



COG OPERATING, LLC

Eddy / Lea County, NM (NAD27) NMEZ

Burch Keely Unit 964H

#964H - Slot 1485'FNL, 215'FEL Sec 24

PP - 1670'FNL, 182'FWL, Sec 19

Lateral

30-015-44149

NM OIL CONSERVATION
ARTESIA DISTRICT

OCT 10 2017

RECEIVED

PLANNED BHL - 1670'FNL, 10'FEL Sec 24

ACTUAL BHL - 1673'FNL, 10'FEL, Sec 24

Please provide signature
page for directional survey





Survey Report



Company: COG OPERATING, LLC
Project: Eddy /Lea County, NM (NAD27) NMEZ
Site: Burch Keely Unit 964H
Well: #964H
Wellbore: Lateral
Design: Lateral

Local Co-ordinate Reference: Site Burch Keely Unit 964H
TVD Reference: 1485+18 @ 1503.00ft (SilverOak3)
MD Reference: 1485+18 @ 1503.00ft (SilverOak3)
North Reference: Grid
Survey Calculation Method: Minimum Curvature
Database: VON_EDM

Project	Eddy /Lea County, NM (NAD27) NMEZ		
Map System:	US State Plane 1927 (Exact solution)	System Datum:	Mean Sea Level
Geo Datum:	NAD 1927 (NADCON CONUS)		
Map Zone:	New Mexico East 3001		

Site	Burch Keely Unit 964H			
Site Position:		Northing:	663,291.90 ft	Latitude: 32° 49' 23.090 N
From:	Map	Easting:	596,299.90 ft	Longitude: 104° 1' 11.479 W
Position Uncertainty:	0.00 ft	Slot Radius:	13.20 in	Grid Convergence: 0.17 °

Well	#964H - Slot 964			
Well Position	+N/-S	0.00 ft	Northing:	663,291.90 ft
	+E/-W	0.00 ft	Easting:	596,299.90 ft
Position Uncertainty	0.00 ft		Wellhead Elevation:	ft
			Ground Level:	1,485.00 ft

Wellbore	Lateral				
Magnetics	Model Name	Sample Date	Declination (°)	Dip Angle (°)	Field Strength (nT)
	IGRF2015	06/14/17	7.21	60.54	48,260

Design	Lateral				
Audit Notes:					
Version:	1.0	Phase:	ACTUAL	Tie On Depth:	0.00
Vertical Section:	Depth From (TVD) (ft)	+N/-S (ft)	+E/-W (ft)	Direction (°)	
	0.00	0.00	0.00	89.79	

Survey Program	Date 07/05/17				
From (ft)	To (ft)	Survey (Wellbore)	Tool Name	Description	
100.00	1,040.00	Survey #1 (Lateral)	GYD_DP_MS	Gyrodatta gyro-compassing and drop	
1,124.00	10,276.00	Survey #2 (Lateral)	MWD	MWD v3:standard declination	
10,341.00	10,341.00	Survey #3 (Lateral)	Projection	Projection	

Survey										
Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
BKU 964 SL										
100.00	0.20	63.88	100.00	0.08	0.16	0.16	0.20	0.20	0.00	
200.00	0.12	116.04	200.00	0.11	0.40	0.40	0.16	-0.08	52.17	
300.00	0.45	142.11	300.00	-0.25	0.74	0.74	0.35	0.34	26.07	
400.00	0.64	159.48	399.99	-1.08	1.17	1.17	0.25	0.19	17.37	
500.00	0.60	145.56	499.99	-2.04	1.67	1.66	0.16	-0.04	-13.92	
600.00	0.53	129.87	599.98	-2.77	2.32	2.31	0.17	-0.07	-15.69	
700.00	0.74	87.24	699.98	-3.03	3.31	3.30	0.50	0.21	-42.62	



