

Drilling the Middle Bakken

Kelly Olds
Whiting Petroleum Corporation

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- Went Public in Nov 2003
- Market Cap \$1.8 B
- Proved Reserves 250.8 MMBOE
- Production 9/08 51.7 mboe/d

Map of Operations

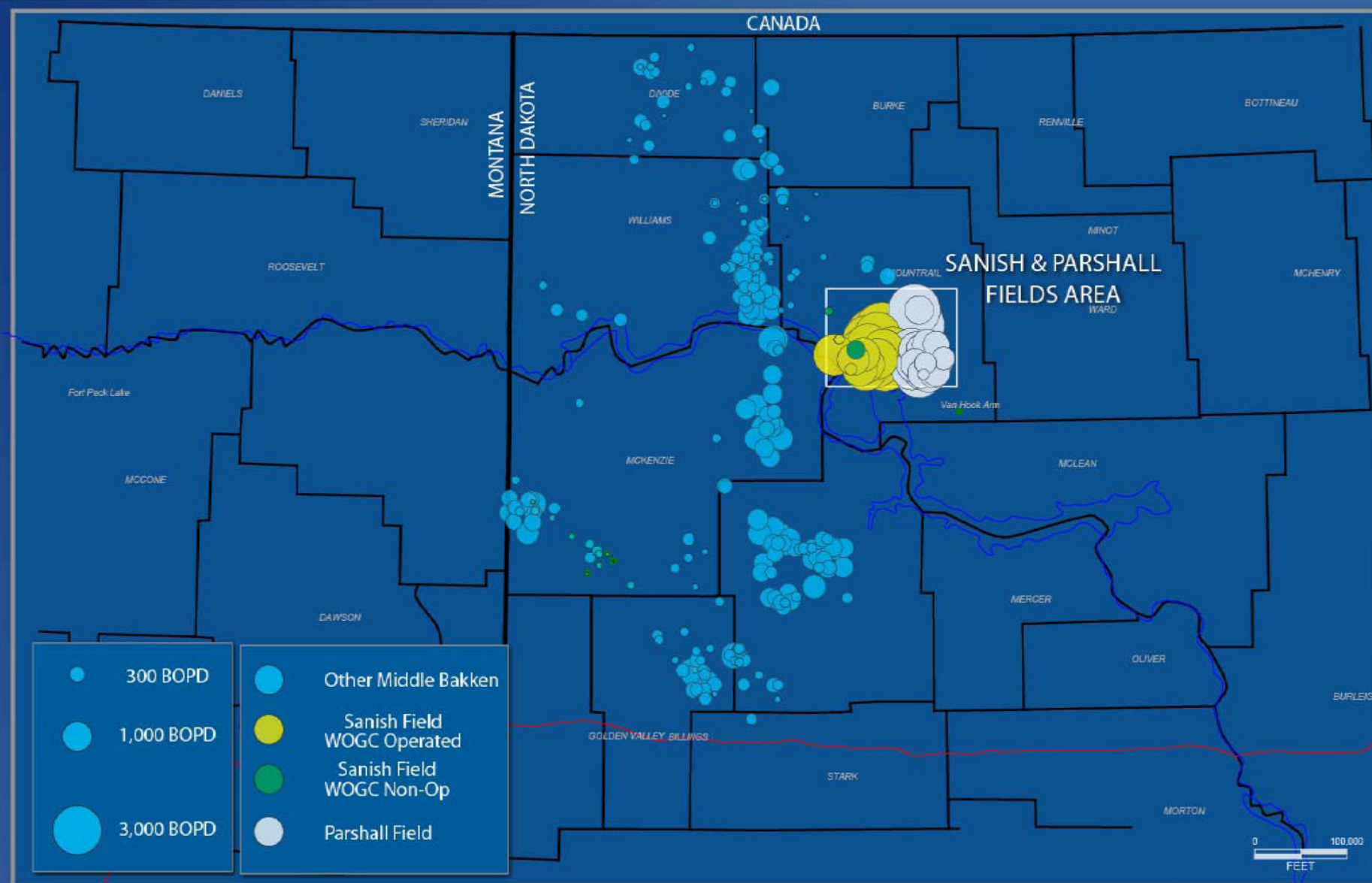


Reported Initial Oil Rate

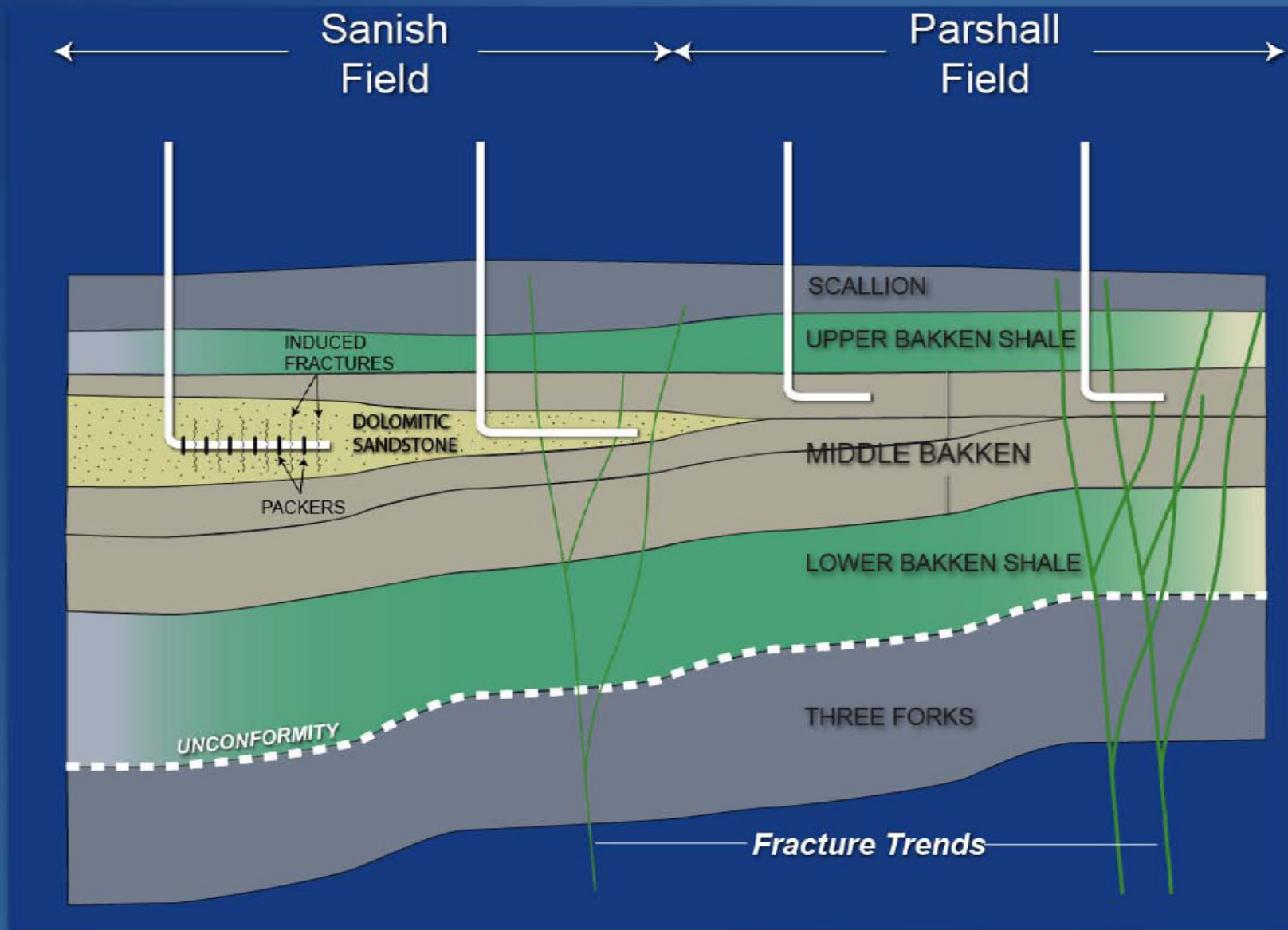
North Dakota Middle Bakken Horizontal Wells since 2000

