Table E-1(1) Dam Cost Curve

Musaverema (I − 2 − 1)

River Bed EL.671.0m F.S.L. 680.0m

Overflow Head(ho)	m	1.0	1.5	2.0	2.5	3.0	
Freeboard	m	2.2	2.7	3.5	3.7	4.2	
Dam Hight	m	11.7	12.2	12.7	13.2	13.7	
Dam Crest EL.	m	682.7	683.2	683.7	684.2	684.7	
Dam Vol.	m³	233,000	268,000	306,000	345,000	383,000	
Dam Cost	$	1,165,000	1,340,000	1,530,000	1,725,000	1,915,000	
Spillway Length	m	492	268	174	125	95	
Spillway Vol. 1.	m³	1,662	1,179	735	309	212	
Spillway Cost 1.	$	265,900	188,600	117,600	49,400	33,900	※1
- do - 2	$	141,300	100,200	62,500	26,300	18,000	※2
Excavation Vol.	m³	100,000	4,500	—	—	—	
- do - Cost	$	4,000,000	180,000	—	—	—	
Total Cost 1.	$	5,430,900	1,708,700	1,647,700	1,774,500	1,948,900	
- do - 2.	$	5,306,300	1,620,200	1,592,500	1,751,300	1,933,000	

※1 Concrete, ※2 Stone Masonry

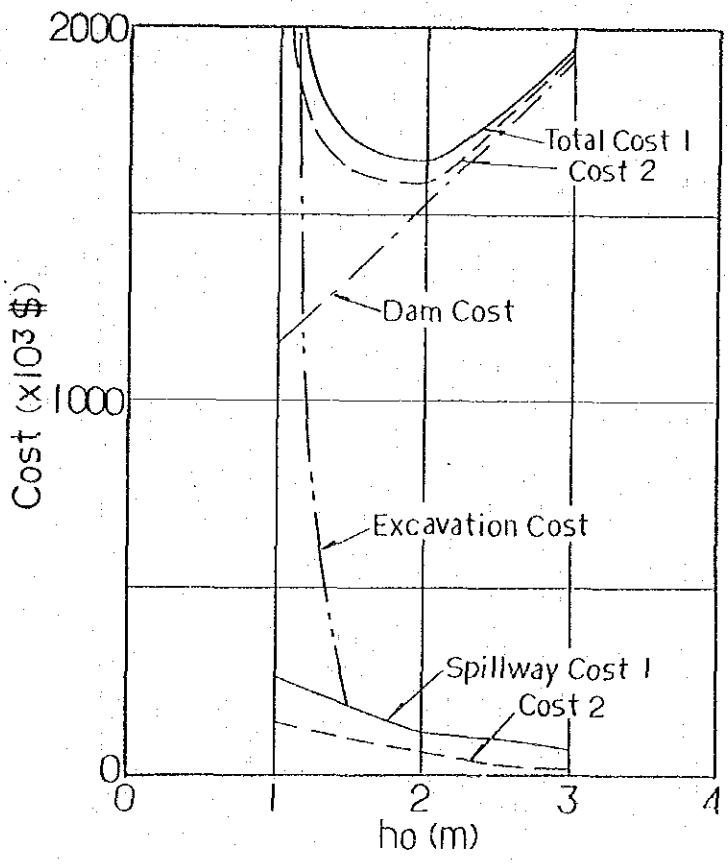


Table E-1(2) Dam Cost Curve

Chinyamatumwa (Ⅱ－1－6)

River Bed EL. 735.0m F.S.L. 751.0m

Overflow Head(ho)	m	1.0	1.5	2.0	2.5	3.0	
Freeboard	m	2.2	2.7	3.2	3.7	4.2	
Dam Hight	m	18.7	19.2	19.7	20.2	20.7	
Dam Crest EL.	m	753.7	754.2	754.7	755.2	755.7	
Dam Vol.	m³	152,000	166,000	179,000	194,000	211,000	
Dam Cost	$	760,000	830,000	895,000	970,000	1,055,000	
Spillway Length	m	96.0	53.0	34.0	25.0	19.0	
Spillway Vol. 1.	m³	3,300	700	200	120	90	
Spillway Cost 1.	$	528,000	112,000	32,000	19,200	14,400	※1
- do - 2	$	280,500	59,500	17,000	10,200	7,700	※2
Excavation Vol.	m³	80,000	34,800	34,800	34,800	34,800	
- do - Cost	$	280,000	121,800	121,800	121,800	121,800	
Total Cost 1.	$	1,568,000	1,063,800	1,048,800	1,111,000	1,191,200	
- do - 2.	$	1,320,500	1,011,300	1,033,800	1,102,000	1,184,500	

※1 Concrete, ※2 Stone Masonry

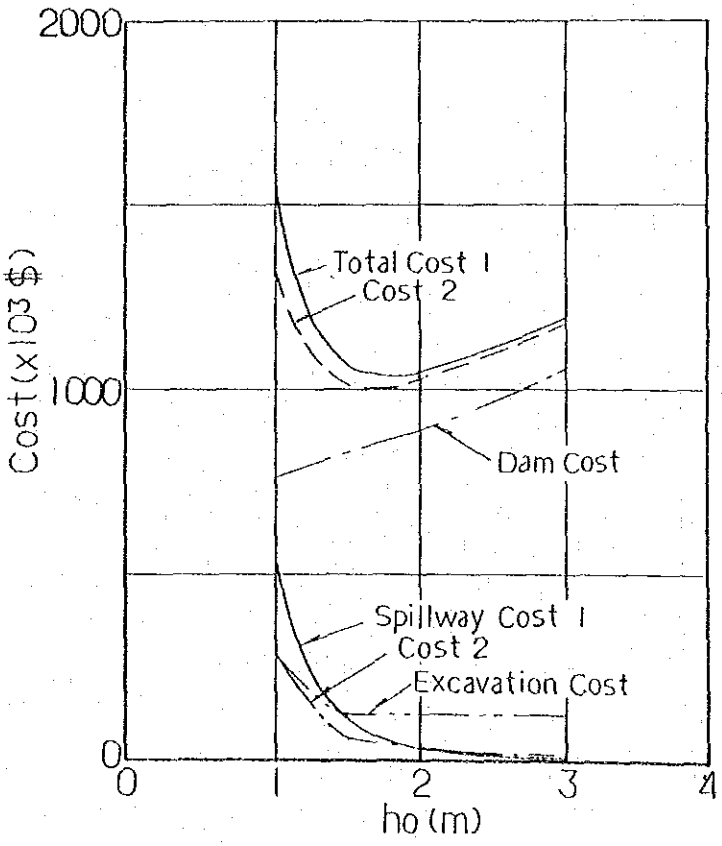


Table E-1(3) Dam Cost Curve

Mashoko (Ⅱ－2－1)

River Bed EL. 648.0m F.S.L. 664.0m

Overflow Head(ho)	m	1.0	1.5	2.0	2.5	3.0	
Freeboard	m	2.2	2.7	3.2	3.7	4.2	
Dam Hight	m	18.7	19.2	19.7	20.2	20.7	
Dam Crest EL.	m	666.7	667.2	667.7	668.2	668.7	
Dam Vol.	m³	208,000	220,000	237,000	262,000	279,000	
Dam Cost	$	1,040,000	1,100,000	1,185,000	1,310,000	1,395,000	
Spillway Length	m	134	73	48	34	26	
Spillway Vol. 1.	m³	865	435	245	135	65	
Spillway Cost 1.	$	138,400	69,600	39,200	21,600	10,400	※1
- do - 2	$	73,500	37,000	20,800	11,500	5,500	※2
Excavation Vol.	m³	13,500	—	—	—	—	
- do - Cost	$	540,000	—	—	—	—	
Total Cost 1.	$	1,718,400	1,169,600	1,224,200	1,331,600	1,405,400	
- do - 2.	$	1,653,500	1,137,000	1,205,800	1,321,500	1,400,500	

※1 Concrete, ※2 Stone Masonry

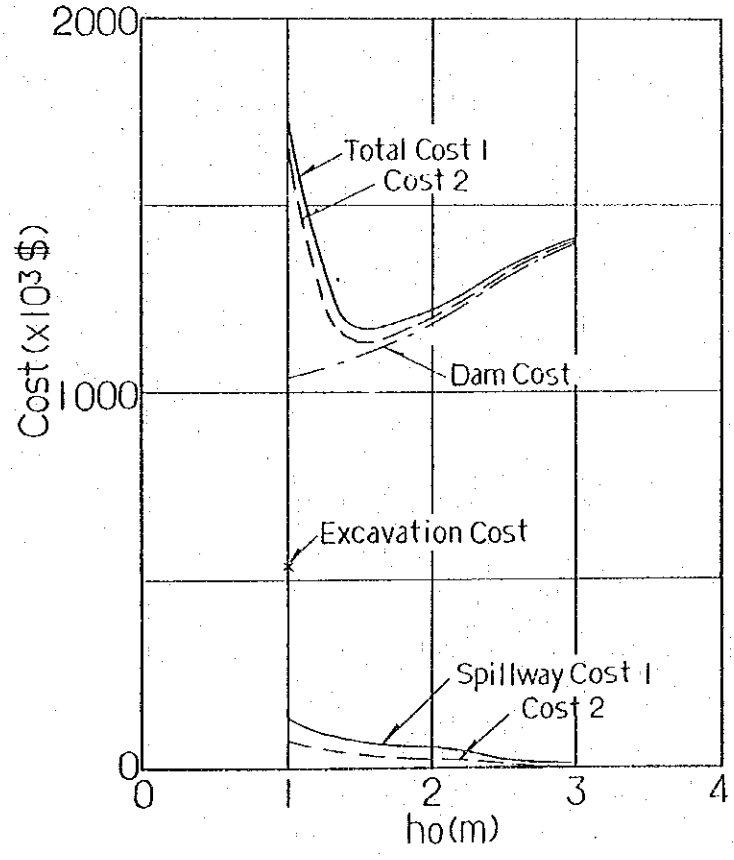


Table E-1(4) Dam Cost Curve

Munjanganja (IV－4－10)

River Bed EL. 1,132.0m F.S.L. 1,149.0m

Overflow Head(ho)	m	1.0	1.5	2.0	2.5	3.0	
Freeboard	m	1.1	2.6	3.1	3.6	4.1	
Dam Hight	m	19.6	20.1	20.6	21.1	21.6	
Dam Crest EL.	m	1,151.6	1,152.1	1,152.6	1,153.1	1,153.6	
Dam Vol.	m³	340,000	400,000	430,000	455,000	490,000	
Dam Cost	$	1,700,000	2,000,000	2,150,000	2,275,000	2,450,000	
Spillway Length	m	206	112	73	52	40	
Spillway Vol. 1.	m³	233	125	83	58	45	
Spillway Cost 1.	$	37,300	20,000	13,300	9,280	7,200	※1
- do - 2	$	19,800	10,600	7,100	4,900	3,800	※2
Excavation Vol.	m³	56,400	30,700	20,000	14,200	11,000	
- do - Cost	$	197,400	107,500	70,000	49,700	38,500	
Total Cost 1.	$	1,934,600	2,127,500	2,233,300	2,334,000	2,495,700	
- do - 2.	$	1,917,200	2,118,100	2,227,100	2,329,600	2,492,900	

※1 Concrete, ※2 Stone Masonry

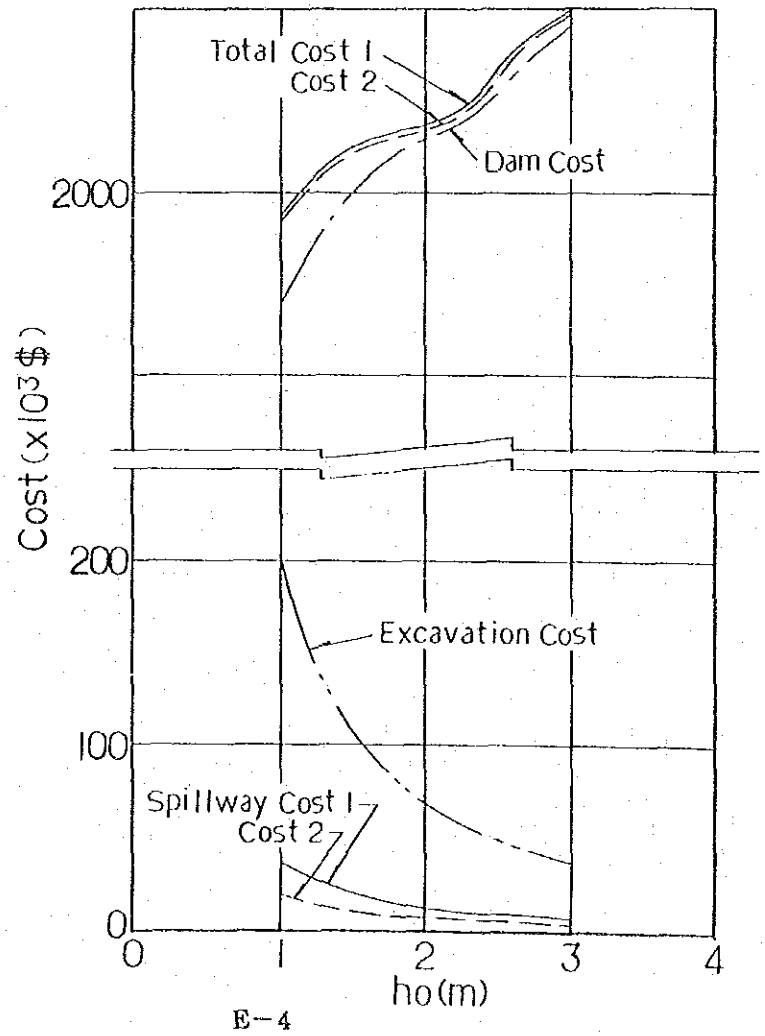


Table E-1(5) Dam Cost Curve

Nagudu (V-3-3)

River Bed EL.514.0m F.S.L. 529.0m

Overflow Head(ho)	m	1.5	2.0	2.5	3.0	4.0	
Freeboard	m	2.7	3.2	3.7	4.2	5.2	
Dam Hight	m	18.2	18.7	19.2	19.7	20.7	
Dam Crest EL.	m	532.2	532.7	533.2	533.7	534.7	
Dam Vol.	m³	146,000	156,000	165,000	173,000	192,000	
Dam Cost	$	730,000	780,000	825,000	865,000	960,000	
Spillway Length	m	133	87	62	47	31	
Spillway Vol. 1.	m³	4,195	2,382	1,218	709	313	
Spillway Cost 1.	$	671,200	381,120	194,880	113,440	50,080	※1
- do - 2	$	356,578	202,470	103,530	60,265	26,605	※2
Excavation Vol.	m³	12,500					
- do - Cost	$	500,000					
Total Cost 1.	$	1,901,200	1,161,100	1,019,900	978,400	1,010,100	
- do - 2.	$	1,586,600	982,500	928,530	925,300	986,600	

※1 Concrete, ※2 Stone Masonry

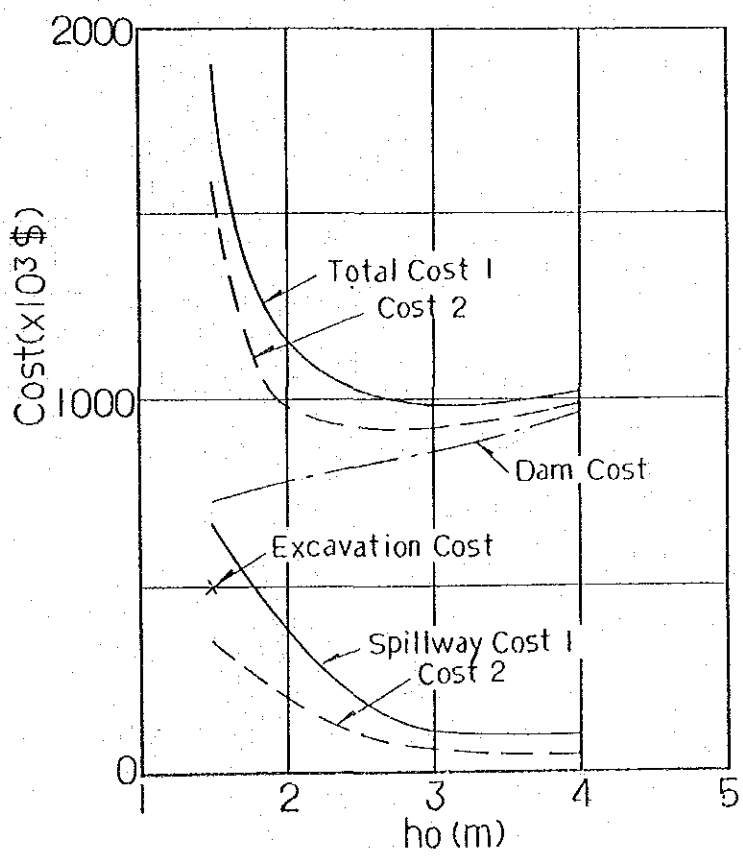


Table E-1(6) Dam Cost Curve

Mabvute (Ⅶ－1－12)

River Bed EL.629.0 F.S.L. 644.0m

Overflow Head(ho)	m	1.0	1.5	2.0	2.5	3.0	4.0	
Freeboard	m	2.2	2.7	3.2	3.7	4.2	5.2	
Dam Hight	m	17.2	17.7	18.2	18.5	19.2	20.2	
Dam Crest EL.	m	646.2	646.7	647.2	647.7	648.2	649.2	
Dam Vol.	m^3	154,000	168,000	185,000	201,000	222,000	255,000	
Dam Cost	$	770,000	840,000	925,000	1,005,000	1,110,000	1,275,000	
Spillway Length	m	202	110	72	52	39	29	
Spillway Vol.	m^3	222	121	79	57	43	29	
Spillway Cost 1.	$	35,520	19,360	12,640	9,100	6,880	4,640	※1)
do - 2	$	18,870	10,290	6,720	4,850	3,660	2,470	※2)
Excavation Vol.	m^3	375,800	150,400	80,400	50,000	33,200	24,900	
※3) - do - Cost	$	7,516,000	3,008,000	1,608,000	1,000,000	664,000	498,000	
Total Cost 1.	$	8,321,500	3,867,400	2,545,600	2,014,100	1,780,900	1,777,600	
- do - 2.	$	8,304,900	3,858,300	2,539,700	2,009,900	1,777,700	1,775,500	

※1) Concrete , ※2) Stone Masonry, ※3) 40$/㎥X0.5

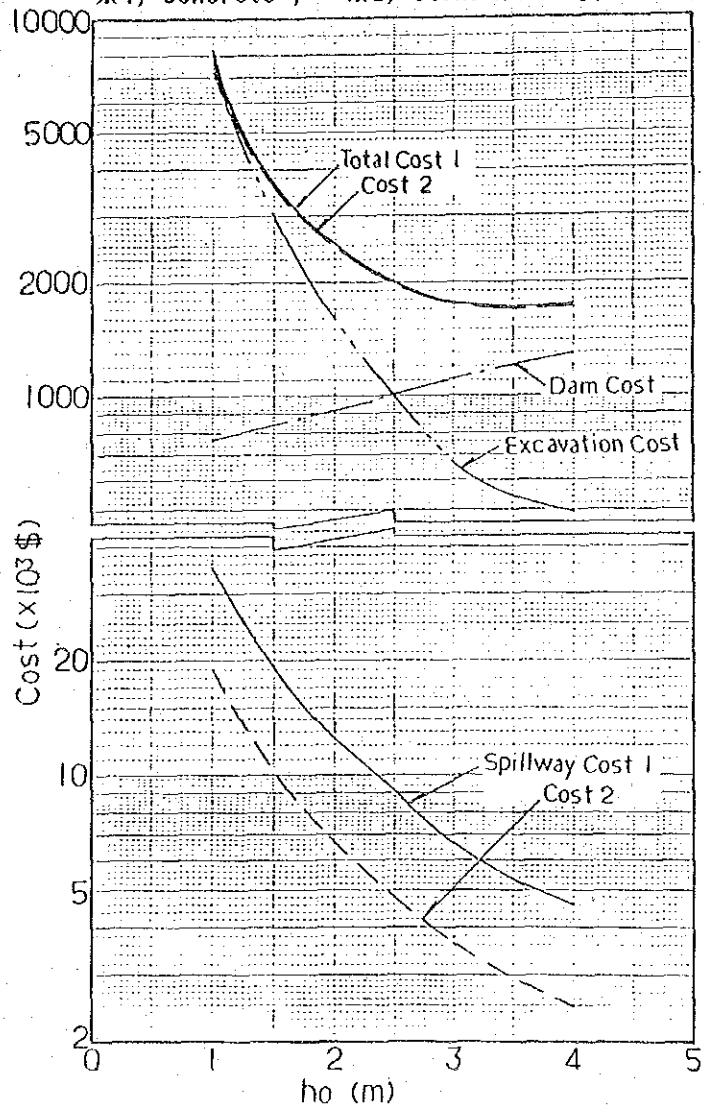


Table E-2(1) Calculation of Dam Volume(tentative)

No. I－2－1 Musaverema

River Bed Elevation 671.0 m ····· (H_1)

River Bed Width 215.0 m ····· (L_2)

Dam Crest Width 6.0 m ····· (B)

F.S.L. 680.0 m ····· (H_2)

Upstream Slope 1:2.25 ····· (M) Downstream Slope 1:2.20 ····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	679.5	681.5	682.5	683.5	684.5	685.5
Dam Hight	H	m	9	11	12	13	14	15
Crest Length	L_1	m	930	1,216	1,435	1,740	1,845	1,946
Dam Volume	V_D	$\times 10^3$ m³	109	188	250	336	402	456

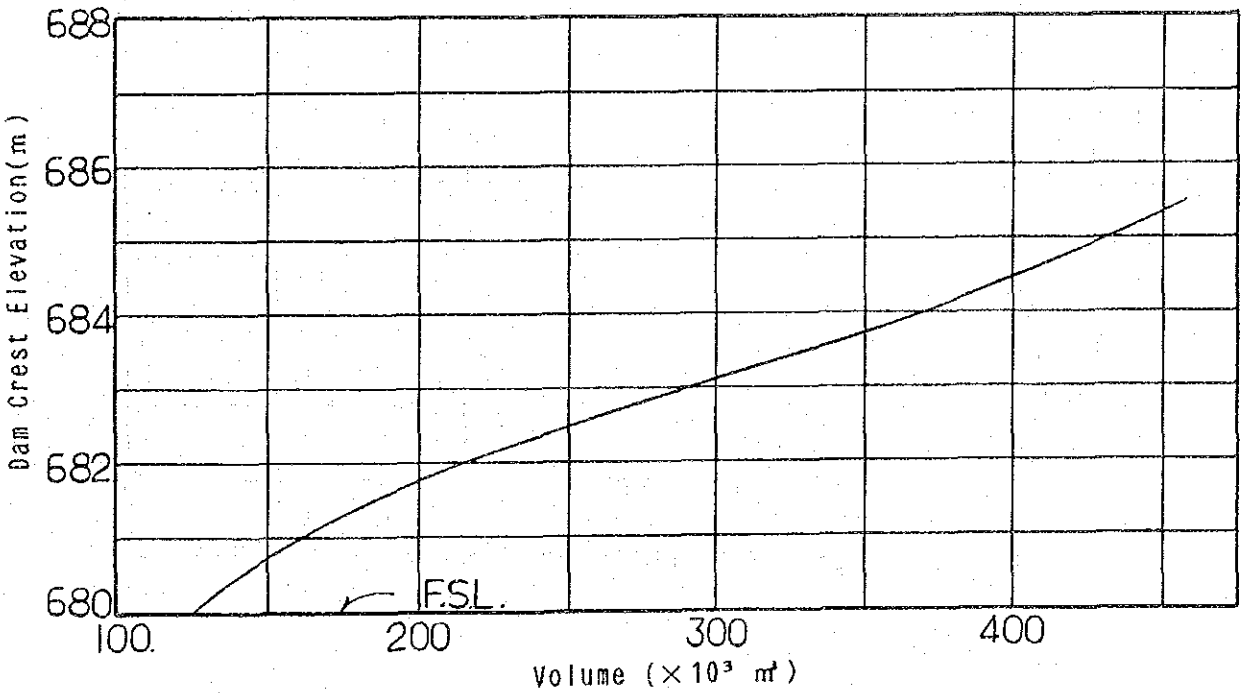


Table E-2(2) Calculation of Dam Volume(tentative)

No. Ⅱ－1－6 Chinyamatumwa

River Bed Elevation	735.0	m	····· (H_1)
River Bed Width	20.0	m	····· (L_2)
Dam Crest Width	6.0	m	····· (B)
F.S.L.	751	m	····· (H_2)

Upstream Slope 1:2.25 ····· (M) Downstream Slope 1:2.0 ····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	750.5	752.5	753.5	754.5	755.5	756.5	757.5
Dam Hight	H	m	16	18	19	20	21	22	23
Crest Length	L_1	m	383	442	479	512	560	615	681
Dam Volume	V_D	$\times 10^3$ m³	96	136	161	188	224	266	319

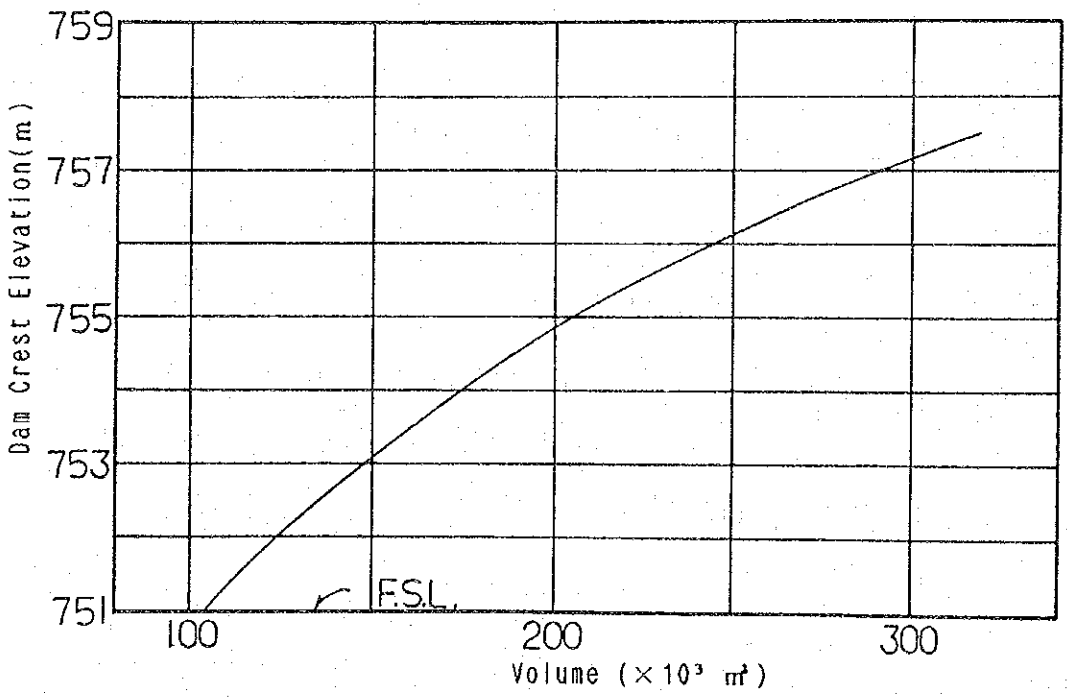


Table E-2(3) Calculation of Dam Volume(tentative)

No. Ⅱ－2－1 Mashoko

River Bed Elevation 648.0 m ····· (H_1)

River Bed Width 10.0 m ····· (L_2)

Dam Crest Width 6.0 m ····· (B)

F.S.L. 664.0 m ····· (H_2)

Upstream Slope 1:2.25 ····· (M) Downstream Slope 1:2.0 ····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	663.5	665.5	666.5	667.5	668.5	669.5	670.5
Dam Hight	H	m	16	18	19	20	21	23	24
Crest Length	L_1	m	590	663	702	725	743	753	792
Dam Volume	V_D	$\times 10^3$ m³	139	193	214	255	286	342	389

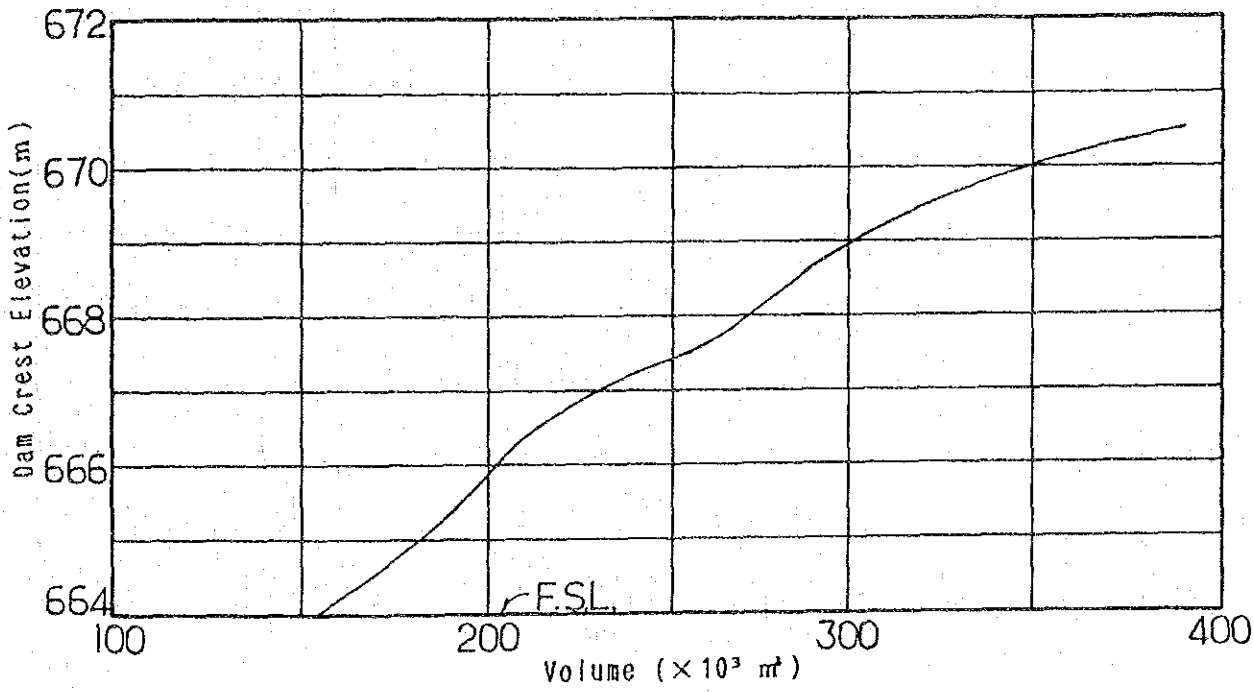


Table E-2(4) Calculation of Dam Volume(tentative)

No. Ⅳ－4－10 Munjanganja

River Bed Elevation	1,132.0 m	····· (H_1)
River Bed Width	15.0 m	····· (L_2)
Dam Crest Width	6.0 m	····· (B)
F.S.L.	1,149.0 m	····· (H_2)

Upstream Slope 1:2.25 ····· (M) Downstream Slope 1:2.0····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	1148.5	1150.5	1151.5	1152.5	1153.5
Dam Hight	H	m	17	19	20	21	22
Crest Length	L_1	m	610	850	1,123	1,180	1,300
Dam Volume	V_D	x10^3 m³	163	274	395	453	543

