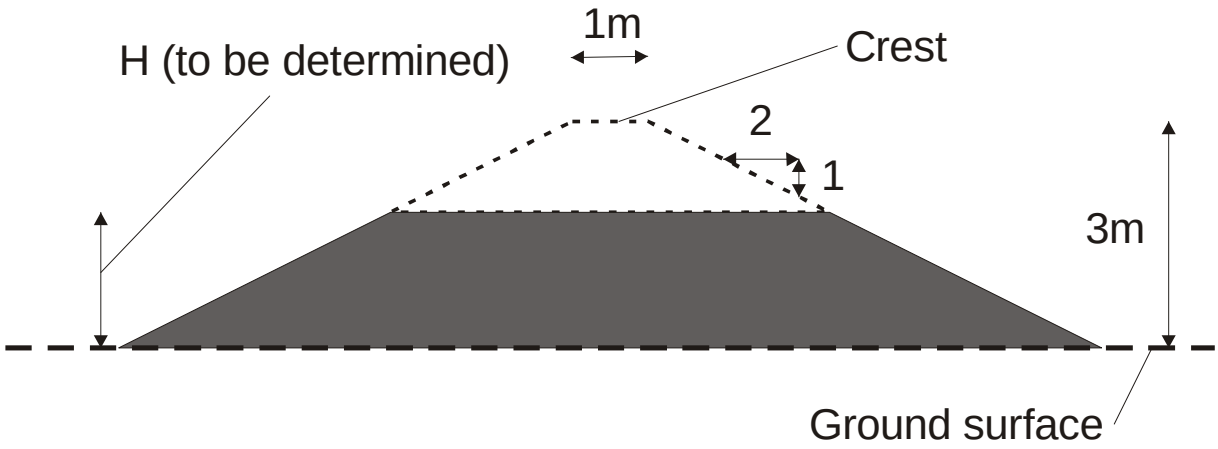
Example 2.5: Embankment on soft peat

An embankment is to be designed which shall enclose an area that will later be hydraulically filled with dredged material. The final height of the embankment will be 3 m, the inclination of the embankment slopes is to be 1:2, and the crest is to have a width of 1 m with no loading. The weight density of the sand fill to form the embankment is 19 kN/m^3 and its characteristic angle of shearing resistance is φ'_k = 32.5°.

The ground surface is effectively horizontal at a level of approximately NN -1.0 m. The ground consists of a few dm of topsoil and normally consolidated clay (weight density of γ = 18 kN/m³ and effective weight density of γ = 9 kN/m³) on a 3 to 7 m thick pseudo-fibrous to amorphous holocene peat layer with an effective weight density of γ' = 2 kN/m³ overlaying pleistocene sand of medium density having an effective weight density of 11 kN/m^3 and a characteristic angle of shearing resistance of φ'_k = 35°. The peat may be assumed to act in an undrained manner during the construction of the embankment. Figures 2.5a to 2.5e show the results of two borings and five vane tests, which have been performed and evaluated according to DIN 4094:2002 “Subsoil – Field testing – Part 4: Field vane tests”. The vane had a width D = 75 mm and height H = 150 mm. The vane tests have a spacing of 40 to 50 m and are situated at the centreline of the embankment. Table 2.5a provides an explanation for the symbols and terms used on the borehole logs.



The objective of this design example is to predict how high the embankment can be constructed in a first phase, without any reinforcement between the embankment and the ground. The topsoil is not to be removed before constructing the embankment. Furthermore it should be assumed that the area within the embankment has not been filled with dredged material. No serviceability requirements have to be fulfilled. No accidental design situations to be checked. This is a persistent design situation, where no variable actions (due to construction machinery) have to be taken into account.

Details of the ground investigation are given below.

