MULTI-STAGING WELLS: WHY RUNNING MORE THAN ONE PLUNGER COULD HELP YOUR WELL

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Multi-staging a well with more than one plunger utilizes more of the well's energy to lift fluid. Setting a Multi-stage tool in a well allows for one plunger to lift below the tool and one plunger to lift above the tool. By staging the well with a multi-stage tool, the fluid load on each plunger is lifted to a shallower depth. The bottom plunger lifts fluid to the tool which is caught with a standing valve. The second plunger then lifts that fluid to the surface. All of the head gas above the liquid level is sellable gas, but is wasted energy. By staging the well, part of the head gas can be used as an energy lifting source.

The multi-stager consists of several different parts. (Figure 1) The tool must first be set in the well with a tubing stop or a collar stop. The top is then pushed down to wedge out the tubing pack off separating the upper stage from the lower stage. A floating spring is then put on top of the multi-stager to keep the upper plunger from damaging the tool.

The multi-stage tool can be used in many different types of wells. Wells that could not be lifted or are having difficulty lifting with a conventional plunger are typically good candidates for the Multi-stage tool. Some good applications for the Multi-stage tool are: Packer wells, Slim-hole wells, Liner wells, Open hole wells, Tapered string wells, and conventional wells. Packer wells have been very successful. With no backside help the ability of the multistage tool to utilize the energy of the well is needed to lift the fluid. Tapered string wells are also a good application since the tool can be set at the point where the tubing changes size. By running a smaller plunger to the tool and the larger plunger on top, plunger lift can be run on the tapered string well.

Deciding where to set the tool is a major contributor to the success of the multi-stager. Much like controlling a well, there is not one clear solution that will work for all wells. Of course there is a point at which to start, but there are several variables that should be considered including; the history of the well, the location, the production, the pressures, the amount of fluids, etc.

For the tool to work, the gas bubble below the tool must be able to lift the upper plunger and liquid load to the surface. The gas in the annulus (if any), fracture and formation must be able to lift the bottom liquid load through the tool into the upper stage and replenish the lower stage liquid.

Boyle's law is used to balance the gas requirements for the two stages. For a 10,000 foot well, 100 psi sales line pressure making five (5) barrels of water per day in five (5) trips, the gas requirements calculate to be approximately 20 Mcf and a starting casing pressure of approximately 750 psi.

For actual wells with these conditions, measured gas production for successful installations ranges from 5 Mcfd to 20 Mcfd with a starting casing pressure that cannot be lowered below 750 psi.

