INFUSE

Feb. 29, 2016

Who is Northeast Natural Energy?

- NNE was founded in 2010 by Mike John, Mark Williams, John Adams and Jo Ellen Yeary, they all had previously worked together at Columbia Natural Resources and Triana Energy Prior to forming NNE
- NNE drilled it's first Wells in 2011 at the MIP location just outside of Morgantown
- NNE has drilled and operates 23 Marcellus Shale wells in West Virginia and Pennsylvania
- We currently have 9 more wells drilled and waiting on Completion
- NNE is a Charleston West Virginia based company with decades of Appalachian Basin experience

Well Planning

- Before we move a blade of grass, there are years of planning that go into each and every well
  1. Geology – a gas or oil bearing formation needs to be identified
  2. Acreage Acquisition – in order to drill a well, oil and gas rights need to be secured, most often done through mineral leasing, assignment of lease interest, or selling of HBP rights
  3. Permitting- WV DEP and PA DEP regulate oil and gas development, and are responsible for issuing most of the necessary permits. There are some permits that require federal agency approval such as US Army Corps of Engineers and US Fish and Wildlife
     - Average WV DEP permit 90-100 days
     - Average PA DEP permit 180-270 days

Site Construction

- Once all of the necessary permits have been acquired construction can begin
- Normal pad size is 200’ x 300’
- Construction takes 6-8 weeks, depending on season and terrain

northeast
NATURAL ENERGY

Drilling – (Phase 1) Spudder Rig

- NNE takes a phased approach to drilling to maximize efficiency
- First rig drills the cellar and conductor casing string

