WellTracer

East Texas Gas Producers Association

Carthage, Texas

September 21st, 2010

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Gas Lift Diagnostics

What methods are available for diagnosing leak points and or gas lift efficiency?

Diagnostic Methods

- Echo Meter Survey
- Tubing Integrity Test
- PSC, pressure surface close
- Pressure Temperature Survey
- Caliper Survey
- Spinner Survey
- WellTracer Survey

EchoMeter Survey: Sounding casing annulus several times to determine if casing fluid level changes which would be an indication of tubing casing communication.

- **Pros:** No well intervention.
- Well does not have to be shut in. No deferred production.
- One man operation.
- Transportation cost is for personnel, not equipment.
- Cost for echo meter survey: $1,500.00 to $2,000.00 per day.

- **Cons:** Will not be able to see leak point if leak is below fluid level or shallow.
- Cannot identify multiple leak points.
- Will not identify leaking gas lift valves.

Tubing Integrity Test

Pressure up on tubing and monitor casing to see if pressure follows tubing pressure.

- **Pros:** Inexpensive.
  Quick.
  No well intervention, no exposure.

- **Cons:** Will only tell you if you have a leak, it won't tell you where the leak is.
  Would need to follow up with some other type of survey to locate hole.

Pressure Surface Close

Shut injection pressure off and monitor where the casing pressure bleeds down to. Might give an indication of which valve was lift valve.

- **Pros**: Inexpensive. No well intervention.

- **Cons:** Not always accurate, especially if there is a hole in the tubing.

  Valves could be off pressure.

  Can't tell the difference in lifting from an orifice valve and lifting from a hole in the tubing.

Pressure Temperature Survey

Memory gauge run on slick line, making stops at points to determine gradient pressure or temperature changes.

Pros:

- Determines close proximity of main injection points.
- Well must be flowing, minimum deferred production.

Cons:

- Introduction of tool strings and wire into well bore.
- Chance of getting blown up the hole.
- Chance of losing tools in hole, necessitating additional wire line work and exposure.
- Personnel requirements: 2 man wire line crew **plus** an electronic technician. Average cost- $5,000.00 per day
- Transportation charges $3,000.00 Electronic gauge rental $1,500.00 per day.
- Foot print.

Caliper Survey

Rental tool run on slick line that measures surface area inside tubing in a 360 degree radius.

Pros:

- Can identify all holes in tubing and determine thickness of tubing walls.
- Very accurate.

Cons:

- Well must be shut in to run survey, lost production.
- Introduction of wire line tools into well.
- Cannot locate holes in tubing accessories.
- Cost of running survey:
- Foot print.
- Cost is similar to previous survey, $10,000.00
- Deferred production

Spinner Survey

Can be run on slick line or electric line. Determines leak points by measuring spinner revolutions.

Pros:

- Fairly accurately locates leak points in tubing string.

Cons:

- 3 person crew, operator, helper and technician. Well must be flowing, allowing the possibility of getting blown up the hole.
- Cost: $4,500.00 to $5,500.00 a day for 3 man crew per day.
- Transportation cost of equipment and crew, $2,000.00 to $3,000.00.
- Foot print

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- **WellTracer Survey**: this technology can be defined as a method to determine lift gas entry point(s) in the production conduit without the need for entry into the wellbore. It aids in identifying the operating valve of a well as well as indicating multipointing or possible leaks in the tubing.

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Pros:

- **No entry into well bore.**
- **Identifies all leak points.**
- **Well is not shut in, no lost production.**
- **One or two man crew.**
- **Transportation cost is minimal.**
- **Small foot print.**
- **Cost: $1,400.00 to $3,000.00 per well**
- **WellTracer Technician $1,200.00 to $1,800.00 per day.**
  per day.
- **More than one survey can be run per day.**
- **Analysis 3 hr min. $740.00**
- **Additional service charge of $800.00 per day for additional personnel may be applicable.**
- **Multiple survey packages available, company, field or platform.**
- **Can survey dual strings simultaneously.**

Cons:

- Only to wire line company.
- WellTracer does not determine gradient information.
- WellTracer does not give any BHP information.

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- Operator: Forest Oil
- Well Site: Paradis, La
- Date of Survey: March 19, 2008
- Type of Well: Single, Gaslift

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Accurate Well Information

Well Bore Schematics
Installed Gas Lift Equipment
2 Pen Charts
BHP information
Fluid Measurements
Gas Measurements
Well Head pressure
Casing pressure
Gas Gravity
Oil Gravity

