

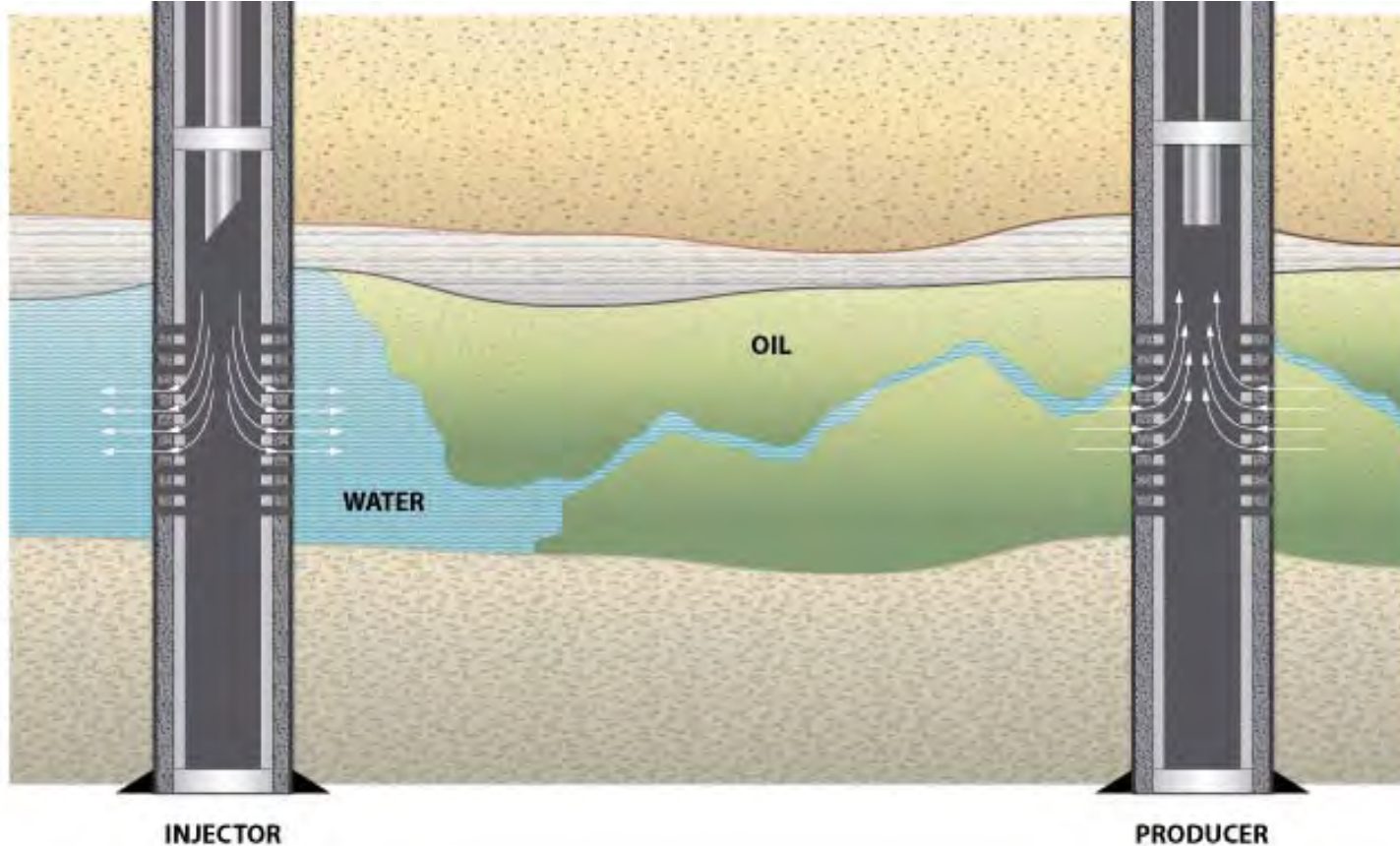
Increase oil recovery using crosslinked gels to block waterflood hot streaks