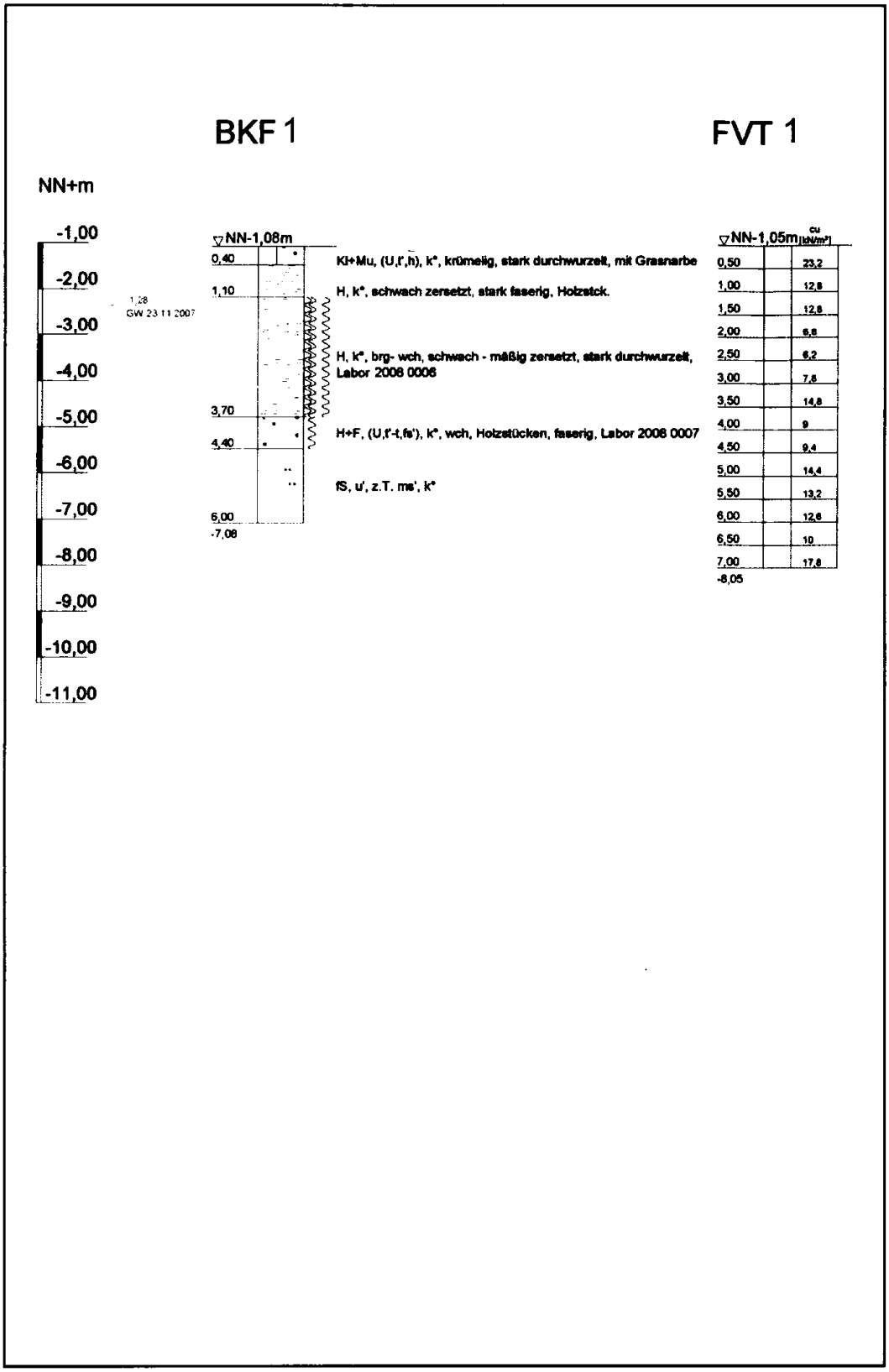


Figure 2.5a: Borehole log and vane test 1

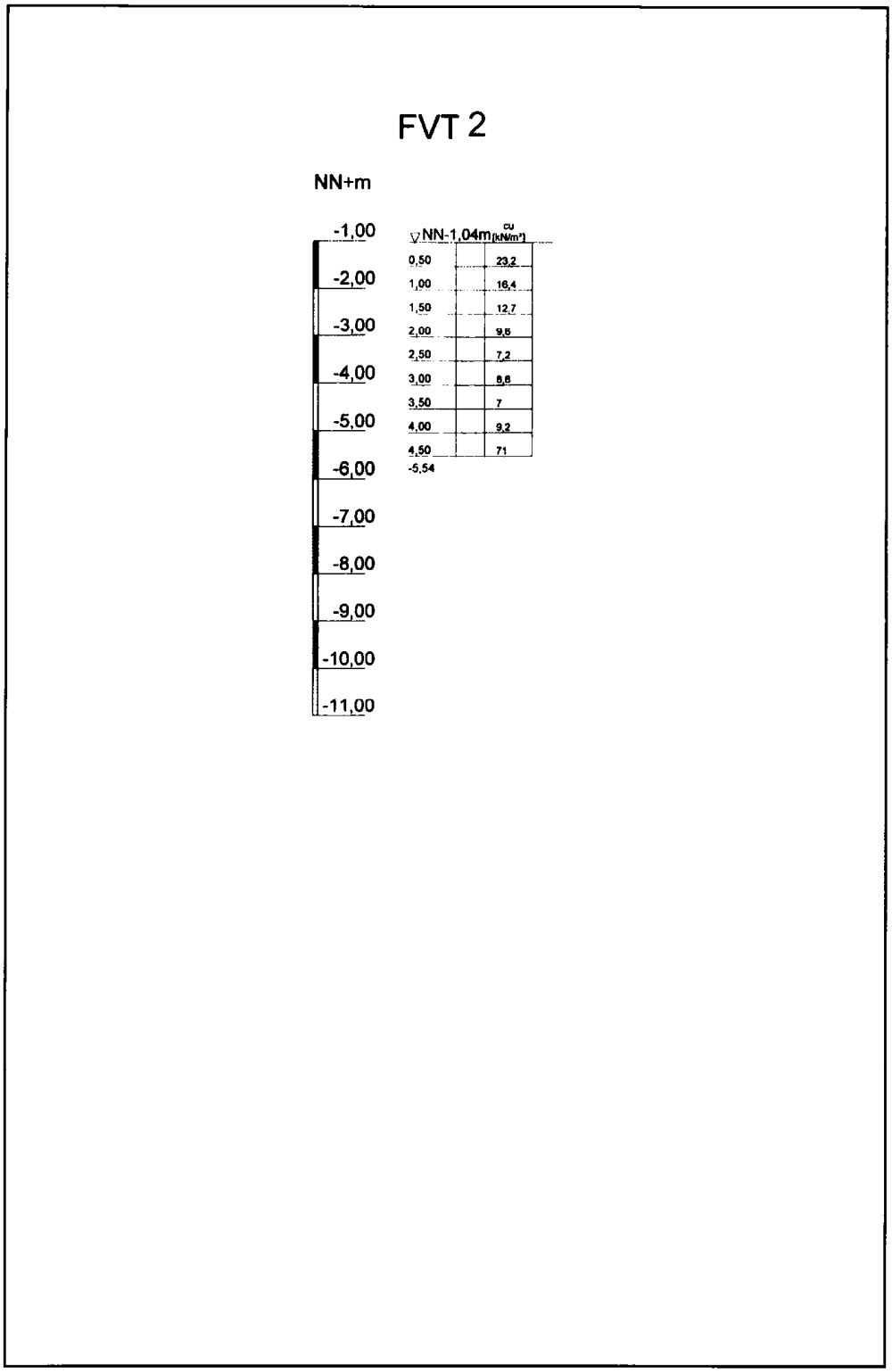


Figure 2.5b: Vane test 2

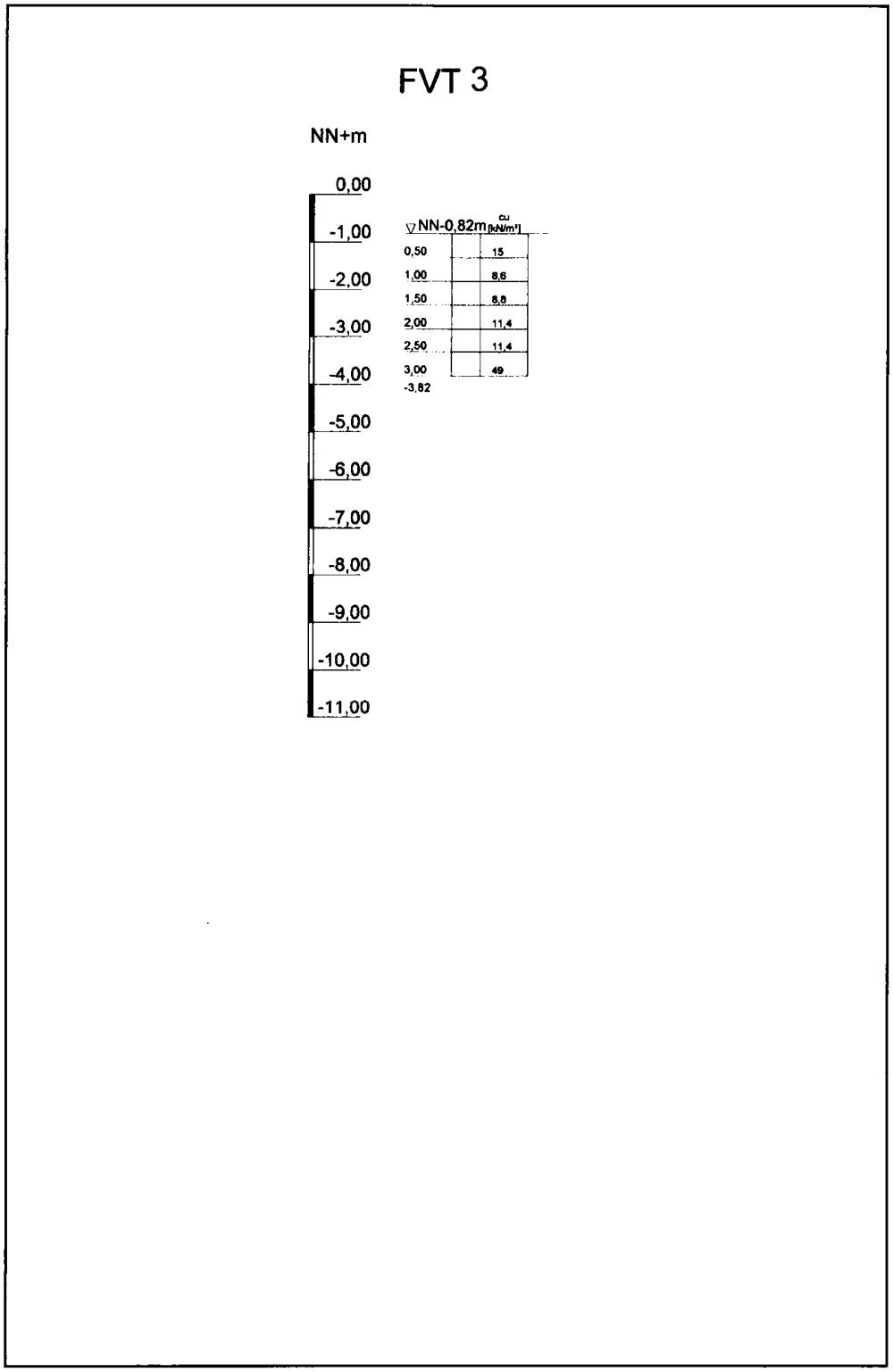


Figure 2.5c: Vane test 3

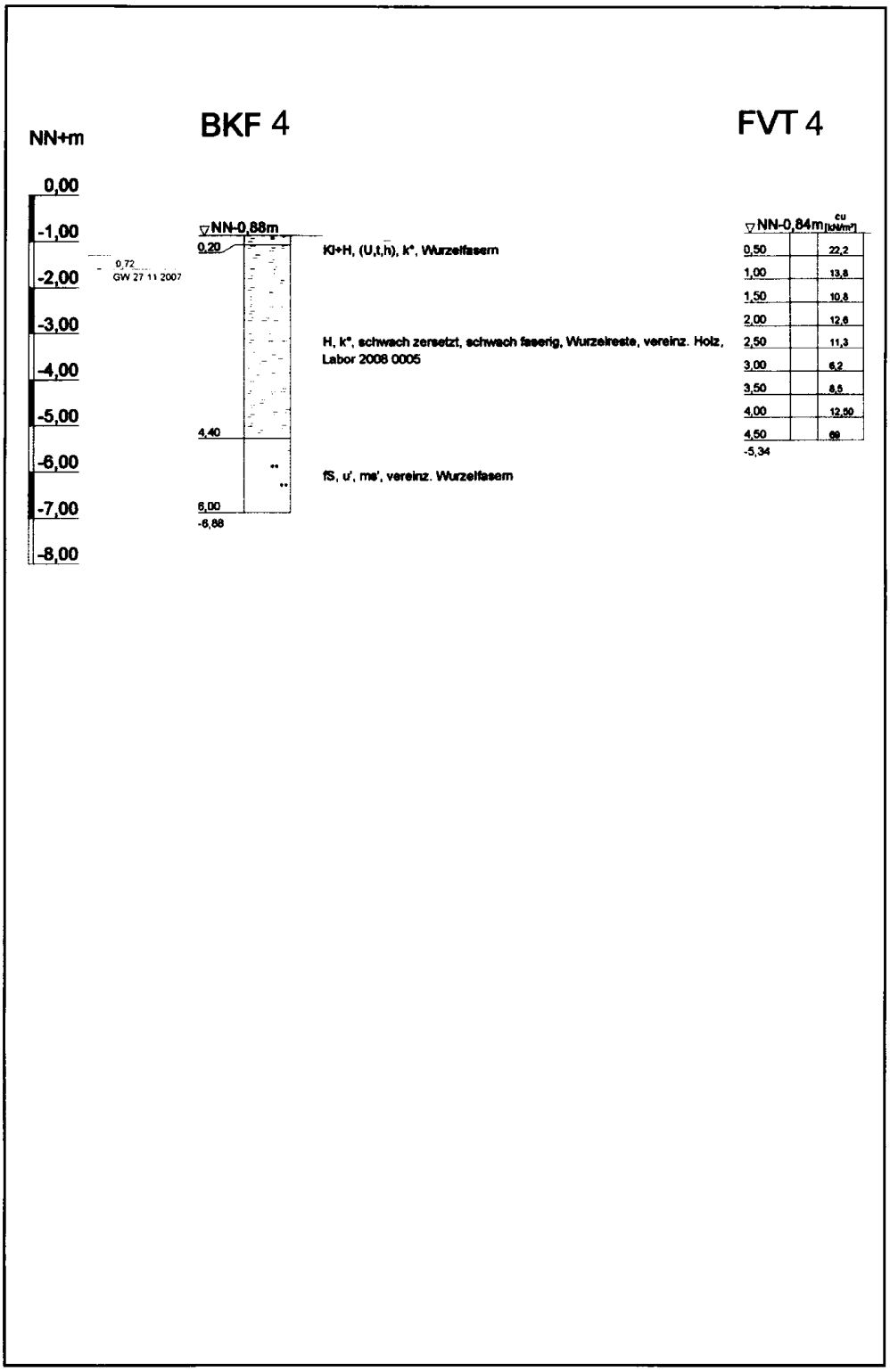


Figure 2.5d: Borehole log and vane test 4

