ANNEX 6

GROUNDWATER UTILIZATION CONDITIONS OF REFUGEE CAMPS

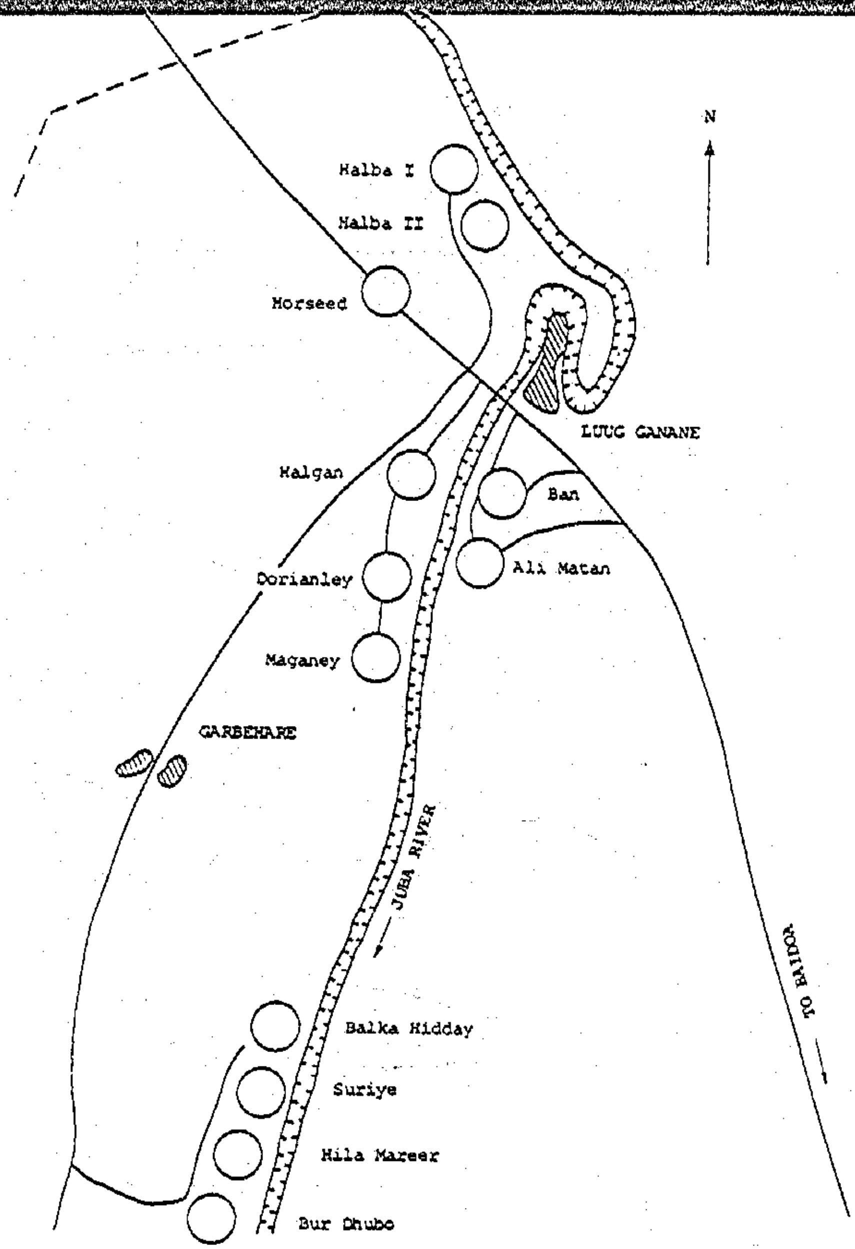


Fig. A6-1 Refugee Camps in the Gedo Region

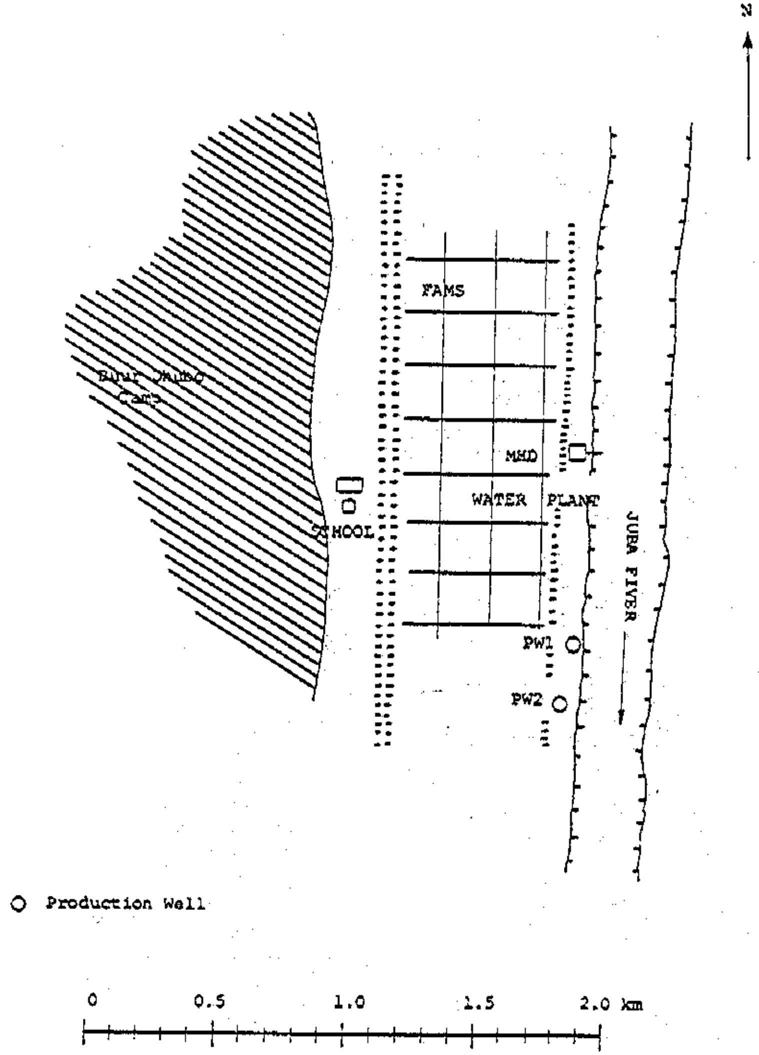


Fig. A6-2 Refugee Camp Buur Dhubo

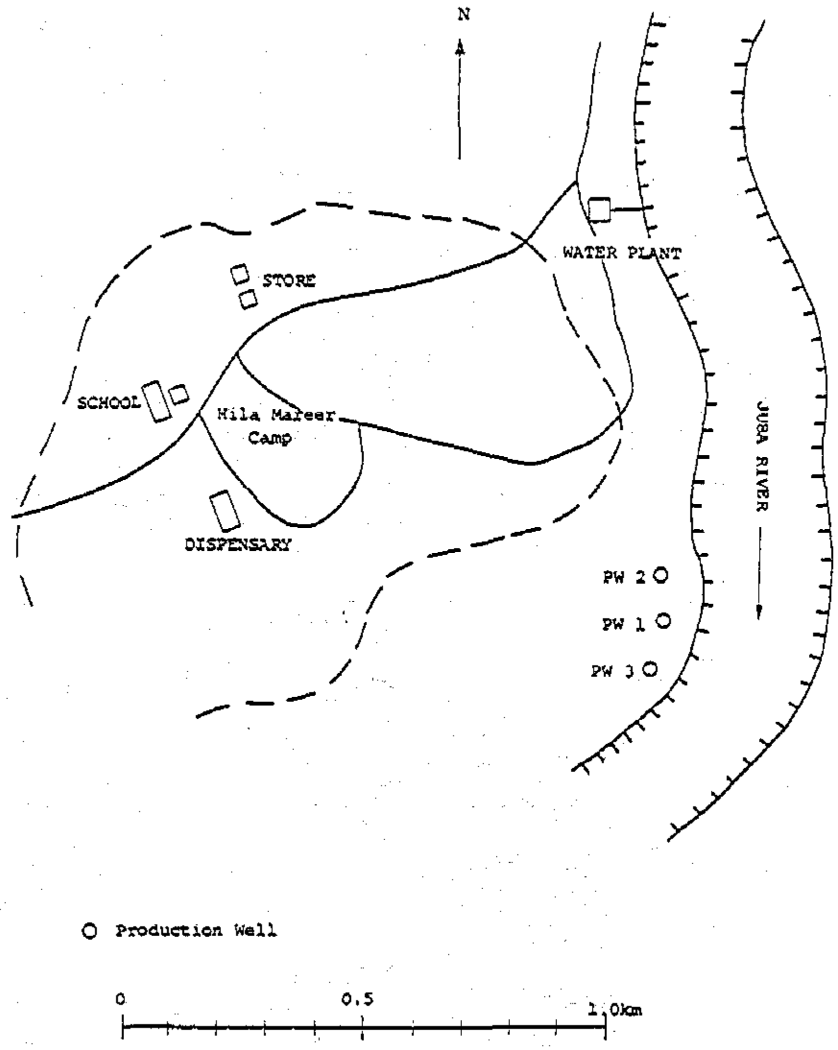


Fig. A6-3 Refugee Camp Hila Mareer

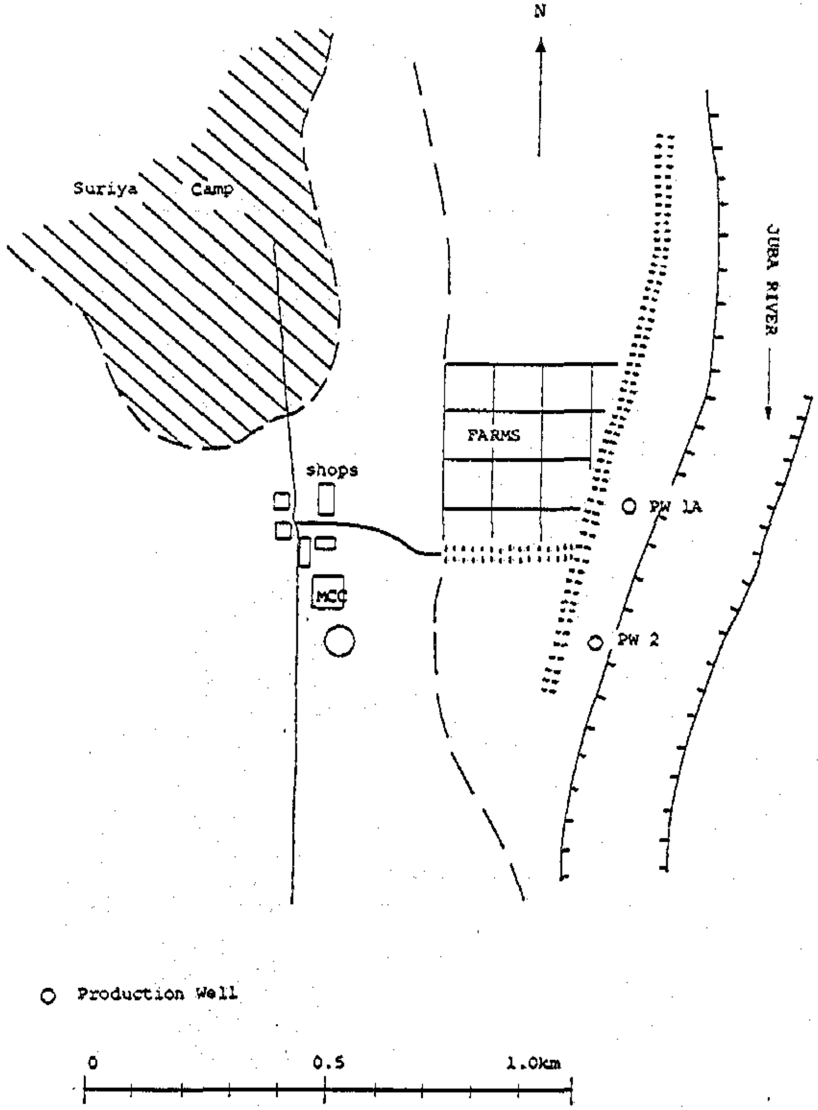


Fig. A6-4 Refugee Camp Suriya

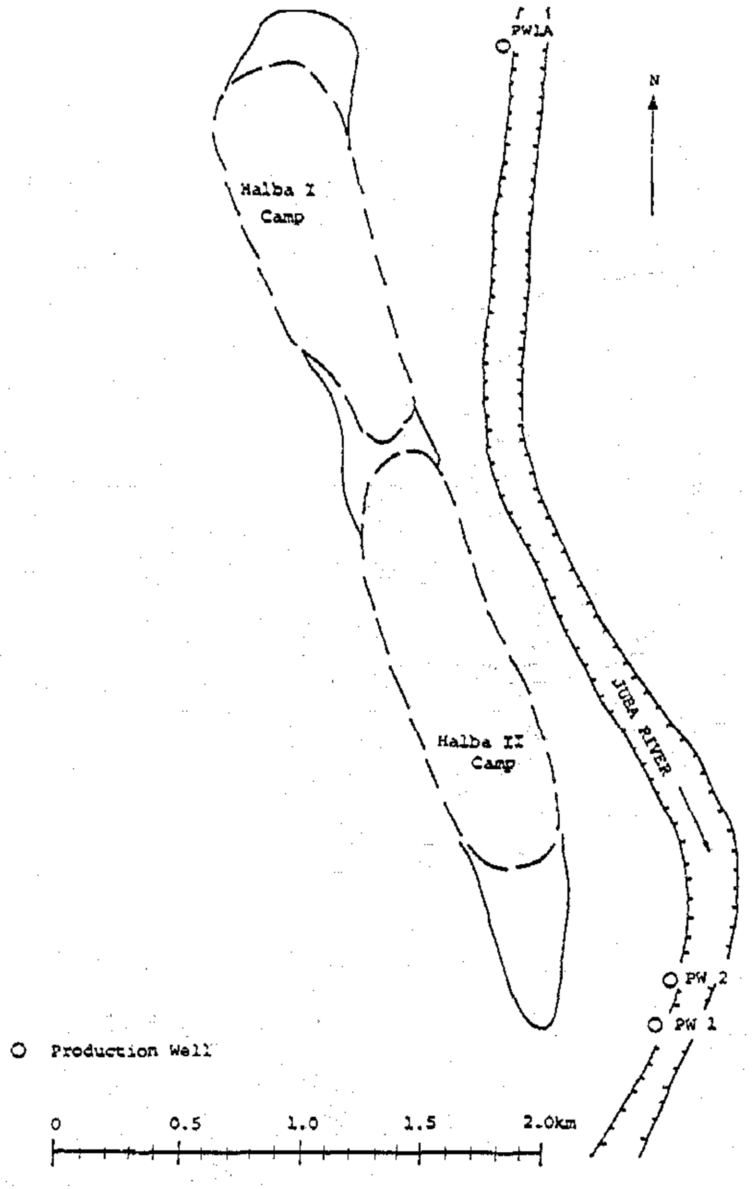


Fig. A6-5 Refugee Camp Halba I and Halba II

