What is the Best way to treat Paraffin?

Thermal or Chemical?

CONCHO

Pulling Unit Deck

How many times have you seen this?

Or This?

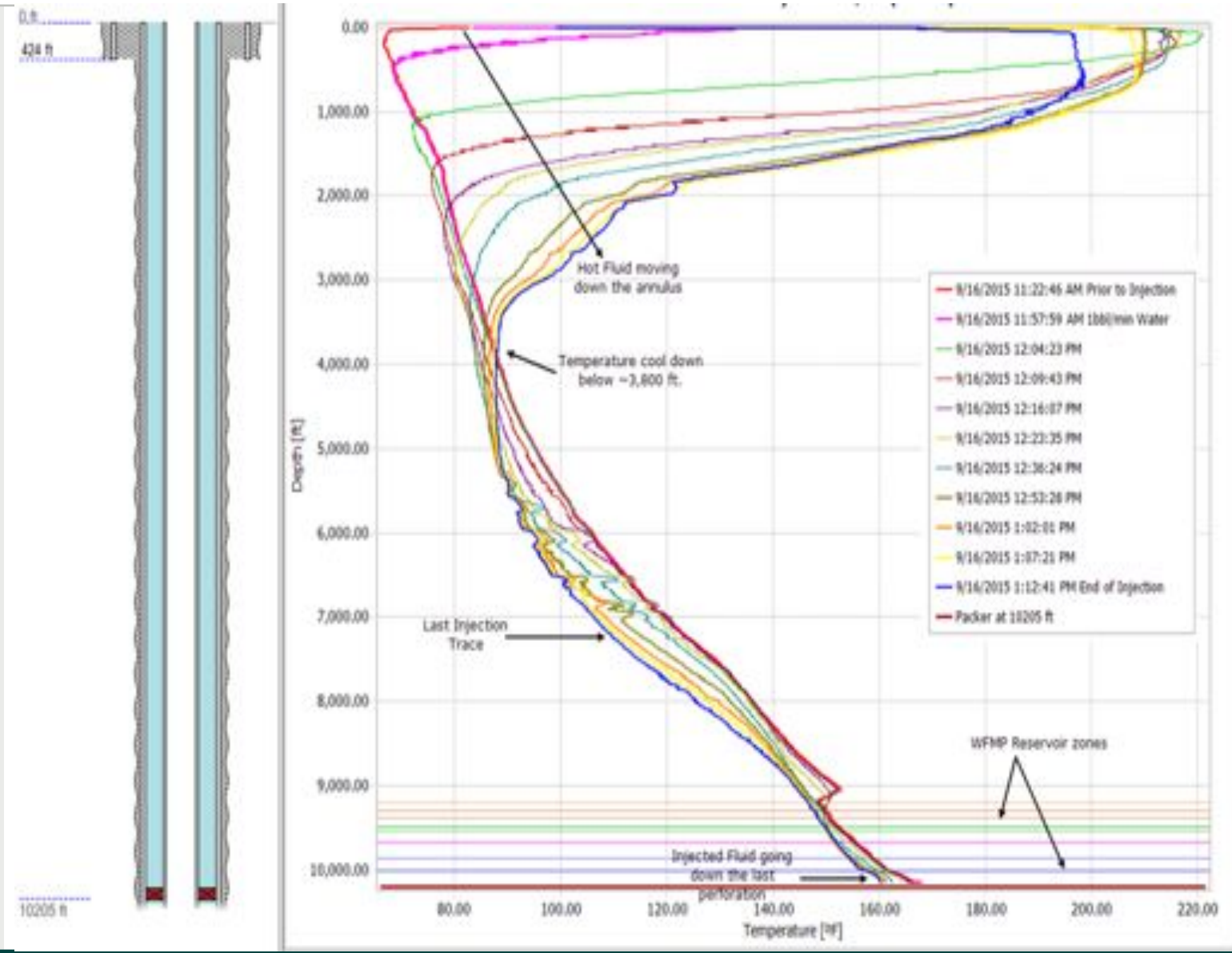
What is the Answer to keep these running?

How effective is this for Paraffin?

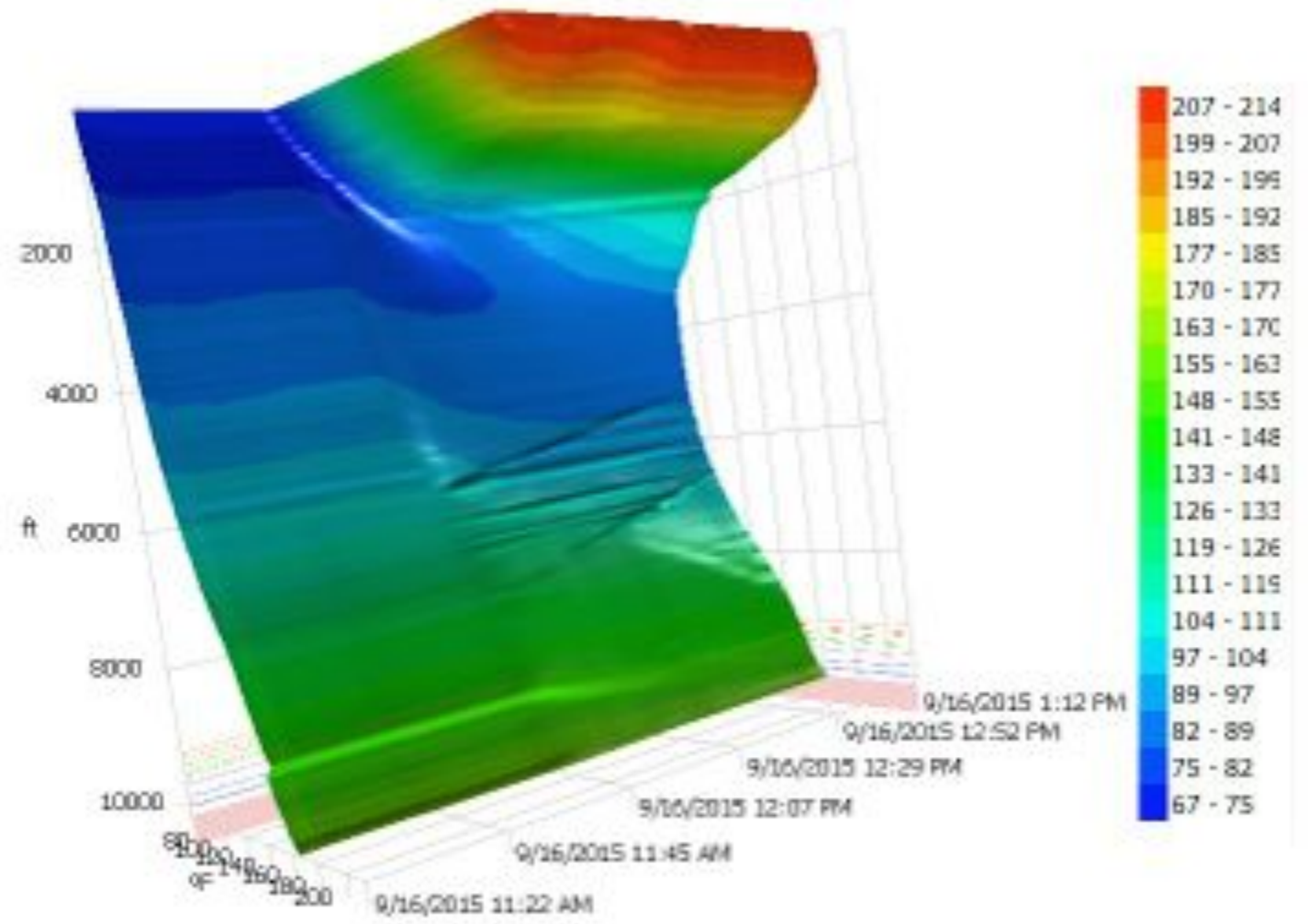
A Test to see how well it works

We conducted at test utilizing fiber optic cable during a thermal treatment operation. We pumped hot water at two different rates and recorded the data. We then pumped hot oil at 0.5 barrel per minute and recorded the data. The results follow.

