

Tertiary Oil Recovery Project Advisory Board Meeting

Arbuckle Polymer Jobs

**University of Kansas
Kansas Union
November 15, 2002**

Rich Pancake



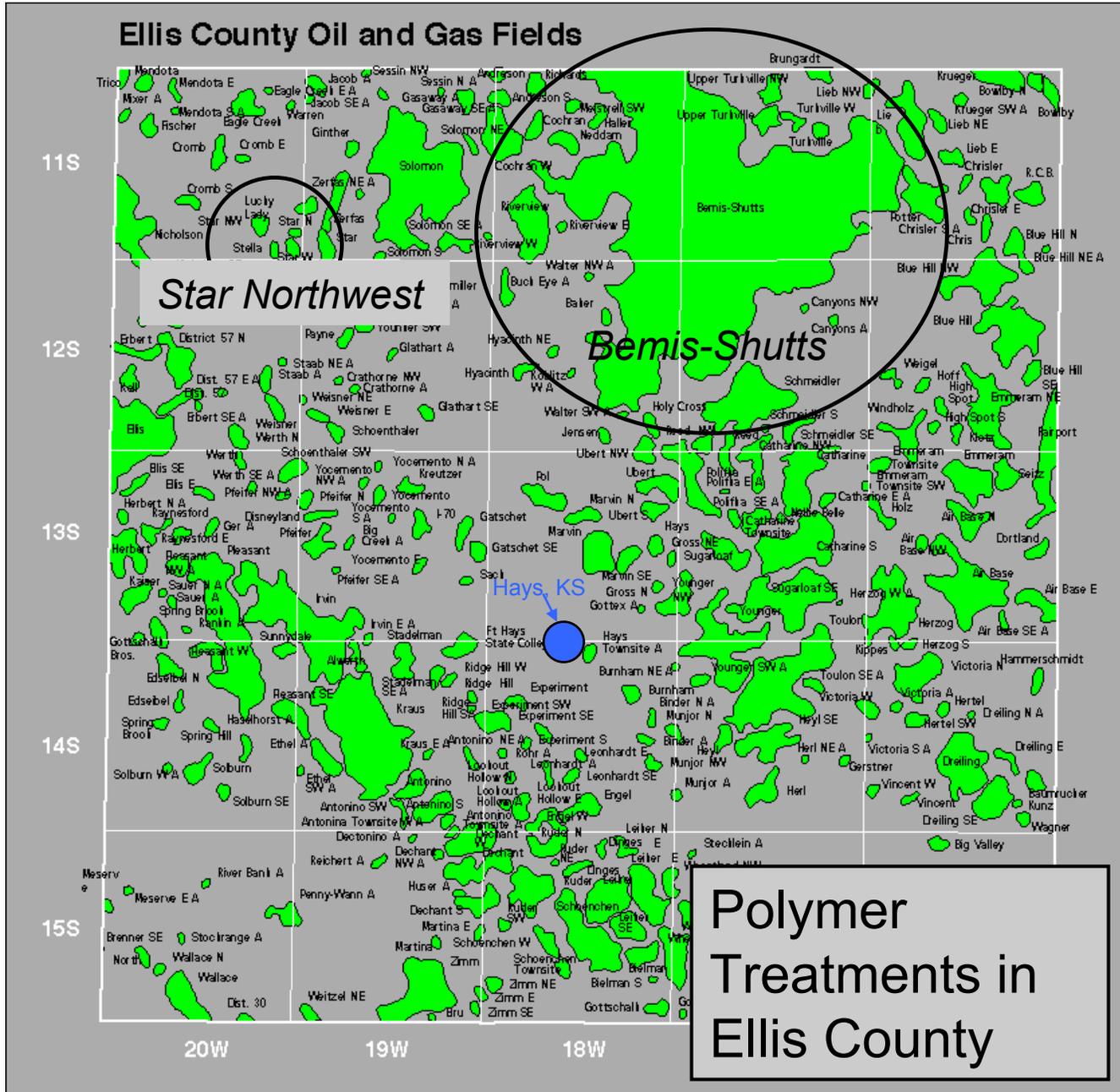
Presentation Outline

- **Status of Arbuckle Polymer Treatments**
- TORP's Efforts in Evaluating Polymer Treatments
- Future TORP/PTTC Activities Related to Polymer Treatments

