TICKETLESS TRACKING OF PRODUCED WATER FROM THE CRADLE TO THE GRAVE WITHOUT HUMAN INVOLVEMENT

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ABSTRACT

This is a discussion of a newly developed and field tested system to measure and track fluids produced in the oilfield. The system's mission is to track the fluid movement from the cradle to the grave using automation. Custody transitions of the fluid are traced precisely, verifiable and electronically to the producer, the trucking company that hauls the fluids, and the companies that handle the final deposition of the fluid, whether that is at a disposal well or a pipeline terminal.

The discussion centers on a West Texas well where the use of this system saves over $10,000 per year in operating costs. The paper discloses patented technology as well as how the implementation process evolved and overcame the paradigms and mindsets of the people and companies. Implementing new technology is a cake walk when compared to altering the complexity of the "oilfield thought" process.

AUTHORS NOTE

The evolution of the technology described herein is best presented in story form as it deals with the oilfield workers and how it affects their jobs. Intertwining human reaction and technology might appear to be fragmented at best, but that is the way it is when personalities, paradigms, technologies, and cultures define the paths taken. Hindsight is always 20-20, but one's forward view is often obscured, not because of the science, but rather how workers react to change. Merging two so different cultures: "We have always done it that way" and "here is new technology" is an arduous process. In the end, successfully introducing a new system can pay huge benefits to all concerned when there is something in it for everybody.

The story begins in 2013 while trying to find a simple and economical way to solve one age-old simple problem: How to resolve tank gauge differences between the pumper and the oil buyer? This is a costly and common problem that plaques most operators, but this situation need not carry the stigma of "It is just part of the costs of doing business" attitude. Along the way, as the original problem was solved, the listening-learning curve kicked in, and other issues, not previously appreciated or understood surfaced. In the end, harmony and partnering became the norm and all involved parties became beneficiaries. It is truly amazing what can happen when everyone knows the rules and are using the same page in the playbook.

GENESIS

This learning experience began at a remote 5,200 Bell Canyon well about 20 miles south of Pecos. For years, this well has been producing at a very predictable 7-8 BOPD and what was thought to be 32 BWPD. The only real operating problems were the remoteness of the well, an occasional bout with paraffin, and an almost constant battle with the contract trucking company that hauled the oil. This well, like most wells in the Permian, used the twentieth century-high end "Mason Jar" system of communicating meaning: "Trust me, I will leave you a ticket" type thinking. On this well, the pumper's gauge reports never matched the hauler's tickets and the

errors were consistently in the trucker's favor. It was two or three inches here and there, maybe on the top gauge or it might be the lower gage. Sometimes the difference would be as much as six inches or 12 bbls of oil. To put the magnitude of this problem in perspective, when this project started (2013), three inches of oil in the tank was worth over $800.

Trying to resolve disputes with three parties involved proved to be a time consuming, frustrating, and a most fruitless process. Reconciling the pumper's gauge against the hauler's gauge with the buyer for the most part, caught in the middle was an unsolvable dilemma. How could one determine who is right? It was relegated to a "I said-you said" situation with no real solution. The root problem: There was no "gate keeper," meaning the pumper was never on the lease when the oil was picked up. He called in a load, went to the next lease, and the truck arrived later on in the day to haul the oil. The first question that came up in every conversation: What time did your pumper gauge the tank and what time did the truck arrive? Did he leave the well pumping? It was clear that some sort of electronic Mason jar was needed. (For those not familiar in current field techniques, the Mason Jar Technology is detailed in appendix A)

ORGINAL PROBLEM SOLVED:

In 2015, an affordable ($500/month), and very simple web based electronic tank gauging system was installed at the battery to measure and report both the oil and water tank levels. Obviously, (tunnel vision) oil was the focus but adding a second tank sensor at the water tank was incrementally small to the overall cost of the SCADA (supervisory control and data acquisition) system, so why not do it? Neither the trucking company nor the oil buyer was told of this installation.

