



“Gas Factories” For Shale Gas Development

CNPC Research Institute of
Petroleum Exploration and
Development

IGU Committee Meeting (WOC 1 and PGC A)
KOTA KINABALU, SABAH, MALAYSIA
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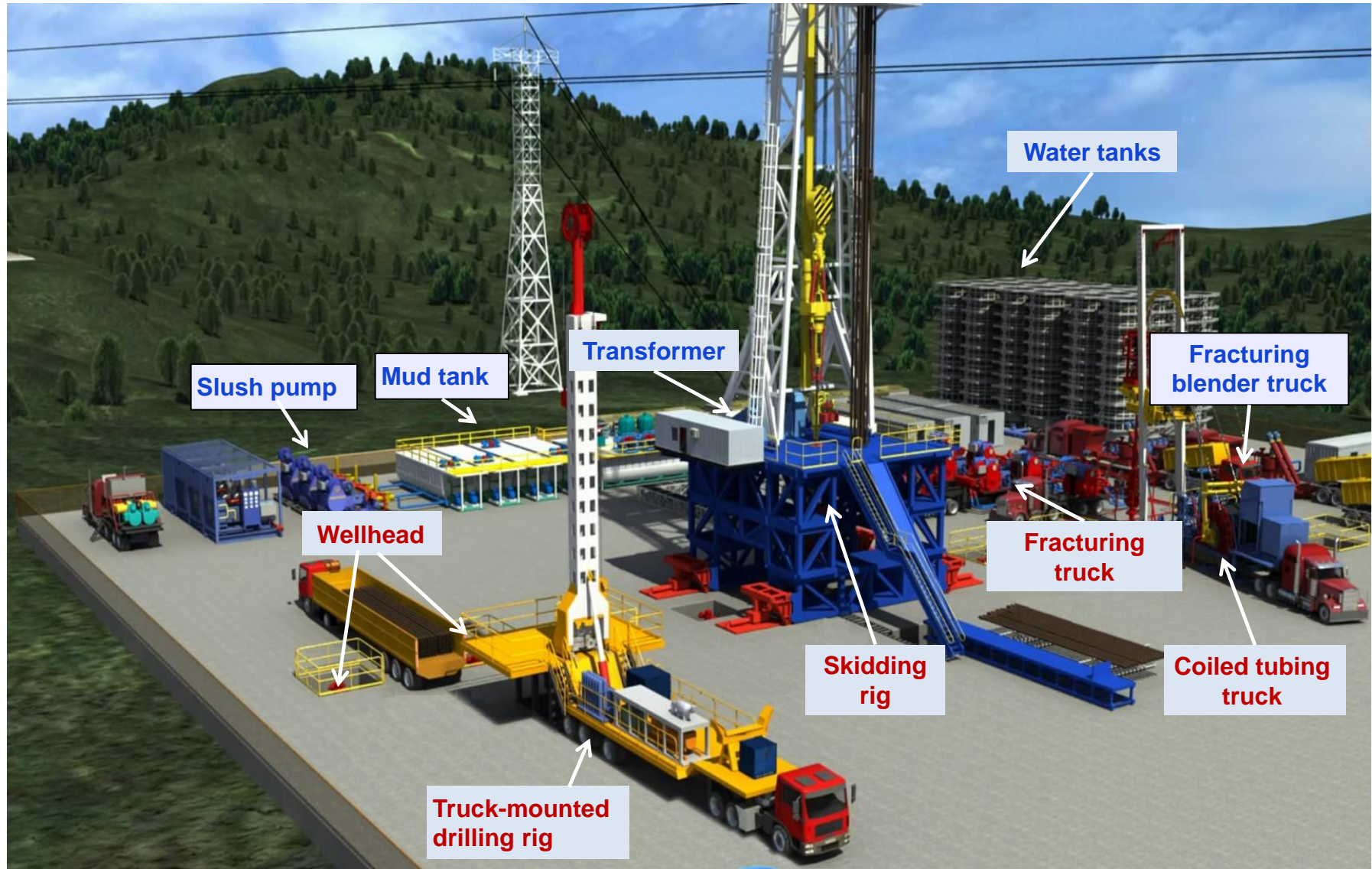
AGENDA

What is factory operation for shale gas development and its advantages?