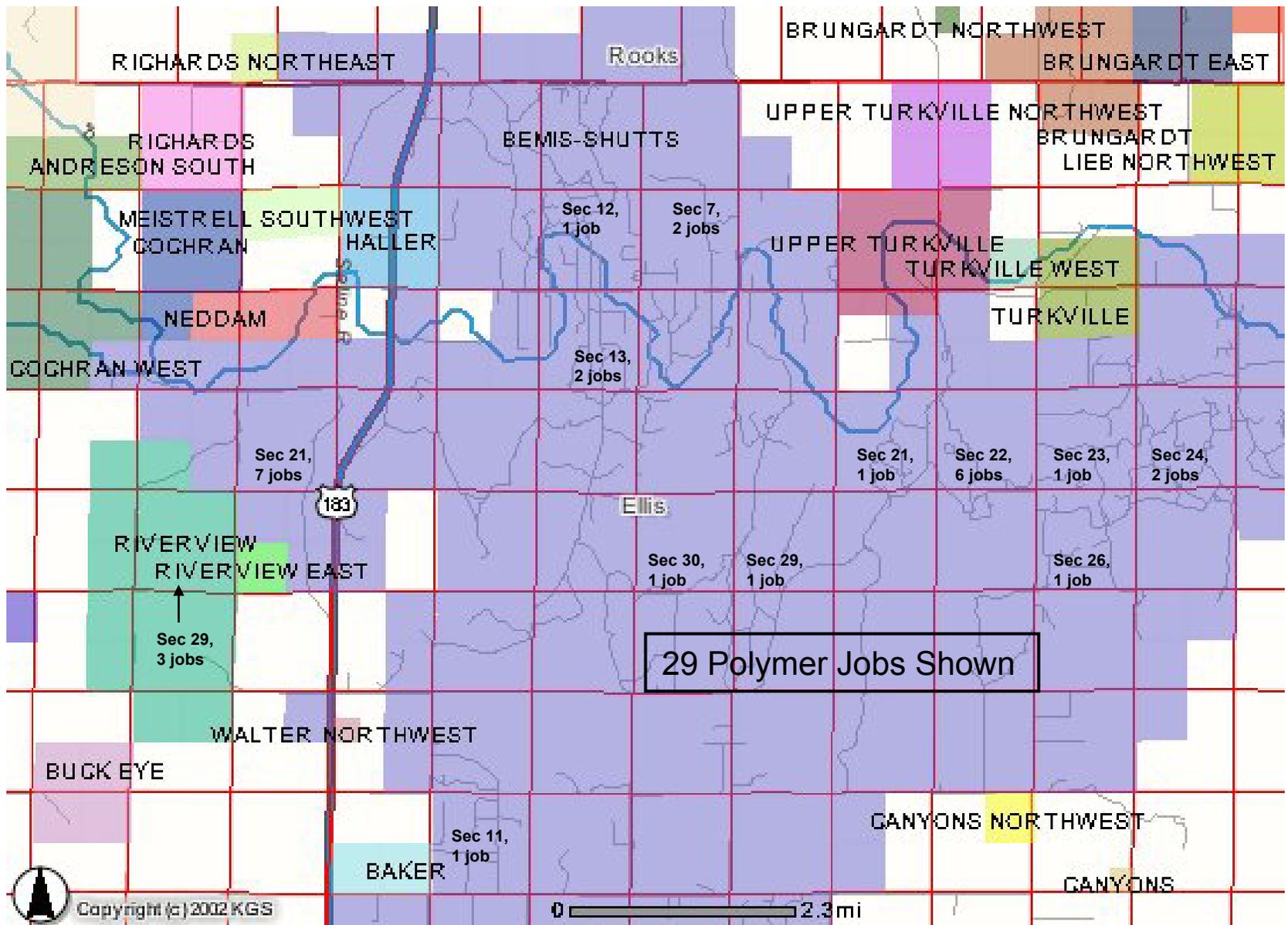
Status of Arbuckle Polymer Treatments

- **+/- 100 MARCIT technology polymer jobs pumped in the Arbuckle since 2000**
 - +/- 60 by TIORCO
 - +/- 40 by Gel-Tec
- **Treatment locations**
 - +/- 60 % of jobs pumped in Bemis-Shutts Field
 - Remainder pumped in Marcotte, Star Northwest, Northampton, Jelinek, Ogallah, Trapp, Geneseo-Edwards, and other fields

Ellis County Oil and Gas Fields



Polymer Treatments in Bemis-Shutts



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Status of Arbuckle Polymer Treatments

- **Well selection criteria**
 - **Well drilled up structure**
 - **Well originally had high, water-free IP**
 - **Well at its economic limit because of high WOR**
 - **Well has very high fluid level**
 - **Well has high calculated flow potential**

Status of Arbuckle Polymer Treatments

- **Treatment design criteria**

Vender 1

- For high fluid level wells, pump 2x well's daily production, up to 4000 bbls.
- For low fluid level wells, pump 1x well's daily production.
- Surface treating pressure not to exceed 200 psig.

Vender 2

- Gel volume pumped to be near well's calculated maximum inflow, up to 4000 bbls.
- Surface treating pressure to be between 200 and 400 psig.

Status of Arbuckle Polymer Treatments

- **Typical treatment design**
 - **Pull pump & tbg. Sand pump well. RIH w/ tbg & packer. Set pkr +/- 100 ft above interval.**
 - **Acidize well w/ between 250 & 1500 gals 15% HCl.**
 - **Recent trend appears to be towards the larger, 1500 gal acid jobs.**
 - **Pump polymer down tbg.**
 - **Small job - 1000 to 1600 bbls.**
 - **Large job - 3000 to 4100 bbls.**
 - **Larger jobs are typically in Bemis.**
 - **Recent trend may be to pump even larger jobs.**

Status of Arbuckle Polymer Treatments

- **Typical treatment design (cont'd)**
 - **Pump polymer down tbg (cont'd).**
 - Gel loadings increase in 3 to 4 stages – 3500, 4000, 5000, and 6500 ppm.
 - Recent trend appears to be to increase gel loading at end of job to 7500 or 8500 ppm.
 - **Flush tbg w/ oil or water.**
 - Typically 100 bbl water flush.
 - Typically 50 to 80 bbl oil flush.
 - Philosophy of oil or water flush varies among operators.
 - **Shut-in well 7 to 14 days. Return well to production.**

