



Titan Directional Drilling, LLC

Survey Report

Company:	Carrizo Oil & Gas, Inc.	Local Co-ordinate Reference:	Well 16-20-9-58 - Slot 16
Project:	Niobrara CON'83	TVD Reference:	WELL @ 4889.00usft (Original Well Elev)
Site:	Bringelson 20-9-58 Pad	MD Reference:	WELL @ 4889.00usft (Original Well Elev)
Well:	16-20-9-58	North Reference:	Grid
Wellbore:	16-20-9-58 OH	Survey Calculation Method:	Minimum Curvature
Design:	16-20-9-58 OH	Database:	EDM 5000.1 Single User Db

Project	Niobrara CON'83, Weld County, CO		
Map System:	US State Plane 1983	System Datum:	Mean Sea Level
Geo Datum:	North American Datum 1983		
Map Zone:	Colorado Northern Zone		Using geodetic scale factor

Site	Bringelson 20-9-58 Pad, Centered on 17-20-9-58		
Site Position:		Northing:	1,515,768.94 usft
From:	Map	Easting:	3,444,594.58 usft
Position Uncertainty:	0.00 usft	Slot Radius:	13.20 in
		Latitude:	40° 44' 17.28 N
		Longitude:	103° 53' 44.09 W
		Grid Convergence:	1.04 °

Well	16-20-9-58 - Slot 16		
Well Position	+N/-S	0.00 usft	Northing:
	+E/-W	0.00 usft	Easting:
Position Uncertainty	0.00 usft		Wellhead Elevation:
			Latitude:
			Longitude:
			Ground Level:

Wellbore	16-20-9-58 OH		
Magnetics	Model Name	Sample Date	Declination
			(°)
	IGRF2015	03/15/15	8.00
			Dip Angle
			(°)
			Field Strength
			(nT)
			52,914

Design	16-20-9-58 OH		
Audit Notes:			
Version:	1.0	Phase:	ACTUAL
		Tie On Depth:	0.00
Vertical Section:	Depth From (TVD)	+N/-S	+E/-W
	(usft)	(usft)	(usft)
	0.00	0.00	0.00
			Direction
			(°)
			91.76

Survey Program	Date	03/30/15		
From	To	Survey (Wellbore)	Tool Name	Description
(usft)	(usft)			
139.00	10,397.00	Survey #1 (16-20-9-58 OH)	MWD	MWD - Standard
10,485.00	10,485.00	Survey #2 (16-20-9-58 OH)	ZERO-ERROR	Zero Error

Survey										
Measured	Inclination	Azimuth	Vertical	+N/-S	+E/-W	Vertical	Dogleg	Build	Turn	
Depth	(°)	(°)	Depth	(usft)	(usft)	Section	Rate	Rate	Rate	
(usft)			(usft)			(usft)	(°/100usft)	(°/100usft)	(°/100usft)	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
139.00	0.60	130.20	139.00	-0.47	0.56	0.57	0.43	0.43	0.00	
231.00	0.60	126.50	230.99	-1.07	1.31	1.34	0.04	0.00	-4.02	
323.00	0.80	107.50	322.99	-1.55	2.31	2.36	0.33	0.22	-20.65	
413.00	0.70	99.60	412.98	-1.83	3.45	3.51	0.16	-0.11	-8.78	
504.00	1.30	280.00	503.97	-1.74	2.98	3.04	2.20	0.66	-197.36	
595.00	3.30	297.90	594.90	-0.34	-0.35	-0.34	2.31	2.20	19.67	
686.00	4.60	303.00	685.68	2.88	-5.72	-5.81	1.48	1.43	5.60	
778.00	4.70	307.90	777.37	7.20	-11.79	-12.01	0.45	0.11	5.33	
870.00	5.90	310.00	868.98	12.56	-18.39	-18.77	1.32	1.30	2.28	

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Wellbore:	16-20-9-58 OH	Survey Calculation Method:	Minimum Curvature
Design:	16-20-9-58 OH	Database:	EDM 5000.1 Single User Db