Shortly after the tank monitoring system was installed, as expected, the oil gauge dispute saga raised its ugly head again; however, this time, it was no longer an "I said-you said" problem. Data was used and the discrepancy was resolved within three days by a trip to the oil buyer's office. A simple graph, when given to the right person, had done its job. Full credit was given for five inches ($1,200) of oil. To the delight of the producer, the expense of the system had paid for itself in less than two months. Over the next few months, the epic gauge dispute happened two more times. The second time, an e mail with an attachment solved the problem. The third time was a bit more melodramatic as the oil buyer not only gave a full credit; they terminated their contract with the trucking company. The problem had gone away. Again: Data triumphed and Reagan had it right: "Trust but Verify."

THE SECOND LESSON PAID EVEN GREATER DIVIDENDS

What was learned and what transpired over the next year was enlightening to everyone involved. Over the course of the past 30 plus years of producing this well, little attention was given to the water as the produced water was viewed as nothing but a nuisance and an expense. The apparent gross water production was steady. Oil equated to money and oil was the focus of everyone involved. However, that changed in 2015 when accurate water tank gage information became available.

Before continuing on with the well story, perhaps it is best to revisit the most fundamental and intrinsic human motivational characteristics of the oilfield worker and review basic job descriptions. The majority of the world relies on *"Maslow's Hierarchy of Needs"* to explain the motivations and unconscious desires of people, but the oilfield can't operate under that theory. Maslow's theory applies to normal folks. Maslow said the basic human motivations are warmth, rest, comfort, and food. The oilfield worker long ago gave up on being comfy and getting nice hot meals. The prime motivation to most pumpers, especially the contract ones, is safety and speed.

Pumpers get to know their wells as well as they know their spouses and as a result, will pay meticulous attention to what is important, both the amount of and quality of the oil in the tanks, and not so much attention to trivial matters, the water. If the well makes a foot or so of water per day and their job is to call a truck when a load is ready and never let the tank overflow, why would one spend 5-10 minutes per day gauging the water tank? They learn that checking the water tank every few days suffices for the task at hand.
The months of October and November 2015 were most informative. During this time span, the contract water hauler invoiced for 16 truckloads or 1,920 bbls. of water taken to the SWD. Every ticket and invoice was for exactly 120 bbls. But: One feature of the SCADA system used is: It automatically sends alerts when a load of oil/water is hauled and that alert includes the top gauge, the bottom gauge, total amount loaded in barrels, as well as a time and date stamp. During that time period, the SCADA system confirmed that 16 loads of water had been hauled, but the volume numbers differed quite dramatically. The facts: According to the SCADA system, 1,620 bbls of water were trucked off location, not the invoiced for 1,920. The SCADA-trucker gauge differences was so large, the pumper was double checking the SCADA system every day. SCADA won out, proving trucker wrong. To put this in prospective, the difference in 300 bbls of water at the contract disposal cost of $2.75/bbl amounts to $825 or a tad bit over $400 per month. Furthermore, the data confirmed that this well actually makes 27, not the 32 BWPD as previously thought. It is too painful to extrapolate how much money might be involved looking backwards over years and years. As a footnote: The pumper carefully checked the oil hauler's gauge tickets, but admitted paying little attention to the water hauler's gauges. Of course, no one in the office had a clue this practice was ongoing as all they had were the hand written tickets.

When confronted with data, the trucking company made no excuses and offered no explanation other than to say: "We have always done it that way. And to be sure, they have, as an audit covering the previous 18 months of invoices from the same local trucking company revealed: Every invoice, all 126 of them, were for 120 bbls of water. No exceptions. The most embarrassing part, the well operator had no idea of what had transpired over the past few years or how much money had been left on the table.