North Dakota Industrial Commission

October, 2008

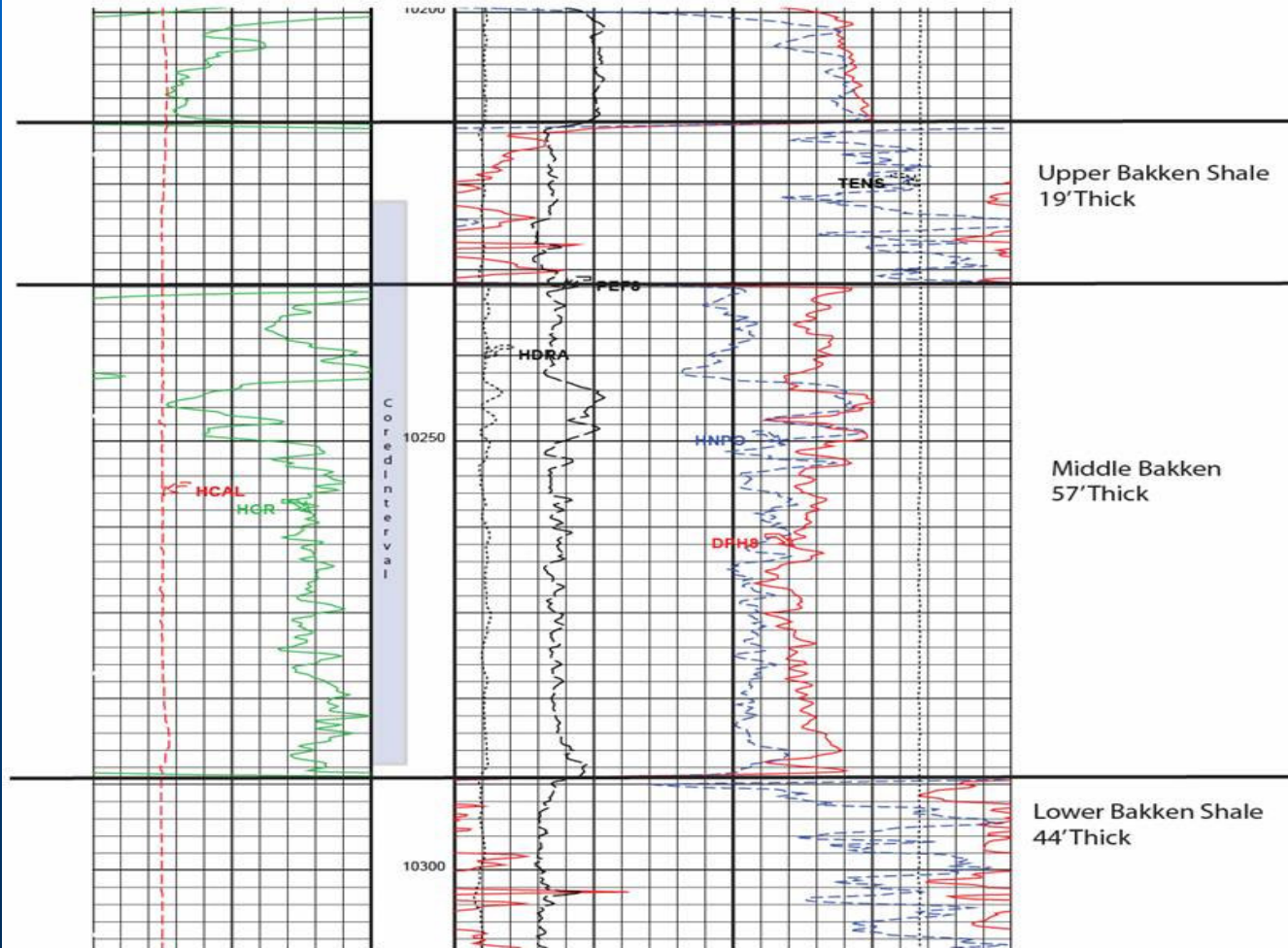


BAKKEN CROSS-SECTION



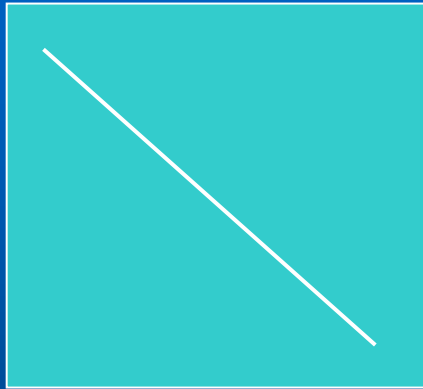
Bakken Interval

Bartleson 44-1H Pilot Hole High Resolution Porosity Log
SE SE 1-T152N-R93W
Mountrail Co., North Dakota

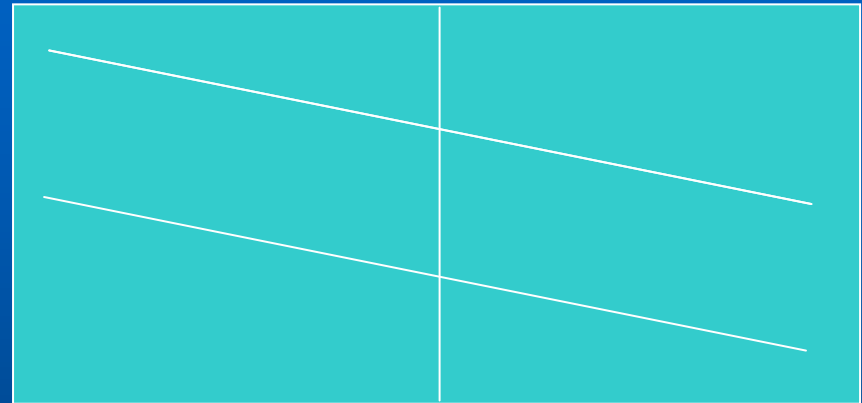


Well Configuration?