Status of Arbuckle Polymer Treatments

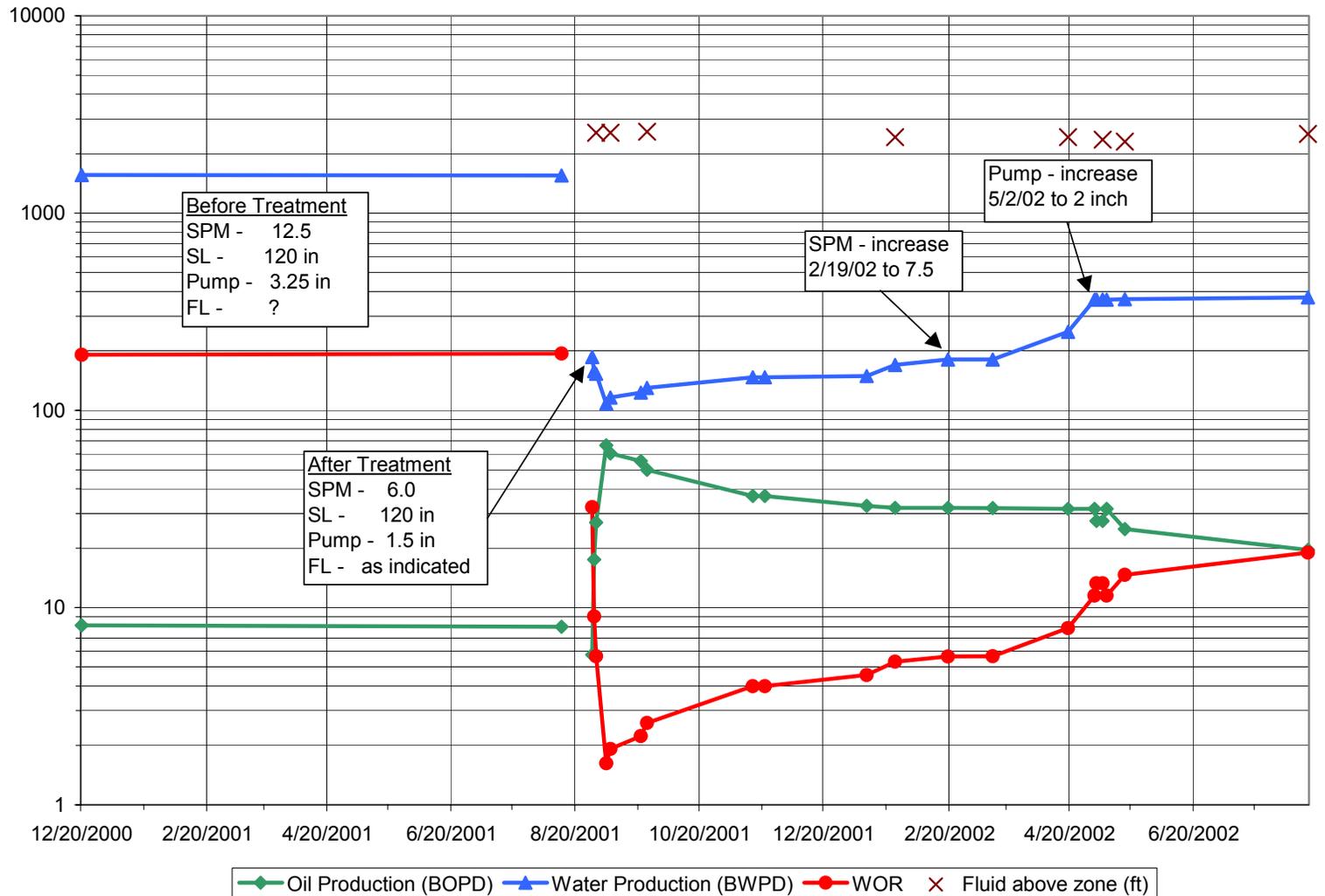
Polymer treatment examples

Example of Good Response

Murfin's Hadley BC #10 Polymer Job

August 14-18, 2001

(3806 bbls gel, 100% of job treated on a vacuum, 0 psig max treating press)