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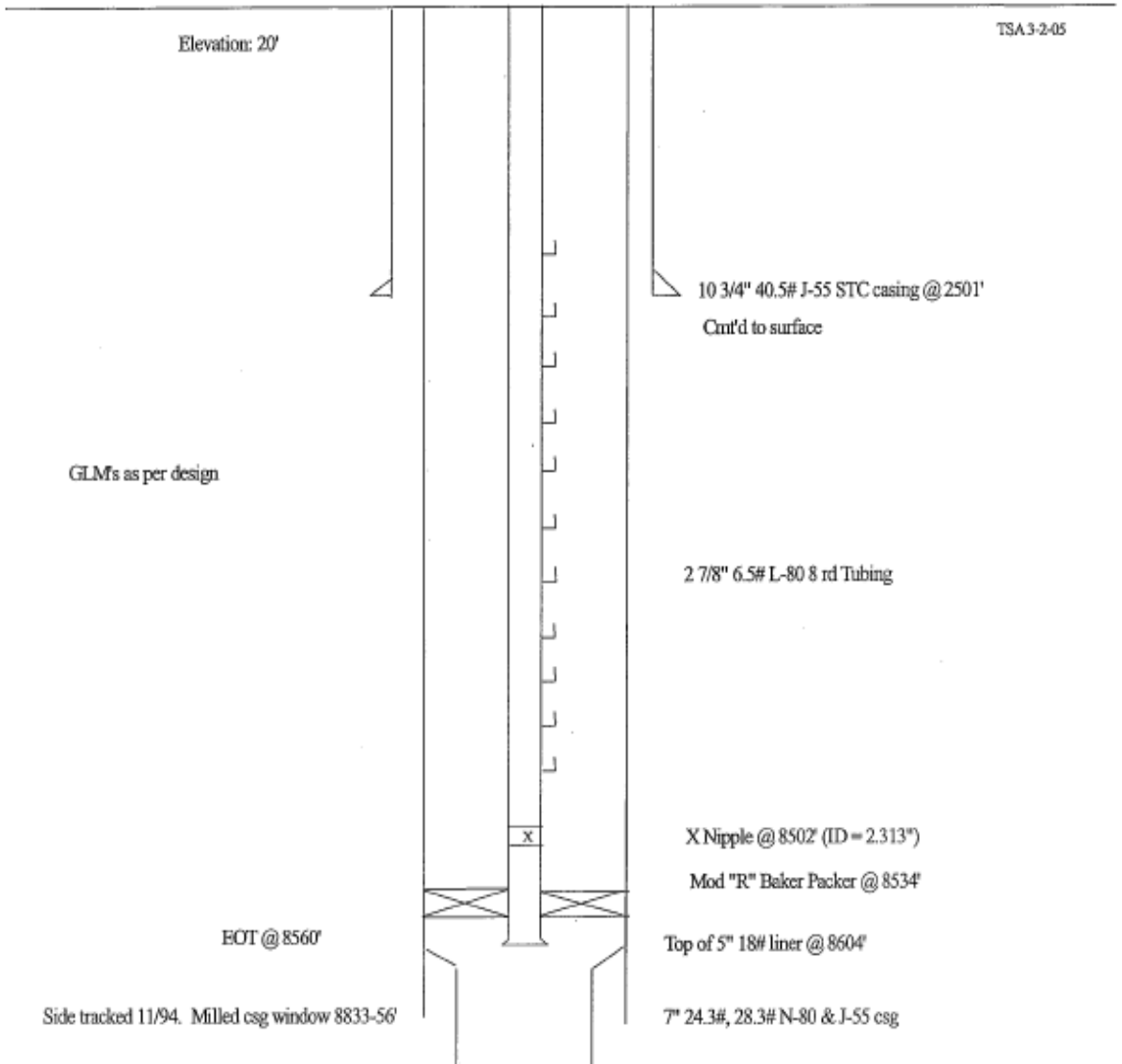
Forest Oil

Paradis
MRP #2ST
Current Schematic

Serial No. 027325
API No: 17-023-
ST Charles Parish
Sec.39 T14S R20E



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Existing Gas Lift Installation

FOREST OIL CORPORATION
GAS LIFT DESIGN

Well: MRP #2
Field: Paradis
Date: 1/11/2007
Design Type: Continuous Flow Pressure Valve - Winkler Method
Tubing: 2 7/8" 6.5# L-80 8 rd mod
Mandrels: 2 7/8" McMurry-Macco SFO-1

Valve Depth	Valve Type	Valve Port	Tubing Effect Factor	1-Ap/Ab	Casing Pressure At Depth	Temp. at Depth	Temp. Corr. Factor	Pt min	Pt max	Casing Pressure Drop Req.	Casing Pressure Drop Act.	T.R.O. at 60 Degrees Calc.	T.R.O. at 60 Degrees Set	Pso	Gas Weight	Surface Closing Pressure
5000	McMurry/Macco RP-1	3/16	0.104	0.906	1200	177	0.799	760	1030	28.1	30	1022.0	**1020**	1080	120	1037
6150	McMurry/Macco RP-1	3/16	0.104	0.906	1195	190	0.782	875	1100	23.4	20	1005.7	**1005**	1050	145	1019
7000	McMurry/Macco RP-1	3/16	0.104	0.906	1195	199	0.770	970	1160	19.8	20	997.8	**995**	1030	165	1006
7500	Orifice	1/4												1010		
7900	McMurry/Macco RP-1	3/16	0.104	0.906	1095	204	0.764	950	1100	15.6	15	912.1	**910**	950	145	934
8200	McMurry/Macco RP-1	3/16	0.104	0.906	1082	206	0.761	1000	1100	10.4	10	902.5	**900**	935	147	924
8500	Orifice	1/4												925		