640 acres

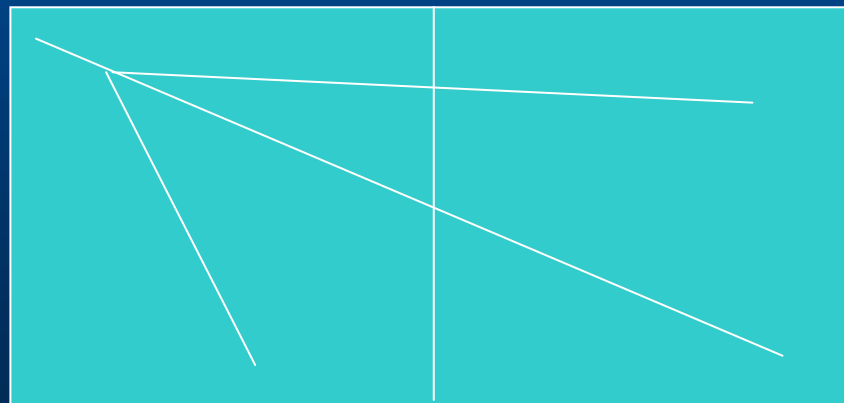


1280 acres



Or

Or



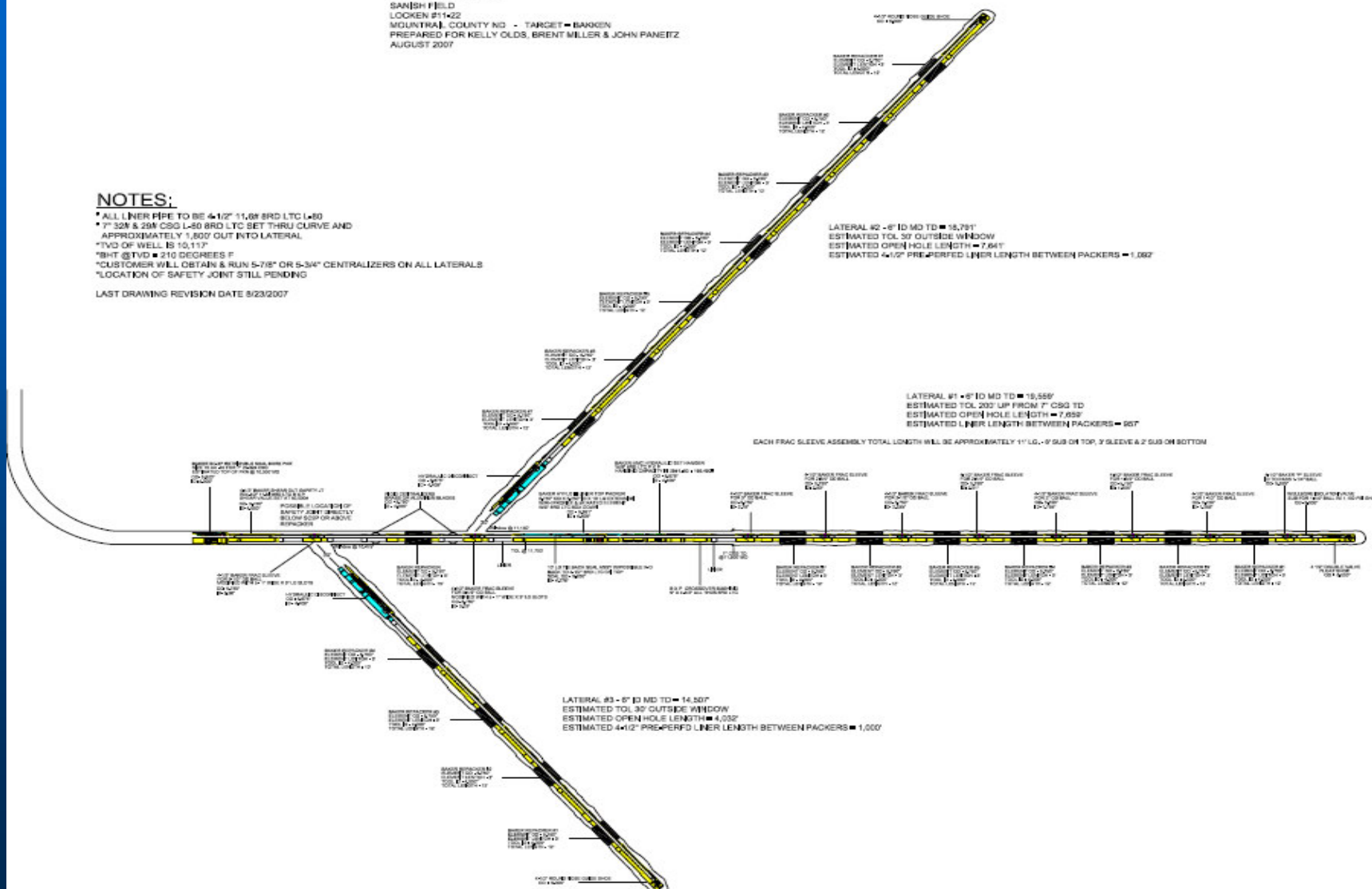
Original Tri-lateral Design

ROBINSON LAKE AREA
SANDHILL FIELD
LOOKEN #11-22
MOUNTRAIL COUNTY NO. - TARGET - BAKKEN
PREPARED FOR KELLY OLDS, BRENT MILLER & JOHN PANETIZ
AUGUST 2007

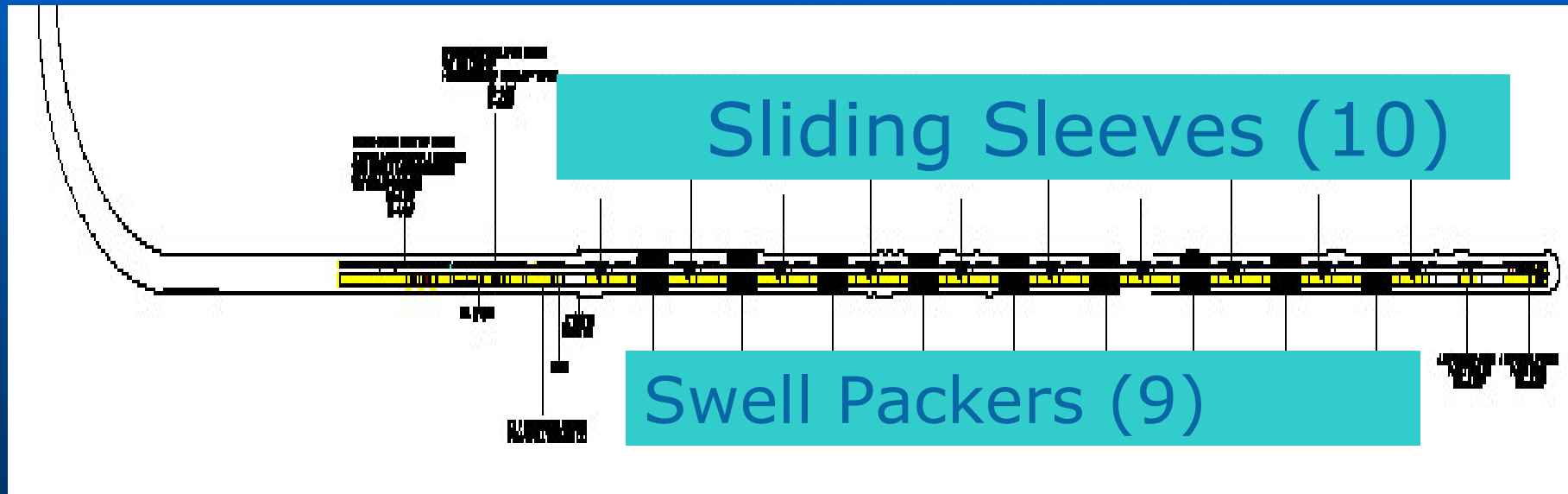
NOTES:

- ALL LINER PIPE TO BE 4-1/2" 11.6R BRD LTC L-80
- 7" 32M & 28M CSG L-80 BRD LTC SET THRU CURVE AND APPROXIMATELY 1,600' OUT INTO LATERAL
- TVD OF WELL IS 10,117'
- BHT @ TVD = 210 DEGREES F
- CUSTOMER WILL OBTAIN & RUN 5-7/8" OR 5-3/4" CENTRALIZERS ON ALL LATERALS
- LOCATION OF SAFETY JOINT STILL PENDING

LAST DRAWING REVISION DATE 8/23/2007

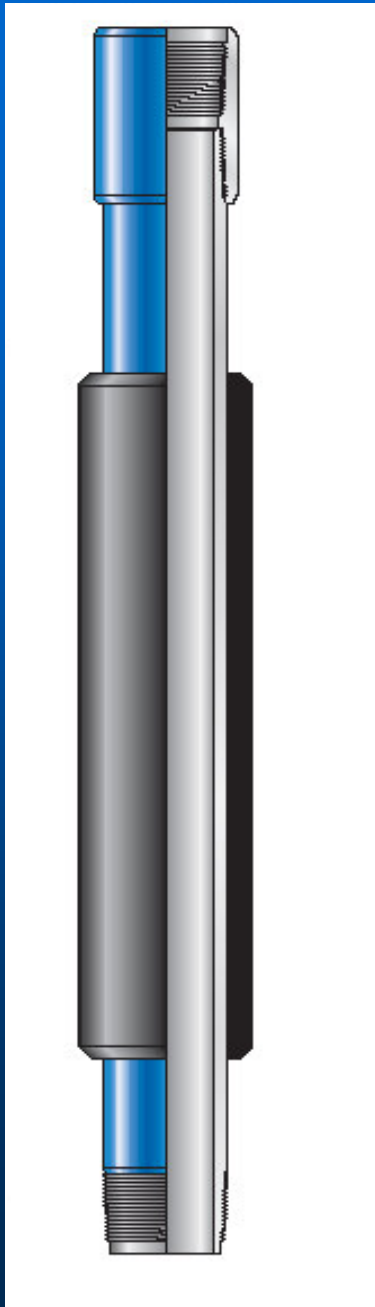


Single-leg Horizontal



Components of System

- Oil Swelling open-hole packers
 - 3'x5.75" tools in 6.00" hole
- Sliding Sleeves (ball actuated)
 - Slotted frac ports
 - Spaced 900' apart
- Double Float-shoe and Float collar
 - For wellbore isolation
 - Could use P-sleeve
- Liner hanger/packer



Oil-Swelling, Open-hole Packer

3'x 5.75" element

Swell Packer Predictor

REPackTM Swell Predictor

Job Details

Customer	
Well Name	
Geomarket Location	
Date	

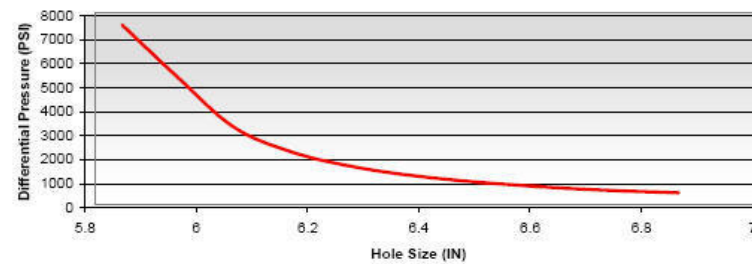
Well Data Input

	Value	Units
Well MD		mts
Well TVD		mts
Run-in Drift		in
Max Deviation		Degrees
Max Dog-Leg Severity		Deg/100ft
Setting Depth		mts
Setting Depth Deviation		Degrees
Setting Depth Hole Size	6	in
Open Hole / Cased	Open	
Wellbore Fluid		
Specific Gravity		API
Salinity		%
Viscosity		cP
Run-in Time to Setting Depth		Hrs
BHT (Setting Conditions)	220	F
BHT (Flowing Conditions)		F
BHP (Static)		psi
BHP (Flowing)		psi
Additional Comments (Mineral Presence, Wellbore Stability, Gauged Hole, etc,...)		

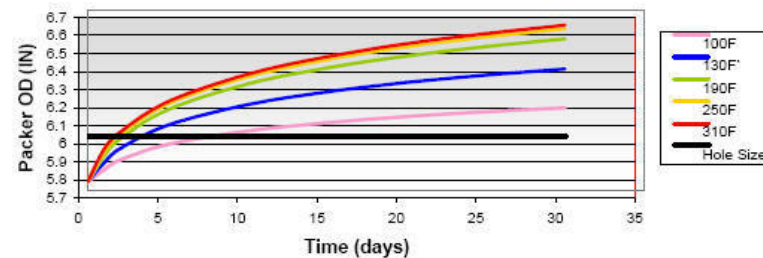
Packer Description

	Value	Units
Mandrel Size	4.5	in
Element OD	5.75	in
Element Length	3	ft
Packer Style	Mandrel Wrapped	
Activation Fluid	Oil	

Differential Pressure vs. Hole Size



Swell Rate vs. Time (Per BHT)