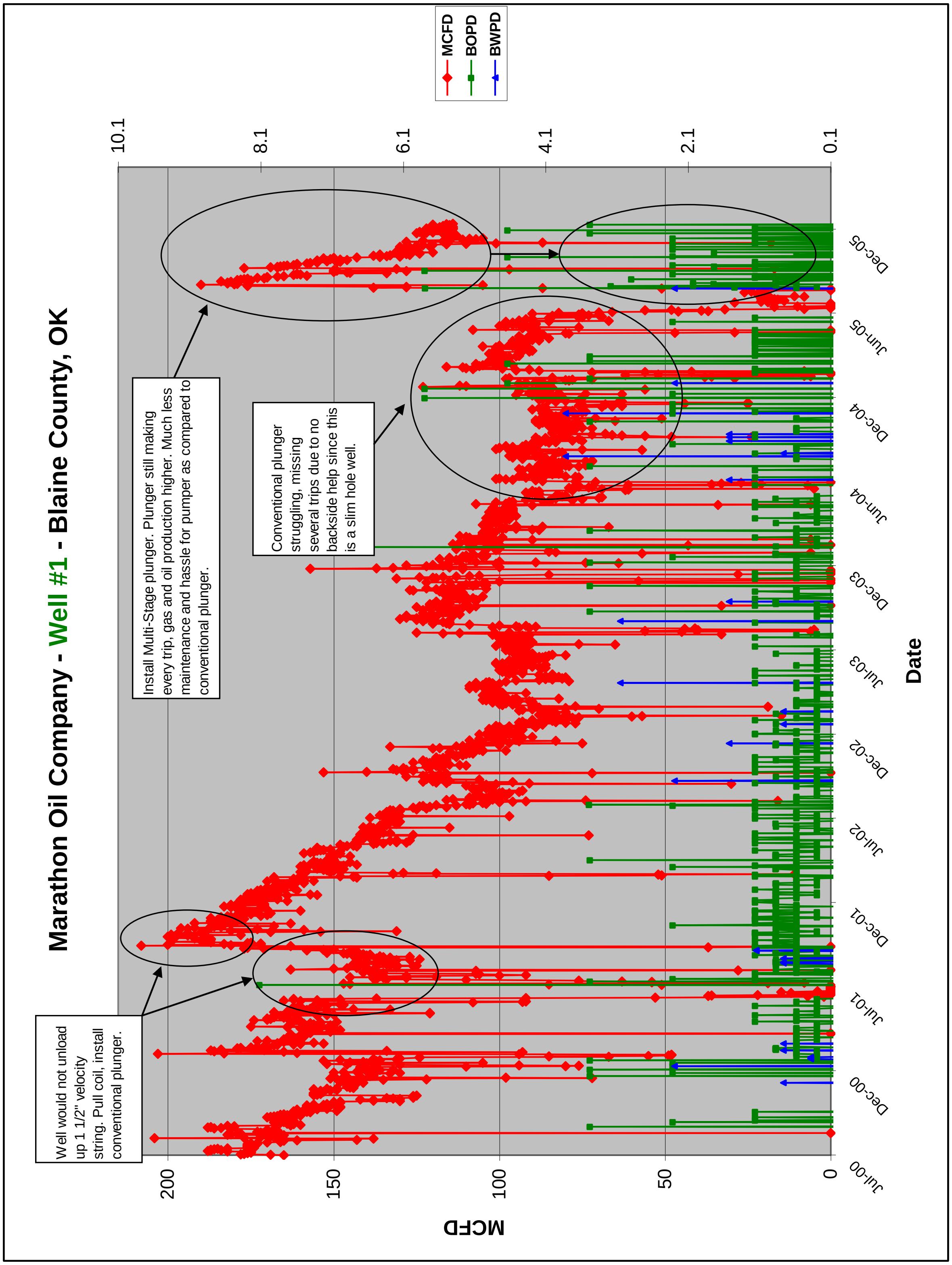
The following three case studies were provided by Matt Lupardus, Production Engineer for Marathon Oil Company.

Well #1 is a 2 7/8" slim hole well (Figure 2). The well would not unload up the 1 ½" velocity string, so conventional plunger was installed, which declined over the next few years (Graph 1). Eventually the conventional plunger could not keep up. The bottom collar/standing valve was placed just above the perfs (7856-66') at 7796'. The multi-stager was installed at a depth of 4692' and the plungers are making every trip, gas and oil production is higher, and there is much less attention needed from the pumper. As you can see in Graph 1, the well was struggling to stay above 75 mcfd and producing little to no oil. Since the installation of the multi-stager the well has steadily produced 120 mcfd and an increase of 0.5 bopd. Considering there was no backside help this is a great increase.