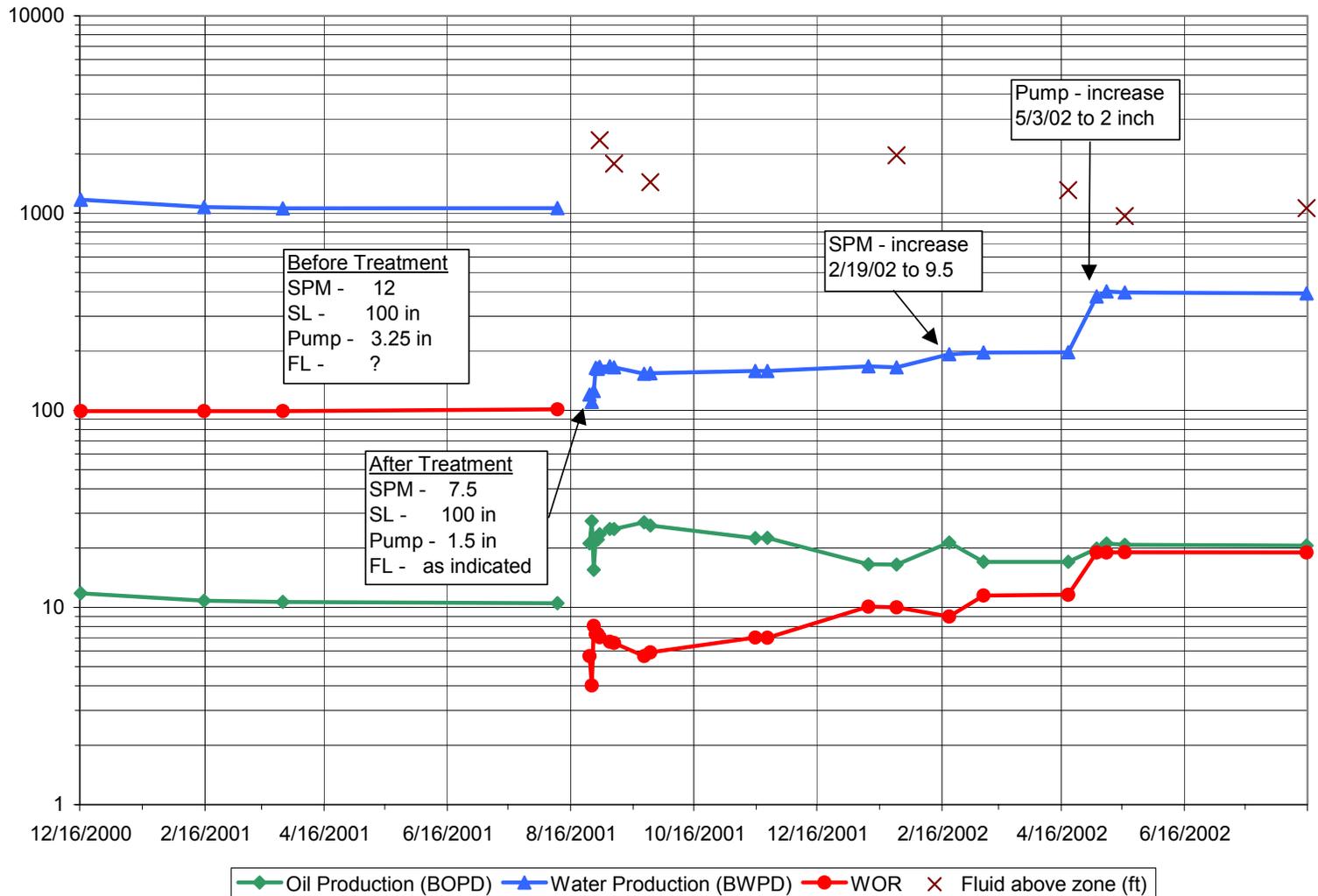


Example of Good Response

Murfin's Peavey A-6 Polymer Job

August 10-13, 2001

(3806 bbls gel, 64% of job treated on a vacuum, 446 psig max treating press)