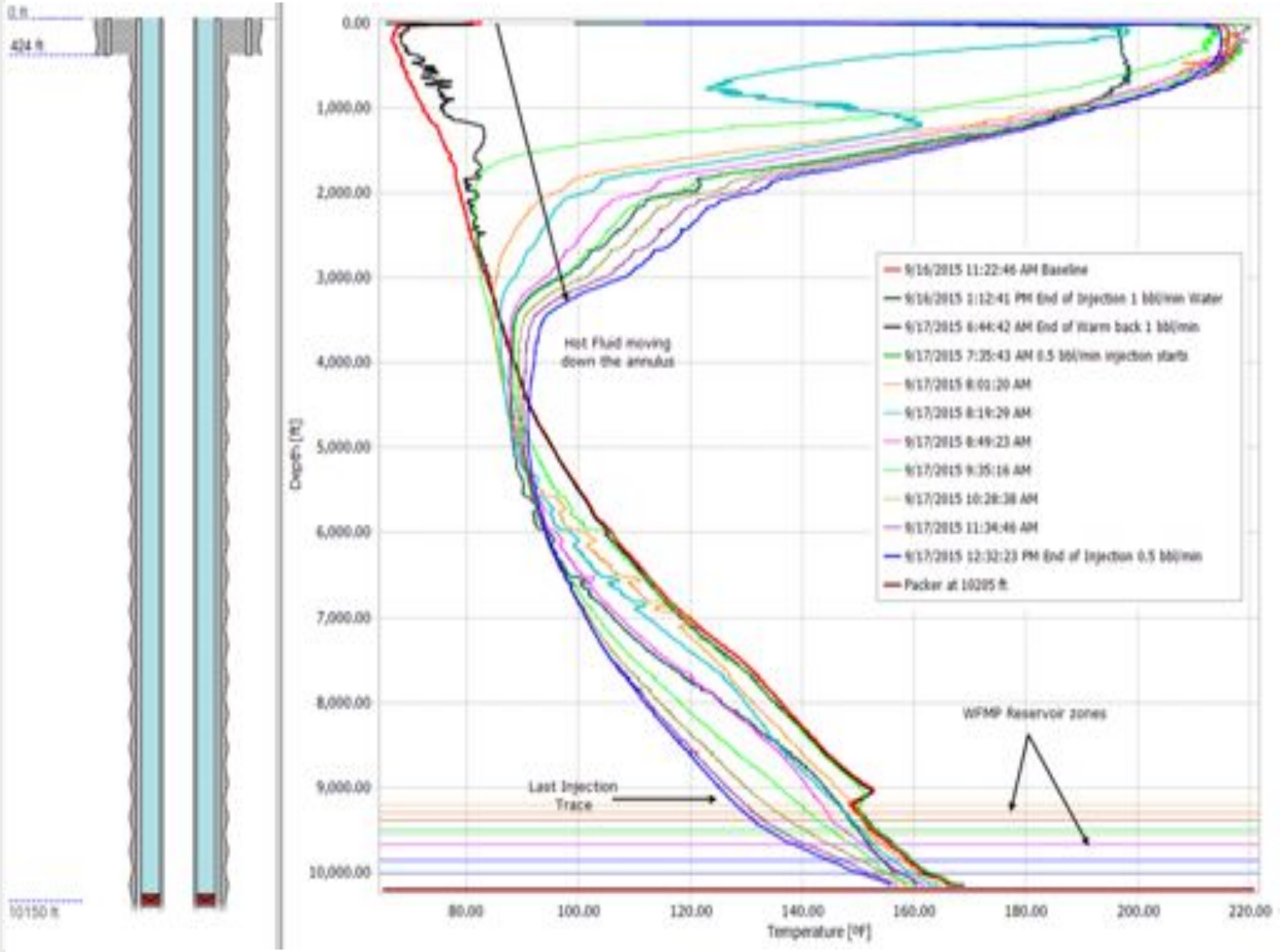
Hot Water @ 1 Barrel per Minute



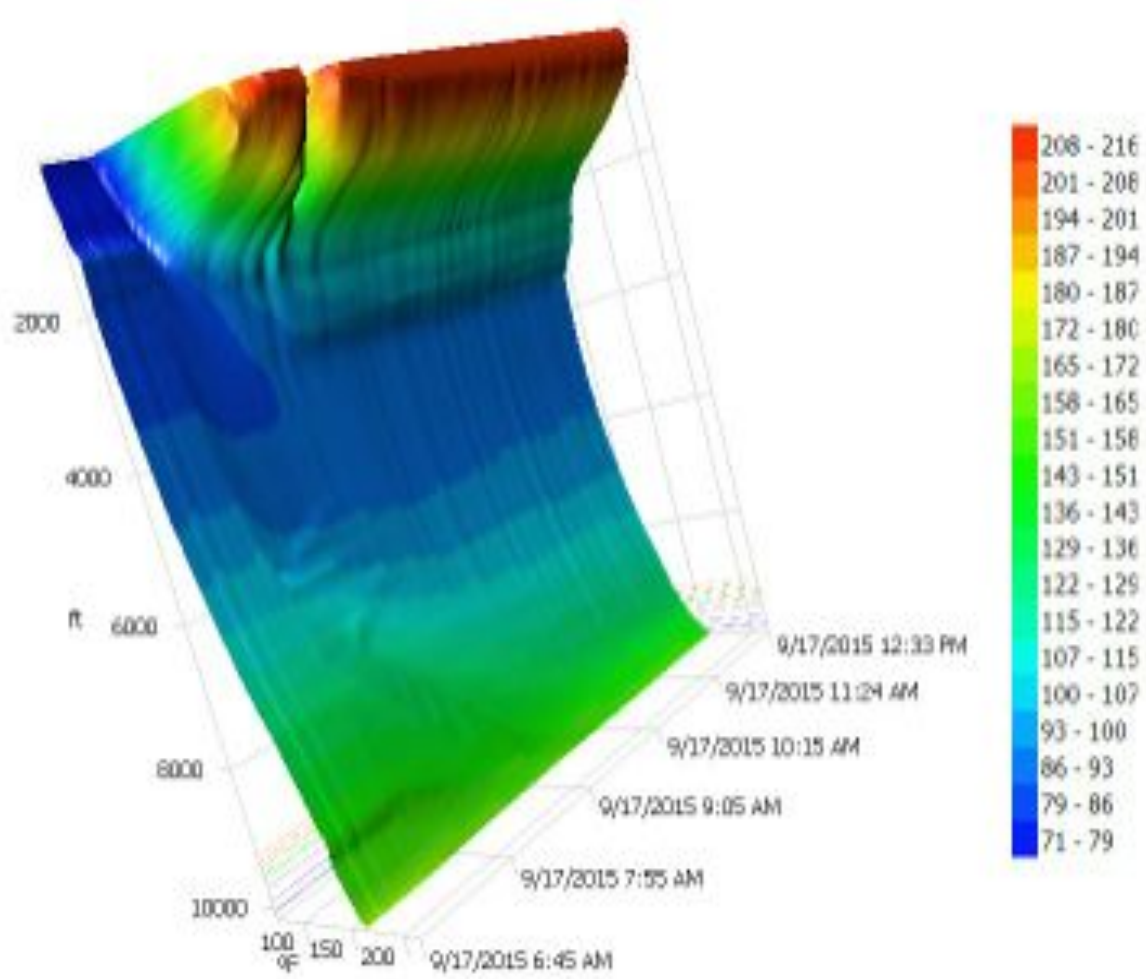
Hot Water @ 1 Barrel per Minute



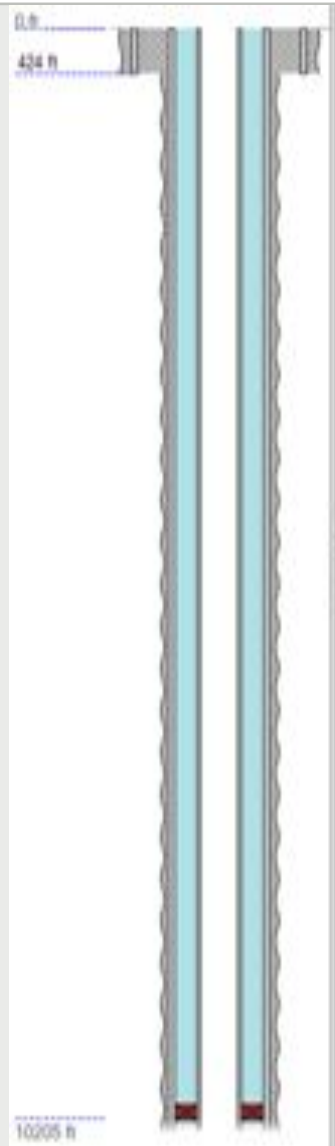
Hot Water @ 0.5 Barrel per Minute

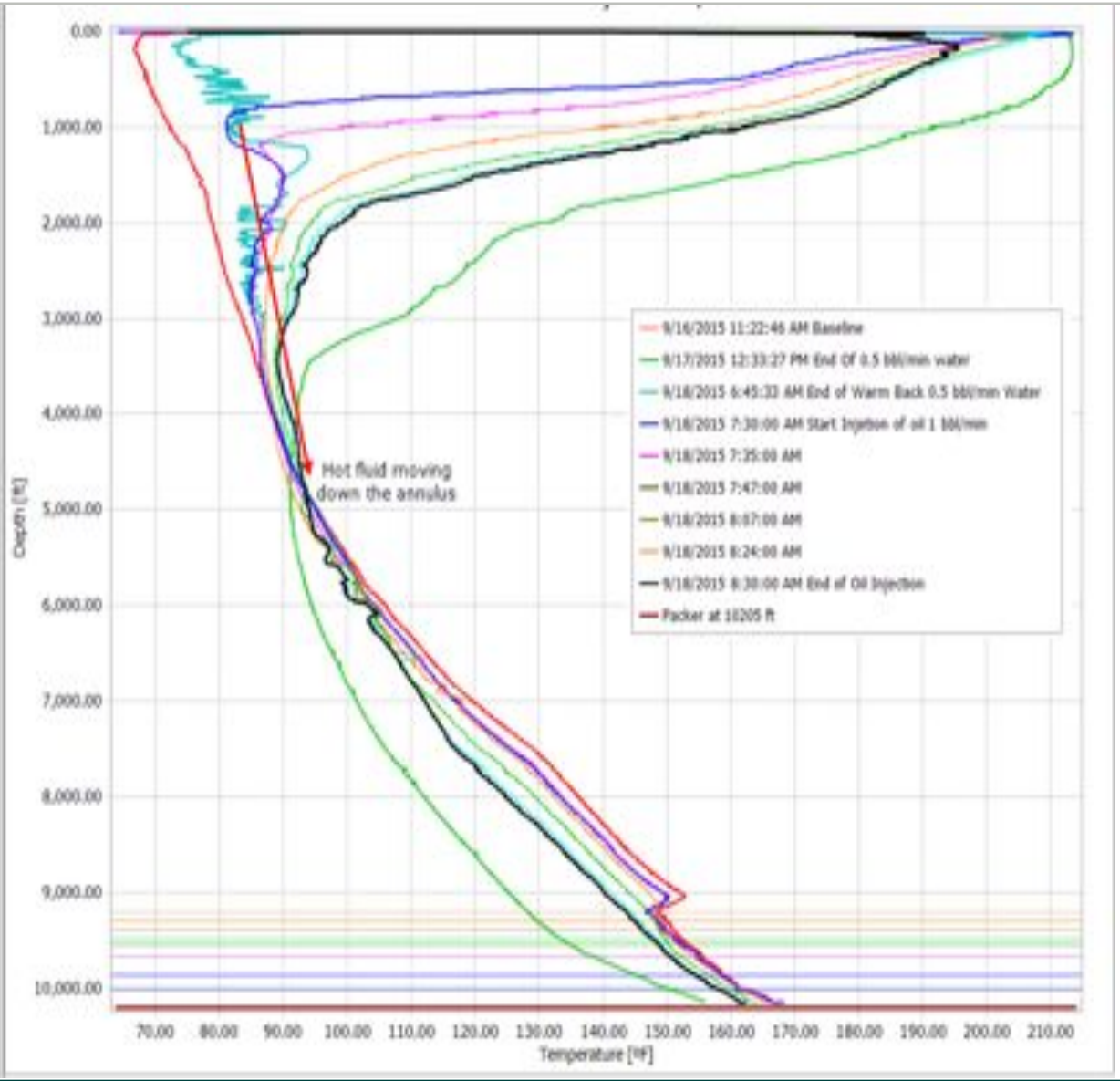


Hot Water @ 0.5 Barrel per Minute

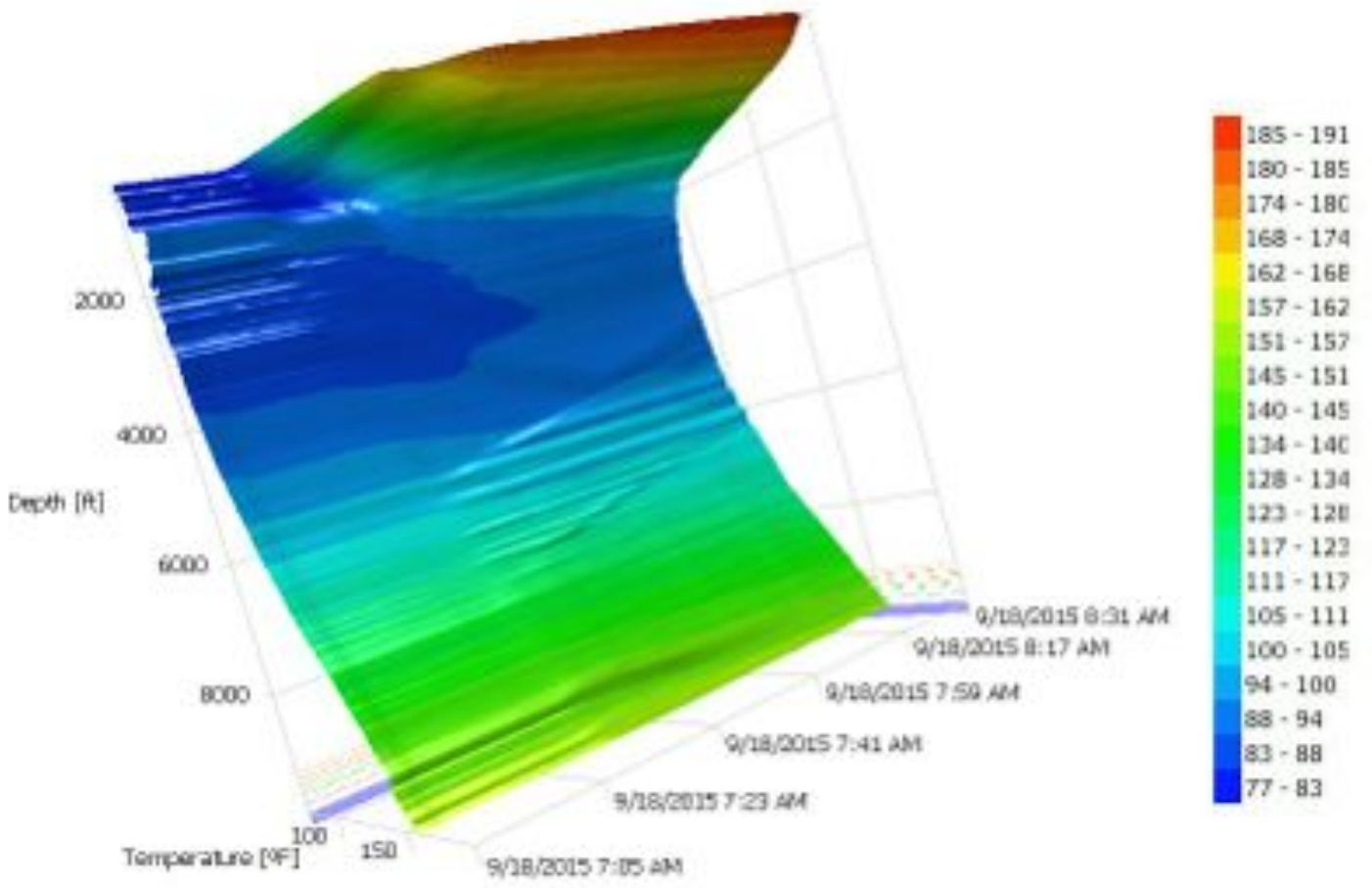


Hot Oil @ 1 Barrel per Minute





Hot Oil @ 1 Barrel per Minute



Results

Hot Water @ 1 BBL per Minute

- Pumped ~220 degree water at 1 Barrel per Minute for 75 minutes
- Achieved 180 Degree Fluid ~1,100’

Hot Water @ 0.5 BBL per Minute

- Pumped ~220 degree water at 0.5 Barrel per Minute for 287 minutes
- Achieved 180 Degree Fluid ~1,100’

Hot Oil @ 1 BBL per Minute

- Pumped ~220 degree water at 1 Barrel per Minute for 60 minutes
- Achieved 180 Degree Fluid ~1,200’

How did we treat Paraffin and what did it cost?