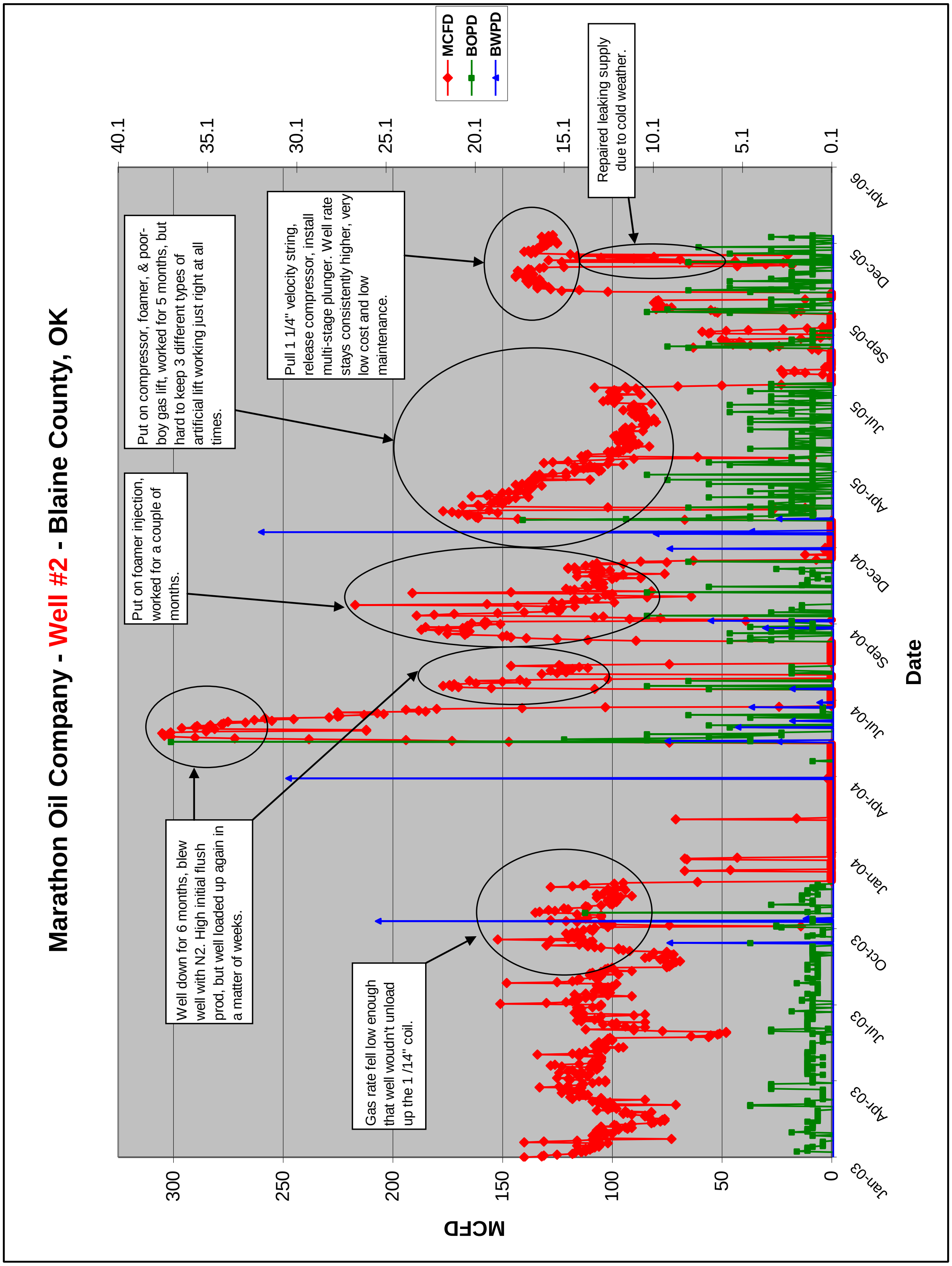
Well #2 is also a 2 7/8" slim hole (Figure 3). As seen in graph 2 several different options were tried on this well unsuccessfully. Marathon struggled with this well for over a year before trying the multi-stager. The upper perfs on this well are at 7863-7865' having the collar stop/standing valve just above them at 7838'. It was determined for this well that the multi-stage tool would be set at 4750'. Since the installation of the multi-stager the well has a consistent production of 125 mcfd and an increase of 1.2 bopd (Graph 2). Again, there was no backside help for this well.

Well #3, also 2 7/8", was down for 4 years with a casing leak (Figure 4). Marathon isolated the leak by closing the sliding sleeve, and cleaned out the tubing with a coil tubing unit. When the well would pressure up, it had high initial flush production, but no water production. The well would load back up in a short amount of time. The multi-stager was then tried. The tool was set at 4773' with the collar stop/standing valve at 7950'. Since the installation of the multi-stager, the well has had a steady production of 65mcfd and 0.5 bowd (Graph 2).

With over 400 multi-stagers in multiple states the multi-stager has proven itself time and time again. With payoffs in just days, it is easy to see why the popularity of this technique is rapidly growing. Anytime there is a loading problem that cannot be solved by conventional plunger, the multi-stager should be considered.