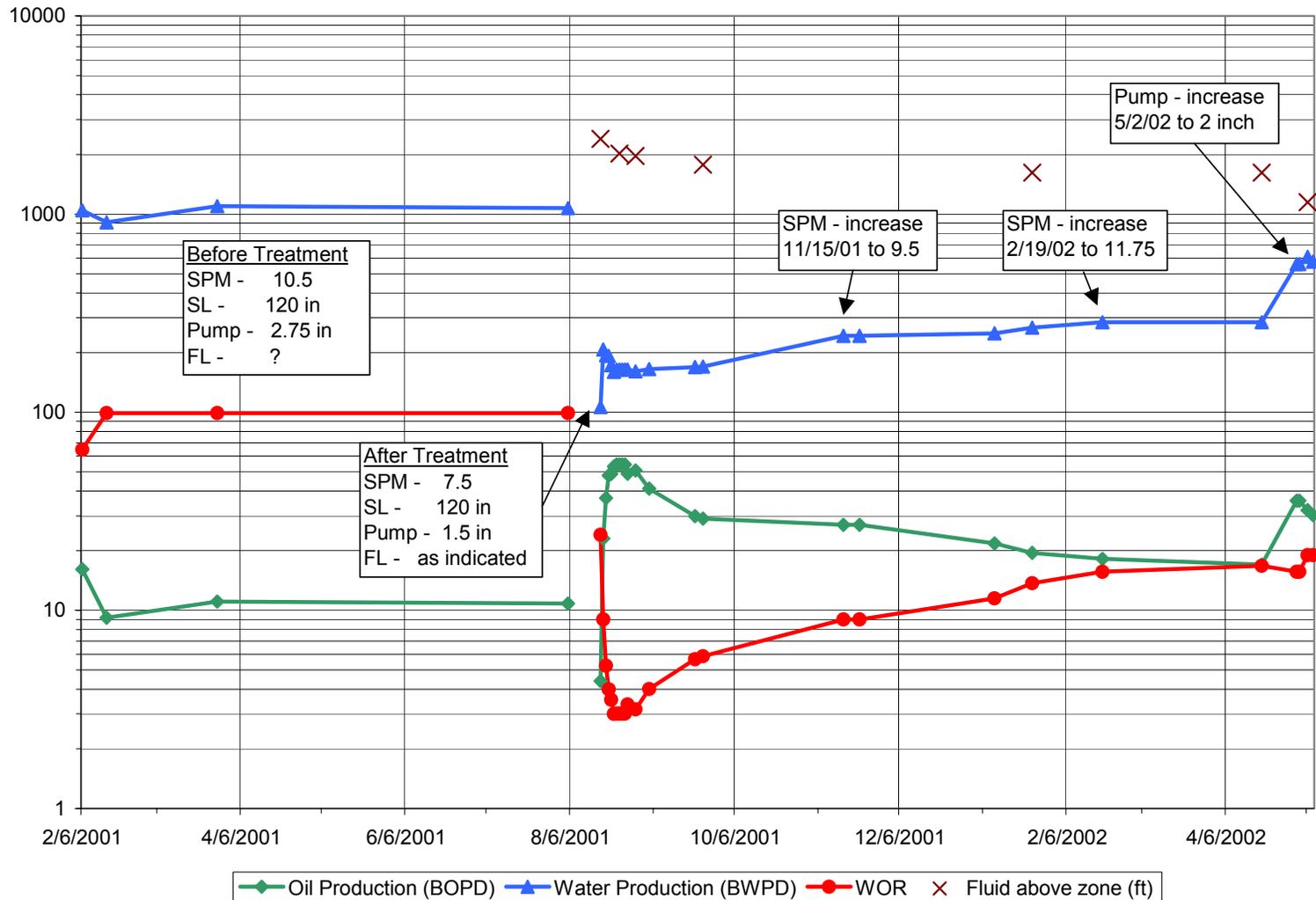


Example of Good Response

Murfin's Jorgensen #4 Polymer Job

August 6-9, 2001

(3805 bbls gel, 58% of job treated on a vacuum, 102 psig max treating press)

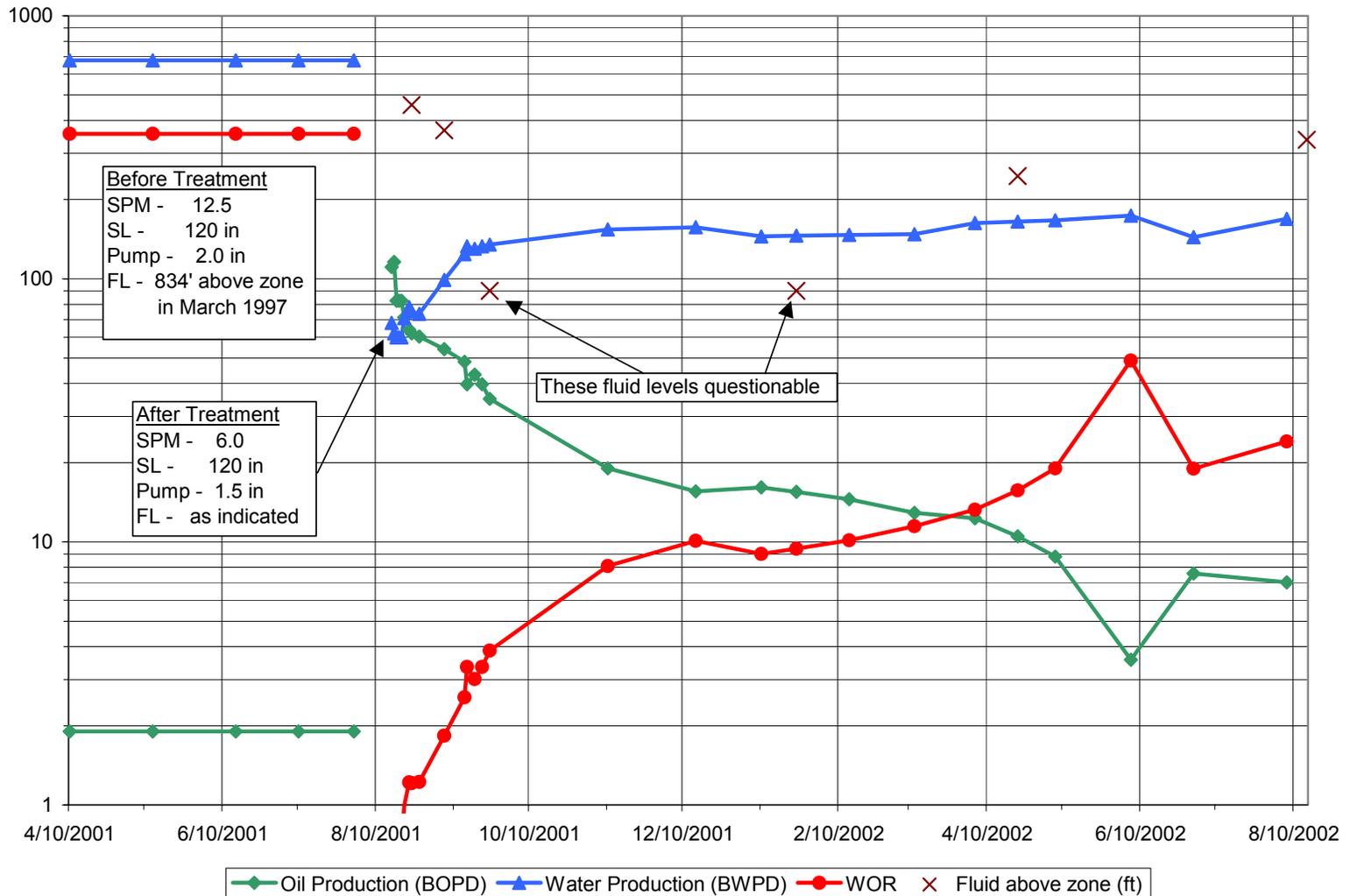


Example of Good Response

Murfin's Johnson B #3A Polymer Job

August 2-3, 2001

(1621 bbls gel, 97% of job treated on a vacuum, 51 psig max treating press)