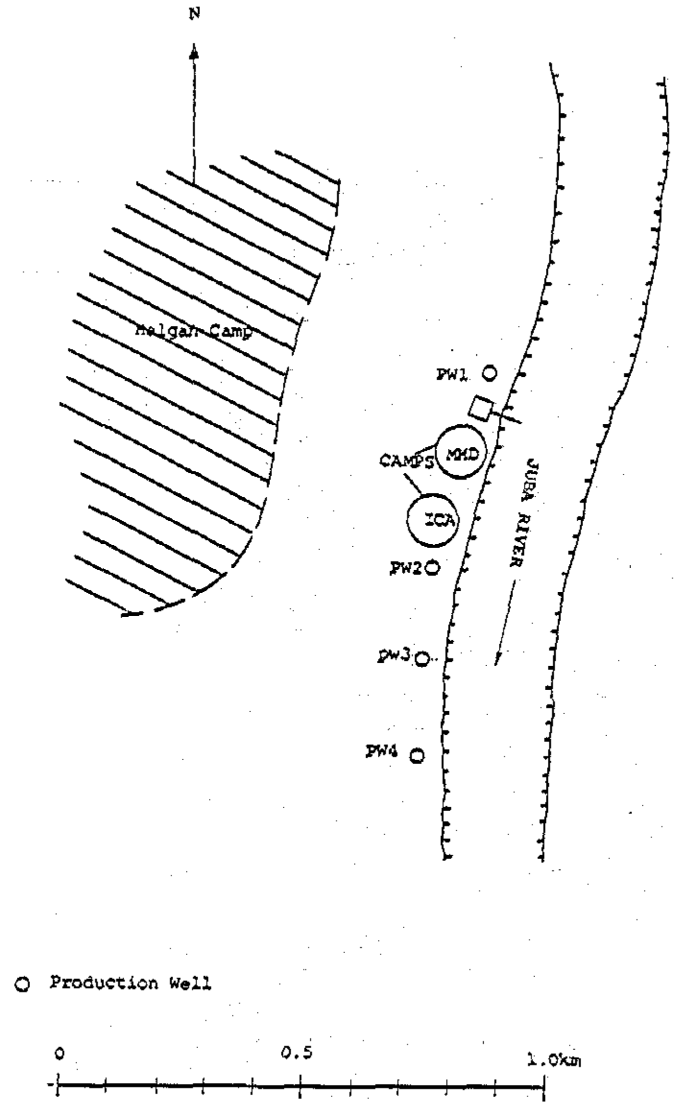


Fig. A6-6 Refugee Camp Halgan

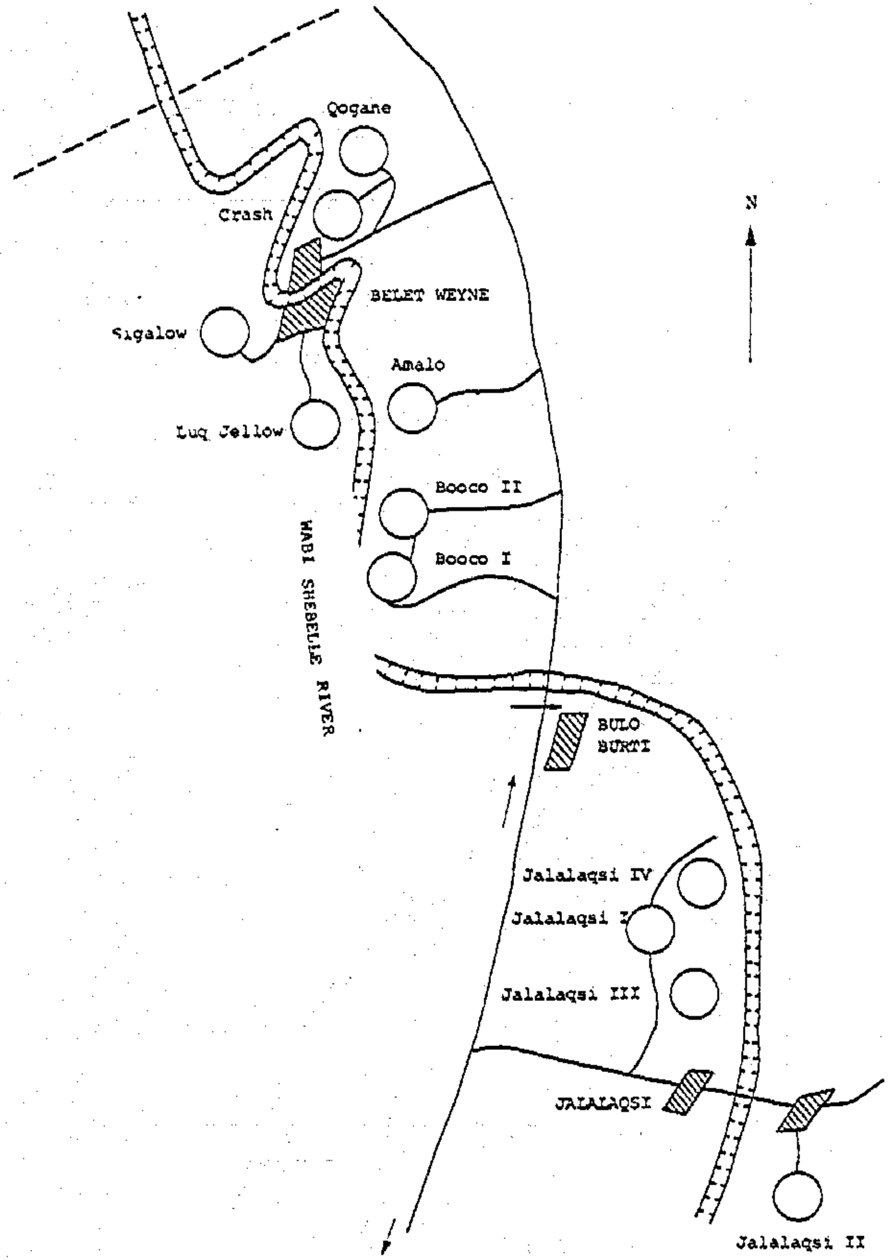


Fig. A6-7 Refugee Camps in the Hiran Region

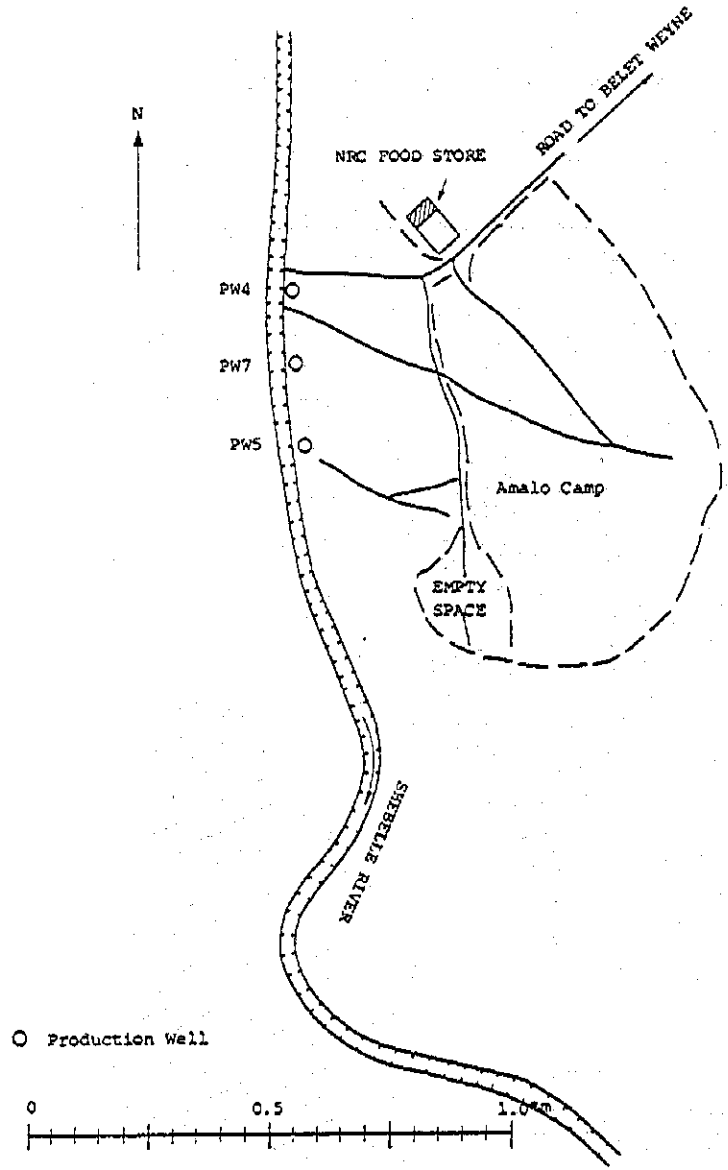


Fig. A6-8 Refugee Camp Amalo

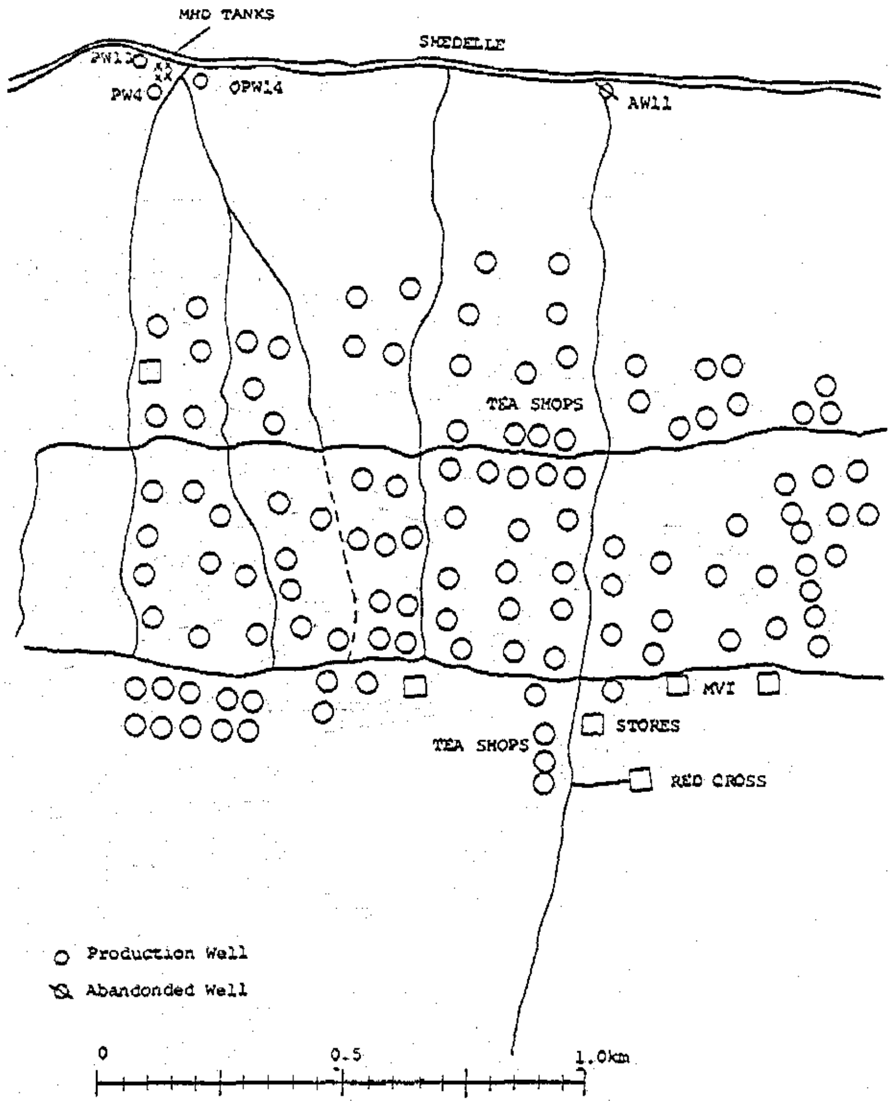


Fig. A6-9 Refugee Camp Boocoi

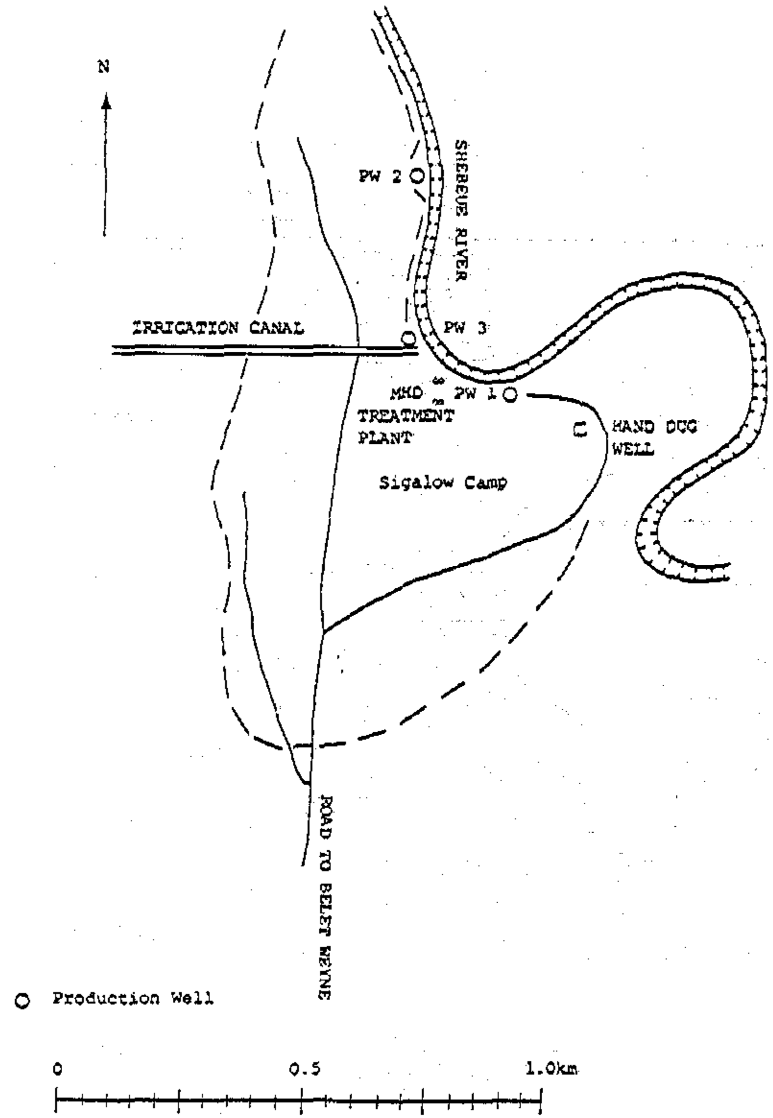


Fig. A6-10 Refugee Camp Sigalow

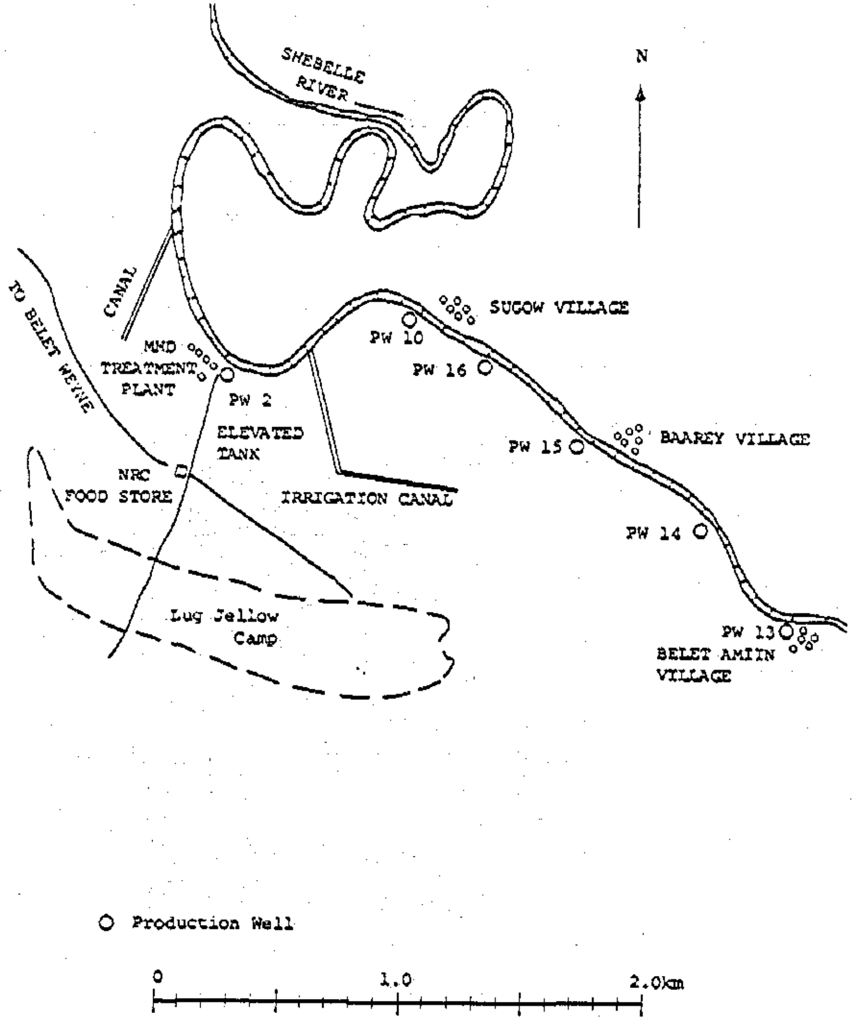


Fig. A6-11 Refugee Camp Lug Jellow