Old design

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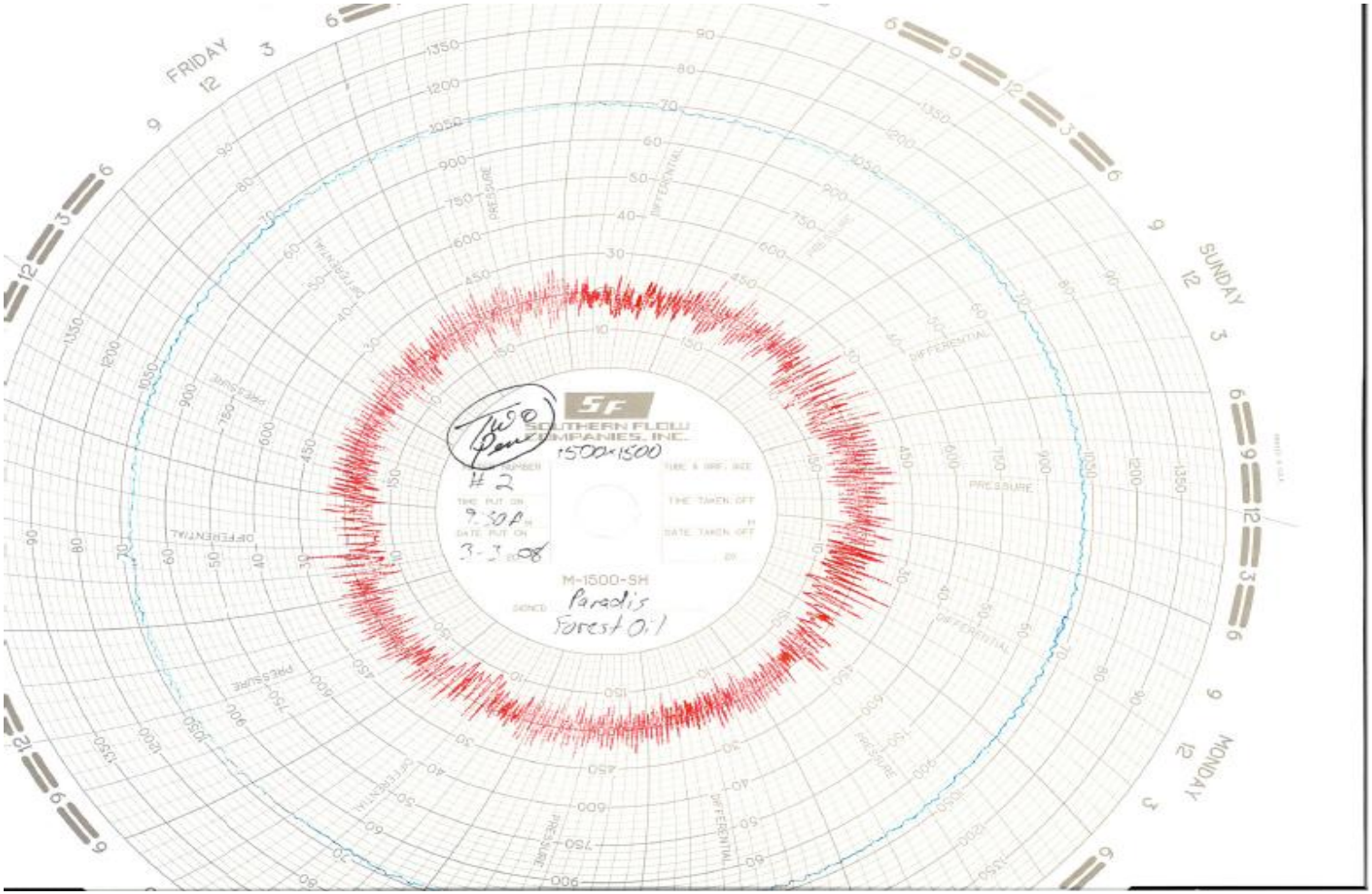
2 Pen Chart: Tbg /Csg



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BHP Info

Perforations / BHP Data:

Sand:	Main Pay
Perforations:	9,982-9,998'
Mid -Pt:	9,990'
BHP:	2,322 psi, 4.5 ppg (meas. 3/99)

Procedure:

1) RU SL. Make 2.125" gauge ring run to 10,000'. Make a 2.125" x 30' dummy run to 10,000'. RD SL.

2) RU EL. Run PNL log from TD @ 10,364' to 8,364' (2000' minimum). RD EL.

3) If possible shut well in and fill tubing/casing with field lease water prior to rig moving on location.

4) Move rig on location.

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WinGlue Analysis

Well Test Properties											
	Timestamp	Test Length	Test Sep. Pressure	Manifold Pressure	Choke Size	Oil Rate	Water Rate	Form Gas Rate	Lift Gas Rate	Production Pressure	Injection Pressure
			psig	*psig*	*64ths*	*bbls/day*	*bbls/day*	*MCF/day*	*MCF/day*	*psig*	*psig*
Calib	03/11/2008 00:00:00	0.0	250	280	0	41.0	242.0	15.0	1,285.0	280	969
Orig					0	41.0	242.0	15.0	1,285.0	250	1,045

Flowline Data					
Segment	Segment Length	Segment Height	Internal Diameter	Roughness	Fluid Temperature
No.	*feet*	*feet*	*inches*	*inches*	*dg.F*

Lift Gas Properties		
Gravity	Surface Temperature	Bottom Temperature
	dg.F	*dg.F*
0.65	75.0	210.0

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ASSUMED

Gas Lift Valve Analysis														
Mnrl No.	Mnrl MD feet	Mnrl TVD feet	Mnrl Dev. degrees	Mnrl Prod Press psig	Mnrl Inj Press psig	Valve Temp dg.F	Close Press psig	Open Press psig	Surf Close Press psig	TRO psig	Est Rate MCF/day	Valve Model	Choke 64ths	Valve Status
1	5,000	5,000	0.00	684	1,095	165.4	1,211	1,211	1,071	1,020	0.0	Weatherford R-1B 3/16 VPC	0	0% open
2	6,150	6,150	0.00	787	1,123	176.8	1,213	1,213	1,046	1,005	0.0	Weatherford R-1B 3/16 VPC	0	0% open
3	7,000	7,000	0.00	864	1,143	185.1	1,214	1,214	1,028	995	0.0	Weatherford R-1B 3/16 VPC	0	0% open
4	7,500	7,500	0.00	911	1,156	190.0	N/A	N/A	N/A	N/A	1,182.0	Orifice	16	Open
5	7,900	7,900	0.00	1,073	1,165	193.2	1,102	1,102	917	910	321.3	Weatherford R-1B 3/16 VPC	0	22% open
6	8,200	8,200	0.00	1,195	1,172	195.6	1,066	1,066	882	900	0.0	Weatherford R-1B 3/16 VPC	0	Back Checked
7	8,500	8,500	0.00	1,319	1,180	198.0	N/A	N/A	N/A	N/A	0.0	Orifice	16	Back Checked