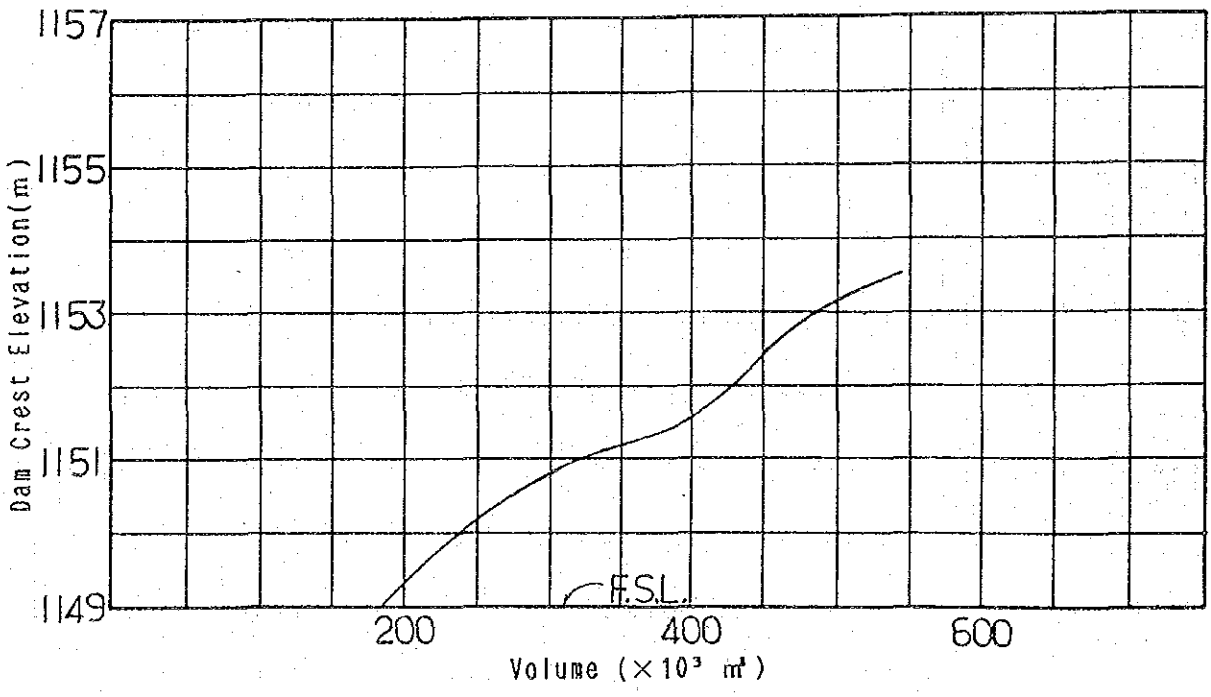


Table E-2(5) Calculation of Dam Volume(tentative)

No. V－3－3 Magudu

River Bed Elevation 514.0 m ····· (H_1)

River Bed Width 30.0 m ····· (L_2)

Dam Crest Width 6.0 m ····· (B)

F.S.L. 529.0 m ····· (H_2)

Upstream Slope 1:2.25 ····· (M) Downstream Slope 1:2.0 ····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	528.5	530.5	531.5	532.5	533.5	534.5	535.5
Dam Hight	H	m	15	17	18	19	20	21	22
Crest Length	L_1	m	407	430	447	456	463	471	477
Dam Volume	V_D	$\times 10^3$ m³	94	124	142	160	178	197	218

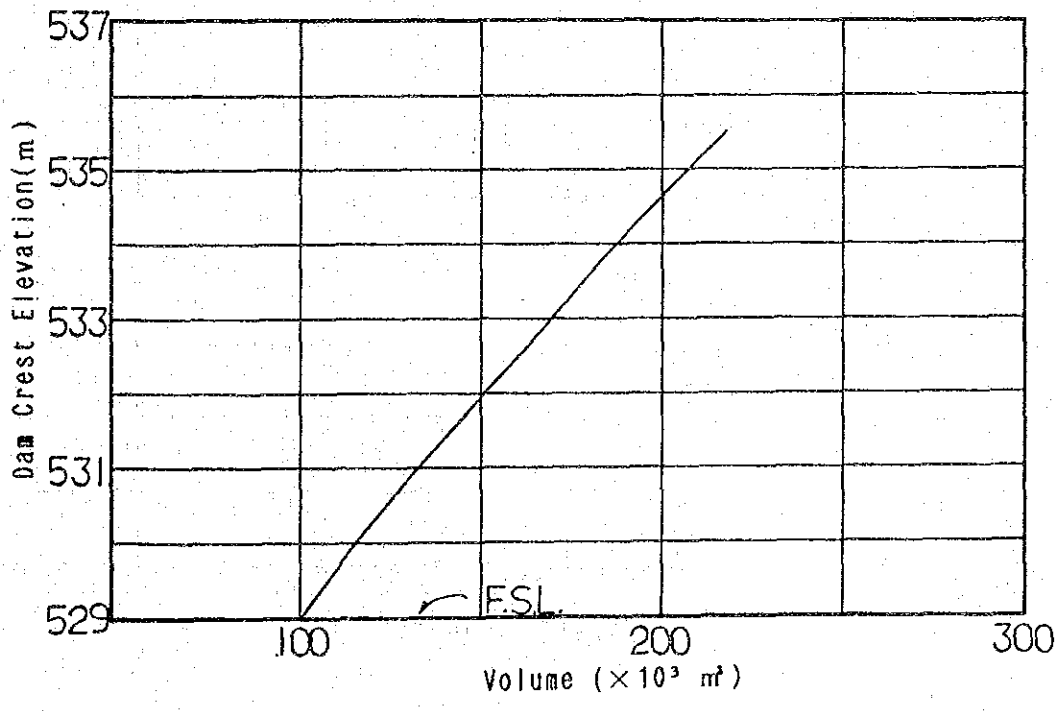


Table E-2(6) Calculation of Dam Volume(tentative)

No. VI－1－12　　Mabvuti

River Bed Elevation	629.0 m	····· (H_1)
River Bed Width	20.0 m	····· (L_2)
Dam Crest Width	6.0 m	····· (B)
F.S.L.	644.0 m	····· (H_2)

Upstream Slope 1:2.25 ····· (M)　Downstream Slope 1:2.0····· (N)

$$V_D = 1/2 \cdot B \cdot H (L_1 + L_2) + 1/6 (M+N) \cdot H^2 \cdot (L_1 + 2L_2)$$

$$H = H_2 - H_1 + a$$

Dam Crest EL.		m	643.5	645.5	646.5	647.5	648.5	649.5	650.5
Dam Hight	H	m	15	17	18	19	20	21	22
Crest Length	L_1	m	356	492	540	592	635	680	730
Dam Volume	V_D	$\times 10^3$ m³	80	135	163	196	231	269	313

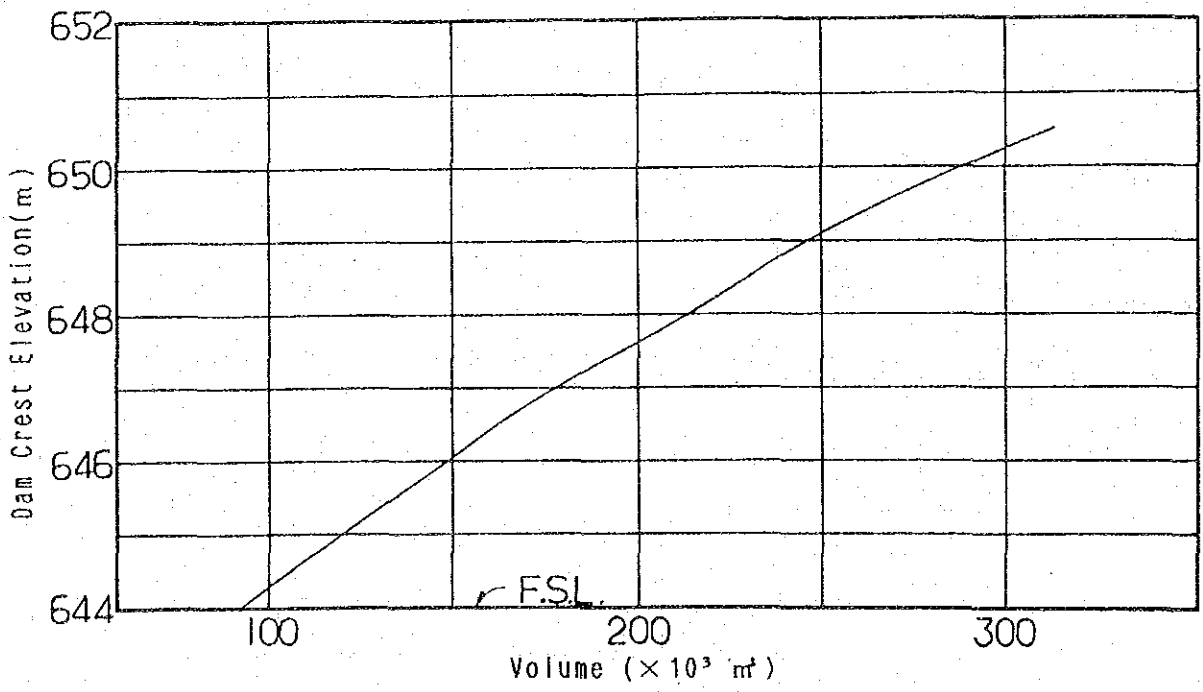


Table E-3(1) Calculation of Spillway Volume(tentative)

NO. I－2－1 Musaverema

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

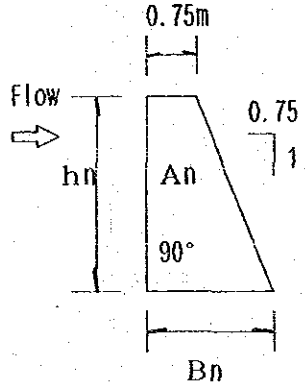
Q ; design flood (835 m³/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	1.0	1.5	2.0	2.5	3.0	5.0	
L	(m)	492	268	174	125	95	44	

2. Volume of Spillway

Spillway Crest Elevation EL. 680.0 m

① Area of Section (An)

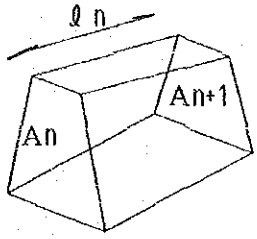


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6	1'	2'
hn	m	1	1	2.9	3.6	4.2	4	1	1
An	m²	1.1	1.1	5.3	7.6	9.8	9.0	1.1	1.1
Σℓ	m	0	44	95	125	174	215	268	492
ℓ n	m	0	44	51	30	49	41	53	439
Vn+1	m³	0	48.4	163.2	97.5	426.3	385.4	58.3	482.9
Σv	m³	0	48.4	211.6	309.1	735.4	1120.8	1179.1	1,662

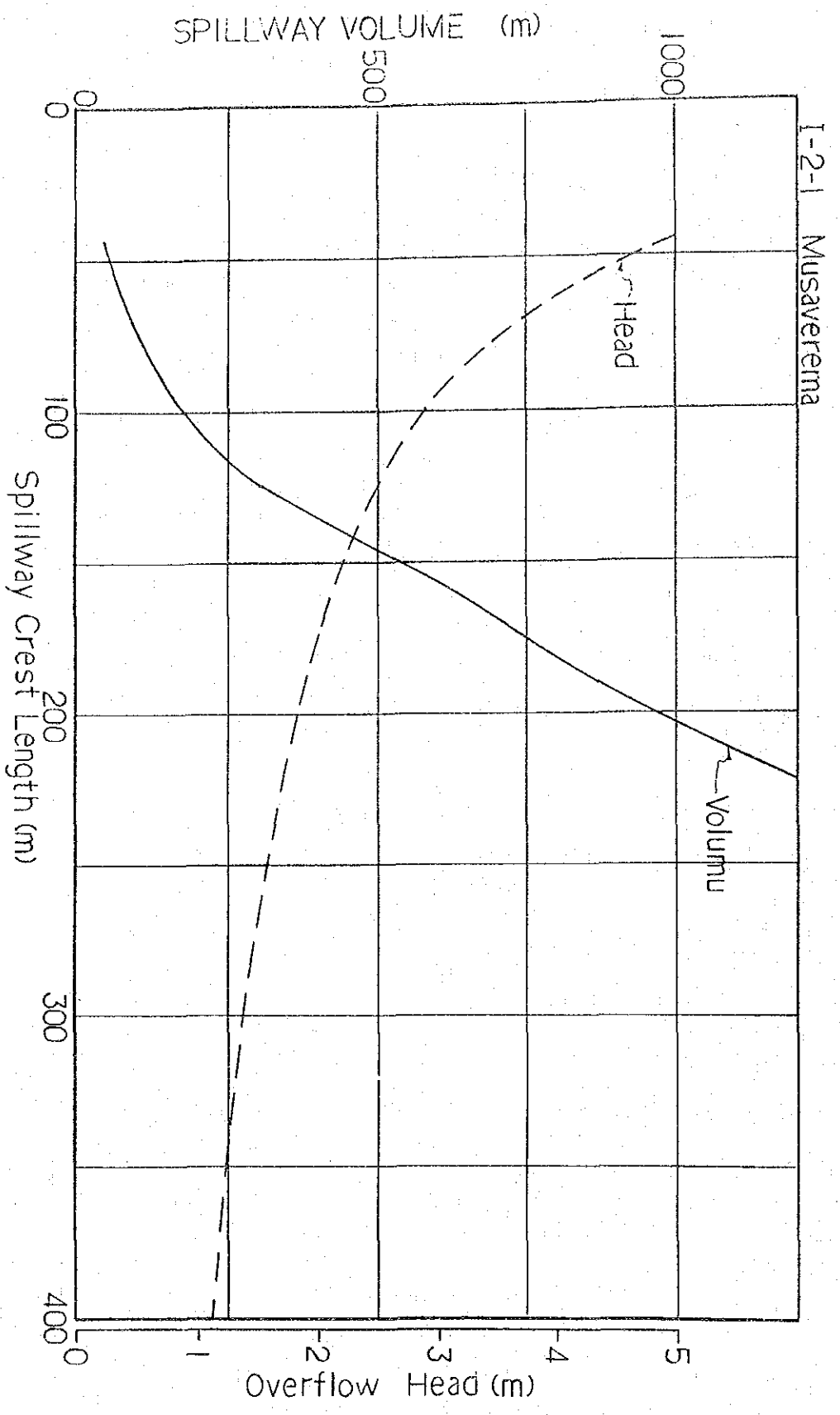

SPILLWAY VOLUME (m)
0
500
1000
I-2-1 Musaverema
Head
Volumu
0
100
200
300
400
Spillway Crest Length (m)
0
1
2
3
4
5
Overflow Head (m)

Table E-3(2) Calculation of Spillway Volume(tentative)

NO. Ⅱ－1－6　　Chinyamatumwa

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

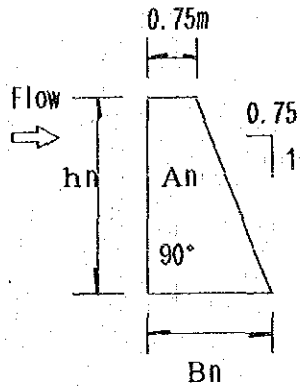
Q ; design flood (163 ㎥/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	0.5	0.75	1.0	1.5	2.0	3.0	5.0
L	(m)	271	148	96	53	34	19	9

2. Volume of Spillway

Spillway Crest Elevation　　EL. 751.0 m

① Area of Section (An)

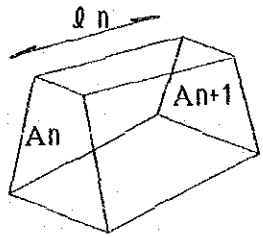


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6
hn	m	0	0.6	1.2	3.1	6.1	9.2
An	㎡	0	0.6	1.4	5.9	18.5	38.6
Σℓ	m	0	10	20	50	100	150
ℓ n	m	0	10	10	30	50	50
Vn+1	㎥	0	3	10	109.5	610	1,427.5
Σv	㎥	0	3	13	122.5	732.5	2,160

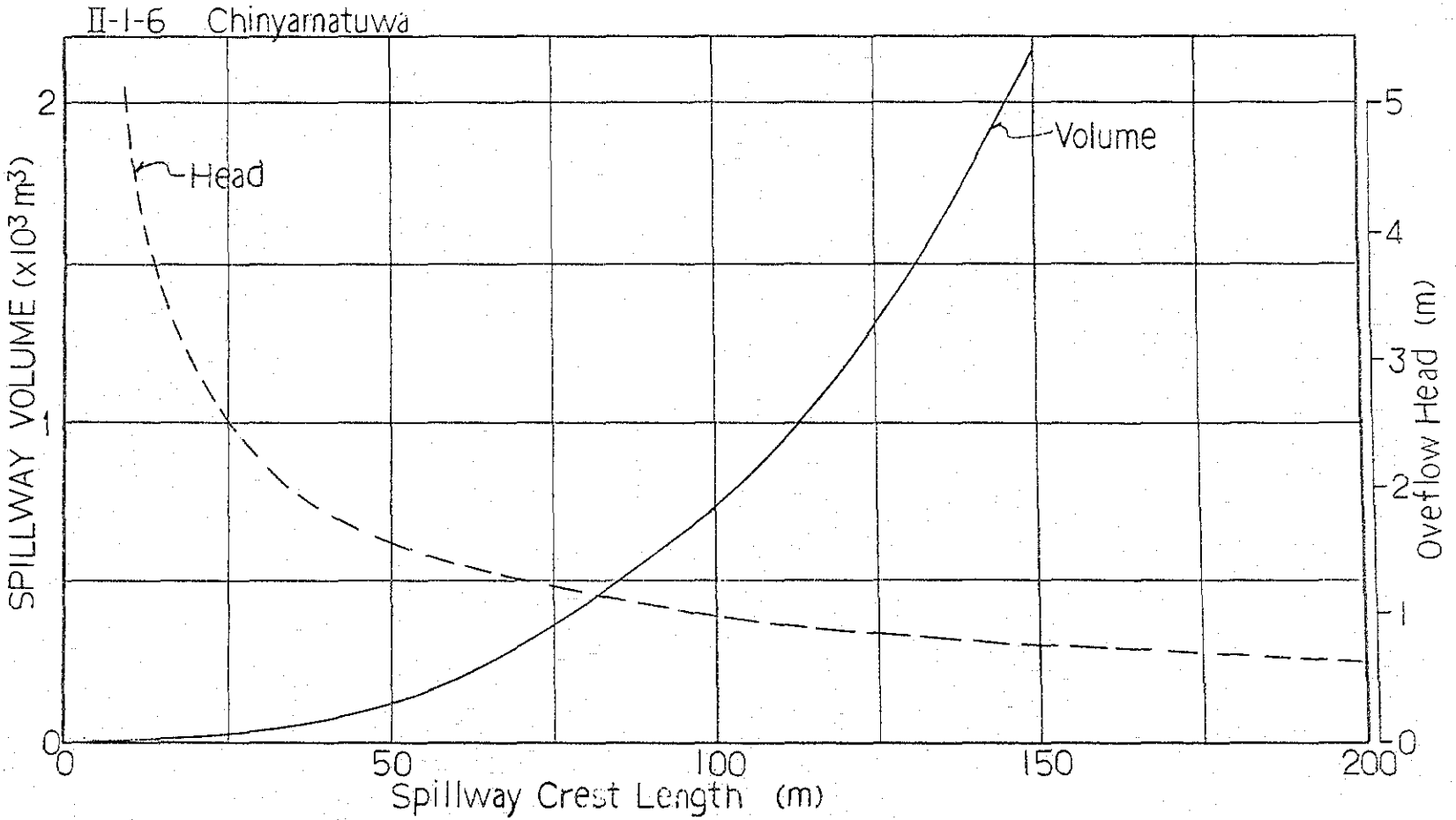

II-1-6 Chinyamatuwa
SPILLWAY VOLUME (x10³ m³)
Overflow Head (m)
Spillway Crest Length (m)
Head
Volume
0
1
2
0
50
100
150
200
0
1
2
3
4
5

Table E-3(3) Calculation of Spillway Volume(tentative)

No. Ⅱ－2－1 Mashoko

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

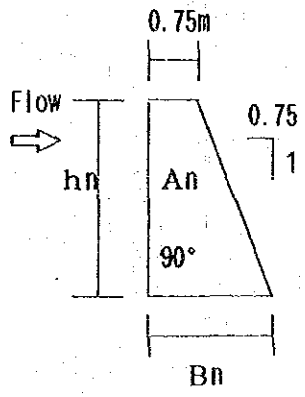
Q ; design flood (228 m³/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	0.5	1.0	1.5	2.0	3.0	4.0	5.0
L	(m)	379	134	73	48	26	17	12

2. Volume of Spillway

Spillway Crest Elevation EL. 664.0 m

① Area of Section (An)

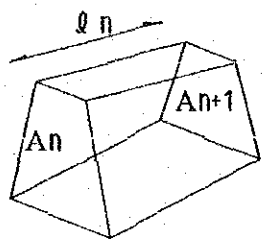


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6	
hn	m	0	3.6	3.6	3.6	3.6	3.6	
An	m²	0	7.6	7.6	7.6	7.6	7.6	
Σℓ	m	0	33	50	75	100	125	
ℓ n	m	0	33	17	25	25	25	
Vn+1	m³	0	125.4	129.2	190	190	190	
Σv	m³	0	125.4	254.6	444.6	634.6	824.6	

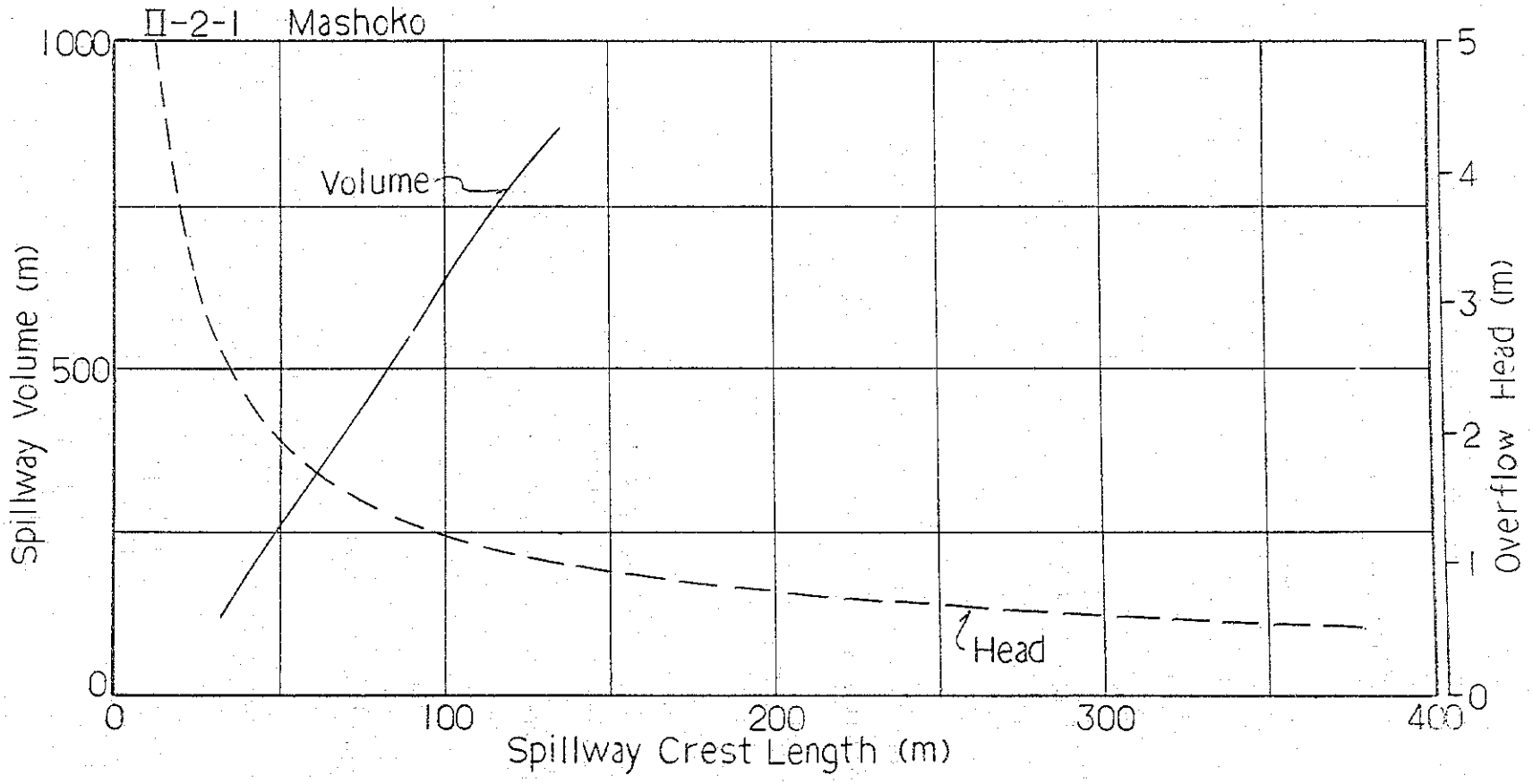

Ⅱ-2-1 Mashoko
1000
500
0
Spillway Volume (m)
Volume
Head
0
100
200
300
400
Spillway Crest Length (m)
5
4
3
2
1
0
Overflow Head (m)

Table E-3(4) Calculation of Spillway Volume(tentative)

NO. Ⅳ－4－10 Munjanganja

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

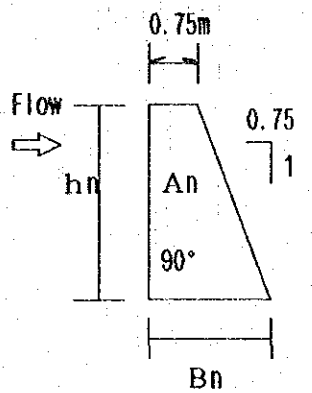
Q ; design flood (349 m³/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	0.5	1.0	1.5	2.0	2.5	3.0	3.5
L	(m)	581	206	112	73	52	40	32

2. Volume of Spillway

Spillway Crest Elevation El. 1,149.0 m

① Area of Section (An)

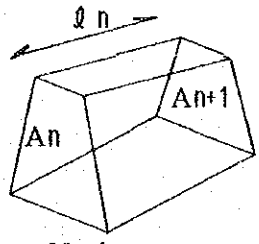


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6	7
hn	m	1	1	1	1	1	1	1
An	m²	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Σℓ	m	0	30	50	100	150	200	250
ℓ n	m	0	30	20	50	50	50	50
Vn+1	m³	0	33	22	55	55	55	55
Σv	m³	0	33	55	110	165	220	275

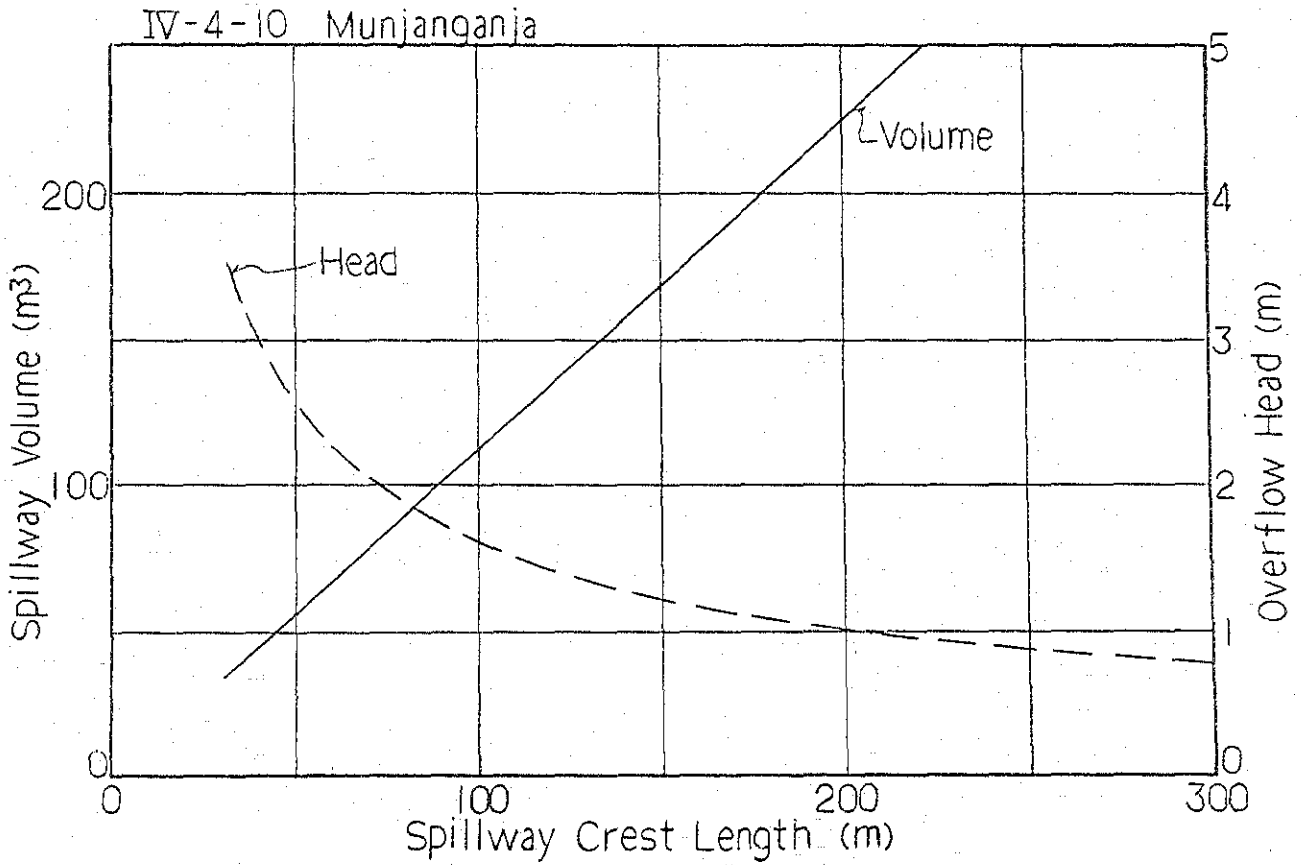

IV-4-10 Munjanganja
Volume
Head
200
100
0
0
100
200
300
5
4
3
2
1
0
Spillway Volume (m³)
Overflow Head (m)
Spillway Crest Length (m)

Table E-3(5) Calculation of Spillway Volume(tentative)

No. V-3-3 Magudu

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

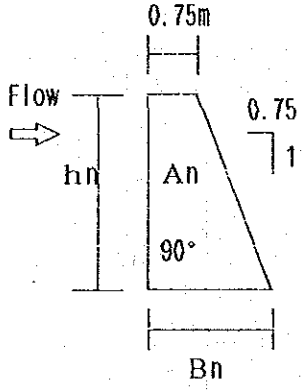
Q ; design flood (415 m³/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	1.0	1.5	2.0	2.5	3.0	4.0
L	(m)	245	133	87	62	47	31

2. Volume of Spillway

Spillway Crest Elevation EL. 529.0 m

① Area of Section (An)

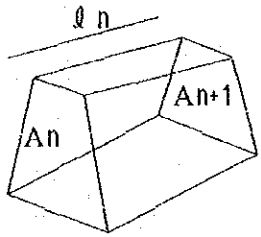


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6	7'
hn	m	0	6.4	7.9	9.2	11.1	11.1	1.0
An	m²	0	20.2	29.3	38.6	54.5	54.5	1.1
Σℓ	m	0	31.0	47.0	62.0	87.0	120.0	133.0
ℓ n	m	0	31.0	16.0	15.0	25.0	33.0	13.0
Vn+1	m³	0	313.1	396	509.0	1,164	1,799	14.0
Σv	m³	0	313.0	709	1,218	2,382	4,181	4,195