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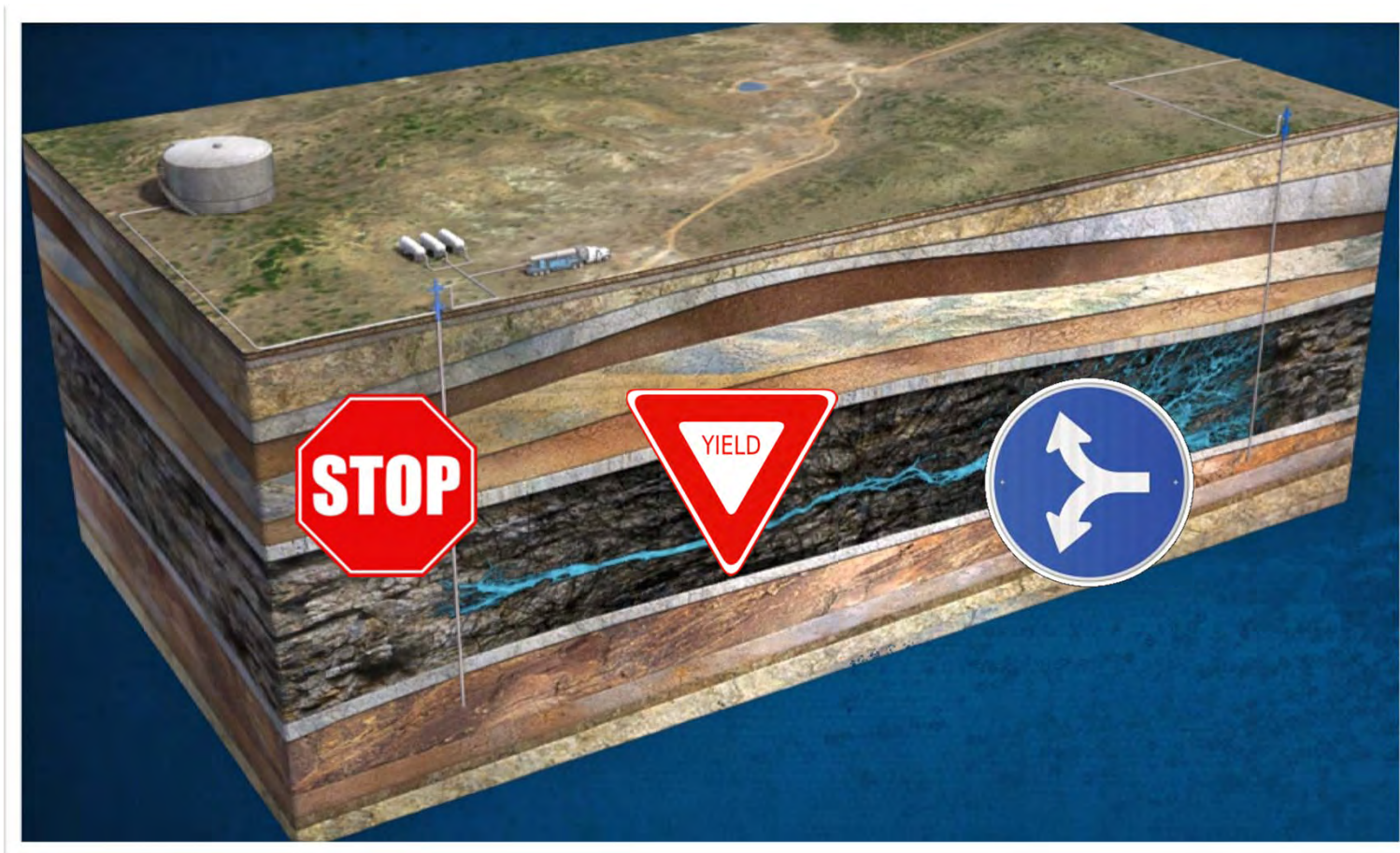
Factors affecting waterflood efficiency

- Poor sweep
 - Injected fluid bypassing hydrocarbon bearing zones
- Cycling of fluid
 - Increased production and handling costs with little benefit to recovery



Conformance & Water Shut-off Objectives

- Shutoff water without damaging hydrocarbon productive zones
- Reduce permeability of water source pathways
- Divert injected fluids into hydrocarbon-bearing strata