Survey									
Measured Depth (usft)	Inclination (°)	Azimuth (°)	Vertical Depth (usft)	+N/-S (usft)	+E/-W (usft)	Vertical Section (usft)	Dogleg Rate (°/100usft)	Build Rate (°/100usft)	Turn Rate (°/100usft)
962.00	6.00	310.70	960.48	18.73	-25.66	-26.22	0.13	0.11	0.76
1,053.00	7.00	306.70	1,050.90	25.15	-33.71	-34.46	1.21	1.10	-4.40
1,145.00	6.90	307.70	1,142.22	31.88	-42.58	-43.53	0.17	-0.11	1.09
1,237.00	7.70	300.50	1,233.48	38.38	-52.26	-53.41	1.32	0.87	-7.83
1,328.00	7.60	301.10	1,323.67	44.59	-62.66	-64.00	0.14	-0.11	0.66
1,400.00	7.30	300.70	1,395.06	49.38	-70.67	-72.16	0.42	-0.42	-0.56
1,435.00	7.45	301.12	1,429.77	51.69	-74.53	-76.08	0.45	0.42	1.21
9 5/8"									
1,494.00	7.70	301.80	1,488.26	55.75	-81.16	-82.84	0.45	0.43	1.15
1,579.00	7.70	303.20	1,572.49	61.87	-90.77	-92.62	0.22	0.00	1.65
1,664.00	7.90	304.40	1,656.70	68.29	-100.35	-102.40	0.30	0.24	1.41
1,749.00	7.30	303.00	1,740.96	74.53	-109.70	-111.94	0.74	-0.71	-1.65
1,833.00	6.90	299.10	1,824.31	79.89	-118.58	-120.98	0.75	-0.48	-4.64
1,919.00	6.30	296.00	1,909.74	84.47	-127.34	-129.87	0.81	-0.70	-3.60
2,004.00	8.70	300.70	1,994.01	89.80	-137.06	-139.75	2.91	2.82	5.53
2,088.00	8.30	298.80	2,077.09	95.96	-147.84	-150.71	0.58	-0.48	-2.26
2,173.00	8.70	297.50	2,161.15	101.89	-158.91	-161.97	0.52	0.47	-1.53
2,258.00	8.70	297.40	2,245.18	107.81	-170.32	-173.55	0.02	0.00	-0.12
2,344.00	8.30	297.40	2,330.23	113.66	-181.61	-185.01	0.47	-0.47	0.00
2,429.00	8.20	298.10	2,414.35	119.34	-192.40	-195.98	0.17	-0.12	0.82
2,514.00	8.10	297.20	2,498.49	124.93	-203.08	-206.82	0.19	-0.12	-1.06
2,599.00	8.30	297.70	2,582.62	130.52	-213.83	-217.74	0.25	0.24	0.59
2,684.00	8.50	297.00	2,666.71	136.23	-224.86	-228.94	0.26	0.24	-0.82
2,769.00	7.70	292.40	2,750.86	141.25	-235.73	-239.95	1.21	-0.94	-5.41
2,854.00	7.40	290.50	2,835.13	145.33	-246.12	-250.47	0.46	-0.35	-2.24
2,939.00	6.50	291.20	2,919.50	148.99	-255.73	-260.19	1.06	-1.06	0.82
3,024.00	6.20	290.90	3,003.98	152.37	-264.50	-269.06	0.36	-0.35	-0.35
3,109.00	6.10	286.10	3,088.49	155.26	-273.13	-277.77	0.62	-0.12	-5.65
3,193.00	6.70	305.60	3,171.98	159.35	-281.41	-286.17	2.67	0.71	23.21
3,278.00	7.60	305.60	3,256.32	165.51	-290.01	-294.95	1.06	1.06	0.00
3,363.00	8.00	306.50	3,340.53	172.30	-299.33	-304.48	0.49	0.47	1.06
3,448.00	8.70	307.00	3,424.63	179.69	-309.22	-314.59	0.83	0.82	0.59
3,532.00	7.90	305.80	3,507.75	186.89	-318.98	-324.57	0.97	-0.95	-1.43
3,617.00	8.30	304.70	3,591.90	193.80	-328.76	-334.56	0.50	0.47	-1.29
3,702.00	7.40	294.40	3,676.11	199.55	-338.79	-344.76	1.96	-1.06	-12.12
3,785.00	7.40	288.70	3,758.42	203.47	-348.72	-354.80	0.88	0.00	-6.87
3,869.00	6.90	283.80	3,841.76	206.41	-358.74	-364.91	0.94	-0.60	-5.83
3,953.00	6.70	293.50	3,925.17	209.57	-368.14	-374.40	1.39	-0.24	11.55
4,038.00	6.40	307.70	4,009.63	214.44	-376.43	-382.84	1.93	-0.35	16.71
4,123.00	7.60	309.00	4,093.99	220.88	-384.55	-391.15	1.42	1.41	1.53
4,208.00	6.90	305.30	4,178.31	227.36	-393.09	-399.88	0.99	-0.82	-4.35
4,292.00	6.20	302.80	4,261.76	232.74	-401.02	-407.98	0.90	-0.83	-2.98
4,376.00	8.20	314.10	4,345.10	239.36	-409.13	-416.29	2.91	2.38	13.45