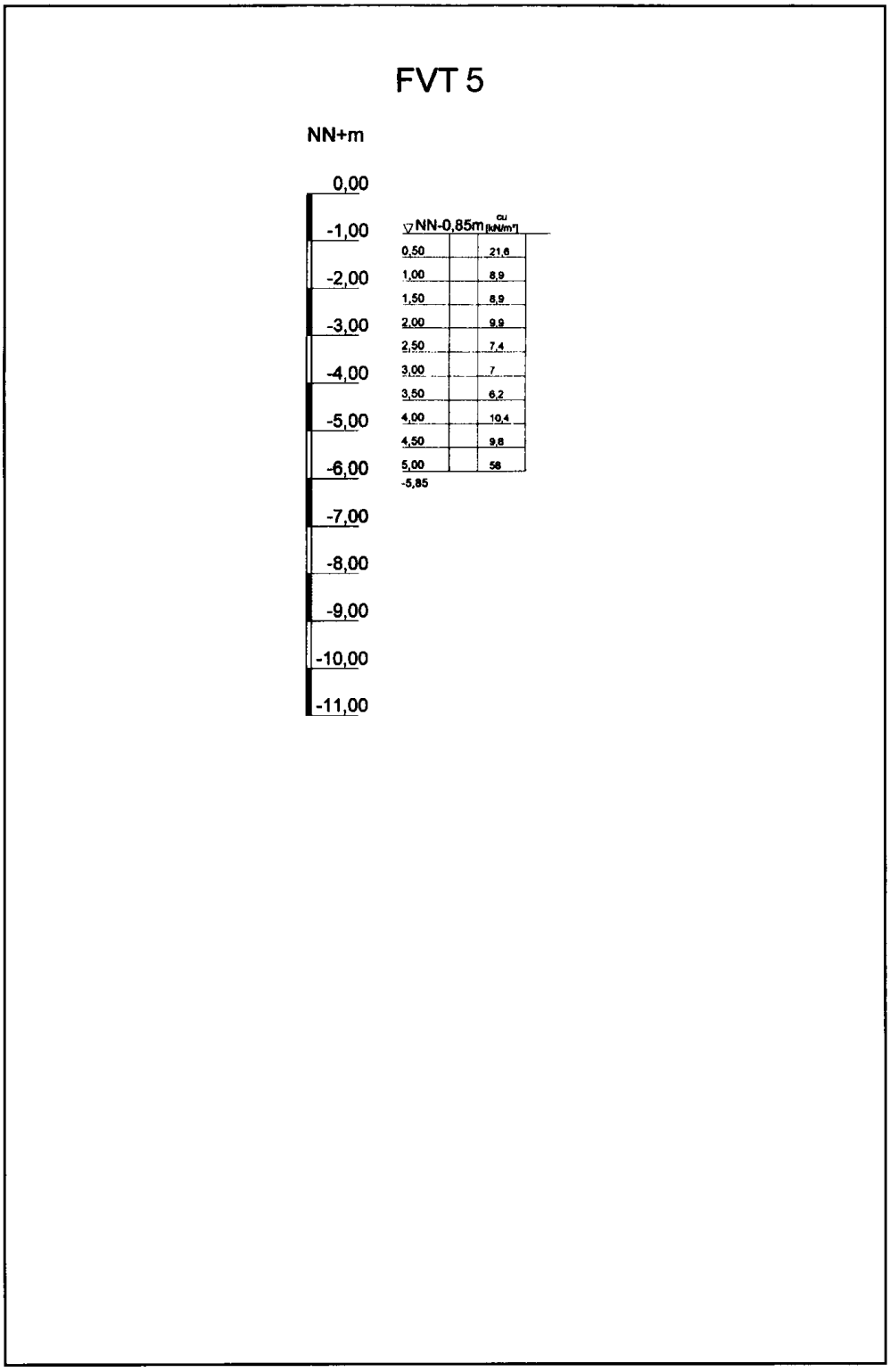


Figure 2.5e: Vane test 5

Table 2.5a: Symbols and terms used on the Borehole logs

Symbol/Term	Description
BKF	Boring, where cores are taken in a liner
F	Sapropel
fS, fs	fine sand, with fine sand
H, h	peat, peaty