Treatment Strategy

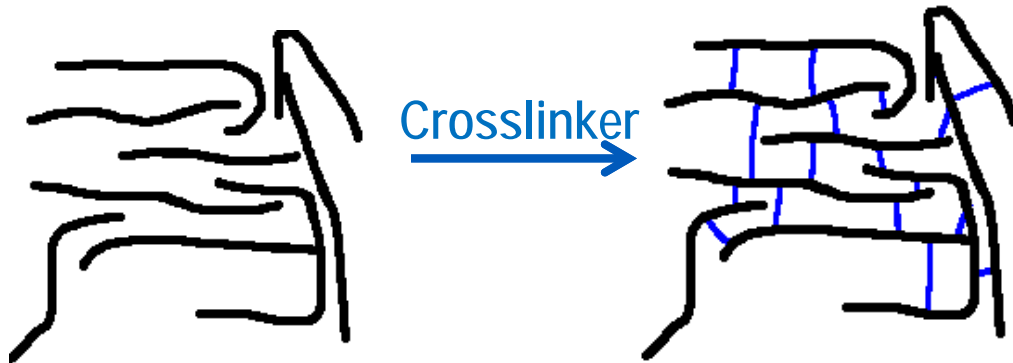
- Water Source?
 - Tracer Study
 - Communication analysis
- Flow Path?
 - Lithology?
 - Natural fractures?
 - Hydraulic fractures?
 - High perm channels?



★ *Treat the source, not the 'symptom'*

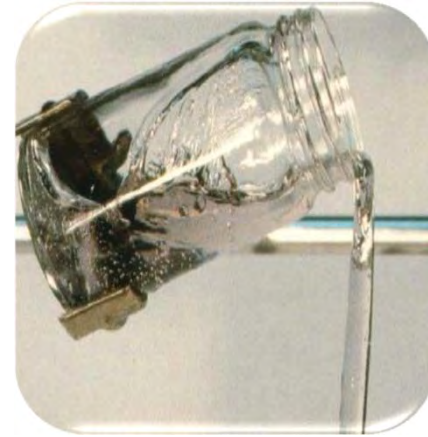
Crosslinked Polymer Gel

- High MW (6-10 MM Daltons)
- Penetrate deep into reservoir away from wellbore
- Partially Hydrolyzed Polyacrylamide (HPAM)
- Gelation is a function of time and temperature
- Stable up to 110°C



- Applied in stages of increasing concentration

3,000+ treatments applied in North America



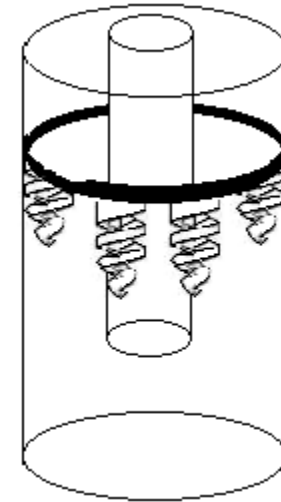
Field Application

Polymer Treatment trailer:

- Wetting head
- 2 x Hydration tanks
- Crosslinker pump
- Static mixer
- Triplex pump

Application methods:

- Bullheading
- Coiled tubing
- Mechanical isolation



Case Study #1

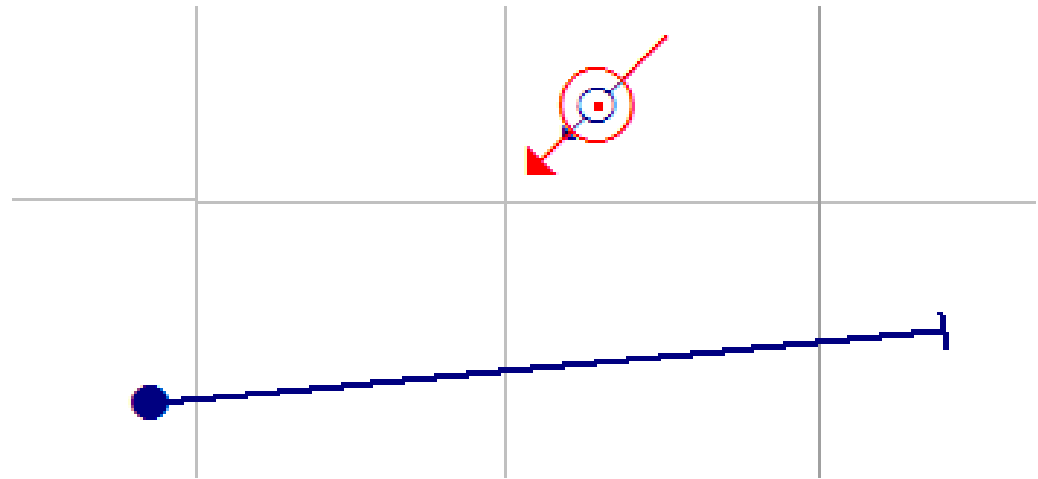
Vertical Injection Well- Eastern Alberta

