Single-Ended (Blind) Directional Wells For Ash Basin Dewatering

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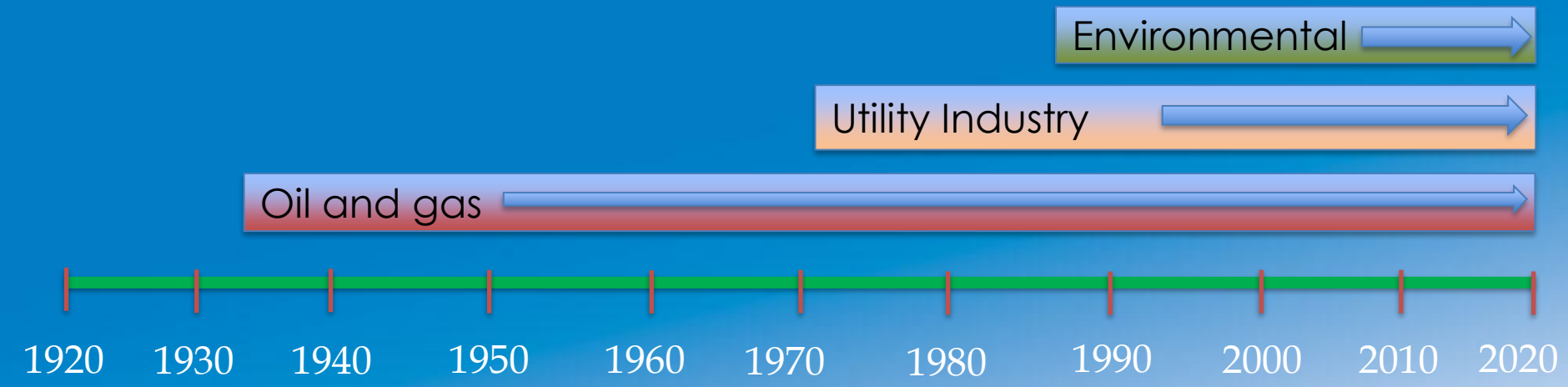
The History of Horizontal Wells