- In the Permian the most used treatment methodology is Thermally while your Production Chemical Provider adds some dispersant.
- This is coupled with using an every other week schedule of adding a dispersant package to your truck treating program. Ask your Production Chemical Provider what he is targeting and he or she will tell you 500 ppm. That is API standards.
- Currently we operate ~1,800 wells in the Wolfberry Field of the Permian Basin.
- For 2014 we averaged $0.31 per BOE on Thermal Treating.
- During that same time frame we spent $0.69 per on chemicals for the same wells.
- Paraffin treatment chemicals were 35% of that, or $0.24 per BOE.
- In 2014 we spent a total of $0.55 per BOE. At that time this was the standard approach to attacking paraffin.
- And it is almost impossible to quantify the cost in failures and lost production.
- Can we do better?

What is the Best way to treat Paraffin?

- Contact Time Model
- Crystalline Modifiers
- Combination Chemicals
- Slip Streams
- Cap Strings
- Paraffin Cutting

CONCHO

Yes we can

- In the Fourth Quarter of 2014 we decided to test some different methodologies to treat paraffin. One of our Production Chemical Companies brought in a new (to us) method of treating paraffin. We were skeptical, but we reluctantly gave them a test group to start pilot test. We were going to try **Contact Time Model Technology**.
- I am not a Chemist, but I understood the principle behind this concept.
- Using a Treating Truck to deliver a pill that has been specifically calculated for the production of that well, that will be in contact will all of the tubular and rods for a specified period of time. This is usually based on a 2 hour or 3 hour period.
- Repeat this process every other week and stop Thermally treating the well.
- In 2015 we did perform a Paraffin Clean Up Circulation before a well was placed on Contact Time Model Treatment. In all of 2016 we have discontinued clean ups.
- We created a list of all wells we were testing and turned that list over to SCADA to monitor for friction.
- We did not Thermally Treat these wells nor did we see any friction.
- It looked to be a success, then we had a failure of a well on this program. It was a rod part and the real test came.

Rods of a Failure on Contact Time Model

Well #1 CONTACT TIME SINCE 09/26/2014. This picture is from 03/19/2015. It is still on Contact Time Model today.

Rods of a Failure on Contact Time Model

Well #2: Contact Time (12-14-2015) Failure occurred a month later for Rod Part. No signs of Paraffin during pull. Pictures are of Rods and Tubing.

Rods of a Failure on Contact Time Model

Well #3: Contact Time This well has been on this program since 2014. No signs of Paraffin during pull. Pictures are of Rods and Tubing.

Rods of a Failure on Contact Time Model

Well #4: Contact Time This well has been on this program since 2014. No signs of Paraffin during pull. Pictures are of Rods and Tubing.

Rods of a Failure on Contact Time Model

- All of the failures we have seen have looked similar to these two examples. Paraffin has not been present on the Rods or Tubing during the Pull.
- We did not Thermally Treat any of these wells before the Pull was started. What better test of any chemical program is there than to look at the Rods and Tubing during a Pull?

What is the Draw Back?

We had a very successful test with the Contact Time Model. There limitations though, we had to develop some parameters. I posed several questions to all of our Production Chemical Providers.

1. Can we use this methodology for all wells?
2. What is the economic breaking point? (When is it higher than what makes sense?)
3. If this is not the answer for a well what are our options?

As the answers to these questions began to surface we were able to develop a set of criteria that would determine which methodology would best fit the production of a well.

Criteria for Contact Time Model

1. The well has to have the seat nipple set deep.
2. The well has to be “Pumped Off” we define this by cycling and a fluid level of less than 500’.
3. We have to make sure the Production Values being used are current.
4. The Maximum Daily Oil production has to be less than 18 barrels a day.

When we have a well producing more than 18 Barrels of Oil a day what do we do? How do we chemically treat these wells economically that allows us to eliminate the Thermal Treating?

Continuous Treatment (Slip Stream) Utilizing Crystalline Modifiers

During 2015 we had determined that Contact Time Model was a viable method to treat paraffin chemically and alleviate thermal treating, but we had to develop a program that would consider higher volume wells.
We asked our Production Chemical Providers to propose us some options.
We chose to test the use of Crystalline Modifiers in a “Slip Stream” delivery system.

Again, I am not a Chemist, but I understood the principle behind this concept.

This is a continuous treatment. It allows us to utilize an option that is more economical method to treat paraffin of higher volume wells.

We created a list of all wells we were testing and turned that list over to SCADA to monitor for friction.

We did not Thermally Treat these wells nor did we see any friction.
It looked to be a success, then we had a failure of a well on this program. It was a rod part and the real test came.

Rods of a Failure on Crystalline Modifiers

Well #1 Crystalline Modifier

Rods of a Failure on Crystalline Modifiers

Well #2 Crystalline Modifier

Continuous Treatment (Slip Stream) Utilizing Crystalline Modifiers

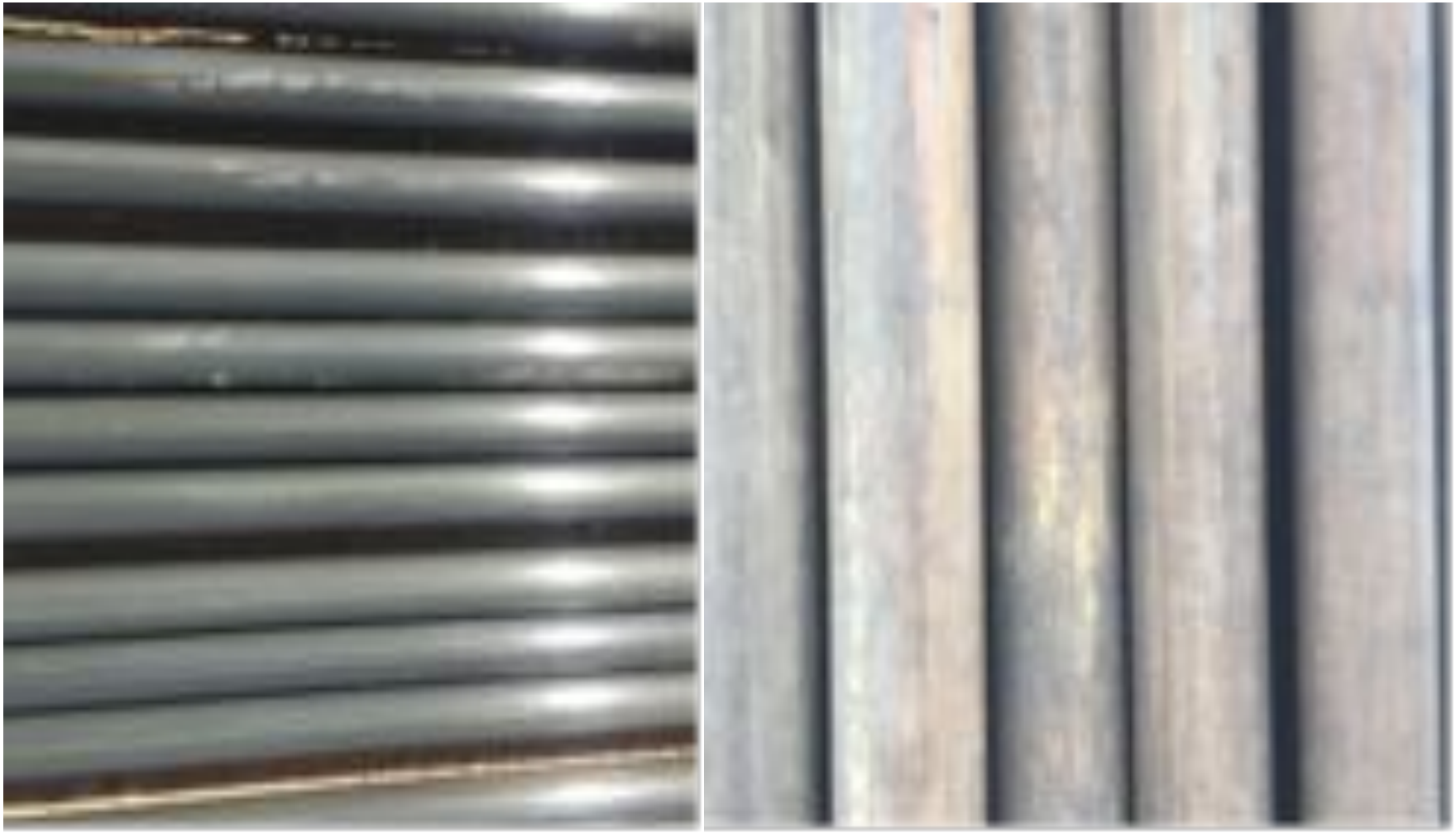
This did allow us to treat any well with a “Slip Stream” and it was successful. The only problem was that if you were treating with a “Slip Stream” for paraffin, chances are you have to have a second “Slip Stream” set up to handle corrosion and scale.