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Survey

Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)
800.00	1.01	86.31	799.97	-2.94	4.83	4.82	0.28	0.28	-0.93
900.00	1.37	82.61	899.94	-2.73	6.90	6.89	0.36	0.35	-3.70
1,000.00	0.99	78.47	999.92	-2.41	8.93	8.92	0.39	-0.38	-4.14
1,040.00	0.97	83.49	1,039.92	-2.30	9.60	9.59	0.22	-0.05	12.57
1,124.00	0.99	65.74	1,123.90	-1.92	10.97	10.96	0.36	0.02	-21.13
1,156.00	0.86	60.03	1,155.90	-1.69	11.43	11.42	0.50	-0.41	-17.84
1,251.00	0.26	272.12	1,250.90	-1.32	11.83	11.83	1.15	-0.63	-155.69
1,346.00	1.82	255.84	1,345.88	-1.69	10.15	10.15	1.65	1.64	-17.14
1,440.00	3.32	247.87	1,439.78	-3.08	6.18	6.17	1.64	1.60	-8.48
1,534.00	4.98	245.97	1,533.53	-5.76	-0.06	-0.08	1.77	1.77	-2.02
1,629.00	6.01	239.32	1,628.10	-9.98	-8.11	-8.14	1.27	1.08	-7.00
1,723.00	6.90	232.78	1,721.50	-15.91	-16.84	-16.89	1.23	0.95	-6.96
1,818.00	7.85	234.20	1,815.71	-23.15	-26.64	-26.73	1.02	1.00	1.49
1,913.00	7.51	234.94	1,909.86	-30.51	-36.99	-37.10	0.37	-0.36	0.78
2,007.00	8.14	234.64	2,002.99	-37.89	-47.44	-47.58	0.67	0.67	-0.32
2,102.00	7.65	234.80	2,097.08	-45.43	-58.09	-58.26	0.52	-0.52	0.17
2,197.00	8.03	238.84	2,191.20	-52.51	-68.94	-69.13	0.70	0.40	4.25
2,292.00	7.58	238.29	2,285.32	-59.24	-79.95	-80.16	0.48	-0.47	-0.58
2,387.00	8.80	238.29	2,379.35	-66.35	-91.46	-91.70	1.28	1.28	0.00
2,481.00	9.37	239.51	2,472.17	-74.01	-104.17	-104.44	0.64	0.61	1.30
2,576.00	9.48	241.17	2,565.88	-81.71	-117.69	-117.99	0.31	0.12	1.75
2,671.00	9.47	243.25	2,659.59	-89.00	-131.52	-131.85	0.36	-0.01	2.19
2,765.00	9.75	243.54	2,752.27	-96.03	-145.55	-145.90	0.30	0.30	0.31
2,859.00	9.92	252.26	2,844.89	-102.04	-160.39	-160.76	1.59	0.18	9.28
2,954.00	9.29	248.56	2,938.56	-107.34	-175.32	-175.71	0.93	-0.66	-3.89
3,048.00	8.61	237.14	3,031.42	-113.93	-188.30	-188.71	2.02	-0.72	-12.15
3,143.00	8.67	230.28	3,125.35	-122.36	-199.78	-200.22	1.09	0.06	-7.22
3,238.00	7.64	228.51	3,219.39	-131.12	-210.02	-210.49	1.12	-1.08	-1.86
3,332.00	6.43	231.37	3,312.68	-138.55	-218.81	-219.31	1.34	-1.29	3.04
3,427.00	6.47	233.48	3,407.08	-145.05	-227.27	-227.80	0.25	0.04	2.22
3,522.00	6.60	234.38	3,501.46	-151.42	-236.00	-236.56	0.17	0.14	0.95
3,616.00	6.75	238.92	3,594.82	-157.42	-245.13	-245.70	0.58	0.16	4.83
3,710.00	6.86	228.79	3,688.16	-163.97	-254.08	-254.68	1.28	0.12	-10.78
3,735.00	6.55	227.11	3,712.99	-165.92	-256.25	-256.86	1.47	-1.25	-6.72
Wellpath Crosses 330°HL in Nudge									
3,805.00	5.71	221.46	3,782.59	-171.25	-261.48	-262.11	1.47	-1.20	-8.07
3,899.00	3.76	225.11	3,876.27	-176.93	-266.76	-267.41	2.10	-2.07	3.88
3,993.00	3.07	207.99	3,970.10	-181.33	-270.12	-270.79	1.30	-0.73	-18.21
4,060.63	2.41	203.55	4,037.66	-184.23	-271.54	-272.22	1.02	-0.97	-6.57
BKU 964 Tgt									
4,087.00	2.16	201.09	4,064.00	-185.20	-271.94	-272.62	1.02	-0.95	-9.32
4,182.00	1.16	164.27	4,158.97	-187.80	-272.33	-273.01	1.49	-1.05	-38.76
4,277.00	1.01	138.28	4,253.95	-189.35	-271.51	-272.20	0.54	-0.16	-27.36
4,308.00	1.88	116.01	4,284.94	-189.77	-270.87	-271.56	3.29	2.81	-71.84



Survey Report



DIRECTIONAL SERVICES, LLC.