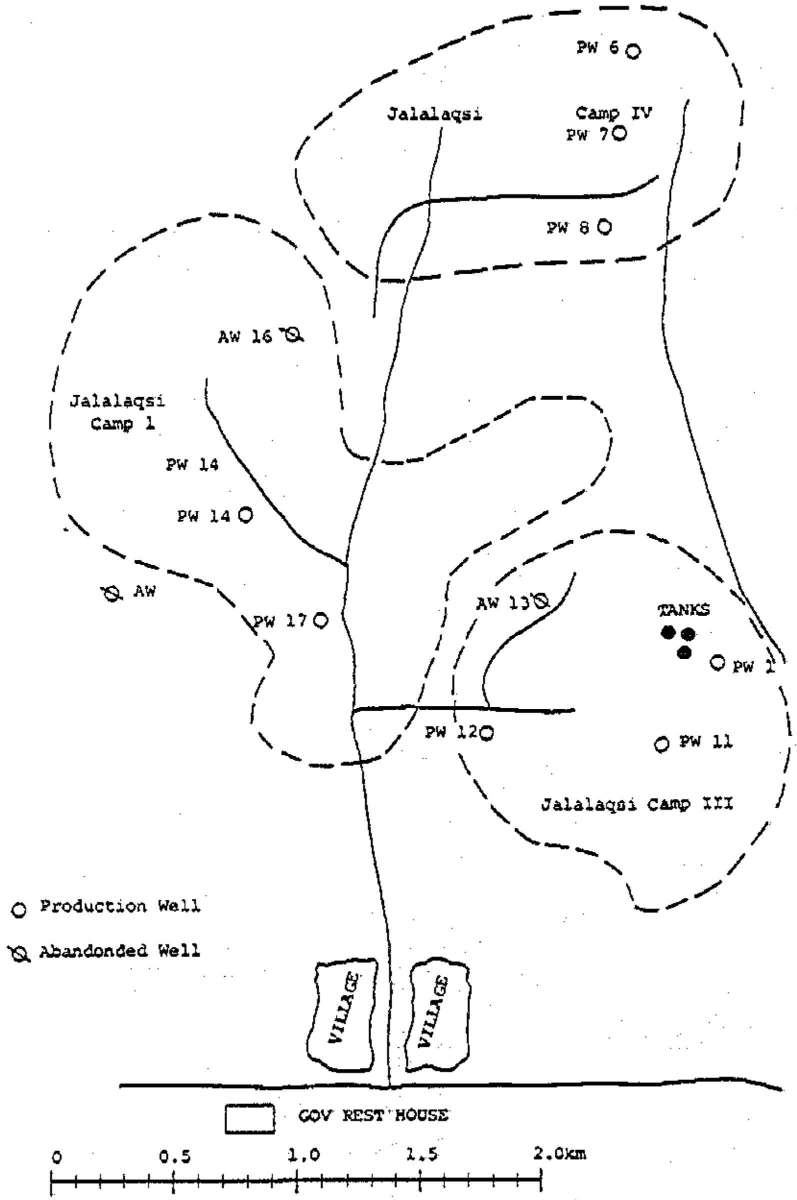


Fig. A6-12 Refugee Camp Jalalaqsi I,III and IV

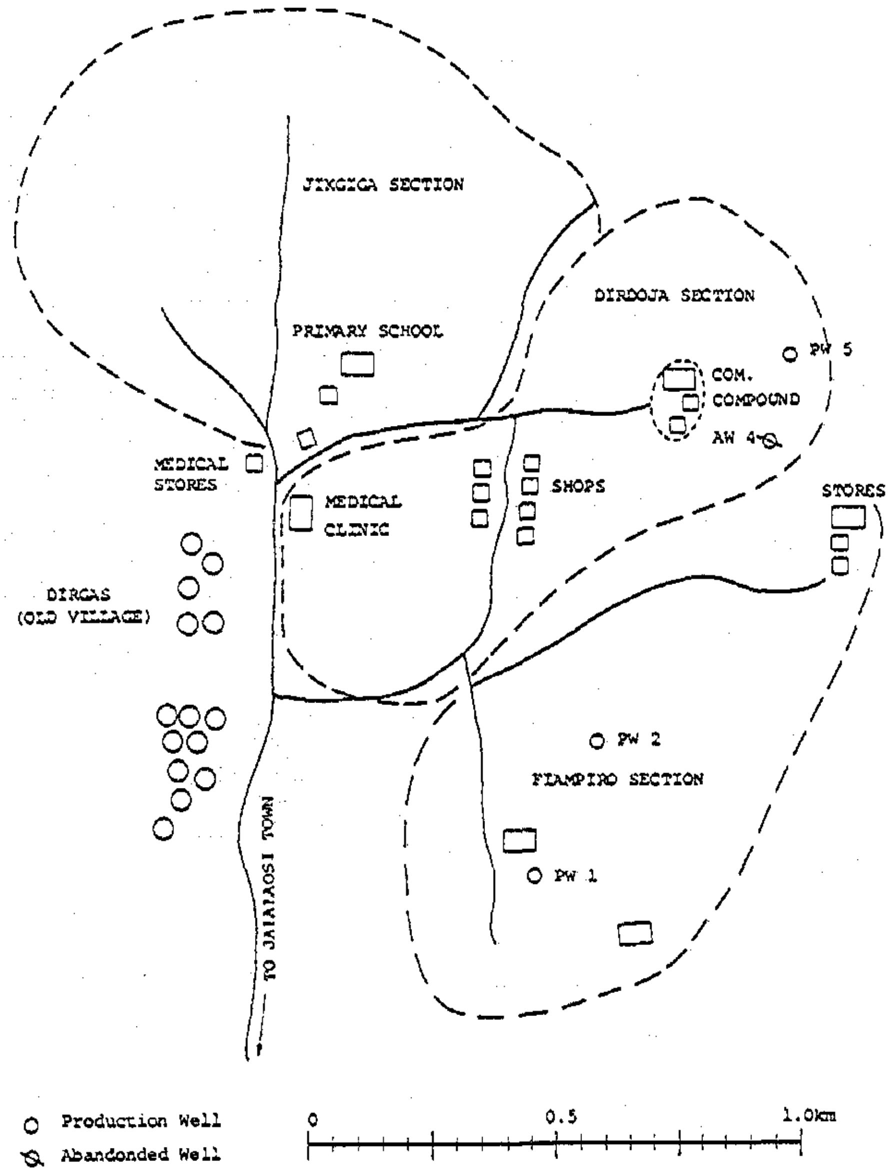


Fig. A6-13 Refugee Camp Jalalaqsi II

ANNEX 7

COST ESTIMATE FOR WATER SUPPLY DECADE

Table A7-1 Cost Estimates for an 80% Urban Water Supply Coverage by 1990 (based on 1983 dollars)

	68 Towns	Mogadishu	Hargeisa	Kismayo	Total
1. 1982 population	400,000	540,000	190,000 1/	50,000	1,180,000
2. 1990 population	536,000	700,000	254,000	80,000	1,570,000
3. 60% of 1982 pop.	240,000	324,000	114,000	30,000	708,000
4. 80% pop. coverage 1990	428,000	560,000	203,000	64,000	1,256,000
5. New population coverage by 1990 (4)-(3)	188,000	236,000	89,000	34,000	548,000
6. Unit costs					
a) New coverage item (5)	$100/cap.	$160/cap.	$160/cap.	$160.000	N.A.
b) Upgrade existing systems under item(3)	$ 67/cap.	$ 48/cap.	$ 48/cap.	$ 48.000	N.A.
7. Total cost					
a) New coverage item (5)	$18.90 mio.	$37.80 mio.	$14.24 mio.	$5.44 mio.	$76.38 mio.
b) Upgrade item (3)	$16.08 mio.	$15.55 mio.	$ 5.47 mio.	$1.44 mio.	$38.54 mio.
Total	$34.98 mio.	$54.35 mio.	$19.71 mio.	$6.88 mio.	$114.92 mio.

1/ According to population data in chapter I, Hargeisa's 1981 population was reported to be 84,000. This is much lower than other estimates provided in interviews. Thus the figure adopted for 1982 is 190,000. Accordingly a downward adjustment was made in the population for the other 68 centres.