Output Calculations

% Swell	22.9%
Pressure Differential	4072 PSI
Time to Swell (Est.)	2.3 days

Baker Oil Tools Representative



Typical Bakken Frac Design

“Hybrid” Frac design

1.8 Million lbs proppant

600,000 lbs 100 mesh

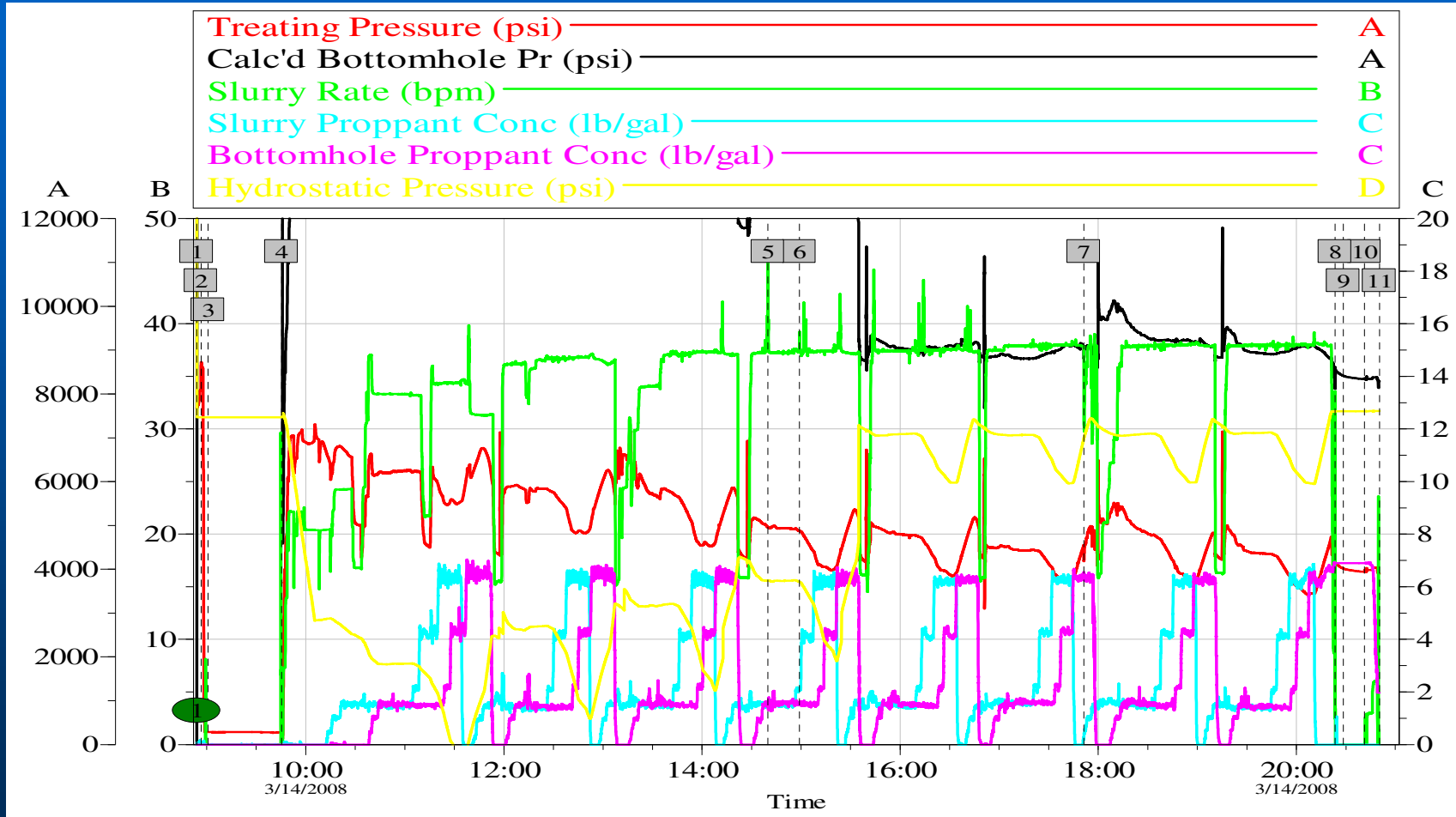
1,200,000 lbs 20/40 sand

18,000 barrels fluid

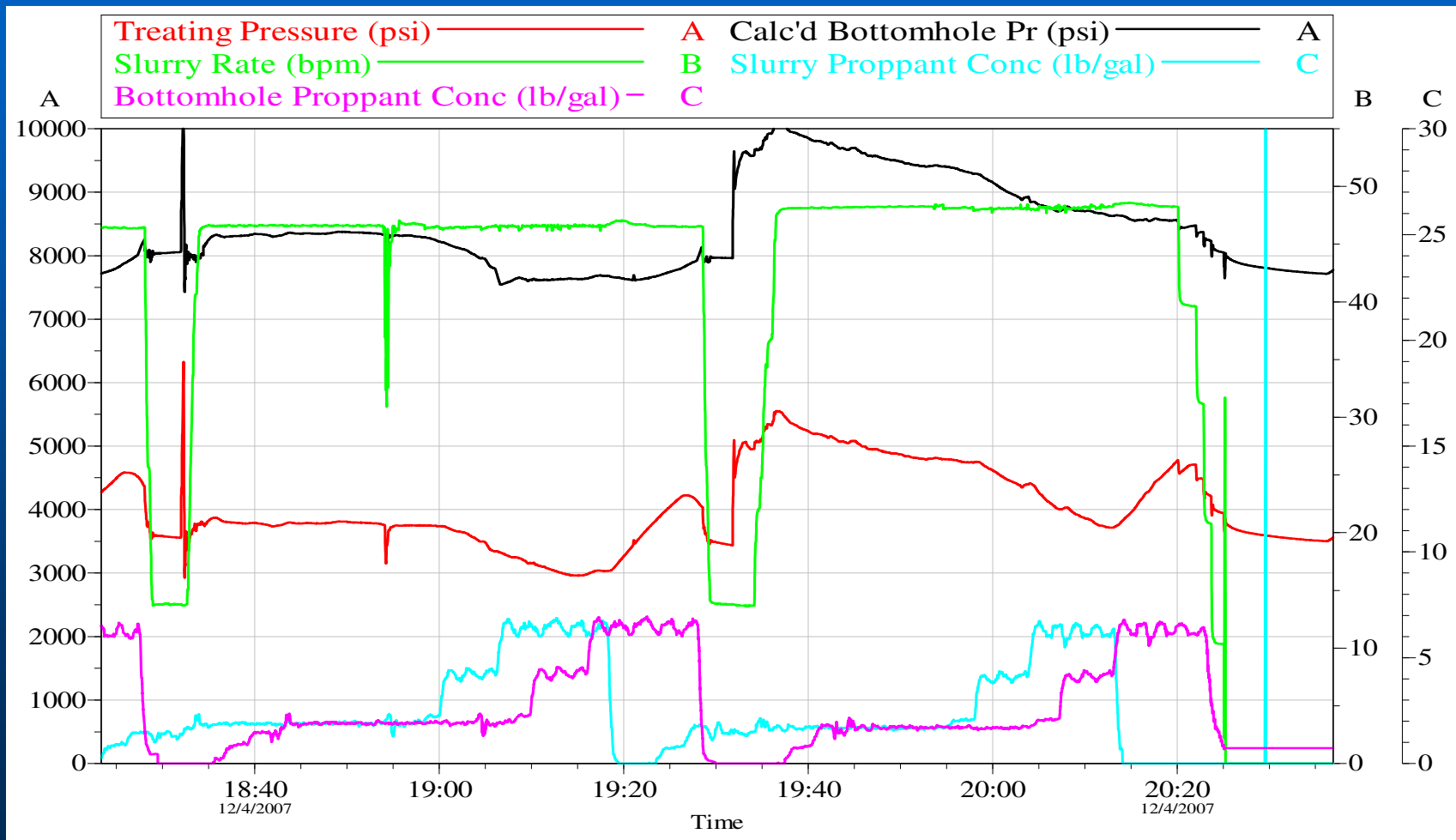
30-40 BPM

Continuous 10-12 hrs. pumping

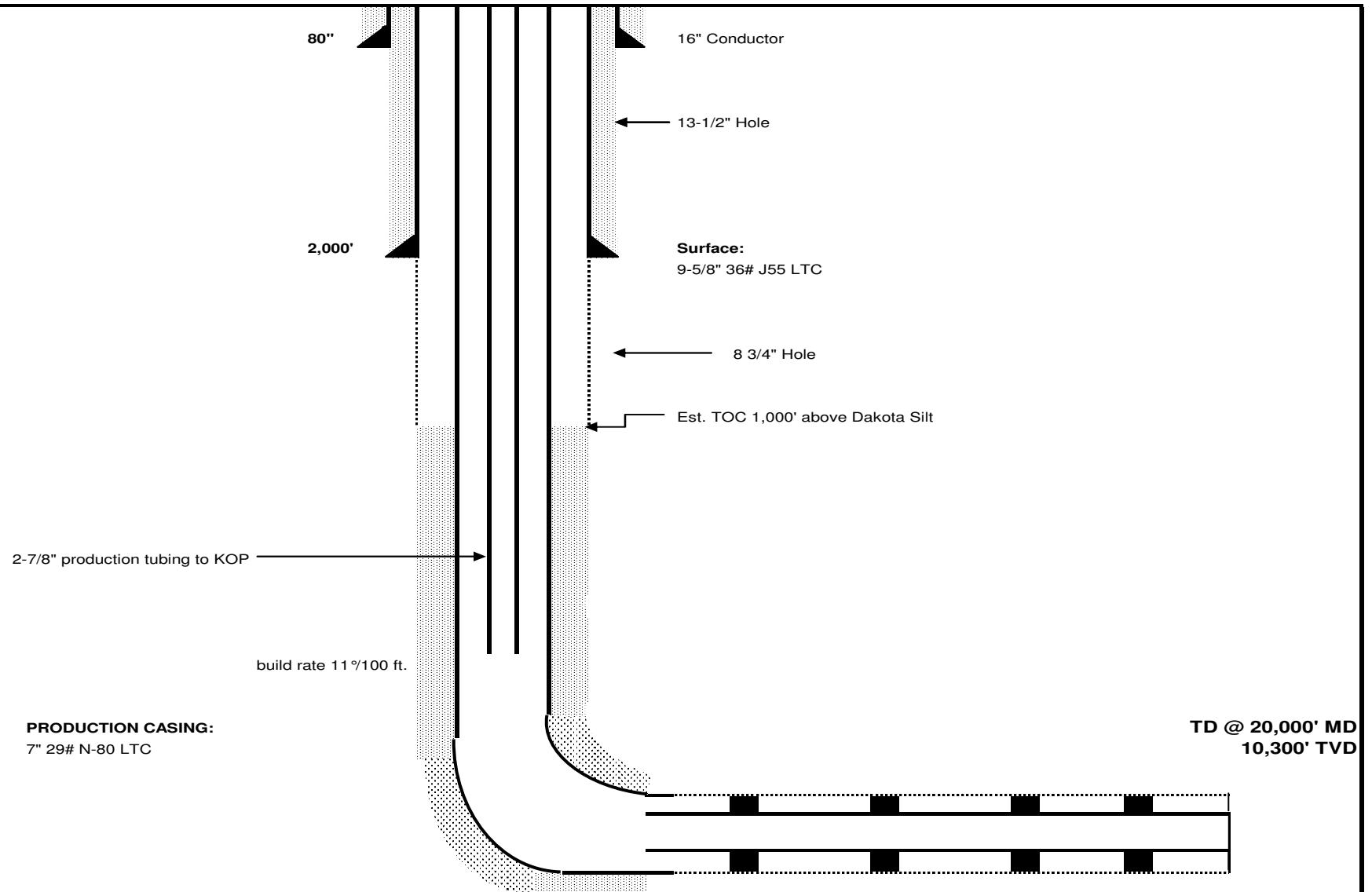
8 stage frac



Two Frac stages with varying treating Pressures