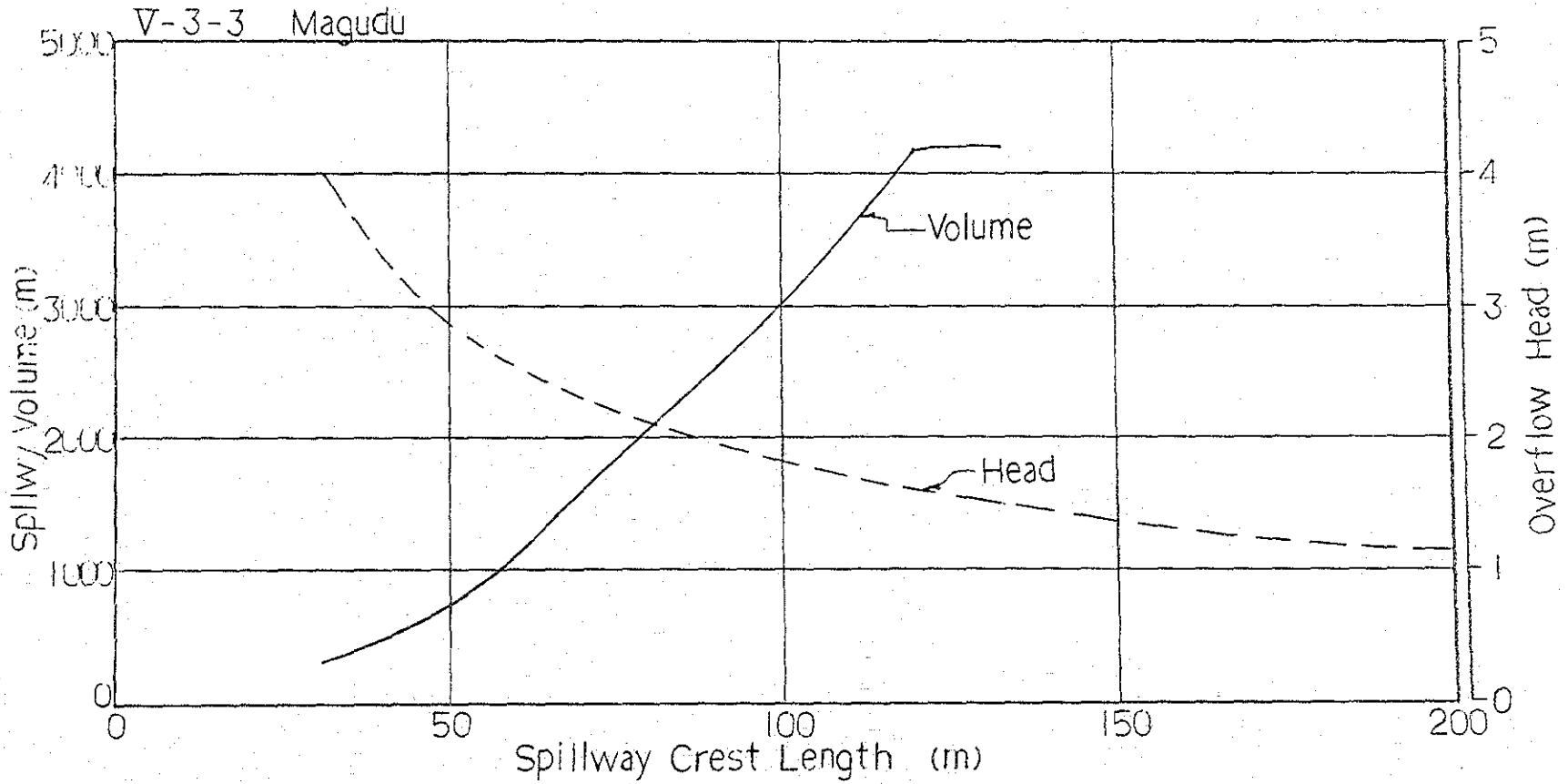

V-3-3 Magudu
Spillw. Volume (m)
5000
4000
3000
2000
1000
0
Volume
Head
Overflow Head (m)
5
4
3
2
1
0
0
50
100
150
200
Spillway Crest Length (m)

Table E-3(6) Calculation of Spillway Volume(tentative)

No. Ⅶ－1－12　　Habvute

1. Relation between Crest Length and Overflow Head of weir

$$Q = C \cdot L \cdot H^{3/2}$$

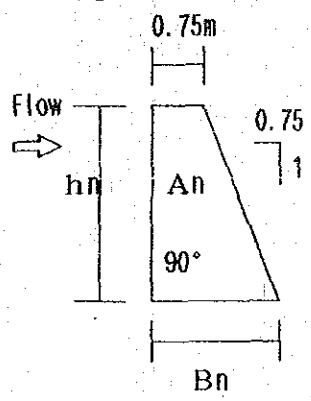
Q ; design flood (343 ㎥/sec)
C ; coefficient (C=1.7)
L ; crest length
H ; overflow head

H	(m)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0
L	(m)	571	202	110	72	52	39	26	19

2. Volume of Spillway

Spillway Crest Elevation　　EL. 1,149.0 m

① Area of Section (An)

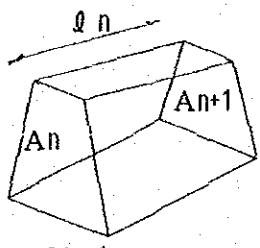


hn ; Spillway Hight

Bn =0.75×hn+0.75
; Bottom width

An =1/2(0.75+Bn)×hn
; Area of Section

② Calculation



Vn+1
=1/2(An+An+1)×ℓ n

Calculation of Volume

n		1	2	3	4	5	6	7	8
hn	m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
An	㎡	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Σℓ	m	0	19	26	39	52	72	110	202
ℓ n	m	0	19	7	13	13	20	38	92
Vn+1	㎥	0	20.9	7.7	14.3	14.3	22	41.8	101.2
Σv	㎥	0	20.9	28.6	42.9	57.2	79.2	121.0	222.2

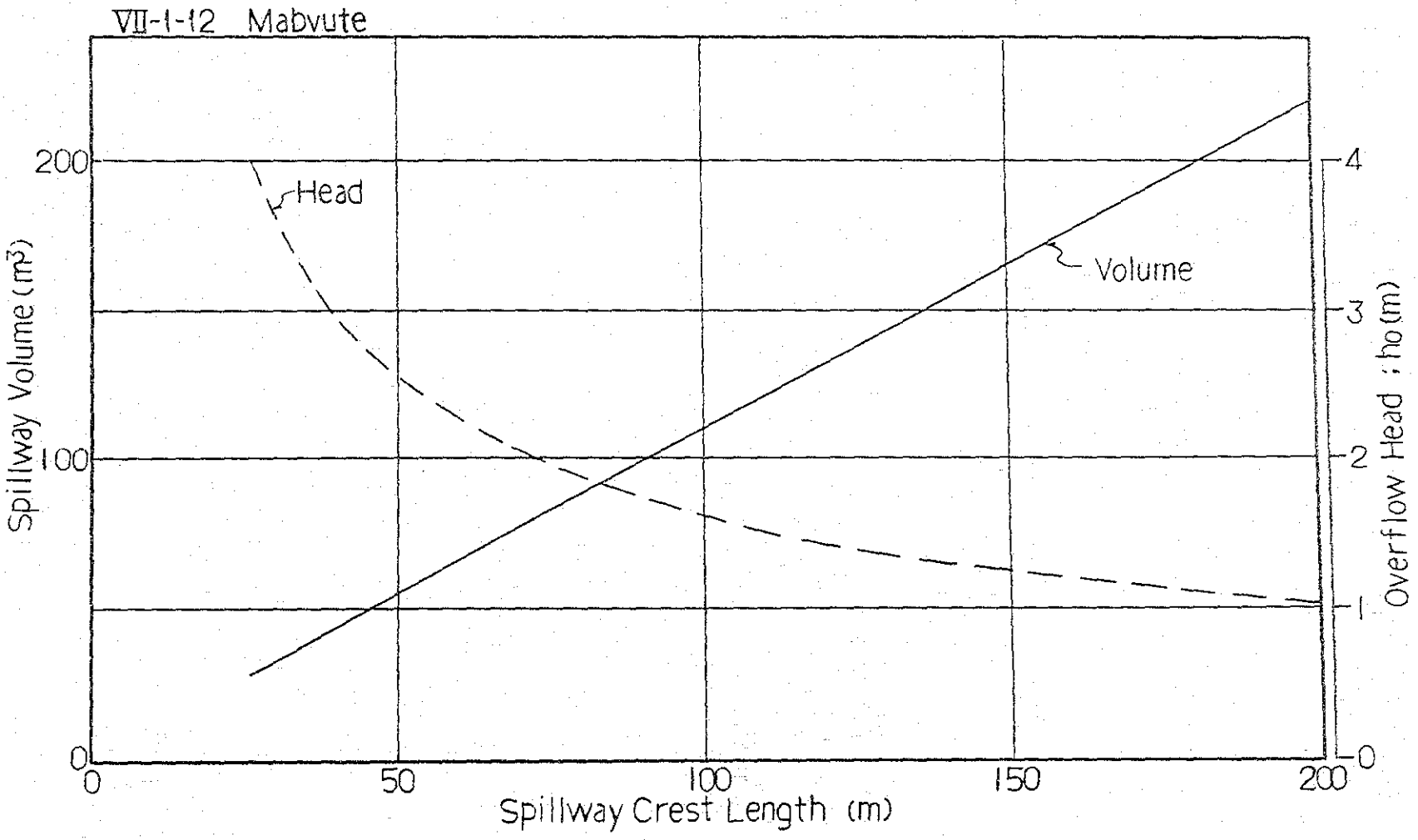

VII-1-12 Mabvute
Head
Volume
Spillway Volume (m³)
Overflow Head ; ho (m)
Spillway Crest Length (m)
0
100
200
50
150
1
2
3
4

Figure E-1 RESULT OF STABILITY CALCULATION

MATERIAL	ANGLE OF SHEAR STRENGTH	APPARENT COHESION	UNIT WEIGHT (Kg/cm³)		
			WET	SATURATED	SUBMERGED
IMPERVIOUS	17°00'	0.2 Kg/cm²	1.83	2.17	1.17
SEMI PERVIOUS	35°00'	0.0 Kg/cm²	1.99	2.14	1.14

*** CASE OF FULL WATER---UPSTREAM SLOPE ***
K= 0.0
W.L= 751.000

X (M)	Y (M)	R (M)	F-RESIST (T)	F-SLIDE (T)	FS
-20.000	770.000	38.000	431.220	201.957	2.135
-20.000	780.000	48.000	482.926	205.565	2.349
-20.000	790.000	58.000	532.837	200.966	2.651
-20.000	800.000	68.000	574.651	193.681	2.967
-20.000	810.000	78.000	609.453	185.875	3.279
-30.000	770.000	38.000	323.927	173.021	1.872
-30.000	780.000	48.000	372.804	199.597	1.868
-30.000	790.000	58.000	425.066	211.417	2.011
-30.000	800.000	68.000	470.803	214.103	2.199
-30.000	810.000	78.000	510.878	212.859	2.400
-40.000	770.000	38.000	171.362	94.602	1.811
-40.000	780.000	48.000	235.532	135.645	1.736
-40.000	790.000	58.000	294.035	167.775	1.753
-40.000	800.000	68.000	338.197	186.822	1.810
-40.000	810.000	78.000	372.531	196.151	1.899
-50.000	770.000	38.000	60.029	33.206	1.808
-50.000	780.000	48.000	89.182	50.133	1.779
-50.000	790.000	58.000	127.274	74.405	1.711
-50.000	800.000	68.000	180.361	107.635	1.676
-50.000	810.000	78.000	230.977	134.327	1.720

*** FS-MIN ***

-50.000	800.000	68.000	180.361	107.635	1.676

*** ELEMENT---FS-MIN ***

N=	251.250	T=	107.635	NE=	0.0	TE=	0.0
NP=	0.0	TP=	0.0	PP=	0.0	OPP=	0.0
OSI=	0.0	CL=	5.669				

*** BASIS ***
X1= -200.000 Y1= 732.000
X2= 200.000 Y2= 732.000

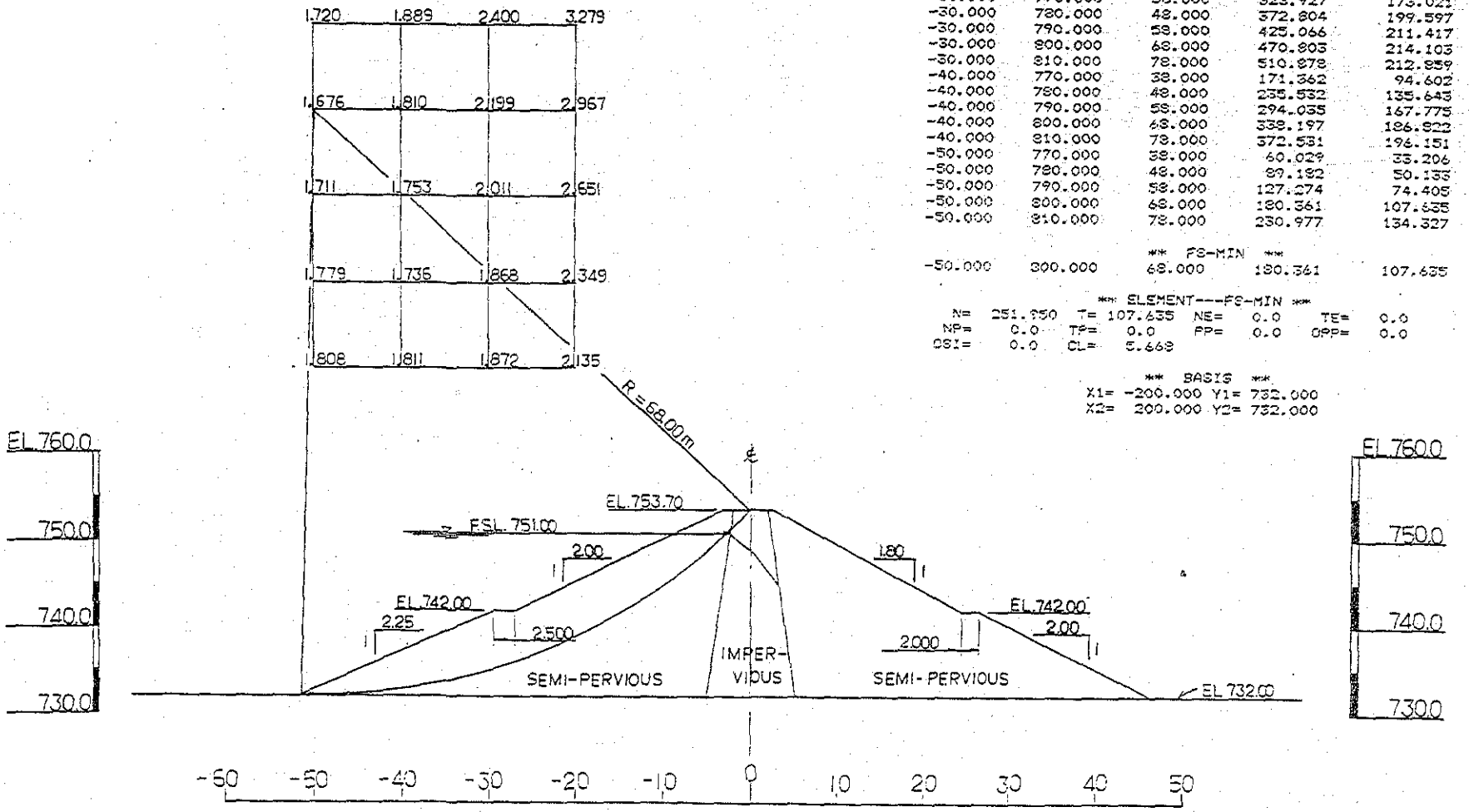


Figure E-2 (1) Location of Test Pits

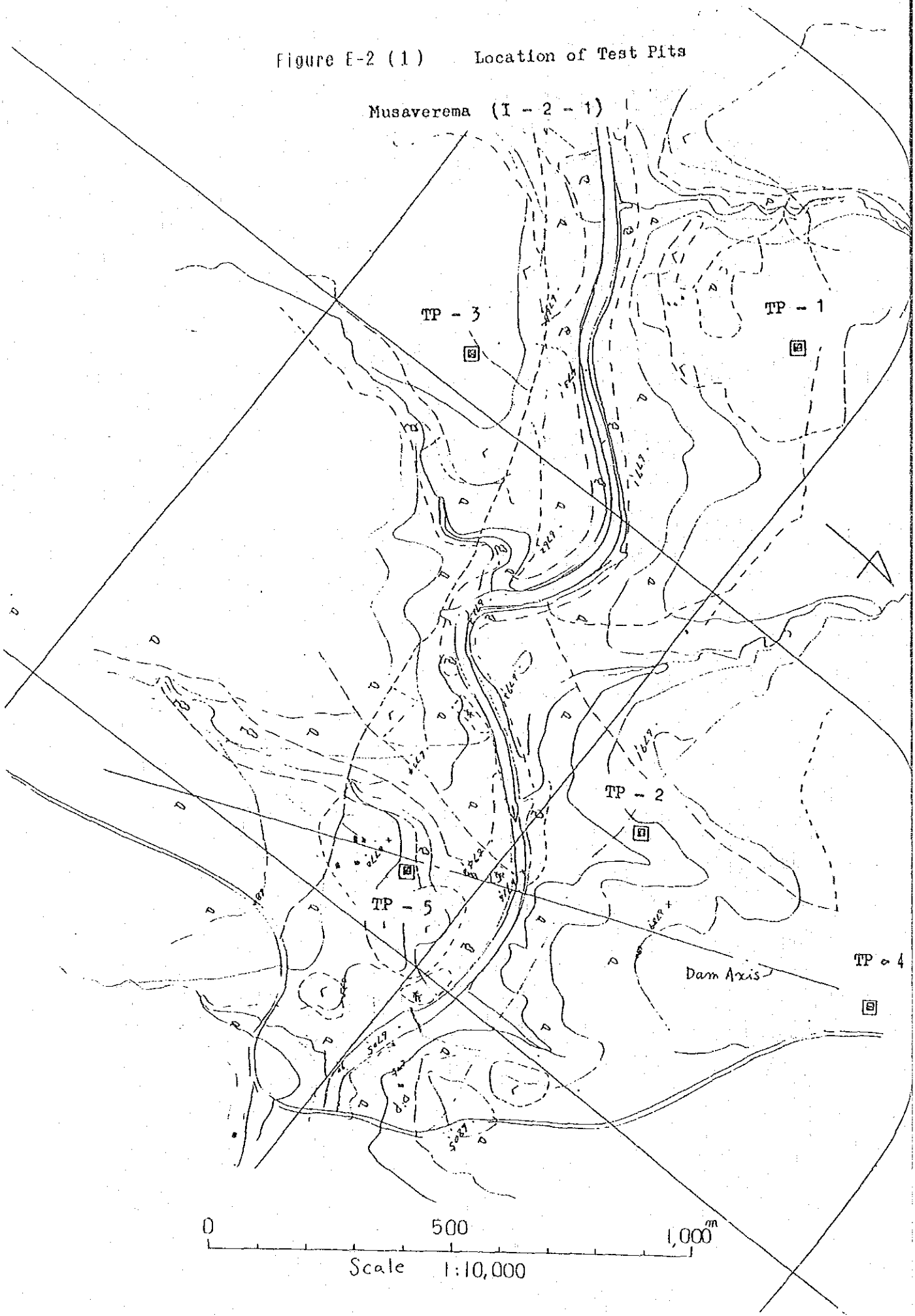


Figure E-2 (2) Location of Test Pits

Mashoko (II-2-1)

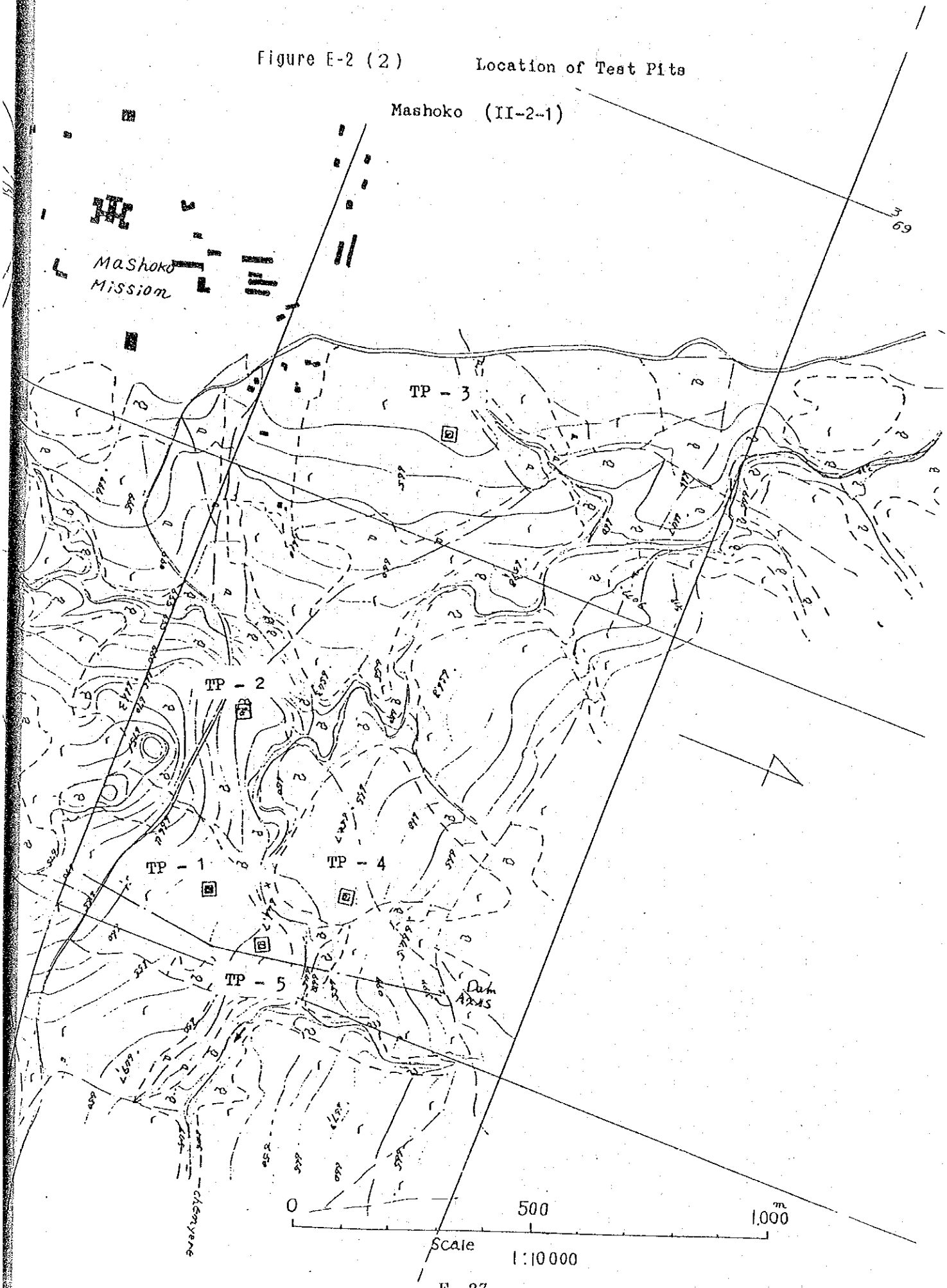


Figure F-2 (3) Location of Test Pits

Chinyamatumwa (II-1-6)

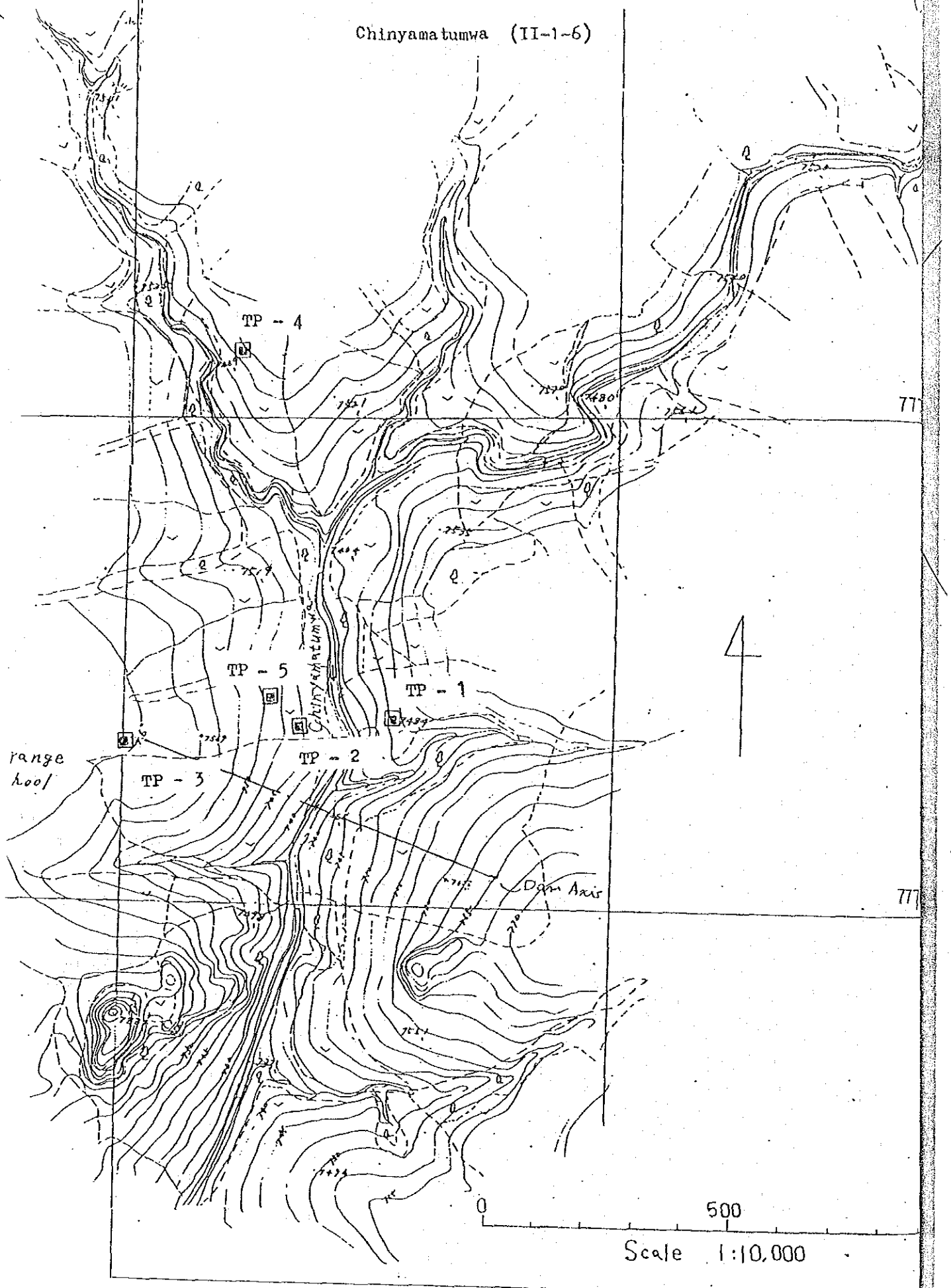


Figure E-2 (4) Location of Test Pits

Munjanganja (IV-4-10)

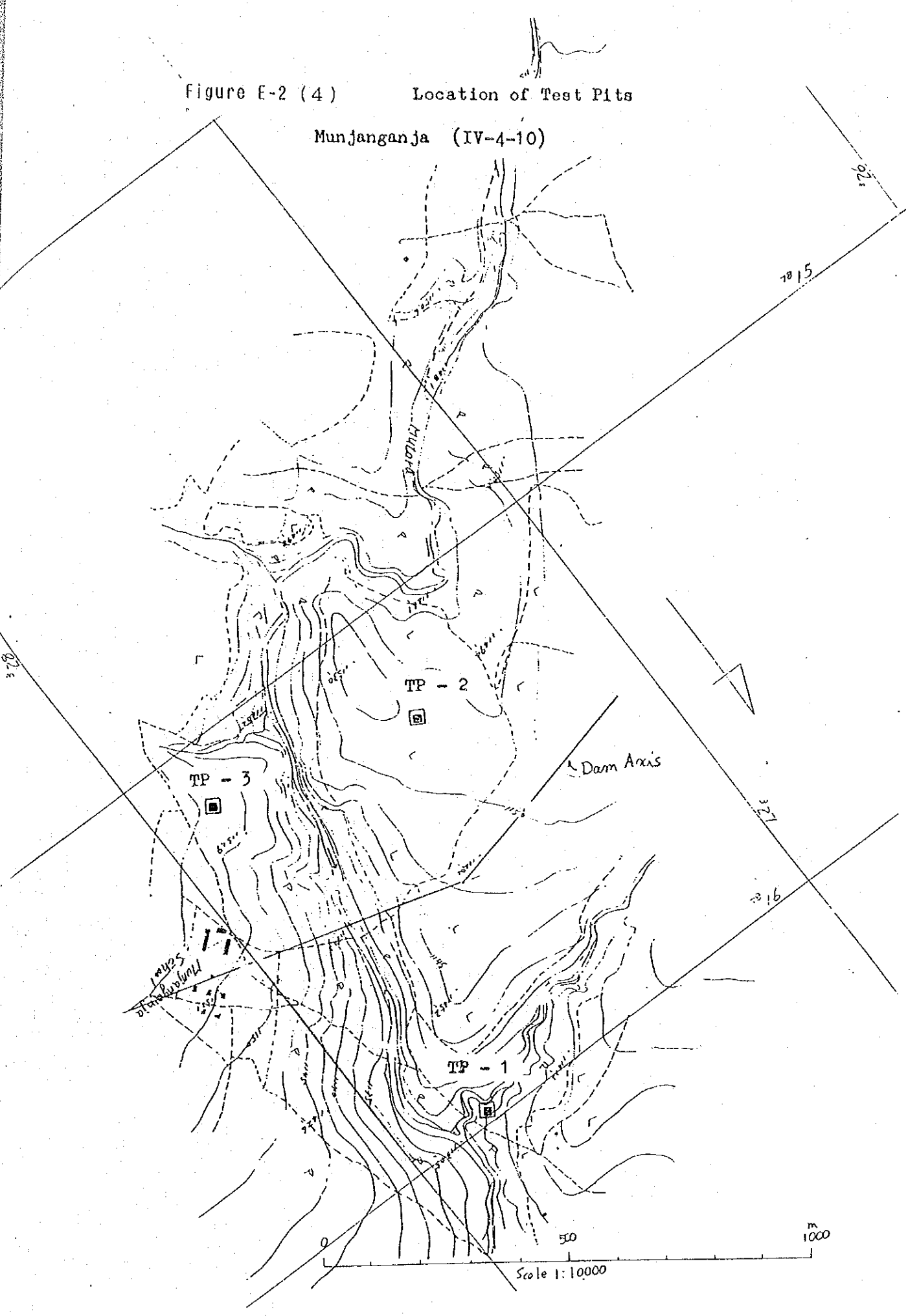


Figure E-2 (5) Location of Test Pits

Magudu (V-3-3)