Injector #1-Problem characterization

- Communication between vertical injector & offset horizontal producer
 - Customer noticed this injector was providing poor pressure maintenance and sweep efficiency to nearby offsets in the pool
 - Suspected hot streak due to high perm channel

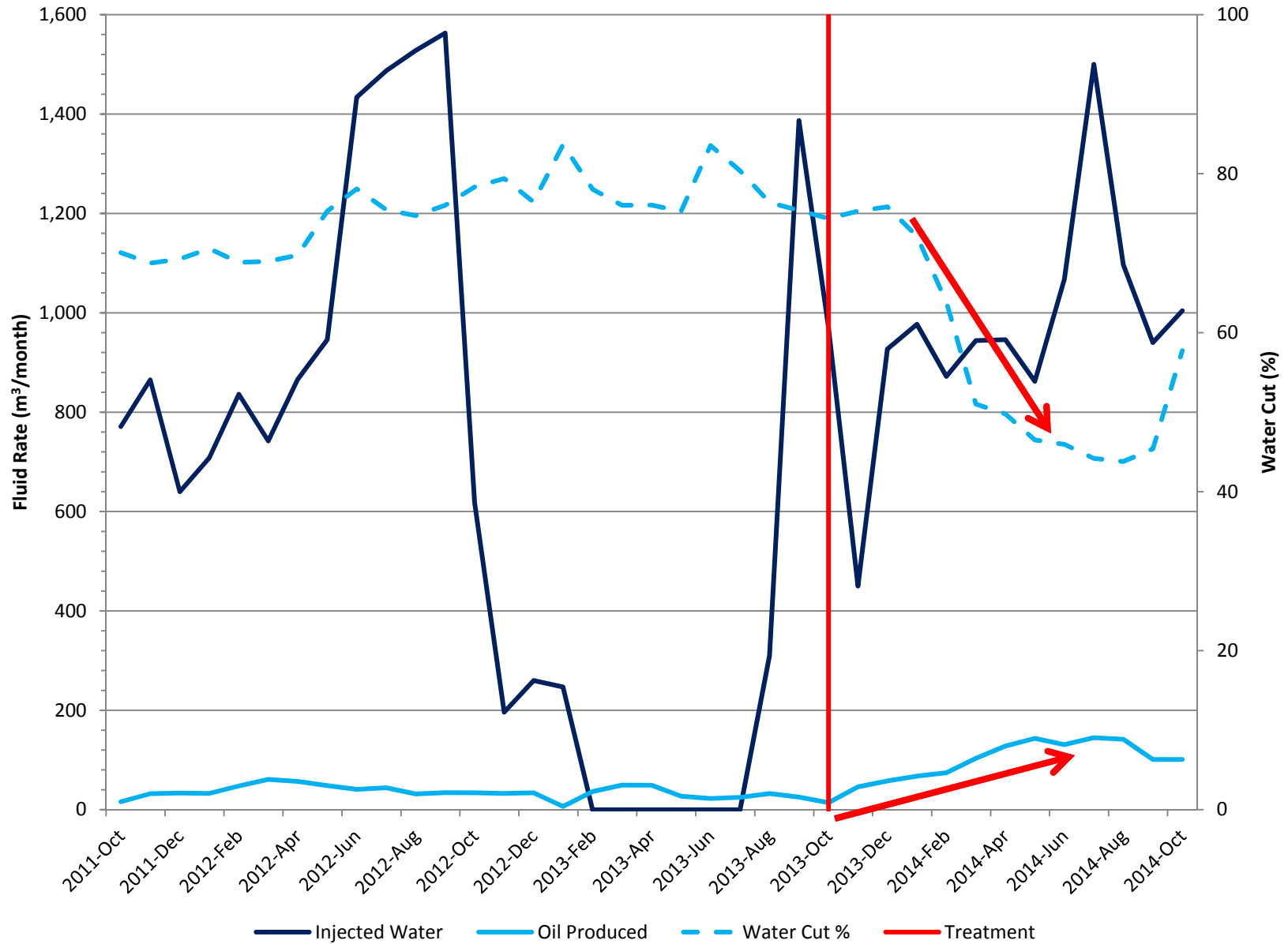
- Properties:

- Sandstone
- 25-200 mD
- Heavy oil ~20°API
- Well spacing ~700m
- Injecting since 2002
- Hz. Offset producing for 14 years



- Treatment: High MW crosslinked polymer gel treatment

Injector #1- Treatment Results



Injector #1: Value

	1 year before treatment	1 year after treatment	Improvement	
Cum. oil	355 m ³	1,240 m ³	885 m ³	250 %
Avg. daily oil rate*	1.2 m ³ /day	3.5 m ³ /day	2.3 m ³ /day	201 %