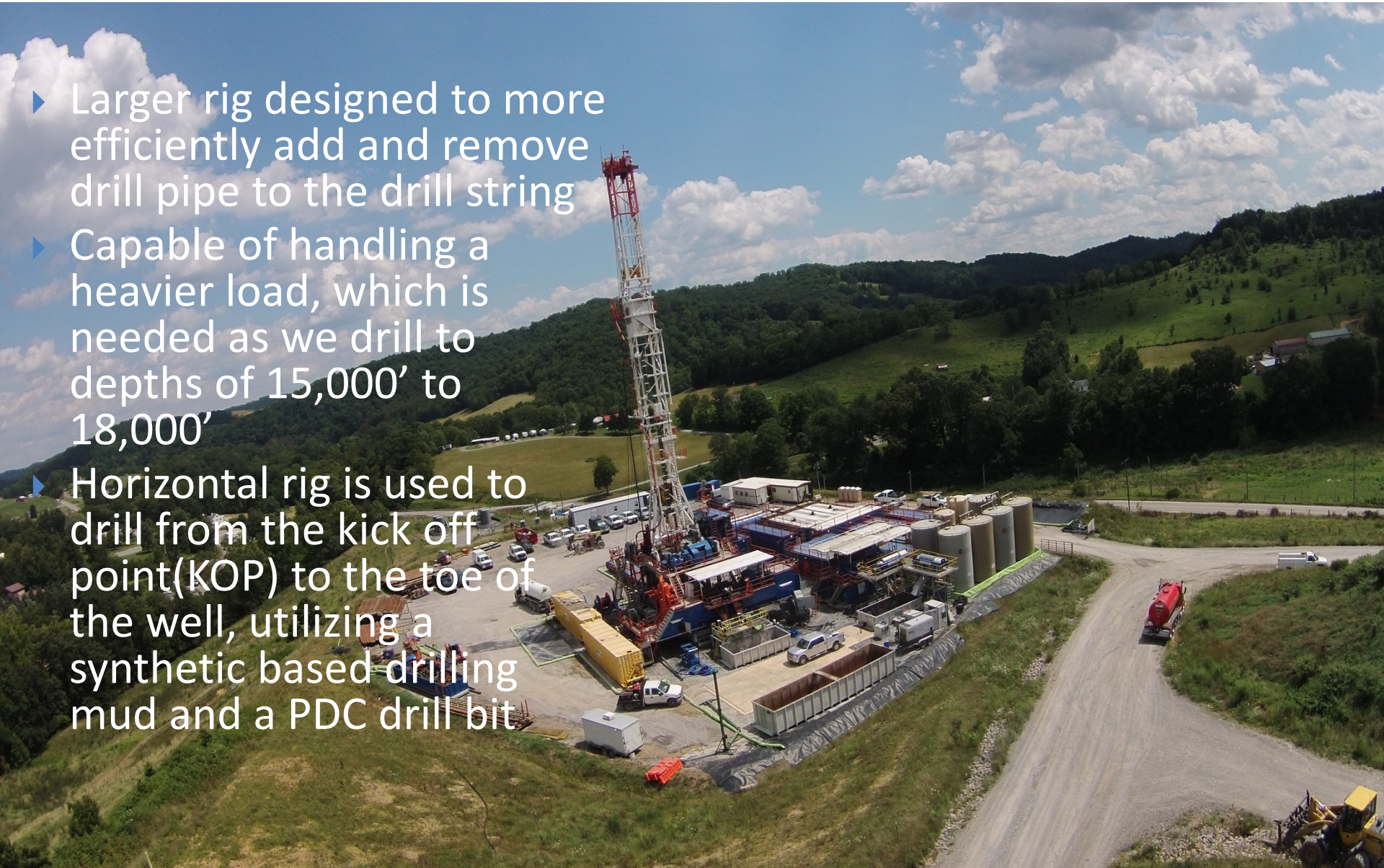
Top Hole Drilling

Drilling – (Phase 2) Top Hole Rig

- A top hole rig is used to drill the surface casing, which is designed to protect the deepest fresh water bearing zone, and the intermediate casing string, designed to isolate non-target pressurized zones from the well bore
- Usually drilled on air with a hammer bit

Horizontal Drilling

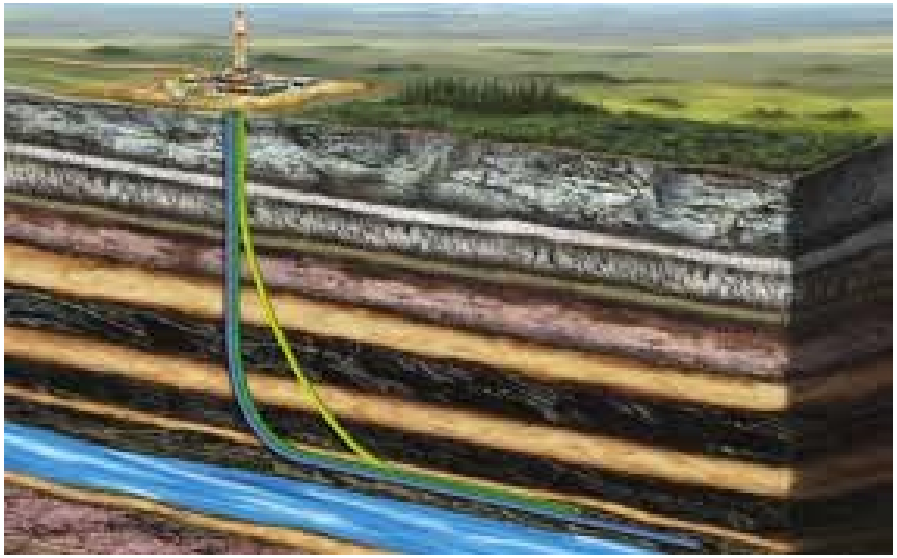