Another one of our Production Chemical Companies provided a solution to that Problem. Tri Combo Chemical 1 and Tri Combo Chemical 2 are both combo chemicals that effectively treat for paraffin, corrosion, and scale. The Chemical 1 is for the traditional “Slip Stream” set up. The Chemical 2 is for the non-flush “Slip Stream” set up.

The main question is did this work? All of the residuals proved it was getting around through the tubing and rods, but did it protect against all three?

Failure on the Tri Combo Chemical #1

Well #1: Chemical #1 (Rods and Tubing)



Failure on the Tri Combo Chemical #1

Well #2: Chemical #1 (Rods and Tubing)

Continuous Treatment (Slip Stream) Utilizing Crystalline Modifiers

All of these worked. They each have their own application and usage, but is there anything else we can do?

I refer back to earlier in this presentation:
This is coupled with using an every other week schedule of adding a dispersant package to your truck treating program. Ask your Production Chemical Provider what he is targeting and he or she will tell you **500 ppm.** That is API standards.

We took on the 500 ppm standard. Most all of our wells are treated with dispersant @ 350 ppm and with Crystalline Modifiers @ 250 ppm.

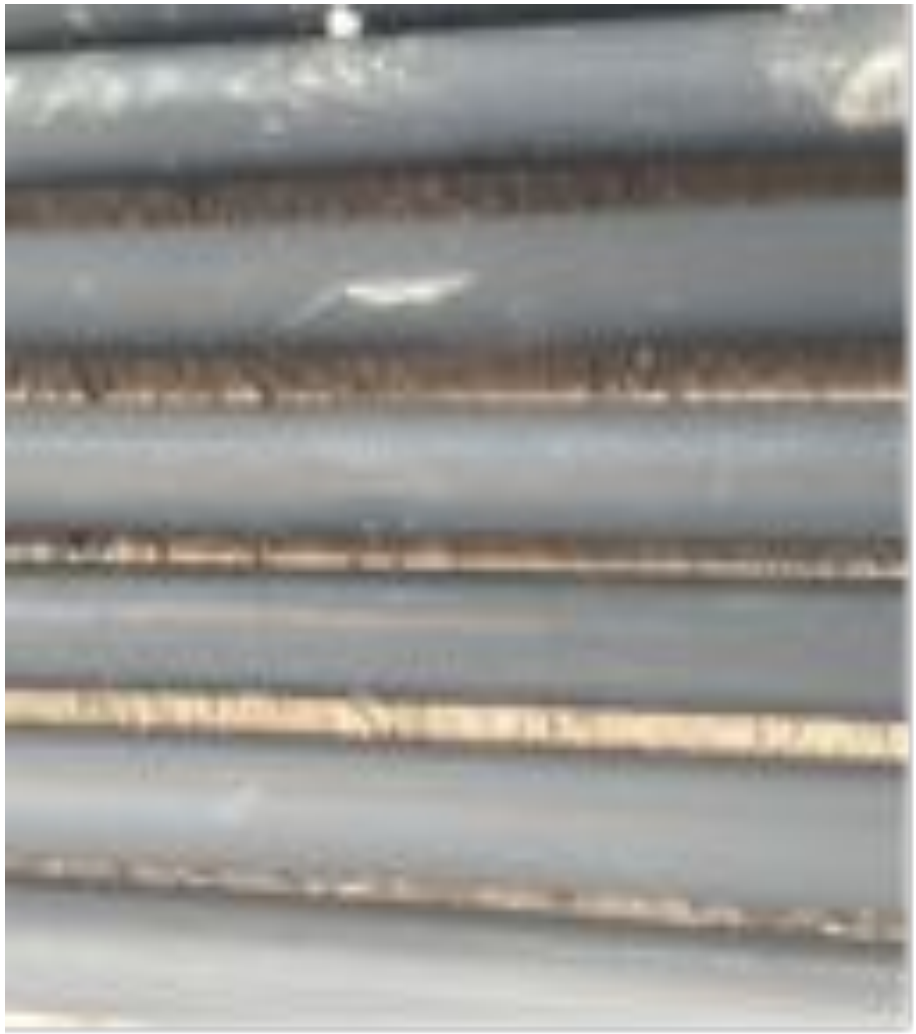
It may not be a new methodology that helps or works, it may just be optimizing what is currently being done.

Failure on the Batch Treating @ 500 ppm

Well #1: Batched Treated @ 500 ppm (Rods and Tubing)

Failure on the Batch Treating @ 300 ppm

Well #2: Batched Treated @ 300 ppm (Rods and Tubing)



Non-Thermal Results

Contact Time Model

- No Thermal Treatments
- No Paraffin present during Pulls
- 1.75 years time of utilization
- 99% success rate

Crystalline Modifiers

- No Thermal Treatments
- No Paraffin present during Pulls
- 1.50 years time of utilization
- 99% success rate

Tri Combo Chemical 1 & 2

- No Thermal Treatments
- No Paraffin present during Pulls
- Corrosion and Scale residuals strong in fluid
- 1 year time of utilization
- 99% success rate

PPM Target Optimization

- No Thermal Treatments
- No Paraffin present during Pulls
- 0.75 years time of utilization
- 99% success rate

Cap Strings

We have tested the use of Cap Strings for delivery of chemicals in several different scenarios.

Horizontal ESP Well

A Cap string is the best application in this situation, according to what we have seen. We still had to Truck Treat these wells bimonthly to protect the back side.

Horizontal Gas Lift Wells

We tested Cap Strings in this application and have found that using atomized chemicals in the gas string and cutting paraffin is a much more economically favorable practice. Treating with chemicals down a Cap String with the volumes of a horizontal well is costly.

Cap Strings

Vertical Wells

We have tried Cap Strings in these wells also. There are very specific conditions that this is warranted over a slip stream.