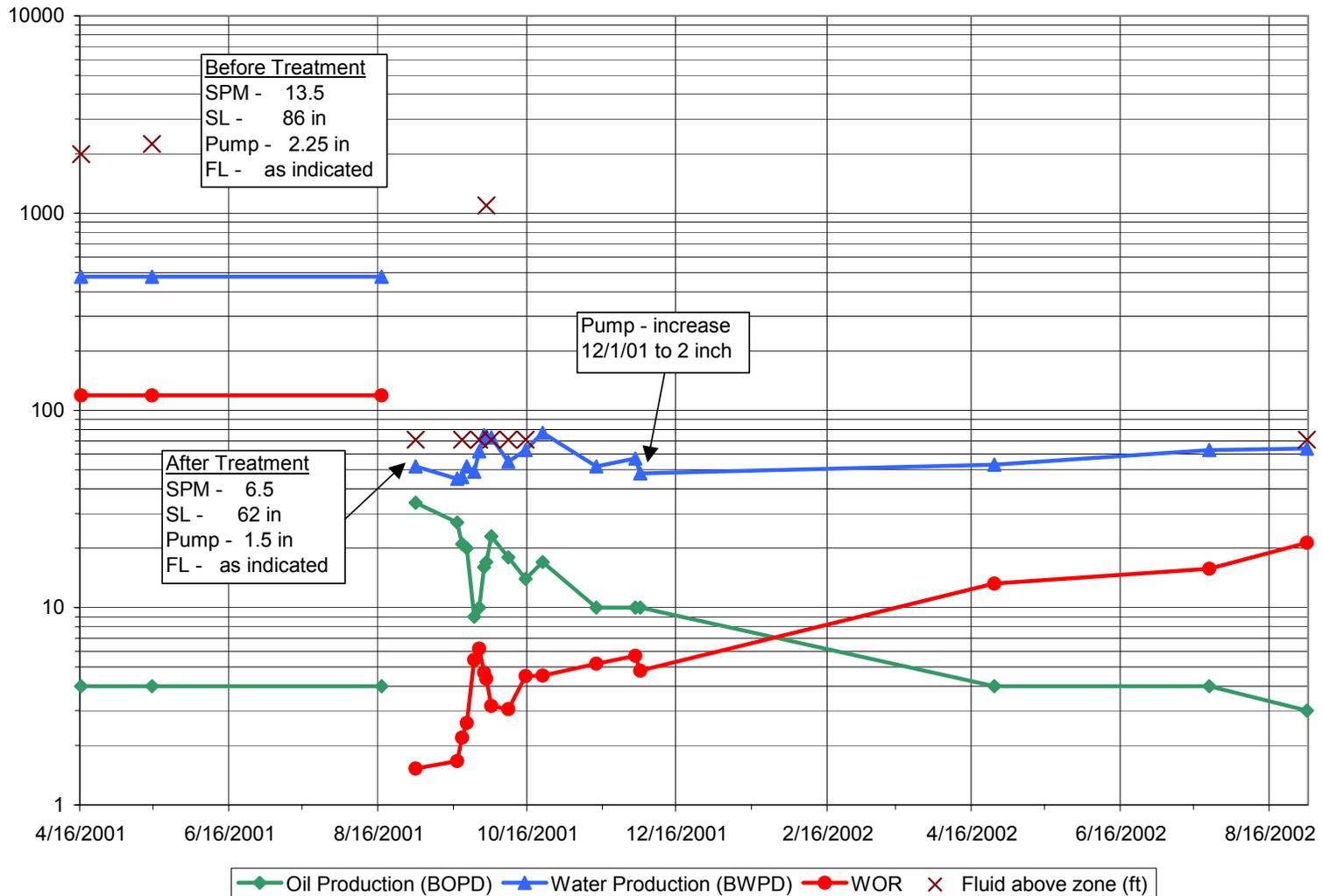


Example of Poorer Response

Vess's Colahan A #41 Polymer Job

August 18-21, 2001

(2988 bbls gel, 8.2% of job treated on a vacuum, 923 psig max treating press)