- **Drilling**

- **Fracturing**

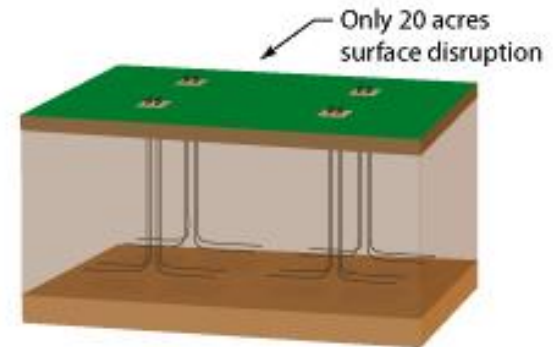
Wellsite Operation Plan Sketch



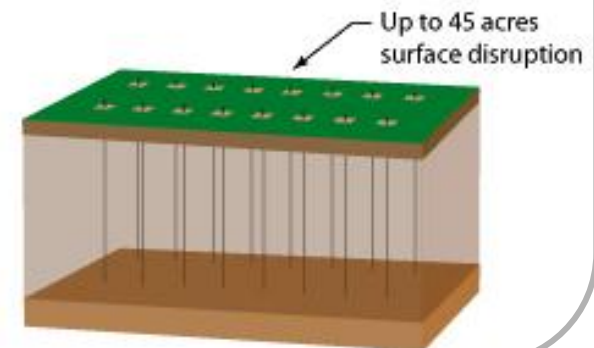
Gas Factories-Responsible Development

- Multi-well pads
- Simultaneous operations
- Manufacturing process
- Skidding rigs
- Single pipeline connection
- Reducing Surface Disturbance
- Reduced overall foot print

Unconventional Multi-Well Pad
Horizontal Shale Development



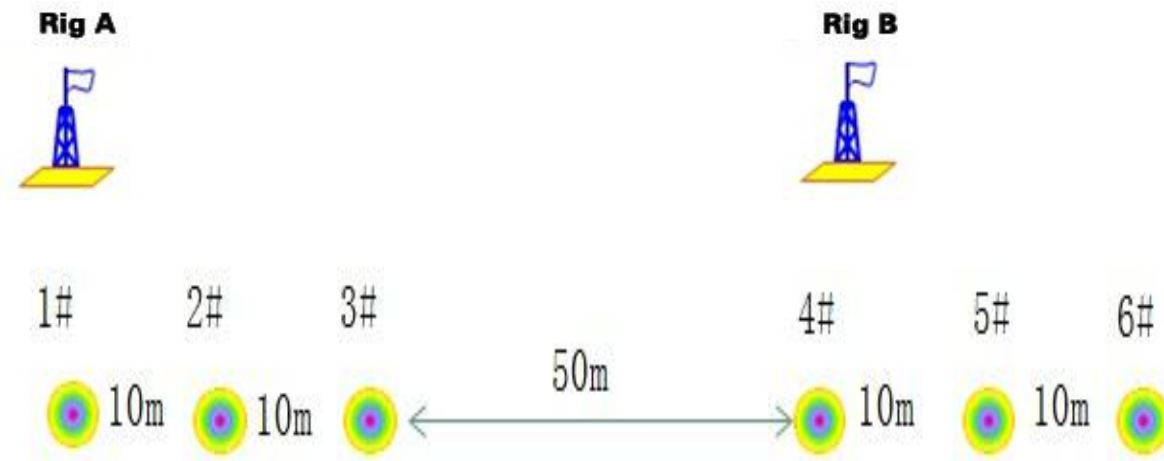
Conventional Single-Well Pad
Vertical Development