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Survey

Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)
4,339.00	3.37	95.65	4,315.91	-190.09	-269.51	-270.20	5.60	4.81	-65.68
4,370.00	6.63	89.30	4,346.78	-190.16	-266.81	-267.50	10.65	10.52	-20.48
4,402.00	9.62	82.91	4,378.46	-189.80	-262.31	-263.00	9.75	9.34	-19.97
4,434.00	12.79	83.14	4,409.85	-189.05	-256.14	-256.83	9.91	9.91	0.72
4,465.00	16.04	82.60	4,439.87	-188.09	-248.48	-249.17	10.49	10.48	-1.74
4,497.00	19.39	82.57	4,470.34	-186.83	-238.83	-239.51	10.47	10.47	-0.09
4,528.00	22.88	83.19	4,499.25	-185.45	-227.74	-228.41	11.28	11.26	2.00
4,560.00	26.37	83.57	4,528.34	-183.92	-214.49	-215.17	10.92	10.91	1.19
4,591.00	29.93	84.41	4,555.67	-182.39	-199.95	-200.62	11.55	11.48	2.71
4,623.00	33.38	85.64	4,582.90	-180.94	-183.22	-183.88	10.97	10.78	3.84
4,654.00	36.55	87.92	4,608.31	-179.96	-165.49	-166.15	11.06	10.23	7.35
4,686.00	39.47	90.53	4,633.52	-179.71	-145.79	-146.45	10.41	9.13	8.16
4,749.00	44.50	91.60	4,680.33	-180.51	-103.67	-104.33	8.06	7.98	1.70
4,843.00	46.77	92.00	4,746.06	-182.63	-36.51	-37.18	2.43	2.41	0.43
4,874.00	47.11	92.21	4,767.22	-183.46	-13.87	-14.55	1.20	1.10	0.68
4,906.00	47.43	92.52	4,788.94	-184.43	9.61	8.94	1.23	1.00	0.97
4,938.00	49.11	92.30	4,810.23	-185.43	33.47	32.79	5.28	5.25	-0.69
4,969.00	52.23	91.57	4,829.88	-186.24	57.43	56.75	10.23	10.06	-2.35
5,000.00	55.27	91.21	4,848.21	-186.84	82.42	81.74	9.85	9.81	-1.16
5,032.00	58.45	91.19	4,865.70	-187.40	109.21	108.52	9.94	9.94	-0.06
5,064.00	61.64	90.37	4,881.68	-187.78	136.93	136.24	10.21	9.97	-2.56
5,095.00	64.97	89.19	4,895.60	-187.67	164.62	163.93	11.27	10.74	-3.81
5,127.00	68.27	88.92	4,908.30	-187.18	193.98	193.30	10.34	10.31	-0.84
5,151.00	70.58	89.67	4,916.73	-186.91	216.45	215.76	10.08	9.65	3.13
Wellpath Crosses Section Line @ Heel									
5,164.00	71.84	90.07	4,920.92	-186.88	228.76	228.07	10.08	9.66	3.06
5,196.00	74.70	90.14	4,930.13	-186.94	259.40	258.71	8.94	8.94	0.22
5,227.00	77.46	89.84	4,937.58	-186.93	289.48	288.80	8.95	8.90	-0.97
5,259.00	80.77	89.66	4,943.63	-186.79	320.90	320.22	10.36	10.34	-0.56
5,290.00	83.99	89.36	4,947.74	-186.53	351.63	350.94	10.43	10.39	-0.97
5,322.00	87.26	88.39	4,950.18	-185.90	383.52	382.84	10.66	10.22	-3.03
5,337.33	87.64	88.46	4,950.86	-185.48	398.83	398.15	2.53	2.49	0.48
BKU 964 LP p2									
5,416.00	89.60	88.84	4,952.75	-183.63	477.45	476.78	2.53	2.49	0.48
5,511.00	89.70	89.67	4,953.33	-182.40	572.44	571.77	0.88	0.11	0.87
5,606.00	90.96	89.97	4,952.79	-182.10	667.44	666.76	1.36	1.33	0.32
5,700.00	91.25	90.23	4,950.97	-182.26	761.42	760.75	0.41	0.31	0.28
5,795.00	90.96	89.66	4,949.14	-182.17	856.40	855.73	0.67	-0.31	-0.60
5,890.00	91.29	90.49	4,947.28	-182.30	951.38	950.71	0.94	0.35	0.87
5,984.00	91.43	90.86	4,945.05	-183.40	1,045.35	1,044.67	0.42	0.15	0.39
6,079.00	91.39	91.77	4,942.71	-185.58	1,140.29	1,139.61	0.96	-0.04	0.96
6,174.00	90.81	90.87	4,940.88	-187.77	1,235.25	1,234.55	1.13	-0.61	-0.95
6,269.00	90.80	91.12	4,939.55	-189.42	1,330.23	1,329.52	0.26	-0.01	0.26