1933: First O/G HDD Conroe Crater, TX or Long Beach, CA

1971: First pipeline river crossing: Pajaro River, CA

2016: First HDD installed CCR pore water removal well

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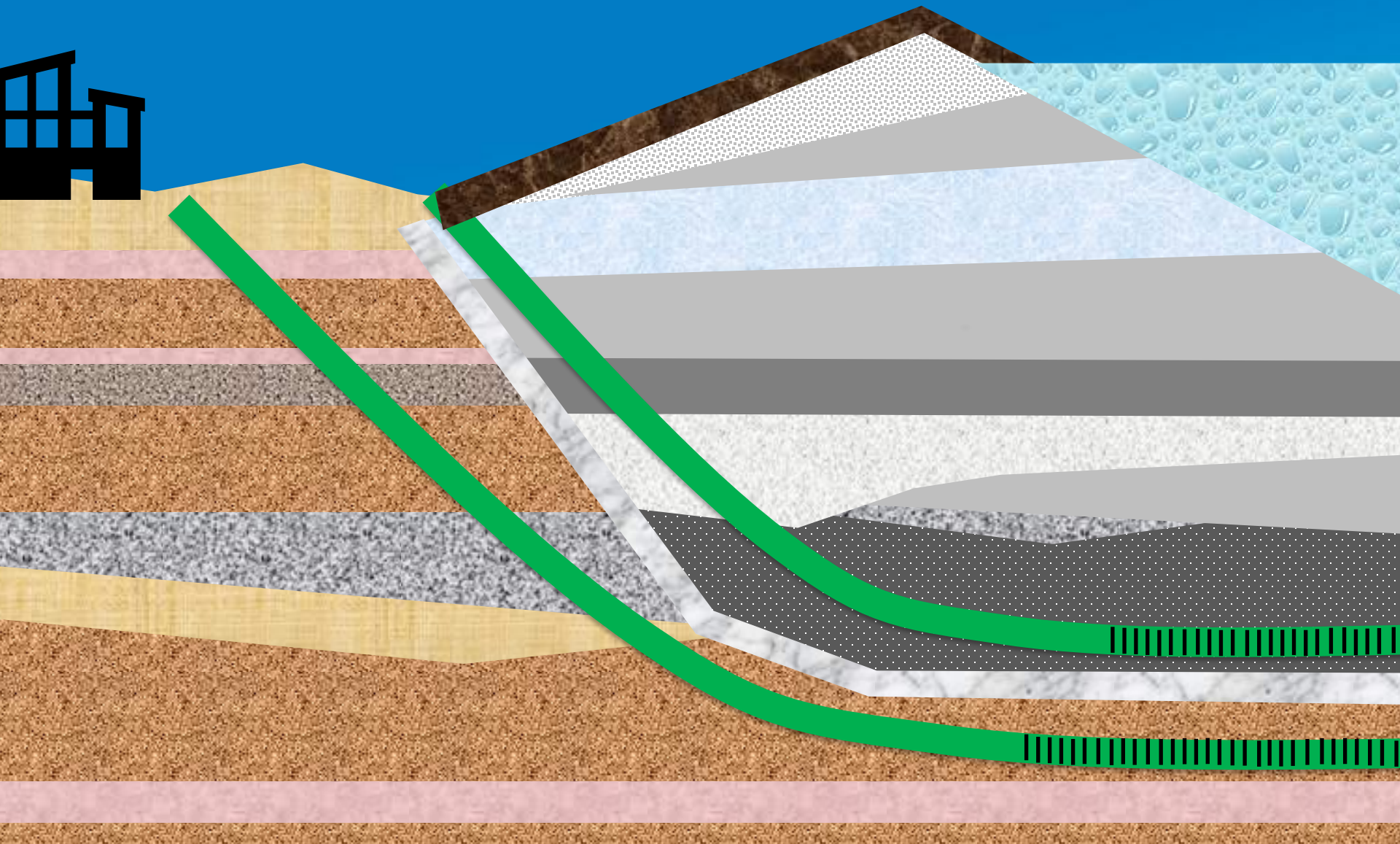
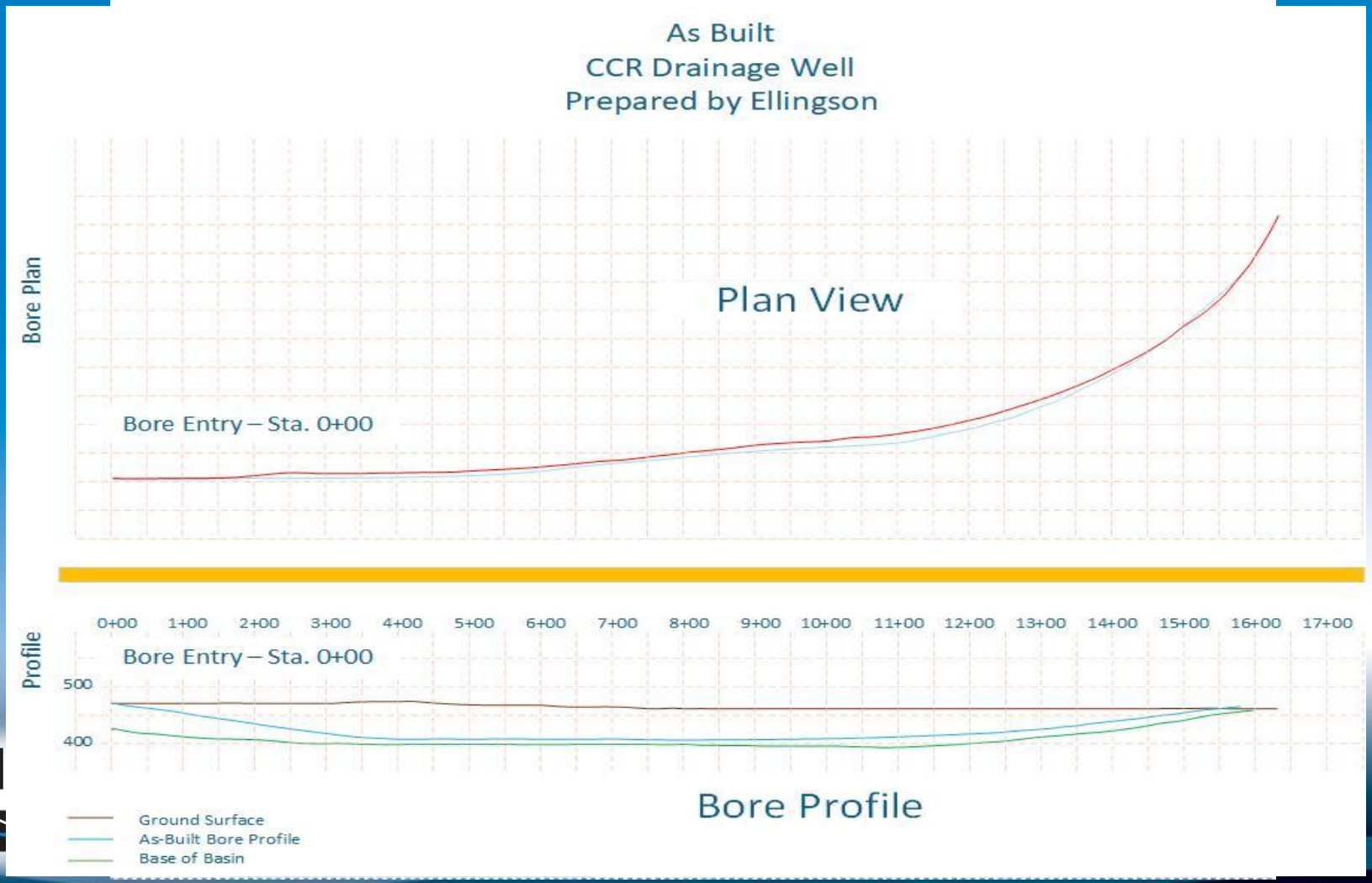
The primary advantages of horizontal wells are ACCESS and GEOMETRY