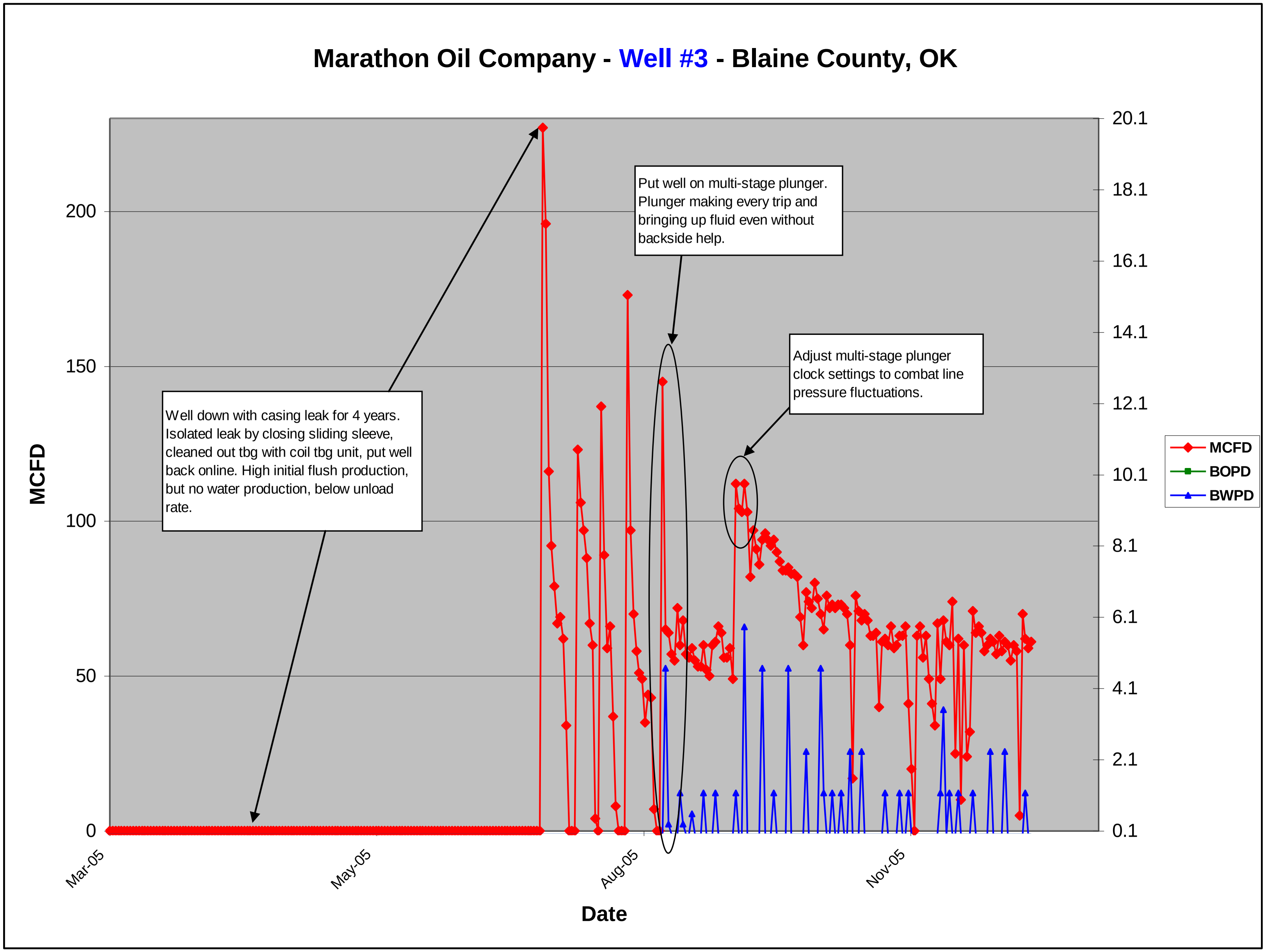

Marathon Oil Company - Well #1 - Blaine County, OK
MCFD
BOPD
BWPD
Install Multi-Stage plunger. Plunger still making every trip, gas and oil production higher. Much less maintenance and hassle for pumper as compared to conventional plunger.
Conventional plunger struggling, missing several trips due to no backside help since this is a slim hole well.
Well would not unload up 1 1/2" velocity string. Pull coil, install conventional plunger.
MCFD
200
150
100
50
0
10.1
8.1
6.1
4.1
2.1
0.1
Jul-00
Dec-00
Jul-01
Dec-01
Jul-02
Dec-02
Jul-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Date