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6,364.00	90.75	89.99	4,938.26	-190.34	1,425.21	1,424.50	1.19	-0.05	-1.19
6,458.00	90.68	89.29	4,937.09	-189.75	1,519.20	1,518.50	0.75	-0.07	-0.74
6,553.00	90.79	89.12	4,935.87	-188.43	1,614.18	1,613.48	0.21	0.12	-0.18
6,648.00	89.98	89.40	4,935.23	-187.20	1,709.17	1,708.48	0.90	-0.85	0.29
6,742.00	89.53	87.97	4,935.64	-185.05	1,803.14	1,802.45	1.59	-0.48	-1.52
6,837.00	89.57	87.68	4,936.38	-181.44	1,898.07	1,897.40	0.31	0.04	-0.31
6,932.00	90.92	88.70	4,935.98	-178.44	1,993.02	1,992.35	1.78	1.42	1.07
7,027.00	92.10	90.46	4,933.47	-177.75	2,087.98	2,087.32	2.23	1.24	1.85
7,121.00	91.94	90.44	4,930.16	-178.48	2,181.92	2,181.25	0.17	-0.17	-0.02
7,215.00	92.07	90.99	4,926.87	-179.66	2,275.85	2,275.18	0.60	0.14	0.59
7,310.00	91.35	90.31	4,924.04	-180.73	2,370.80	2,370.13	1.04	-0.76	-0.72
7,404.00	90.99	90.75	4,922.12	-181.60	2,464.78	2,464.10	0.60	-0.38	0.47
7,499.00	91.18	89.79	4,920.32	-182.05	2,559.76	2,559.08	1.03	0.20	-1.01
7,593.00	90.97	89.92	4,918.55	-181.81	2,653.74	2,653.06	0.26	-0.22	0.14
7,688.00	91.25	89.74	4,916.71	-181.53	2,748.73	2,748.04	0.35	0.29	-0.19
7,783.00	91.42	89.46	4,914.50	-180.87	2,843.70	2,843.02	0.34	0.18	-0.29
7,877.00	91.34	90.06	4,912.24	-180.47	2,937.67	2,936.99	0.64	-0.09	0.64
7,972.00	91.01	90.63	4,910.29	-181.04	3,032.65	3,031.96	0.69	-0.35	0.60
8,066.00	91.59	89.51	4,908.16	-181.16	3,126.62	3,125.94	1.34	0.62	-1.19
8,161.00	91.66	90.17	4,905.46	-180.89	3,221.58	3,220.90	0.70	0.07	0.69
8,256.00	92.03	88.95	4,902.40	-180.17	3,316.53	3,315.85	1.34	0.39	-1.28
8,351.00	91.95	89.33	4,899.10	-178.74	3,411.46	3,410.78	0.41	-0.08	0.40
8,446.00	91.62	89.88	4,896.14	-178.09	3,506.41	3,505.73	0.67	-0.35	0.58
8,541.00	91.50	90.17	4,893.56	-178.13	3,601.38	3,600.70	0.33	-0.13	0.31
8,636.00	91.33	90.51	4,891.21	-178.69	3,696.34	3,695.66	0.40	-0.18	0.36
8,731.00	90.62	88.85	4,889.60	-178.16	3,791.33	3,790.65	1.90	-0.75	-1.75
8,826.00	90.49	89.14	4,888.68	-176.49	3,886.31	3,885.63	0.33	-0.14	0.31
8,920.00	90.44	88.75	4,887.91	-174.76	3,980.29	3,979.62	0.42	-0.05	-0.41
9,014.00	90.54	89.02	4,887.11	-172.93	4,074.27	4,073.60	0.31	0.11	0.29
9,109.00	90.48	89.71	4,886.26	-171.88	4,169.26	4,168.60	0.73	-0.06	0.73
9,203.00	90.75	89.70	4,885.25	-171.40	4,263.25	4,262.59	0.29	0.29	-0.01
9,298.00	91.03	90.47	4,883.78	-171.54	4,358.24	4,357.58	0.86	0.29	0.81
9,393.00	90.45	89.26	4,882.55	-171.31	4,453.23	4,452.57	1.41	-0.61	-1.27
9,487.00	90.58	89.37	4,881.71	-170.19	4,547.22	4,546.56	0.18	0.14	0.12
9,582.00	90.70	90.04	4,880.65	-169.70	4,642.21	4,641.55	0.72	0.13	0.71
9,676.00	91.15	90.57	4,879.13	-170.20	4,736.19	4,735.54	0.74	0.48	0.56
9,770.00	89.47	88.48	4,878.62	-169.42	4,830.18	4,829.53	2.85	-1.79	-2.22
9,865.00	89.47	89.17	4,879.50	-167.47	4,925.16	4,924.51	0.73	0.00	0.73
9,960.00	89.86	89.41	4,880.05	-166.30	5,020.15	5,019.50	0.48	0.41	0.25
10,022.00	90.02	89.53	4,880.12	-165.73	5,082.14	5,081.50	0.33	0.26	0.20
Wellpath Crosses 330°HL @ Toe									
10,055.00	90.11	89.60	4,880.08	-165.48	5,115.14	5,114.50	0.33	0.26	0.20
10,150.00	90.81	90.51	4,879.32	-165.57	5,210.14	5,209.50	1.21	0.74	0.96
10,245.00	89.66	91.07	4,878.93	-166.88	5,305.13	5,304.48	1.35	-1.21	0.59