Wellbore Diagram



Surface Hole



- 13½" hole - 50' into Pierre Shale ±2,000'
- 9-5/8" 36# J-55 STC
- Problems
 - Lost Returns
 - Drill blind if possible
 - Cement if needed

Vertical Section



- OBM in 8³/₄" hole
- MW 9.6 to 9.8
- Unmanned MWD for surveys
- Dakota Silt
- Salts
 - Dunham, Pine, Opeche, Charles
- Nitrogen kicks - Minnekahta
- Lost Circ – Mission Canyon
- H₂S – (Bakken is Sweet)

Directional Plan

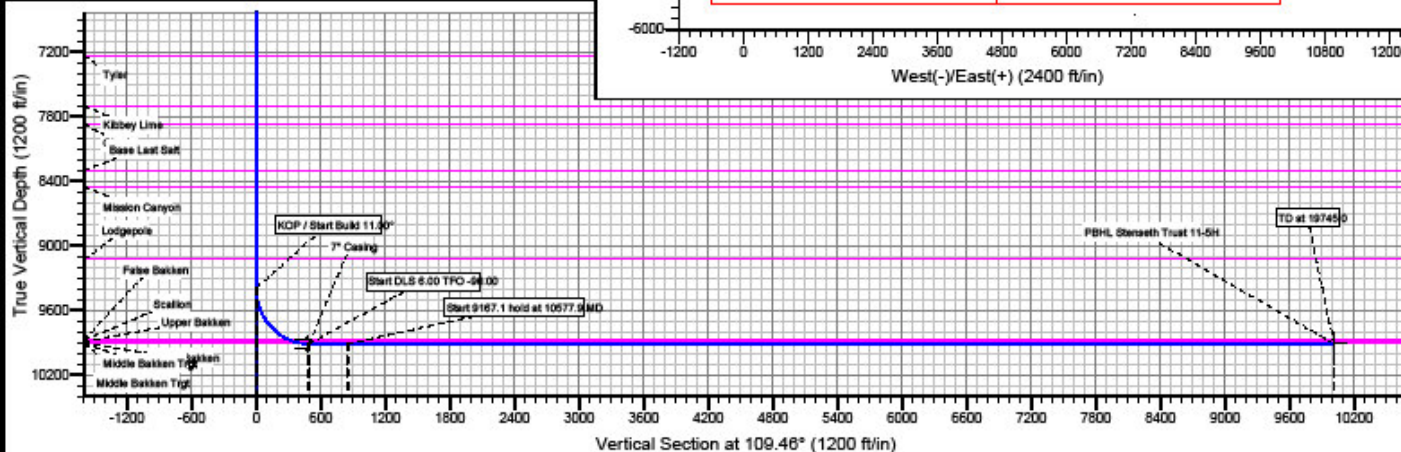
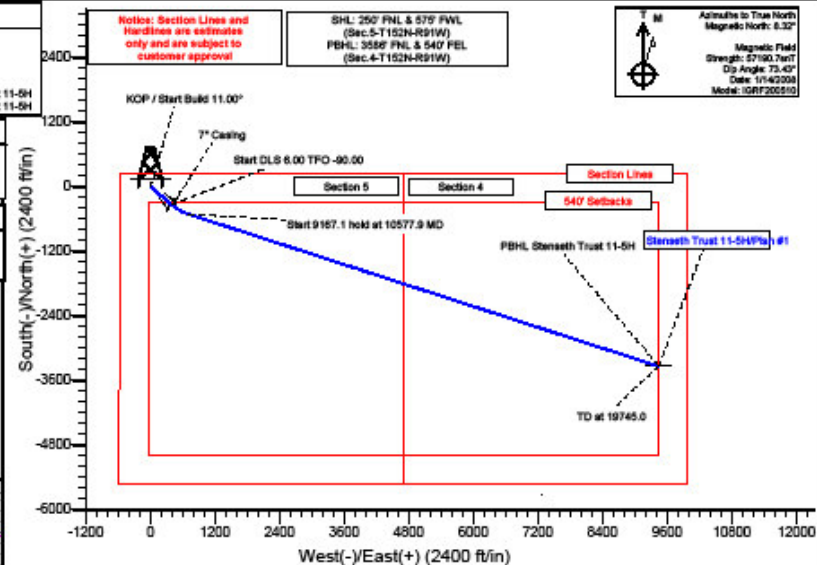