Graph 1



Marathon Oil Company - Well #2 - Blaine County, OK
MCFD
Date
MCFD
BOPD
BWPD
0
50
100
150
200
250
300
0.1
5.1
10.1
15.1
20.1
25.1
30.1
35.1
40.1
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Sep-04
Dec-04
Apr-05
Jul-05
Sep-05
Dec-05
Apr-06
Gas rate fell low enough that well woudn't unload up the 1 /14" coil.
Well down for 6 months, blew well with N2. High initial flush prod, but well loaded up again in a matter of weeks.
Put on foamer injection, worked for a couple of months.
Put on compressor, foamer, & poor-boy gas lift, worked for 5 months, but hard to keep 3 different types of artificial lift working just right at all times.
Pull 1 1/4" velocity string, release compressor, install multi-stage plunger. Well rate stays consistently higher, very low cost and low maintenance.
Repaired leaking supply due to cold weather.

Graph 2


Marathon Oil Company - Well #3 - Blaine County, OK
MCFD
Date
0
50
100
150
200
0.1
2.1
4.1
6.1
8.1
10.1
12.1
14.1
16.1
18.1
20.1
Mar-05
May-05
Aug-05
Nov-05
MCFD
BOPD
BWPD
Well down with casing leak for 4 years. Isolated leak by closing sliding sleeve, cleaned out tbg with coil tbg unit, put well back online. High initial flush production, but no water production, below unload rate.
Put well on multi-stage plunger. Plunger making every trip and bringing up fluid even without backside help.
Adjust multi-stage plunger clock settings to combat line pressure fluctuations.