<u>HOLD ON: THE BEST WAS YET TO COME</u>
Disappointed and angered at the turn of events with the trucking company, the operator set out to find a different trucking contractor and during negotiations, the alerting and verification features of the web based SCADA system were featured.
In order to fully appreciate the real savings gained here, one must understand the thought process or mindset of a trucking company. The word "Partnering" has been thrown around in the oilfield for years, but with few exceptions and for the most part, the "partnering" concept has failed: The vendor-buyer relationships remain solidly intact meaning, the oil company's costs remains the vendor's income. That battle rages on every day.
In the end, understanding the "mindset" of the trucking company became the keystone to the greatest financial gain of all using this technology. The old way: The pumper gauges the tanks and calls for a truck when a load is ready. The trucker perceives that call as a "command" and responds by dispatching a truck. To the trucker, that is "service" and that is what his/her business is all about: providing the best service in the area at a fair price. The trucker's mindset was one of providing an "on demand" type service to the customer.
In the case of this remote well, true "Partnering up" seemed to be the best fit and the operator threw out a carrot: "I will help you save money if you will pass some of those savings back to me. Here are the rules:"

1. You will receive text and e mail alerts when a load of water is ready to be hauled. No phone calls, no hassle.

2. You will have a 3-4 day window to haul the water. No hurry. Just get it within the 3 day window. Make it fit what is best for you.
3. You will be given full access to the website to check fluid levels and load status at any time.
4. Your trucks will be monitored for volume verification.

The trucker liked this window option and priced the trucking accordingly. Since they routinely had empty trucks passing within 4-6 miles of this well, saving time and mileage became a simple dispatching puzzle. The result: The time to pick up a load and take it to the SWD was decreased from 4 to 2 hours. The trucking company passed on some of the savings by lowering the price from $2.75/bbl to $1.75/bbl. That alone reduced the well operating costs by over $10,000 per year. In addition, the profitability per hour for the trucking company increased by 25%.

It was truly a win-win situation, but there was still much more to do and learn, especially at the field level.

THE FIELD SYNERGY: SAVING TIME AND SAFETY ISSUES:

Sensor driven web based systems that accurately measure tank levels in the oilfield is a mature art as several companies offer this service. However, it has been said many times, gathering data is the simple part: Making full use of the data is where the work begins and the real benefits reside. The goal of this system became twofold: 1) Get pertinent data in the hands of those who need it at the time they need it, and 2) Develop a “Management by Exception” system to manage the produced fluids. After all, viewing a website depicting tank levels only is much akin to watching paint dry.

It is noteworthy that at the beginning of this project, the pumper was a curmudgeon and a skeptic. He had a flip phone, did not text, nor did he do internet and e mail. For the most part, he was “the outsider’ and initially took a jaundice type position: “I am helping to develop my replacement.” As time progressed, the operator, the pumper, and trucking company gained confidence and trust in each other and it became abundantly clear, more opportunities were in store. At the start, the only initial benefit to the pumper was he did not have to call for a truck. Certainly not much, but it was a start.

The full and complete “buy in by all” was accomplished by the field people when the resident Wi-Fi system was merged with the wellsite SBC (Single Board Computer) and SCADA system. (This is where the patented technology starts). Three very clear benefits emerged:

1) Meaningful data was available to them when they needed it. They were comfortable with it.
2) They saved time.
3) Their jobs were safer.

THE PUMPER:

When the pumper drives on location, his/her smart phone auto-connects with the Wi-Fi and before the door of the truck is opened, he/she has an immediate overview of the well’s status. (Figure 1)

- The pumper no longer has to climb the tank (A real safety issue)
- He/she will save about 10-15 minutes per day.
- There is no longer a need for paper gage books and mailings which saves time.
- The system auto alerts the trucking company when a load is ready, eliminating the need for phone calls.
- The pumper can focus on the other aspects of the job: Pumping unit status, leaks, pressures, stuffing box condition.
- Gathering, collating, and mailing the Mason jar tickets became a thing of the past.

Noteworthy: A side benefit to this technology is the onsite SBC captures/records when the pumper arrives and departs the lease. This information can be used by the operator for oversight purposes as well as tracking man hours on location for safety stats. (See Figure 2)

THE TRUCK DRIVER AND HAULING COMPANY:

As soon as the trucker arrives on location, the smart phone or onboard truck device auto-connects with the Wi-Fi and the system recognizes the truck has arrived.