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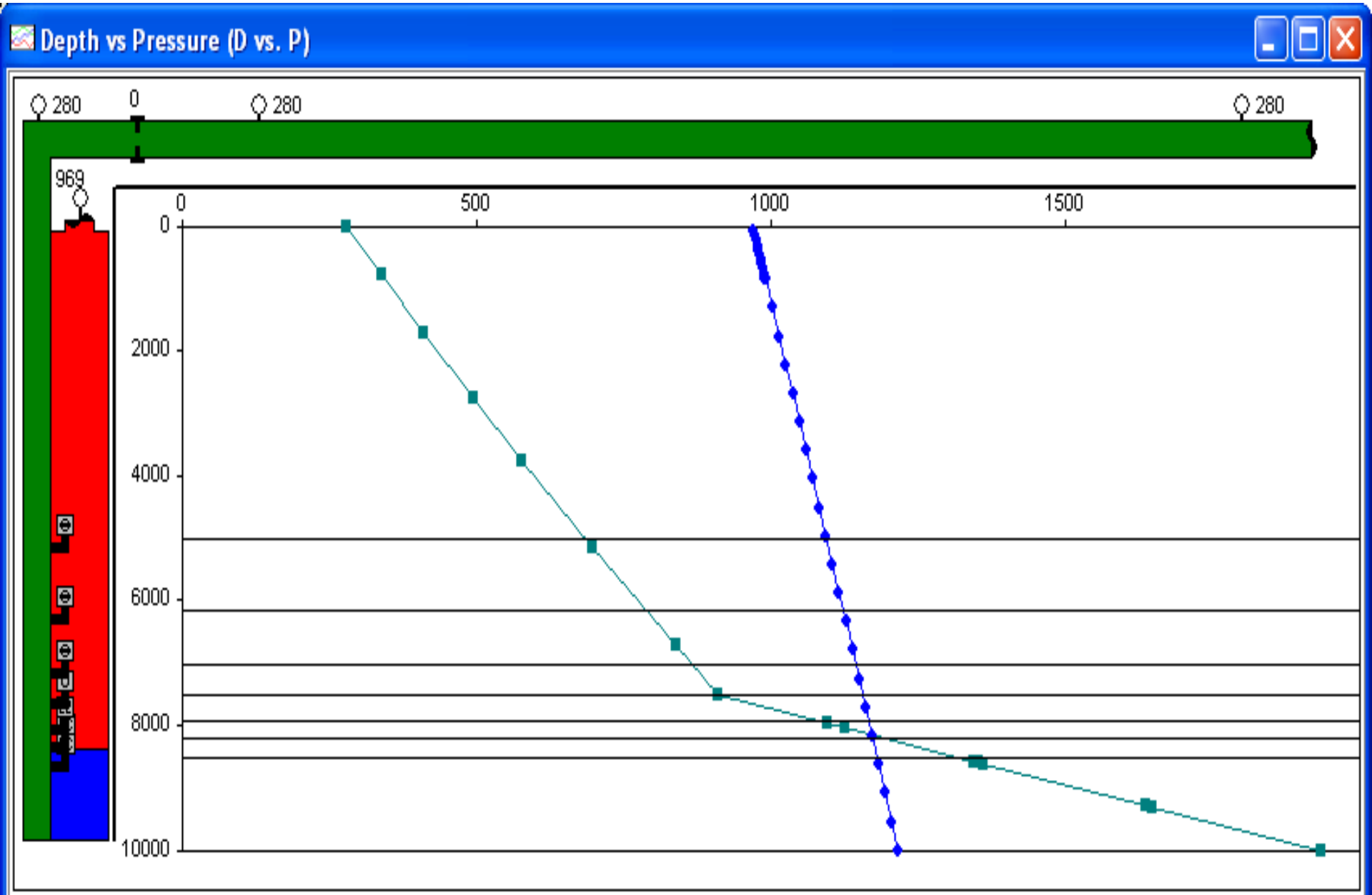
ASSUMED



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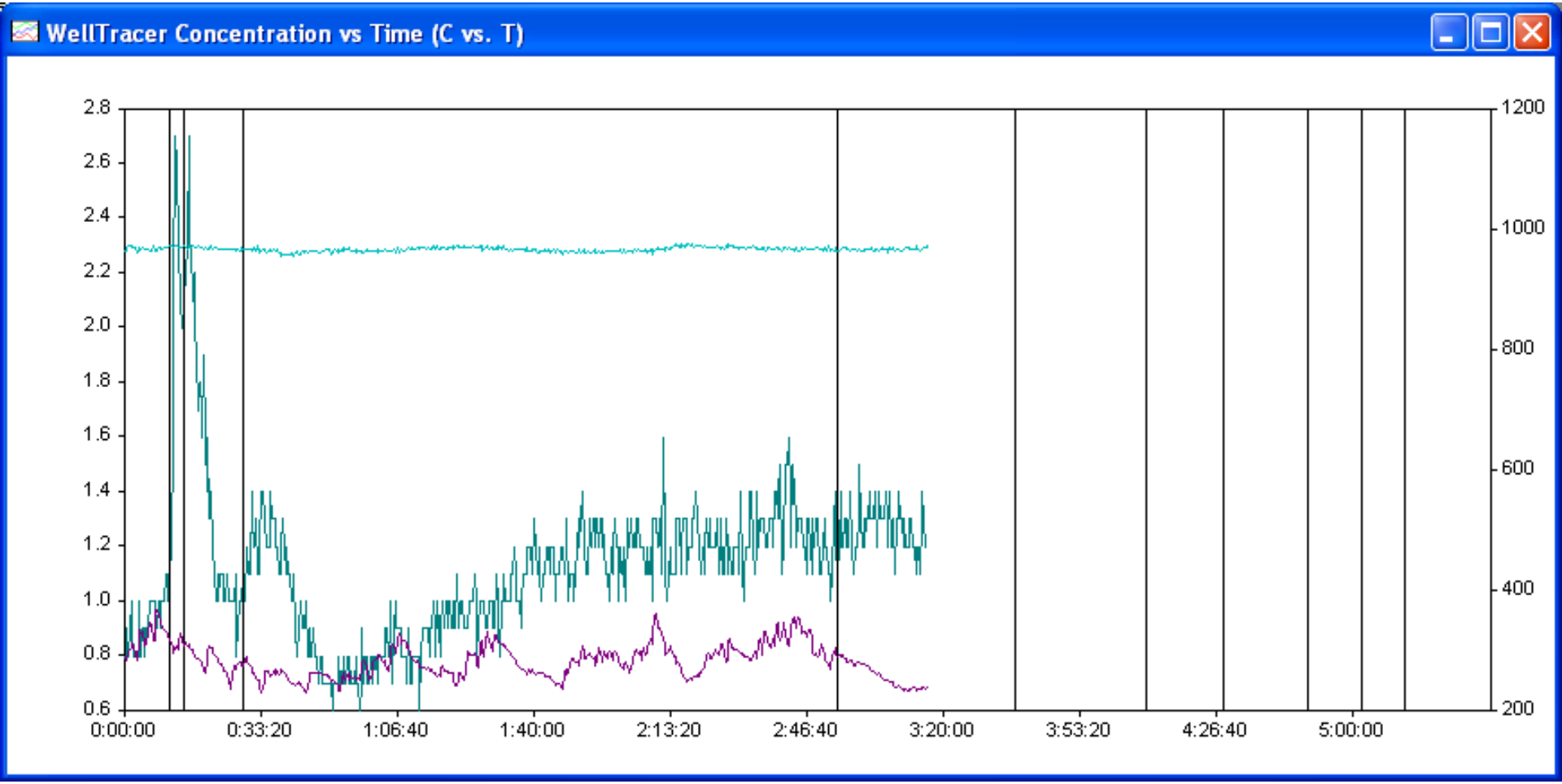
PREDICTED