Graph 3

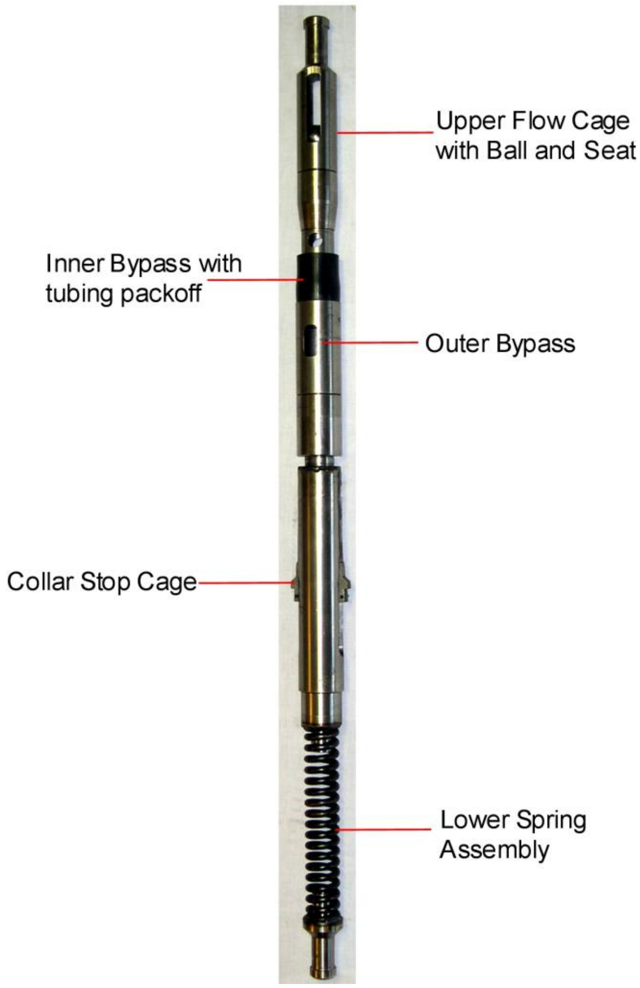
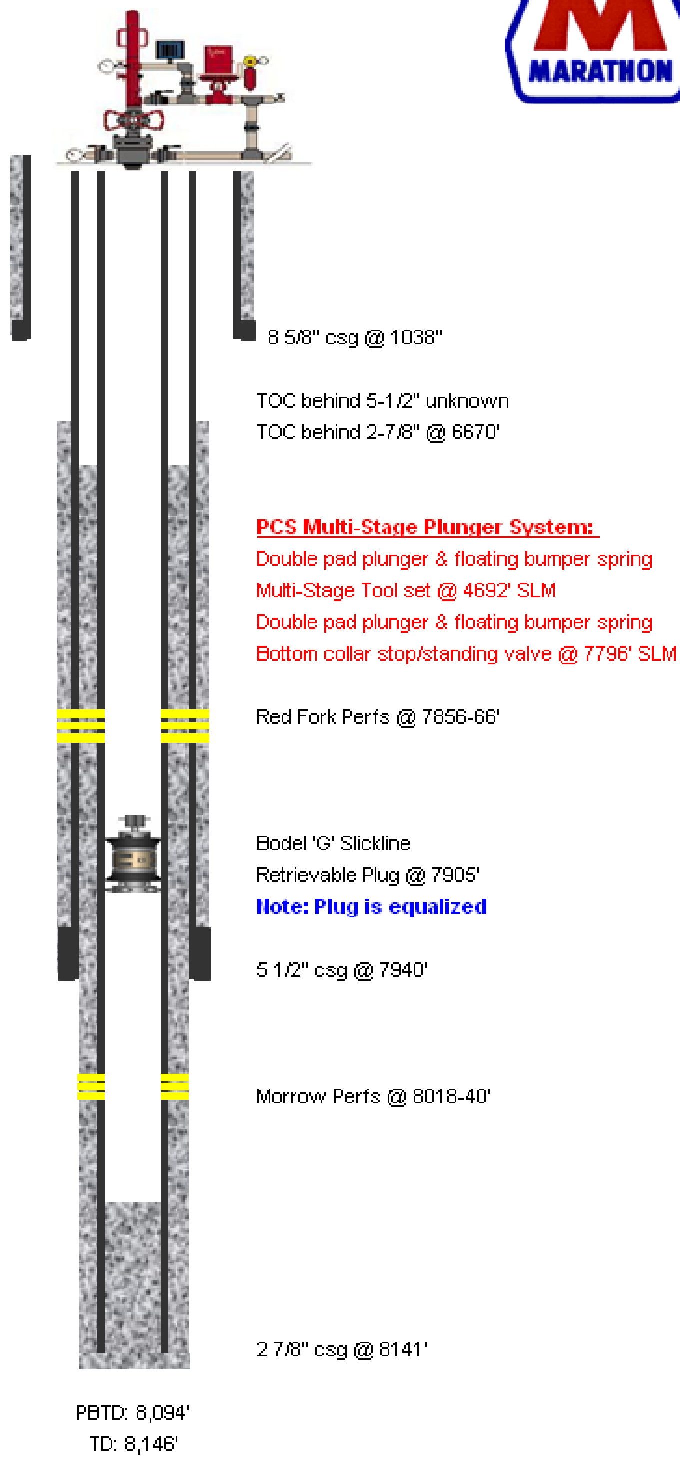

Upper Flow Cage
with Ball and Seat
Inner Bypass with
tubing packoff
Outer Bypass
Collar Stop Cage
Lower Spring
Assembly