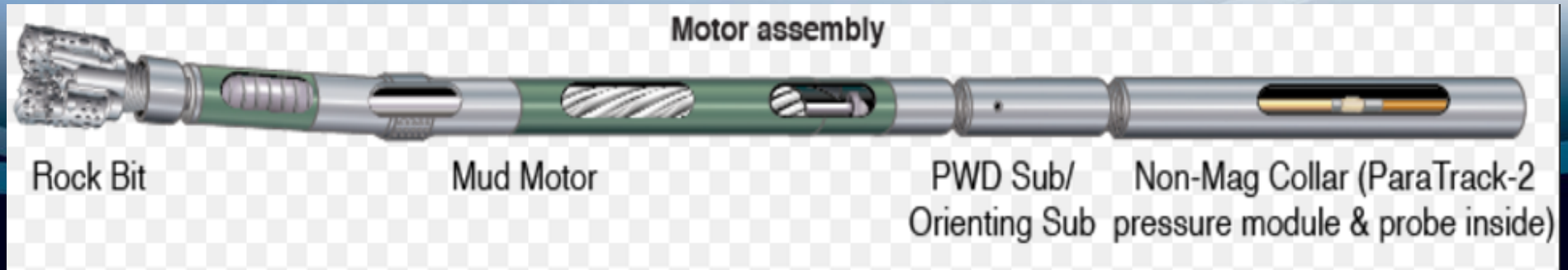
Traditional Dewatering Methods Can be Intrusive

Major Advantage of Horizontal DIRECTIONAL Wells

Wells Don't Need to be Straight or Horizontal



Asymmetry in the bit allows steering in three dimensions



There are two basic locating technologies available

Walkover

- Require stable surface ash access for personnel
- Subject to interference
- Depth limited to about 80’ bgs
- Inexpensive

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There are two basic locating technologies available

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There are two basic locating technologies available

Gyroscopic Steering Tool - GST

- "Oilfield" technology
- Solid state gyroscope connected from housing behind drill bit to the surface
- No ash surface access needed
  - Ideal for unstable ash or under free water