Survey Report



Company: COG OPERATING, LLC
Project: Eddy /Lea County, NM (NAD27) NMEZ
Site: Burch Keely Unit 964H
Well: #964H
Wellbore: Lateral
Design: Lateral

Local Co-ordinate Reference: Site Burch Keely Unit 964H
TVD Reference: 1485+18 @ 1503.00ft (SilverOak3)
MD Reference: 1485+18 @ 1503.00ft (SilverOak3)
North Reference: Grid
Survey Calculation Method: Minimum Curvature
Database: VON_EDM

Survey

Measured Depth (ft)	Inclination (°)	Azimuth (°)	Vertical Depth (ft)	+N/-S (ft)	+E/-W (ft)	Vertical Section (ft)	Dogleg Rate (°/100ft)	Build Rate (°/100ft)	Turn Rate (°/100ft)
10,276.00	89.60	91.20	4,879.13	-167.49	5,336.12	5,335.47	0.46	-0.19	0.42
10,341.00	89.60	91.20	4,879.58	-168.85	5,401.10	5,400.45	0.00	0.00	0.00

TD @ 10°FEL, 1673°FNL - BKU 964 PBHL

Design Targets

Target Name - hit/miss target - Shape	Dip Angle (°)	Dip Dir. (°)	TVD (ft)	+N/-S (ft)	+E/-W (ft)	Northing (ft)	Easting (ft)	Latitude	Longitude
BKU 964 SL - actual wellpath hits target center - Point	0.00	0.01	0.00	0.00	0.00	663,291.90	596,299.90	32° 49' 23.090 N	104° 1' 11.479 W
BKU 964 BHL - actual wellpath hits target center - Point	0.00	0.01	4,879.58	-168.85	5,401.10	663,123.05	601,701.00	32° 49' 21.256 N	104° 0' 8.190 W

Design Annotations

Measured Depth (ft)	Vertical Depth (ft)	Local Coordinates +N/-S (ft)	+E/-W (ft)	Comment
3,735.00	3,712.99	-165.92	-256.25	Wellpath Crosses 330'HL In Nudge
5,151.00	4,916.73	-186.91	216.45	Wellpath Crosses Section Line @ Heel
10,022.00	4,880.12	-165.73	5,082.14	Wellpath Crosses 330'HL @ Toe
10,341.00	4,879.58	-168.85	5,401.10	TD @ 10°FEL, 1673°FNL

Checked By: _____ Approved By: _____ Date: _____

COG OPERATING, LLC

Project: Eddy /Lea County, NM (NAD27) NMEZ
 Site: Burch Keely Unit 964H
 Well: #964H
 Wellbore: Lateral
 Design: Lateral



1485+18 @ 1503.00ft (SilverOak3)
 NAD 1927 (NADCON CONUS)