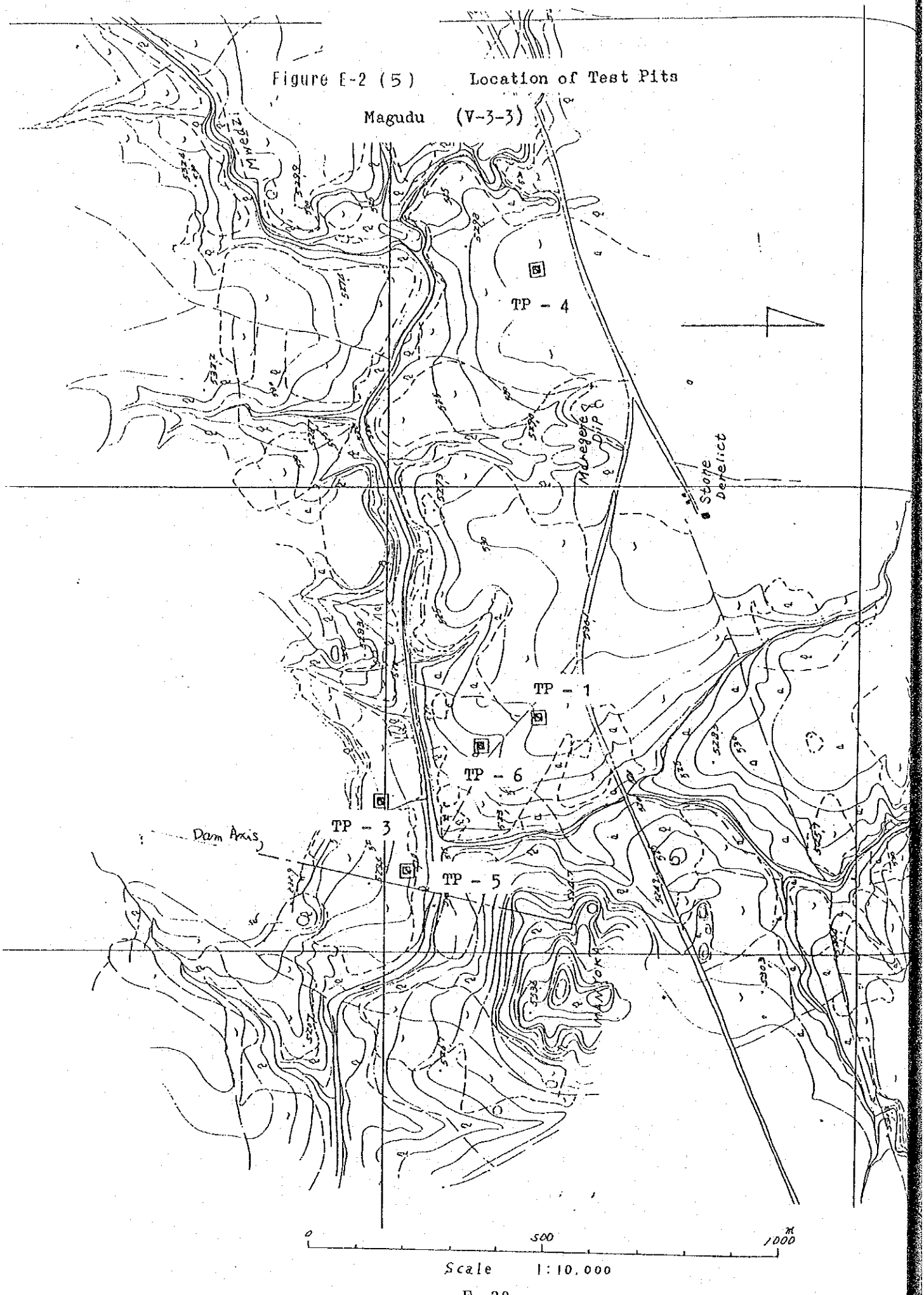


Figure E-2 (6) Location of Test Pits

Mabvute (VII-1-12)

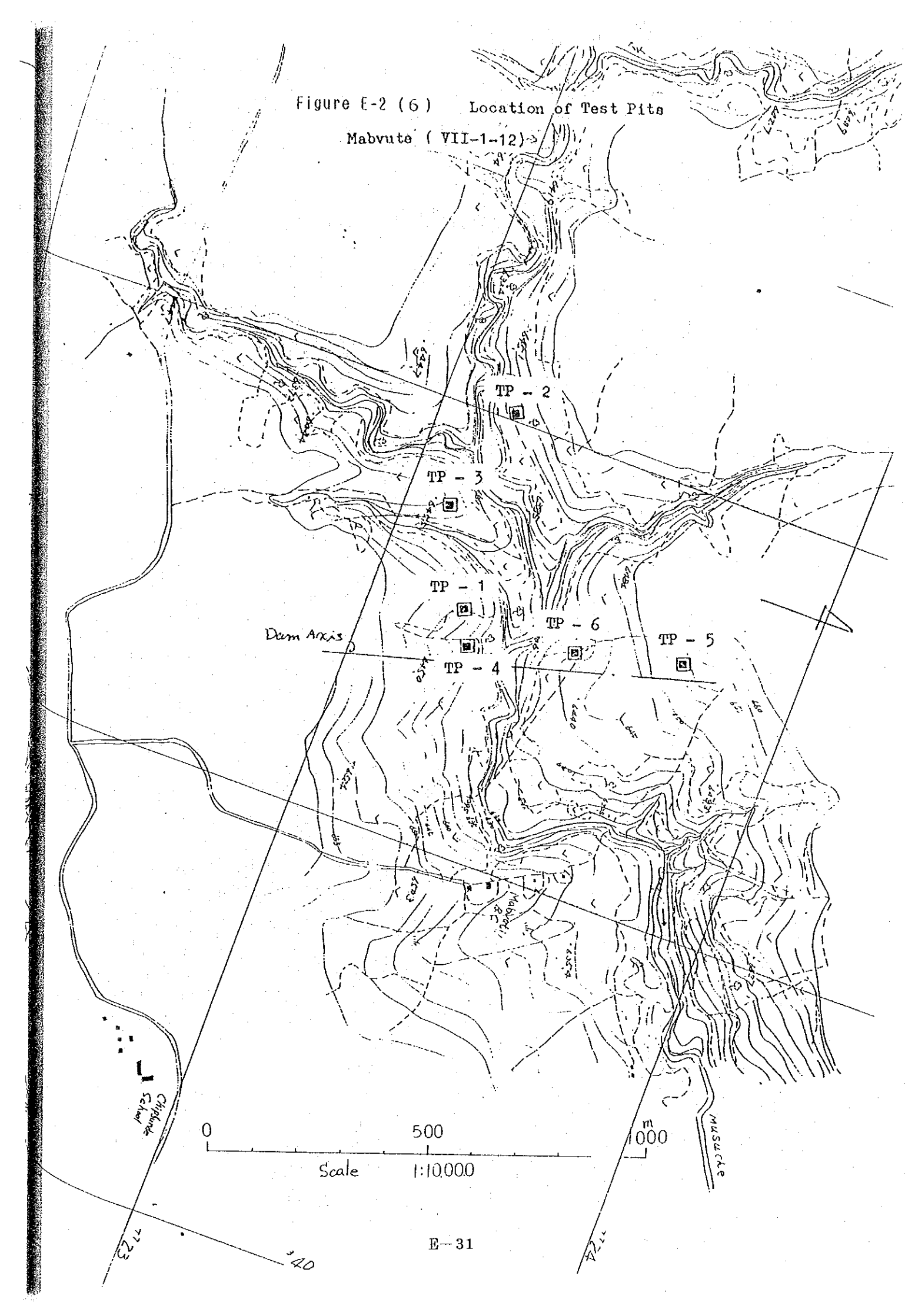


Figure E-2 (7) Formation of Dam

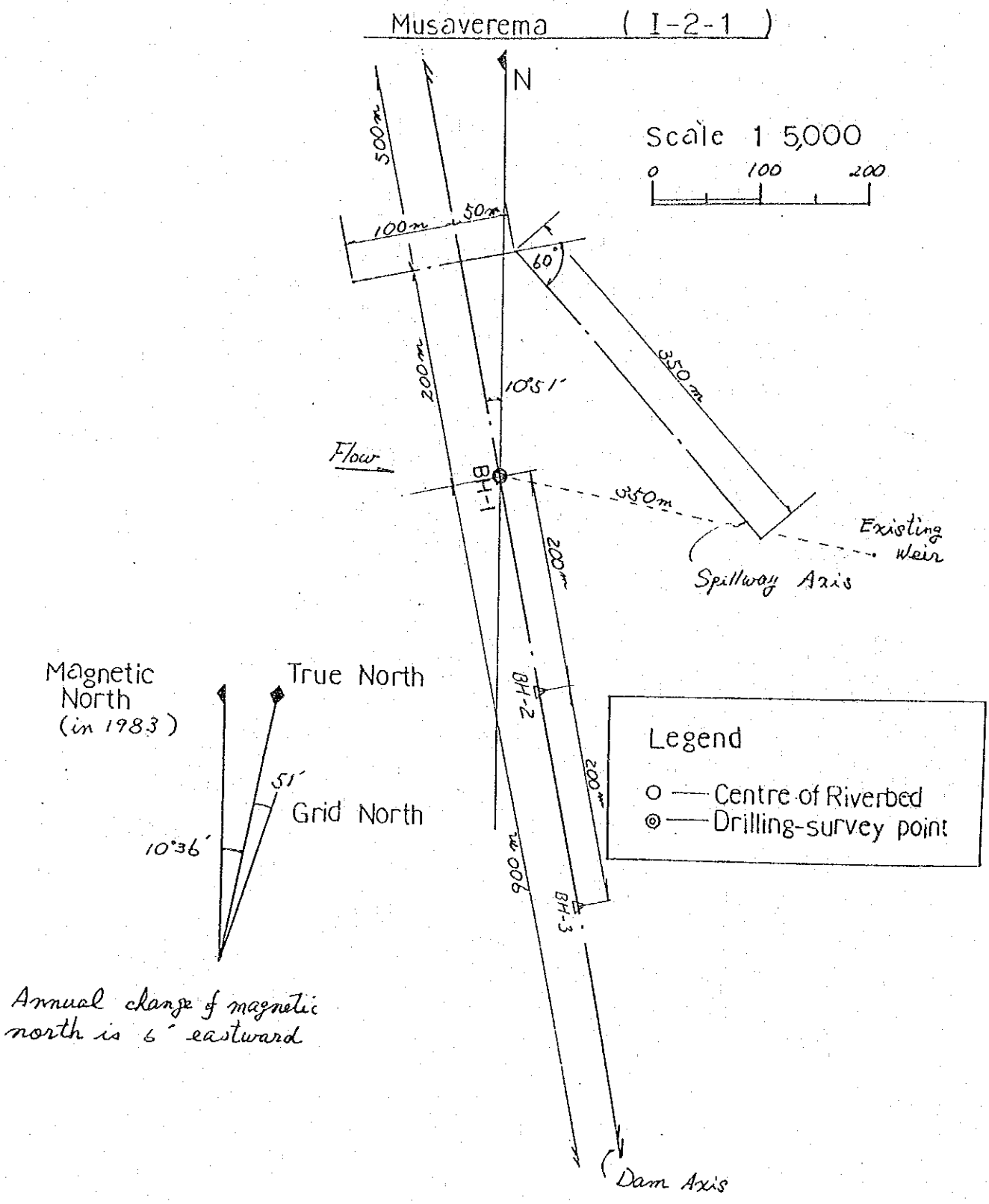


Figure E-2 (8) Formation of Dam

Chinyamaturnwa (II-1-6)

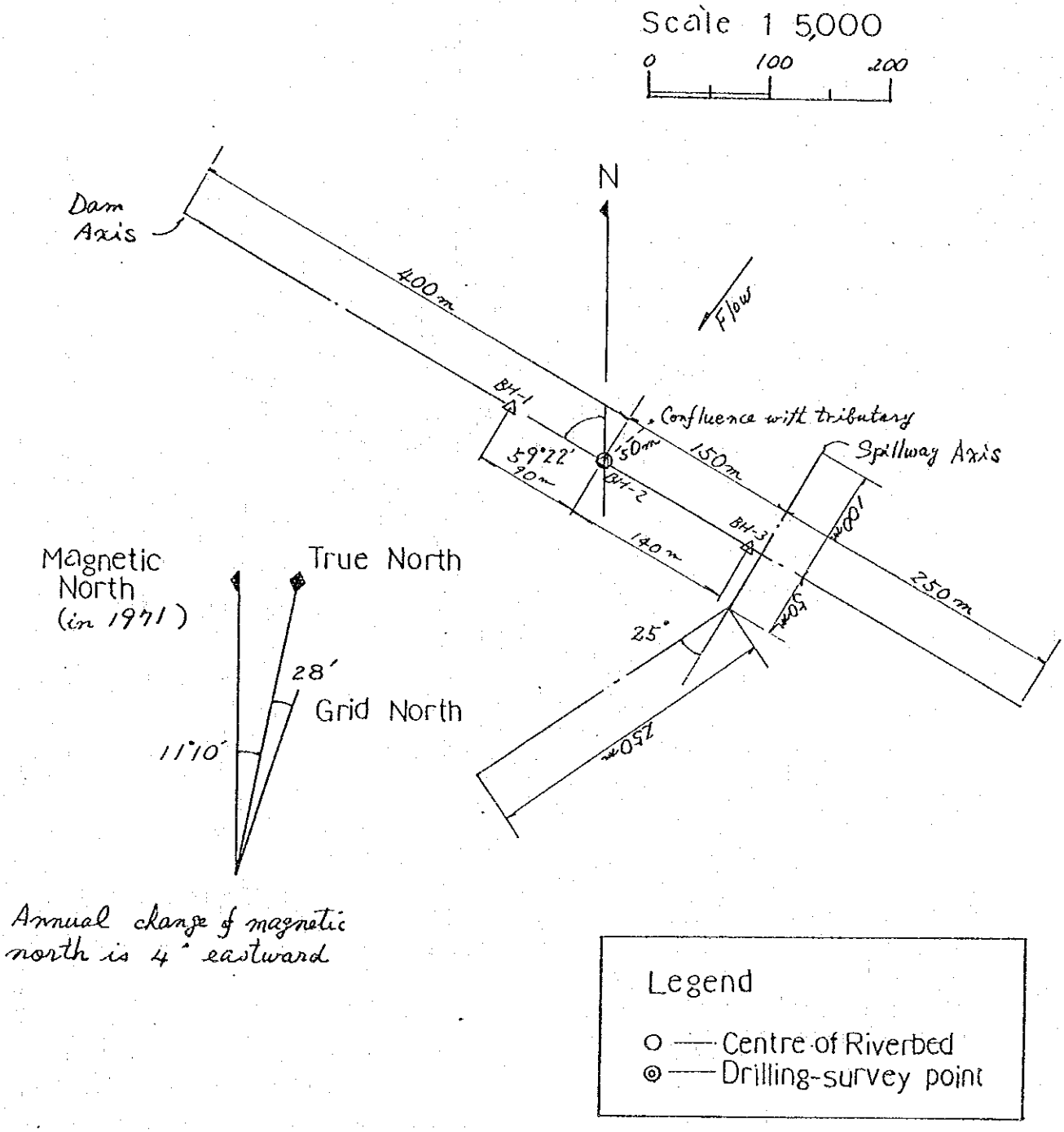


Figure E-2 (9) Formation of Dam

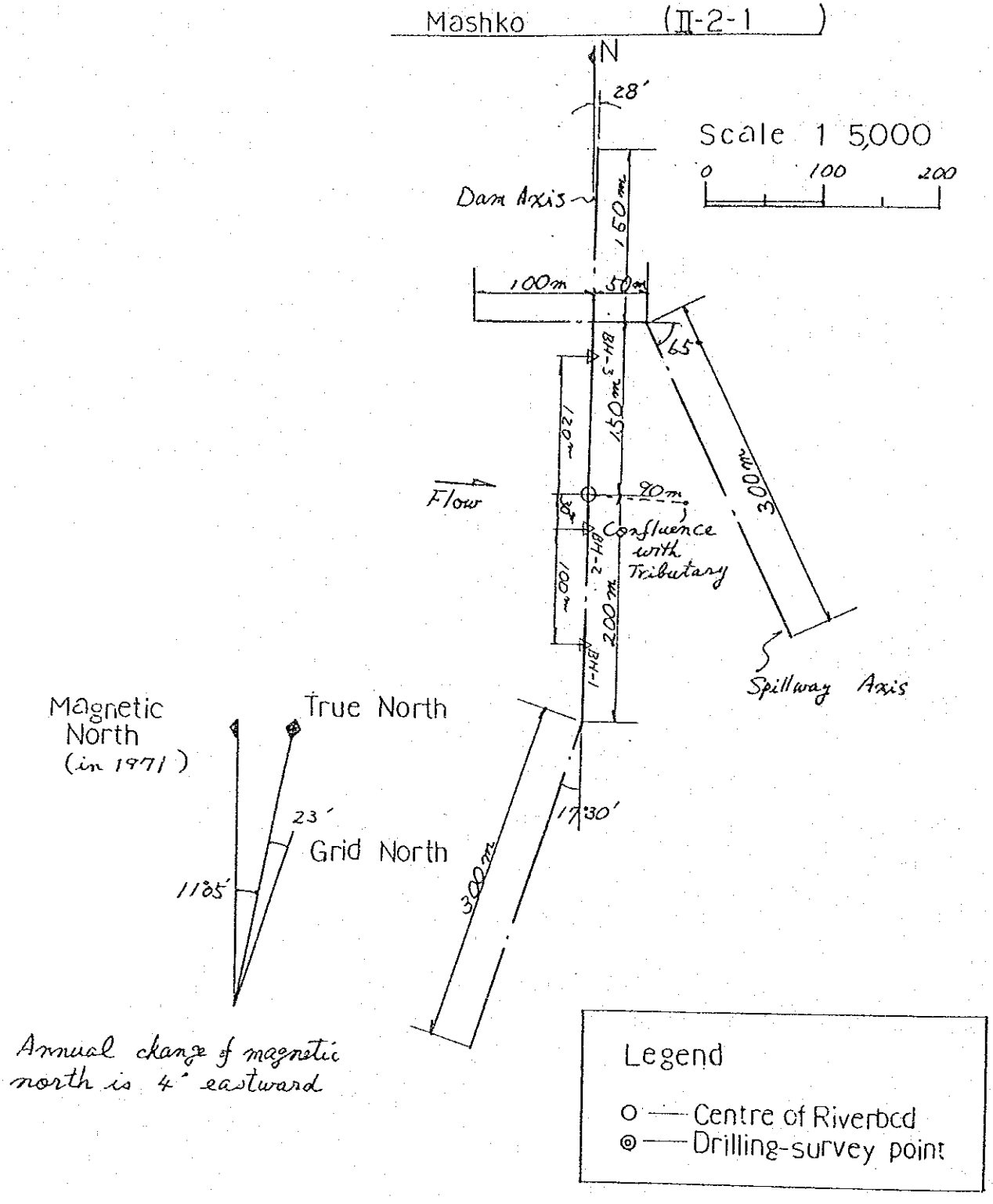


Figure E-2 (10) Formation of Dam

Munjanganja (IV-4-10)

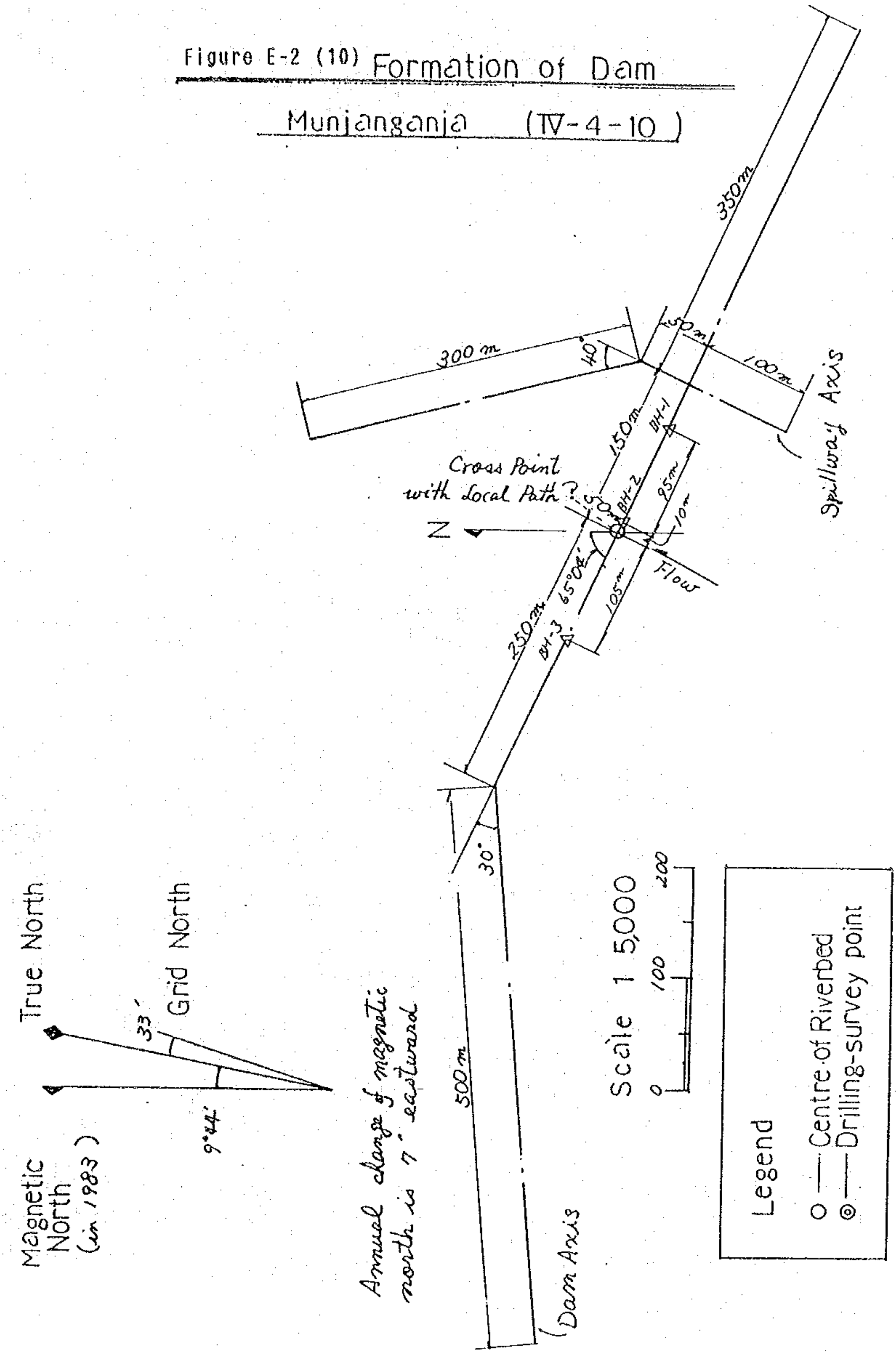


Figure E-2 (11) Formation of Dam

Magudu (V-3-3)

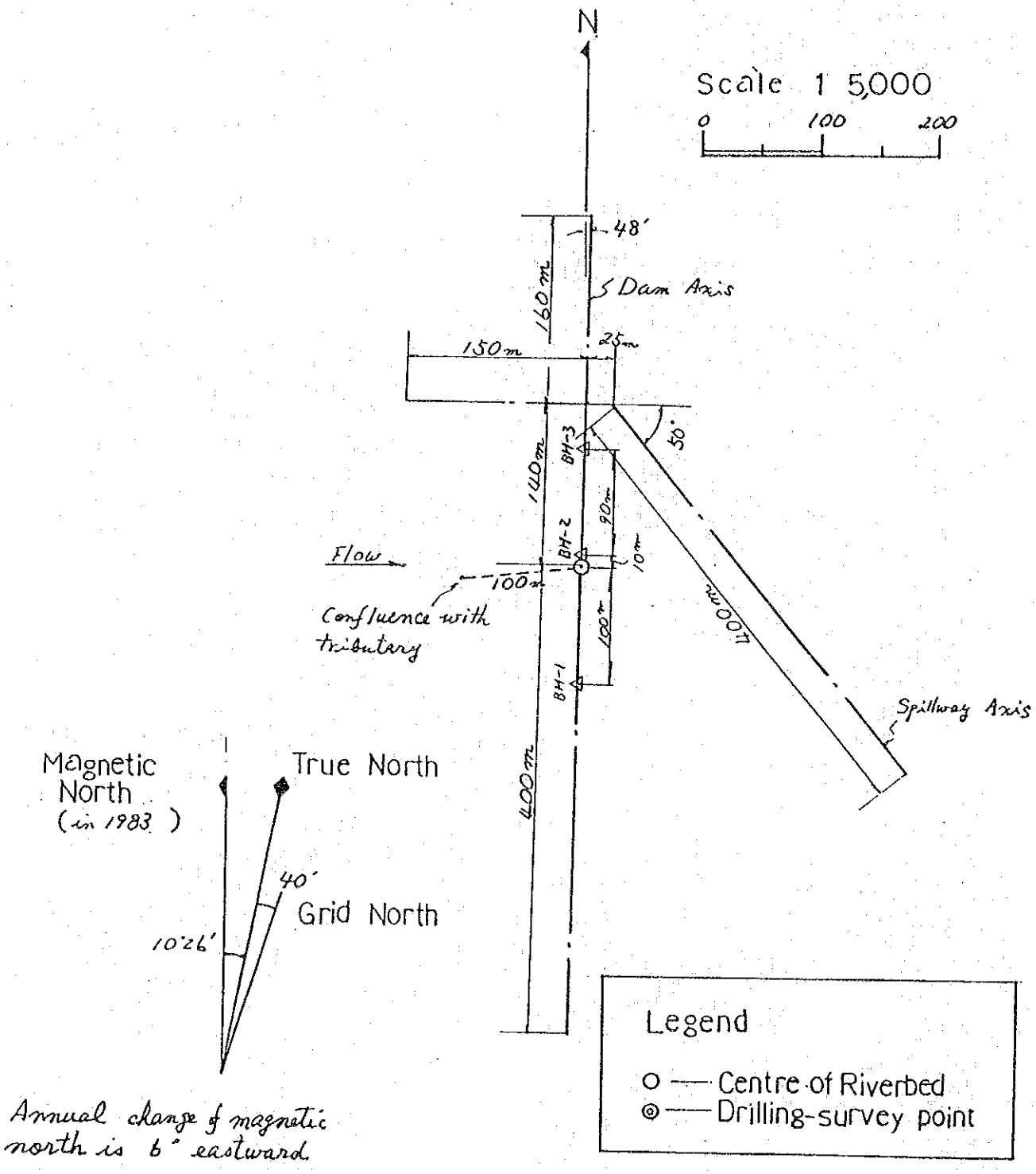


Figure E-2 (12) Formation of Dam

Mabvute (VII -1-12)

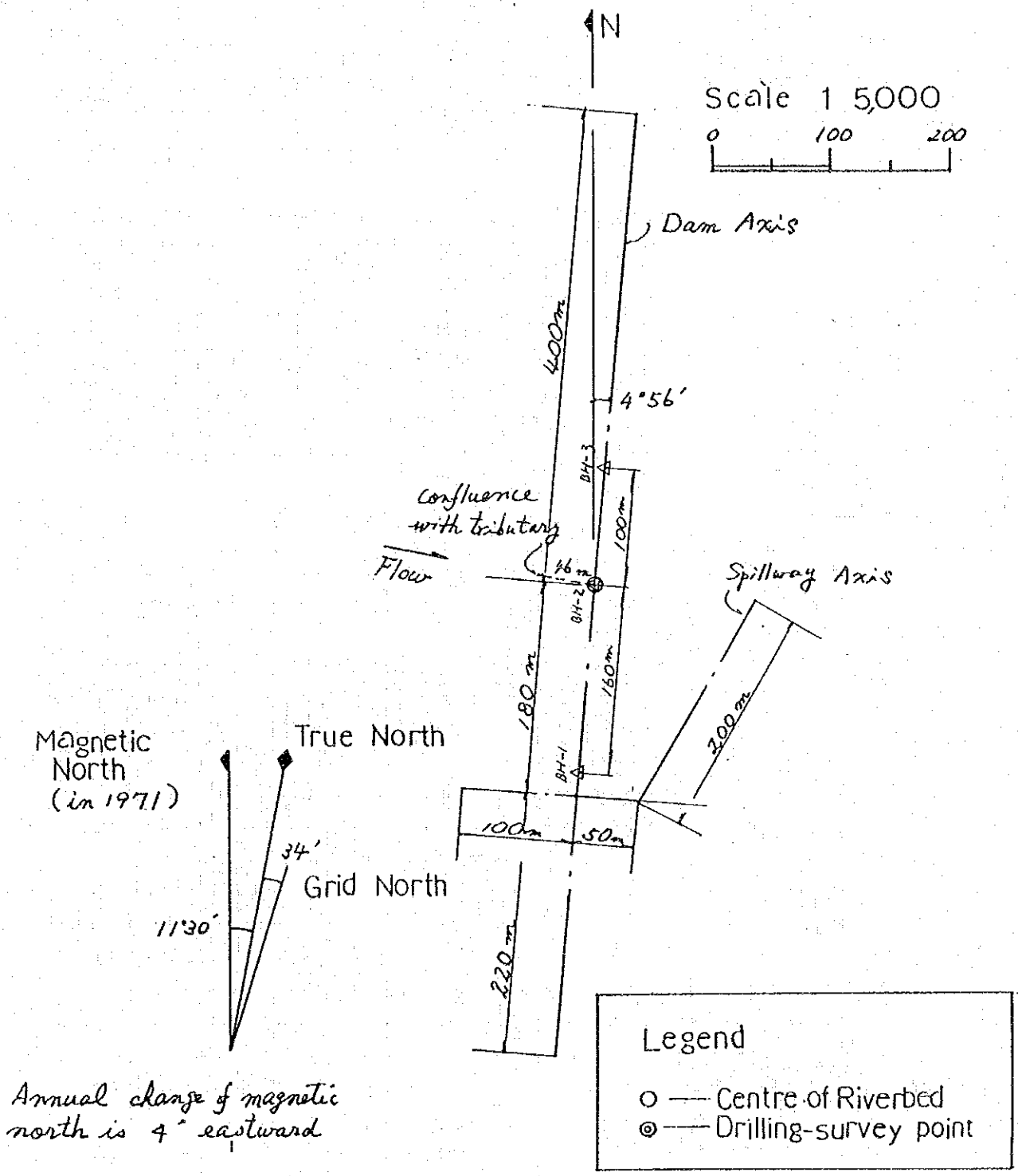


Figure E-3 (1) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LTD. JOB No.: 8071

PROJECT: MUSAVEREMA 1-2-1 DATE: 31 AUGUST 198

SAMPLE No. TP	1	1	2	2	3	3		
DEPTH	1	2	1	1.5	1	2		
GRAVEL	9	11	15	17	21	21		
COARSE SAND	26	27	27	41	23	33		
MEDIUM SAND	17	18	11	18	11	14		
FINE SAND	9	9	7	7	5	7		
SILT CLAY	39	35	40	17	40	25		

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	37	35	48	34	44	32		
PLASTIC INDEX	19	19	24	14	21	12		
LINEAR SHRINKAGE %	7	9	10	4	8	5		
PLASTICITY PRODUCT	740	665	960	240	840	300		
COARSENESS INDEX	9	11	15	17	21	21		
CLASSIFICATION	SC	SC	SC	SC	SC	SC		

