Hydraulic Fracturing 101

Presented by Donato Judice
Field Manager
Supervisory Petroleum Engineer
Bureau of Land Management
Great Falls Oil & Gas Field Office

Agenda

- Intro to Hydraulic Fracturing and Horizontal Drilling.
- ‘Fracking” Process.
- Environmental Concerns.
- Questions

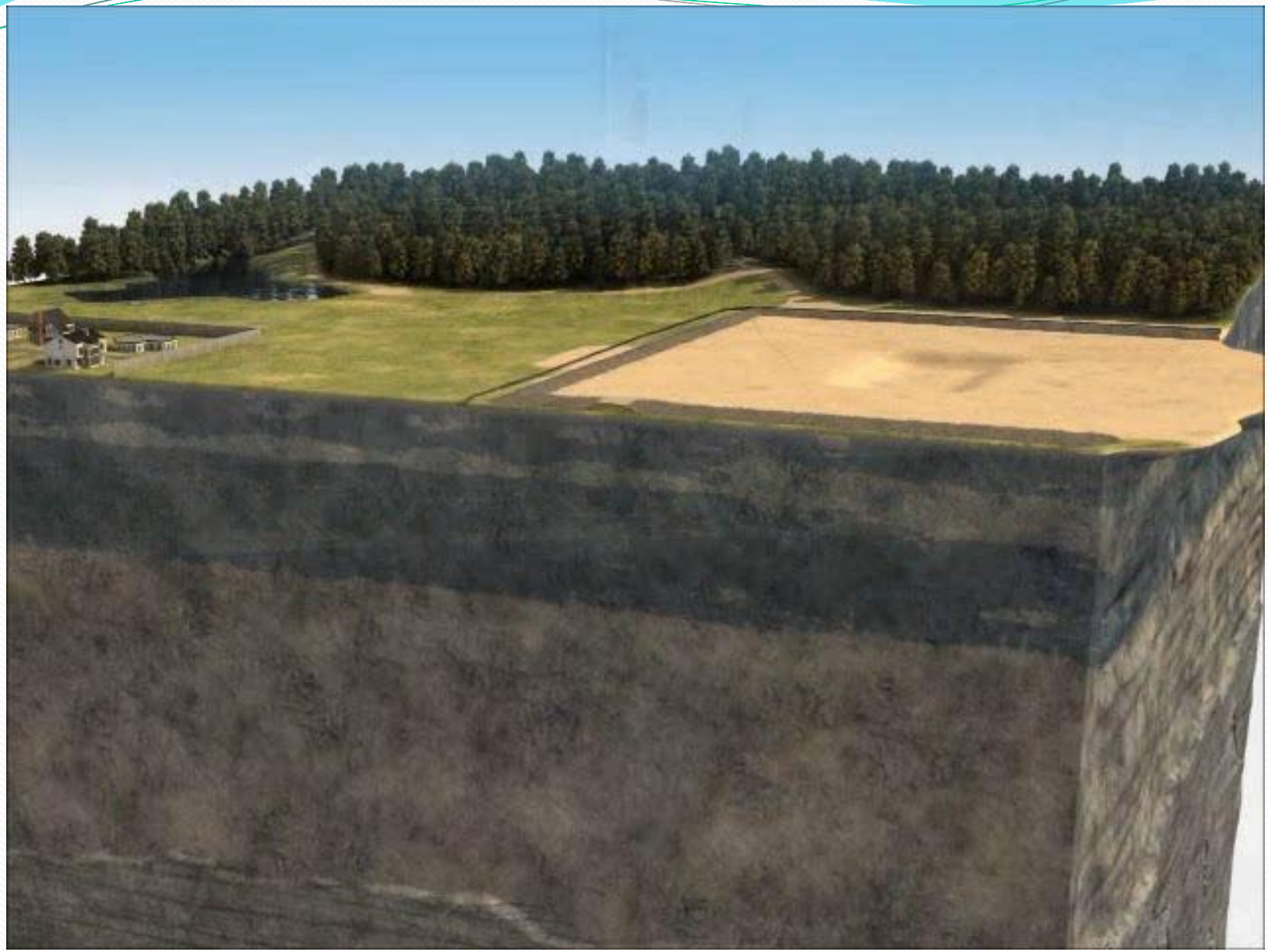
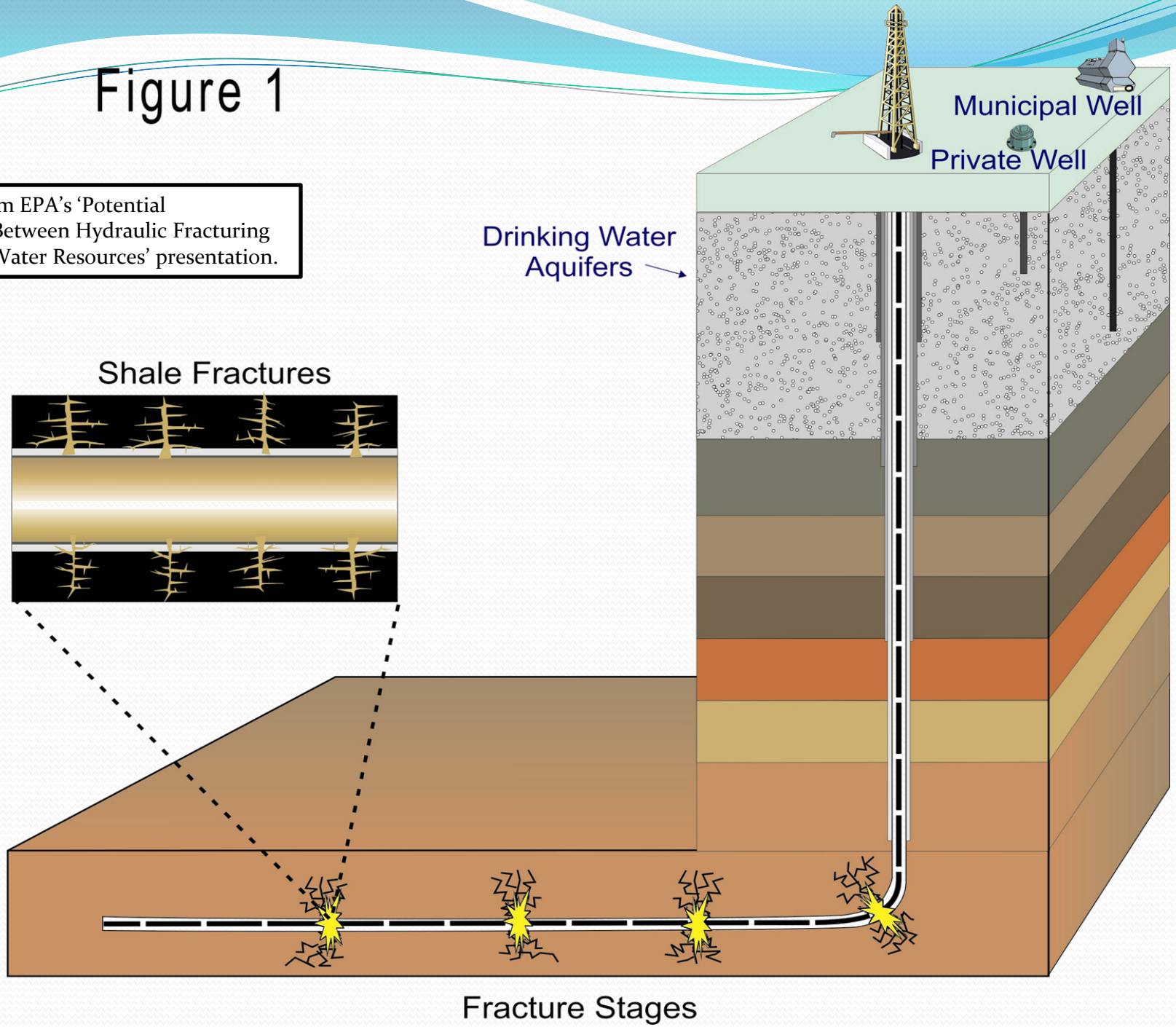
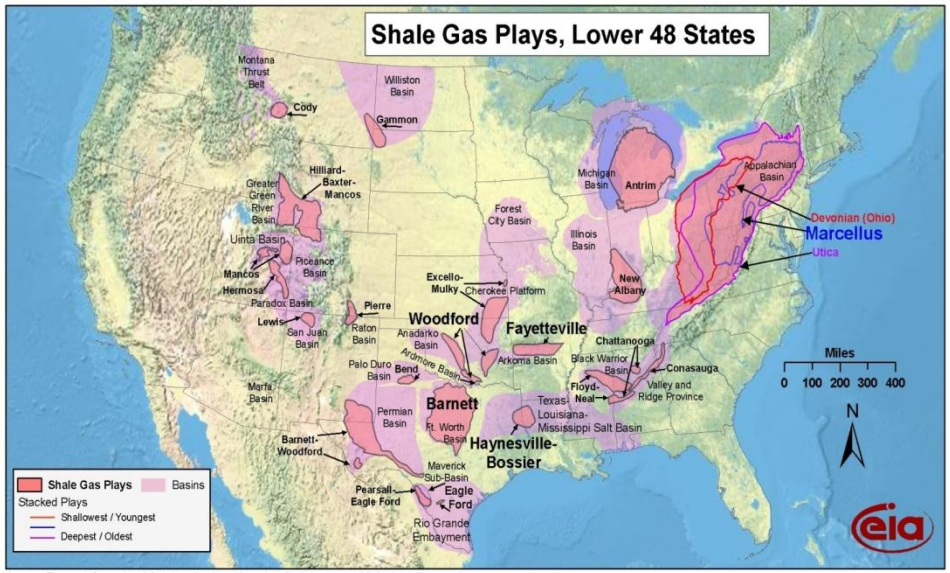


Figure 1

Illustration from EPA's 'Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources' presentation.

