit and steering tools**

- **Clay (Bentonite)**
- **Bio-polymer**

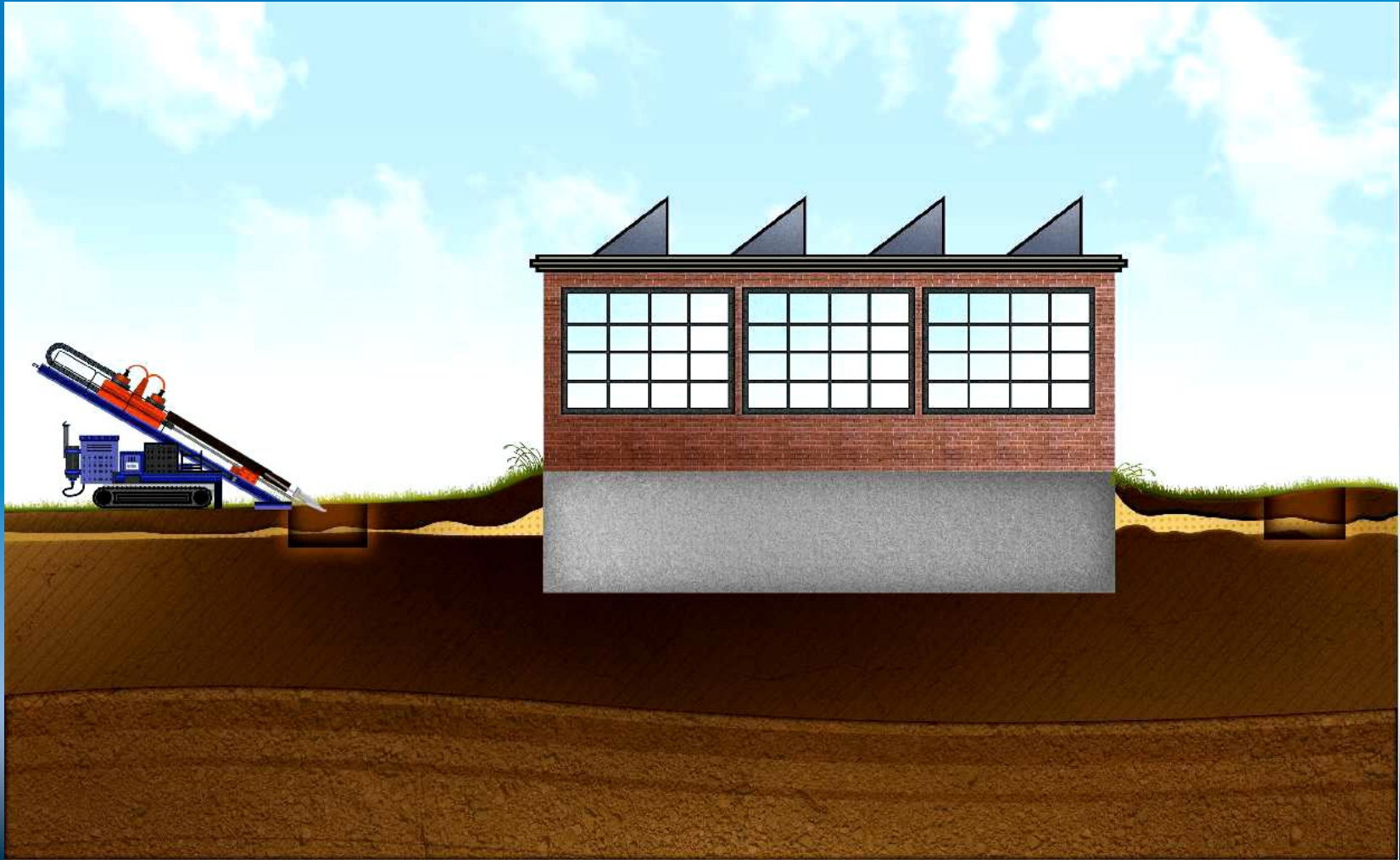
Well Materials (Screen & Casing)

- **Similar materials to vertical well installations**
 - PVC
 - Carbon steel
 - Stainless steel (304 and 316L)
 - HDPE
 - Fiberglass

Types of Horizontal Wells

- **Continuous Completions**
 - Two access points to the well (entry and exit)
 - Well depths over 200'
 - Well lengths over 2,850'
 - Screen and casing pulled into the borehole
 - Requires access to the exit point

