

Hydraulic Fracture Impact Radius Report

HFIR / Factor of Safety Analysis

PROJECT NAME

Demo - Case #1

CLIENT

ABC Pipeline

CALCULATED BY

John Smith, PE

DATE

July 3, 2026

1. EXECUTIVE SUMMARY

ELEVATED RISK — MINIMUM SF BELOW 1.0

Assessment: ELEVATED RISK

The HFIR analysis has identified 16 station(s) where the Factor of Safety is below 1.0. The minimum Factor of Safety is 0.07 at Station 6+00. Immediate mitigation measures should be considered, including reduced flow rates, lower mud density, or alignment adjustments.

Analysis Parameters			
Calculation Method	Queen's University (Xia & Moore)	Min Factor of Safety	0.07 @ Sta. 6+00
Bore / Bit Diameter	12.75 in	SF < 1.0 First At	Sta. 0+25 (FoS 0.48)
Total Stations	27	Max Pmax (Allowable)	43 psi
Number of Soil Bores	2	Max High End Pressure	34.4 psi
		Max Low End Pressure	24.7 psi

1.1 Annular Pressure Assumptions

Parameter	Unit	Low End	High End
Plastic Viscosity	cP	7	30
Yield Point	lb/100ft ²	9	30
Mud Density	ppg	9.5	11.5
Flow Rate	gpm	120	250
Drill Pipe OD	in	4.5	4.5
Drill Bit Diameter	in	12.75	12.75

2. SOIL BORE DATA

2.1 SB-1 — Station 5+00 — GW Elev. 70 ft

Layer	Type	Elev. Range (ft)	Thickness (ft)	Hardness / Stiffness	N-Value / UCS
CL — Inorganic Clay of Low to Medium Plasticity "Lean Clay"	Soil	141 – 120	21.0	Soft	N = 4
CL — Inorganic Clay of Low to Medium Plasticity "Lean Clay"	Soil	120 – 102	18.0	Medium	N = 10
SC — Clayey Sand	Soil	102 – 82	20.0	Medium Dense	N = 11
Sandstone — Sandstone	Rock	82 – 75	7.0	Medium	UCS 3450 psi, RQD 80%

2.2 SB-2 — Station 2+50 — GW Elev. 0 ft

Layer	Type	Elev. Range (ft)	Thickness (ft)	Hardness / Stiffness	N-Value / UCS
CL — Inorganic Clay of Low to Medium Plasticity "Lean Clay"	Soil	146.7 – 129	17.7	Soft	N = 6
CH — Clay of High Plasticity "Fat Clay"	Soil	129 – 110	19.0	Medium	N = 9
CH — Clay of High Plasticity "Fat Clay"	Soil	110 – 89	21.0	Medium	N = 10
Sandstone — Sandstone	Rock	89 – 75	14.0	Medium	UCS 1320 psi, RQD 89%

This analysis is based on geotechnical data from 2 soil bore(s) and interpolated ground/pipeline profiles. Actual subsurface conditions may vary between bore locations. Results should be used for preliminary engineering assessment only. All values should be verified against site-specific geotechnical investigations and applicable regulations before construction.

3. IR ANALYSIS RESULTS

Station	Ground Elev. (ft)	Pipeline Elev. (ft)	Depth of Cover (ft)	Bore	Soil Type	σ'_v (psi)	Pmax (psi)	Annular Press. (psi)	Factor of Safety
0+00	156.2	156.2	0.0	SB-1	N/A	0.00	0.00	0.00	0.00
0+25	154.8	151.8	3.0	SB-1	CL	1.99	1.48	3.10	0.48
0+50	152.8	147.4	5.4	SB-1	CL	3.31	2.75	6.19	0.44
0+75	153.3	143.0	10.3	SB-1	CL	6.61	6.09	9.28	0.66
1+00	149.8	138.6	11.2	SB-1	CL	7.27	6.73	12.38	0.54
1+25	149.4	134.2	15.2	SB-1	CL	9.91	9.24	15.48	0.60
1+50	146.5	129.8	16.8	SB-1	CL	11.23	10.47	18.58	0.56
1+75	145.7	125.3	20.4	SB-1	CL	13.21	12.28	21.67	0.57
2+00	145.1	121.0	24.1	SB-1	CL	16.03	21.74	24.75	0.88
2+25	145.3	117.2	28.1	SB-1	CL	18.91	29.89	27.47	1.09
2+50	146.7	114.2	32.5	SB-1	CL	21.79	37.55	29.71	1.26
2+75	146.2	112.0	34.2	SB-1	CL	23.23	41.24	31.47	1.31
3+00	138.3	110.6	27.7	SB-1	CL	18.91	29.89	32.77	0.91
3+25	138.6	110.0	28.6	SB-1	CL	19.63	31.85	33.59	0.95
3+50	141.6	110.0	31.6	SB-1	CL	21.79	37.55	34.07	1.10
3+75	144.8	110.3	34.5	SB-1	CL	23.23	41.24	34.37	1.20
4+00	144.7	111.3	33.4	SB-2	CH	21.59	43.30	34.20	1.27
4+25	141.6	113.2	28.4	SB-2	CH	18.59	36.37	33.56	1.08
4+50	143.4	115.8	27.6	SB-2	CH	17.99	34.93	32.45	1.08
4+75	140.2	119.3	20.9	SB-2	CH	13.79	24.07	30.86	0.78
5+00	141.1	123.5	17.6	SB-2	CH	11.99	18.80	28.81	0.65
5+25	141.6	127.9	13.7	SB-2	CL	9.53	13.93	26.64	0.52
5+50	144.3	132.3	12.0	SB-2	CL	8.17	11.90	24.46	0.49
5+75	142.5	136.7	5.8	SB-2	CL	4.09	5.52	22.29	0.25
6+00	143.6	141.1	2.5	SB-2	CL	1.37	1.39	20.13	0.07
6+25	145.9	145.5	0.4	SB-2	CL	0.01	0.02	17.95	0.00
6+40	148.2	148.2	0.0	SB-1	N/A	0.00	0.00	16.65	0.00