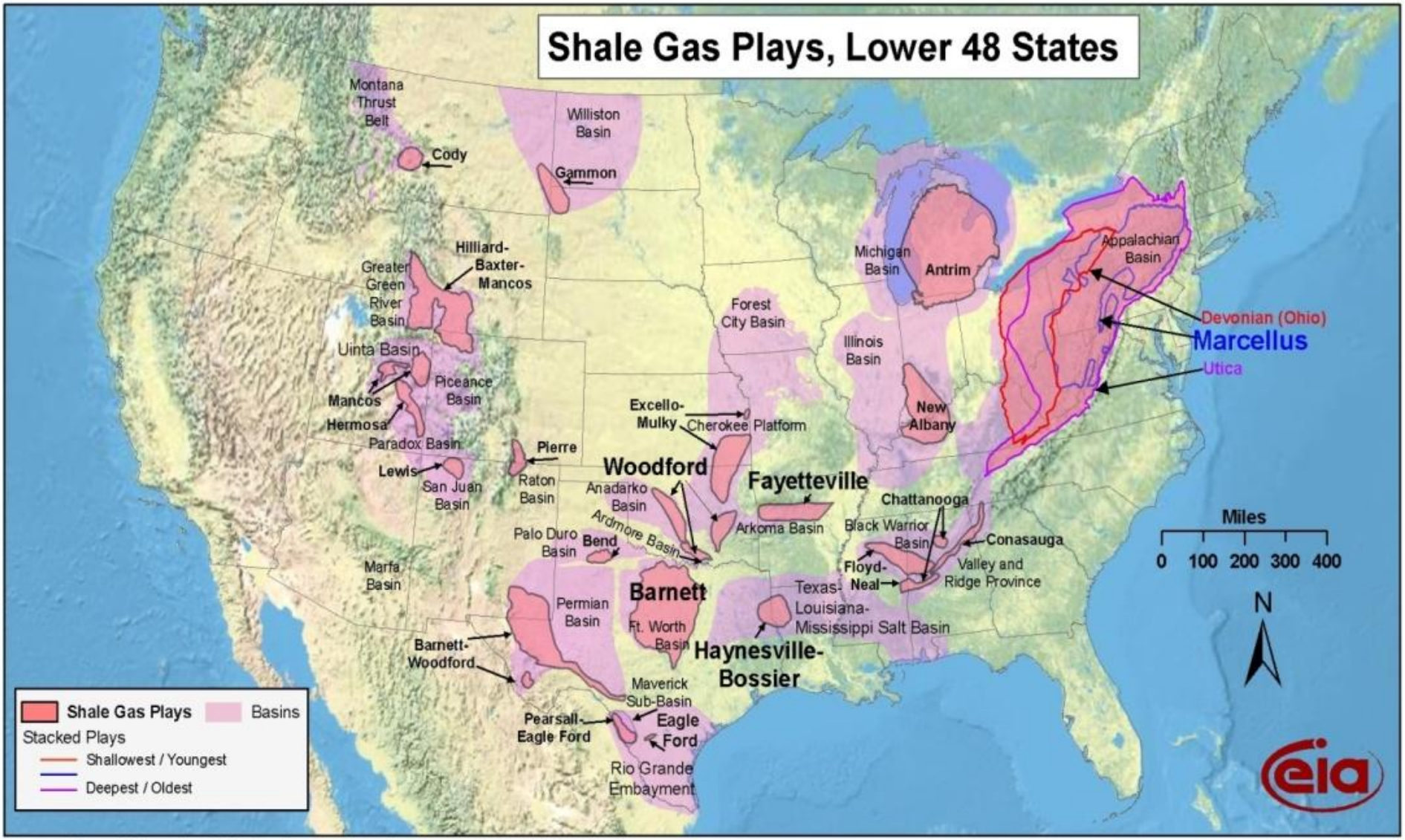


A game changer



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

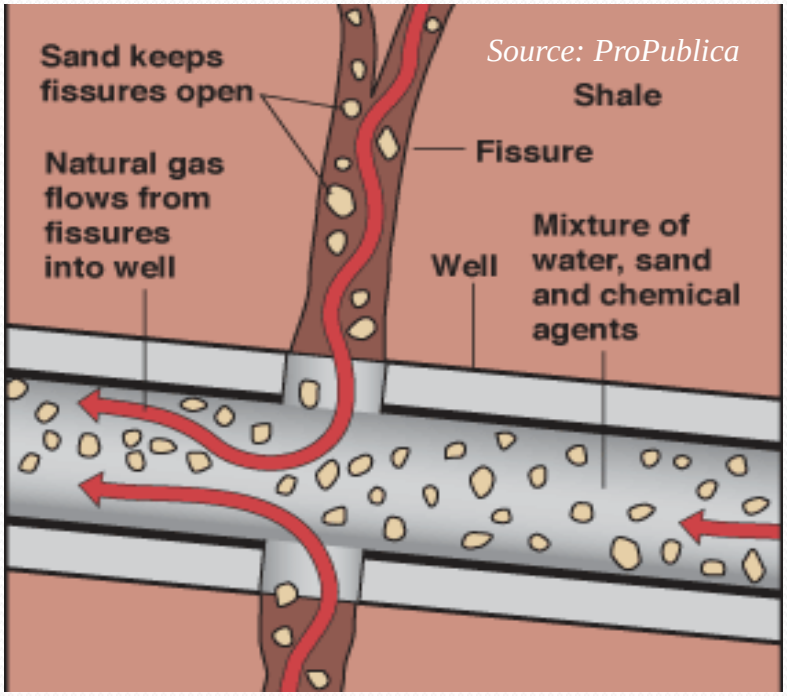
- World's major gas reserves:
  - Qatar 1200 TCF
  - Russia 400 TCF
  - US Marcellus 300 TCF
  - US Haynesville 250 TCF
  - US Eagle Ford (emerging)
  - US Niobrara (emerging)
- Bakken Shale (N.D.)
  - Largest US oil discovery since Alaska at 3.6B bbls
- US is global leader in shale technology & development <u>and</u> in proven gas reserves!



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Source: Energy Information Administration based on data from various published studies.
Updated: March 21, 2011

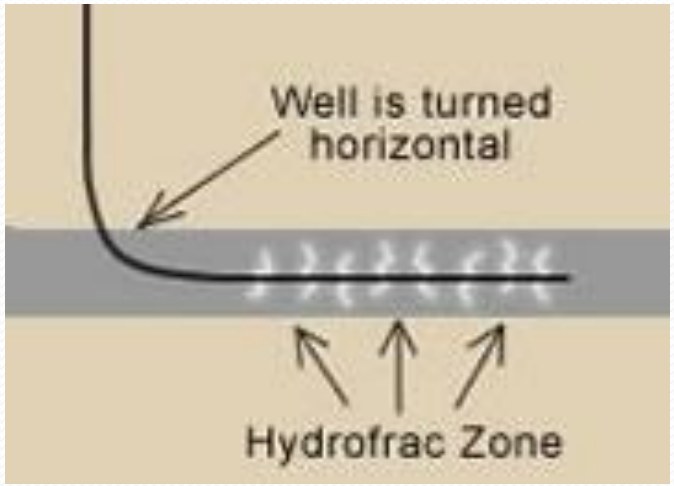
What is Hydraulic Fracturing?



- Well stimulation technique that has been employed by the oil and gas industry since 1947. The technique is used to create spaces in the rock pores deep underground to release the oil and natural gas so that it can flow to the surface.

- Fracturing fluids are injected at high pressure into the targeted formation, creating fissures that allow oil and gas to move freely from rock pores where it was trapped.

What is Horizontal Drilling?



- Hydraulic fracturing is generally associated with horizontal drilling practices.
- It is defined as deviating the wellbore at least 80 degrees from vertical so that the borehole penetrates a productive formation in a manner parallel to the formation. Or simply "drilling sideways".

http://geology.com

http://www.oilandgasiq.com/glossary/horizontal-drilling/

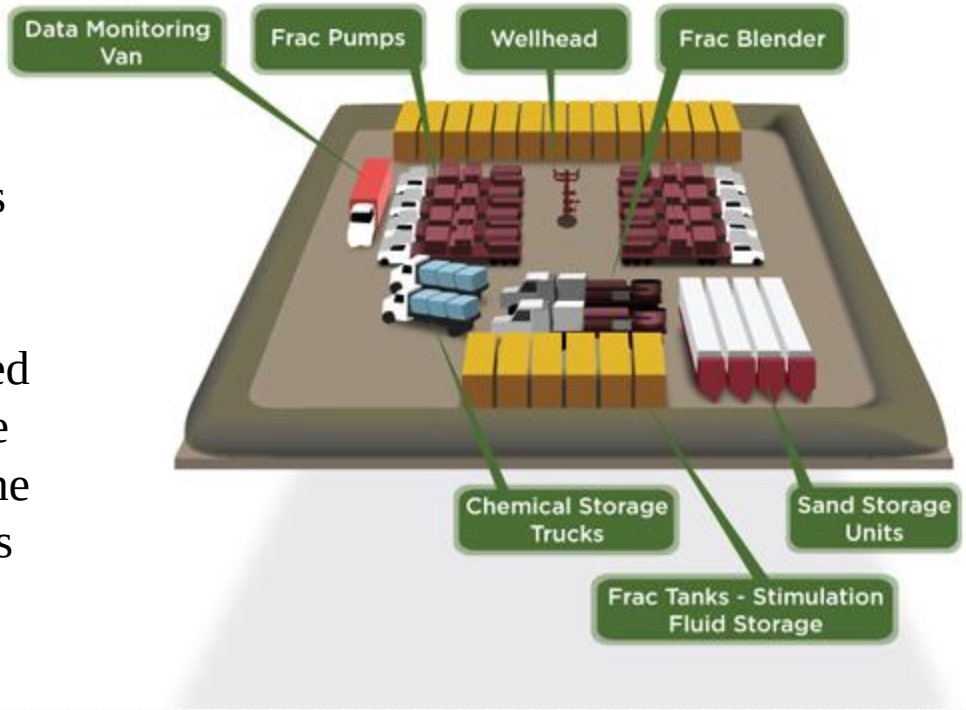
Typical Sanjel Hydraulic Fracture job set-up.

Simplified Steps In Hydraulic Fracturing

1. Water, sand and additives are pumped at extremely high pressures down the wellbore.

2. The liquid goes through perforated sections of the wellbore and into the surrounding formation, fracturing the rock and injecting sand or proppants into the cracks to hold them open.

3. Experts continually monitor and gauge pressures, fluids and proppants, studying how the sand reacts when it hits the bottom of the wellbore, slowly increasing the density of sand to water as the frac progresses.