Drilling – (Phase 3) Horizontal Rig



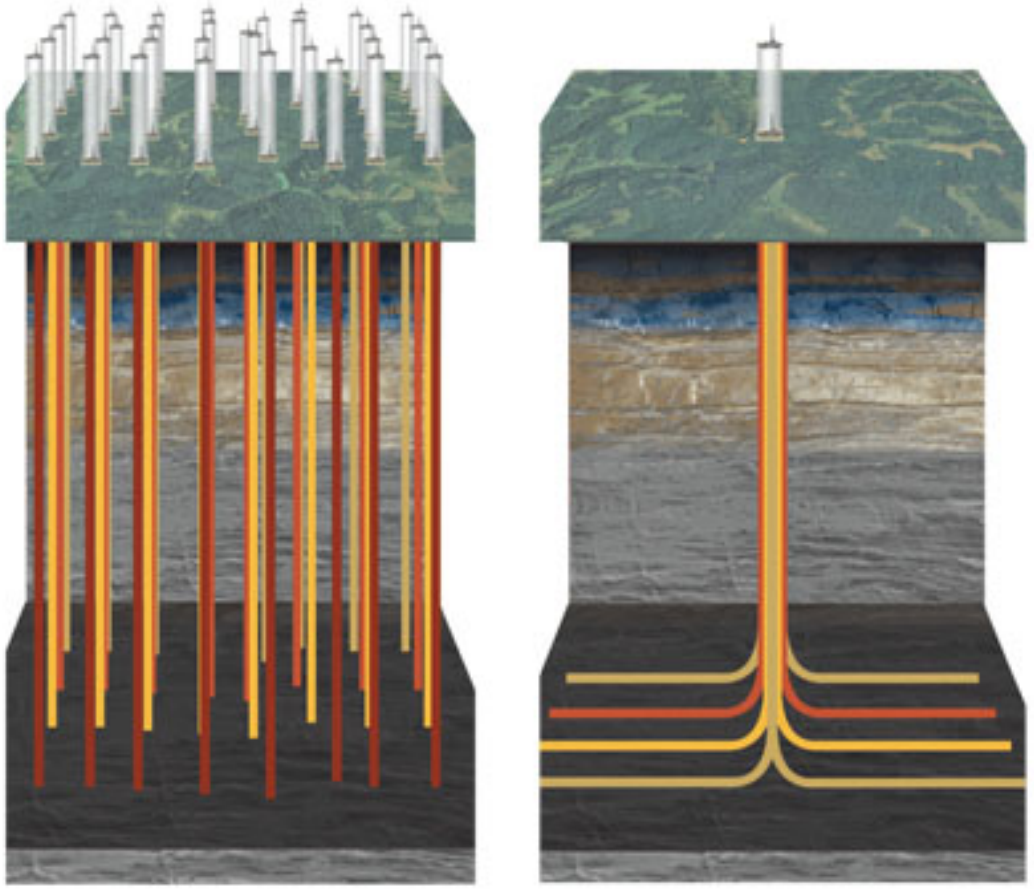
- Larger rig designed to more efficiently add and remove drill pipe to the drill string
- Capable of handling a heavier load, which is needed as we drill to depths of 15,000’ to 18,000’
- Horizontal rig is used to drill from the kick off point(KOP) to the toe of the well, utilizing a synthetic based drilling mud and a PDC drill bit