Company: Whiting Oil & Gas
Field: Mountrail Co., ND
Location: Sec.5-T152N-R91W
Well: Stenseth Trust 11-5H
Wellbore #1

Plan: Plan #1 (Stenseth Trust 11-5H/Wellbore #1)



SECTION DETAILS									
Sec	MD	Inc	Azi	TVD	+N-S	+E-W	DLeg	TPlace	VSec Target
1	0.0	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.0
2	9392.1	0.00	0.00	9392.1	0.0	0.0	0.00	0.00	0.0
3	10210.3	90.00	130.00	9913.0	-334.8	399.0	11.00	130.00	497.8
4	10577.9	90.00	107.94	9913.0	-511.3	718.5	6.00	-90.00	848.1 PBHL Stenseth Trust 11-5H
5	19745.0	90.00	107.94	9913.0	-3338.0	9439.8	0.00	0.00	10512.0 PBHL Stenseth Trust 11-5H
WELL DETAILS: Stenseth Trust 11-5H									
Ground Level: 2104.0									
+N-S	+E-W	North	East	Latitude	Longitude	Skid			
0.0	0.0	115398.27	461052.64	48° 1' 20.880 N	102° 21' 45.500 W				
WELLBORE TARGET DETAILS									
Name	TVD	+N-S	+E-W	Shape					
PBHL Stenseth Trust 11-5H	9913.0	-3338.0	9439.8	Point					
ANNOTATIONS									
TVD	MD	Annotation							
9392.1	9392.1	KOP / Start Build 11.00°							
9913.0	10210.3	Start DLS 6.00 TFO -90.00							
9913.0	10577.9	Start 9167.1 hold at 10577.9 MD							
9913.0	19745.0	TD at 19745.0							
CASING DETAILS									
TVD	MD	Name	Size						
9913.0	10210.3	7" Casing	7.000						



Build Section



- 11° /100' build rate
- 2.38° fixed motor
- PDC bit
- Raise MW to 10.1+
- Casing Point must cross hard line

7" Casing



- 7" 29# L-80 LTC
- 7" 32# HCL-80 LTC
 - 200' above & below salts
- Top of Tail cement – 500' above salt
- Top of lead cement – 1,000' above Dakota

Why Underbalanced Drilling?



- Not an issue until you hit a fracture
- Pore Pressure
 - West Side ± 12.5 lb/gal
 - East Side ± 14.0 lb/gal
- Ballooning?
 - Lost circ vs Flow

Underbalanced Drilling

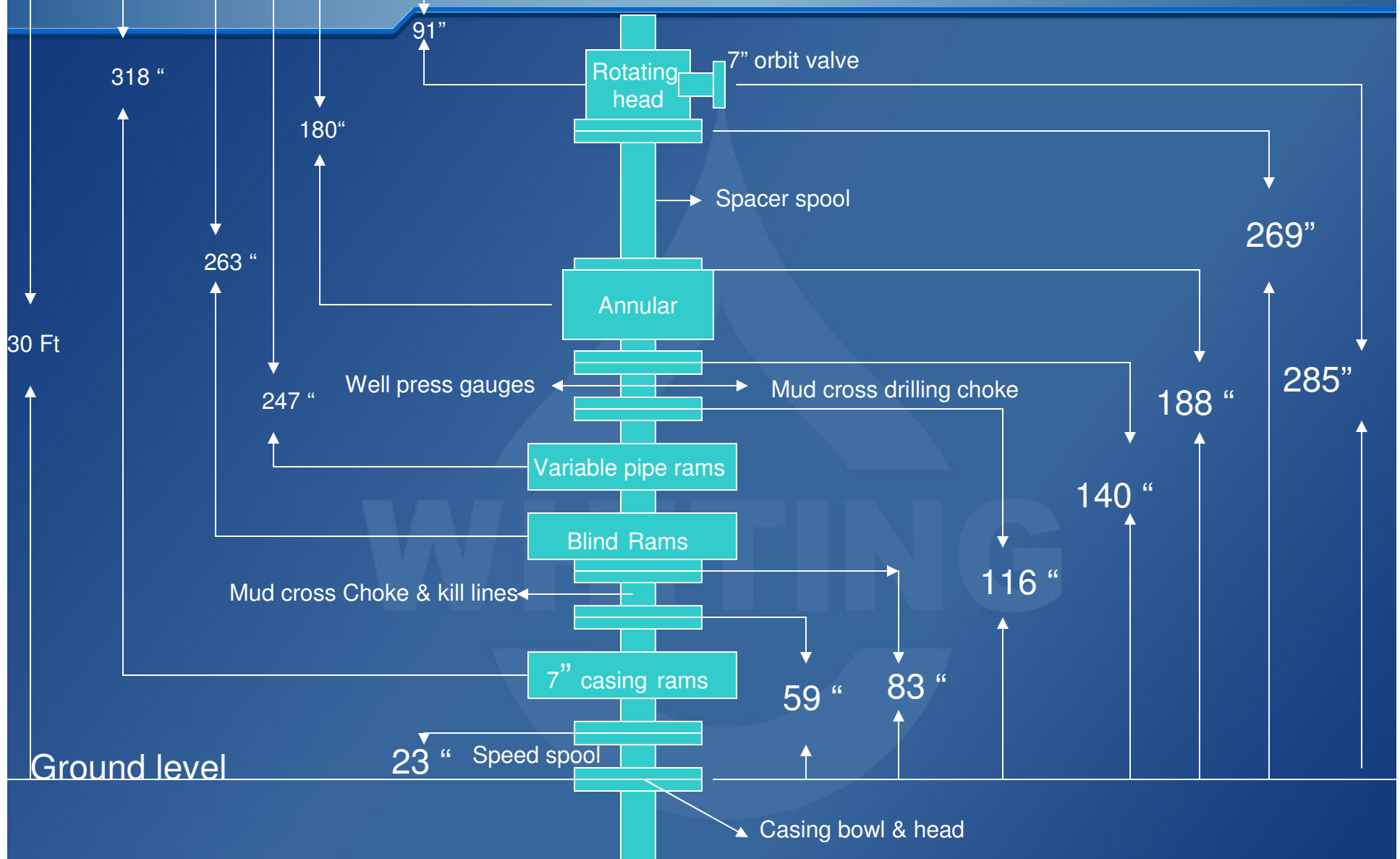


- Rotating head rated to 2,500 psi.
- Hold 500 psi on annulus
- Drill w/5-30' flare
- Trip w/800 psi to casing shoe
- Spot Kill mud in casing