- A message is sent to the driver/truck showing the top tank gauge and well ID, which eliminates the need for the driver to climb a tank stairway. The driver sees this message and can quickly off load the fluids. (Figure 3)
- After the truck is loaded, the driver simply presses the icon button. *If, in the event the driver fails to press the button, the SBC assumes such and when the truck drives out of range, the SBC assumes the transaction is complete at the lease by default.*
- As soon as the icon is pressed, the SBC sends the lower gauge reading along with how many barrels are loaded. The system populates the smart device with the needed data for a Bill of Lading. (Figure 4)
- All the information above is sent to the Cloud.
- No paper ticket is needed as the information resides on the smart device as well as in the cloud.

THE SWD OPERATOR:

The SWD wells are geo-fenced and trigger the smart device/truck when it comes within the boundaries of the well. This is much akin to using the smart phone for driving directions and when one arrives at the target address, the little voices says: "You have arrived at your address."

- When the loaded truck enters the geo-fenced boundaries of a SWD or pipeline terminal, the app on the smart device lights up with the screen shown in Figure 5.
- The driver simply pressed the icon to confirm the unloading process.
- That information is sent to the Cloud and is stored on the smart device.
- No ticket is needed as the SWD operator knows how much water was delivered by whom, and from whence it came.

At this juncture, the entire life cycle of the fluid has been captured, tracked, and documented. The information is stored on the respective device and in the Cloud based server and no paper has been used. Production rates, disposal information, and custody issues are all verifiable.

MASTER WORK STATION:

In the office, all the information "Necessary to Manage" the produced fluids can be displayed and worked at one site. More about this later, but first, a brief primer of how the tank gauge charts are presented and how they are used for a "quick visual" reference of everything that happened during the time span presented. Figure 6 is a chart for all water activity for a month; however, a zooming function on the X axis is available enabling the user to view any time span from hours to days or months.

The pertinent points on Figure 6 are as follows:

SN: Situation normal. The production going into the tank at a constant and predictable rate. This well is making 14 inches or 23 Bbls/day. Slope is normal with no anomalies.

FT: Flat time or non-productive: This could be down time for any reason, but in this case, the well is being circulated for chemical treatment. Note the second flat time on the 20th. The pumper is instructed to treat the well with paraffin solvent twice monthly and the chart confirms he is doing his job.

DDE: Draw down event. A truck has arrived and extracts water from the tank. The top gage [A] minus the bottom gage [B] equals the net water loaded. The truck information, when combined with the date time information, is used to generate an E-ticket, which is sent to the Cloud and to the smart device.

The user of this screen can quickly see: All is normal with this well. Five loads of water were hauled and electronically documented during the month.

Going back to viewing actual data, when first logging on, the operator sees an overview of all the assets being monitored by the company. This site is real time. (Figure 7)

Suppose the clerk or production engineer wants to review, approve, or send to accounts payable (if applicable) water hauling activity for a particular asset. Click on the asset icon of choice in Figure 7 and Figure 8 pops up.

Every attempt was made to make this screen as intuitive and user friendly as possible. One can select several options. Real time, last week, last month, or any time span. In this shot, it can be concluded that:

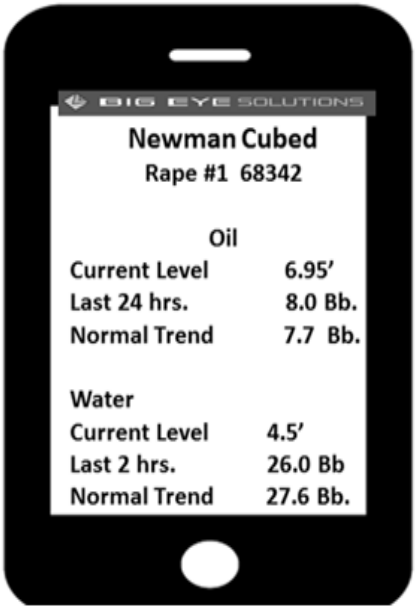
- The current tank level is at 62% of capacity.
- There were three loads of water hauled from this lease during this time span.
- In tabular form, each truck load is documented as to time/date, net barrels hauled, truck number, and to which SWD the water was delivered. This information can become the E-Ticket.
- Tending and alarming from this data can be set up to alert the operator when a well is out of tolerance. Oil/Water ratios, pressures, unexplained slope changes, etc.
- There are various reports available from this website. See Figures 9 and 10.