Directional Drilling-Rotary Steerable

- Smoother wellbores
- Longer laterals
- Eliminates tripping to surface for bit replacement
- Directional tools are closer to the drill bit making geo-steering more accurate



Horizontal vs. Vertical Development

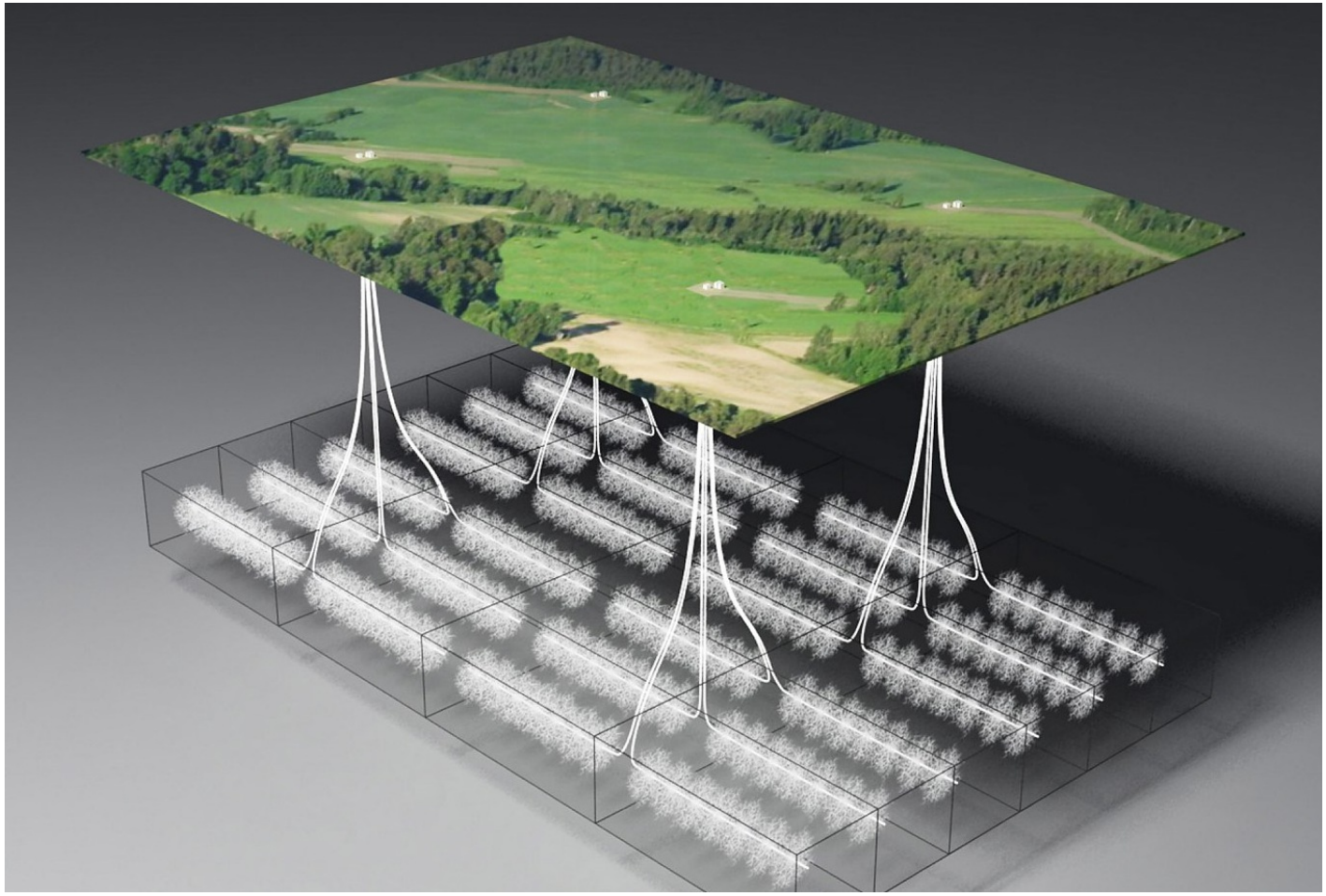


Traditional Vertical Well Spacing:
32 Separate Padsites Needed For 32 Wells.