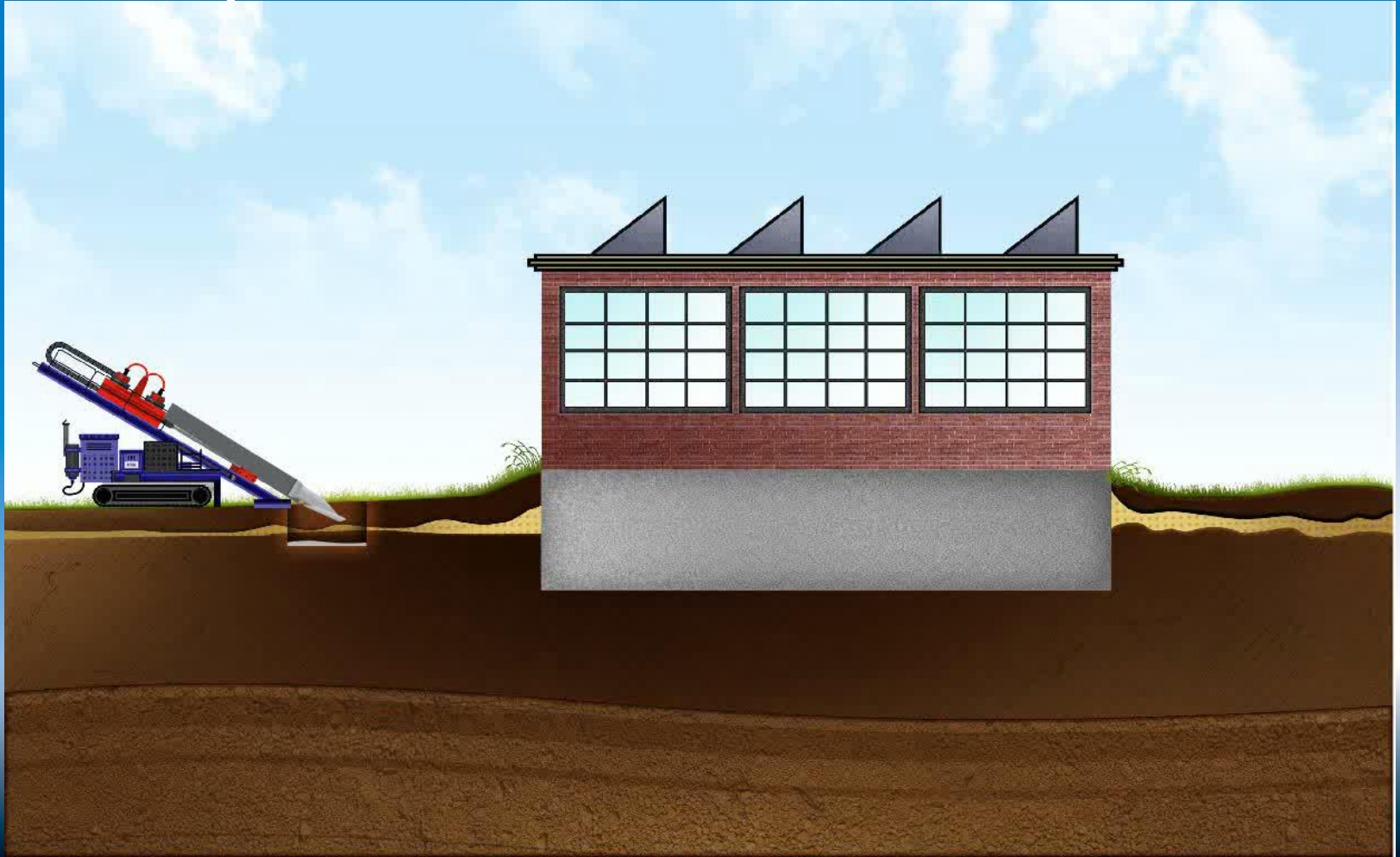
Continuous Well Installation



Types of Horizontal Wells

- **Blind Completion**
 - Only one access point to the well
 - Ideal for offsite plumes
 - Well depths over 200'
 - Well lengths over 1,500'
 - Screen and casing pushed into open borehole
 - Screen and casing installed inside of drill pipe using patent pending “knock off” technology

Open Hole Blind Well Completion



Drilling Equipment

- **Drill rig**
- **Fluid cleaning/recycling system**
- **Pipe trailer**
- **Support equipment**
 - **Water truck**
 - **Crew truck**
 - **Backhoe**
 - **Excavator**

Small Rig Set Up Area

- 7,000 lb. capacity rig
- 30' x 50' area
- Continuous well requires area at exit point



Large Rig Set Up Area

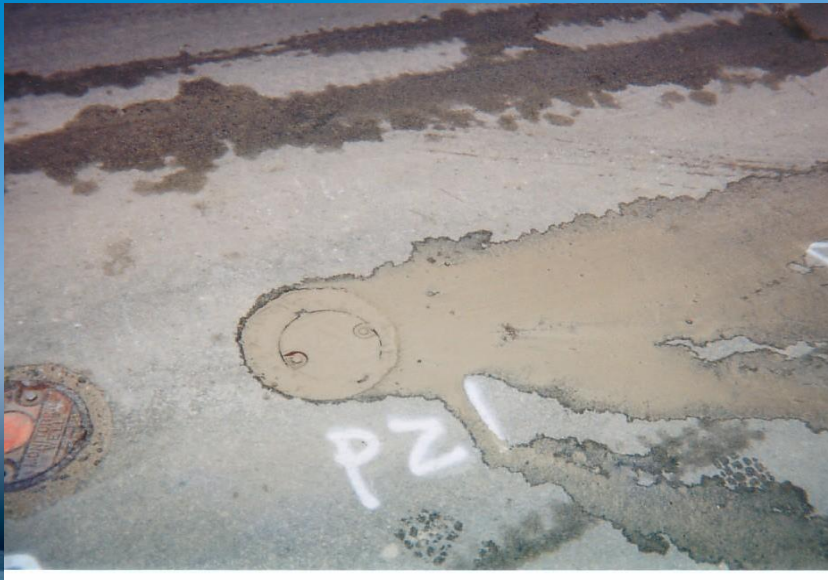
- 200,000 lb. capacity rig
- 100' x 150' area



Installation Challenges

- **Drilling fluid vent to the ground surface – “Frack Out” or “Inadvertent Fluid Return”**
 - **Drilling fluid properties and depth below ground surface are contributing factors**
 - High mud weight and pump pressure
 - Shallow portions of the bore or long shallow wells (less than 10’ deep)
 - Mitigated by drilling techniques
 - Spills contained with sand bags and pumping systems
 - Impacted area normally “heals” in 24 hrs.

Installation Challenges



In Summary

- **The technology is innovative - not experimental**
- **Horizontal wells are a proven, cost effective installation method**
- **Thousands of wells have been successfully completed in the US**
- **Horizontal wells can be used with all remediation technologies**

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