Table A7-2 Cost Estimates for a 50% Rural Nomadic Water Supply Coverage (based on 1983 dollars)

	Deep Drilled Wells	Dug Wells	Rainwater Catchments	Infiltration Galleries	Surface Water Slow Sand Filters	Total
1. Number of systems	88	1,000	750	450	150	2,438
2. Total population served	390,000	790,000	920,000	390,000	130,000	2,620,000
3. Ave. population served per system	4,430	790	1,230	870	870	N.A.
4. Ave. cost per system in US $	220,000	10,000	222,500	70,000	60,000	N.A.
5. Ave. unit cost $/capita	50	12.5	180	80.00	70.00	N.A.
6. Total cost in mio. US $	19.36	10.00	166.93	31.50	9.00	236.78

ANNEX 8

HYDROLOGICAL AND METEOROLOGICAL DATA

Table A8-1 Mean Monthly and Annual Shabeelle River Flows cm^3/sec) (Station number 15 Awdheegle)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
1963	2.84	-	-	-	-	62.04	38.61	65.76	73.81	69.71	37.50	67.33	-
64	33.34	13.28	4.59	11.27	28.08	14.85	19.49	59.07	74.72	33.68	66.30	23.32	421.99
65	39.59	11.34	3.12	1.73	35.10	9.08	2.47	6.72	46.43	57.01	74.31	43.62	330.52
66	8.26	1.49	-	-	58.74	29.85	24.56	36.99	66.96	68.21	64.13	15.86	-
67	1.51	0.0	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	52.35	74.29	71.97	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	83.97	87.07	76.83	-	-	-
77	11.65	11.30	14.40	43.11	99.20	70.86	-	99.70	93.47	88.84	96.37	97.54	-
78	37.58	-	-	60.14	81.08	72.36	-	-	-	-	85.63	40.65	-
81	0.0	0.0	13.23	77.90	85.24	64.07	39.28	67.98	83.33	83.23	60.52	25.03	599.81
83	54.90	39.28	33.54	29.39	-	88.71	70.22	83.70	84.72	82.83	83.80	58.62	-
84	32.97	26.08	26.49	17.05	25.74	61.33	50.08	72.35	71.12	69.87	32.21	-	-
Mean	22.26	12.85	15.90	36.62	60.93	54.51	34.96	72.39	75.74	74.47	66.25	46.50	573.88

Table A8-2   1977 Per Season Water Consumption

Canal	Gross area irrigated	Measured discharge (m^3/s)					Approximate monthly consumption (Mm^3)				
	(ha)	Aug	Sep	Oct	Nov	Dec	Aug	Sep	Oct	Nov	Dec
Sigaale	290	0.00	0.00	1.80	1.06	0.68	0.0 (1)	0.0 (1)	4.8	2.8	1.8
Giddu	600	0.00	0.37	1.21	0.69	0.05	0.0 (1)	1.0	3.2	1.8	0.1
Asayle	7 550	1.67	1.23	4.13	2.02	1.03	2.8 (3)	2.9 (2)	11.1	5.2	2.8
Dhamme Yaasiin	9 630	3.20	2.75	6.23	6.37	3.25	8.6	7.1	16.7	16.5	8.7
Primo Secondario	13 690	5.13	6.66	6.98	5.73	4.64	13.8	17.3	18.7	14.8	12.4
Wadajir	2 890	0.88	0.91	0.86	0.77	0.44	2.4	2.4	2.3	2.0	1.2
Liibaan	1 230	0.12	0.00	0.11	0.00	0.07	0.3	0.0	0.3	0.0	0.2
Bokore	5 730	1.96	1.70	2.69	2.69	1.14	5.3	4.4	7.2	7.0	3.1
Sub-total of 8 main canals	41 620	12.96	13.62	24.01	19.33	11.3	33.2	35.1	64.3	50.1	30.3
TOTAL for complete irrigated area	54 180	16.87	17.73	31.26	25.16	14.71	43.2	45.7	83.7	65.2	39.4

Notes: (1) closed all month for weed clearance
(2) closed 6th - 9th for seepage test
(3) closed 13th - 25th for repair work

Table A8-3 Monthly and Annual Rainfall (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1929	?	?	?	?	?	122.0	64.0	52.9	196.9	26.2	117.8	19.1	(559.3)
1930	0.0	0.0	1.0	234.8	70.7	22.7	22.0	13.0	0.0	76.2	25.0	80.5	545.9
1931	0.0	2.0	0.0	33.5	276.6	42.6	45.2	30.7	0.0	3.6	61.1	2.5	497.8
1932	0.0	0.0	0.0	2.8	47.6	49.6	50.2	37.7	15.9	3.2	18.0	20.7	245.7
1933	21.1	0.0	0.0	99.2	13.8	39.4	39.3	34.0	14.7	42.8	41.5	40.2	386.0
1934	0.0	0.0	0.0	64.4	90.0	39.4	57.3	85.3	50.8	15.5	22.7	3.8	429.2
1935	0.0	0.0	0.0	24.1	114.0	77.2	58.2	58.0	10.4	14.0	30.2	34.6	420.7
1936	0.0	0.0	0.0	59.8	0.0	69.6	99.5	57.0	13.3	27.4	2.6	112.4	441.6
1937	0.4	0.0	11.1	204.0	66.0	111.1	110.0	21.7	61.0	70.5	54.8	14.0	724.6
1938	0.0	0.0	0.0	19.0	77.8	137.5	48.0	76.0	10.2	117.5	10.7	14.0	510.7
1939	0.0	0.0	0.0	35.5	28.0	79.9	0.0	24.7	3.0	94.7	29.3	8.0	303.1
1940	0.0	0.0	18.0	?	?	?	?	?	?	?	?	?	(18.0)
1944	0.0	0.0	5.0	78.5	29.5	41.0	35.5	88.0	3.5	31.7	2.0	7.5	322.2
1945	0.0	0.0	0.0	101.2	43.8	67.2	60.3	51.5	11.8	3.2	46.0	19.4	404.4
1946	0.0	0.0	0.0	9.0	51.0	164.6	49.5	34.5	9.0	45.0	?	0.0	(362.6)
1947	0.0	0.0	0.0	96.0	155.5	38.5	37.0	164.0	0.0	0.0	?	?	(491.0)
1948	?	?	?	?	7.0	112.2	?	?	?	?	?	?	(119.2)
1951	0.0	0.0	30.2	73.1	226.0	238.4	107.5	73.8	19.7	61.1	88.3	127.3	1,045.4
1952	0.0	0.0	0.0	53.2	31.0	105.8	5.4	0.0	0.0	35.8	69.1	0.0	300.3
1953	5.4	0.0	24.2	73.5	10.0	40.2	62.1	60.0	38.4	47.5	172.1	9.9	543.3
1954	0.0	0.0	0.0	76.7	60.2	76.3	20.2	37.9	11.6	10.0	61.2	33.0	387.1
1955	5.3	0.0	0.0	17.0	47.5	30.9	31.5	6.1	1.7	0.5	2.3	6.1	148.9
1956	0.0	0.0	0.0	111.7	31.5	65.5	72.3	7.6	1.2	5.9	108.4	0.2	404.3
1957	1.4	0.0	0.0	61.6	102.8	75.1	145.7	12.5	20.4	19.7	101.9	10.8	551.9
1958	0.5	0.0	0.2	141.9	118.7	84.0	39.5	63.5	0.6	0.6	38.8	12.2	500.5
(1929 ~1958) Mean	1.5	0.1	3.9	75.9	73.9	80.5	54.8	47.4	21.5	32.7	52.6	26.2	471.0
1980	0.0	0.0	0.0	?	?	?	?	68.5	0.0	58.5	66.5	0.0	244.0
1981	0.0	0.0	8.4	221.2	183.5	?	44.3	234.4	4.4	2.0	34.0	11.0	747.0
1982	0.0	0.0	0.0	111.6	71.0	114.0	102.0	10.0	1.0	77.2	50.2	26.6	569.6
1983	0.0	0.0	0.0	48.0	120.2	30.1	46.2	35.3	0.0	13.6	38.4	0.0	331.8
1984	0.0	0.0	0.0	12.0	54.0	94.7	40.4	0.0	0.0	0.0	112.6	0.0	313.7
(1980 ~ 1984) Mean	0.0	0.0	1.7	98.2	107.2	79.6	58.2	69.6	1.1	30.3	61.5	7.5	441.2
(1929 ~ 1984) Mean	1.2	0.1	3.5	79.3	76.0	80.4	55.3	51.4	17.9	32.3	54.3	22.7	465.0