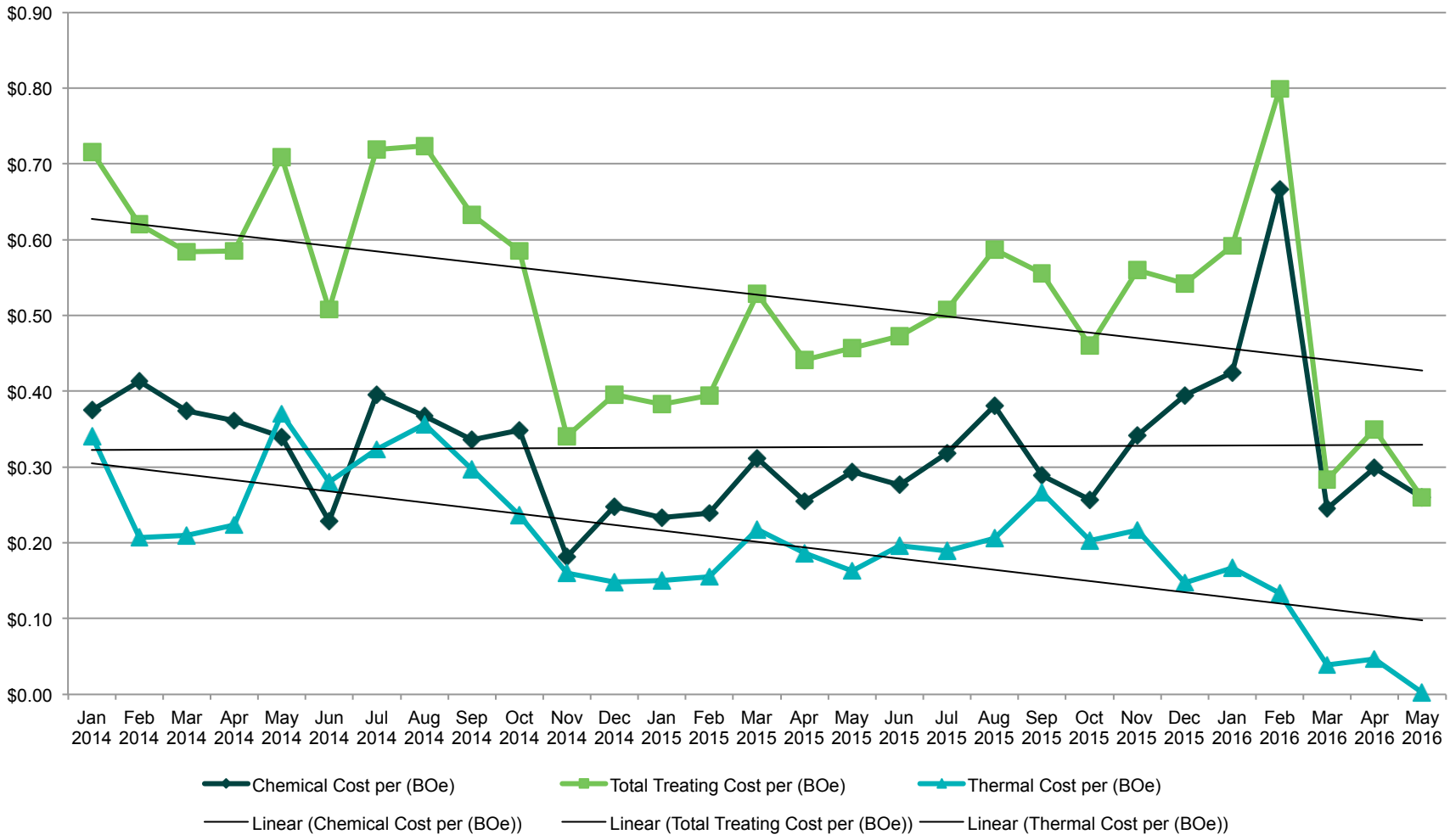
Non-Thermal Results

I have spent all of this time explaining what we are doing and how it has been successful mechanically. Now, what does it cost?

If something works, but is so costly that it makes it impossible to use the technology then what good is it?

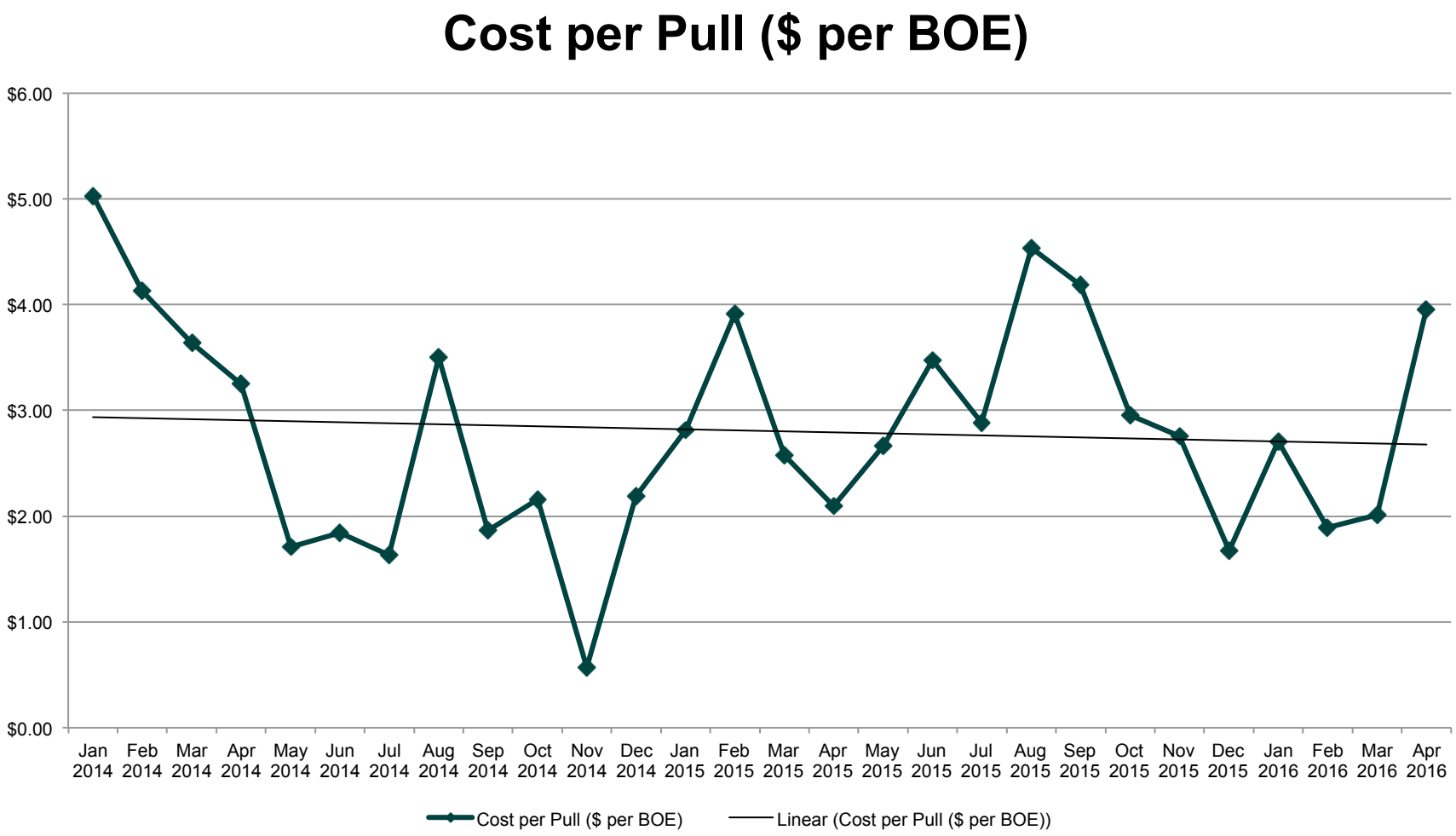
Paraffin Treating Cost for an Area 100% Non-Thermal