To convert a Magnetic Direction to a Grid Direction, Add 7.04°

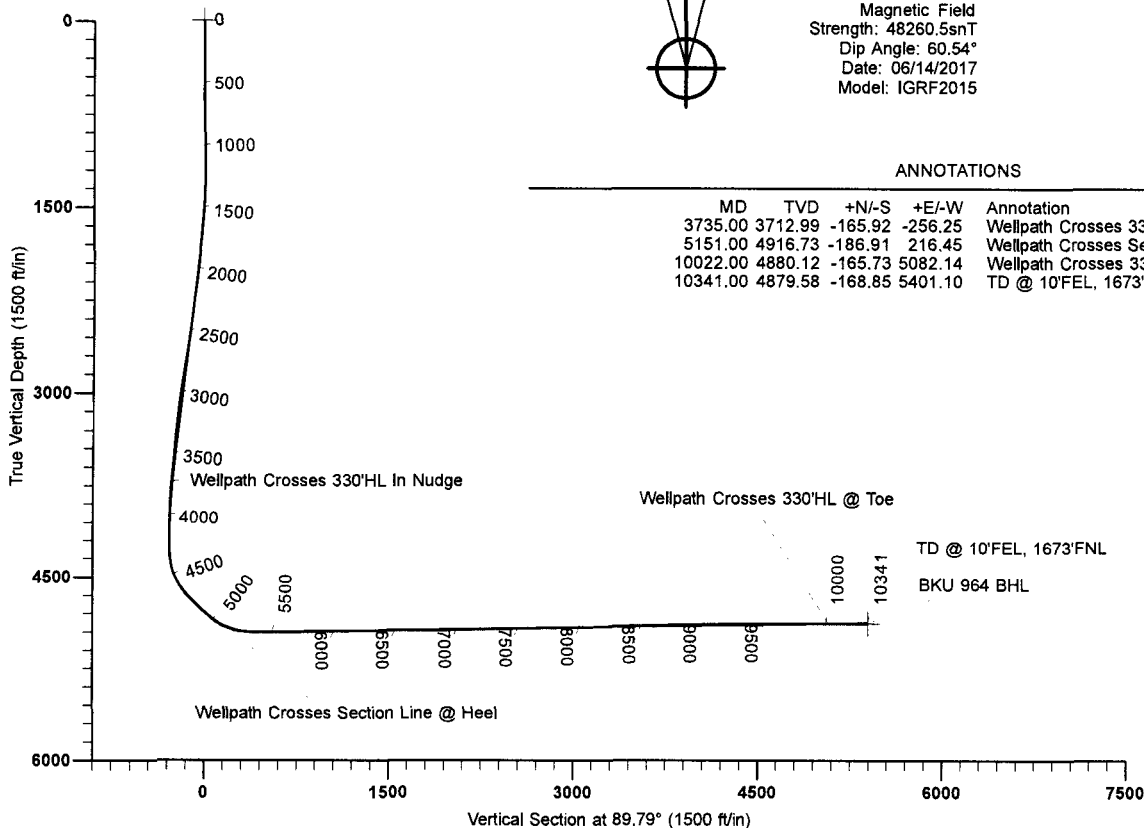


Azimuths to Grid North
 True North: -0.17°
 Magnetic North: 7.04°

Magnetic Field
 Strength: 48260.5nT
 Dip Angle: 60.54°
 Date: 06/14/2017
 Model: IGRF2015

ANNOTATIONS

MD	TVD	+N/-S	+E/-W	Annotation
3735.00	3712.99	-165.92	-256.25	Wellpath Crosses 330'HL In Nudge
5151.00	4916.73	-186.91	216.45	Wellpath Crosses Section Line @ Heel
10022.00	4880.12	-165.73	5082.14	Wellpath Crosses 330'HL @ Toe
10341.00	4879.58	-168.85	5401.10	TD @ 10'FEL, 1673'FNL



TARGET DETAILS

Name	TVD	+N/-S	+E/-W	Northing	Easting	Shape
BKU 964 SL	0.00	0.00	0.00	663291.90	596299.90	Point
BKU 964 BHL	4879.58	-168.85	5401.10	663123.05	601701.00	Point

Design: Lateral (#964H/Lateral)
 Created By: Mekka Williams
 eSomnia Well Design
 mekka@esominawelldesign.com
 10:57, July 05 2017

VON DIRECTIONAL
 12074 FM 3083 Conroe, Texas 77301
 936-756-2400