*based on # operating hours per month

Netback = \$37/bbl = \$232.72/m³

Based on daily rate : took *66 days* to pay off using incremental oil

Incremental Revenue within one year following treatment:
\$206,000

Treatment Cost = 17% of incremental revenue

Case Study #2

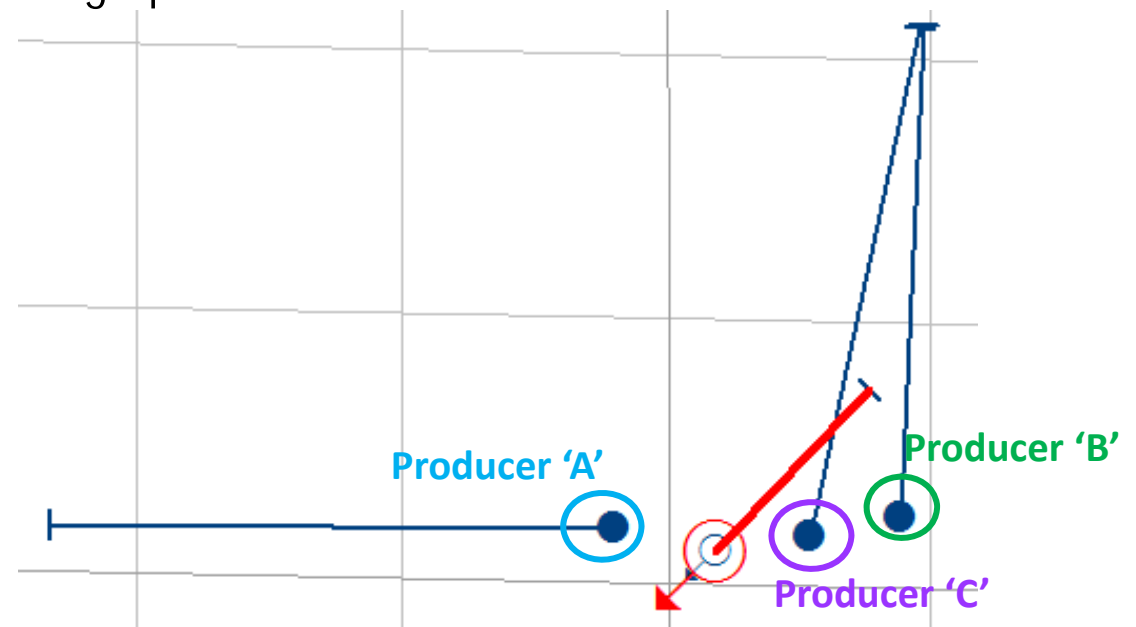
Directional Injection Well- Eastern Alberta

Injector #2: Problem Characterization

- Communication between injector & offset producers
 - Customer noticed this injector communicating with certain offsets in the pool
 - Suspected hot streak due to high perm channel