Drilling

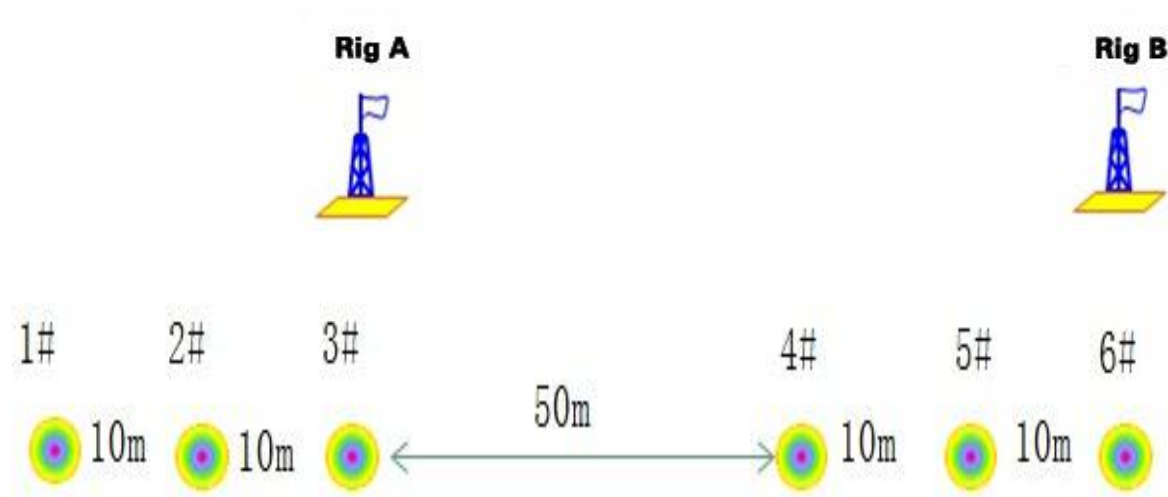
Process

Frist stage of multi-well pad drilling process



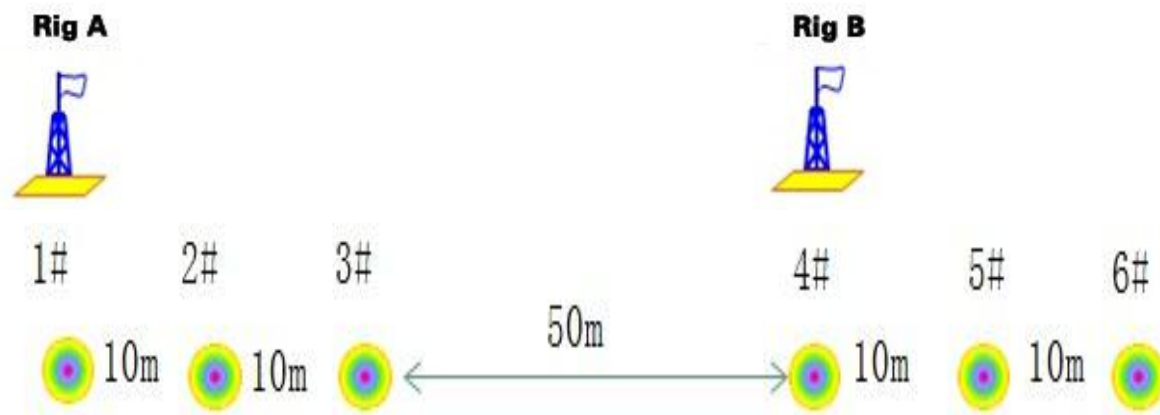
Process

Second stage of multi-well pad drilling process



Process

Third stage of multi-well pad drilling process



Fracturing

Process

- Pump Pad

- Causes rock to fracture

- Creates fractures to accept Proppant

- Pump Slurry

Proppant (size-graded particles, spherical white sand / man-made) mixed into fluid Slurry; pumped in to prop open created fractures