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There are two basic locating technologies available

GST

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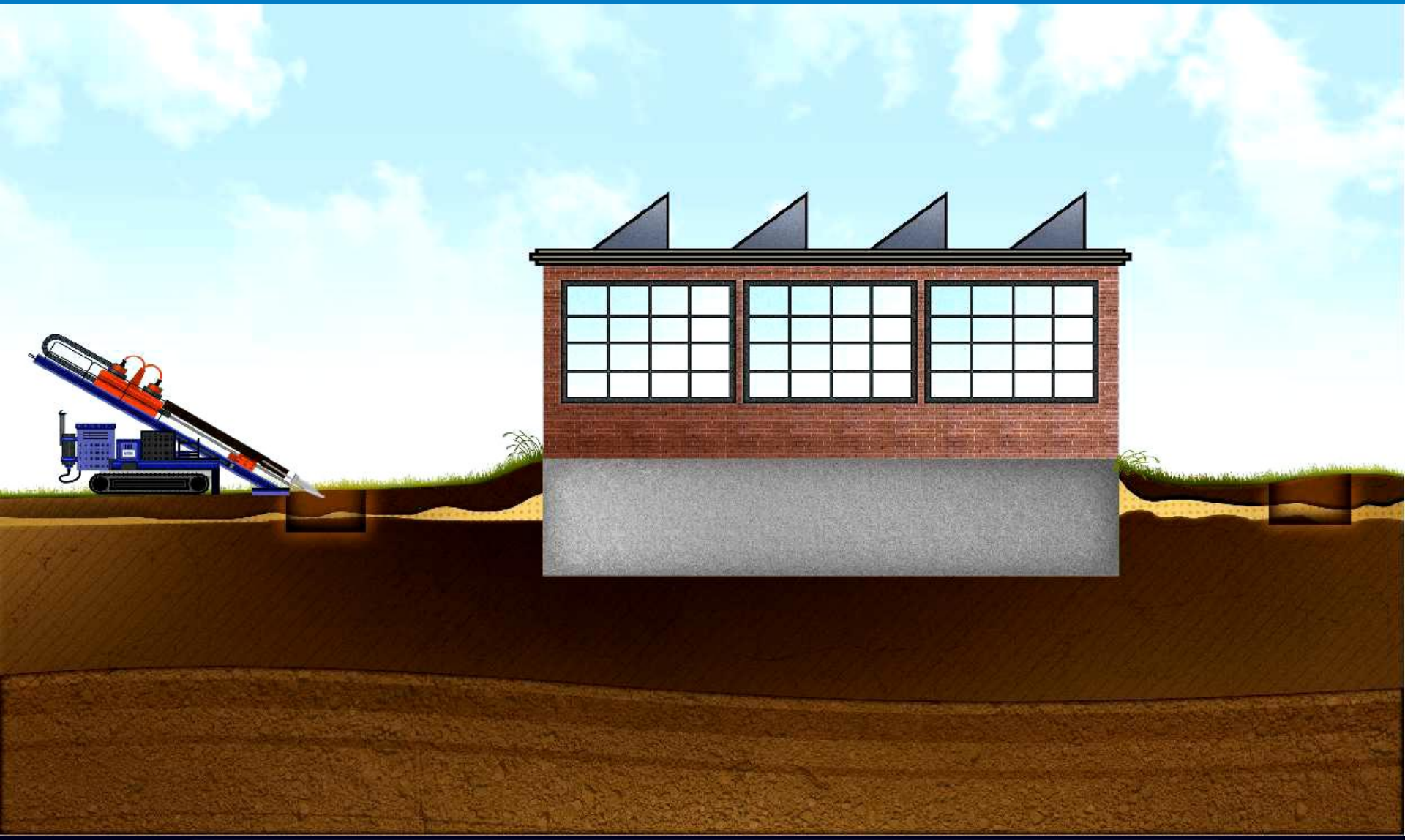
Photo from Google