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Survey									
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4,461.00	7.70	311.20	4,429.28	247.33	-417.77	-425.17	0.75	-0.59	-3.41
4,546.00	6.40	301.90	4,513.64	253.59	-426.08	-433.67	2.03	-1.53	-10.94
4,631.00	8.00	304.20	4,597.97	259.42	-434.99	-442.75	1.91	1.88	2.71
4,716.00	7.50	299.30	4,682.19	265.46	-444.72	-452.67	0.97	-0.59	-5.76
4,801.00	6.20	297.20	4,766.58	270.27	-453.64	-461.73	1.56	-1.53	-2.47
4,886.00	7.70	308.80	4,850.96	275.94	-462.16	-470.42	2.41	1.76	13.65
4,970.00	7.50	312.80	4,934.22	283.19	-470.57	-479.05	0.67	-0.24	4.76
5,055.00	6.10	310.90	5,018.62	289.91	-478.06	-486.74	1.67	-1.65	-2.24
5,098.00	5.20	309.50	5,061.41	292.65	-481.29	-490.05	2.12	-2.09	-3.26
5,142.00	4.70	310.50	5,105.25	295.09	-484.20	-493.03	1.15	-1.14	2.27
5,184.00	4.20	304.90	5,147.12	297.09	-486.77	-495.66	1.58	-1.19	-13.33
5,227.00	3.30	343.90	5,190.04	299.18	-488.40	-497.36	6.14	-2.09	90.70
5,269.00	6.90	24.70	5,231.88	302.63	-487.68	-496.75	11.67	8.57	97.14
5,311.00	10.50	50.60	5,273.40	307.36	-483.67	-492.88	12.47	8.57	61.67
5,353.00	13.30	61.80	5,314.50	312.07	-476.45	-485.81	8.61	6.67	26.67
5,396.00	15.40	67.60	5,356.16	316.58	-466.81	-476.31	5.91	4.88	13.49
5,439.00	18.20	71.30	5,397.32	320.91	-455.17	-464.81	6.97	6.51	8.60
5,481.00	22.40	75.90	5,436.71	324.97	-441.19	-450.96	10.69	10.00	10.95
5,523.00	26.90	79.90	5,474.87	328.58	-424.06	-433.95	11.42	10.71	9.52
5,566.00	31.70	81.50	5,512.36	331.96	-403.30	-413.31	11.31	11.16	3.72
5,608.00	35.90	82.70	5,547.25	335.16	-380.16	-390.28	10.13	10.00	2.86
5,651.00	39.40	84.10	5,581.29	338.17	-354.07	-364.29	8.38	8.14	3.26
5,693.00	42.60	84.70	5,612.99	340.85	-326.65	-336.97	7.68	7.62	1.43
5,736.00	46.50	84.30	5,643.63	343.74	-296.63	-307.05	9.09	9.07	-0.93
5,778.00	51.30	84.80	5,671.23	346.74	-265.14	-275.66	11.46	11.43	1.19
300' entry									
5,820.00	56.70	86.10	5,695.91	349.43	-231.28	-241.90	13.10	12.86	3.10
5,863.00	62.30	87.80	5,717.72	351.38	-194.30	-205.00	13.46	13.02	3.95
5,905.00	65.80	88.90	5,736.10	352.46	-156.55	-167.30	8.66	8.33	2.62
5,948.00	68.10	89.60	5,752.93	352.98	-116.99	-127.78	5.55	5.35	1.63
5,990.00	68.90	89.10	5,768.33	353.42	-77.92	-88.73	2.20	1.90	-1.19
6,033.00	73.10	88.90	5,782.32	354.13	-37.27	-48.13	9.78	9.77	-0.47
6,075.00	79.40	90.10	5,792.30	354.48	3.50	-7.39	15.25	15.00	2.86
6,120.00	84.22	90.23	5,798.71	354.35	48.03	37.12	10.71	10.70	0.28
7"									
6,146.00	87.00	90.30	5,800.70	354.23	73.95	63.03	10.71	10.70	0.28
6,191.00	86.70	91.20	5,803.18	353.65	118.87	107.96	2.11	-0.67	2.00
6,237.00	89.40	92.40	5,804.74	352.20	164.82	153.93	6.42	5.87	2.61
6,283.00	90.70	92.00	5,804.70	350.44	210.79	199.92	2.96	2.83	-0.87
6,375.00	90.50	91.30	5,803.74	347.79	302.74	291.92	0.79	-0.22	-0.76
6,466.00	89.10	91.00	5,804.05	345.96	393.72	382.91	1.57	-1.54	-0.33
6,558.00	89.70	90.60	5,805.02	344.68	485.71	474.89	0.78	0.65	-0.43
6,650.00	90.10	90.50	5,805.18	343.79	577.70	566.87	0.45	0.43	-0.11
6,741.00	89.90	90.50	5,805.18	343.00	668.70	657.85	0.22	-0.22	0.00