Time to run WellTracer Survey

WellTracer Travel Predictions									
Well Name	**Mnrl No**	**Measured Depth**	**Vertical Depth**	**Total Travel Time**	**Tubing Travel Time**	**Casing Travel Time**	**Tubing Pressure**	**Casing Pressure**	**Valve Status**
		feet	***feet***	***hh:mm:ss***	***hh:mm:ss***	***hh:mm:ss***	***psig***	***psig***	
2ST	1	5,000	5,000	02:53:17	00:05:01	02:48:16	684	1,095	0% open
2ST	2	6,150	6,150	03:36:39	00:06:43	03:29:56	787	1,123	0% open
2ST	3	7,000	7,000	04:08:31	00:08:02	04:00:29	864	1,143	0% open
2ST	**4**	**7,500**	**7,500**	**04:27:13**	**00:08:50**	**04:18:23**	**911**	**1,156**	**Open**
2ST	5	7,900	7,900	04:48:14	00:15:35	04:32:39	1,073	1,165	22% open
2ST	6	8,200	8,200	05:01:07	00:17:47	04:43:19	1,195	1,172	Back Checked
2ST	7	8,500	8,500	05:11:45	00:17:47	04:53:58	1,319	1,180	Back Checked

ACTUAL SURVEY



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Gas Lift Valve Analysis														
Mnrl	Mnrl MD	Mnrl TVD	Mnrl Dev.	Mnrl Prod Press	Mnrl Inj Press	Valve Temp	Close Press	Open Press	Surf Close Press	TRO	Est Rate	Valve	Choke	Valve Status
No.	*feet*	*feet*	*degrees*	*psig*	*psig*	*dg.F*	*psig*	*psig*	*psig*	*psig*	*MCF/day*	*Model*	*64ths*	
1	750	750	0.00	345	988	122.6	N/A	N/A	N/A	N/A	0.0	Hole In Tubing	0	Open
2	820	820	0.00	351	990	123.3	N/A	N/A	N/A	N/A	0.0	Hole In Tubing	0	Open
3	1,190	1,190	0.00	385	1,000	127.1	N/A	N/A	N/A	N/A	0.0	Hole In Tubing	0	Open
4	5,000	5,000	0.00	790	1,095	165.4	1,211	1,211	1,071	1,020	0.0	Weatherford R-1B 3/16 VPC	0	0% open
5	6,150	6,150	0.00	933	1,123	176.8	1,213	1,213	1,046	1,005	0.0	Weatherford R-1B 3/16 VPC	0	0% open
6	7,000	7,000	0.00	1,048	1,143	185.1	1,214	1,214	1,028	995	0.0	Weatherford R-1B 3/16 VPC	0	0% open
7	7,500	7,500	0.00	1,116	1,156	190.0	N/A	N/A	N/A	N/A	536.0	Orifice	16	Open
8	7,900	7,900	0.00	1,280	1,165	193.2	1,102	1,102	917	910	0.0	Weatherford R-1B 3/16 VPC	0	0% open
9	8,200	8,200	0.00	1,404	1,172	195.6	1,066	1,066	882	900	0.0	Weatherford R-1B 3/16 VPC	0	Back Checked
10	8,500	8,500	0.00	1,528	1,180	198.0	N/A	N/A	N/A	N/A	0.0	Orifice	16	Back Checked