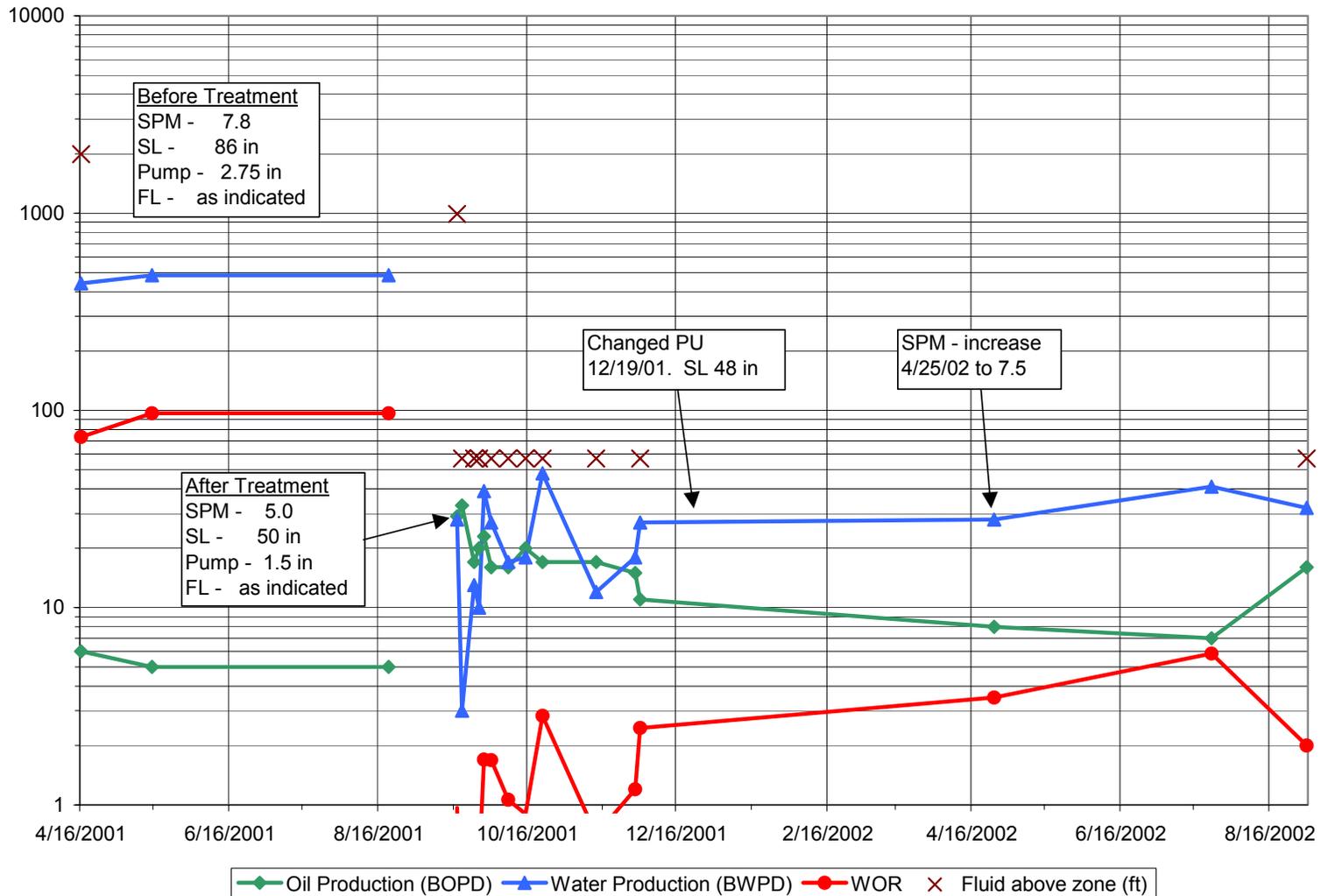


Example of Poorer Response

Vess's Colahan A #2 Polymer Job

August 26-30, 2001

(4093 bbls gel, 29% of job treated on a vacuum, 591 psig max treating press)