Idealized Horizontal Well Spacing:
1 Padsite Yields Up To 32 Wells.

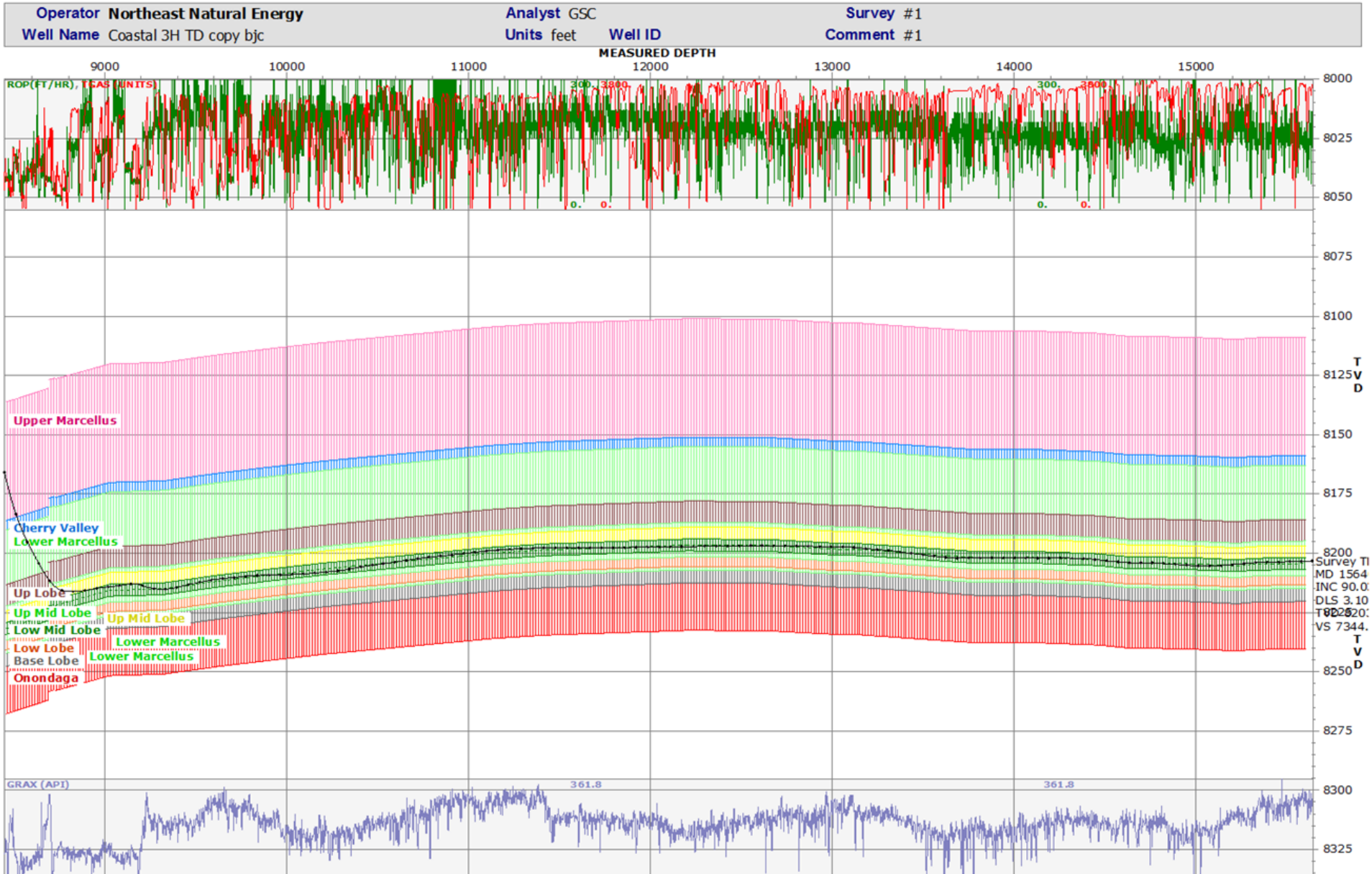
northeast
NATURAL ENERGY

Longer Laterals Lessen the Surface Impacts



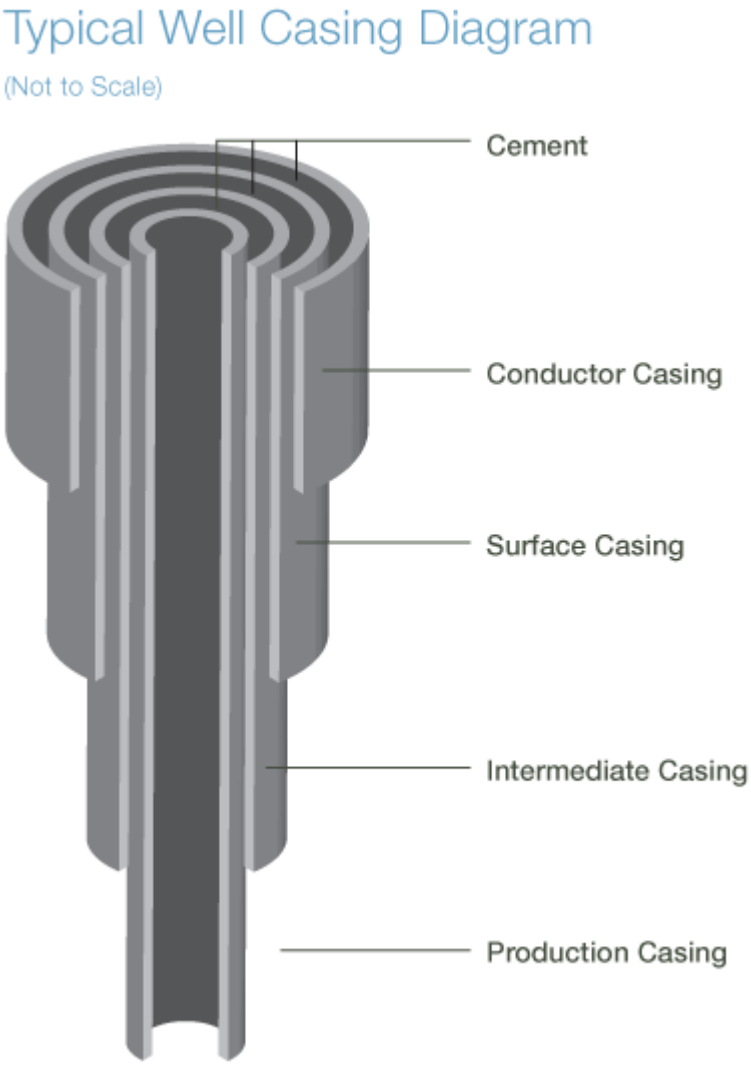
northeast
NATURAL ENERGY

Horizontal Drilling – Geo Steering



Casing Program

- Conductor Casing
  - 20” Pipe drilled to 40’
  - Provides structural support for the well and wellhead
- Surface Casing
  - 13 3/8” Pipe drilled to 50’ below the deepest fresh water bearing zone
- Intermediate Casing
  - 9 5/8” Pipe
  - Isolates any non- targeted pressurized formations from the well bore
- Production Casing
  - 5 ½” Pipe drilled to Total Measured depth