Holzstücke	pieces of wood
k°	containing carbonate
Kl	clay
mäßig zersetzt	amorphous peat
mS, ms, ms´	medium sand, with medium sand, with little medium sand
Mu	topsoil
NN	sea level
S, s	sand, sandy
schwach zersetzt	pseudo-fibrous peat
stark faserig	fibrous peat
T, t	clay (fraction), clayey,
U, u, u´	silt, silty, with little silt
Wurzelfasern	root fibres
z	Depth

Table 2.5b: Undrained shear strength measured by field vane tests

Depth below ground level m	Undrained shear strength measured by field vane tests in kN/m²				
	FVT 1	FVT 2	FVT 3	FVT 4	FVT 5
0.5	23,20	23,20	15,00	22,20	21,60
1.0	12,80	16,40	8,60	13,80	8,90
1.5	12,80	12,70	8,80	10,80	8,90
2.0	6,60	9,60	11,40	12,60	9,90
2.5	6,20	7,20	11,40	11,30	7,40
3.0	7,80	8,80		6,20	7,00
3.5	14,80	7,00		8,50	6,20
4,0	9,00	9,20		12,50	10,40
4.5	9,40				9,80
5.0	14,40				
5.5	13,20				
6.0	12,60				
6.5	10,00				
7.0	17,80				