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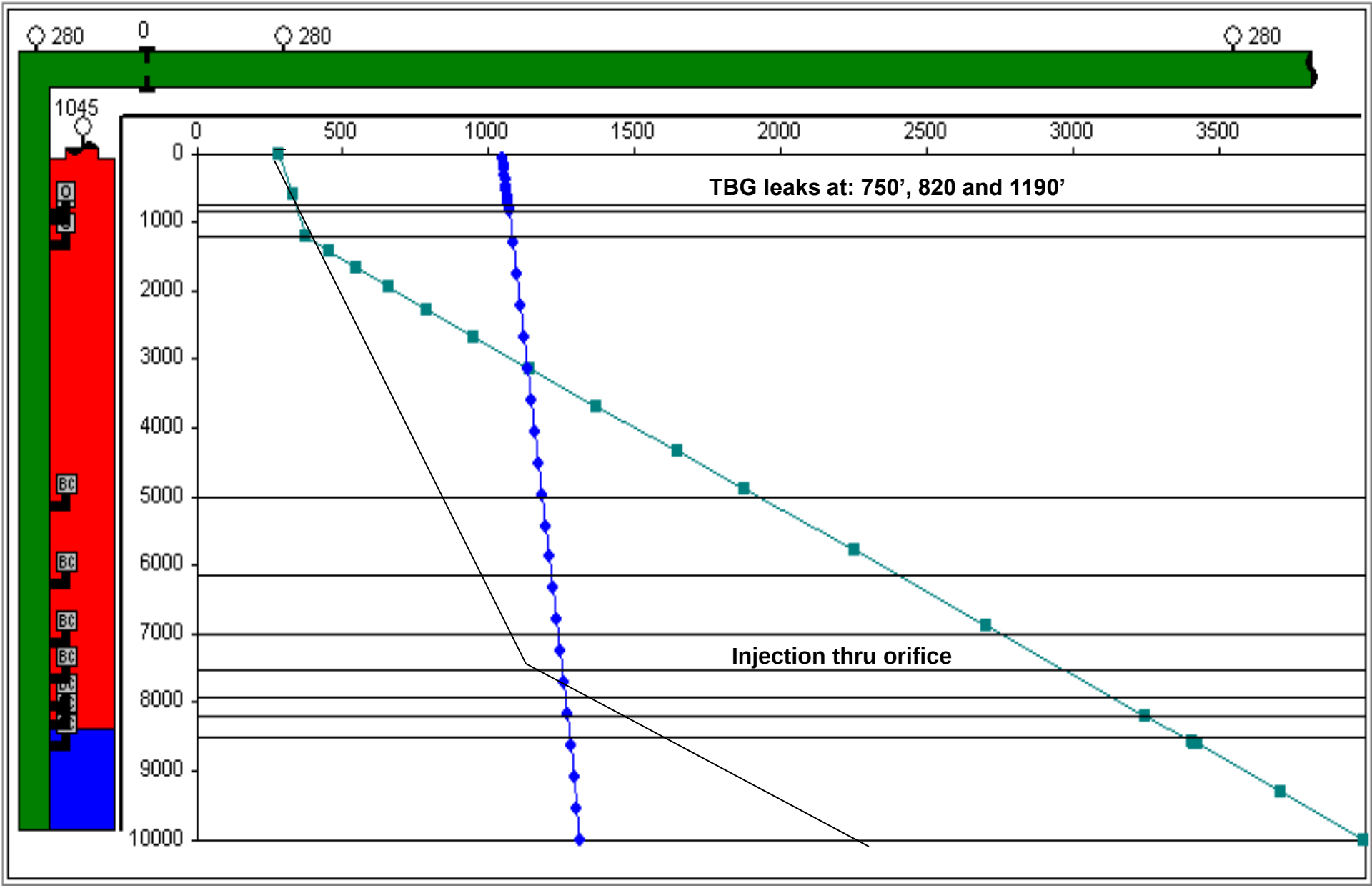
ACTUAL



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WellTracer Evaluation	
Remarks	**Recommendations**
9:00 Arrived at well site. Discussed hook up and summarized objectives. Shot echometer to determine casing fluid level. Fluid level @ 7700' approx. Began survey at 3:22 PM. Based on initial prediction, survey concluded at 6:42 PM.	Repair or replace tbg. Pull and replace live valves. Pull orifice from 7500', run live valve. Run orifice at 8200'. Pulling orifice from 8500' and replacing with dummy is optional.

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- **From:** Ted Andrus [TSAndrus@forestoil.com]
  Sent: Thursday, October 09, 2008 6:13 PM
  To: Robinson, Jerry
  Cc: John Zellitti; Ben Kelly
  Subject: FW: MRP #2 ST Evening Report 10/8/2008
  Jerry
-
- Good news. The holes identified in the WellTracer report, 750, 820 and 1,190' correspond almost exactly to what we found! Should help on presenting a case history.
-
- Thanks
-
- Ted
-
-
- -----Original Message-----
  From: thomas182667@bellsouth.net [mailto:thomas182667@bellsouth.net]
  Sent: Thursday, October 09, 2008 5:06 PM
  To: Ted Andrus
  Subject: RE: MRP #2 ST Evening Report 10/8/2008

- 750' +/-, 780', 820', and 1190' according to the number of joints we had layed out and I simply used an average length of 31 ft.
- --
  Mark Thomas/EPI
  185 Grand Rue de Josh
  Opelousas, La. 70570
  (c)985-209-1198
  thomas182667@bellsouth.net

WellTracer

Robinson, Jerry

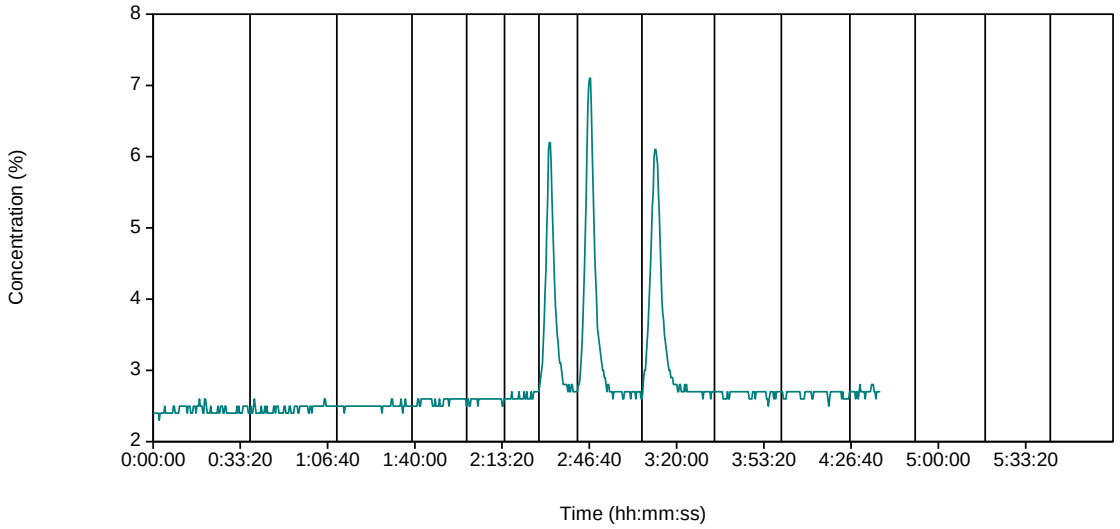
From: Ted Andrus [TSAndrus@forestoil.com]
Sent: Thursday, October 23, 2008 2:25 PM
To: Robinson, Jerry
Subject: FW: Scanned image from MX-6200N