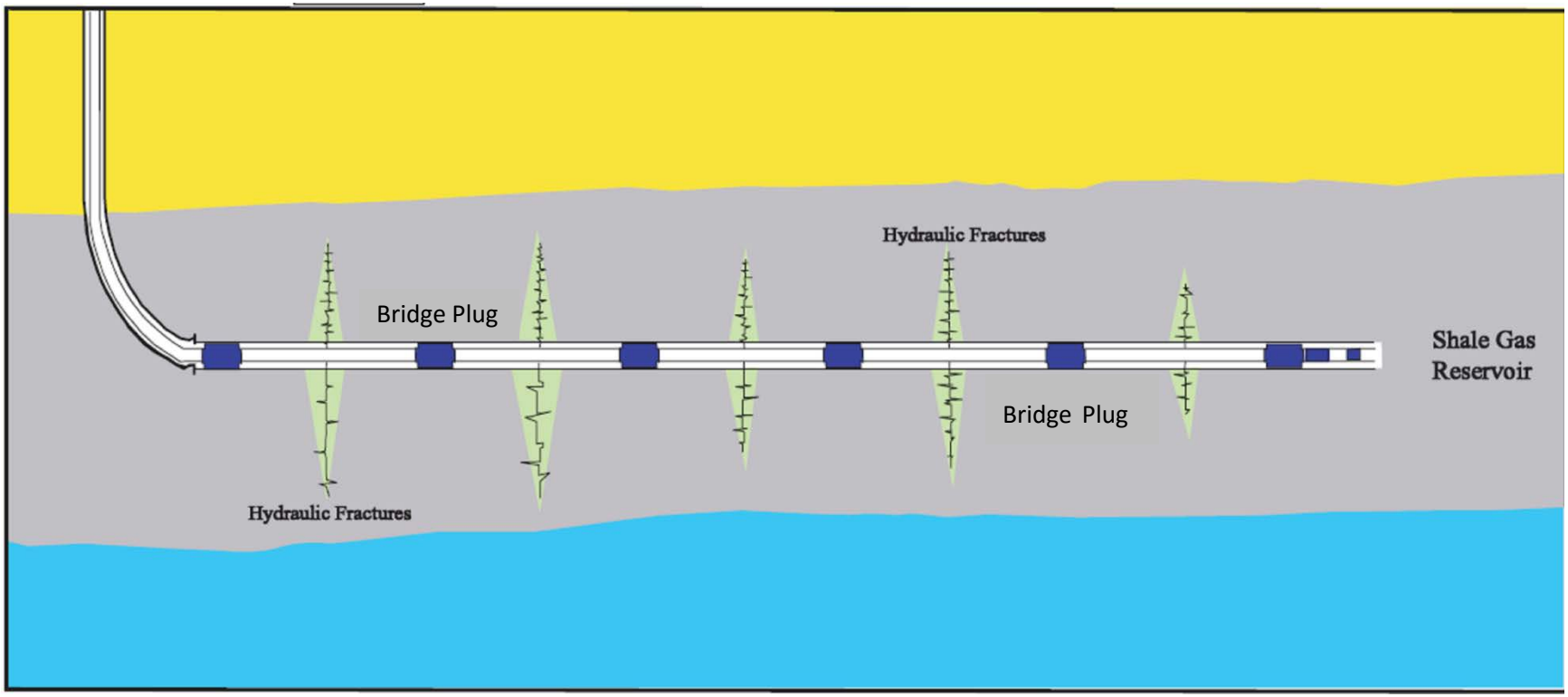
Hydraulic Fracturing

Hydraulic Fracturing

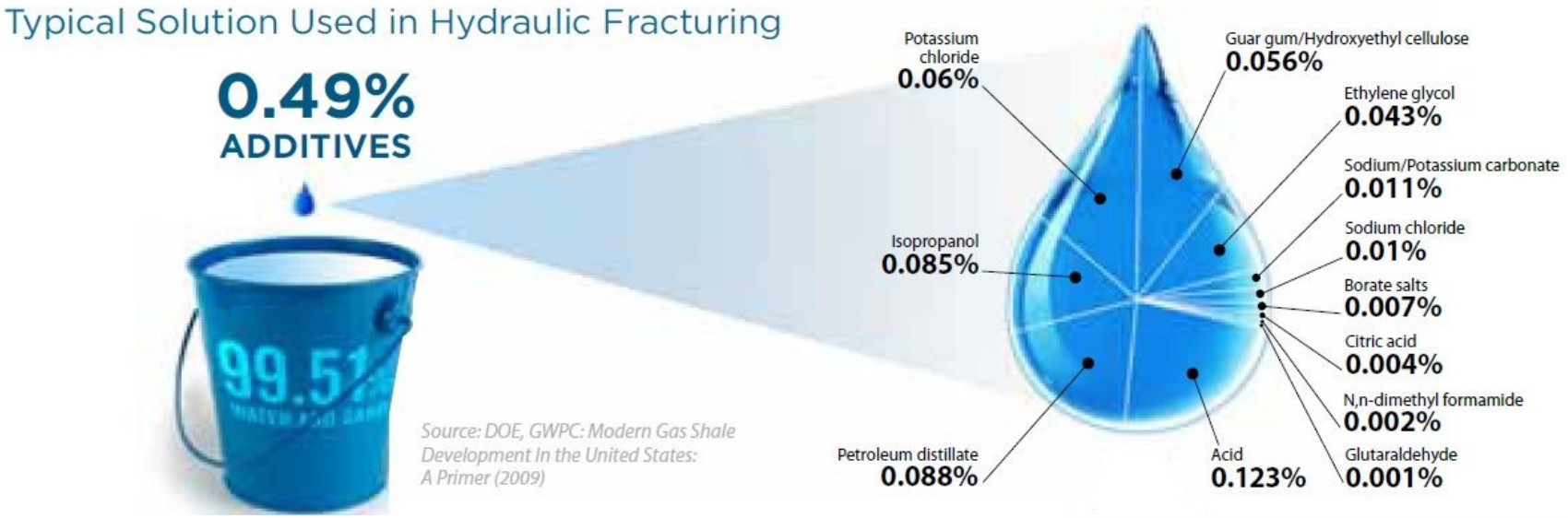
- Production casing is perforated in stages throughout the horizontal section of the well
- A combination of water, sand and other additives is pumped at high pressure through the perforations into the target formation to create a fracture network, allowing gas to flow from the formation into the casing and up to the surface
- This process is completed in stages ranging from 150’ to 500’
- Each stage is isolated with a bridge plug
- Stages can be engineered to alter the distance between perforations, amounts of water, and types of sand to optimize production