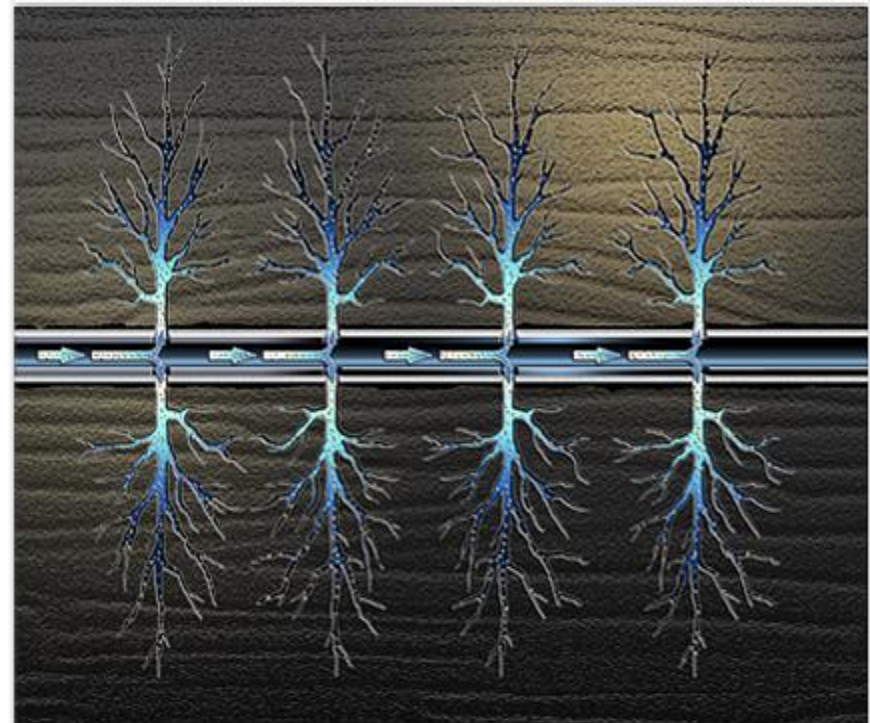
- Flush

Clean fluid to clear surface lines & well tubulars of proppant; pumps shut down

- Bleed Off well pressure to allow fractures to close on proppant

- Recover injected fluid by flowing/lifting well

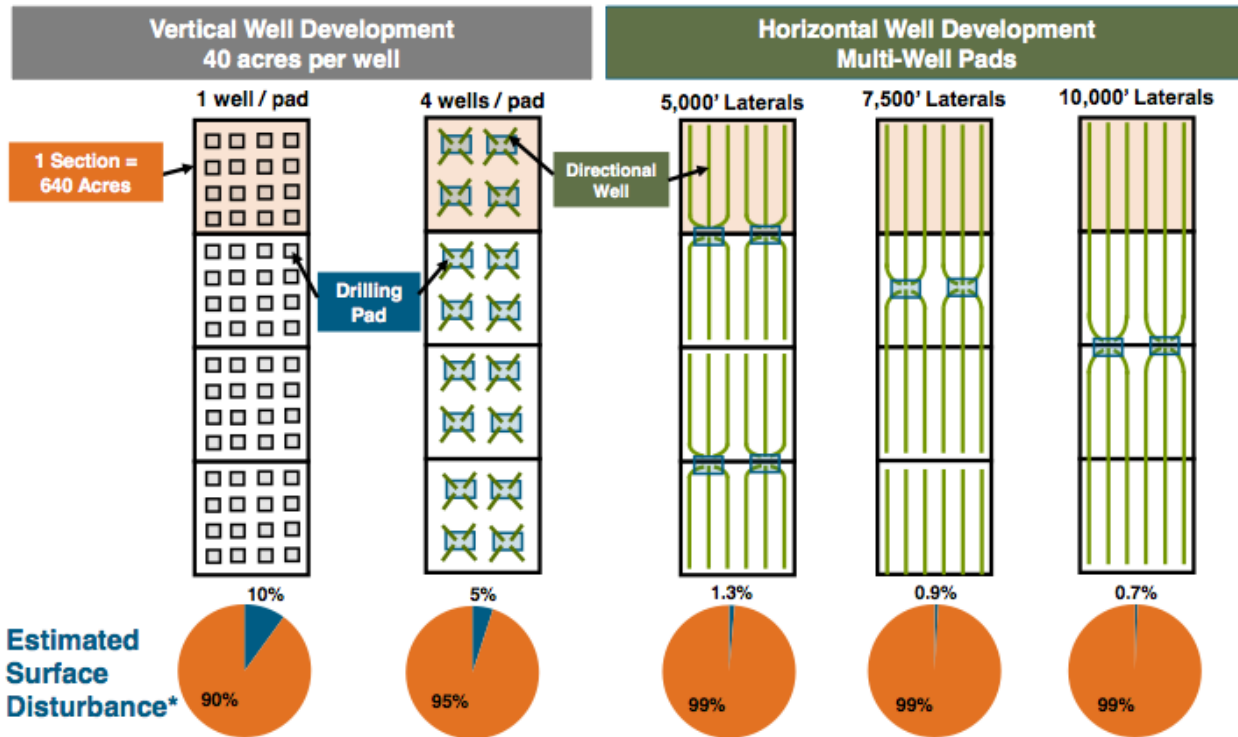
Hydraulic Fracturing: Mixture of water, sand and chemicals pressurized and pumped into the well to form microscopic fractures in shale.