GRADING ANALYSIS

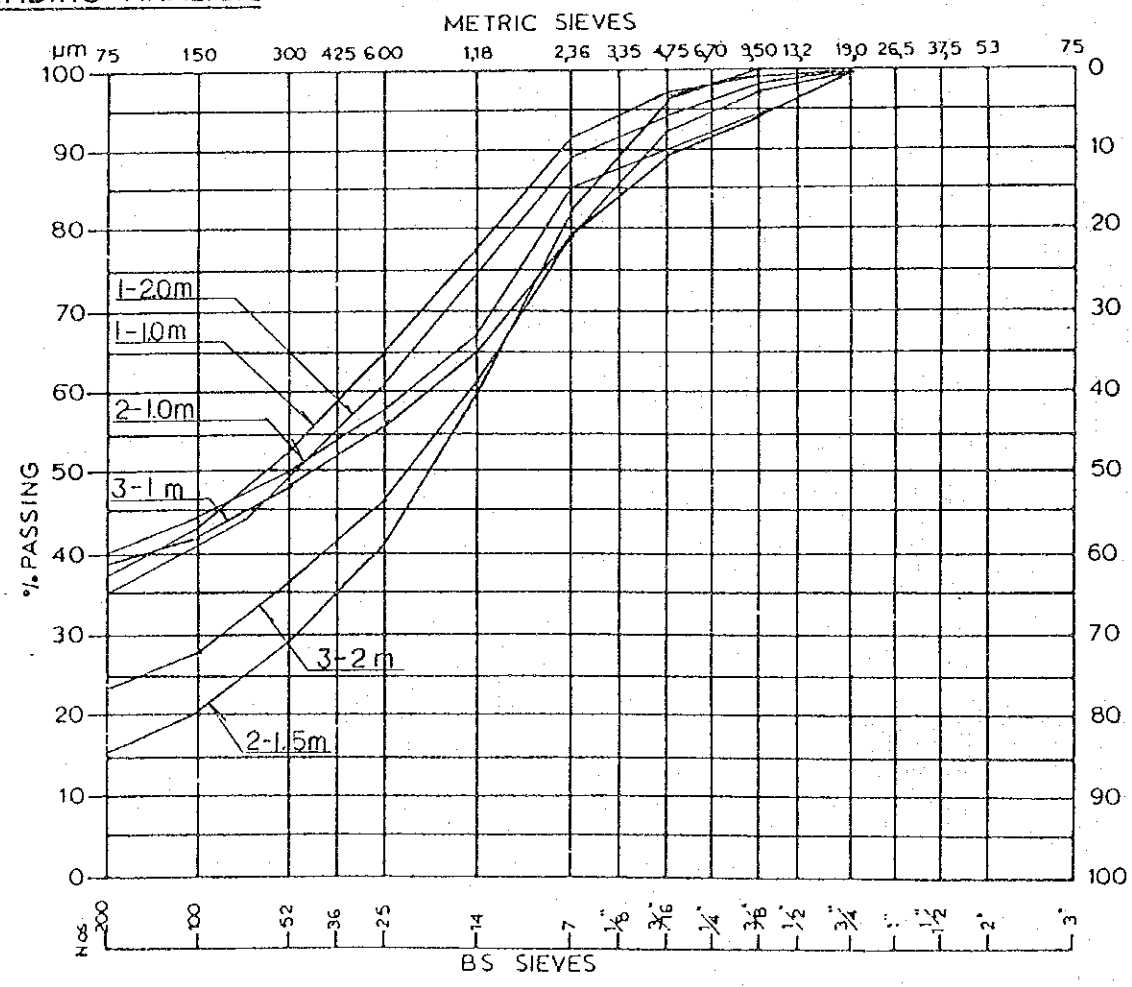


Figure E-3 (2) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LTD. JOB No: 8071

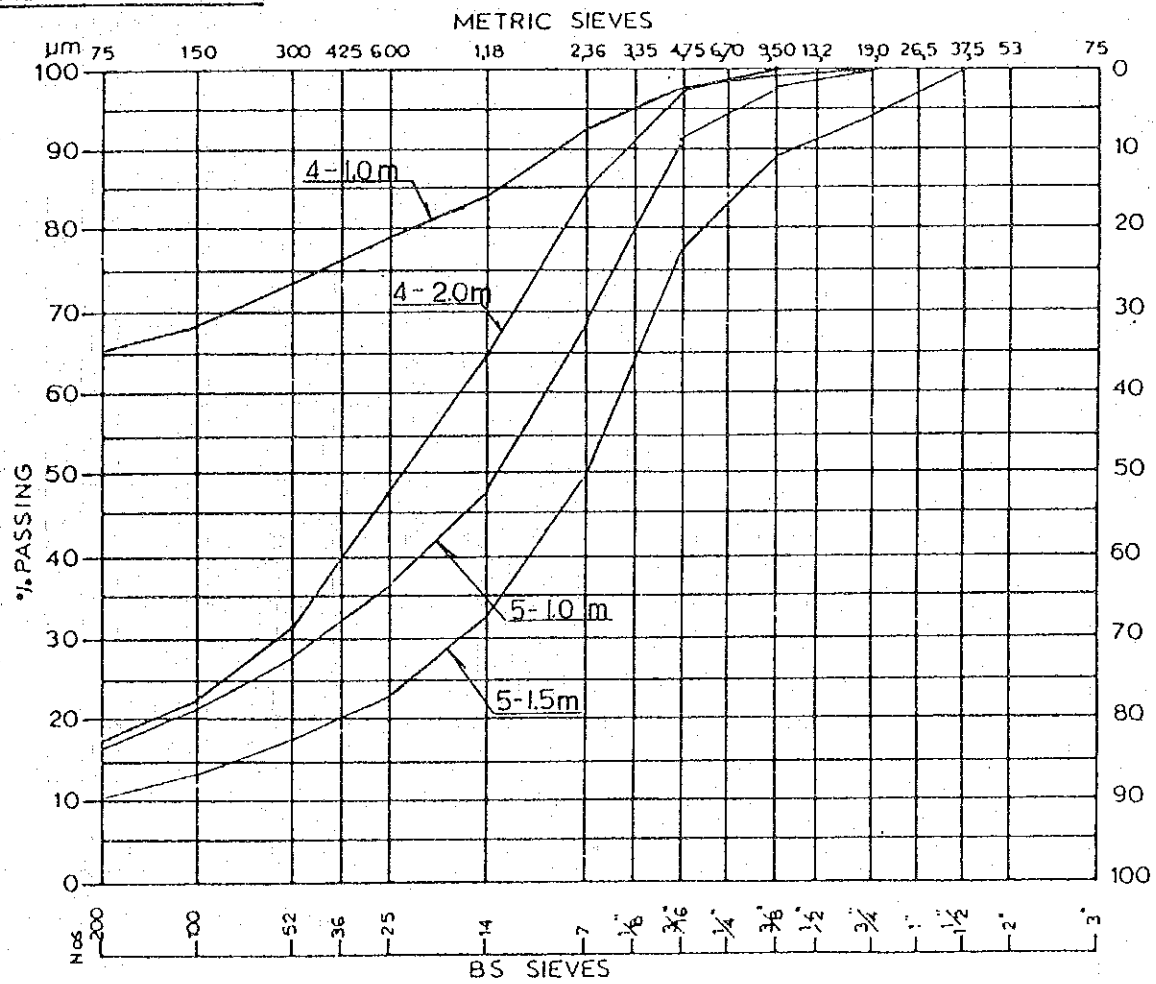
PROJECT: MUSAVEREMA 1-2-1 DATE: 31 AUGUST '8

SAMPLE No. TP	4	4	5	5				
DEPTH	1	2	1	1.5				
GRAVEL	7	15	30	49				
COARSE SAND	14	38	34	27				
MEDIUM SAND	9	21	12	9				
FINE SAND	4	8	6	4				
SILT CLAY	66	18	18	11				

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	52	39	32	26				
PLASTIC INDEX	15	19	16	10				
LINEAR SHRINKAGE %	11	7	7	3				
PLASTICITY PRODUCT	990	340	290	110				
COARSENESS INDEX	7	15	30	49				
CLASSIFICATION	MH	SC	SC	GC-GM				

GRADING ANALYSIS



Client : GEOTECHNICAL SERVI((1980) (PVT) LIMITED

Job No. : 8071

Project : 1-2-1 MUSAVEREMA

Operator :

Sample Nos. and Descriptions : SAND

Date : 31 AUGUST 1987

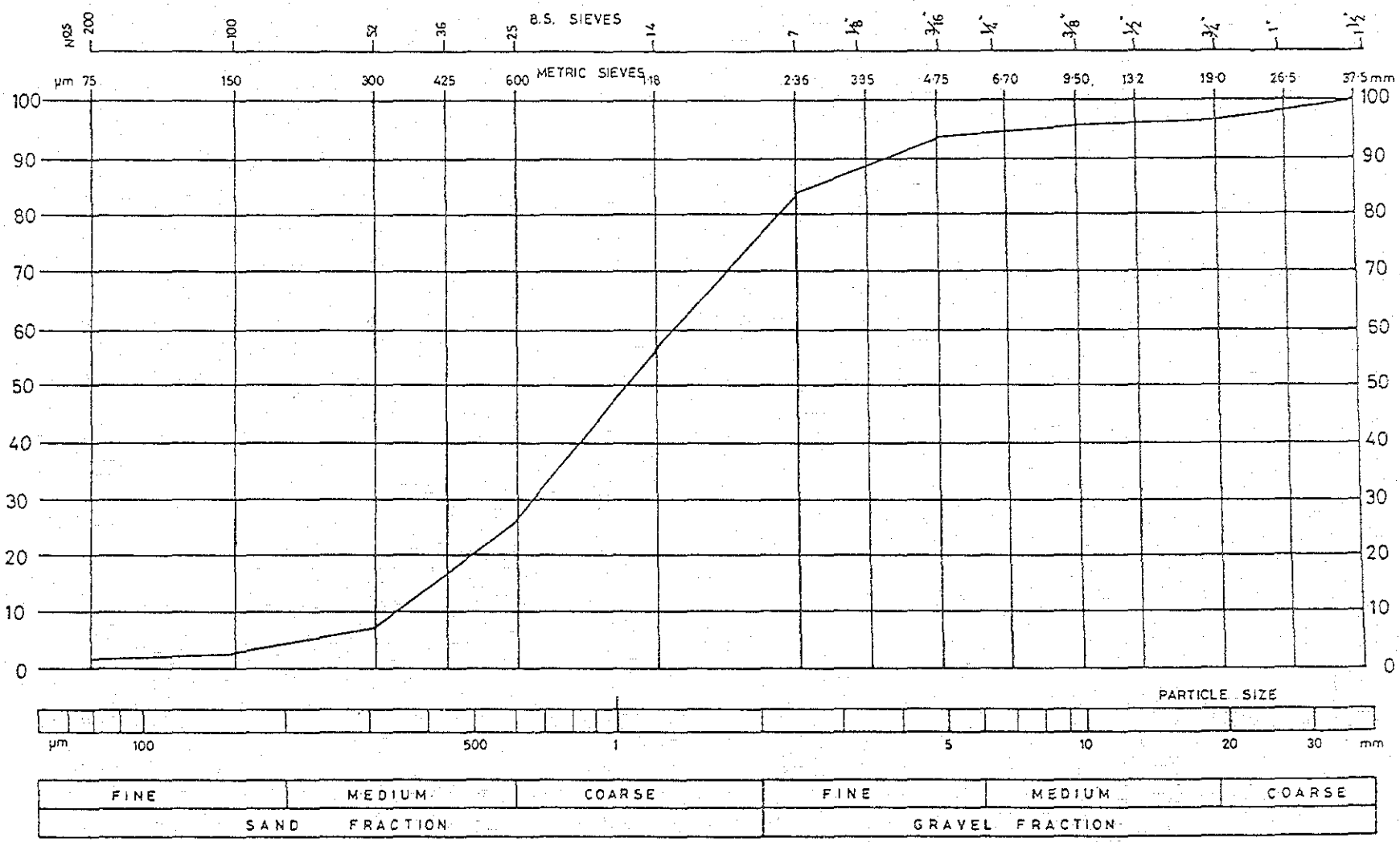


Figure E-3 (3) GRADING ANALYSIS

NORTHERN TESTING LABS.

P.O. BOX 1834 PHONE 47222 HARARE

Figure E-3 (4) GRADING ANALYSIS

CLIENT: _____ JOB No: _____

PROJECT: IT-1-6 DATE: _____

SAMPLE No.	1	1	2	2	3	3		
DEPTH	1.5	3.0	1.5	3.0	1.5	3.0		
GRAVEL	24	9	15	52	1	21		
COARSE SAND	36	35	31	25	1	5		
MEDIUM SAND	12	23	21	5	3	2		
FINE SAND	7	10	16	5	1	3		
SILT CLAY	21	23	17	13	94	69		

SOIL CONSTANTS (on material passing No. 425 μm sieve)

LIQUID LIMIT	33	34	—	35	70	53		
PLASTIC INDEX	15	18	N.P	16	33	23		
LINEAR SHRINKAGE %	5	9	—	3	13	13		
PLASTICITY PRODUCT	315	415	15	210	3100	1585		
COARSENESS INDEX	24	9	15	52	1	2		
CLASSIFICATION	SC	SC	SM	GC	MH	MH-CH		

GRADING ANALYSIS

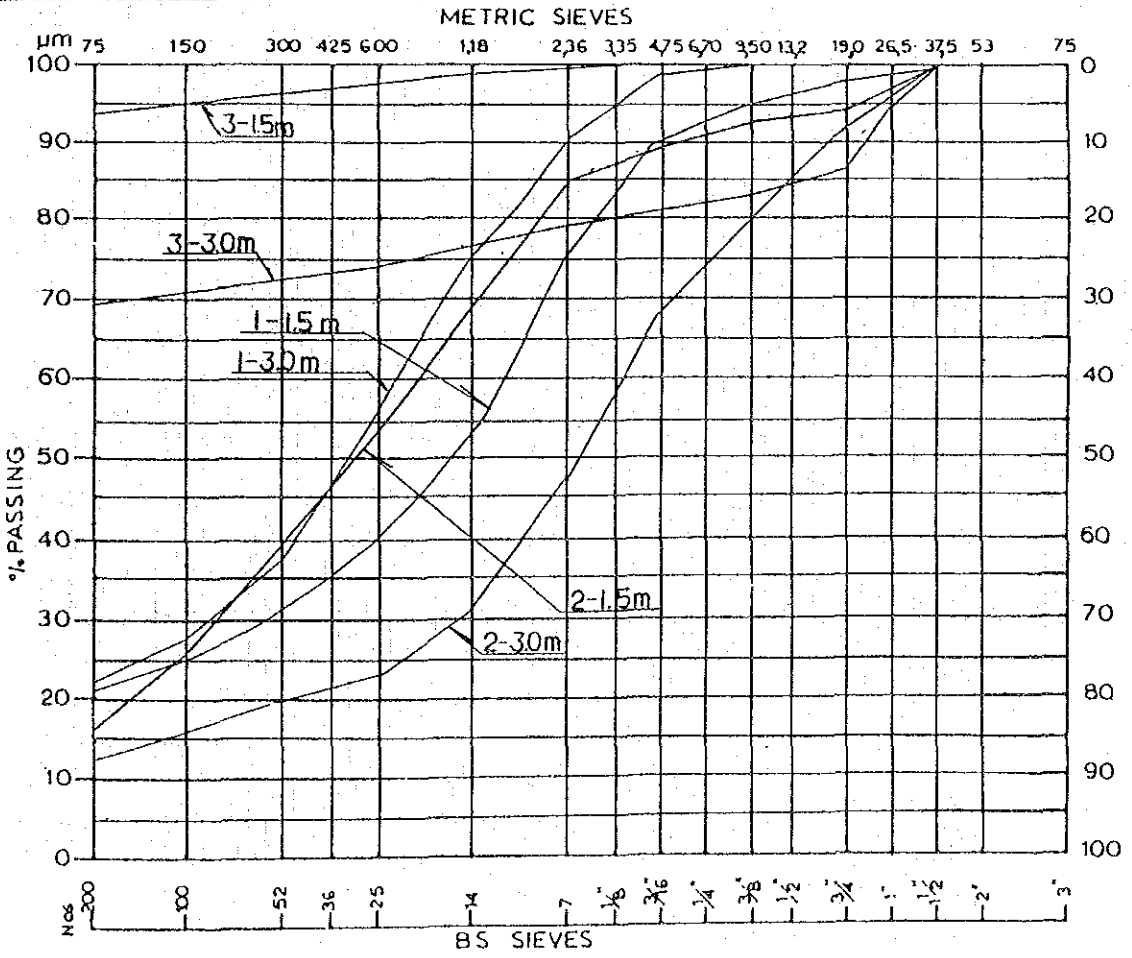


Figure E-3 (5) GRADING ANALYSIS

CLIENT: _____ JOB No: _____

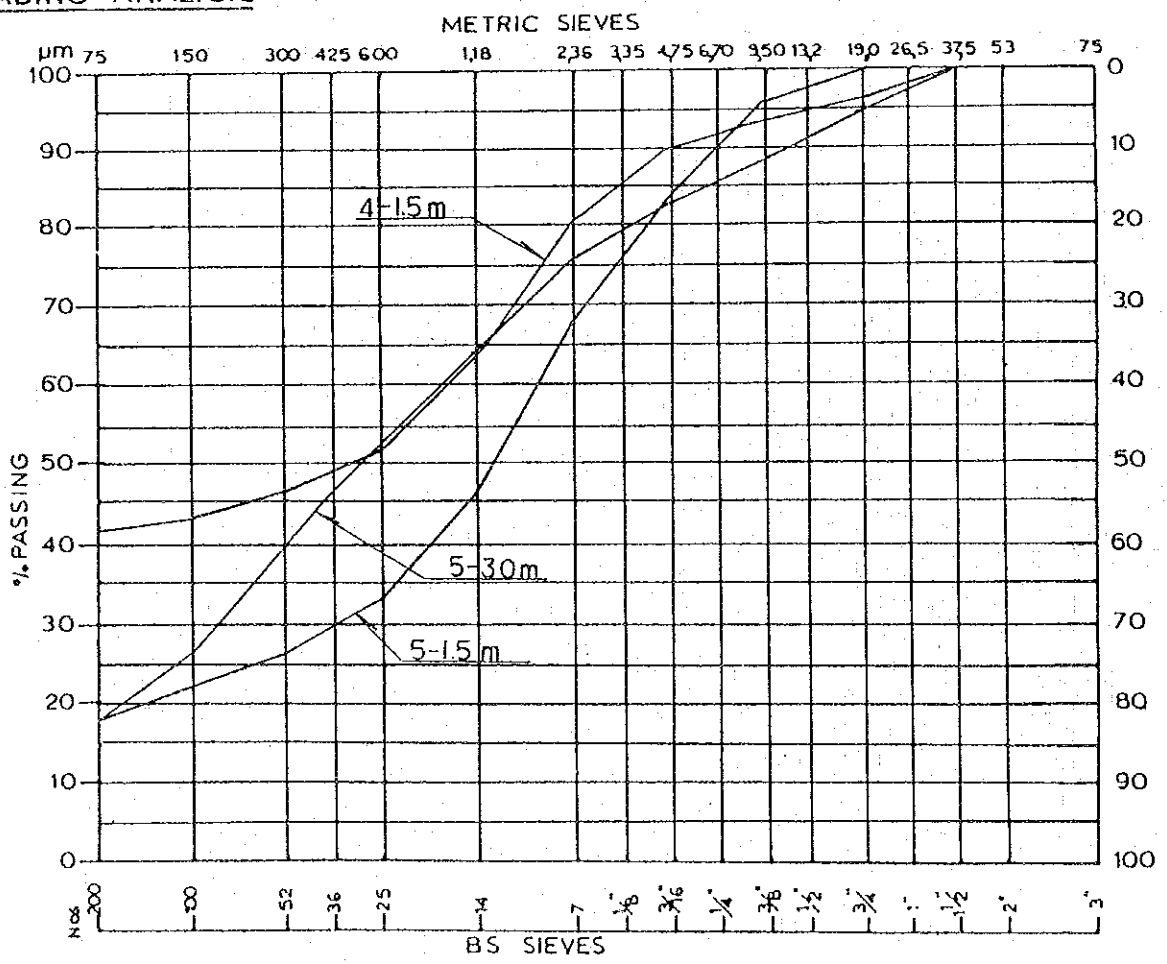
PROJECT: II-1-6 DATE: _____

SAMPLE No.	4	5	5					
DEPTH	1.5	1.5	3.0					
GRAVEL	19	24	32					
COARSE SAND	29	22	36					
MEDIUM SAND	7	20	8					
FINE SAND	3	15	5					
SILT CLAY	42	19	19					

SOIL CONSTANTS (on material passing No. 425 μm sieve)

LIQUID LIMIT	56	20	35					
PLASTIC INDEX	29	4	20					
LINEAR SHRINKAGE %	9	2	6					
PLASTICITY PRODUCT	1220	75	380					
COARSENESS INDEX	19	24	32					
CLASSIFICATION	SC	SW	SC					

GRADING ANALYSIS



Client : _____ Job No. : _____

Project : II-1-6 Operator : _____

Sample Nos. and Descriptions : NON-PLASTIC RIVER SAND Date : _____

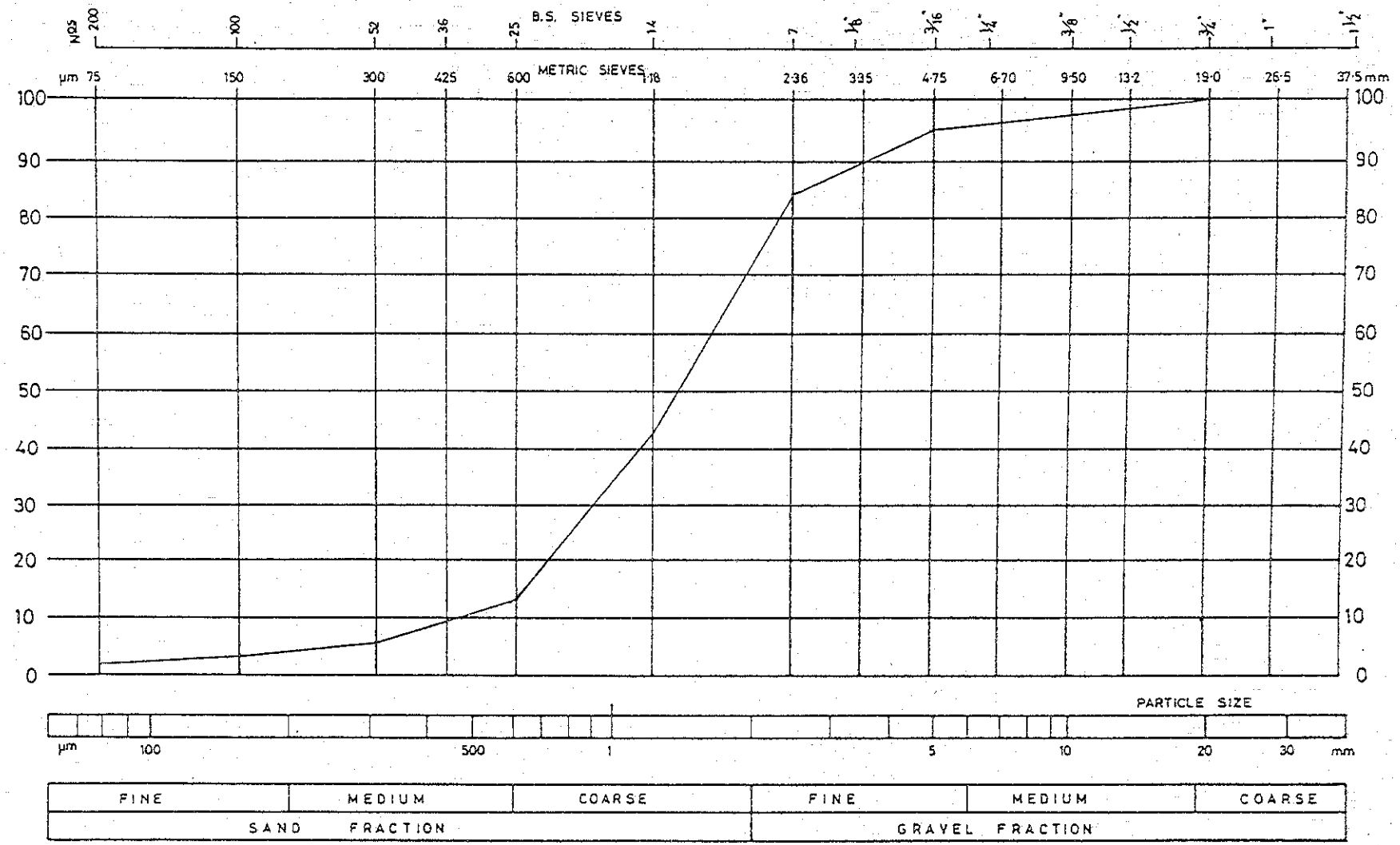


Figure E-3 (6) GRADING ANALYSIS

NORTHERN TESTING LABS.
P.O. BOX 1834 PHONE 47222 HARARE

Figure E-3 (7) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LIMITED JOB No: 8071

PROJECT: MASHOKO II-2-1 DATE: AUGUST 1987

SAMPLE No.	1	1	2	2	3	3	3	
DEPTH	1.5	-	1.5	3.0	1.5	3.0	3.0	
GRAVEL	54	38	42	11	7	46	-	
COARSE SAND	22	24	10	7	9	26	2	
MEDIUM SAND	9	15	8	18	5	12	11	
FINE SAND	5	5	6	18	3	6	9	
SILT CLAY	10	18	34	46	76	10	78	

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	26	26	59	44	69	29	45	
PLASTIC INDEX	11	10	32	19	41	13	13	
LINEAR SHRINKAGE %	3	5	16	7	17	5	9	
PLASTICITY PRODUCT	110	130	1 090	875	3 115	130	1 015	
COARSENESS INDEX	54	38	42	11	7	46	-	
CLASSIFICATION	GC	SC	GC	SC	CH	GC	MI	

GRADING ANALYSIS

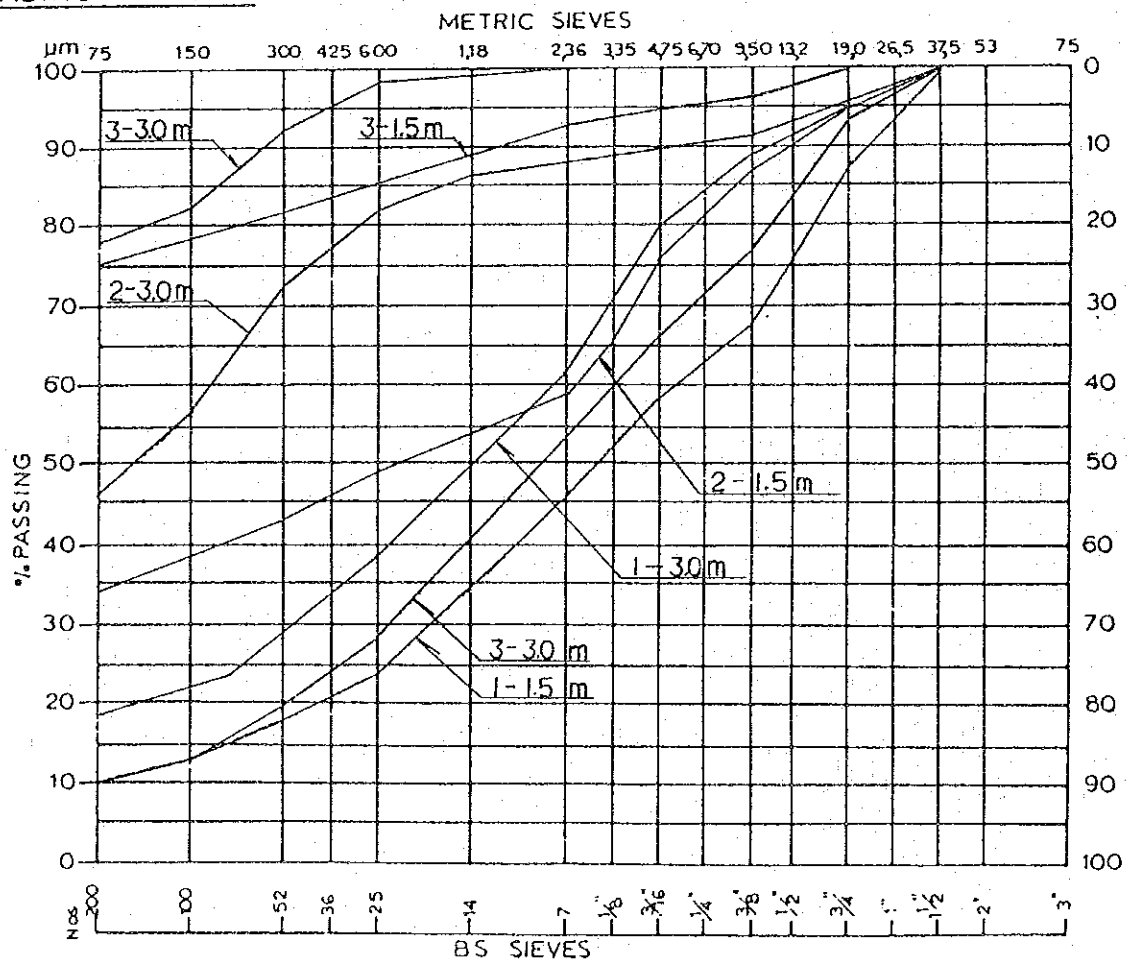


Figure E-3 (8) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LIMITED JOB No: 8071

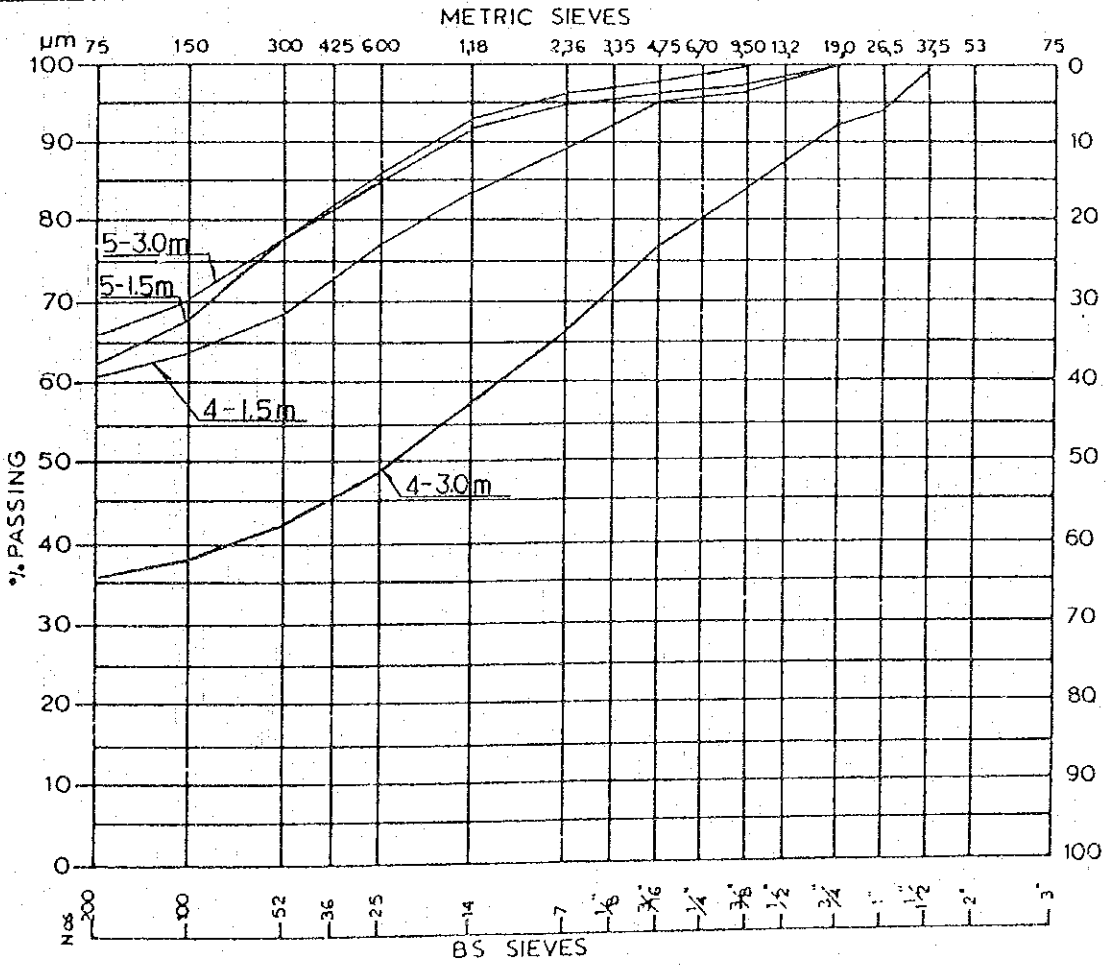
PROJECT: MASHOKO II-2-1 DATE: AUGUST 1987