Attachments: Calcium@ForestOilScanner.com_20081023_131744.pdf

Calcium@ForestOilScanner.com_2...

Attached is a plot for the MRP #2. The plot does not have the recent well production after upgrading GL installation. However the last test was 142 BOPD, 500 BWPD, 20 MCFD, 64/64 choke, 210 FTP, 1170 psi csg, 556 Mcfd injection. I will send a chart next week with the updated production.

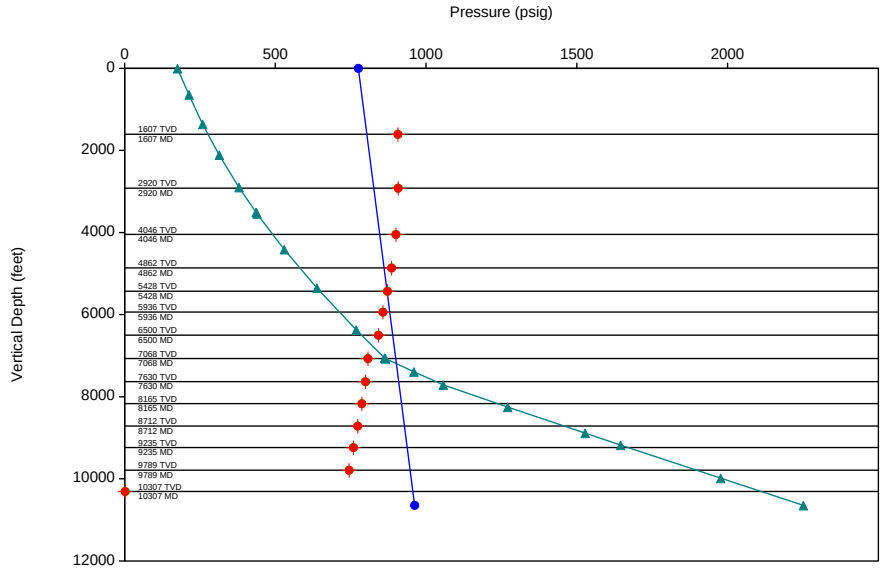
WellTracer Survey



Concentration Vs. Time Well: [WFT] CONOCO,MG,1-10,1 01-Aug-2009 11:45:33

Total Transit 1 (1607 MD - Macco R-1D 3/	Total Transit 6 (5936 MD - Macco R-1D 3/	Total Transit 11 (8712 M
Total Transit 2 (2920 MD - Macco R-1D 3/	Total Transit 7 (6500 MD - Macco R-1D 3/	Total Transit 12 (9235 M
Total Transit 3 (4046 MD - Macco R-1D 3/	Total Transit 8 (7068 MD - Macco R-1D 3/	Total Transit 13 (9789 M
Total Transit 4 (4862 MD - Macco R-1D 3/	Total Transit 9 (7630 MD - Macco R-1D 3/	Total Transit 14 (10307
Total Transit 5 (5428 MD - Macco R-1D 3/	Total Transit 10 (8165 MD - McMurry C-1	Raw CO2 Concentratior

WellTracer VPC



Well Test Date: 26-Jun-2009 00:00:00			
LIQUIDS (bbls/day)		**GAS (MCF/day)**	
Oil	1.0	Form	70.0
Water	85.0	Inj.	314.0
Total	86.0	Total	384.0
Pressure(psig)		**G/L Ratio (scf/bbl)**	
THP	175	Form GOR	70,000
CHP	775	Total GLR	4,465
Perf Depth	10,640	Tubing	
Water Cut	99	Casing	
		Choke	0
Evaluation			
Pressures (psig)			
SBHP	3,500	Inj. Depth	7,068
FBHP	2,414	PI	0.079
Draw dow n	1,086		

Depth Vs. Pressure Well: [WFT] CONOCO,MG,1-10,1 01-Aug-2009 11:45:33

- Mandrel 1 (UIPO/0% open)
- Mandrel 2 (UIPO/0% open)
- Mandrel 3 (UIPO/0% open)
- Mandrel 4 (UIPO/0% open)
- Mandrel 5 (UIPO/0% open)
- Mandrel 6 (UIPO/0% open)
- Mandrel 7 (UIPO/0% open)
- Mandrel 8 (UIPO/0% open)
- Mandrel 9 (UIPO/Back Checked)
- Mandrel 10 (UIPO/Back Checked)
- Mandrel 11 (UIPO/Back Checked)
- Mandrel 12 (UIPO/Back Checked)
- Mandrel 13 (UIPO/Back Checked)
- Mandrel 14 (Orifice/Back Checked)
- Production Pressure Model
- Injection Pressure Model
- Opening Points
- Closing Points