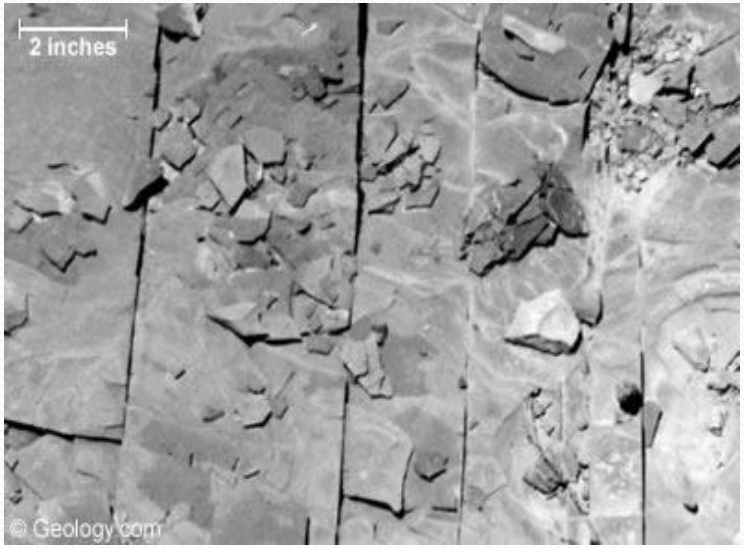


http://hydraulicfracturing.aitrk.com/Process/Pages/information.aspx

Simplified Steps In Hydraulic Fracturing (Cont'd.)

4. This process may be repeated multiple times, in "stages" to reach maximum areas of the wellbore. When this is done, the wellbore is temporarily plugged between each stage to maintain the highest water pressure possible and get maximum fracturing results in the rock.

5. The frac plugs are drilled or removed from the wellbore and the well is tested for results.



6. The water pressure is reduced and fluids are returned up the wellbore for disposal or treatment and re-use, leaving the sand in place to prop open the cracks and allow the oil/gas to flow.

http://hydraulicfracturing.aitrk.com/Process/Pages/information.aspx

Why Hydraulic Fracturing and Horizontal Drilling?

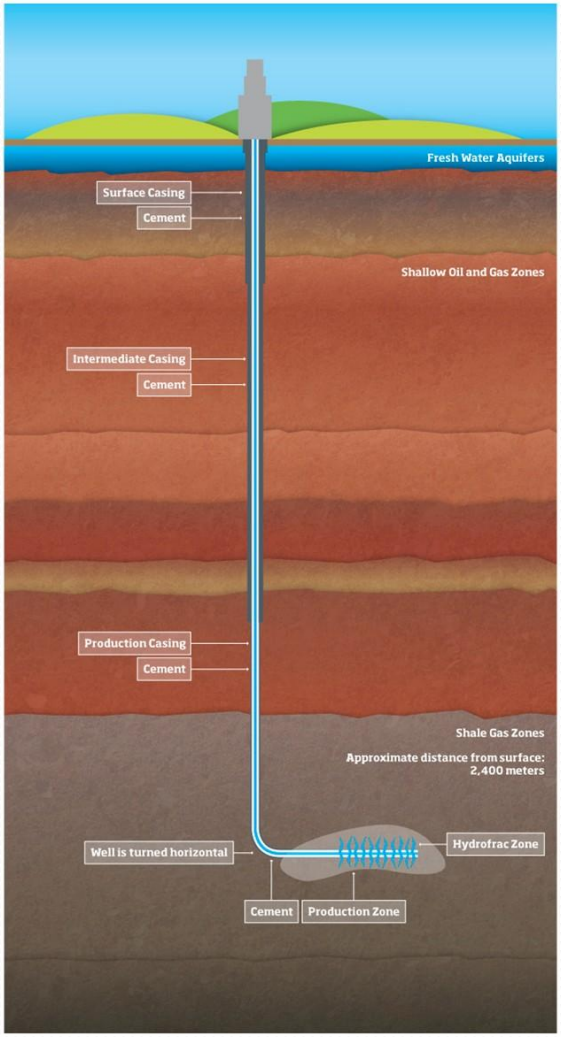
http://geology.com

- Combined with horizontal drilling in shale formations, hydraulic fracturing has unlocked vast new supplies of oil and natural gas.
- The technology has also made production feasible in many areas that were previously considered too deep, too hard, and too expensive to access.
- The “fracture paths” created by hydraulic fracturing, and the increased surface area exposed by horizontal drilling, can increase production rates up to many hundreds of percent.
- Hydraulic fracturing and horizontal drilling provide an environmental advantage in that they reduce the amount of wells needed to effectively drain an underground oil/gas reservoir. Less wells mean less roads, less pipeline, less surface disturbance, etc.

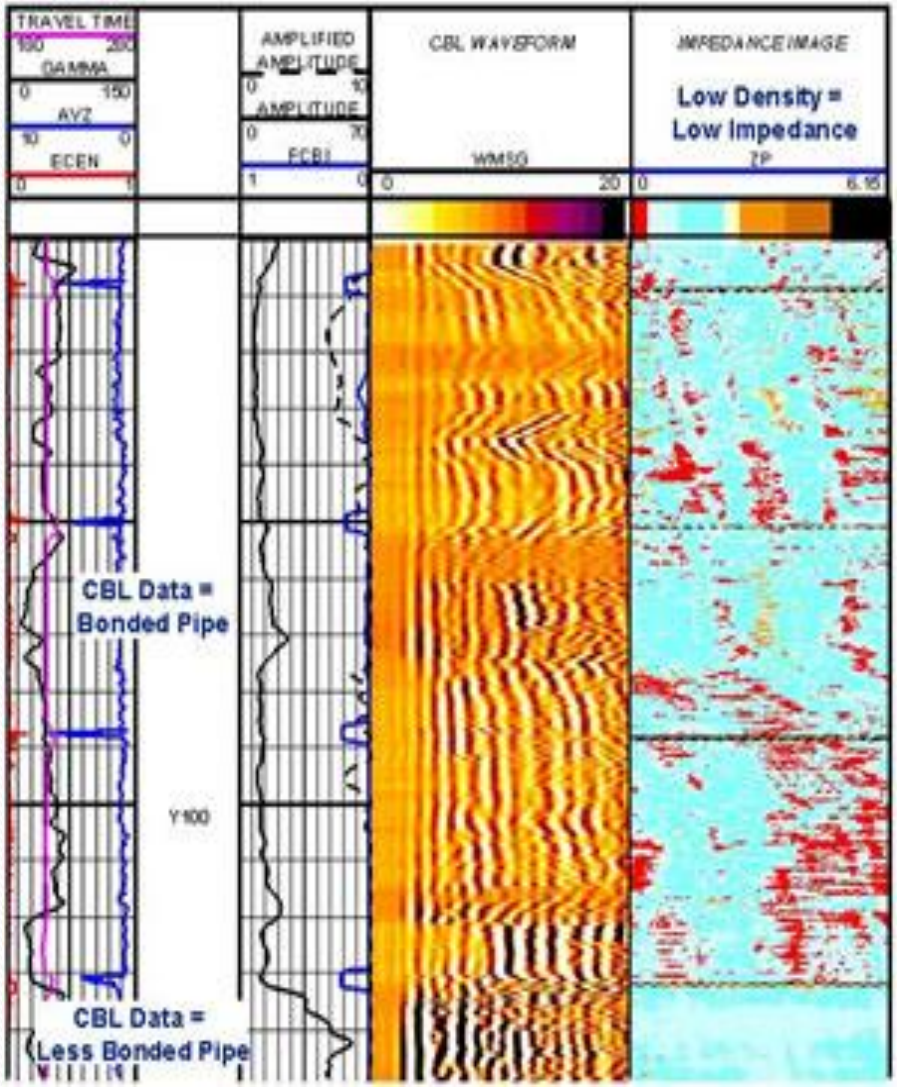
Environmental Concerns

- **Protection of groundwater and surface water from contamination.**
- Chemicals and additives in the fracturing fluid.
- Large volumes of water needed for hydraulic fracturing.
- Disposal of spent fracturing fluid (or flow-back fluid).

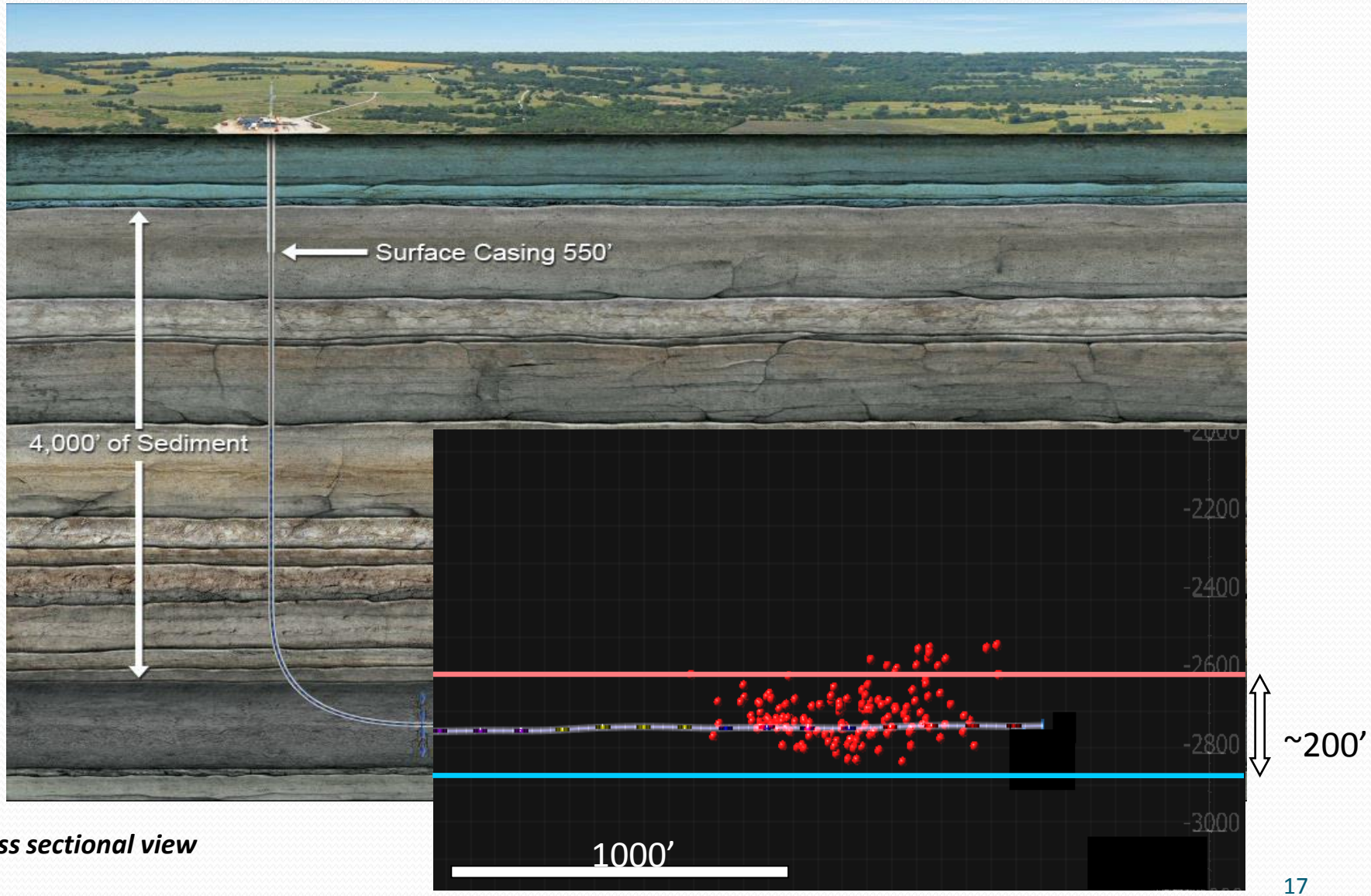
Groundwater Protection



- Well integrity: Design and construction of the well to ensure isolation in wellbore.
- Surface casing set below useable groundwater and cemented to surface.
- Intermediate and Production casing is cemented to isolate hydrocarbon zones, providing further protection to groundwater.
- Multiple layers of protective steel casing surrounded by cement.
- Cement Bond Logs verify quality of cement job and centralizers placed on the casing assures uniform cementing.