There are two commonly used types of drilling fluid

Bentonite

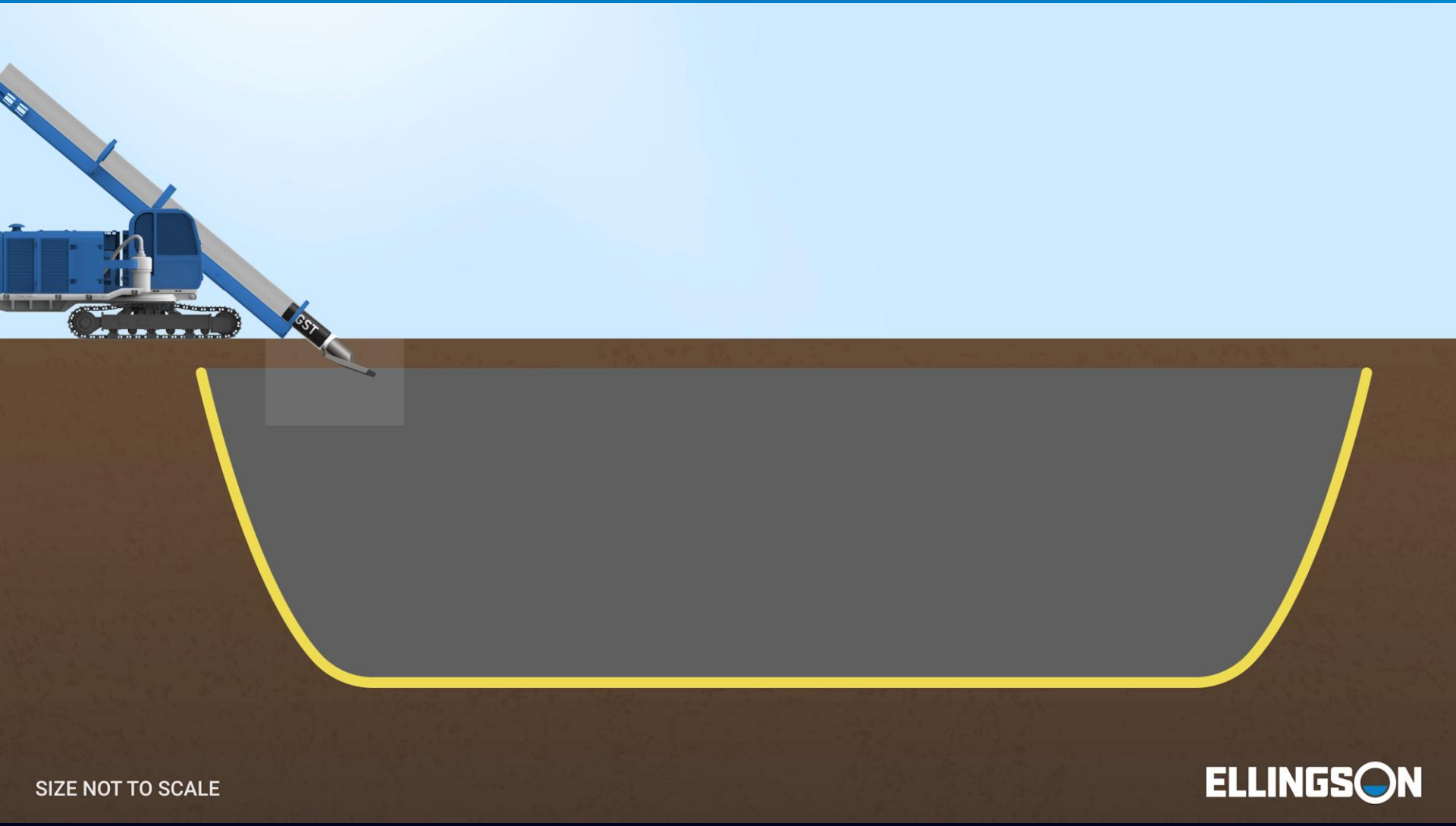
Biopolymer

Continuous Well Installation



Continuous Wells Require Exit Side

Blind Well Knock Off



SIZE NOT TO SCALE

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Horizontal CCR Project Evolution