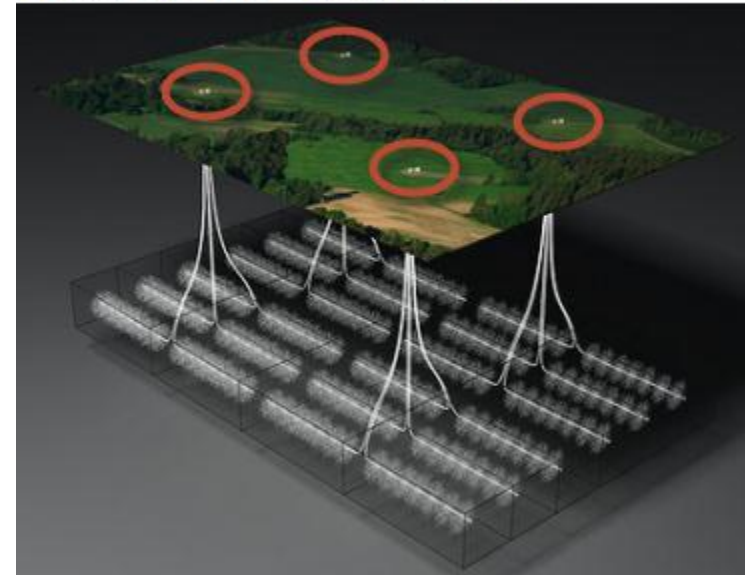
Advantages

■ Save land use & Reducing Surface Disturbance

Vertical and Horizontal Well Development Examples Estimated Surface Disturbance



Drilling pads allow widespread underground development by concentrating wellheads at the surface



Source: U.S. Energy Information Administration, reproduced with permission from Statoil.