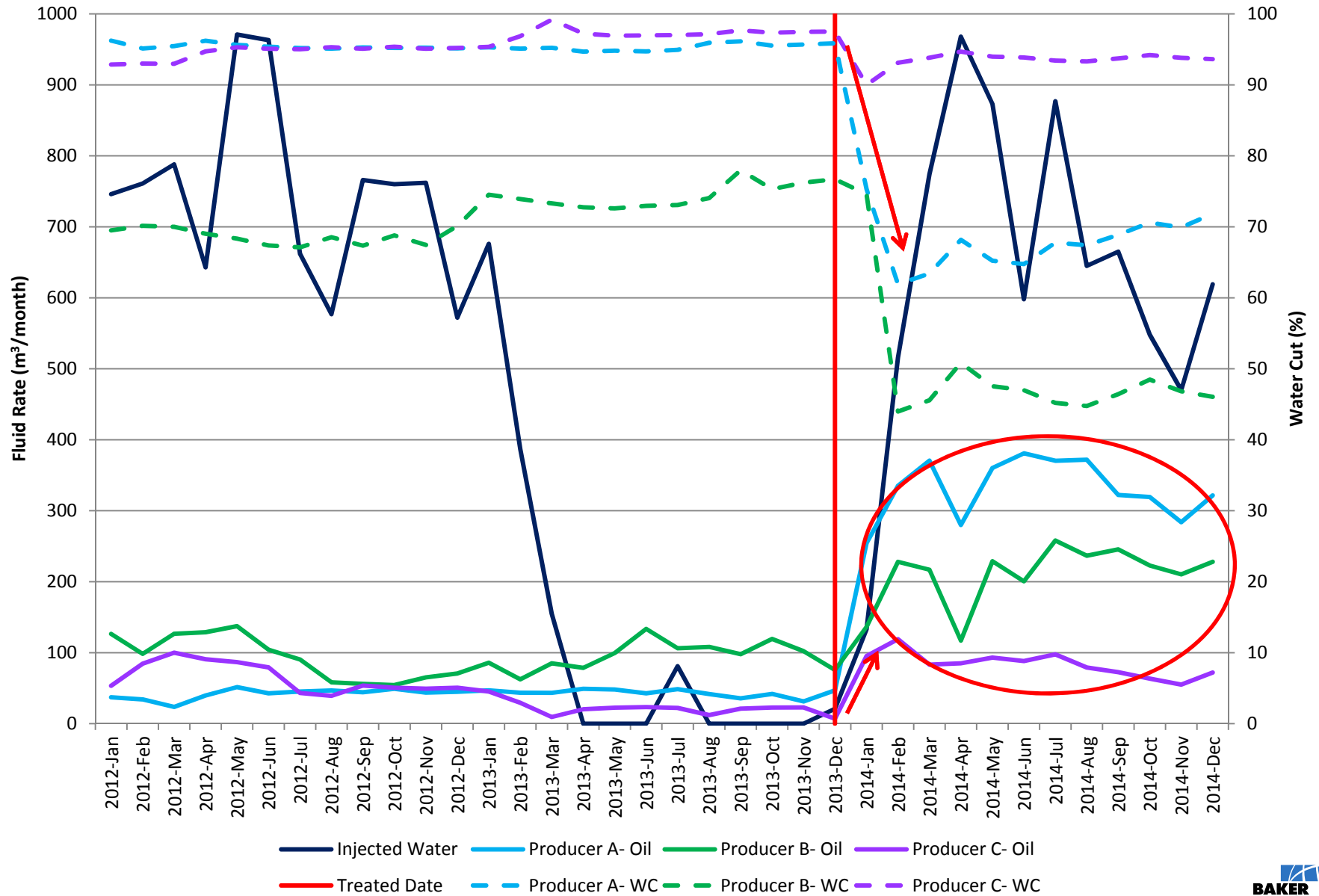
- Properties:

- Sandstone
- 25-200 mD
- Heavy oil ~20°API
- Well spacing 150 – 1050 m
- Injecting since 2003
- Producer A = 17 years old
- Producer B & C = 13 years old