- Pilot test horizontal well
  - We suggest two wells
- Perform pump tests
  - Flow rates between 11 gpm and 60 gpm
    - Mixed waste – FGD and gypsum emplaced with ash
    - Fly ash only
    - Fly and bottom ash
    - Bottom ash
- Develop basin wide model

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Case Study

- Primary ash basin
- Roughly 2,500 ft x 1,000 ft
- Unlined
- Ash depth ~ 45 ft
- Pilot horizontal dewatering well completed in September 2022

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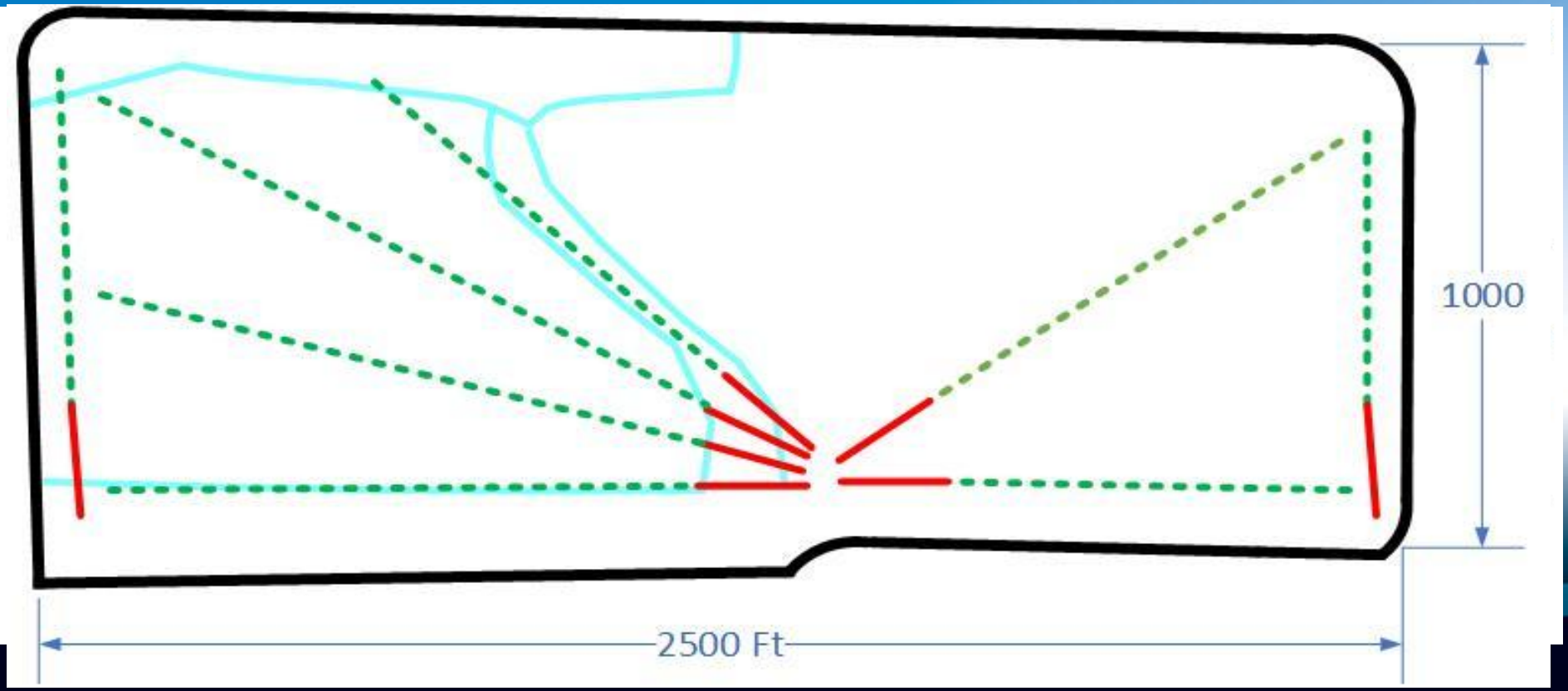
Full scale implementation