SAMPLE No.	4	4	5	5				
DEPTH	1.5	3.0	1.5	3.0				
GRAVEL	10	33	4	5				
COARSE SAND	15	18	10	10				
MEDIUM SAND	10	9	14	12				
FINE SAND	4	4	9	7				
SILT CLAY	61	36	63	66				

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	56	68	24	42				
PLASTIC INDEX	31	44	9	25				
LINEAR SHRINKAGE %	13	15	1	9				
PLASTICITY PRODUCT	1 890	1 585	565	1 650				
COARSENESS INDEX	10	33	4	5				
CLASSIFICATION	CH	GC	CL	CI				

GRADING ANALYSIS



Client : GEOTECHNICAL SERVICES)80) (PVT) LIMITED

Job No. : 8071

Project : MASHOKO II-2-1

Operator :

Sample Nos. and Descriptions : NON PLASTIC RIVER SAND

Date : AUGUST 1987

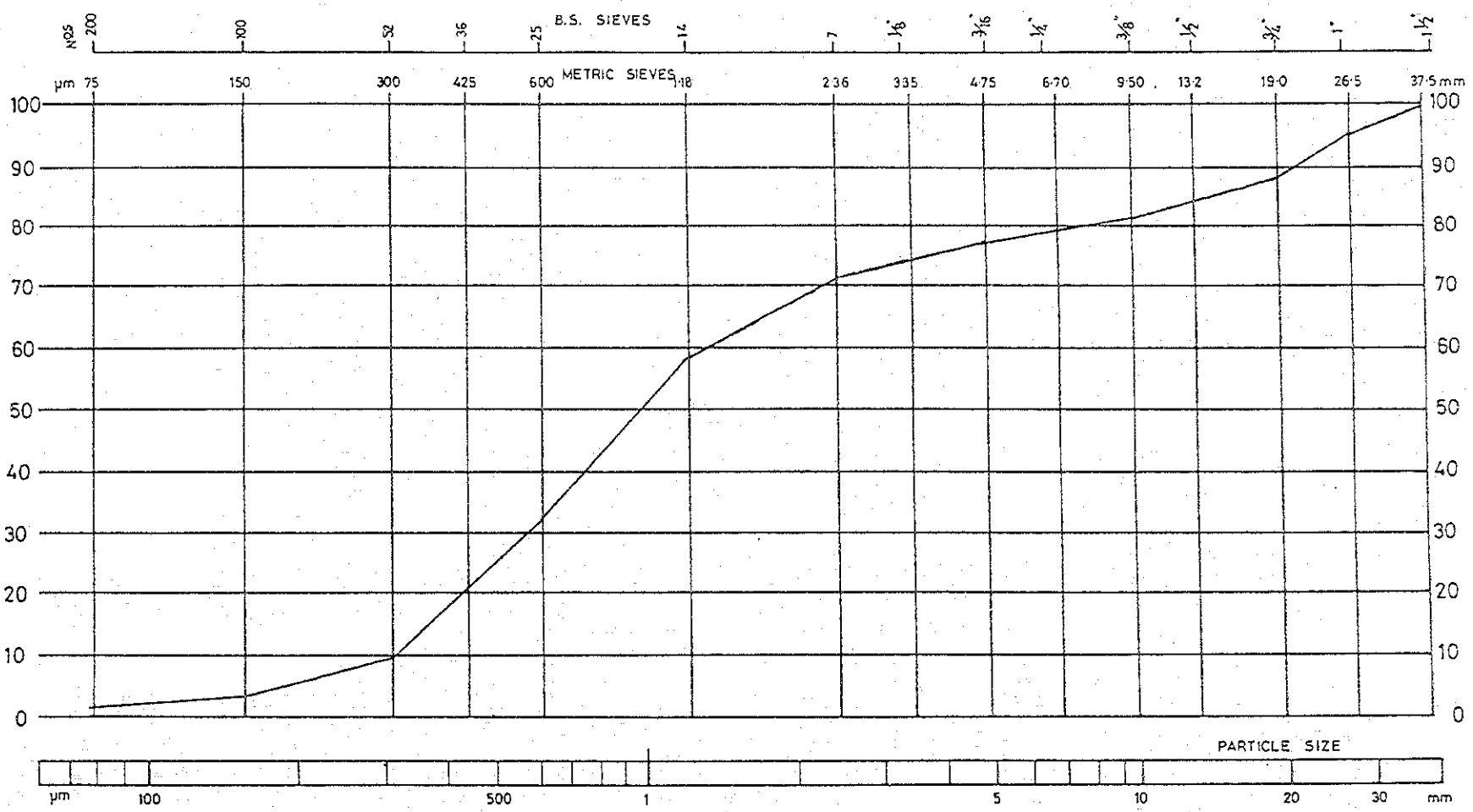


Figure E-3 (9) GRADING ANALYSIS

NORTHERN TESTING LABS.

P.O. BOX 1834 PHONE 47222 HARARE

Figure E-3 (10) GRADING ANALYSIS

CLIENT: _____ JOB No.: _____

PROJECT: IV-4-10 MASVINGO DATE: _____

SAMPLE No.	1	1	1					
DEPTH	1.0	2.0	3.0					
GRAVEL	23	12	7					
COARSE SAND	26	24	19					
MEDIUM SAND	13	17	16					
FINE SAND	6	9	9					
SILT CLAY	32	38	49					

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	52	41	52					
PLASTIC INDEX	30	24	30					
LINEAR SHRINKAGE %	13	11	13					
PLASTICITY PRODUCT	960	910	1470					
COARSENESS INDEX	23	12	7					
CLASSIFICATION	SC	SC	SC					

GRADING ANALYSIS

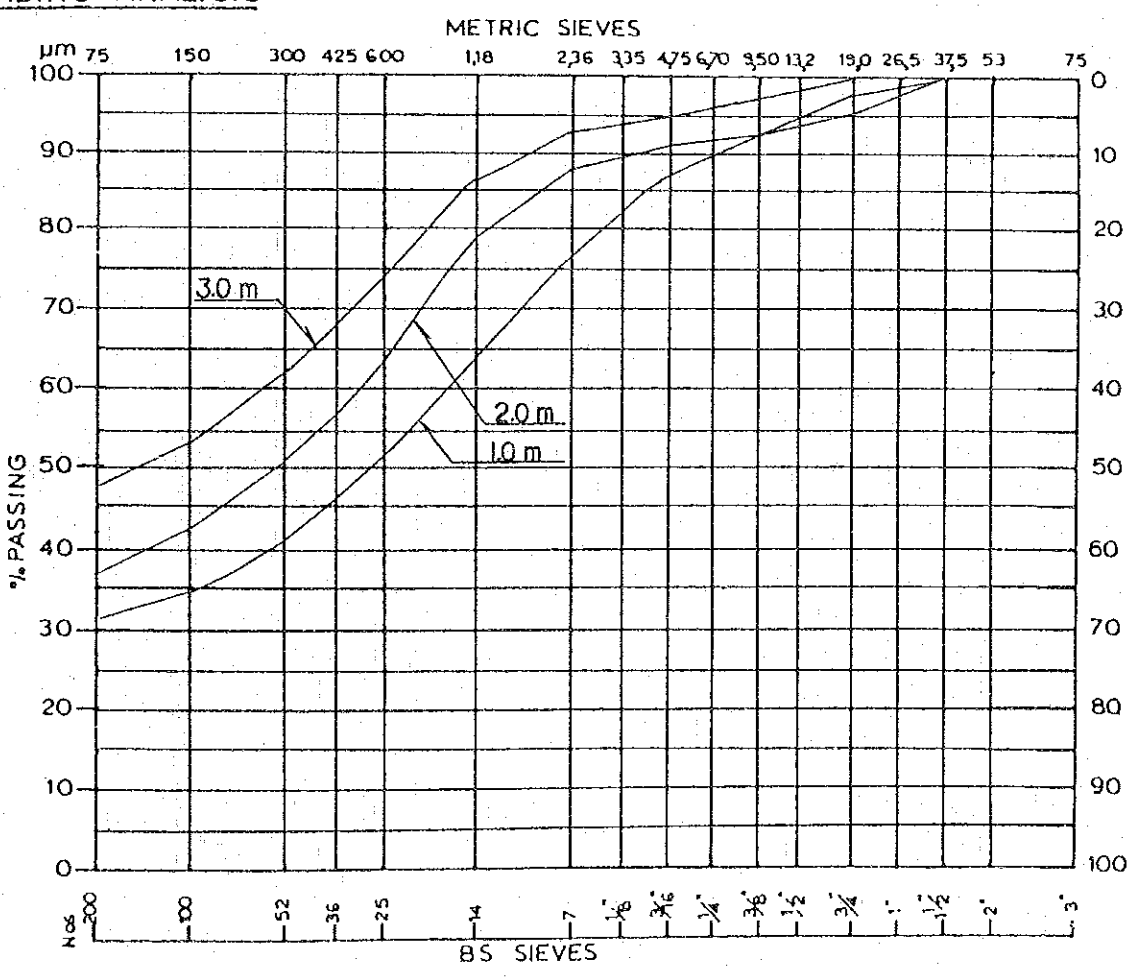


Figure E-3 (11) GRADING ANALYSIS

CLIENT: _____ JOB No: _____

PROJECT: VI-4-10 MASVINGO DATE: _____

SAMPLE No.	2	2	2					
DEPTH	1.0	2.0	3.0					
GRAVEL	2	6	14					
COARSE SAND	31	36	30					
MEDIUM SAND	25	20	17					
FINE SAND	10	9	9					
SILT CLAY	32	29	30					

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	36	36	34					
PLASTIC INDEX	20	19	19					
LINEAR SHRINKAGE %	9	8	8					
PLASTICITY PRODUCT	640	550	570					
COARSENESS INDEX	2	6	14					
CLASSIFICATION	SC	SC	SC					

GRADING ANALYSIS

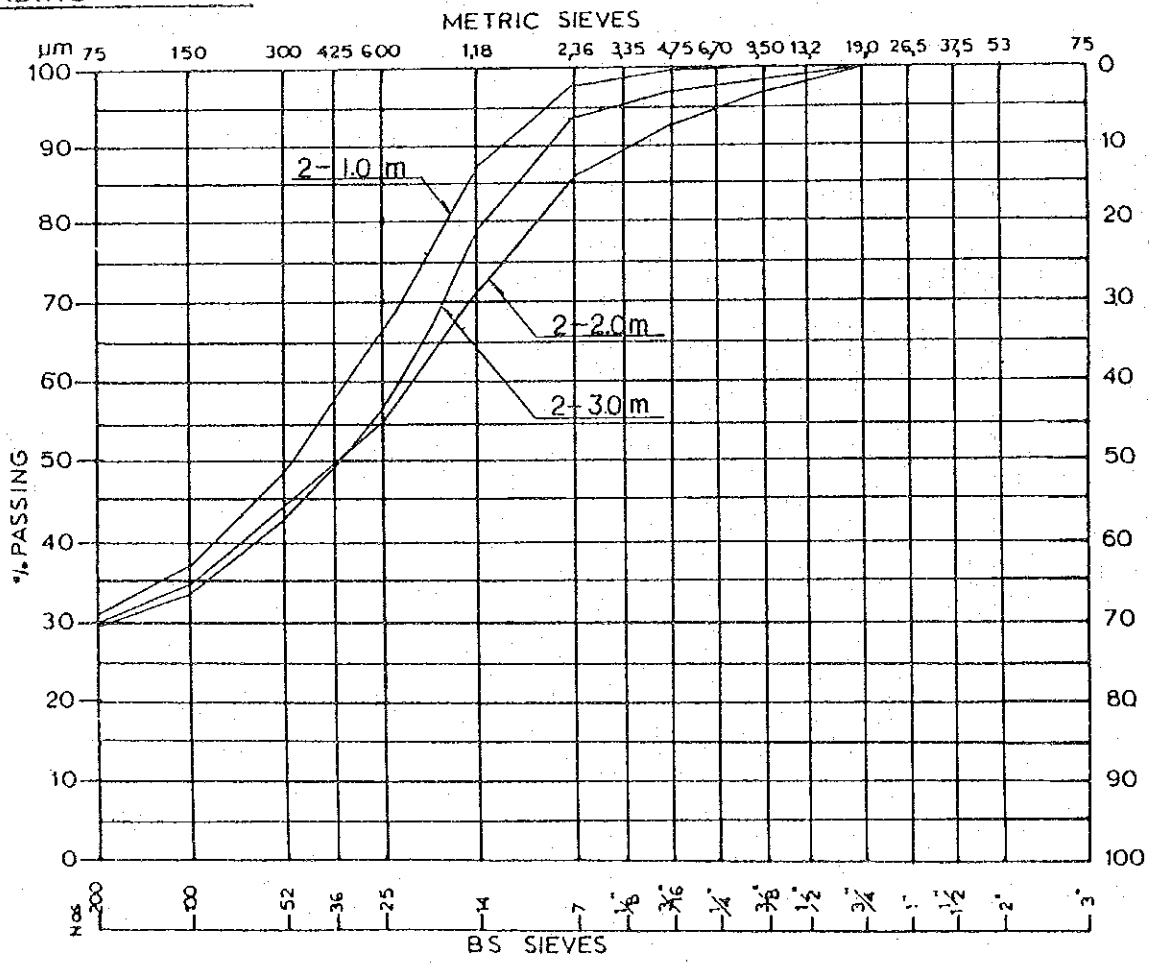


Figure E-3 (12) GRADING ANALYSIS

CLIENT: _____ JOB No: _____

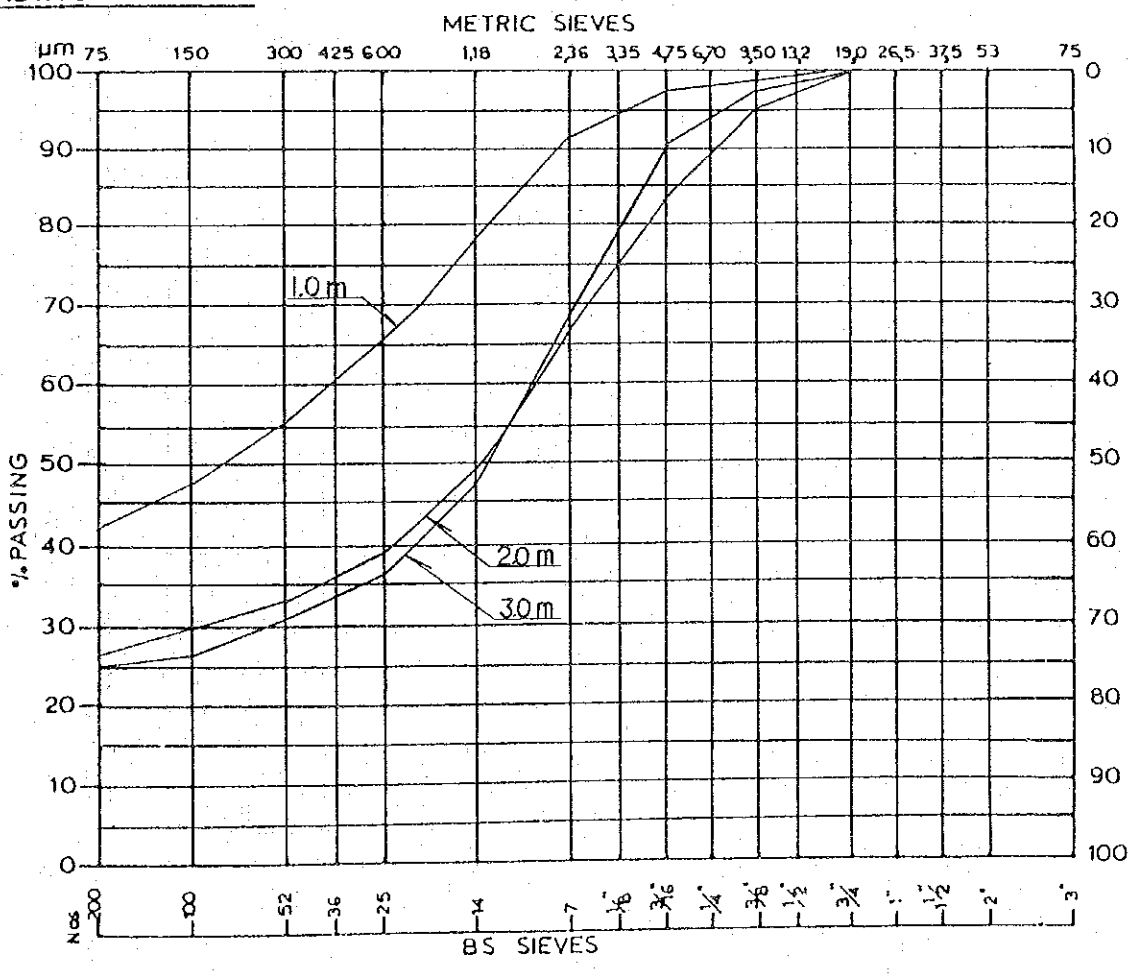
PROJECT: VI-4-10 MASVINGO DATE: _____

SAMPLE No.	3	3	3					
DEPTH	1.0	2.0	3.0					
GRAVEL	8	34	32					
COARSE SAND	27	27	30					
MEDIUM SAND	14	8	10					
FINE SAND	8	4	3					
SILT CLAY	43	27	25					

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	36	41	37					
PLASTIC INDEX	18	20	19					
LINEAR SHRINKAGE %	7	10	9					
PLASTICITY PRODUCT	775	540	475					
COARSENESS INDEX	8	34	32					
CLASSIFICATION	SC	SC	SC					

GRADING ANALYSIS



Client : _____ Job No. : _____

Project : IV-4-10 MASVINGO Operator : _____

Sample Nos. and Descriptions : NON-PLASTIC RIVER SAND Date : _____

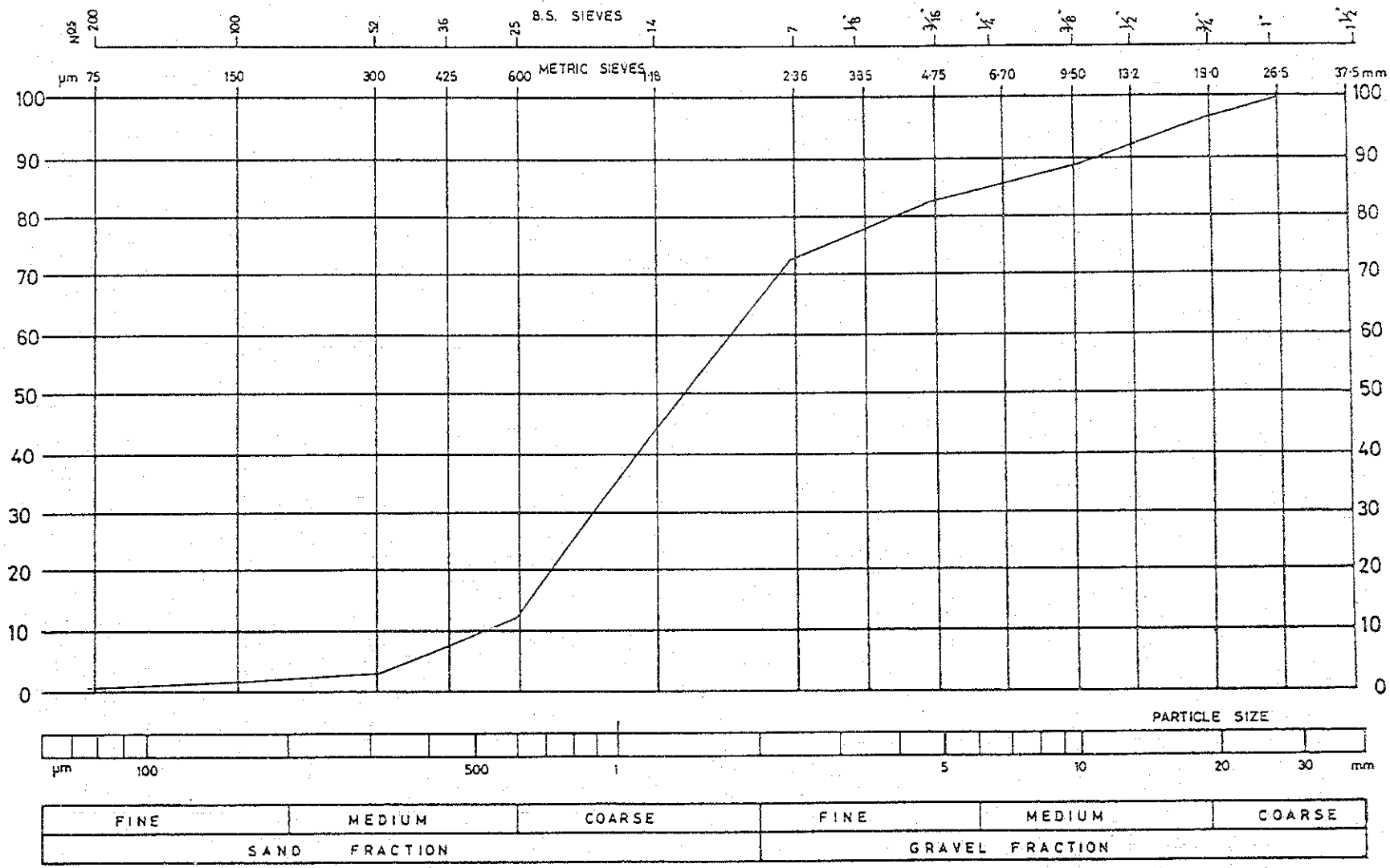


Figure E-3 (13) GRADING ANALYSIS

NORTHERN TESTING LABS.

P.O. BOX 1834 PHONE 47222 HARARE

Figure E-3 (14) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980)(PVT) LIMITED JOB No: 8071

PROJECT: V-3-3 DATE: 1.9.87

SAMPLE No. TP	1	1	3	3	4	4		
DEPTH	1.5	3	1	2.5	1	2		
GRAVEL	7	4	18	16	3	5		
COARSE SAND	20	27	20	20	20	28		
MEDIUM SAND	7	15	7	16	9	22		
FINE SAND	2	10	4	6	5	8		
SILT CLAY	64	44	51	42	63	37		

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	56	33	53	34	53	31		
PLASTIC INDEX	31	14	28	16	26	11		
LINEAR SHRINKAGE %	12	6	12	7	13	3		
PLASTICITY PRODUCT	1 985	615	1 430	670	1 640	405		
COARSENESS INDEX	7	4	18	16	3	5		
CLASSIFICATION	CH	SC	CH	SC	CH	SC		

GRADING ANALYSIS

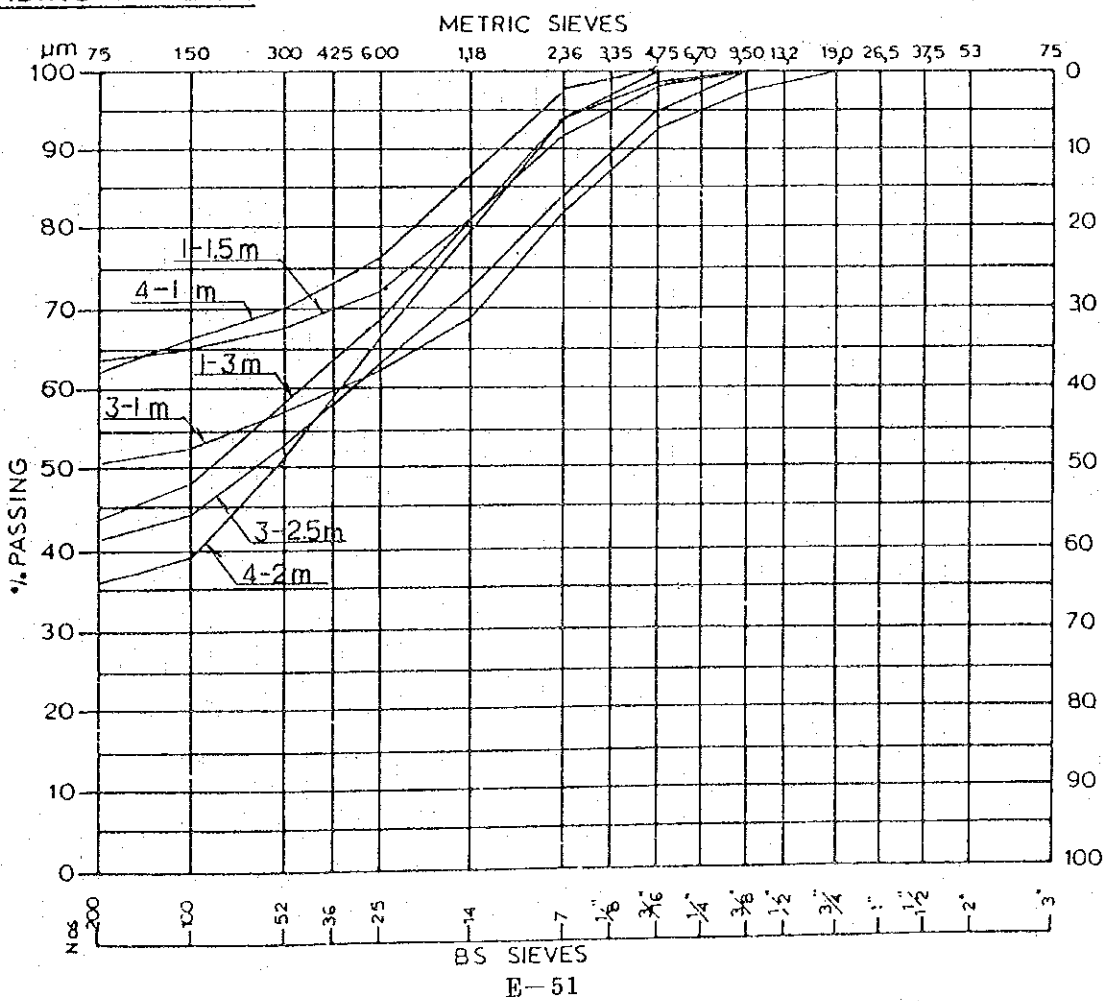


Figure E-3 (15) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980)(PVT) LIMITED JOB No: 8071

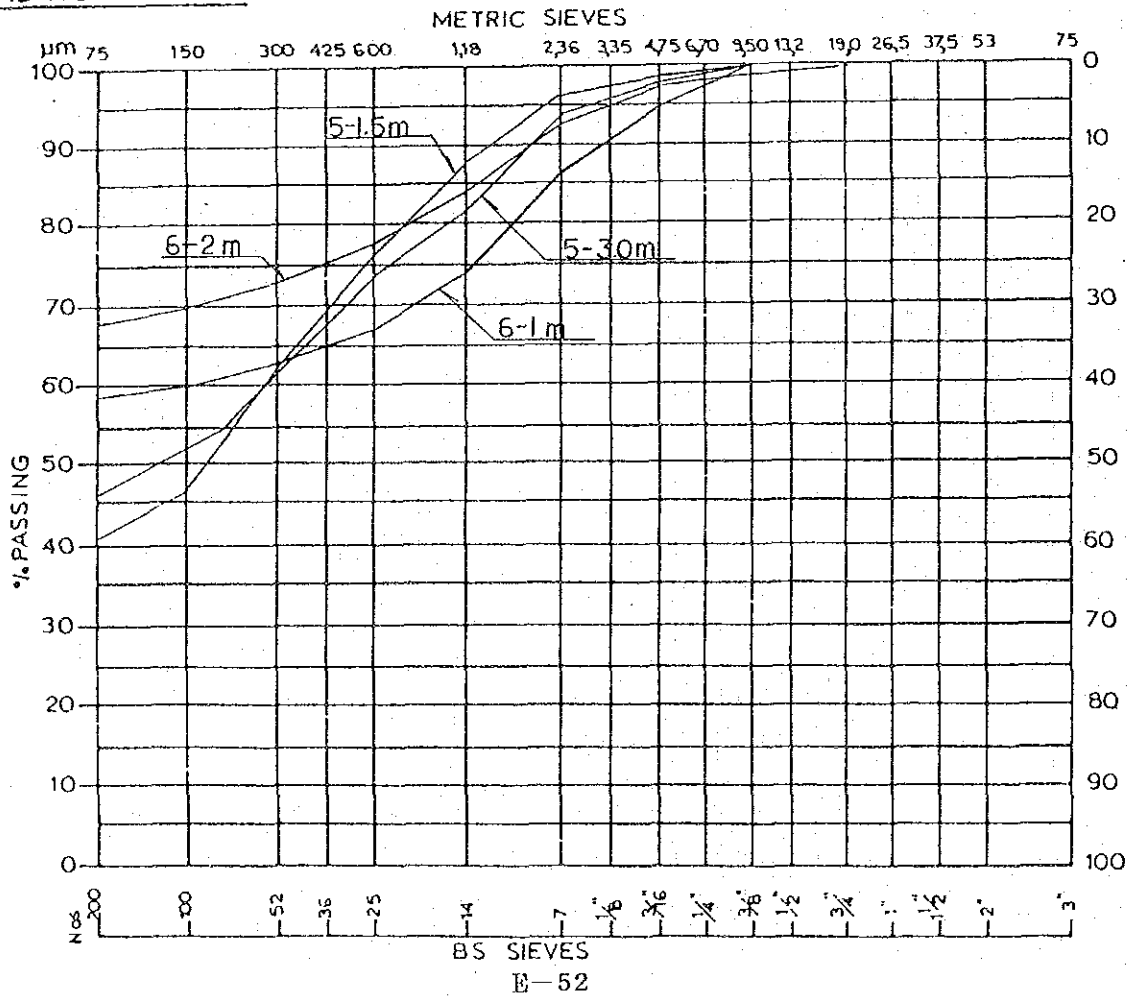
PROJECT: V-3-3 DATE: 1.9.87

SAMPLE No.	5	5	6	6				
DEPTH	1.5	3	1	2				
GRAVEL	4	7	4	8				
COARSE SAND	20	19	19	14				
MEDIUM SAND	22	19	6	7				
FINE SAND	13	9	2	3				
SILT CLAY	41	46	59	68				

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	34	40	54	54				
PLASTIC INDEX	20	23	25	26				
LINEAR SHRINKAGE %	11	7	12	13				
PLASTICITY PRODUCT	820	1 060	1 475	1 770				
COARSENESS INDEX	4	7	4	8				
CLASSIFICATION	SC	SC	CH	CH				

GRADING ANALYSIS



Client : GEOTECHNICAL SERVICES (1980) (PVT) LIMITED

Job No. : 8071

Project : V-3-3

Operator :

Sample Nos. and Descriptions : SAND

Date : 1 SEPTEMBER 1987

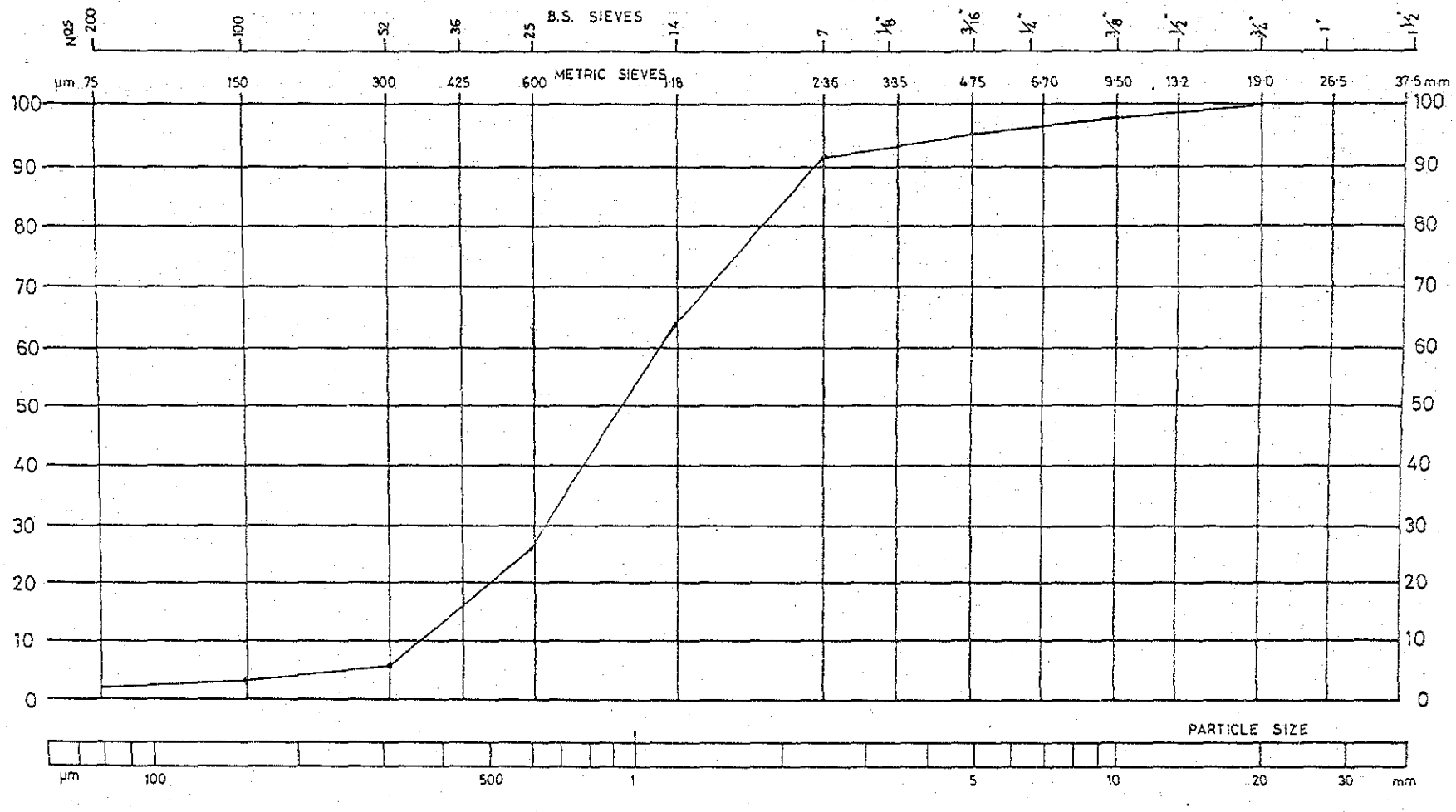


Figure E-3 (16) GRADING ANALYSIS

NORTHERN TESTING LABS.