The user, experienced or not, can look, verify, and either pass on the information to the next level or actually instigate the pay process from this screen. (Future…not available in 2017)

Summary:

This fluid management system is truly a “Management by Exception” tool that can save a great deal of time for all parties. It affords the opportunity for operators and vendors to become true partners and when used properly, will it reduce the back office workload for all.

Figure 1



What does the pumper need/want to know about fluid production to do his job?

- Is the well pumping?
- What are the current tank levels?
- Is the well behaving normally?
- Is the oil/water ratio consistent?
- Do I need to investigate an abnormality?

Figure 2

Pumper on Location Activity as Tracked by Smart Devices

Recent Onsite Activity:

Activity Date		User	MAC Address
10/21/2016 04:11:23 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/20/2016 03:22:02 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/19/2016 04:55:51 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/19/2016 04:54:38 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/18/2016 05:31:02 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/17/2016 04:46:28 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/14/2016 04:12:03 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/12/2016 04:48:26 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/11/2016 05:17:21 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/10/2016 04:29:04 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/08/2016 07:18:09 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/07/2016 04:16:31 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/06/2016 08:26:34 PM	User Onsite Connectivity Detected	Toni's Son	4c:66:41:72:45:7e
10/05/2016 04:40:04 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/04/2016 04:29:13 PM	User Onsite Connectivity Detected	Fred Newman	d0:a6:37:60:83:6c
10/04/2016 04:21:44 PM	User Onsite Connectivity Detected	Fred Newman	d0:a6:37:60:83:6c
10/04/2016 04:07:39 PM	User Onsite Connectivity Detected	Fred Newman	d0:a6:37:60:83:6c
10/04/2016 03:44:03 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb
10/04/2016 03:32:00 PM	User Onsite Connectivity Detected	Fred Newman	d0:a6:37:60:83:6c
10/03/2016 03:46:03 PM	User Onsite Connectivity Detected	Toni Delgado	80:7a:bf:4b:7d:fb