Horizontal directional rig placed on stable ash

Full scale implementation

- Eight horizonal pore water removal wells installed
- Average length 1,074 ft, installed at ~45' below the ash surface



Full scale implementation results

- Current combined flow rate is ~ 80 gpm
- Total water removed ~ 33,000,000 gallons
- Water level in basin lowered roughly 9’ in Southern and 6’ in Northern portions of the basin

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Pore Water

Pump Selection & Installation

Well ID	Low elevation (feet amsl)	Distance from surface (feet)	Station
HEW-02	413.1	228.0	01+89
HEW-03	404.65	231.9	02+26
HEW-04	411.1	407.6	03+75
HEW-05	411.4	237.8	02+41
HEW-06	411.3	416.4	03+87
HEW-08	411.3	383.1	03+54
HEW-09	410.7	525.1	04+96

GRUNDFOS

Submittal Data

PROJECT:	UNIT TAG:	QUANTITY:
	TYPE OF SERVICE:	
REPRESENTATIVE:	SUBMITTED BY:	DATE:
ENGINEER:	APPROVED BY:	DATE:
CONTRACTOR:	ORDER NO.:	DATE:

Note! Product picture may differ from actual product

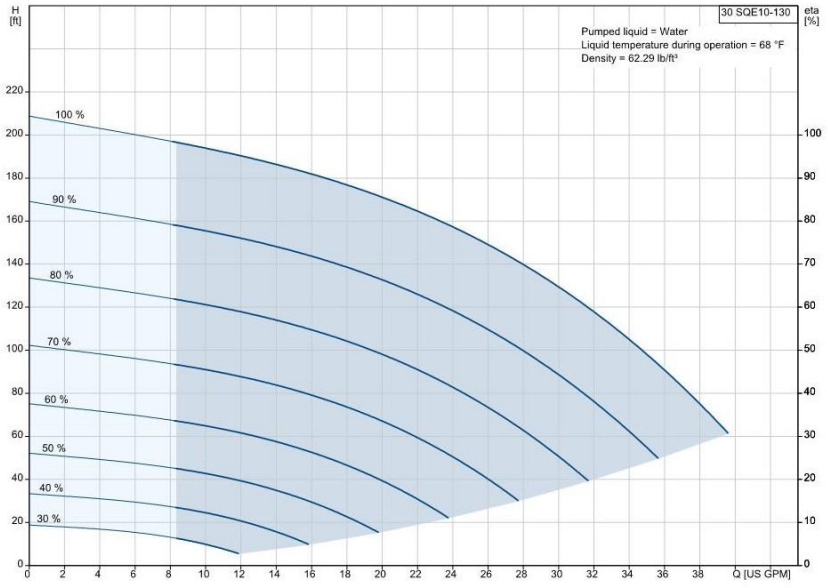
30 SQE10-130

Submersible pumps with variable speed motor

Conditions of Service	
Liquid:	Water
Temperature:	68 °F
Specific Gravity:	1.000

Pump Data	
Liquid temperature range:	32 .. 95 °F
Product number:	96160204

Motor Data	
Rated voltage:	200-240 V
Mains frequency:	60 Hz
Enclosure class:	IP68
Insulation class:	F
Motor protection:	Y
Thermal protection:	internal
Motor type:	MSE3



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Ellingson CCR Experience

- 36 Horizontal Wells Installed at CCR Sites
- 20 Pore Water Removal/Dewatering
- 16 Under Ash and Ponds for Groundwater Containment and Control
- Wells Completed in IN, MT, TN, NC, TX, WY, MI, AZ, WI, GA
- Over 56,000' of Horizontal Wells Completed
- Pore water production rates between 11 gpm and 60 gpm

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Final Thoughts

Horizontal wells are less intrusive and reduce risks of personnel working on unstable ash surfaces

Horizontal directional drilling (HDD) methods can complete wells in ash for pore water removal

Double-ended wells can be complete over 3,000'

Single-ended wells completed to 2,600'

Ground water control and containment

Installation of vibrating wire piezometers

Monitoring under existing lined and unlined basins

Office Locations

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