P.O. BOX 1834 PHONE 47222 HARARE

Figure E-3 (17) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LIMITED JOB No: 8071

PROJECT: V11-1-12 DATE: 1.9.87

SAMPLE No. TP	1	1	2	2	3	3		
DEPTH	1.5	3	1.5	3	1.5	3		
GRAVEL	1	3	1	2	1	5		
COARSE SAND	6	8	11	37	12	15		
MEDIUM SAND	11	10	7	23	17	17		
FINE SAND	11	10	4	7	17	16		
SILT CLAY	71	69	77	31	53	47		

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	46	43	60	43	39	39		
PLASTIC INDEX	21	15	31	19	19	19		
LINEAR SHRINKAGE %	11	7	13	7	10	10		
PLASTICITY PRODUCT	1 490	1 035	2 385	590	1 005	895		
COARSENESS INDEX	1	3	1	2	1	5		
CLASSIFICATION	CI	MI	CH	SC	CI	CI		

GRADING ANALYSIS

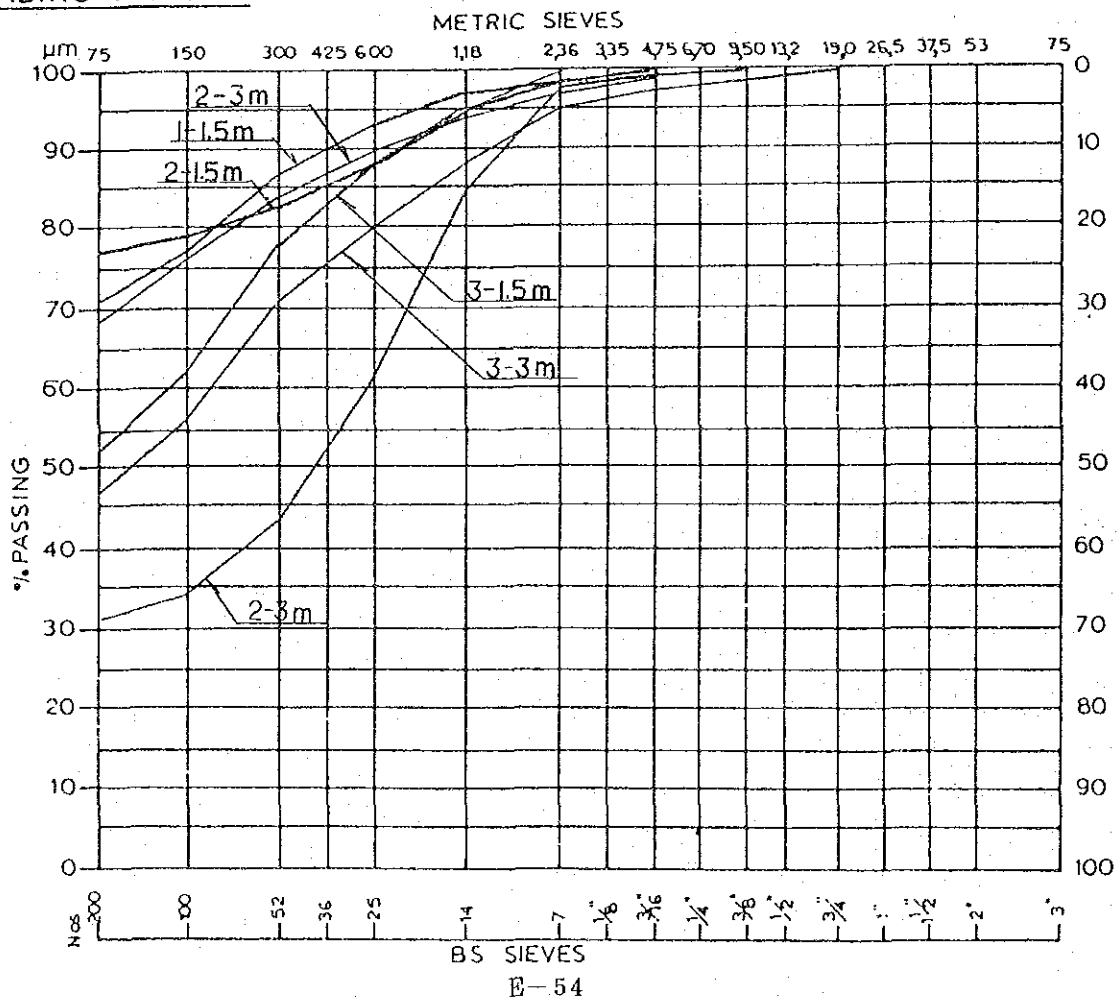


Figure E-3 (18) GRADING ANALYSIS

CLIENT: GEOTECHNICAL SERVICES (1980) (PVT) LIMITED JOB No.: 8071

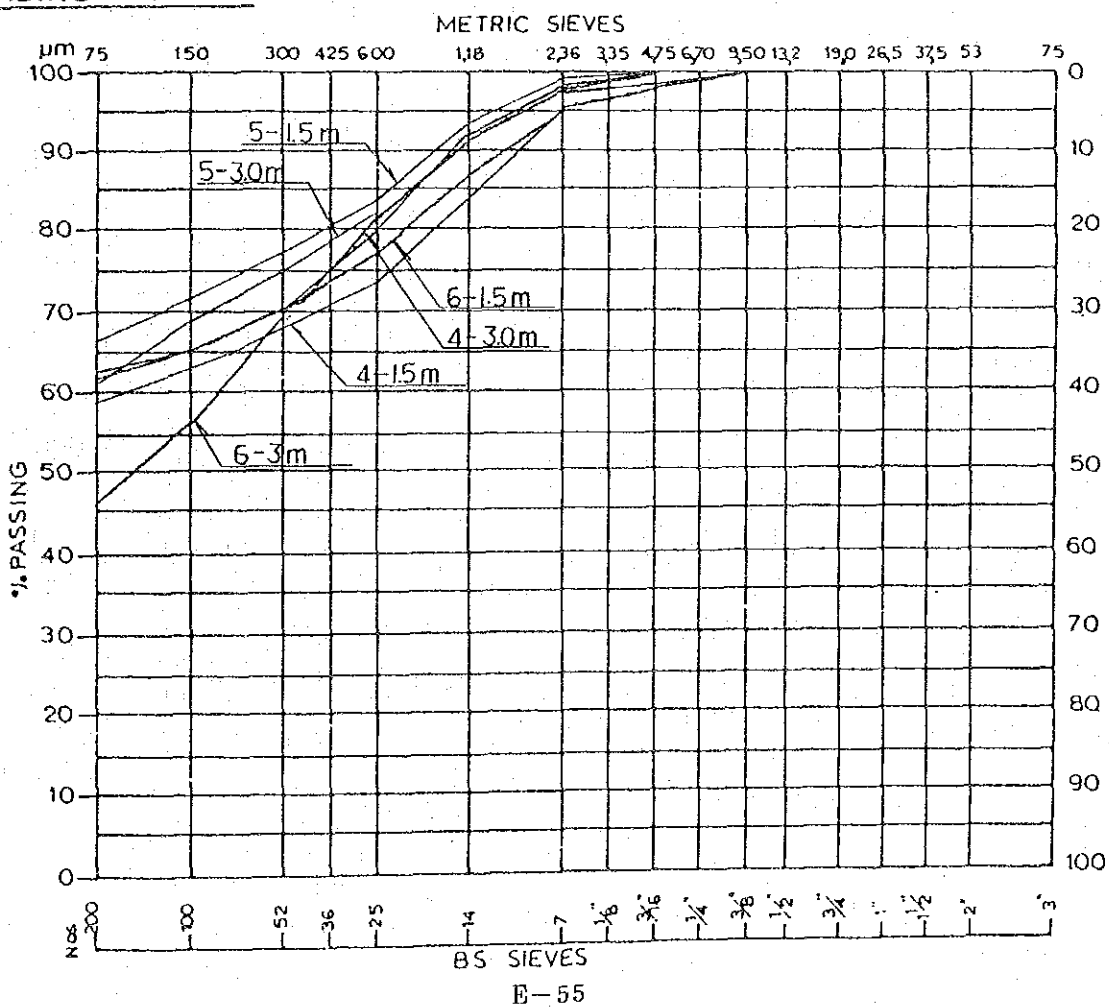
PROJECT: V11-1-12 DATE: 1.9.87

SAMPLE No. TP	4	4	5	5	6	6		
DEPTH	1.5	3	1.5	3	1.5	3		
GRAVEL	4	1	2	2	6	2		
COARSE SAND	23	20	15	16	17	17		
MEDIUM SAND	8	12	9	11	10	18		
FINE SAND	6	5	8	11	4	16		
SILT CLAY	59	62	66	60	63	47		

SOIL CONSTANTS (on material passing No. 425 µm sieve)

LIQUID LIMIT	61	56	47	48	57	48		
PLASTIC INDEX	32	25	21	23	28	15		
LINEAR SHRINKAGE %	15	12	11	11	13	5		
PLASTICITY PRODUCT	1 890	1 550	1 385	1 380	1 765	705		
COARSENESS INDEX	4	1	2	2	6	2		
CLASSIFICATION	CH	MH	CI	CI	CH	MI		

GRADING ANALYSIS



Client : GEOTECHNICAL SERVICES (J) (PVT) LIMITED

Job No. : 8071

Project : V11-1-12

Operator :

Sample Nos. and Descriptions : SAND

Date : 1 SEPTEMBER 1987

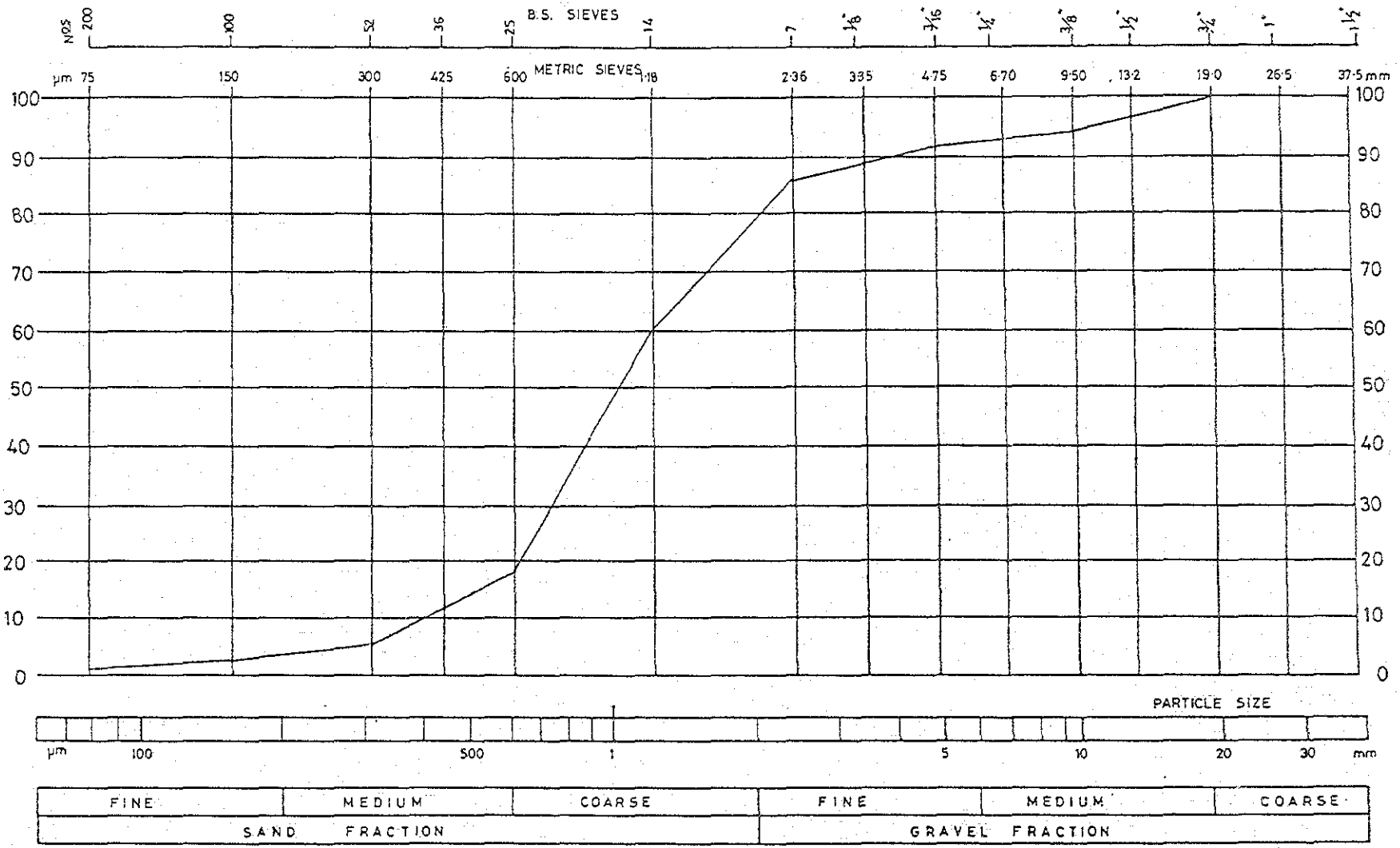


Figure E-3 (19) GRADING ANALYSIS

NORTHERN TESTING LABS.

P.O. BOX 1834 PHONE 47222 HARARE

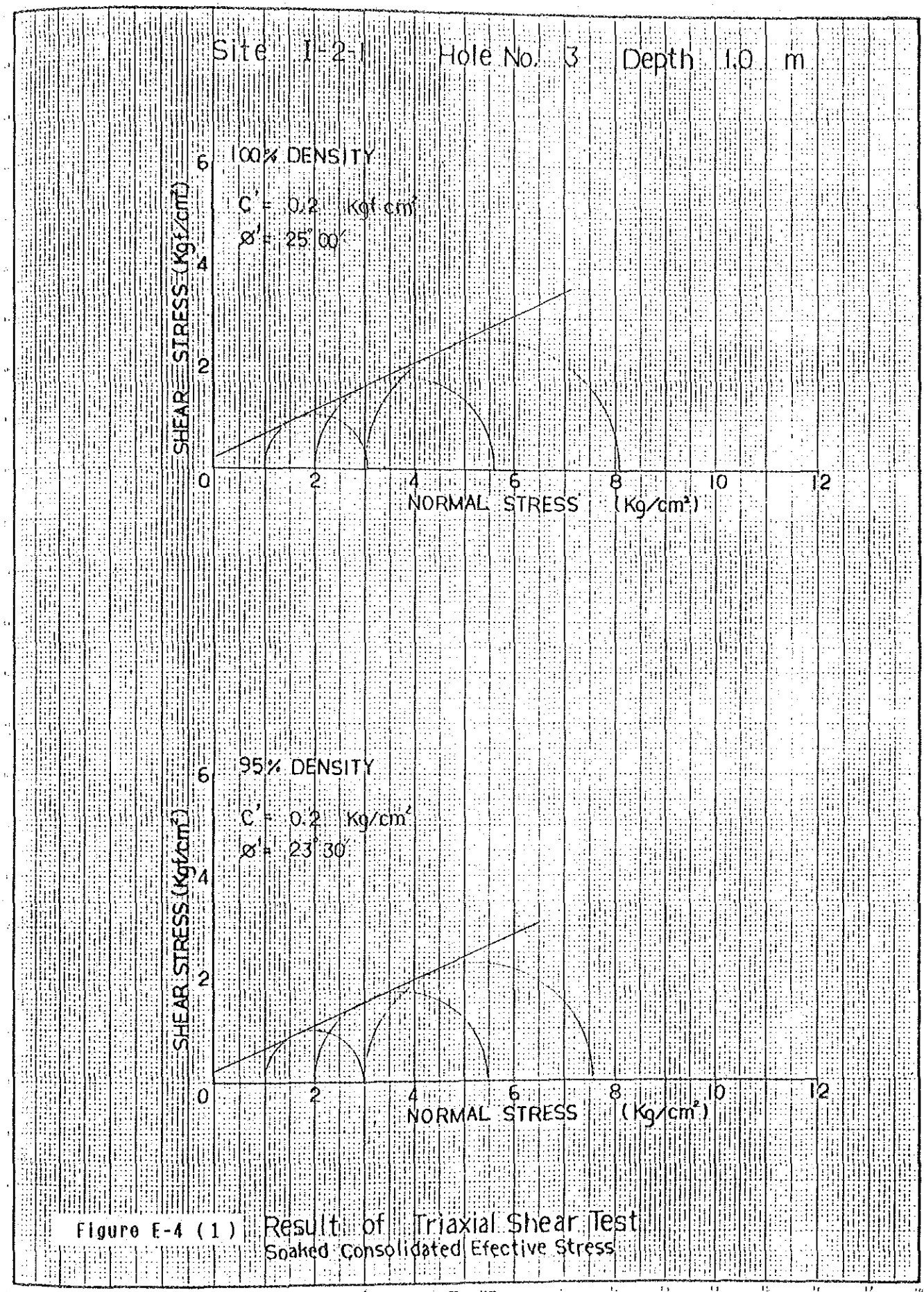


Figure E-4 (1) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

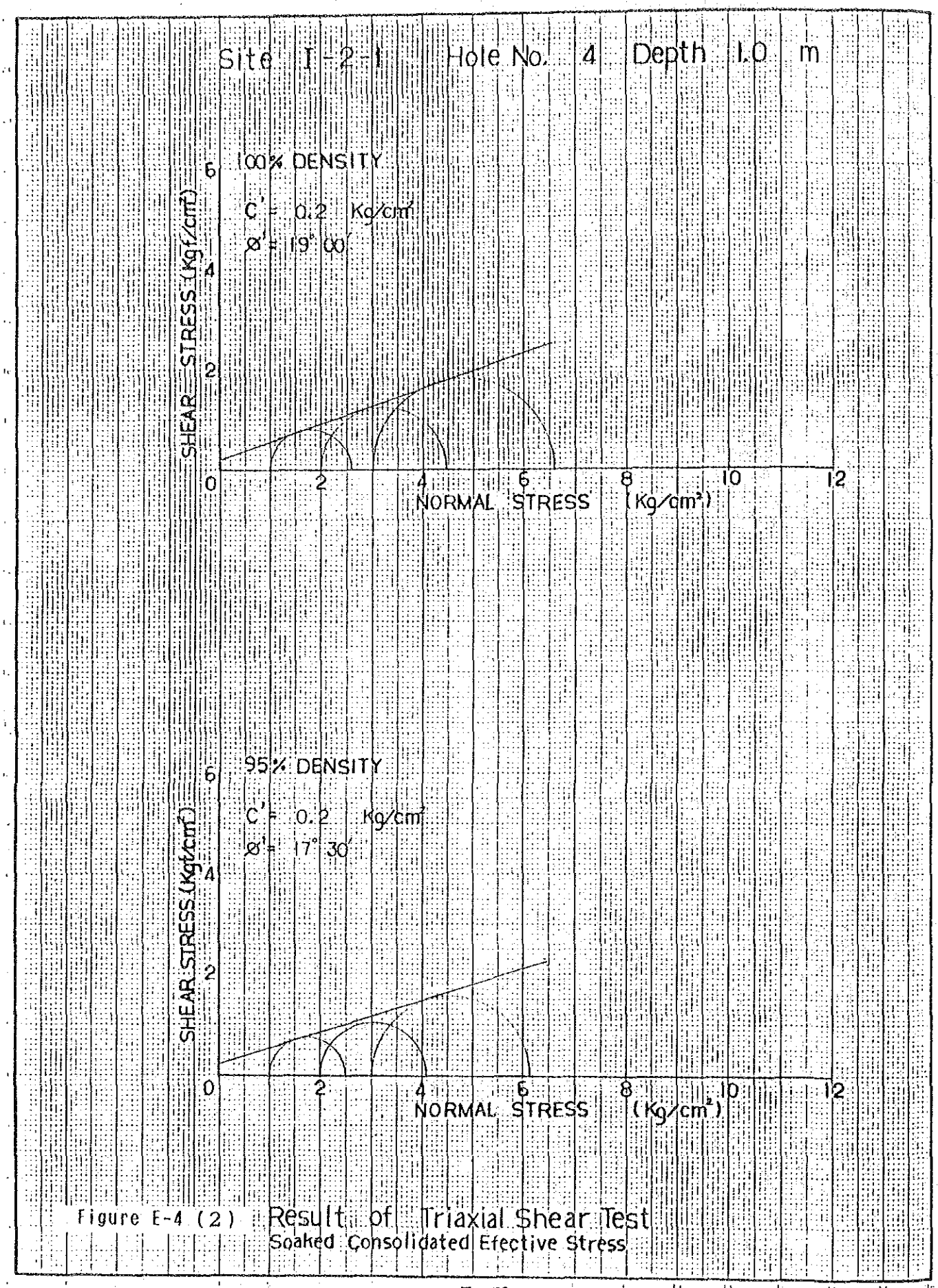


Figure E-4 (2) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

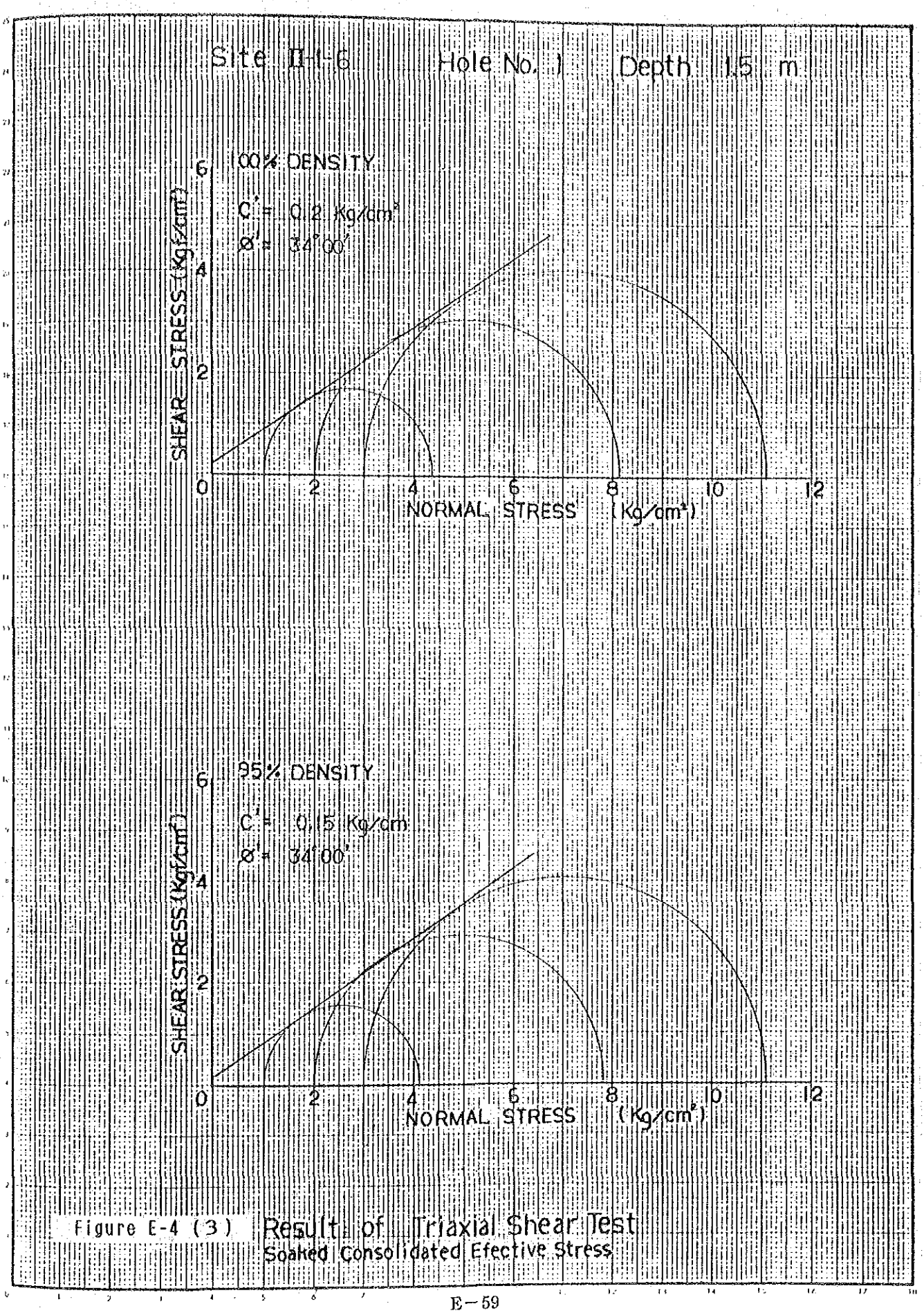


Figure E-4 (3) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

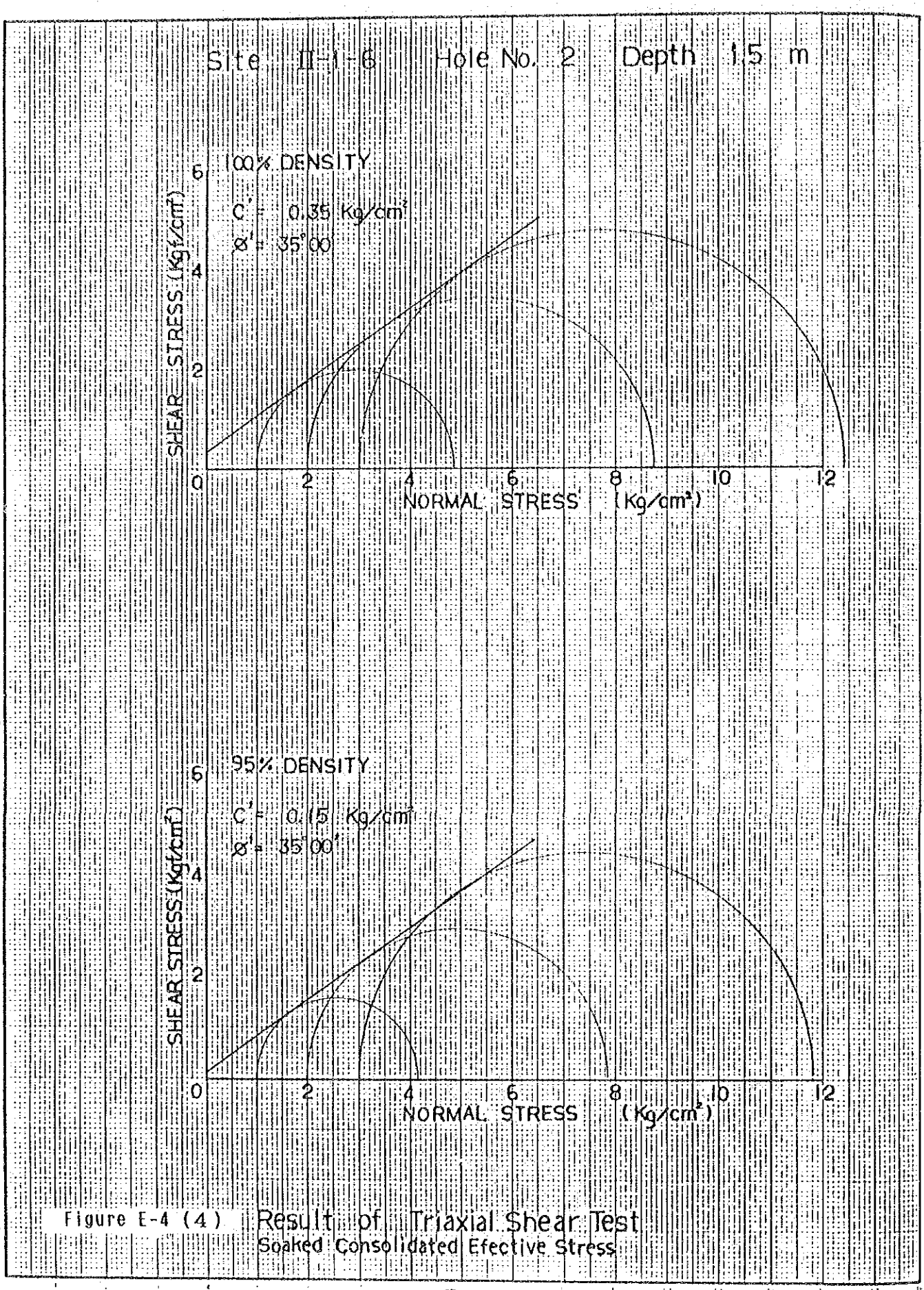
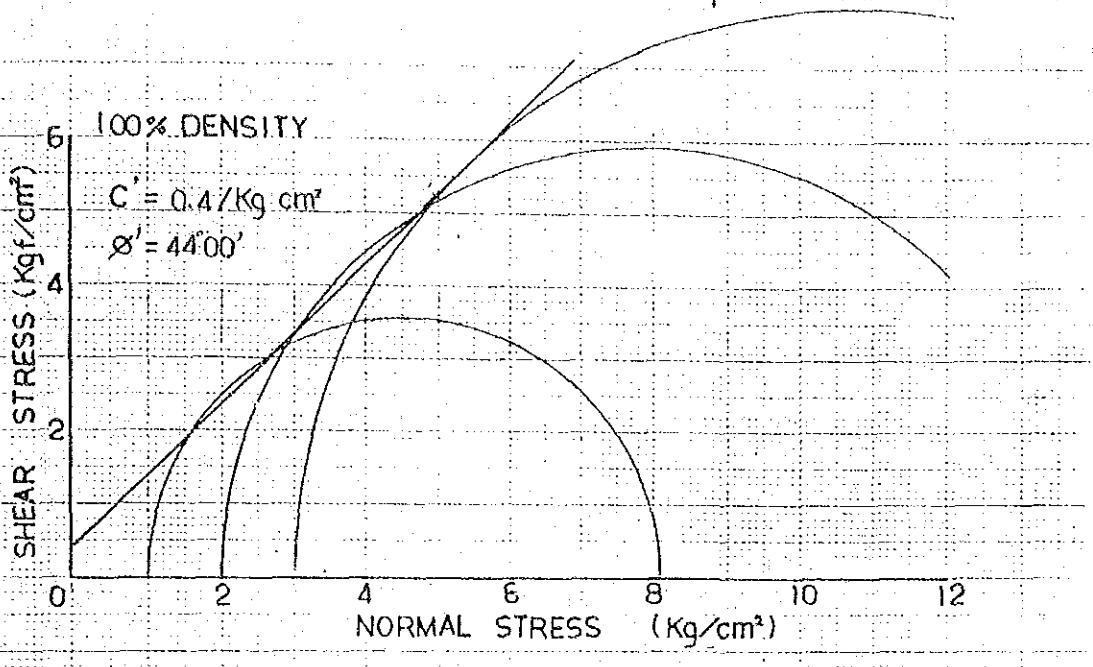