Table A8-4 Monthly and Annual Absolute Maximum Temperatures (°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1930	?	?	39.0	39.0	35.0	35.0	34.0	35.0	36.0	35.0	35.0	34.0	(39.0)
1931	35.0	38.0	37.0	39.0	38.0	31.0	30.5	31.0	30.5	31.0	32.0	31.5	39.0
1932	33.0	32.0	32.5	32.0	32.5	31.5	29.5	29.0	29.5	31.0	31.0	32.0	33.0
1933	31.0	32.0	32.0	35.0	32.0	30.5	28.5	?	29.5	31.0	33.0	36.0	(36.0)
1934	38.0	37.0	37.0	33.0	33.0	30.5	30.0	29.8	30.8	30.8	32.0	33.0	38.0
1935	32.8	34.0	36.0	35.0	37.0	33.0	29.0	30.0	31.0	31.0	32.0	33.0	37.0
1936	33.0	33.0	33.0	33.5	33.0	31.0	30.0	31.0	31.5	32.0	33.0	33.5	33.5
1937	35.5	36.0	36.5	?	?	?	32.0	29.5	29.2	?	32.0	31.0	(36.5)
1938	31.8	33.0	34.5	32.8	31.5	30.5	27.5	28.0	30.0	29.6	30.5	33.4	34.5
1939	34.2	32.8	33.6	32.6	31.6	30.5	29.5	29.6	29.8	?	?	?	(34.2)
1953	35.0	35.4	38.5	38.0	33.6	33.2	30.0	29.0	30.0	31.5	32.2	33.7	38.5
1954	35.5	34.8	35.2	34.8	33.5	31.2	29.1	31.0	30.6	32.7	32.8	33.8	35.5
1955	34.5	35.0	35.1	35.0	34.2	31.8	30.6	30.2	30.4	32.4	34.2	34.9	35.1
1956	35.5	36.6	36.3	36.7	32.7	30.3	29.3	30.4	40.8	31.5	33.4	34.4	36.7
1957	37.2	35.2	36.2	36.1	34.0	32.5	30.5	30.2	30.2	31.6	33.6	33.3	37.2
1958	33.7	35.6	33.9	33.9	32.8	30.3	29.8	31.2	32.2	32.5	34.0	33.3	35.6
Max.	38.0	38.0	39.0	39.0	38.0	35.0	34.0	35.0	36.0	35.0	35.0	36.0	39.0

Table A8-5 Monthly and Annual Absolute Minimum Temperatures (°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1930	?	?	21.0	23.0	23.0	21.0	20.0	21.0	20.0	23.0	21.0	21.0	(20.0)
1931	20.0	21.0	22.0	23.0	23.0	22.0	21.0	19.5	19.5	21.5	21.5	19.0	19.0
1932	29,9	18.0	21.5	21.0	22.0	20.0	19.0	19.0	20.0	21.5	20.5	20.5	18.0
1933	19.5	21.0	20.0	21.0	21.0	19.0	19.0	?	19.0	21.0	19.0	15.0	(15.0)
1934	13.0	18.0	19.0	22.0	21.5	19.0	18.5	18.9	18.0	20.2	19.0	18.1	13.0
1935	18.6	19.2	18.6	?	19.0	18.0	18.0	20.0	21.0	21.0	20.0	21.0	(18.0)
1936	20.0	20.5	22.0	22.5	23.0	21.5	20.5	19.5	19.5	20.5	21.0	20.0	19.5
1937	19.0	20.5	21.0	?	?	?	21.0	18.0	19.0	?	20.5	18.5	(18.0)
1938	18.0	18.0	18.0	21.0	22.0	20.0	19.0	17.0	18.8	19.6	19.4	18.8	17.0
1939	18.0	19.1	19.9	20.3	20.8	19.4	17.2	17.2	23.9	?	?	?	17.2
1953	17.5	18.0	21.4	21.7	21.0	19.5	19.4	19.4	18.0	19.5	21.0	19.5	17.5
1954	17.5	19.0	20.5	21.5	21.2	20.0	19.2	18.0	19.2	20.2	20.1	18.0	17.5
1955	18.0	17.0	19.1	21.0	20.5	19.4	19.1	18.2	19.3	20.5	20.7	20.0	17.0
1956	18.	18.6	21.0	21.2	21.2	19.8	18.4	18.9	20.1	20.6	20.0	19.2	18.4
1957	19.2	18.4	21.0	21.2	20.1	19.0	18.5	18.8	19.3	22.1	20.1	18.2	18.2
1958	18.9	19.2	20.1	20.0	22.6	21.5	19.0	20.0	20.3	20.6	19.8	20.0	18.9
Min	13.0	17.0	18.0	20.0	19.0	18.0	17.2	17.0	18.0	19.5	19.0	15.0	13.0

Table A8-6 Mean Monthly and Annual Average Daily Temperatures (°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean annual
1930	?	?	29.7	30.0	28.4	27.4	26.6	28.2	28.6	29.1	27.9	27.8	(28.3)
1931	28.3	29.1	30.0	30.9	28.1	26.0	26.1	25.6	26.1	26.9	27.1	25.7	27.5
1932	26.7	25.5	27.2	27.3	27.1	25.6	24.7	24.5	25.4	26.2	26.3	26.5	26.0
1933	25.7	26.3	26.5	27.4	26.7	25.0	24.7	?	25.2	26.1	26.3	27.5	(26.1)
1934	26.1	27.9	28.8	27.8	27.4	25.1	25.1	25.1	25.4	26.3	26.2	26.5	26.5
1935	25.9	26.9	?	?	27.4	25.3	24.8	24.8	25.6	26.4	26.2	26.7	(26.0)
1936	26.9	26.6	27.4	27.9	28.2	26.3	25.2	25.2	26.1	26.8	27.0	26.9	26.7
1937	27.5	27.8	28.6	?	?	?	25.6	24.5	25.1	?	25.9	25.1	?
1938	25.5	26.3	26.9	27.4	26.5	24.9	23.7	23.5	24.9	25.1	25.4	25.7	25.5
1939	25.4	26.2	26.8	26.8	26.4	24.8	24.4	25.3	27.3	?	?	?	?
1953	26.4	27.9	28.9	29.3	27.8	25.7	24.8	24.6	25.4	25.9	26.6	27.0	26.6
1954	26.4	27.4	28.3	28.3	27.5	25.5	24.8	24.9	25.6	26.4	26.6	26.2	26.5
1955	27.1	27.2	28.3	28.4	27.3	25.5	25.0	24.9	25.4	26.9	27.3	27.8	26.8
1956	27.7	27.9	29.3	28.9	27.2	25.5	24.6	25.2	25.8	26.4	26.5	27.0	26.8
1957	27.3	27.3	28.8	28.7	27.1	25.9	24.4	24.9	25.2	26.6	26.5	26.2	26.6
1958	26.7	27.0	27.5	28.0	27.2	26.4	24.9	25.4	26.0	27.0	27.0	27.1	26.7
(1930 ∿ 1958)													
Mean	26.6	27.2	28.2	28.3	27.4	25.7	24.9	25.1	25.8	26.6	26.6	26.6	26.6
1980	26.7	26.5	27.3	?	?	?	26.3	25.4	25.2	26.7	26.4	28.4	26.5
1981	26.8	26.8	27.3	26.5	26.7	26.5	26.7	26.4	27.1	28.1	28.0	27.2	26.8
1982	28.1	28.1	29.8	28.7	27.9	27.0	26.1	26.0	27.0	27.7	27.8	27.8	27.2
1983	28.0	28.8	29.5	29.6	28.3	27.3	26.8	26.4	27.4	27.7	28.3	28.4	28.0
1984	28.8	27.2	28.0	29.6	28.0	26.1	25.4	25.6	26.6	27.5	27.6	27.8	27.3
(1980 ∿ 1984)													
Mean	27.7	27.7	28.4	28.6	27.7	26.7	26.3	26.0	26.7	27.5	27.6	27.9	27.2
(1930 ∿ 1984)													
Mean	26.9	27.3	28.3	28.4	27.5	25.9	25.2	25.3	26.0	26.8	26.9	26.9	26.8