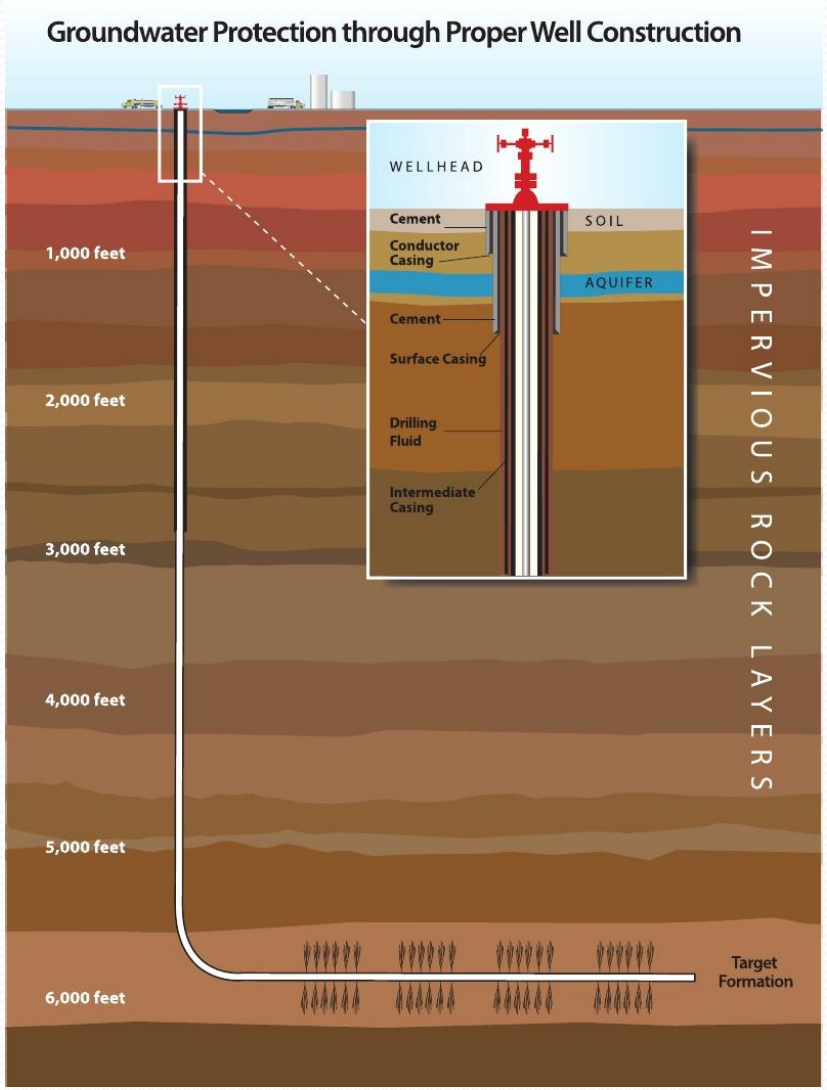

TRAVEL TIME
100
200
GAMMA
0
150
AVZ
10
0
ECEN
0
1
AMPLIFIED AMPLITUDE
0
10
AMPLITUDE
0
70
ECBI
1
0
CBL WAVEFORM
WM50
0
20
IMPEDANCE IMAGE
Low Density =
Low Impedance
ZP
0
6.15
CBL Data =
Bonded Pipe
Y100
CBL Data =
Less Bonded Pipe