Figure 1

Well #1

Blaine County, OK

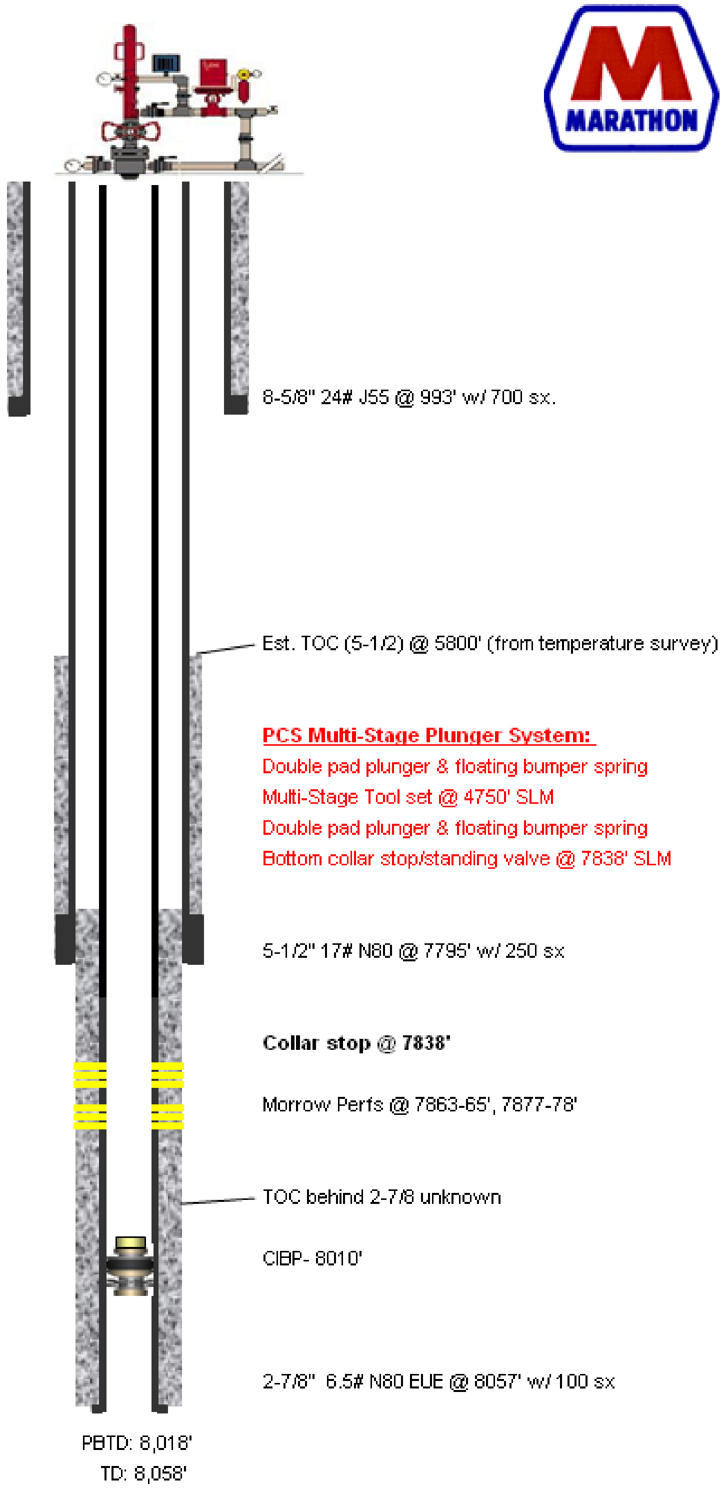


Well Name & Number:		**Lease:**			
County or Parish:	Blaine County	**State/Prov.**	Oklahoma	**Country:**	U.S.A.
Perforations (MD)	Red Fork (7,856' - 7,866'); Morrow (8,018' - 8,040')			**TD:**	8,146'
Diagram Last Updated By:	Matt Lupardus	**Diagram Last Updated:**	11/2/2005		