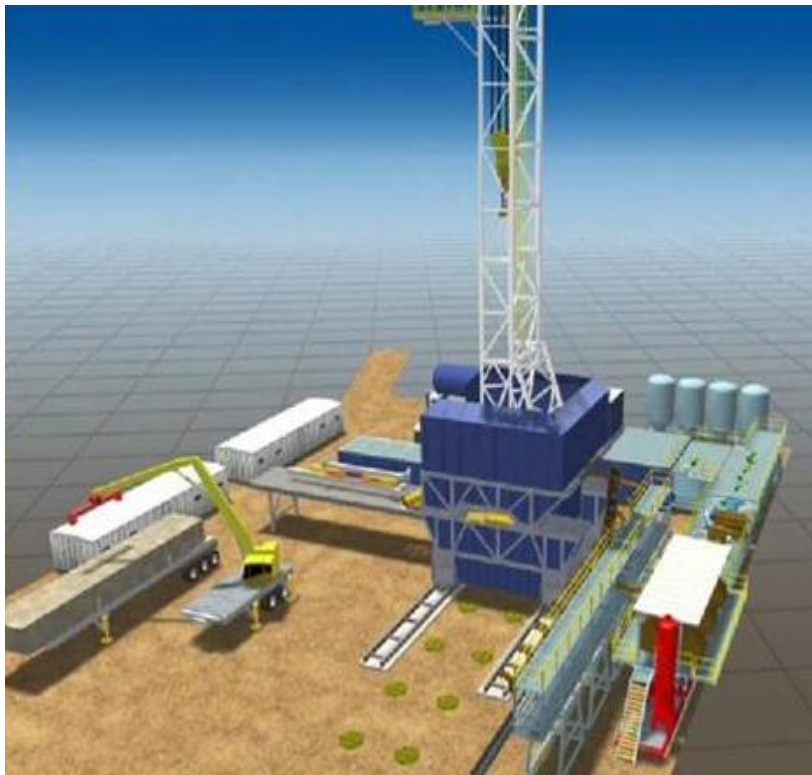
Note: Three-dimensional representation of oil or natural gas development of a large underground area, from four drilling pads on the surface (depicted within the red ovals)

■ Save time & Save money

Skidding rigs /Assembly line process/ Less time to relocate

Save rig occupied time during Cementing operation/Cement curing /Well logging

Nobody need to sit there waiting!