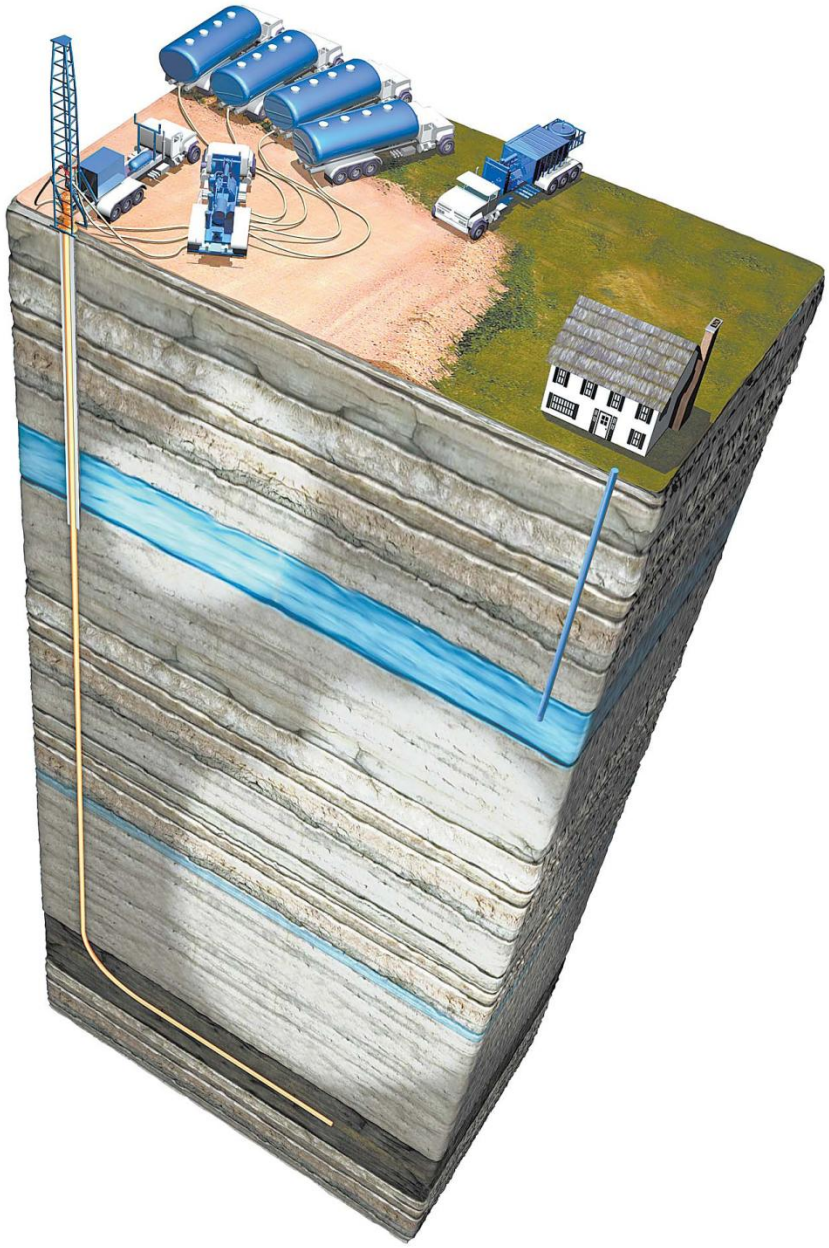
Microseismic Evaluation of Fracking

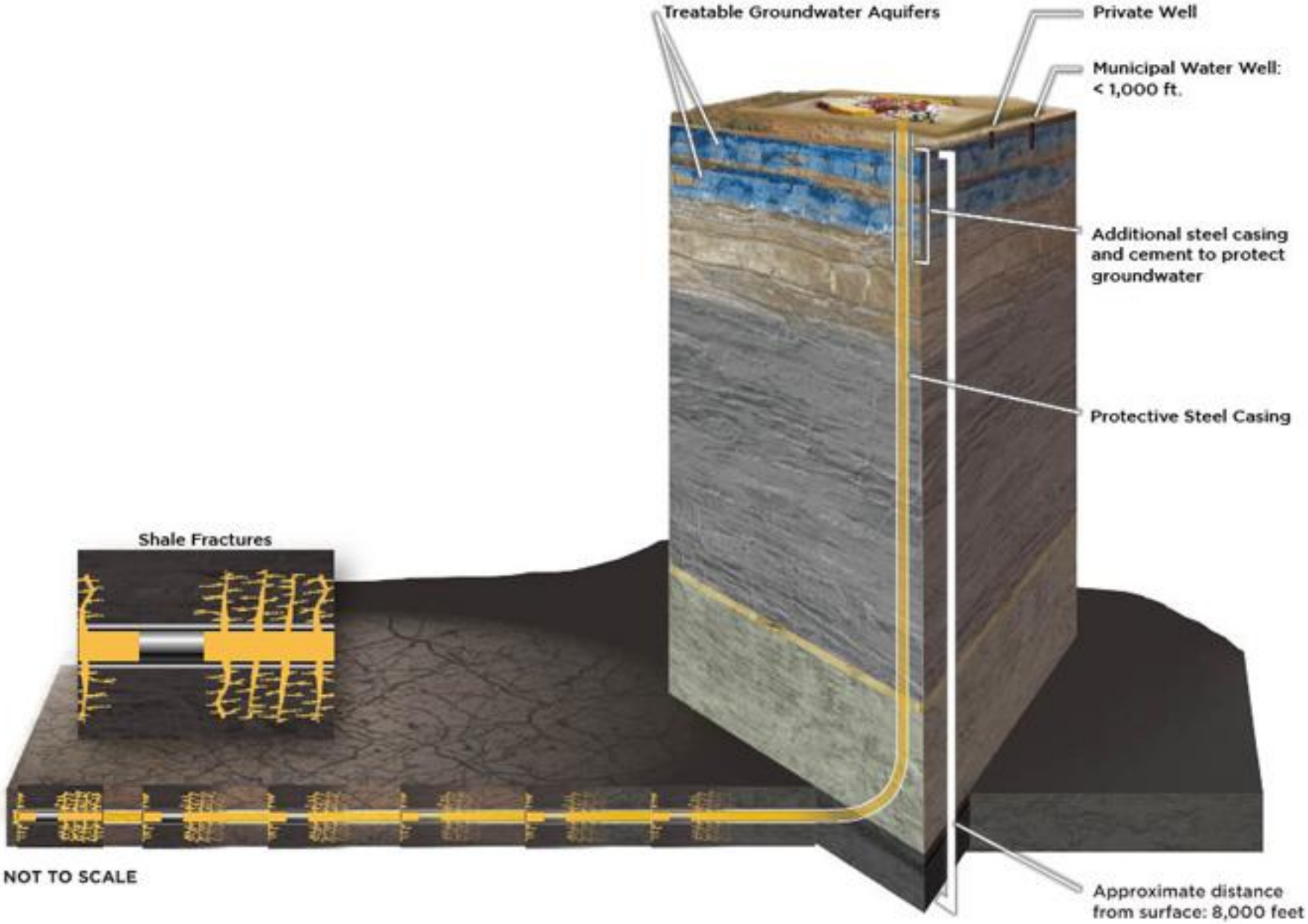


Cross sectional view

Groundwater Protection

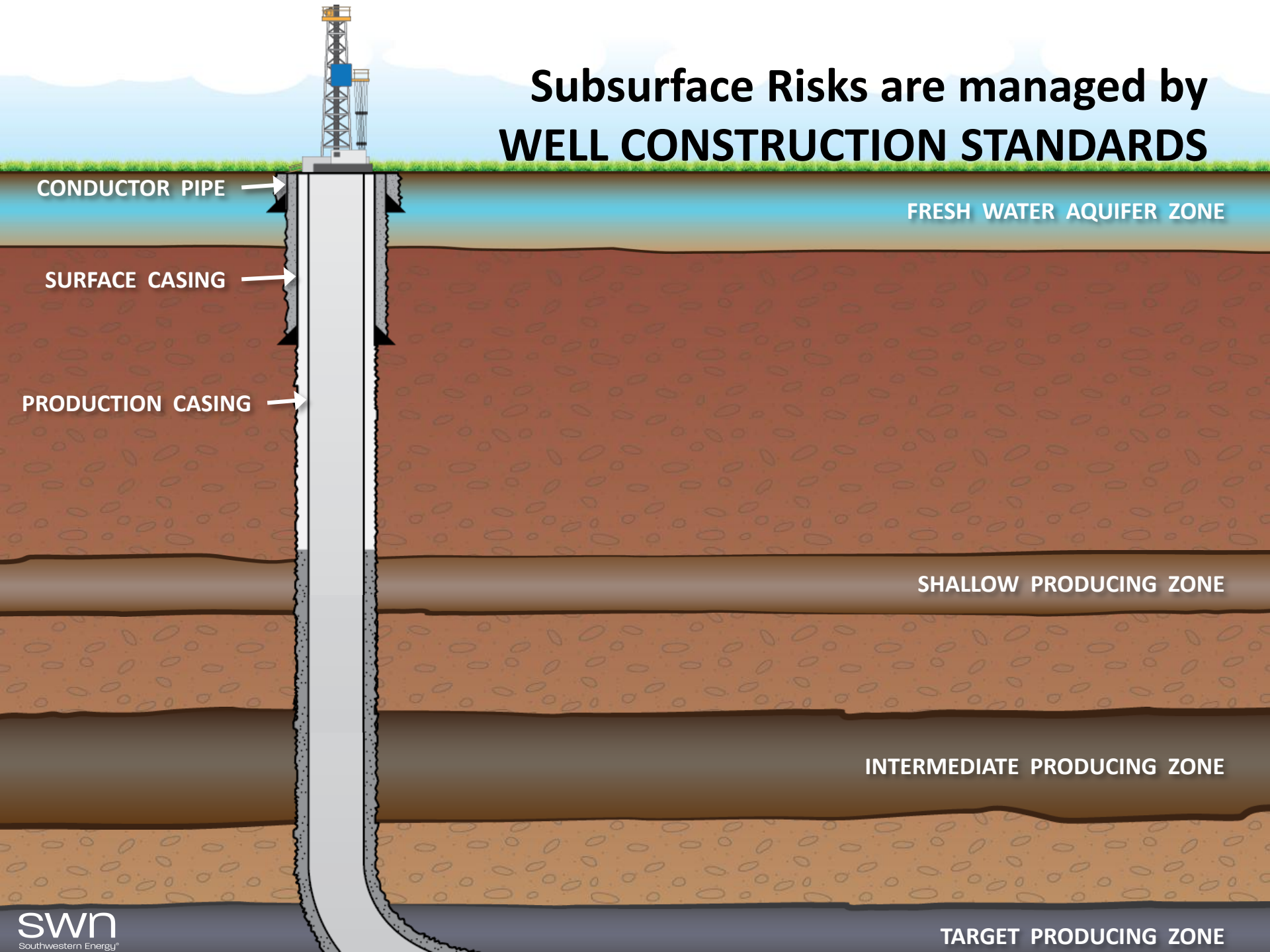






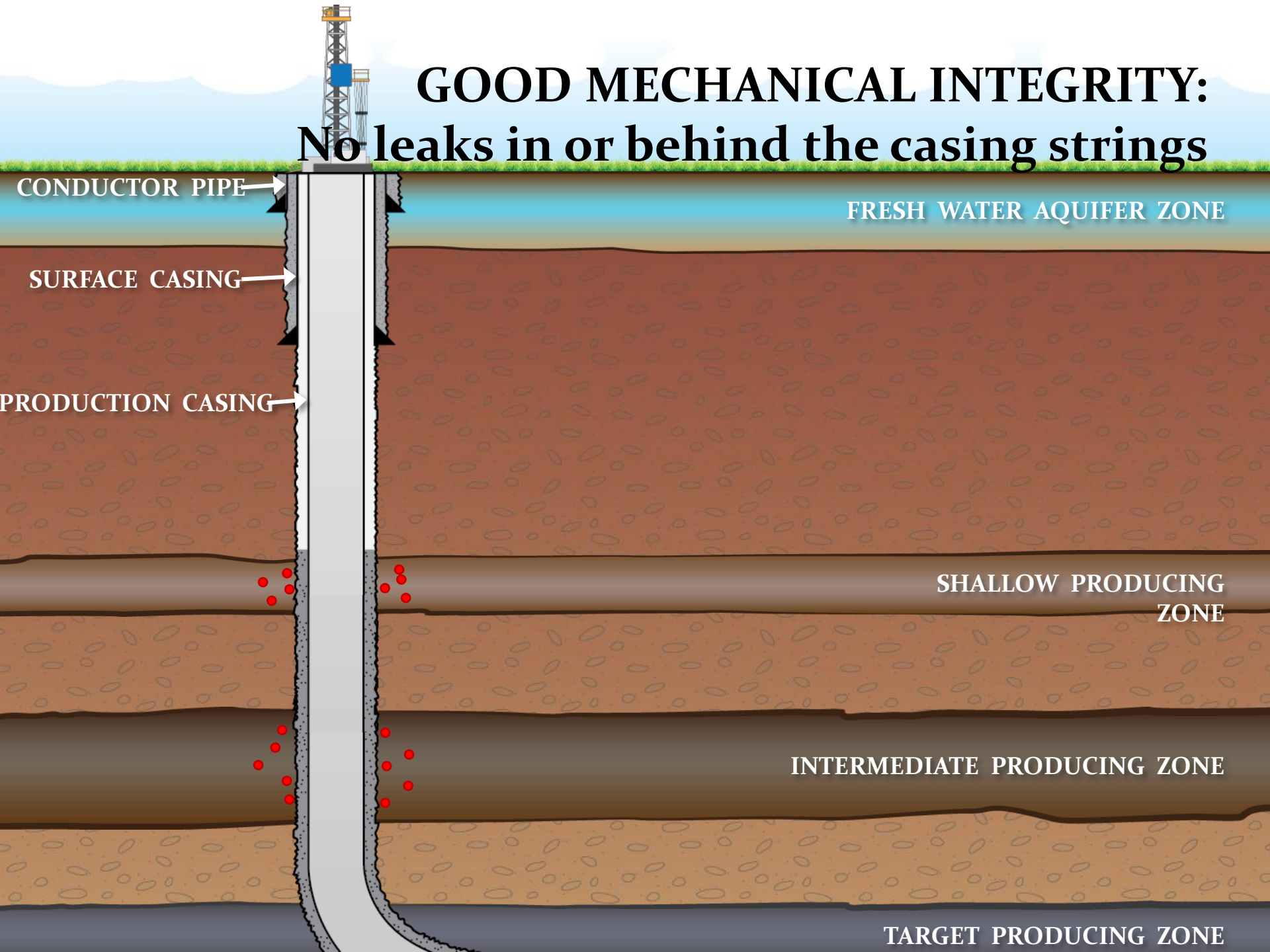
http://hydraulicfracturing.aitrk.com/Process/Pages/information.aspx