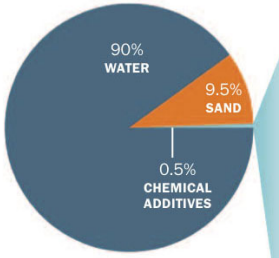
northeast
NATURAL ENERGY

Hydraulic Fracturing – Plug and Perf



Hydraulic Fracturing Fluid





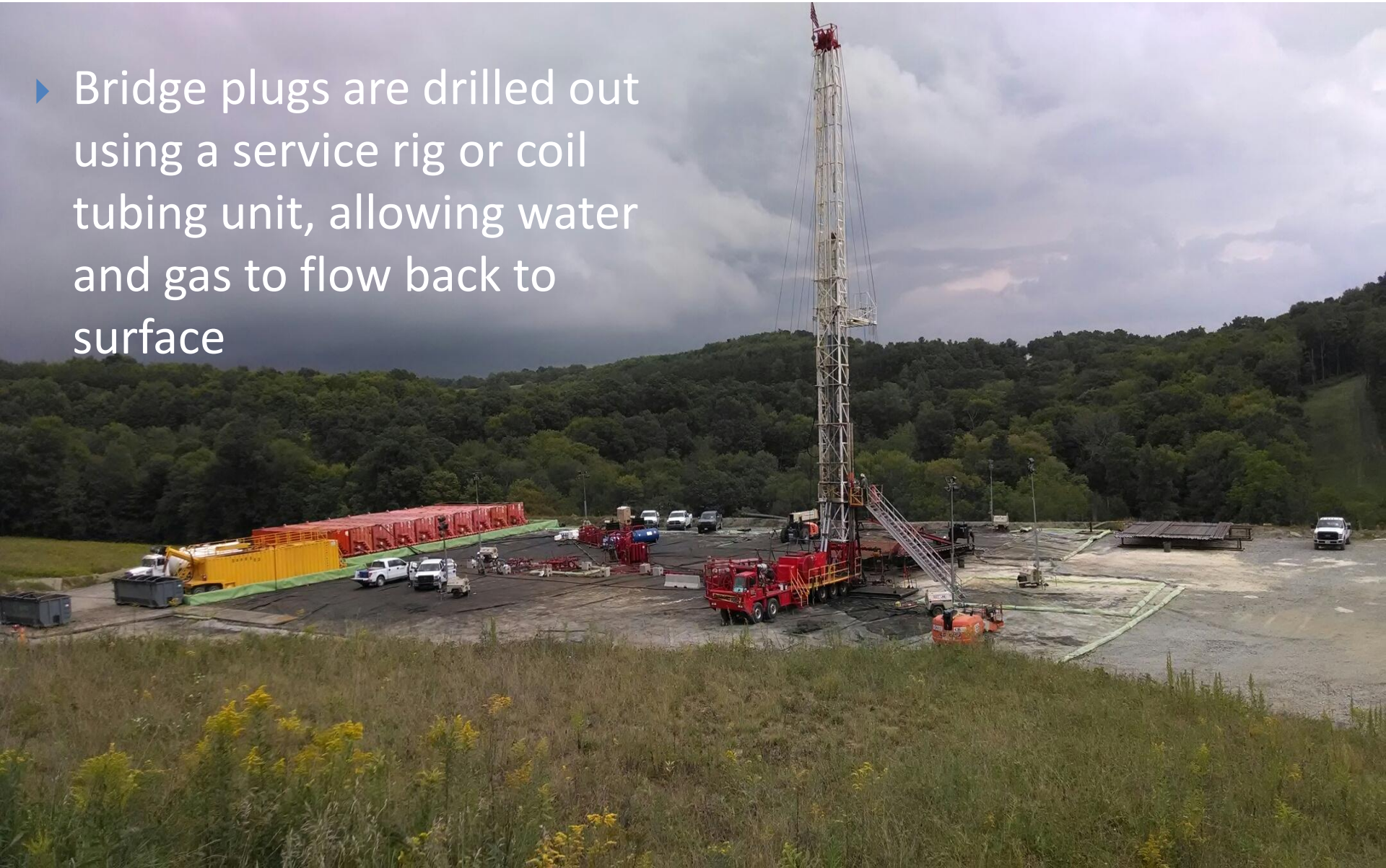
Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

northeast NATURAL ENERGY

Drill Out

- Bridge plugs are drilled out using a service rig or coil tubing unit, allowing water and gas to flow back to surface