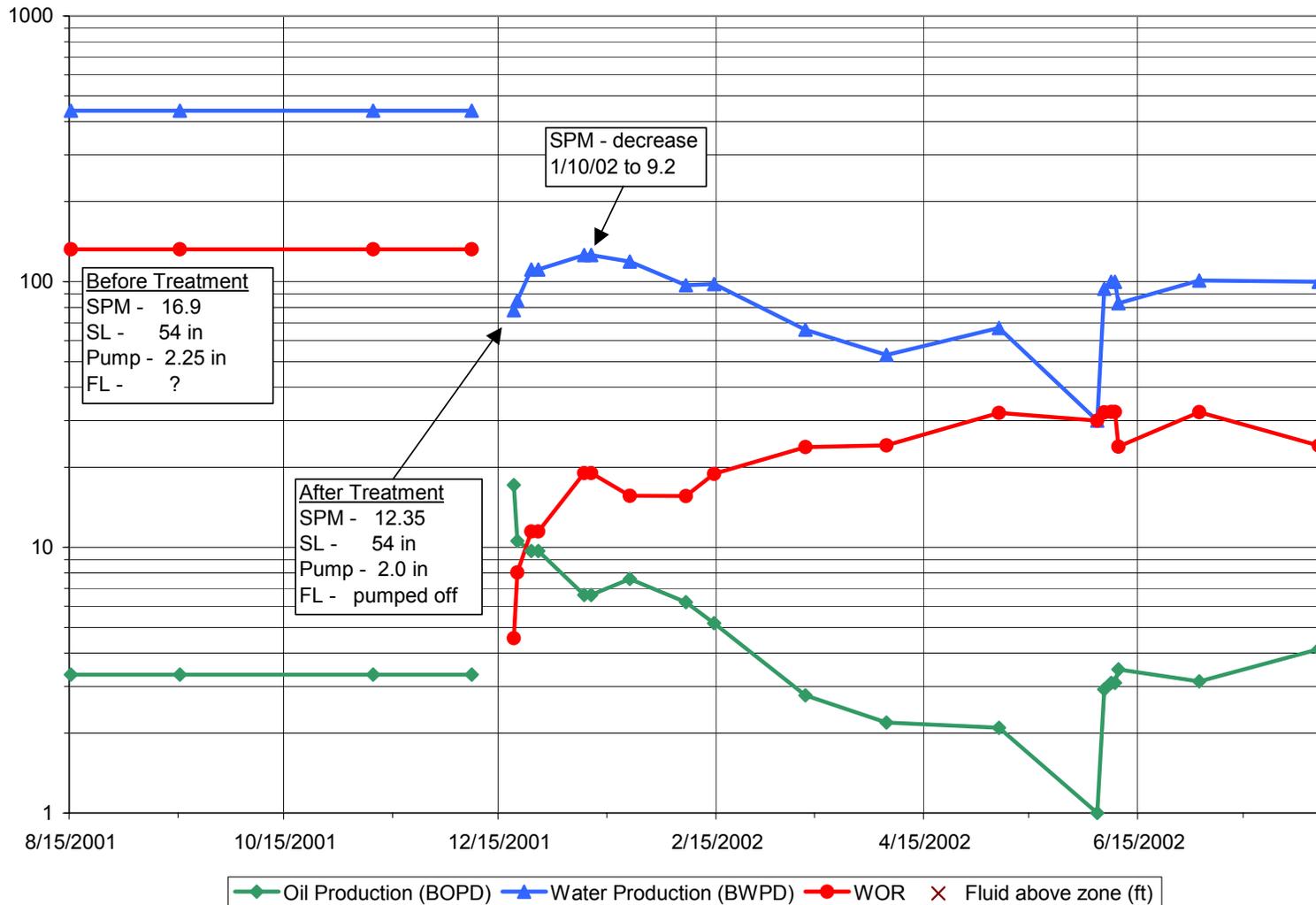


Example of Poorest Response

Murfin's Glathart #1 Polymer Job

December 8-9, 2001

(1007 bbls gel, 0% of job treated on a vacuum, 200 psig max treating press)



Status of Arbuckle Polymer Treatments

- **Job costs**

- **Gel cost**

- \$30 M to \$35 M for larger jobs (4,000 bbl)
- \$15 M to \$20 M for smaller jobs (1,500 bbl)

- **Rig & acid costs**

- \$5 M to \$10 M depending on rig time & volume acid

- **Total costs**

- \$45 M for large jobs
- \$20 M for very small jobs

Status of Arbuckle Polymer Treatments

- **Pay-out (based only on incremental oil recovery)**
 - ***3.8 months for average performing jobs (4 wells)***

Assumptions

- +/- 3200 bbl/well net incremental oil recovery over 6 months (+/- 18 bbl/day/well incremental for 6 months)
- \$22/bbl oil price
- \$45 M job cost

- ***Three poorest performing jobs did not pay-out***

Assumptions

- +/- 1120 bbl/well net incremental oil recovery over 6 months (+/- 6 bbl/day/well incremental for 6 months)
- \$22/bbl oil price
- \$45 M job cost



Murfin's Hadley A #3 Polymer Job



TIORCO's Polymer Injection Equipment



TIORCO's Polymer Mixing Hopper



Gel-Tec Polymer Job on an Elysium Well



Pumping into well



Tri-plex pump and crosslinker storage



Computer Monitors

Presentation Outline

- Status of Arbuckle Polymer Treatments
- **TORP's Efforts in Evaluating Polymer Treatments**
- Future TORP/PTTC Activities Related to Polymer Treatments

TORP's Efforts

- **Objective – help operators maximize gel polymer treatments.**
- **Develop comprehensive database by which to compare all Arbuckle gel polymer treatments.**
 - **Hope to spot trends that lead to improved treatments.**
 - **Have contacted several operators requesting information on gel polymer treatments.**
 - **Getting some positive feedback and information.**

TORP's Efforts

- **Conduct and analyze pre and post-treatment build-up tests using TORP's computerized Echometer.**
 - **Measure formation kh and skin.**
 - **Determine if reservoir flow is linear (through fracture) or radial (through matrix).**
 - **For pre-treatment build-ups, attempt to predict how much polymer a well will take.**
 - **Have performed pre-treatment build-ups on 7 Arbuckle wells.**
 - 5 in Bemis-Shutts
 - 2 in Geneseo-Edwards



Build-up Test on Vess Oil's McCord A #4



View from Vess Oil's Colahan A #8

TORP's Efforts

- **Analyze bottom-hole pressure (BHP) surveys that are to be run on 4 wells.**
 - **Bottom-hole pressure to be measured (via pressure bomb on slickline) before, during, and after gel treatment.**
 - **Hope to gain insights into the gel/rock interface, which should help in sizing treatments and setting maximum treating pressures.**
 - **Hope to determine a friction coefficient for pumping gel down tubing.**
 - **3 BHP surveys have already been run in Bemis-Shutts.**



Trilobite Testing's Slickline Trailer at Vess Oil's Hall B #4

Presentation Outline

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- TORP's Efforts in Evaluating Polymer Treatments
- **Future TORP/PTTC Activities Related to Polymer Treatments**

Future TORP/PTTC Activities

- **Conduct post-treatment build-ups on same 7 wells.**
 - Hope to document how reservoir changes after treatment.
- **Sponsor operator forum for those operators who have pumped jobs.**
 - Possibly in late January 2003.
- **Put gel polymer database online.**