Subsurface Risks are managed by WELL CONSTRUCTION STANDARDS

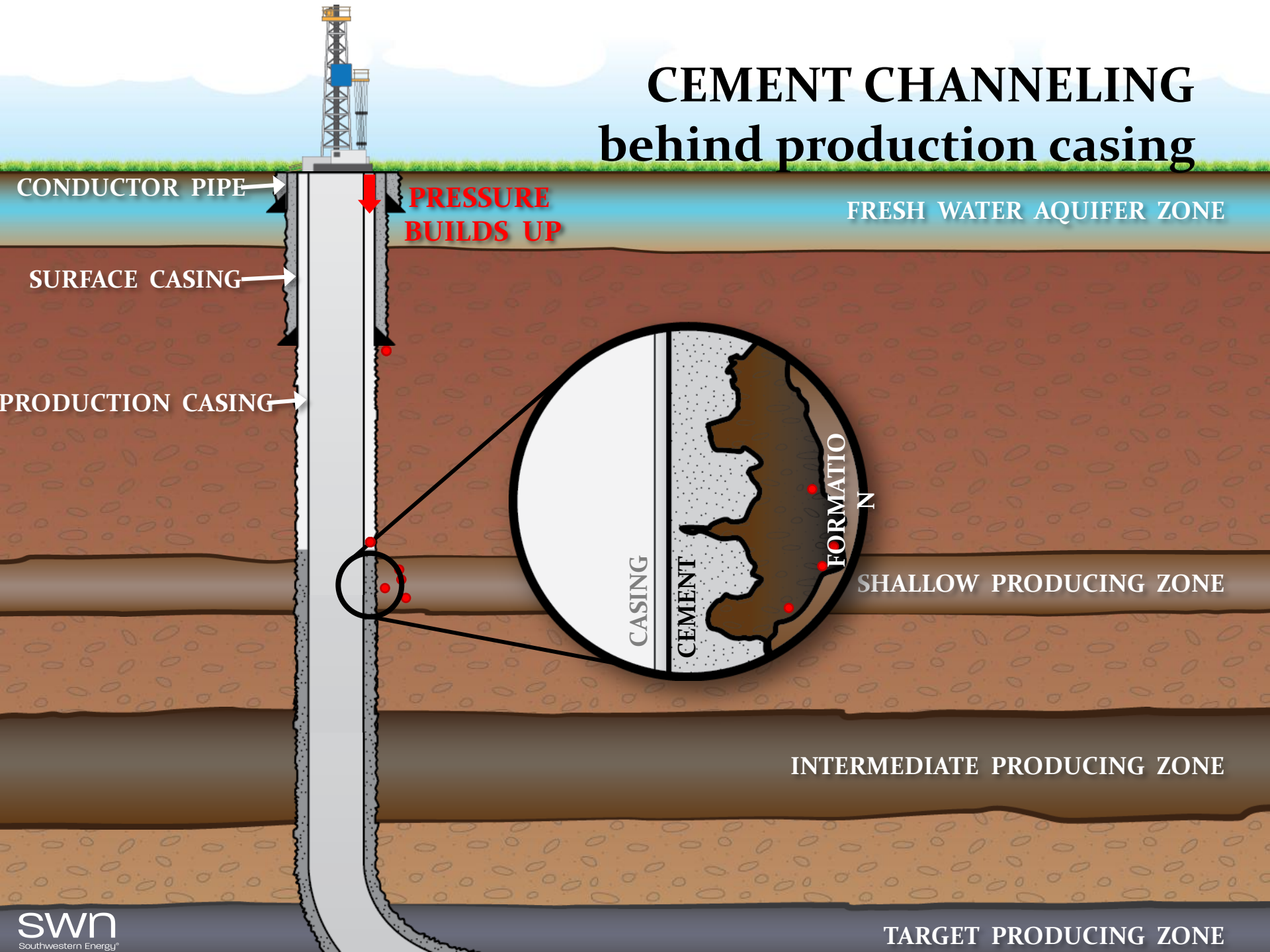


swn
Southwestern Energy

GOOD MECHANICAL INTEGRITY:
No leaks in or behind the casing strings

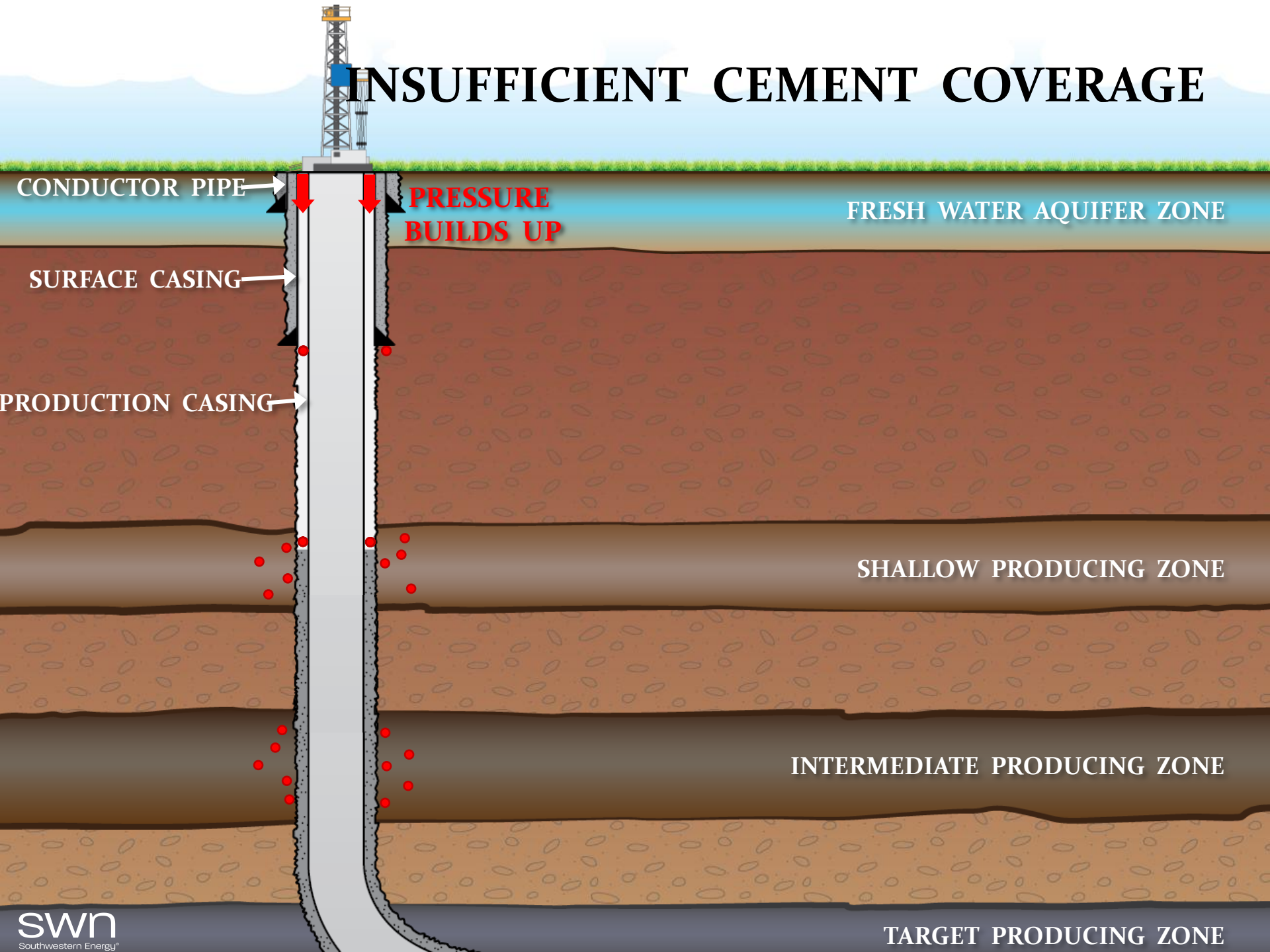


CEMENT CHANNELING behind production casing



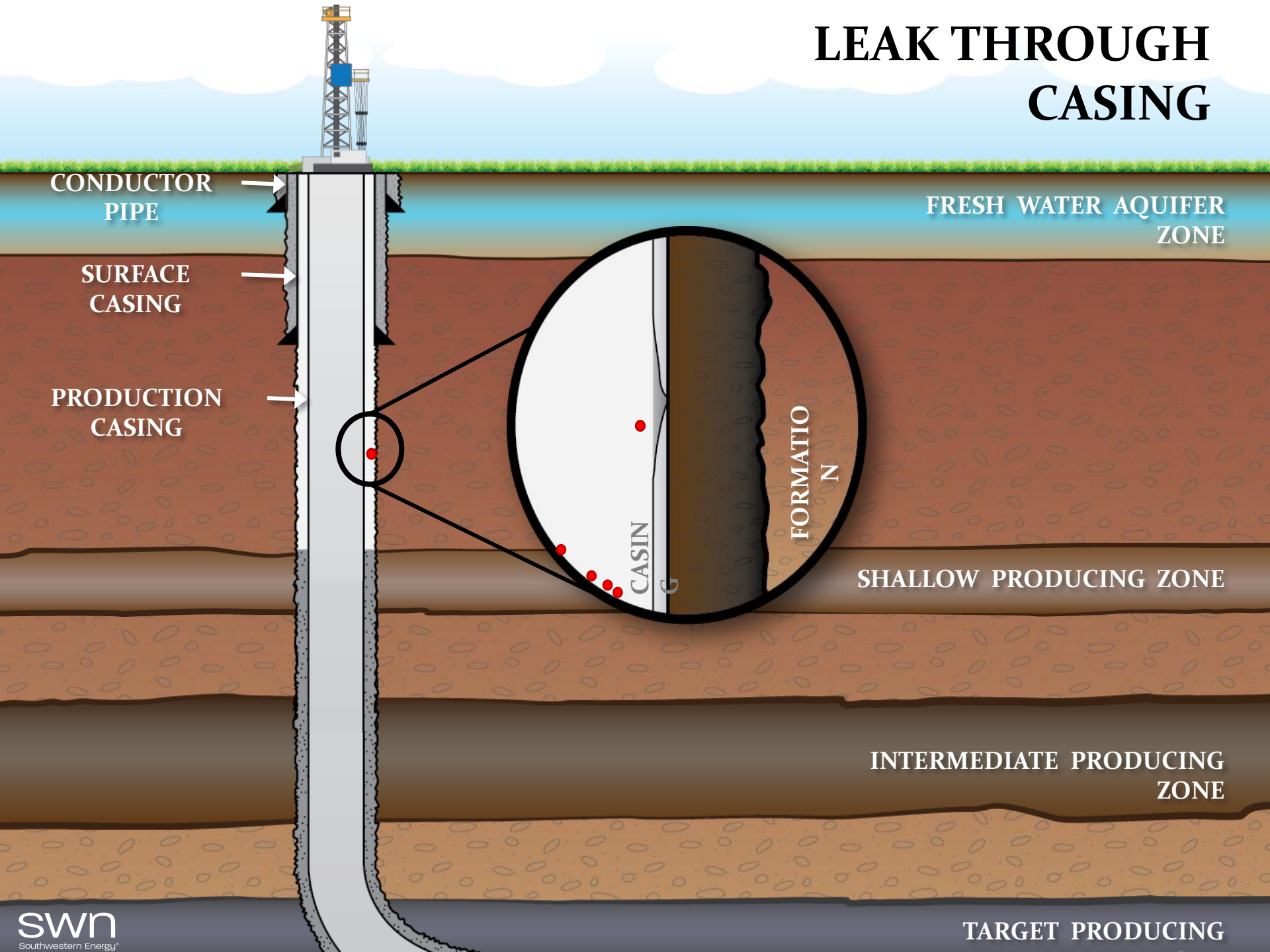
swn
Southwestern Energy