Table level

Pioneer rig 66

11 " 5000 psi
rotating head & BOP system



Ground level

Drill Lateral



- 6" hole w/PDC bit
- 1½° bent motor
- Max dogleg 5.0°/100 ft
- 4" XT39 drill pipe
- OBM vs Water

OBM vs Water



OBM

- Raise MW as needed
- Less drag
- Less pipe wear

Water

- Faster
- Cheaper
- More pipe wear
- Limited Density

Torque & Drag



- Not much problem until $\pm 16,000'$
- Max Torque $\pm 20,000$ ft/lbs
- Lube sweeps – various brands
- Agitator / shock sub
- Beads
 - Bead recovery units

4½" Liner

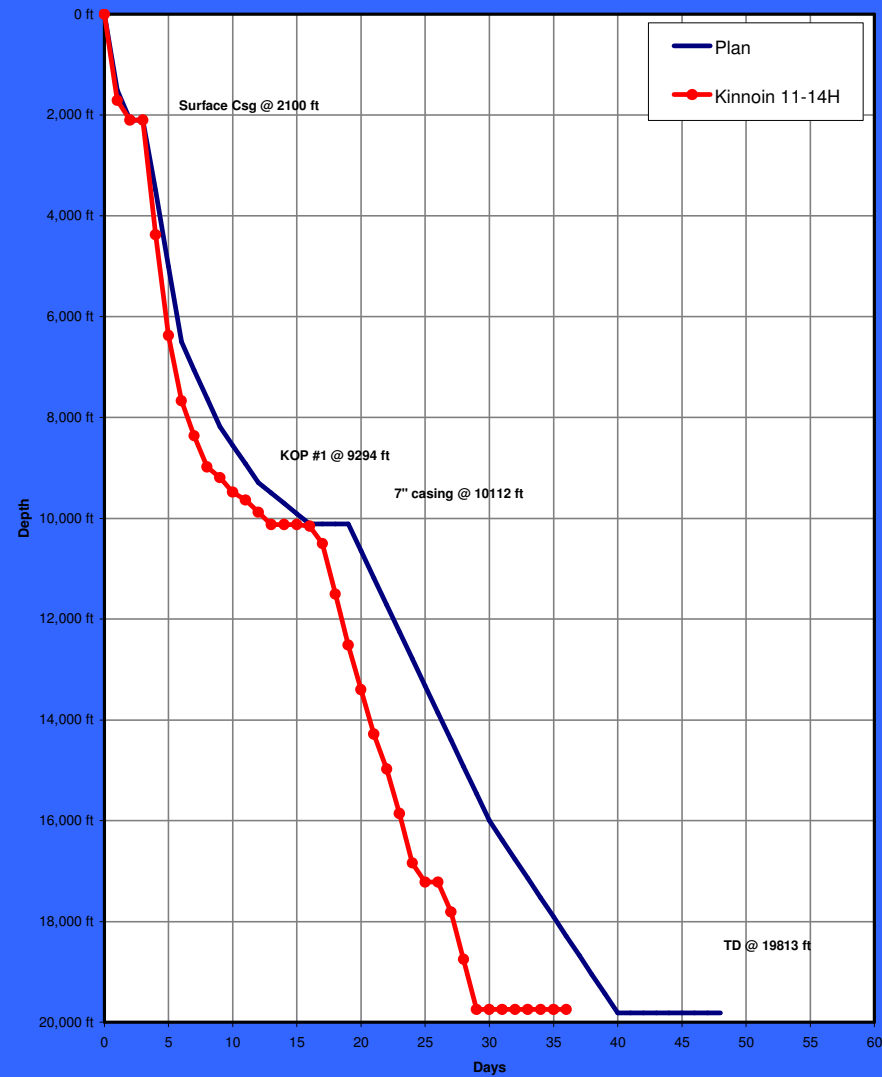


- Reamer run
 - 3 x 5-7/8" mills
- Spot lube
- Work liner if necessary
- Buckling problem at 16,000'+

Drilling Curve



Kinnoin 11-14H



Sanish Field Well Results

30- and 60-day Average Production Rates for Whiting Operated Sanish Field Wells



Well Name	WI	NRI	Comp. Date	IP (BOE/D) 24-hr. Test	Average 1 st 30 Days (BOE/D)	Average 1 st 60 Days (BOE/D)
1) Kinnoin 11-14H	52%	42%	10/29/08	3,646	N/A	N/A
2) Richardson Federal 11-9H	85%	69%	10/22/08	4,570 ⁽¹⁾	N/A	N/A
3) Roggenbuck 11-25H	78%	64%	10/13/08	1,950	N/A	N/A
4) Lacey 11-10H	73%	59%	09/29/08	1,811	N/A	N/A
5) Pennington 11-3H	66%	54%	09/20/08	1,473	714	N/A
6) Nesheim 1-24H	67%	54%	09/10/08	2,169	1,048	N/A
7) Brehm 44-5H	99%	81%	09/04/08	1,298	709	N/A
8) Kannianen 11-4H	95%	77%	08/09/08	2,226	914	714
9) Smith 11-7H	69%	56%	07/31/08	2,421	717 ⁽²⁾	757
10) Littlefield 11-29H	93%	75%	07/27/08	1,986	673 ⁽²⁾	640
11) Stenseth Trust 11-5H	73%	59%	07/06/08	3,044	903 ⁽²⁾	717
12) Lacey 11-1H	86%	70%	07/01/08	2,330	976	793
13) Behr 11-34H	54%	44%	06/20/08	3,245	1,335	969
14) Abbott 11-18H	99%	80%	06/16/08	1,959	1,088	892
15) Locken 14-28H	78%	63%	05/31/08	1,719	935	756
16) Braaflat 11-11H	97%	78%	05/23/08	2,997	1,505	1,271
17) Maynard Uran Tr. 11-24H	84%	68%	04/23/08	2,132	1,056	883
18) Peterson 11-34H	91%	75%	03/19/08	1,088	541	437
19) Liffrig 11-27H	81%	67%	01/24/08	2,530	1,114	932
20) Locken 11-22H	99%	82%	12/16/07	1,651	946	756
21) Peery State 11-25H	99%	80%	05/13/07	1,254	825	738
Averages	82%	67%		2,262	941	804

⁽¹⁾ The Richardson Federal 11-9H recorded the highest initial rate for any Bakken well drilled to date, according to the NDIC.

⁽²⁾ The first 30-day average production rate was restricted due to maintenance on the Enbridge crude oil line.

Questions?