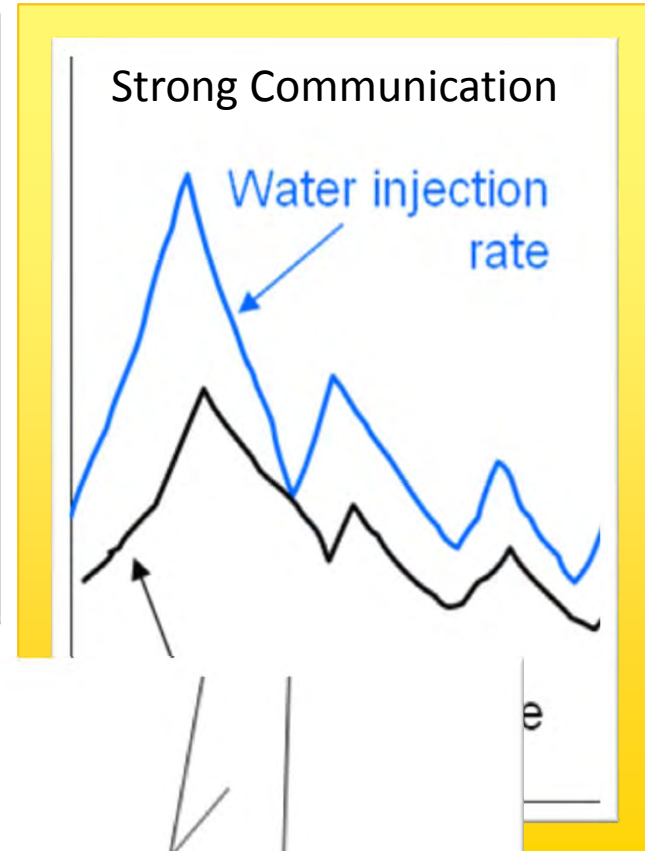
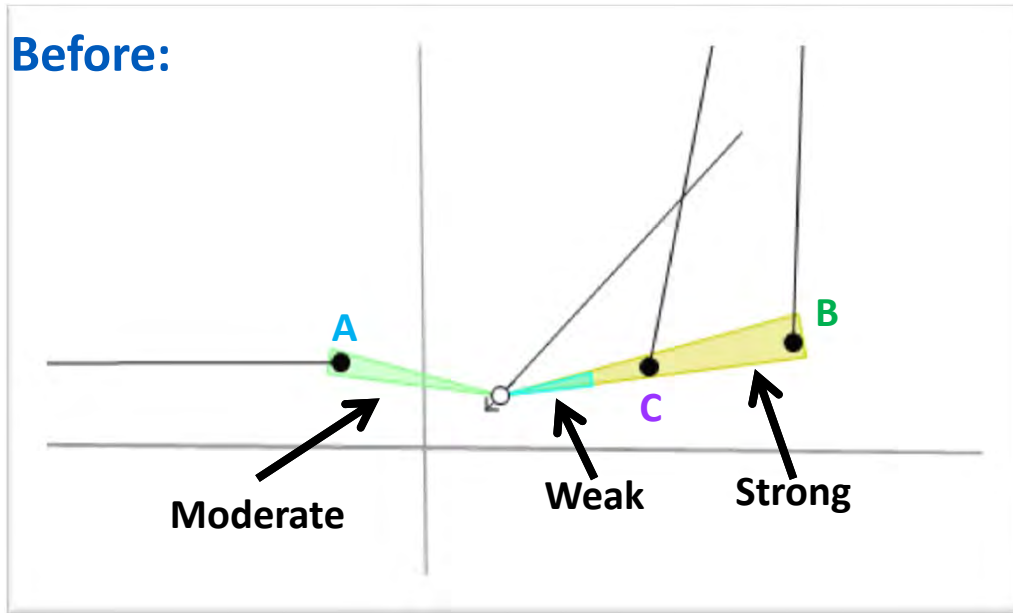