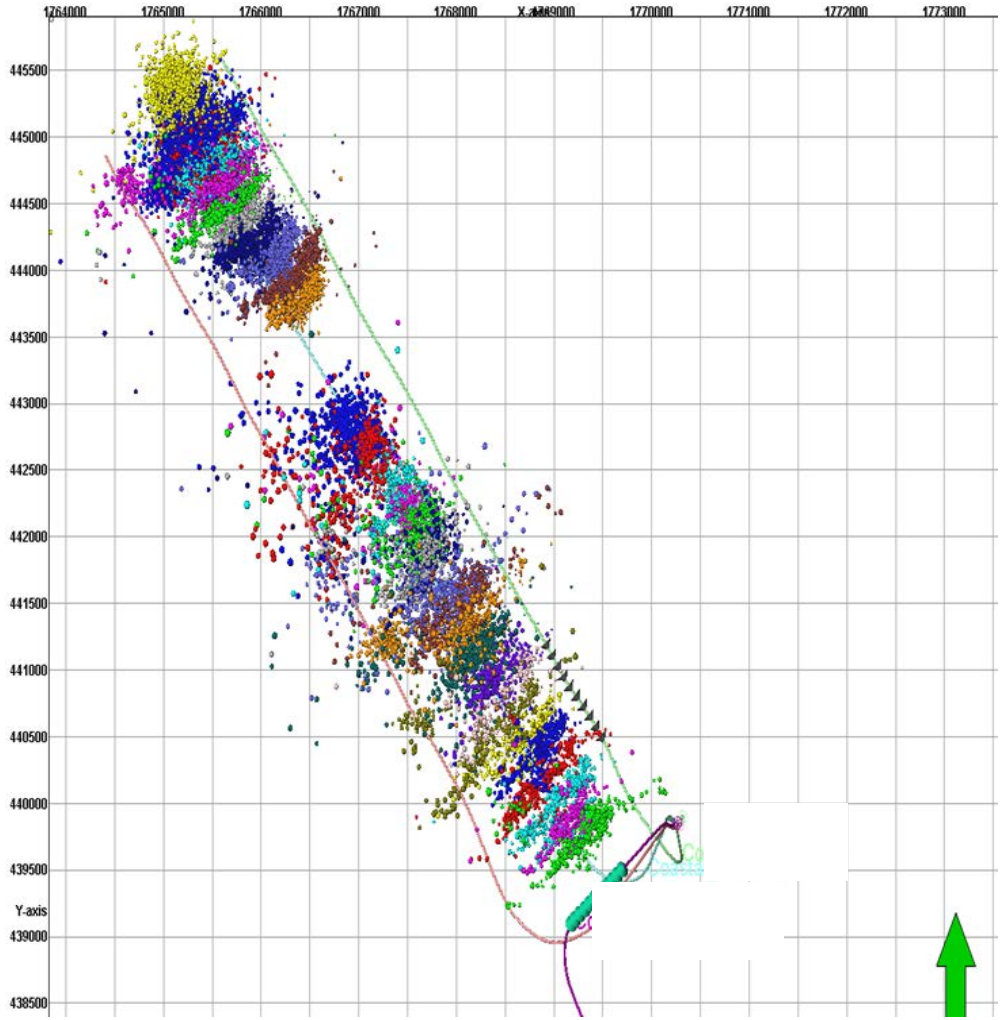
Flow Back

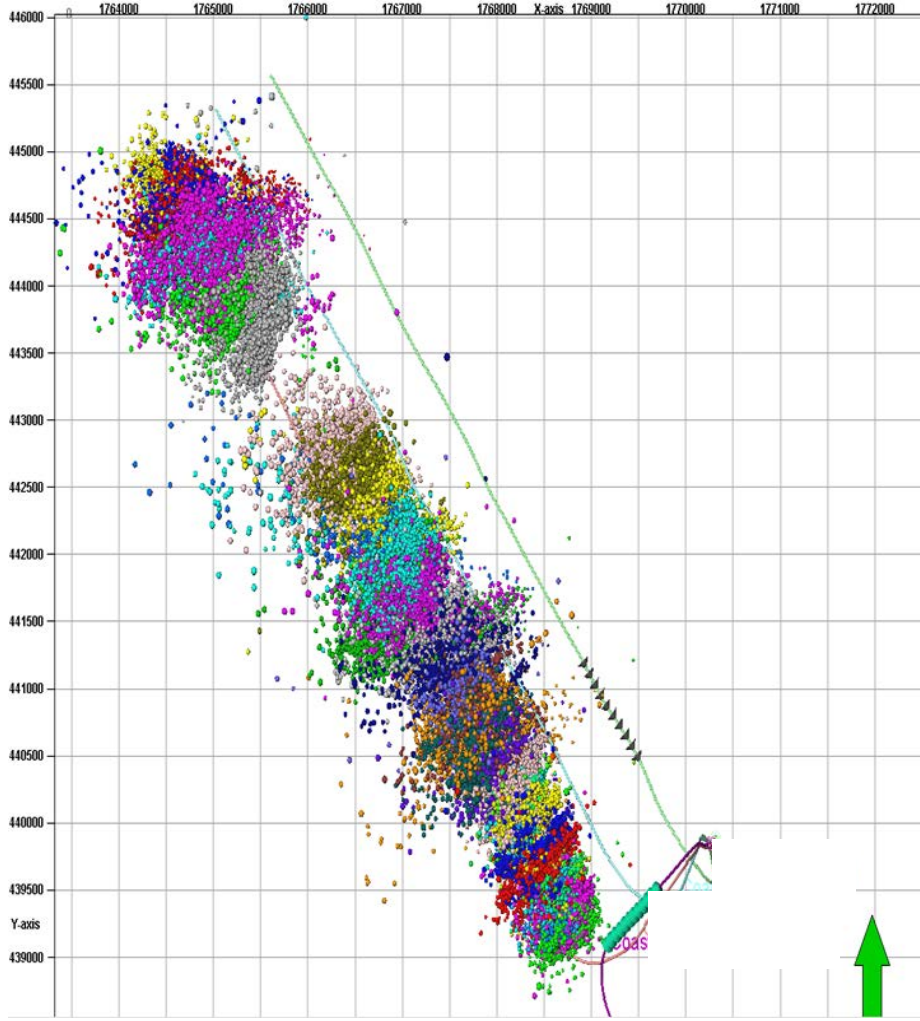
- Flow back equipment is designed to handle large volumes of water and gas at high pressure while the well is conditioned to start production

Production

The production phase is longest phase and is expected to continue for decades

Hydraulic Fracturing – Microseismic





Questions?