Figure 2

Well #2

Blaine County, OK

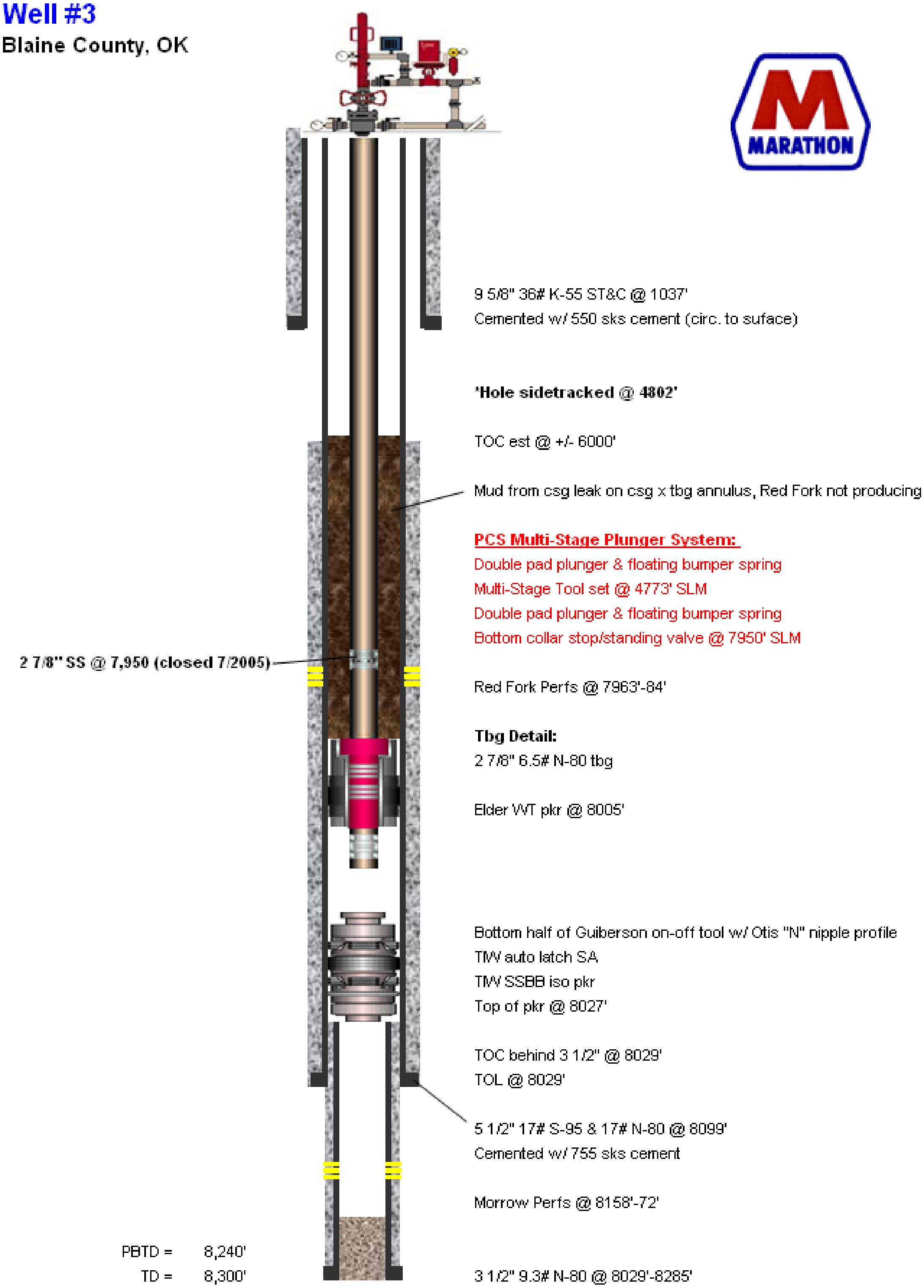


Well Name & Number:		**Lease:**			
County or Parish:	Blaine County	**State/Prov.**	Oklahoma	**Country:**	U.S.A.
Perforations (MD)	Morrow (7,863' - 7,878')			**TD:**	8,058'
Diagram Last Updated By:	Matt Lupardus		**Diagram Last Updated:**	11/4/2005	

Figure 3

Well #3

Blaine County, OK



Well Name & Number:		**Lease:**			
County or Parish:	Blaine County	**State/Prov.**	Oklahoma	**Country:**	U.S.A.
Perforations (MD)	Red Fork (7963'-84'); Morrow (8158'-72')			**TD:**	8,285'
Diagram Last Updated By:	Matt Lupardus	**Diagram Last Updated:**	9/7/2005		

Figure 4