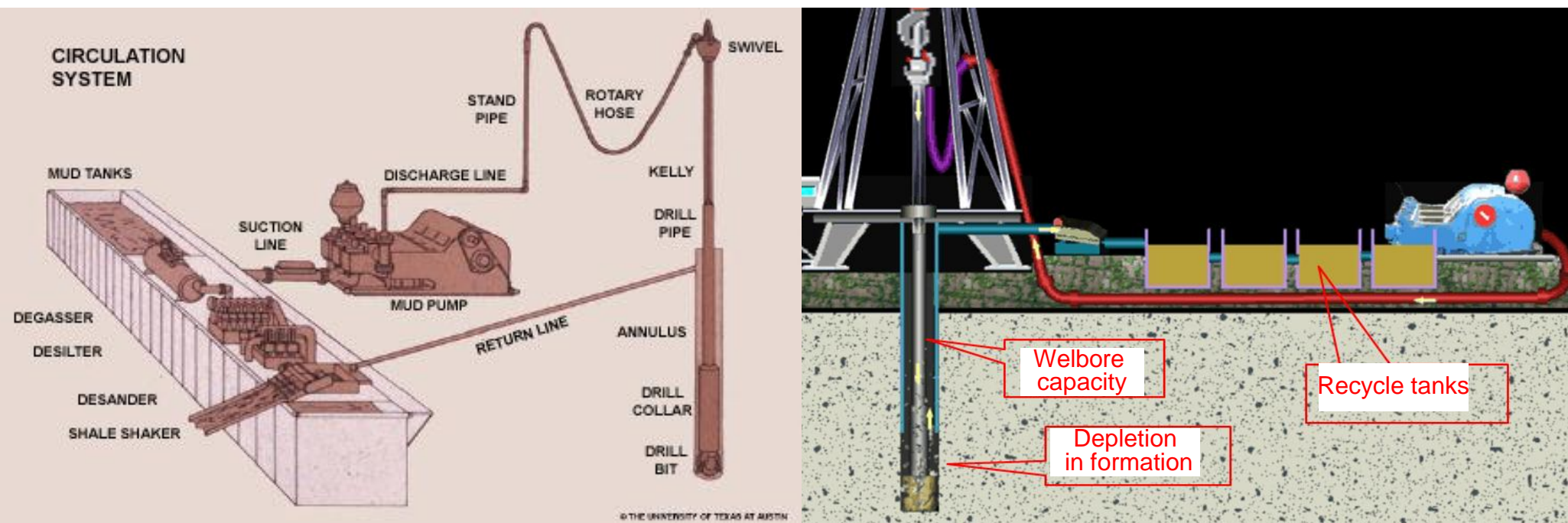


Bi-directional Skidding System to Accommodate Multiple-row Well Pads

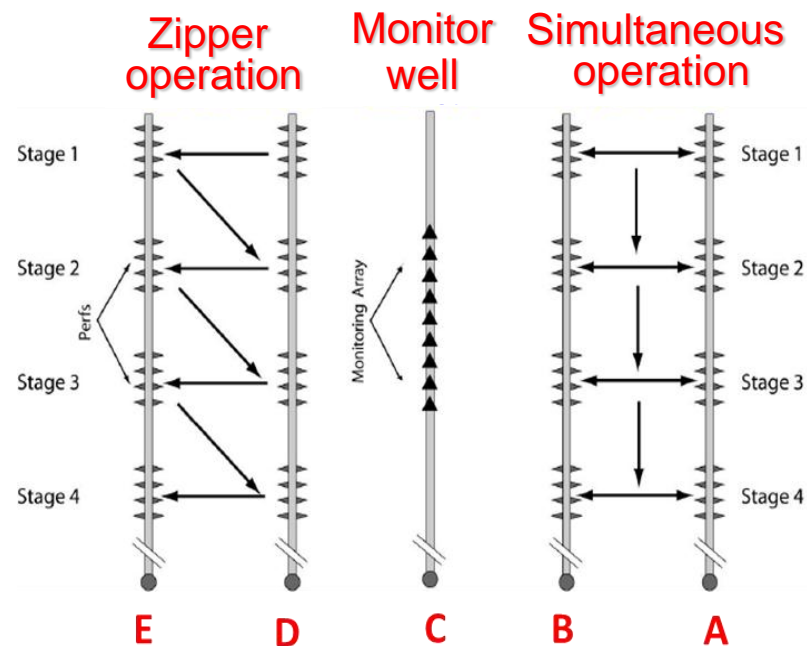
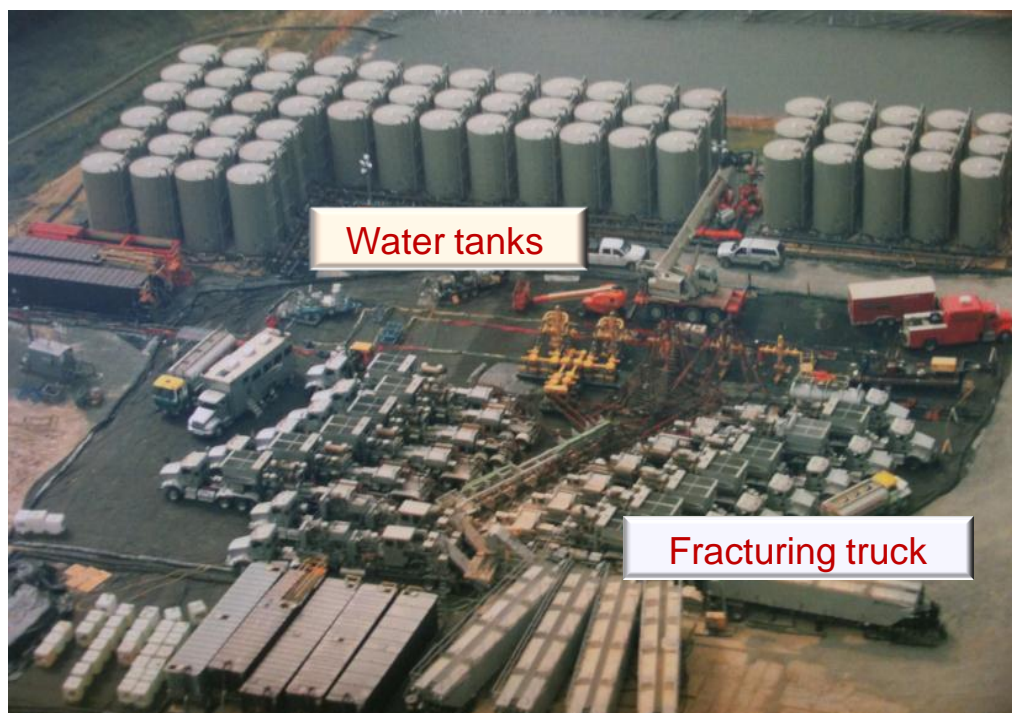
■ Drilling fluid circulation