Middle Area



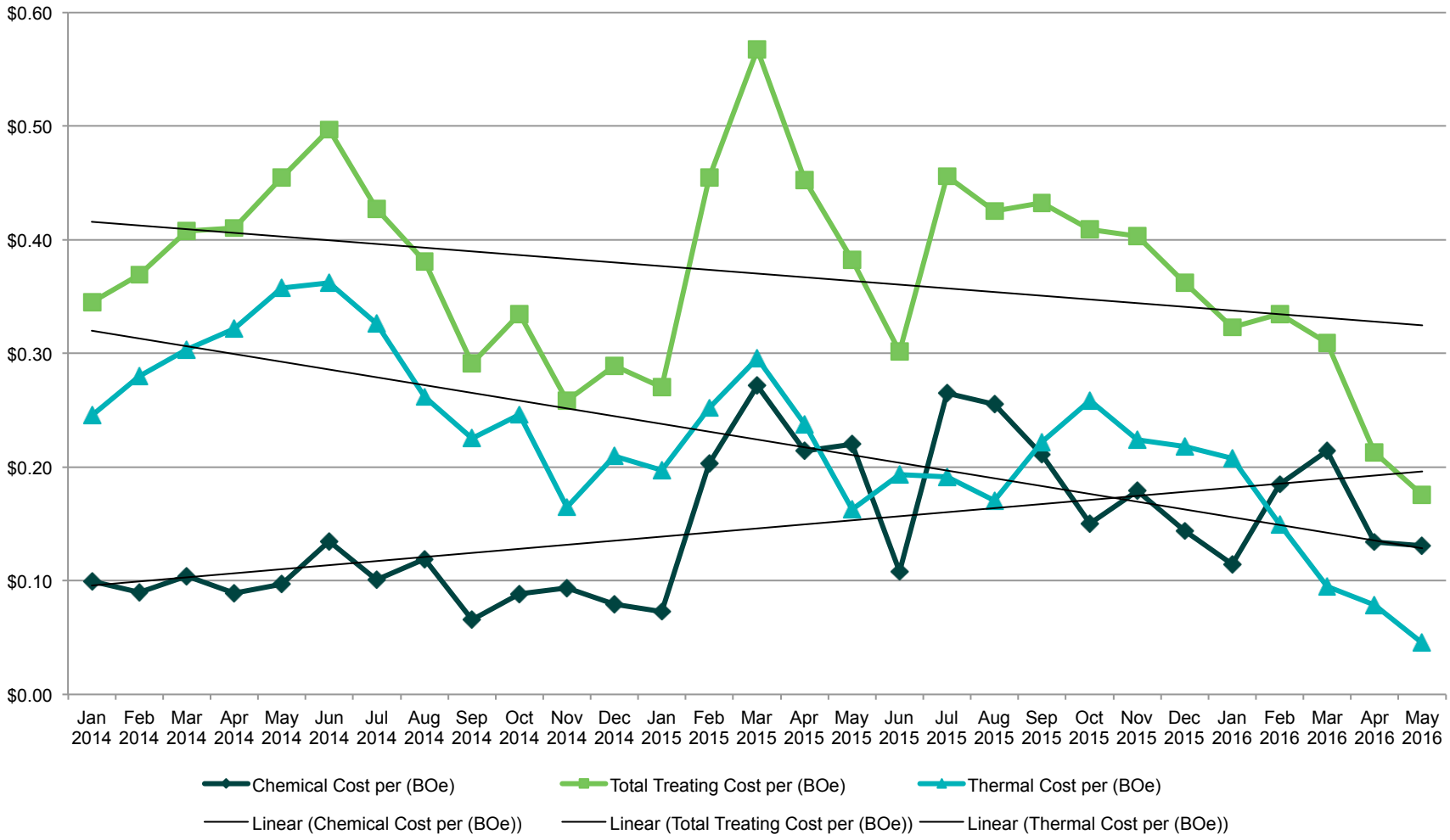
Cost per Pull for an Area 100% Non-Thermal

Middle Area



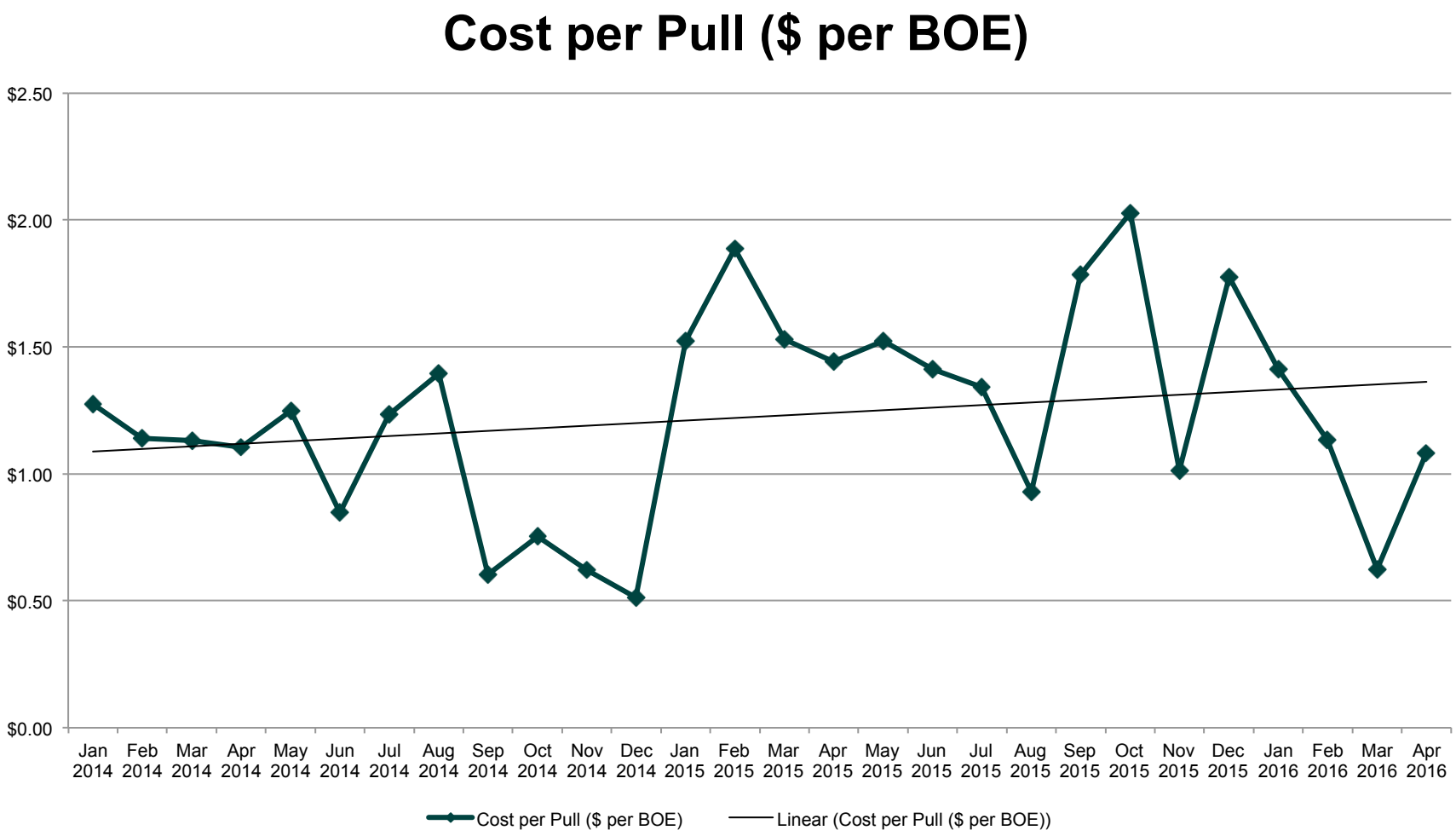
Paraffin Treating Cost for an Area 65% to 75% Non-Thermal