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6,831.00	90.20	91.00	5,805.10	341.82	758.69	747.83	0.65	0.33	0.56	
6,922.00	90.70	92.60	5,804.38	338.96	849.64	838.83	1.84	0.55	1.76	
7,007.00	89.30	91.70	5,804.38	335.77	934.58	923.82	1.96	-1.65	-1.06	
7,092.00	89.80	91.70	5,805.05	333.25	1,019.54	1,008.82	0.59	0.59	0.00	
7,177.00	89.70	92.00	5,805.42	330.51	1,104.49	1,093.82	0.37	-0.12	0.35	
7,262.00	87.40	91.90	5,807.57	327.62	1,189.41	1,178.78	2.71	-2.71	-0.12	
7,346.00	87.10	91.90	5,811.60	324.84	1,273.27	1,262.69	0.36	-0.36	0.00	
7,431.00	88.80	90.30	5,814.65	323.21	1,358.19	1,347.62	2.75	2.00	-1.88	
7,516.00	89.40	89.90	5,815.98	323.06	1,443.18	1,432.58	0.85	0.71	-0.47	
7,601.00	88.50	91.90	5,817.54	321.72	1,528.15	1,517.55	2.58	-1.06	2.35	
7,686.00	89.50	92.80	5,819.02	318.24	1,613.06	1,602.53	1.58	1.18	1.06	
7,770.00	90.00	92.20	5,819.39	314.57	1,696.98	1,686.52	0.93	0.60	-0.71	
7,854.00	90.30	90.10	5,819.17	312.89	1,780.96	1,770.51	2.53	0.36	-2.50	
7,938.00	88.00	85.50	5,820.41	316.11	1,864.86	1,854.27	6.12	-2.74	-5.48	
8,023.00	89.70	88.40	5,822.12	320.63	1,949.71	1,938.94	3.95	2.00	3.41	
8,108.00	89.10	92.90	5,823.01	319.67	2,034.68	2,023.90	5.34	-0.71	5.29	
8,192.00	91.10	94.30	5,822.86	314.39	2,118.50	2,107.85	2.91	2.38	1.67	
8,277.00	91.10	93.60	5,821.23	308.54	2,203.29	2,192.77	0.82	0.00	-0.82	
8,362.00	92.90	93.80	5,818.27	303.06	2,288.05	2,277.67	2.13	2.12	0.24	
8,446.00	91.70	94.00	5,814.90	297.35	2,371.79	2,361.54	1.45	-1.43	0.24	
8,531.00	92.10	93.30	5,812.08	291.94	2,456.57	2,446.45	0.95	0.47	-0.82	
8,616.00	91.60	93.50	5,809.33	286.90	2,541.38	2,531.37	0.63	-0.59	0.24	
8,700.00	89.40	91.50	5,808.60	283.24	2,625.28	2,615.35	3.54	-2.62	-2.38	
8,785.00	91.70	91.70	5,807.78	280.87	2,710.24	2,700.34	2.72	2.71	0.24	
8,870.00	92.10	91.90	5,804.97	278.20	2,795.15	2,785.29	0.53	0.47	0.24	
8,955.00	92.00	91.00	5,801.93	276.05	2,880.07	2,870.23	1.06	-0.12	-1.06	
9,040.00	92.30	90.30	5,798.74	275.08	2,965.00	2,955.16	0.90	0.35	-0.82	
9,125.00	91.10	90.10	5,796.22	274.79	3,049.96	3,040.09	1.43	-1.41	-0.24	
9,210.00	90.00	89.40	5,795.40	275.16	3,134.96	3,125.03	1.53	-1.29	-0.82	
9,294.00	91.90	90.80	5,794.01	275.01	3,218.94	3,208.98	2.81	2.26	1.67	
9,379.00	92.60	93.50	5,790.67	271.83	3,303.81	3,293.90	3.28	0.82	3.18	
9,464.00	92.90	93.50	5,786.59	266.64	3,388.55	3,378.76	0.35	0.35	0.00	
9,549.00	92.00	94.30	5,782.96	260.87	3,473.27	3,463.62	1.42	-1.06	0.94	
9,634.00	92.20	94.20	5,779.84	254.57	3,557.98	3,548.49	0.26	0.24	-0.12	
9,719.00	90.00	93.30	5,778.21	249.02	3,642.78	3,633.41	2.80	-2.59	-1.06	
9,804.00	89.40	93.50	5,778.66	243.97	3,727.63	3,718.38	0.74	-0.71	0.24	
9,888.00	90.20	94.00	5,778.95	238.48	3,811.45	3,802.33	1.12	0.95	0.60	
9,973.00	88.00	92.40	5,780.28	233.74	3,896.30	3,887.28	3.20	-2.59	-1.88	
10,057.00	89.00	91.50	5,782.48	230.88	3,980.22	3,971.25	1.60	1.19	-1.07	
10,142.00	88.90	91.30	5,784.04	228.80	4,065.18	4,056.23	0.26	-0.12	-0.24	
10,227.00	91.50	90.60	5,783.74	227.39	4,150.16	4,141.22	3.17	3.06	-0.82	
10,312.00	90.30	88.50	5,782.41	228.06	4,235.14	4,226.14	2.85	-1.41	-2.47	
10,397.00	89.10	87.30	5,782.85	231.18	4,320.08	4,310.94	2.00	-1.41	-1.41	