4. HFIR ANALYSIS CHART

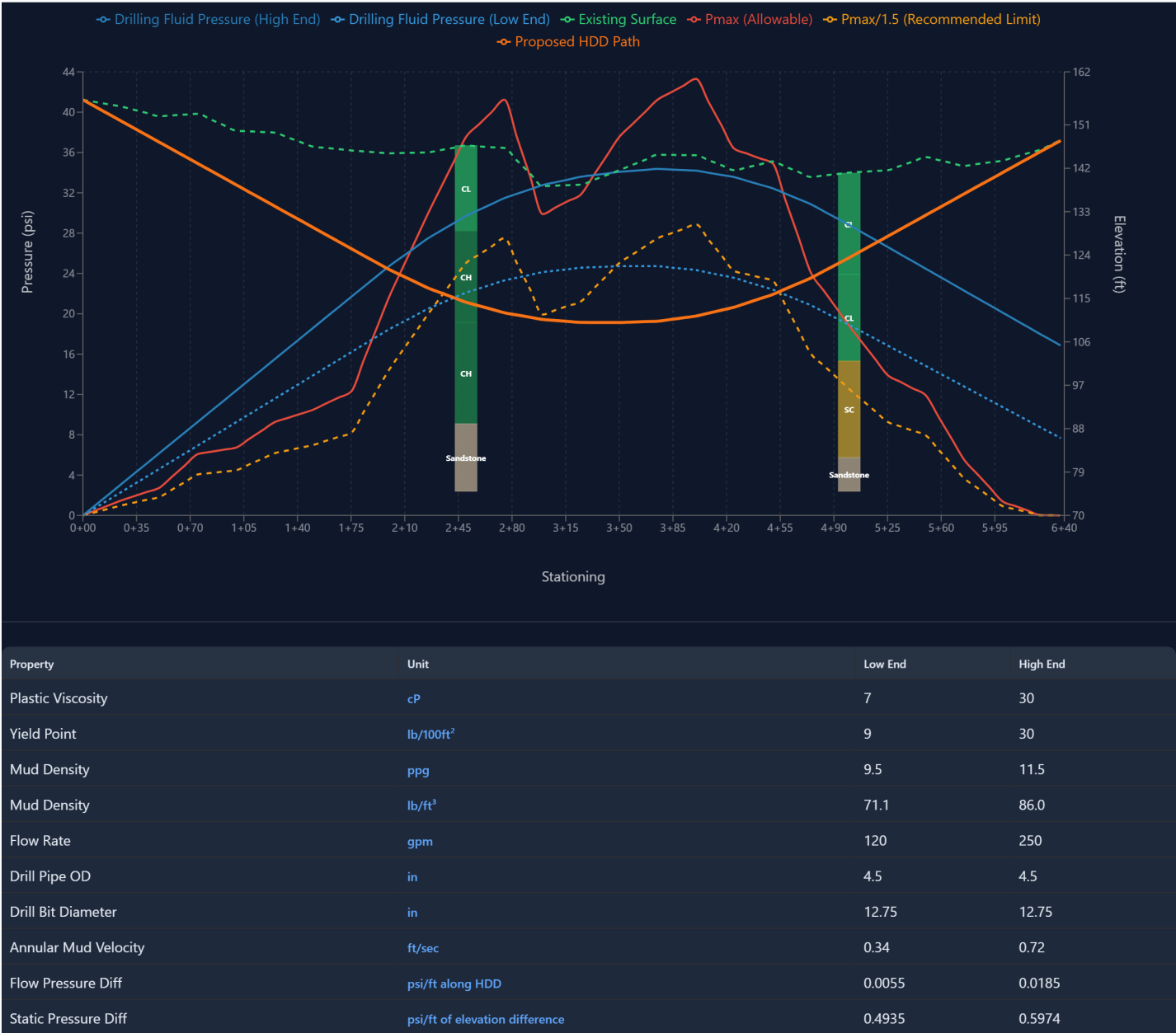


Figure 1 — HFIR Analysis: Allowable Pressure (Pmax) vs. Drilling Fluid Pressure Along HDD Profile

HFIR — Hydraulic Fracture Initiation & Return