✓ Present and Accounted For

✗ Not on Lease

Figure 3

Figure 4

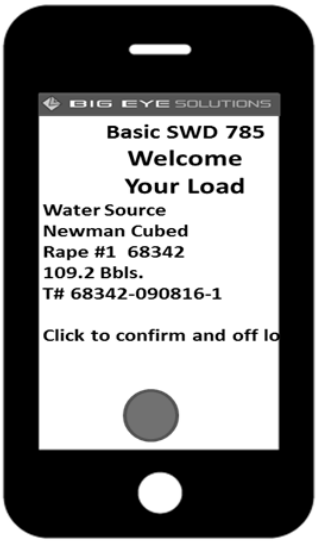


Figure 5

Figure 6

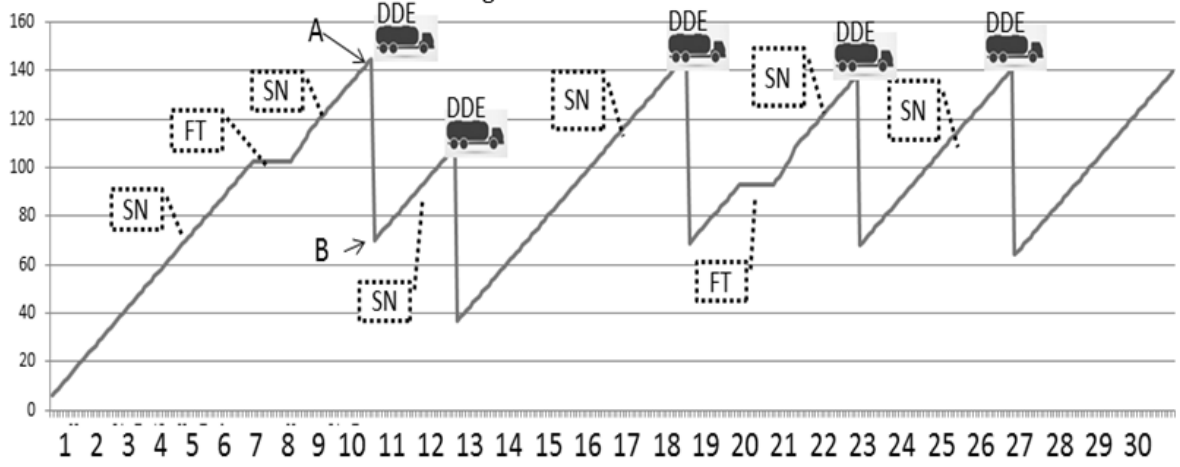


Figure 7

Figure 8

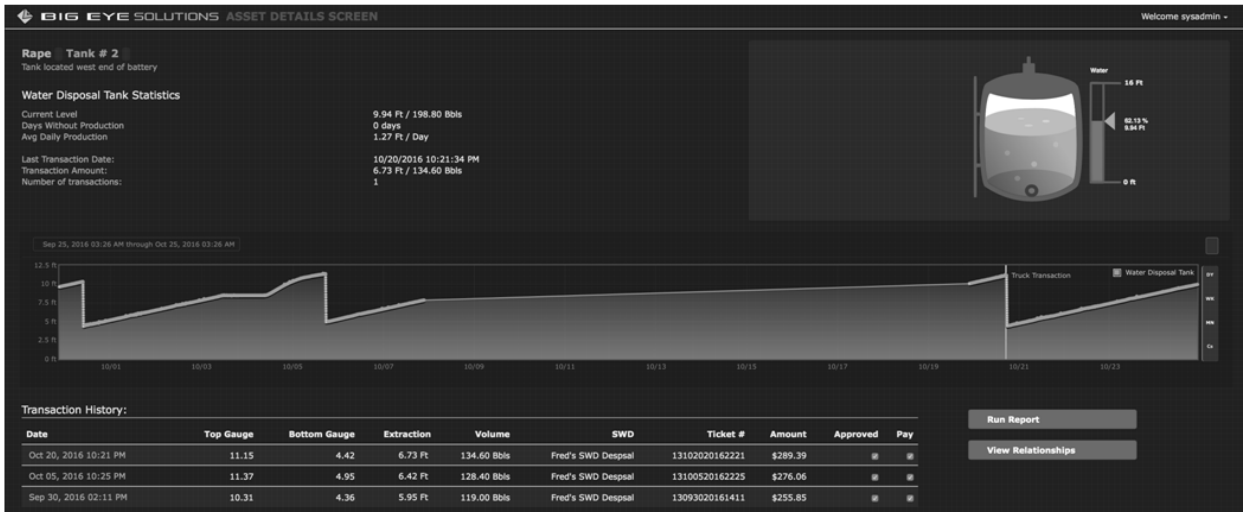


Figure 9

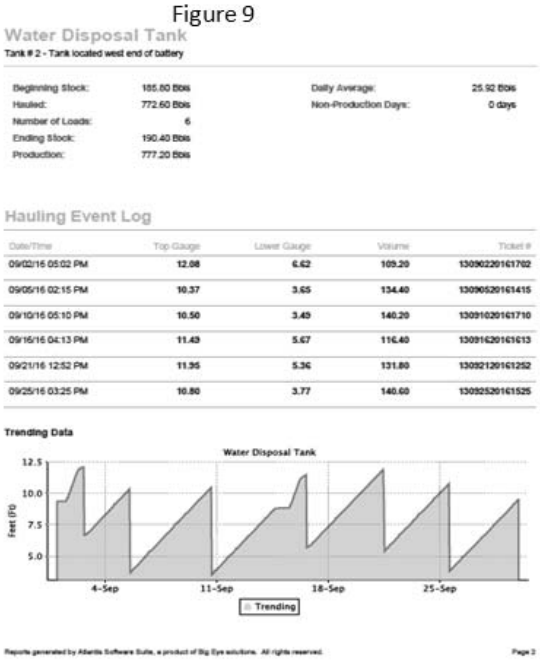
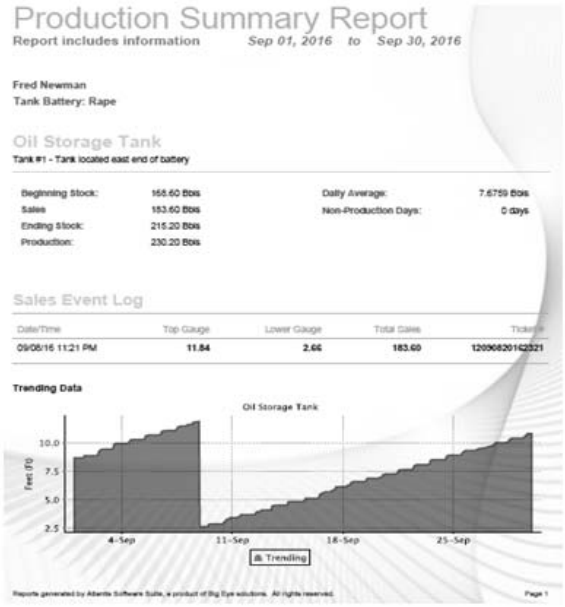


Figure 10



Appendix A:

The convoluted and almost laughable 2016 Mason jar technology process currently used for a billion dollar business.

Note: A number is placed each time a “person” who is involved, touches, spends time, or handles paper tickets during the process of disposing of one transport load of water when hauled by a truck.

The field process:

1. The pumper (1) calls the truck pusher when a load of water is ready.
2. The pusher (2) dispatches a truck. When the truck arrives on location:
    a. The driver (3) climbs the tank and takes a top gauge.
    b. The driver loads the truck normally using his truck mounted sight gage.
    c. The driver climbs the ladder again and takes a lower gage.
    d. The driver fills out two tickets, leaves one in a Mason jar for the pumper and takes the other for his/her office.
3. The truck arrives at the SWD and unloads.
    a. The driver (4) fills out two tickets, one for the SWD operator and one for his/her office.
4. Often times, the driver will not gauge the tanks. He/She will use the sight glass only which often induces an error of over 10%.
5.

At various intervals during the month:

1. At the production site, the pumper (5) will gather and mail to the office all the tickets found in the Mason jar.

    a. The tickets will collated at the production office (6) awaiting an invoice from the hauling company.