INSUFFICIENT CEMENT COVERAGE



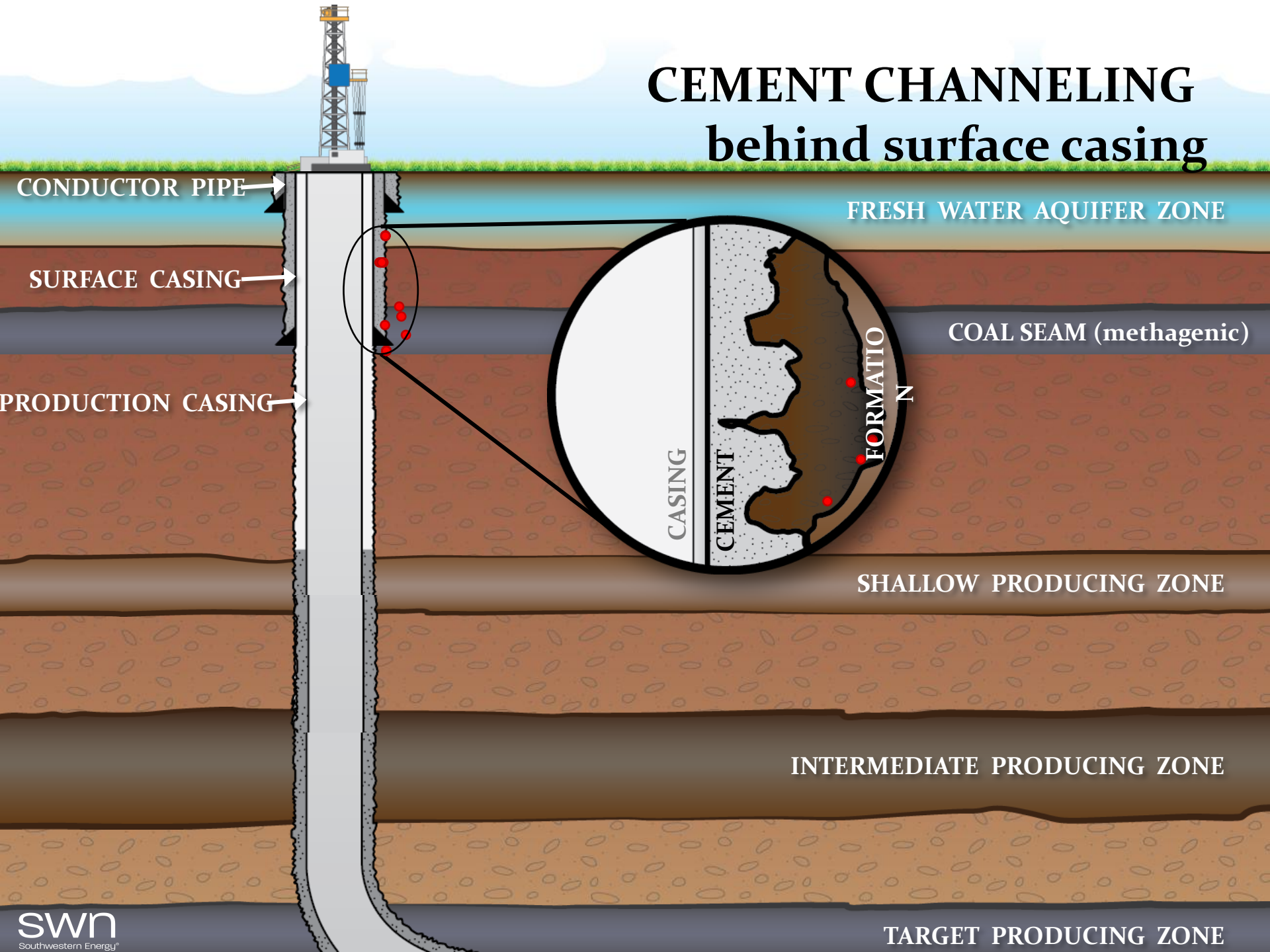
swn
Southwestern Energy

LEAK THROUGH CASING

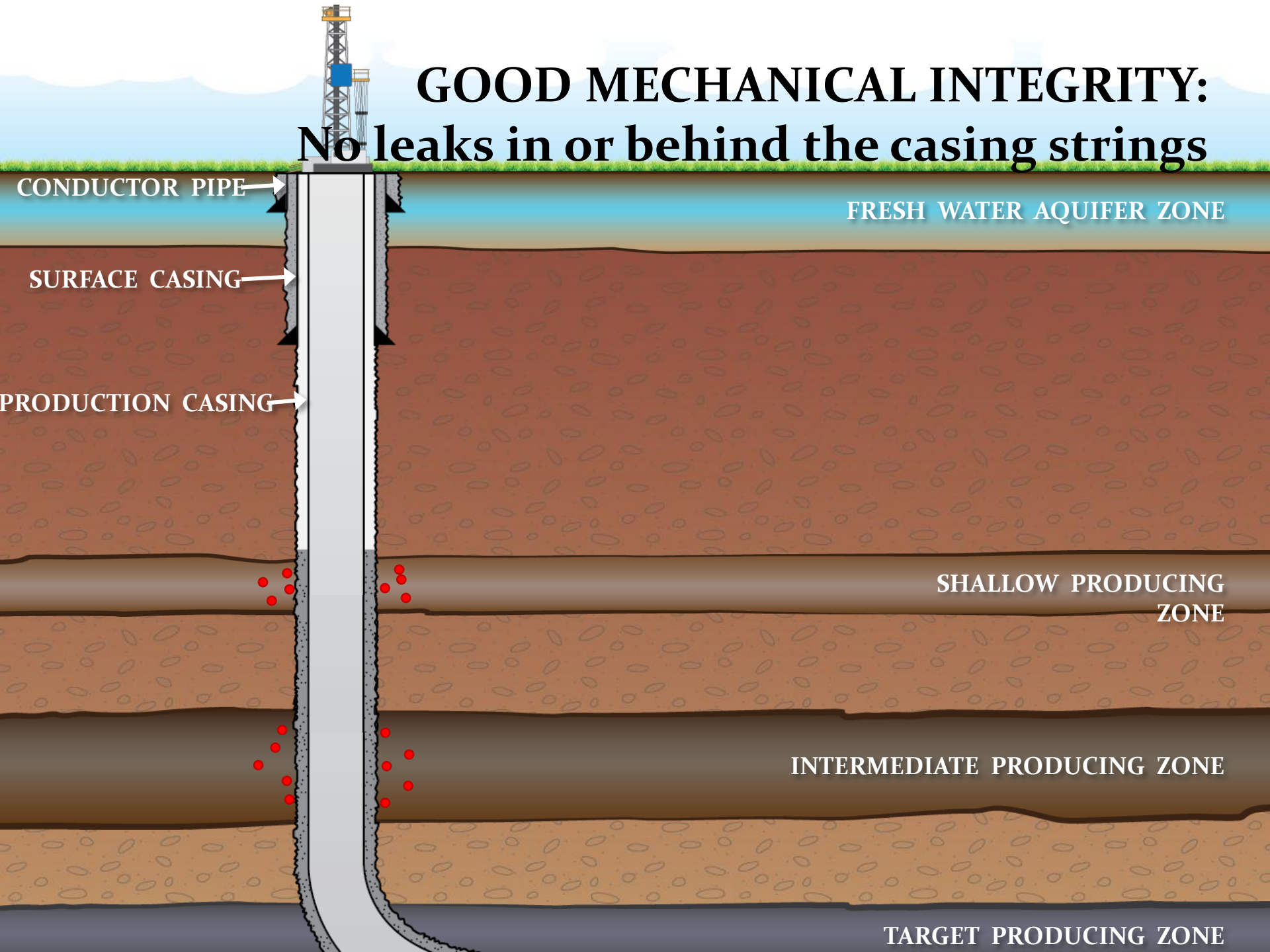


swn
Southwestern Energy®

CEMENT CHANNELING behind surface casing



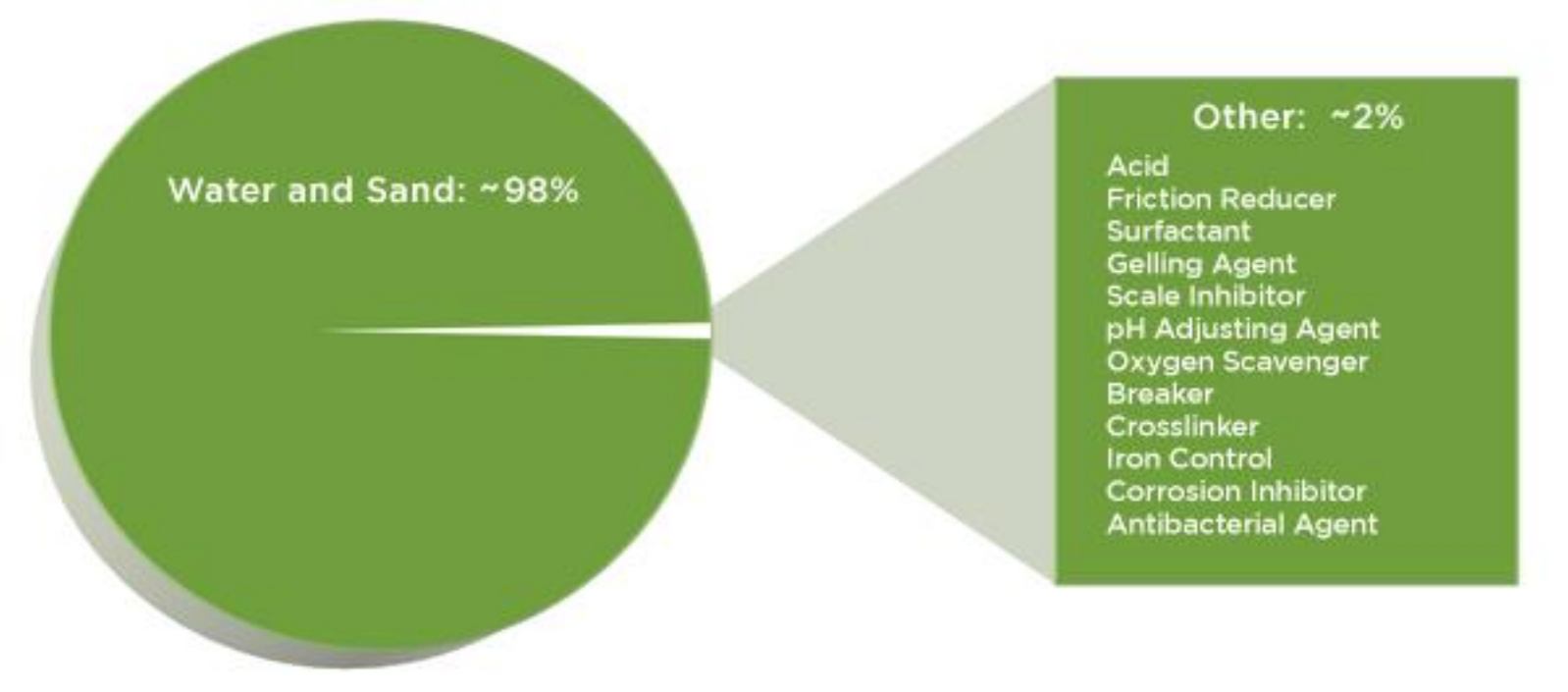
GOOD MECHANICAL INTEGRITY:
No leaks in or behind the casing strings