Figure E-4 (4) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site II-2-1 Hole No. 1 Depth 1.5 m



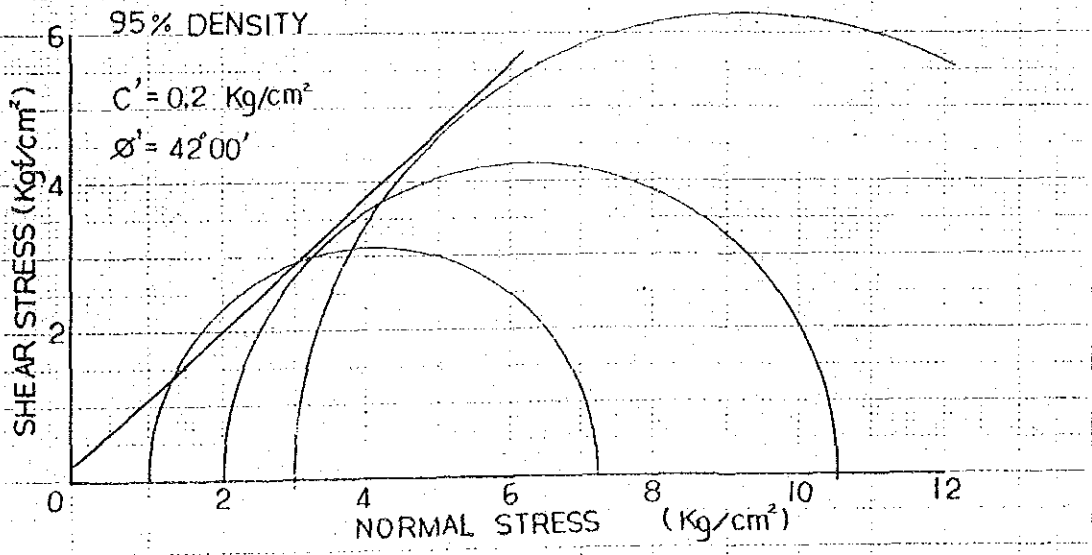
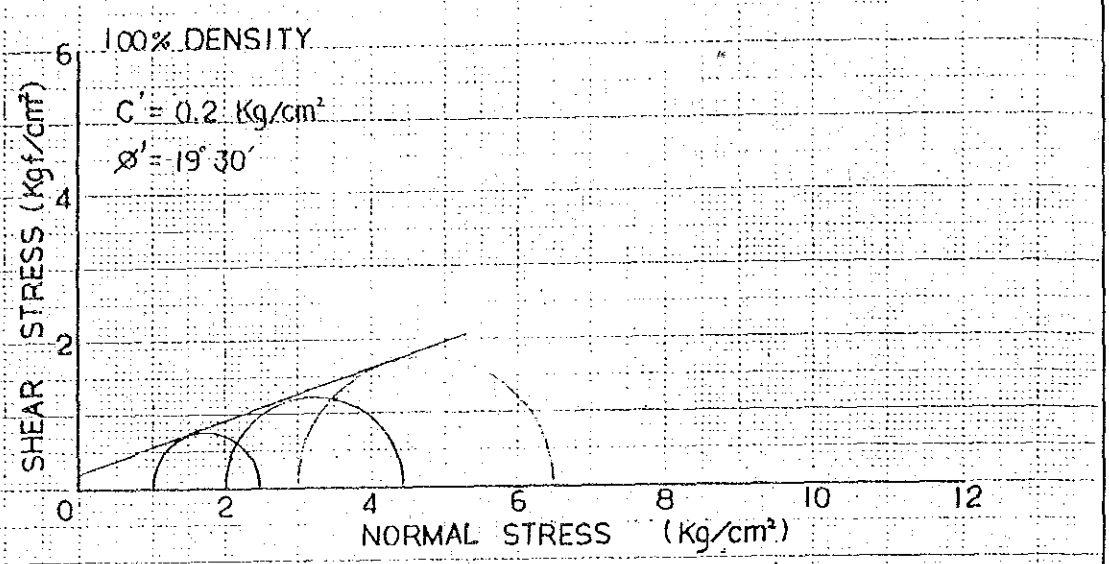


Figure E-4 (5) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site II-2-1 Hole No. 4 Depth 1.5 m



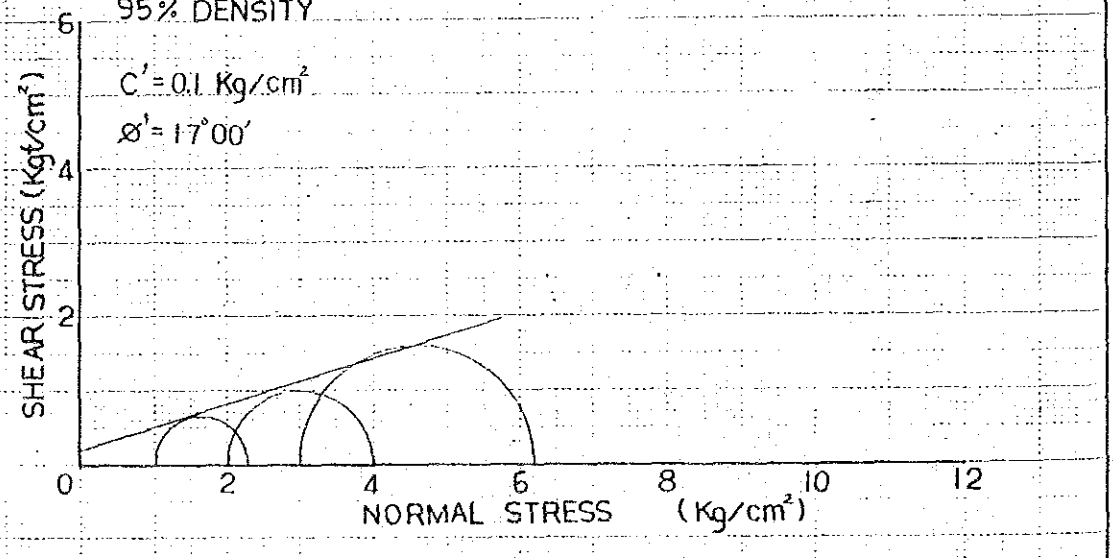


Figure E-4 (6) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

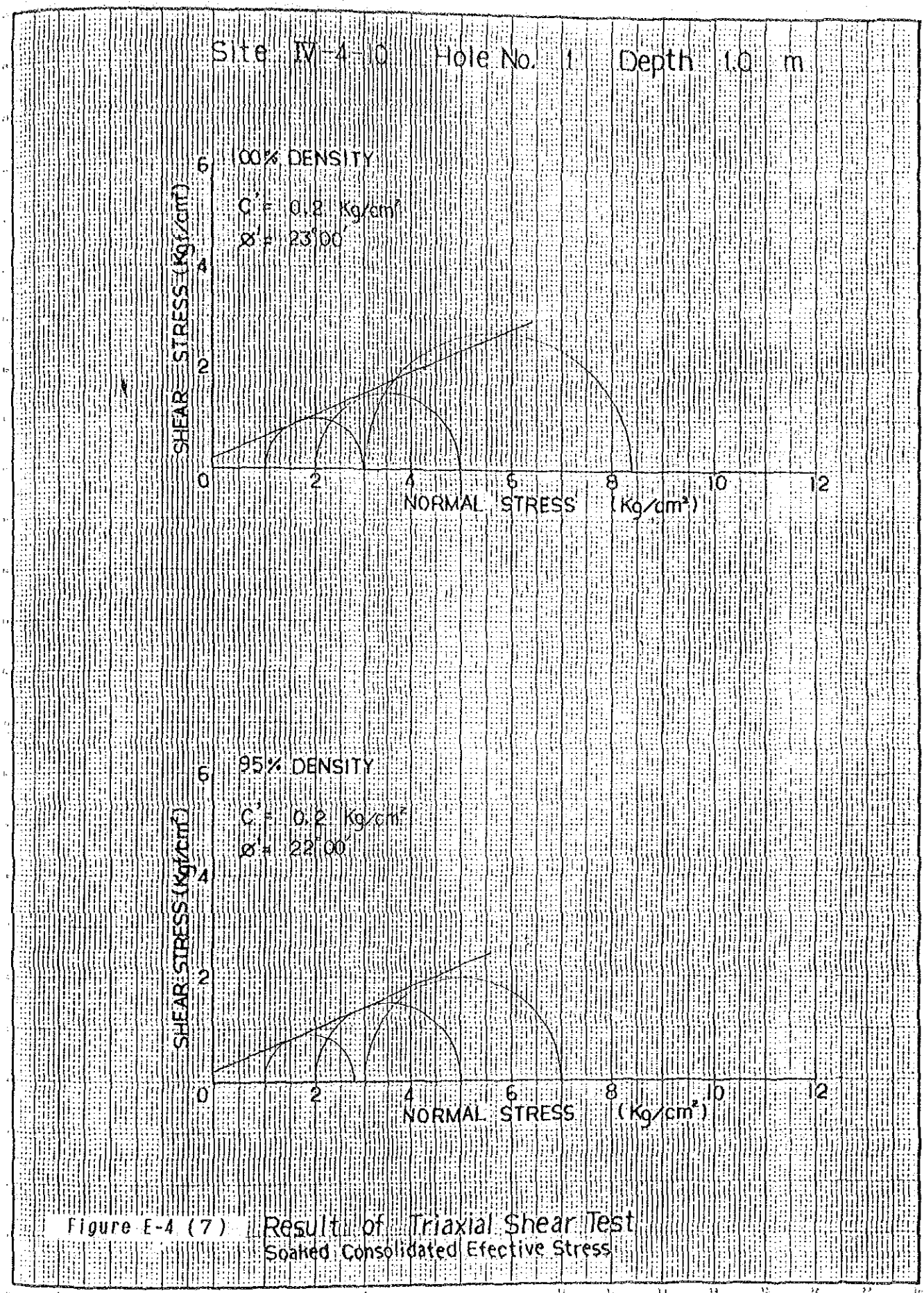


Figure E-4 (7) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

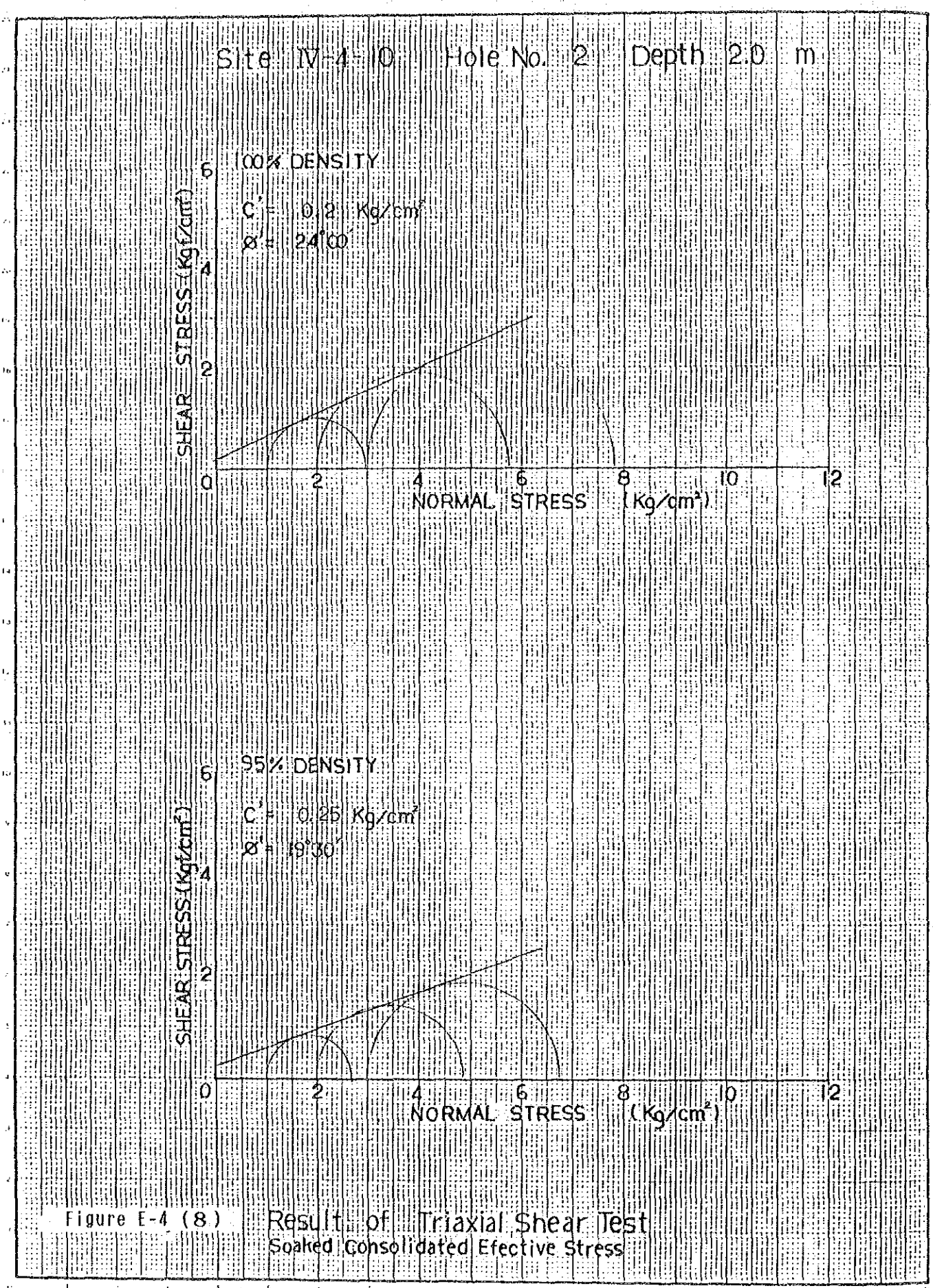
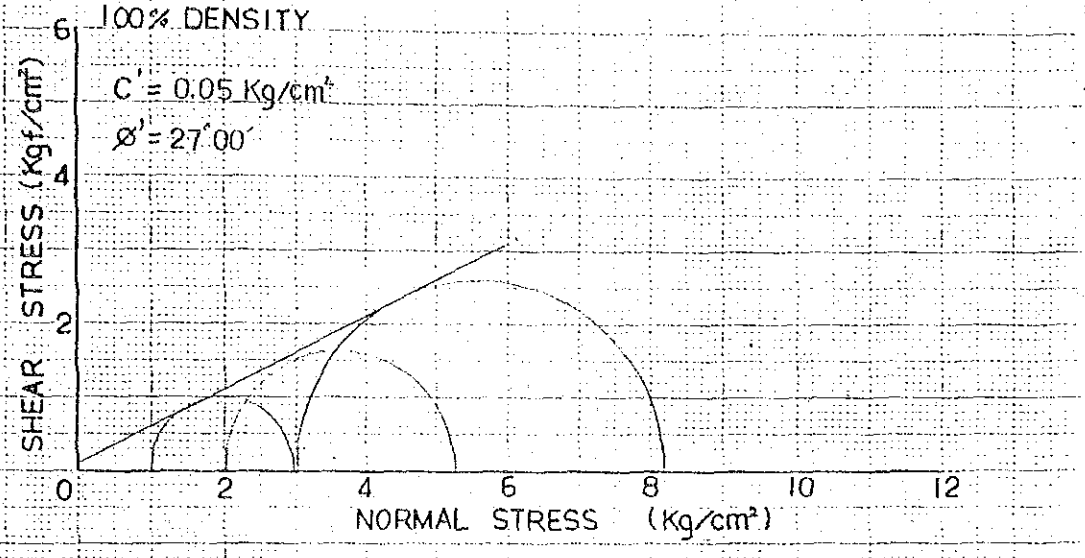


Figure E-4 (8) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site V-3-3 Hole No. 5 Depth 1.5 m



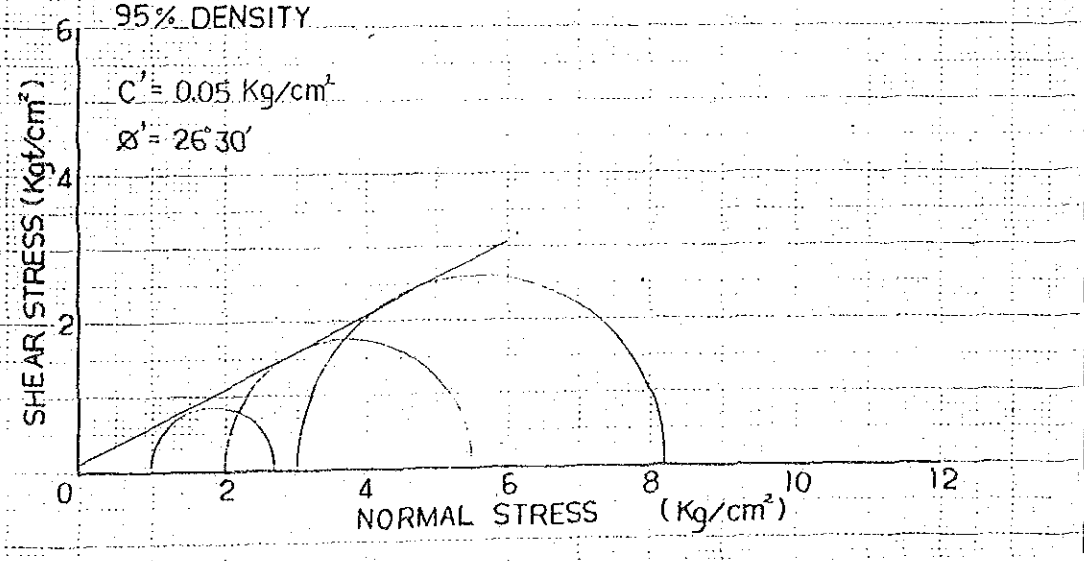
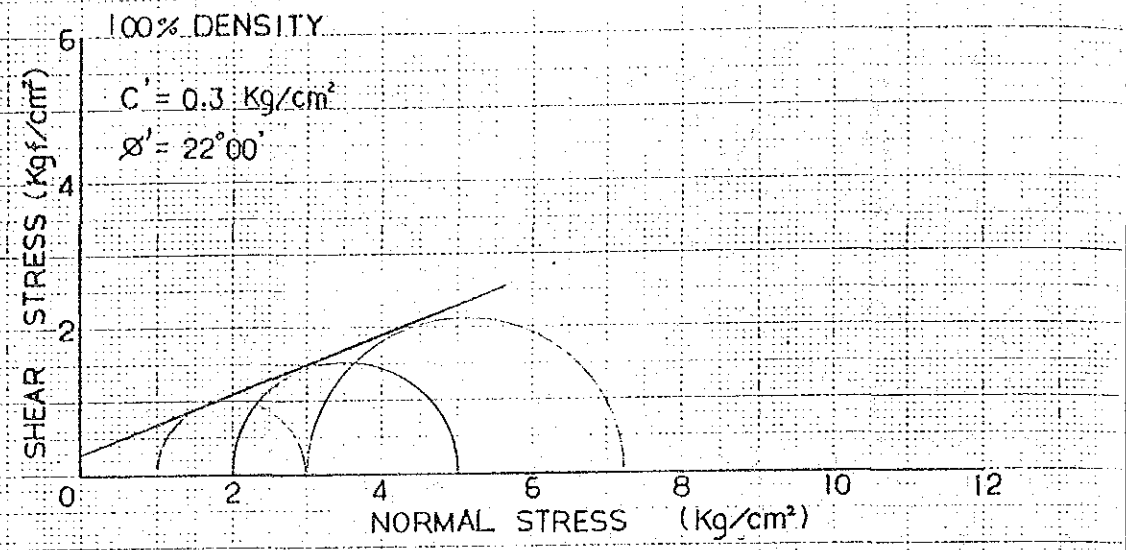


Figure E-4 (9) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site V-3-3 Hole No. 6 Depth 1.5 m



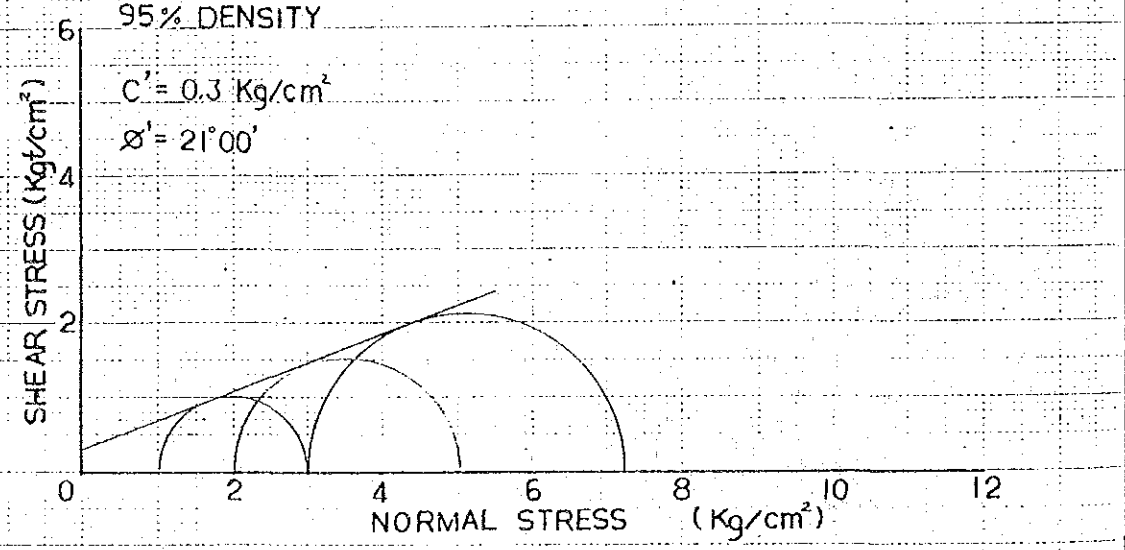
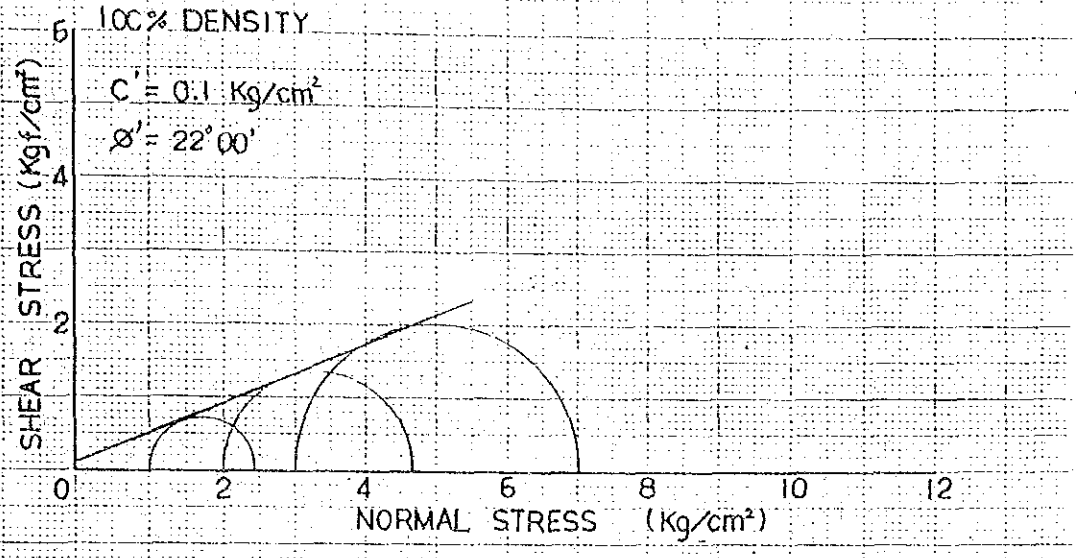


Figure E-4 (10) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site VII-1-12 Hole No. 1 Depth 1.5 m



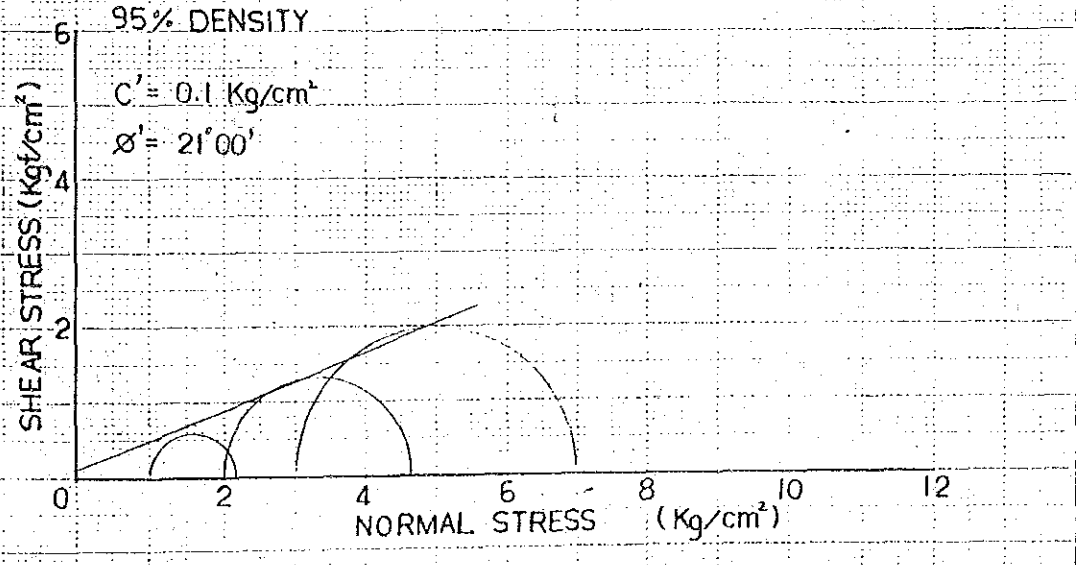
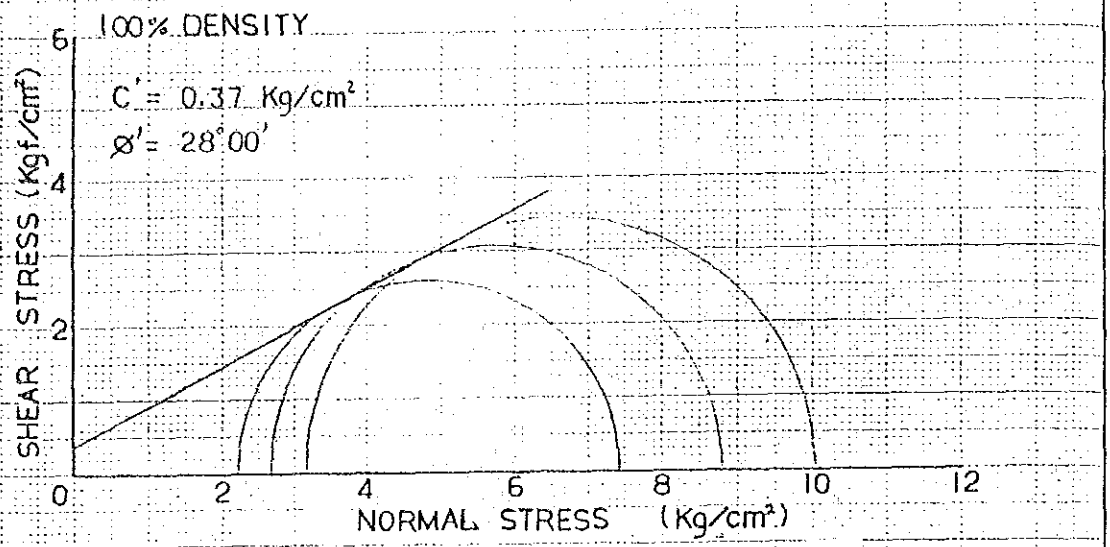


Figure E-4 (11) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress

Site VII-1-12 Hole No. 6 Depth 1.5 m



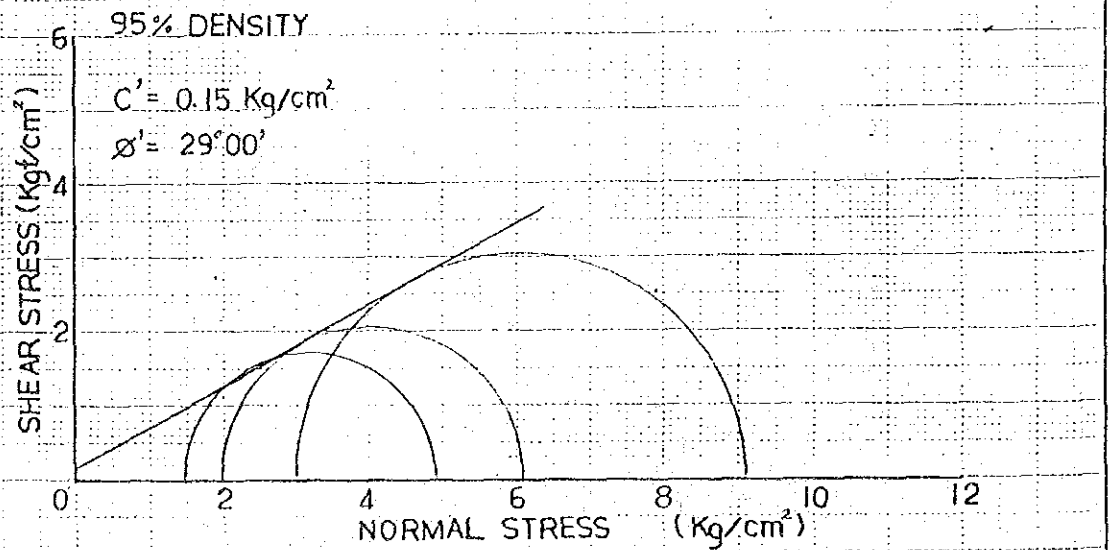


Figure E-4 (12) Result of Triaxial Shear Test
Soaked Consolidated Efective Stress