2. The SWD operator (8) will drive to the well, collect the tickets and take them to the office.
    a. The SWD office person (9) will collate the tickets and mail out invoices to the trucking company.
    b. The SWD clerk populates a P-18 for the RRC

The Trucking Company:

1. A clerk (10) collects the tickets daily from the drivers, sorts them by customer and sends them to the accounting folks.
    a. A clerk (11) will compare these tickets to the SWD tickets to insure accuracy
    b. A clerk (12) will sort the tickets by client and mail out invoices to the oil company.
    c. After verifying the SWD tickets are accurate, the clerk (13) forwards the information to AP.
    d. Note: High volume customers often require field approval resulting in the pusher (14) chasing down the field foreman getting him to sign the tickets. (Very time consuming)

At the Oil Company:

The field foreman (15) approves the tickets and invoices somewhere along in the process.

- Normally at the end of the month, and when approved, a clerk (16) will collate all the tickets and invoices and sent to AP (17)
- At some point, the tickets will be tallied (18) for total water production and entered into the well files.

Author's Note: Trying to capture and document the Mason Jar process was difficult, but fun, as so many folks have so many different procedures to follow. The point is: It is a time consuming and convoluted process. Something to think about…No one really knows, but it is a safe assumption that there are over 5,000 trucks hauling produced water in the U. S. Each truck will generate, depending on the haul time and distance, approximately a dozen to two dozen tickets per day and as seen from the above. Each ticket is "touched" at least 18 times by someone somewhere.