Environmental Concerns

- Protection of groundwater and surface water from contamination.
- **Chemicals and additives in the fracturing fluid.**
- Large volumes of water needed for hydraulic fracturing.
- Disposal of spent fracturing fluid (or flow-back fluid).

Chemicals and Additives



http://hydraulicfracturing.aitrk.com/Fracturing-Ingredients/Pages/information.aspx

Chemicals and Additives

Product	Main Ingredient	Purpose	Other Common Uses
Water		Expand fracture and deliver sand.	Municipal, agricultural, manufacturing, etc.
Sand		Props the fractures open so that oil/gas can escape.	Drinking water filtration, play sand, concrete and brick mortar.
Acid	Hydrochloric acid or muriatic acid.	Helps dissolve minerals and initiate cracks in the rock.	Swimming pool chemical and cleaner.
Antibacterial agent	Glutaraldehyde	Eliminates bacteria in the water that produces corrosive by-products.	Disinfectant; Sterilizer for medical and dental equipment.
Breaker	Ammonium persulfate	Allows a delayed breakdown of the gel.	Used in hair coloring, as a disinfectant, and in the manufacture of common household plastics.
Corrosion inhibitor	N, n-dimethyl formamide	Prevents the corrosion of the steel pipe.	Used in pharmaceuticals, acrylic fibers and plastics.
Crosslinker	Borate salts	Maintains fluid viscosity as temperature increases.	Used in laundry detergents, hand soaps and cosmetics.

http://hydraulicfracturing.aitrk.com/Fracturing-Ingredients/Pages/information.aspx

Chemicals and Additives

Product	Main Ingredient	Purpose	Other Common Uses
Friction Reducer	Petroleum distillate	“Slicks” the water to minimize friction.	Used in cosmetics including hair, make-up, nail and skin products.
Gel	Guar gum or hydroxyethyl cellulose	Thickens the water in order to suspend the sand.	Thickener used in cosmetics, baked goods, ice cream, toothpaste, sauces and salad dressings.
Iron control	Citric acid	Prevents precipitation of iron oxides.	Food additive, food and beverages; lemon juice.
Clay stabilizer	Potassium chloride	Creates a brine carrier fluid.	Used in low-sodium table salt substitute, medicines and IV fluids.
pH adjusting agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers.	Used in laundry detergents, soap, water softener and dishwasher detergents.
Scale inhibitor	Ethylene glycol	Prevents scale deposits in the pipe.	Used in household cleaners, de-icer, paints and caulk.
Surfactant	Isopropanol	Used to increase the viscosity of the fracture fluid.	Used in glass cleaner, multi-surface cleaners, antiperspirant, deodorants and hair color.

http://hydraulicfracturing.aitrk.com/Fracturing-Ingredients/Pages/information.aspx

Chemicals and Additives

- Wellbore integrity isolates fracture fluids.
- Fluid “flow-back” adequately stored in lined earthen pits or steel tanks until proper disposal.
- Material handling on surface is in accordance with requirements and long-standing industry practices.
- MSDS sheets available for review on well site.

Environmental Concerns

- Protection of groundwater and surface water from contamination.
- Chemicals and additives in the fracturing fluid.
- **Large volumes of water needed for hydraulic fracturing.**
- Disposal of spent fracturing fluid (or flow-back fluid).

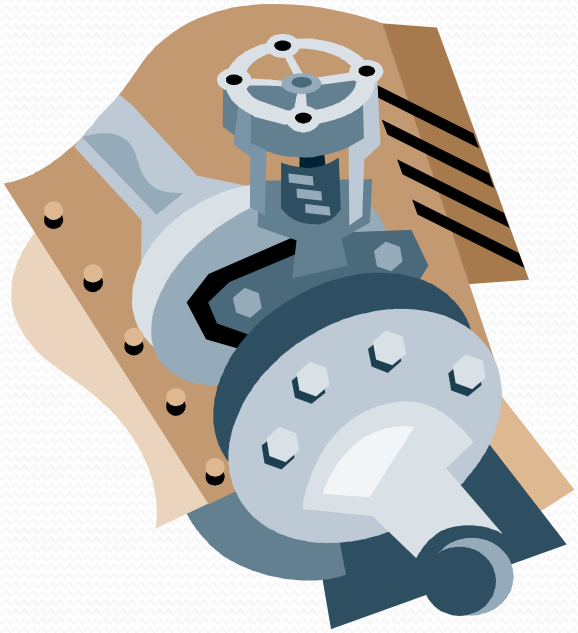
Water Volumes

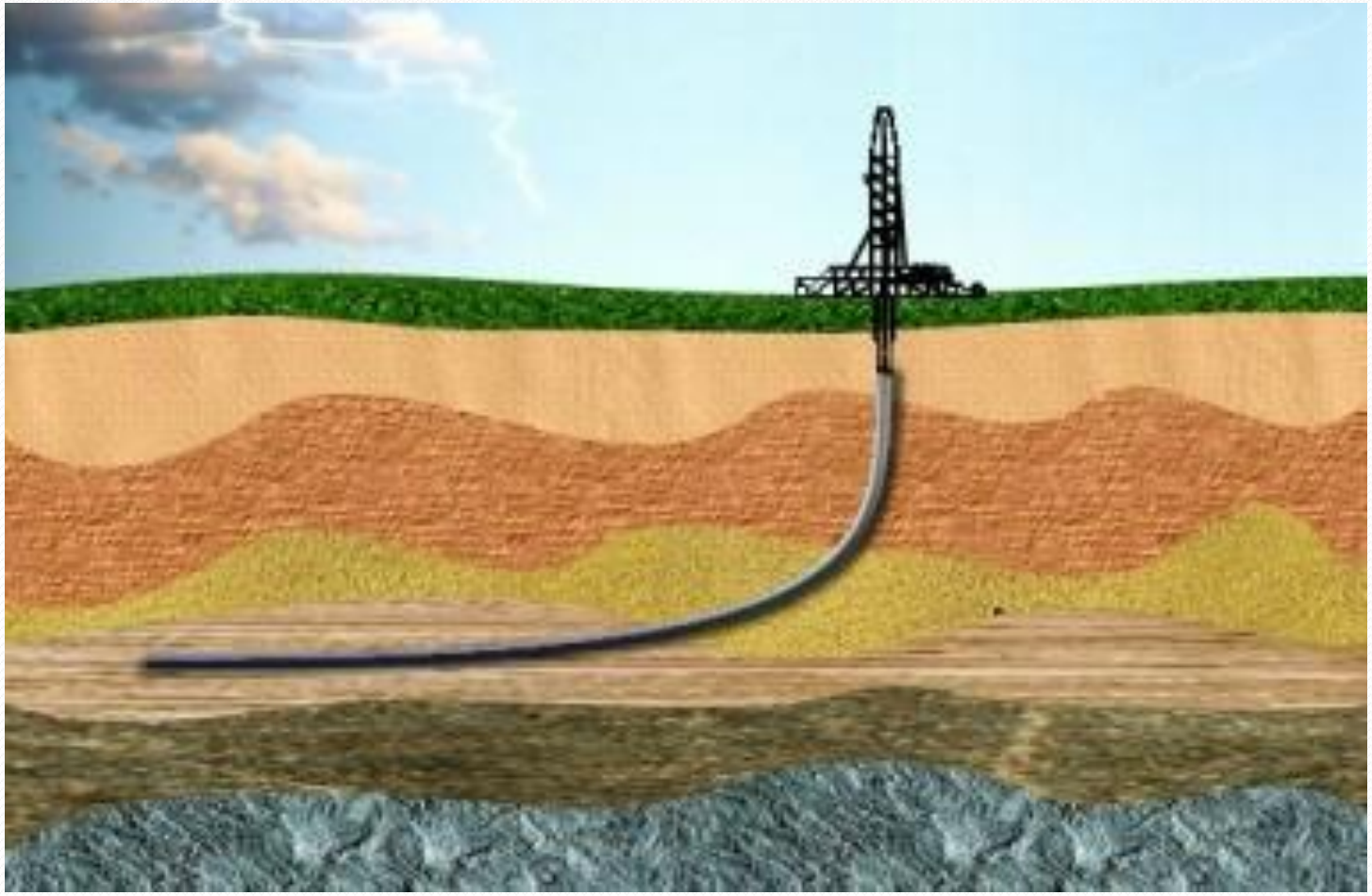
- Typically,10,000-15,000 barrels per well (420,000-630,000 gallons) are needed for fracture stimulation. 30-40% will flow back to surface.
- Use is temporary, not a long term commitment.
- The amount of water that is used can be reduced when fracture fluids are recycled.
- Other water use should be considered with respect to current water uses (i.e. agricultural, municipal, power generation, etc.).

Environmental Concerns

- Protection of groundwater and surface water from contamination.
- Chemicals and additives in the fracturing fluid.
- Large volumes of water needed for hydraulic fracturing.
- **Disposal of spent fracturing fluid (or flow-back fluid).**

Fluid Disposal



- Underground injection.
- Commercial disposal facilities.
- Surface disposal pits.
- Treatment/Reuse

Questions?