Titan Directional Drilling, LLC

Survey Report

Company:	Carrizo Oil & Gas, Inc.	Local Co-ordinate Reference:	Well 16-20-9-58 - Slot 16
Project:	Niobrara CON'83	TVD Reference:	WELL @ 4889.00usft (Original Well Elev)
Site:	Bringelson 20-9-58 Pad	MD Reference:	WELL @ 4889.00usft (Original Well Elev)
Well:	16-20-9-58	North Reference:	Grid
Wellbore:	16-20-9-58 OH	Survey Calculation Method:	Minimum Curvature
Design:	16-20-9-58 OH	Database:	EDM 5000.1 Single User Db

Survey									
Measured Depth (usft)	Inclination (°)	Azimuth (°)	Vertical Depth (usft)	+N/-S (usft)	+E/-W (usft)	Vertical Section (usft)	Dogleg Rate (°/100usft)	Build Rate (°/100usft)	Turn Rate (°/100usft)
10,485.00	89.10	87.30	5,784.24	235.32	4,407.97	4,398.66	0.00	0.00	0.00

Design Targets									
Target Name	Dip Angle (°)	Dip Dir. (°)	TVD (usft)	+N/-S (usft)	+E/-W (usft)	Northing (usft)	Easting (usft)	Latitude	Longitude
- hit/miss target									
- Shape									
16-20-9-58 BHL	0.00	0.00	5,784.24	235.32	4,407.97	1,516,004.00	3,448,987.52	40° 44' 18.81 N	103° 52' 46.97 W
- actual wellpath hits target center									
- Point									

Casing Points					
Measured Depth (usft)	Vertical Depth (usft)	Name	Casing Diameter (in)	Hole Diameter (in)	
1,435.00	1,429.77	9 5/8"	9.62	12.25	
6,120.00	5,798.71	7"	7.00	7.50	

Design Annotations				
Measured Depth (usft)	Vertical Depth (usft)	Local Coordinates		
		+N/-S (usft)	+E/-W (usft)	Comment
5,778.00	5,671.23	346.74	-265.14	300' entry