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5. FACTOR OF SAFETY CHART

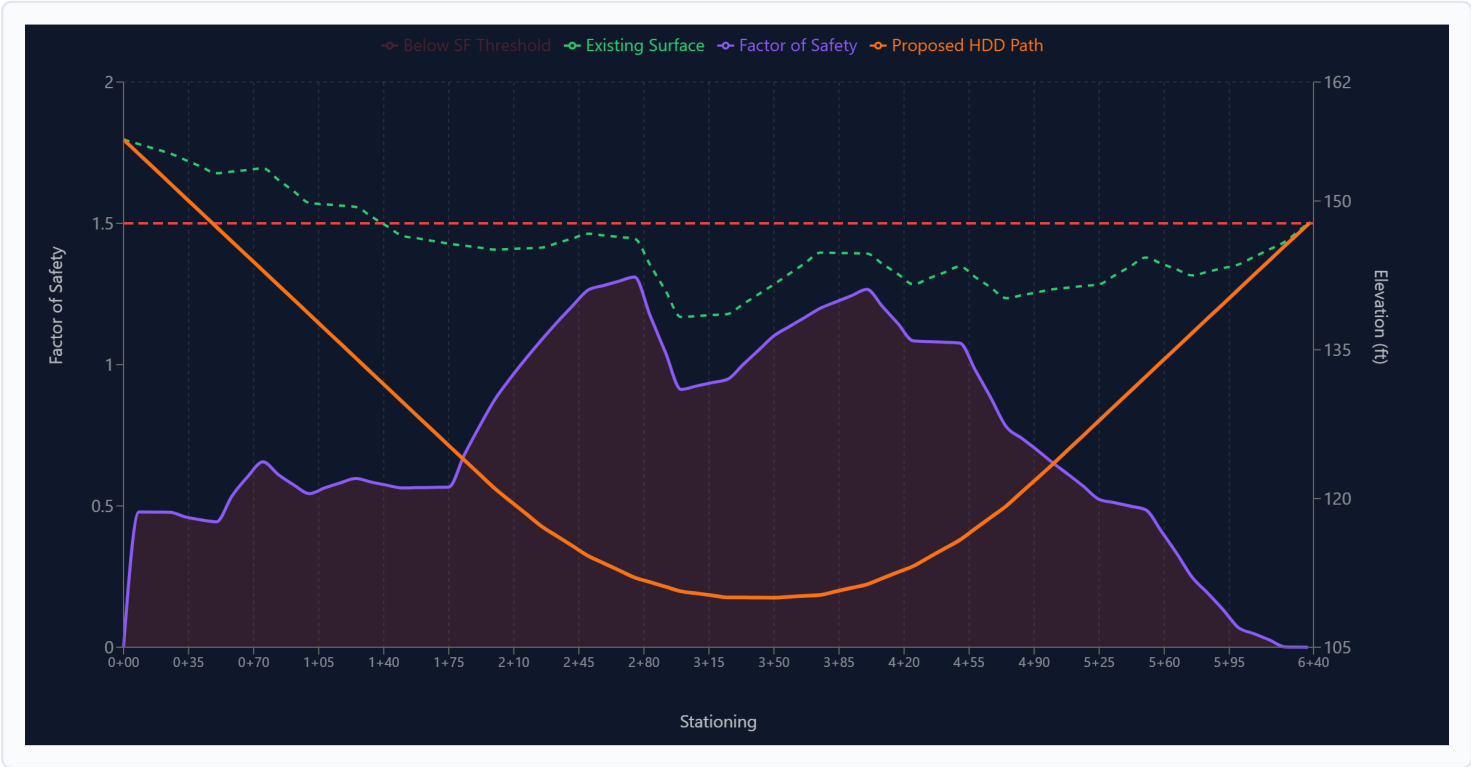


Figure 2 — Factor of Safety (P_{max} / High-End Drilling Fluid Pressure) Along HDD Alignment