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WellTracer Return Data											
#	Return Time	Return Duration	Return Elapsed	Calc Trav Time	Casing Trav Time	Tubing Trav Time	Total Gas Vel	Mand MD	Calcd Inj MD	Pct Error	Man No.
		hh:mm:ss	*hh:mm:ss*	*hh:mm:ss*	*hh:mm:ss*	*hh:mm:ss*	*feet/sec*	*feet*	*feet*	*%*	
1	06/26/2009 11:45:35	00:11:07	02:28:17	02:28:22	02:18:00	00:10:22	1.33369	5,936	5,933	0.05%	6
2	06/26/2009 12:00:15	00:11:26	02:42:57	02:42:59	02:31:07	00:11:52	1.32934	6,500	6,499	0.02%	7
3	06/26/2009 12:25:20	00:13:24	03:08:02	03:07:38	02:54:08	00:13:30	1.25563	7,068	7,083	0.21%	8

WellTracer Predicted Travel

WellTracer Gas Lift Valve Analysis								
Man	Mandrel MD	Mandrel TVD	Total Travel Time	Casing Travel Time	Tubing Travel Time	Total Gas Velocity	Casing Gas Velocity	Tubing Gas Velocity
No.	*feet*	*feet*	*hh:mm:ss*	*hh:mm:ss*	*hh:mm:ss*	*feet/sec*	*feet/sec*	*feet/sec*
1	1,607	1,607	00:37:57	00:36:05	00:01:52	1.41148	0.74212	14.39655
2	2,920	2,920	01:11:10	01:07:20	00:03:50	1.36769	0.72277	12.69866
3	4,046	4,046	01:39:49	01:33:54	00:05:56	1.35105	0.71820	11.36827
4	4,862	4,862	02:00:42	01:53:00	00:07:42	1.34263	0.71707	10.52040
5	5,428	5,428	02:15:14	02:06:12	00:09:02	1.33800	0.71686	10.02082
6	5,936	5,936	02:28:22	02:18:00	00:10:22	1.33369	0.71693	9.54469
7	6,500	6,500	02:42:59	02:31:07	00:11:52	1.32934	0.71690	9.12329
8	7,068	7,068	03:07:38	02:54:08	00:13:30	1.25563	0.67646	8.72958
9	7,630	7,630	03:35:23	03:16:55	00:18:27	1.18088	0.64578	6.89018
10	8,165	8,165	04:00:57	03:34:20	00:26:37	1.12959	0.63493	5.11300
11	8,712	8,712	04:27:04	03:51:21	00:35:43	1.08734	0.62762	4.06466
12	9,235	9,235	04:52:06	04:07:34	00:44:33	1.05383	0.62172	3.45541
13	9,789	9,789	05:18:46	04:24:40	00:54:05	1.02364	0.61642	3.01629
14	10,307	10,307	05:43:42	04:40:37	01:03:05	0.99961	0.61218	2.72276

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WellTracer Valve Analysis

Gas Lift Valve Analysis														
Mnrl No.	Mnrl MD feet	Mnrl TVD feet	Mnrl Dev. degrees	Mnrl Prod Press psig	Mnrl Inj Press psig	Valve Temp dg.F	Close Press psig	Open Press psig	Surf Close Press psig	TRO psig	Est Rate MCF/day	Valve Model	Choke 64ths	Valve Status
1	1,607	1,607	0.00	276	795	133.6	906	906	873	795	0.0	Macco R-1D 3/16 VPC	0	0% open
2	2,920	2,920	0.00	378	817	150.7	907	907	849	775	0.0	Macco R-1D 3/16 VPC	0	0% open
3	4,046	4,046	0.00	487	836	164.9	899	899	822	755	0.0	Macco R-1D 3/16 VPC	0	0% open
4	4,862	4,862	0.00	576	849	175.0	885	885	795	735	0.0	Macco R-1D 3/16 VPC	0	0% open
5	5,428	5,428	0.00	641	859	181.8	872	872	775	720	0.0	Macco R-1D 3/16 VPC	0	0% open
6	5,936	5,936	0.00	705	867	187.9	858	858	755	705	27.9	Macco R-1D 3/16 VPC	0	5% open
7	6,500	6,500	0.00	777	877	194.5	842	842	731	690	78.9	Macco R-1D 3/16 VPC	0	18% open
8	7,068	7,068	0.00	854	886	201.0	806	806	692	675	91.6	Macco R-1D 3/16 VPC	0	31% open
9	7,630	7,630	0.00	1,021	895	208.7	799	799	679	660	0.0	Macco R-1D 3/16 VPC	0	Back Checked
10	8,165	8,165	0.00	1,226	904	216.1	786	786	661	695	0.0	McMurry C-1 1/4 VPC	0	Back Checked
11	8,712	8,712	0.00	1,445	913	223.6	773	773	644	675	0.0	McMurry C-1 1/4 VPC	0	Back Checked
12	9,235	9,235	0.00	1,658	921	230.7	758	758	626	655	0.0	McMurry C-1 1/4 VPC	0	Back Checked
13	9,789	9,789	0.00	1,886	930	238.3	744	744	608	635	0.0	McMurry C-1 1/4 VPC	0	Back Checked
14	10,307	10,307	0.00	2,100	939	245.4	N/A	N/A	N/A	N/A	0.0	Orifice	20	Back Checked

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- Every gas lift well should have a WellTracer survey run at least once a year to verify gas lift efficiency. A consistent surveillance program can insure that all gas lift wells are lifting as efficiently as possible and production is maximum.


H.P
L.P
0.6 S
WT
ON
DATA LOGGER
OFF
L.P ADJ
H.P ADJ
W.H.
CO²
L.P REG
L.P S—O
H.P INPUT
H.P OUTPUT
L.P OUTPUT

Figure 4

Note: After all hose connections are made, slowly bring on pressure to Tracer Kit equipment through valves BV201 & BV601 and check all connections for leaks. If a leak is detected

WellTracer Land Unit

WellTracer

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Houston, Texas
USA

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