- Treatment: High MW crosslinked polymer gel treatment

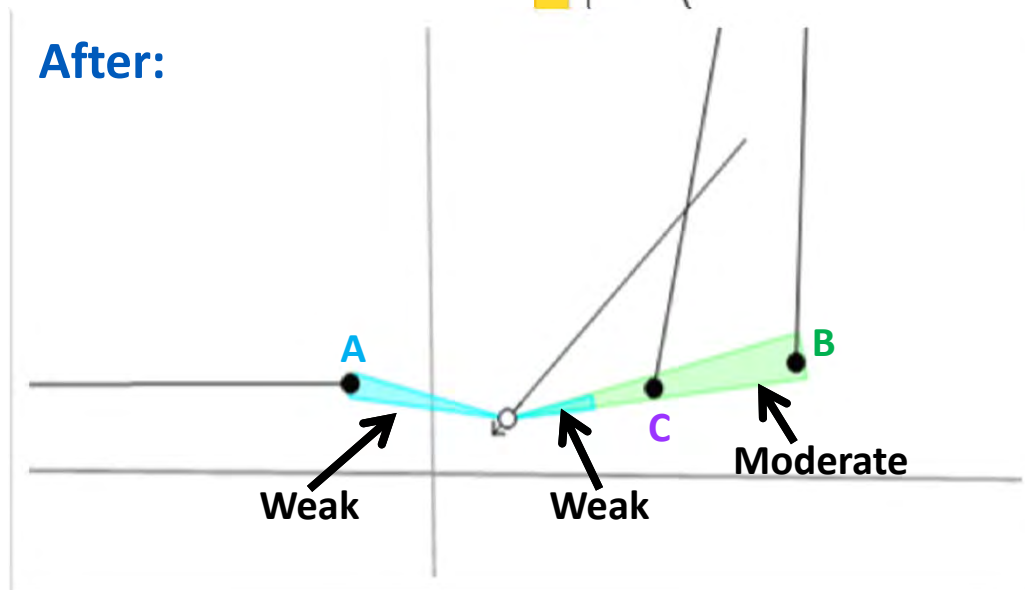
Injector #2: Results



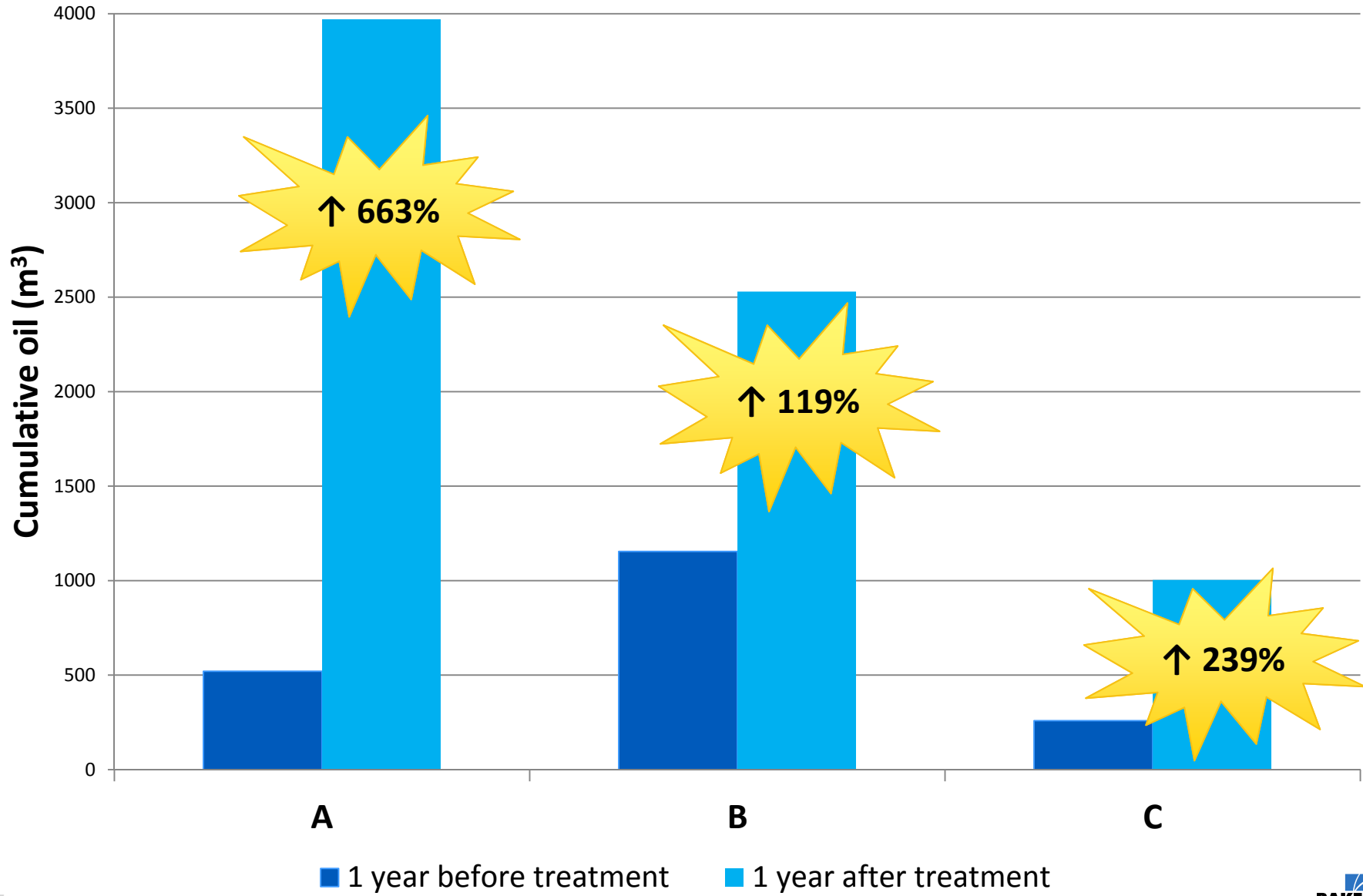
Case Study #2- Communication Before and After



- Very weak
- Weak
- Moderate
- Strong
- Very strong



Injector #2: Value



Injector #2: Value Summary

	1 year before treatment	1 year after treatment	Improvement	
Cumulative Oil	1934 m ³	7504 m ³	5570 m ³	288 %
Avg. daily oil rate*	5.6 m ³ /day	21.2 m ³ /day	15.6 m ³ /day	280 %

*based on # operating hours per month

Netback = \$37/bbl = \$232.72/m³

Based on daily rate : took *10 days* to pay off using incremental oil

Incremental Revenue earned in one year following treatment:
\$1,296,000

Treatment Cost = 3% of incremental revenue

Questions