North Area



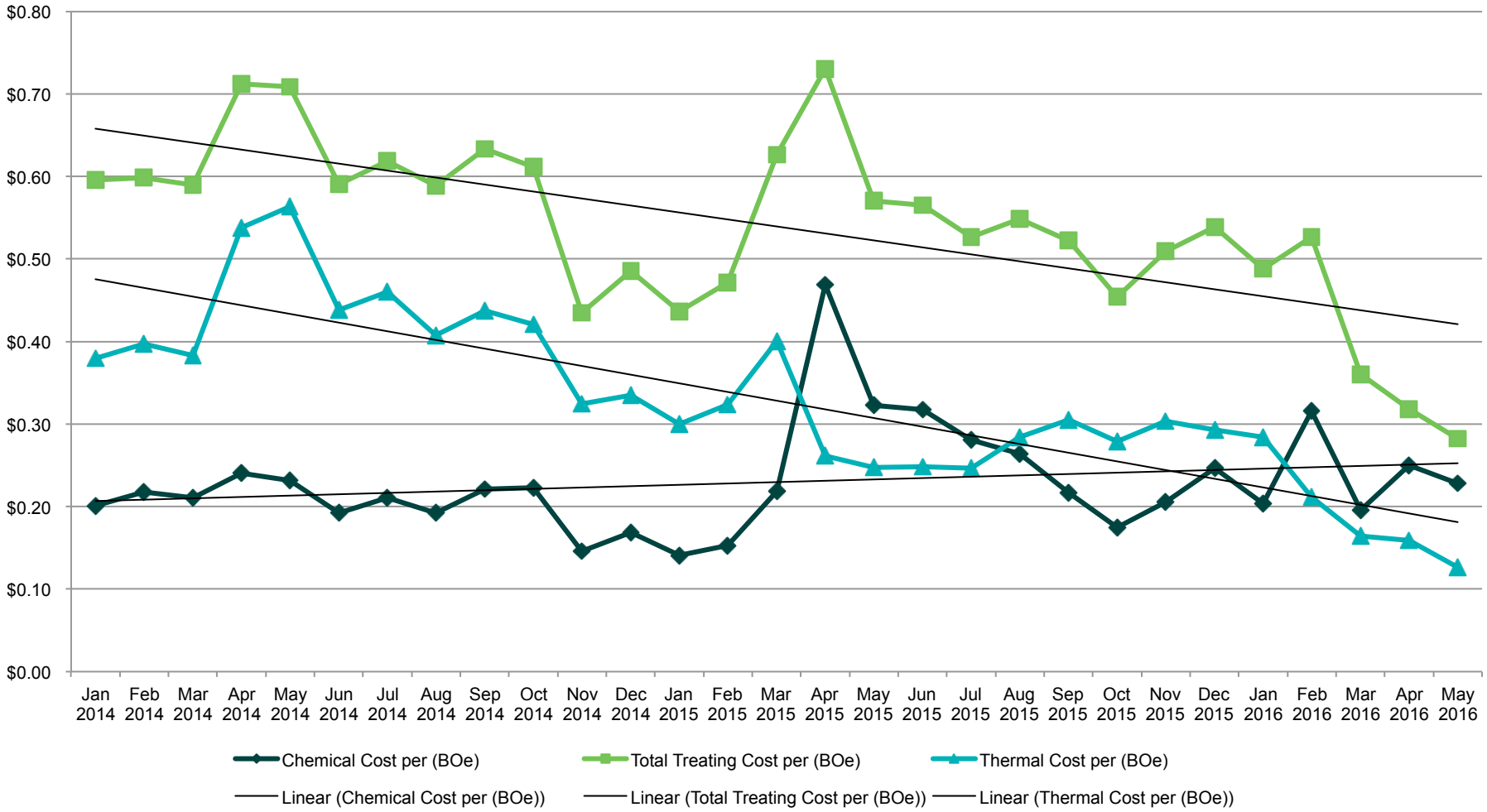
Cost per Pull for an Area 65% to 75% Non-Thermal

North Area



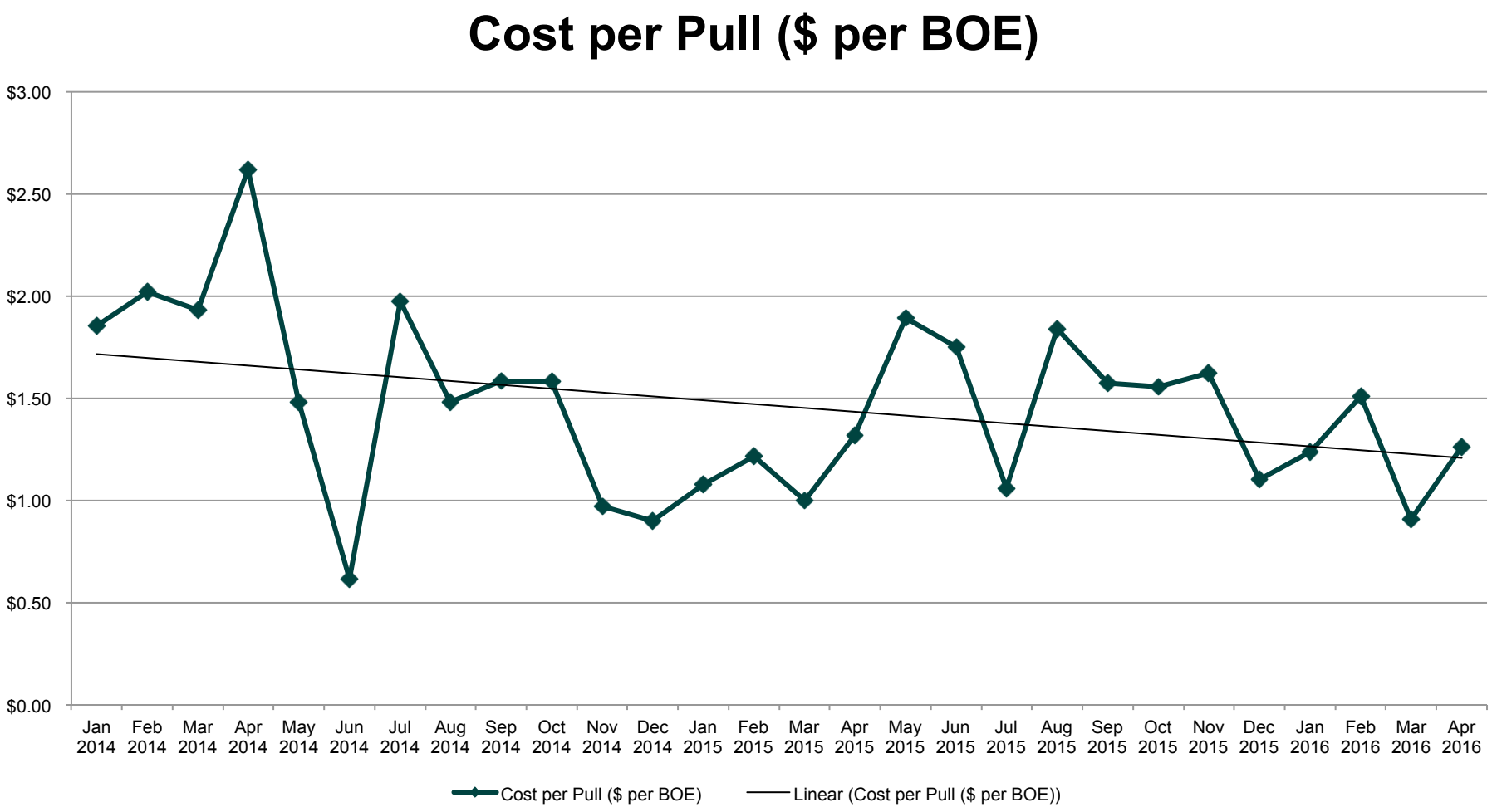
Paraffin Treating Cost in an Area Predominantly Thermal converting to Chemical

South



Cost per Pull in an Area Predominantly Thermal converting to Chemical Treating Program

South



Conclusions

We have seen that chemically treating for paraffin is a much more advantageous practice than thermal treating.

There are multiple options to work with, we had to develop a list of tools to use. We developed sets of guidelines to use for each methodology to be incorporated.

We track the results continuously. This is a never ending part of any successful chemical program.

We had to include thermal cost in our evaluations to derive an answer.

As I have stated I am not a Chemist and you do not have to be one to develop a program as ours. We all have Chemical Gurus, they are our Production Chemical Company Team Members.

Conclusions

We have also seen a reduction in failures that are directly related to paraffin.

This is seen in a reduction of stripping jobs during a pull.

There is not a real way to quantify this other than in the number of stripping jobs. The number of Horizontals being completed have skewed the failure data.

Appendix