Reduce drilling fluid consumption

Reduce transportation and processing cost



■ Increased efficiency of frac equipment utilization



Water recycle & decrease sewage disposal

Recycling Frack Water

Numerous companies are developing technologies to clean up water used to hydraulically fracture shale wells. Here's a look at a process offered by Halliburton.

WATER USE

- 1 Fracking a shale-gas well uses as much as five million of gallons of water. Up to 40% of it returns to the surface containing hydrocarbons, heavy metals, solids and bacteria.



COLLECTION

Contaminated water is stored temporarily in a man-made pond or in storage tanks.

ELECTROCOAGULATION CELLS

The cleaning process uses electricity to destabilize and clot suspended matter in the water.

PH ADJUSTMENT

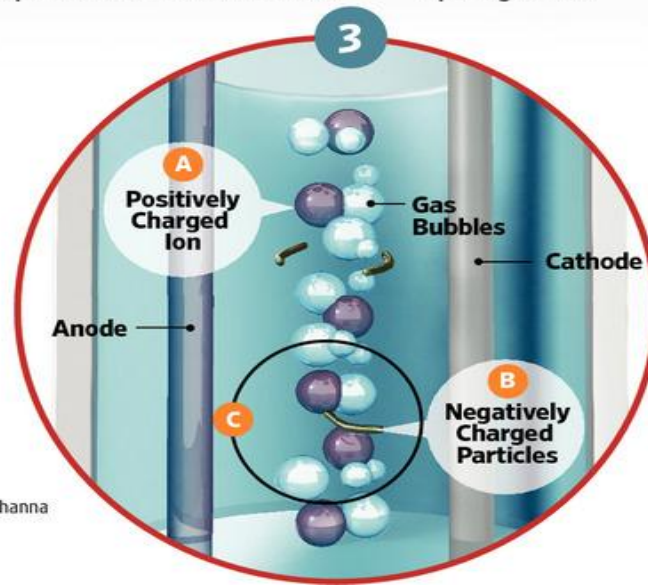
If required, the pH balance of the water can be adjusted to speed up coagulation.

FILTRATION AND REUSE

This step removes any remaining suspended materials. This water can be reused for future frack jobs.

CLEANING PROCESS

- A When contaminated water passes through the electrocoagulation cells, positively charged ions are released by the anode tube...
- B ...binding to negatively charged particles, resulting in coagulation, or clotting...
- C ...gas bubbles attach to the solids, sending them to the surface.



2012 PENNSYLVANIA FRACK WATER*

A growing percentage of water used to frack Marcellus Shale wells is being recycled.

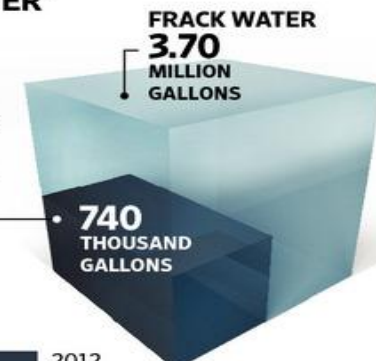
RECYCLED WATER

PERCENTAGE OF RECYCLED WATER



* Through Oct. 24

Note: Represents the average well drilled in Susquehanna River watershed, about 60% of all wells in Pennsylvania.



Sources: Halliburton (recycling process); Susquehanna River Basin Commission (recycled water)

Graphic by Alberto Cervantes/
The Wall Street Journal



Thank you for your attention!