Table A8-7 Average and Design Reference Evaporation Rates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Average reference evaporation rate (mm/d)	5.03	5.44	5.65	5.06	4.66	4.26	4.21	4.55	5.11	4.77	4.26	4.54	
Design reference evaporation rate (mm/d)	5.53	5.98	6.22	5.57	5.13	4.69	4.63	5.01	5.62	5.25	4.69	4.99	
(mm/month)	171.43	167.44	192.82	167.1	153.9	140.7	143.53	150.3	168.6	162.75	140.7	154.69	1,913.96 (Annual)

ANNEX 9

DATA OF EXISTING WELLS

Table A9-1 Summary of Well and Aquifer Characterisics

Well No.	Date	Q (m^3/h)	Maximum draw-down (m)	SC ($m^3/h/m$)	T (m^2/d)	Method of analysis	S	Comments
M12	-	120	15	8.0				Faillace data
M18	-	120	15	8.0				
M20	-	36	19	1.9				
M21	-	3	3	1.0				
M27	-	120	11	10.9				
M41	10/10/73	9.6	5.2	1.9	17	Boulton	-	r/b=0.1; recovery and drawdown data
M42	-	130	7	18.6				
M43	-	120	13.5	8.8				
M46	-	120	12.5	9.6				
M55	-	120	10.0	12.0				
M57	-	130	12.5	11.3				
M63	-	130	8	16.2				
M68	-	100	12	8.3				
M72	-	120	11.5	16.4				
M80	-	120	9.5	12.6				
M81	-	120	9	13.3				
M90	-	120	9.5	12.6				
M99	-	140	13.5	10.3				
M100	-	120	9.5	12.7				
M103	13/2/78	-	-	-	480	Boulton	6.8x 10^{-3}	r/b=1.0 (observation well)
M104	-	120	11.5	10.4				
M104	13/2/78	201	7.8	25.8	275	Boulton		r/b=0.1
M107	-	120	7.8	15.4				
M109	-	100	9	11.0				
M114	-	120	10	12.0				
M117	-	110	9	12.0				
M121	-	110	13	8.4				
M122	-	100	17	5.8				
M123	-	120	11.5	10.0				
M125	-	120	16.5	7.2				
M126	30/10/73	206	11.7	17.6	58	Boulton	-	r/b=0.6; drawdown data
M127	-	110	11.5	9.5				
M128	-	100	25.5	4.0				
M142	14/10/73	25	8.1	3.1	29	Boulton	-	r/b=0.1; recovery and drawdown data
M143	13/10/73	195	5.2	37.5	759	Theis	-	Recovery and drawdown data
M144	-	100	12.5	8.0				
M145	9/10/73	200	8.4	23.8			-	Data inconsistent
M148	10/10/73	247	9.4	26.3	262	Boulton	-	r/b=0.1; recovery and pumping data
M149	June/73	194	9.2	21.0	212	Boulton	-	r/b=0.1; recovery data
M149	Oct/73	238	12.3	19.3	245	Boulton	-	r/b=0.05; pumping and recovery data
M150	20/10/73	169	12.0	14.1	147	Boulton	-	r/b=0.1; pumping and recovery data
M154	-	120	12.0	10.0				
M155	24/6/73	187	5.8	32.2	210	Boulton	-	r/b=0.2; recovery data
M155	17/10/73	271	5.0	54.2	157.3	Boulton	-	r/b=0.6; recovery and drawdown data
M156	June/73	187	3.6	51.9	235	Boulton	-	r/b=0.5; recovery data
M156	16/10/73	288	13.2	21.8	250	Boulton	-	r/b=0.1; recovery and drawdown data
M158	-	120	7	17.0				
M169	11/10/73	203	12.4	16.4				Data inconsistent
M170	11/10/73	257	13.7	18.8	135	Boulton	-	r/b=0.5; drawdown data
M170	18/6/73	187	8.0	23.4	319	Theis	-	Recovery data
M171	19/6/73	130	14.1	9.3	42	Boulton	-	r/b=0.4; recovery data
M174	29/10/73	222	7.4	30.0	232.1	Boulton	-	r/b=0.1; recovery and drawdown data
M174	June/73	202	8.9	22.7	68.8	Boulton	-	r/b=0.6; recovery data
M176	-	120	12.0	10.0				
M178	-	120	9.5	12.6				
M185	18/10/73	231	10.9	21.2	67	Boulton	-	r/b=0.6; recovery data

(Cont.)

Well No.	Date	Q (m^3/h)	Maximum draw-down (m)	SC ($m^3/h/m$)	T (m^2/d)	Method of analysis	S	Comments
M186	-	100	11	9.0				
M187	-	120	11	10.9				
M194	-	100	12	7.9				
M194	17/ 6/73	137	11.8	11.6	73	Boulton	-	r/h =0.8;recovery data show barrier effect
M194	24/10/73	205	18.5	11.1	341	Theis	-	Shows barrier effect.Recovery and drawdown data
M194	15/10/77	158	26.0	6.1	138	Theis	-	First 10 minutes valid pumping
M194	15/10/77	-	-	-	116	Theis	-	Recovery
M196	16/ 6/73	98	4.2	23.3	216	Boulton	-	r/b=0.6;recovery data show barrier effect
M197	-	100	10	10.0				
M198	-	110	10.5	10.5				
M199	21/ 6/73	151	2.3	65.6	535	Boulton	-	r/b=0.2;recovery data
M199	10/10/73	110	4.7	23.4	207	Boulton	-	r/b=0.1;pumping and recovery data
M202	29/10/73	241	10.5	23.0	419	Theis	-	Recovery and drawdown data
M205	25/ 6/73	112	7.6	14.7	234	Theis	-	Recovery data
M206	15/10/73	119	10.3	11.6	38	Boulton	-	r/b=0.6;recovery and drawdown data
M207	Oct/73	83	8.3	10.0	62	Boulton	-	r/b=0.4;drawdown and recovery data
M209	-	100	18.0	5.5				
M210	11/12/73	-	-	-	43	Boulton	-	r/b=0.4;recovery with barrier
M210	11/12/73	51.4	8.2	6.3	58	Boulton	-	r/b=0.1; affected by changes in pumping rate
M212	12/ 1/73	198	4.8	41.3	382	Boulton	-	r/b=0.1;recovery data
M212	-	120	11	10.9				
M217	-	100	12	8.3				
M220	-	100	11	9.0				
M221	-	110	8.5	14.6				
M223	-	100	9	11.1				
M226	-	100	11.5	8.6				
M231	1/ 7/73	194	13.7	14.2	206	Theis	-	Recovery
M231	13/10/73	262	13.3	19.7	137	Boulton	-	r/b=0.2;recovery and pumping data
M232	30/ 6/73	187	7.9	23.7	238	Boulton	-	r/b=0.1;recovery data
M233	14/ 6/73	158	3.3	47.9	350	Boulton	-	r/b=0.2;recovery data
M233	14/10/73	240	7.0	34.3	358	Boulton	-	r/b=0.1;recovery and pumping data
M235	-	110	14.0	8.0				
M236	10/ 6/73	169	25.0	6.8	150	Boulton	-	r/b=0.1;recovery data
M236	Oct/73	195	22.9	8.5	120	Theis	-	Recovery and drawdown values differ
M241	Jan/78	-	-	-	374	Boulton	0.38×10^{-3}	r/b=0.1; (observation well,Agrotec test M240)
M252	-	100	15.0	6.6				
M256	-	140	7.0	20.0				
M265	-	100	8.0	12.5				
M267	30/10/73	14.7	2.2	6.7	85	Boulton	-	r/b=0.05;recovery and drawdown
M295	18/10/77	-	-	-	687	Theis	1.7×10^{-3}	Piezometer for M194; recovery shows barrier boundary
M296	-	100	11.0	9.0				
M300	-	100	10.0	10.0				
M301	-	100	12.0	8.0				
M302	-	100	11.0	9.0				
M303	-	100	8.0	12.5				
M304	-	120	13.5	9.0				
M305	-	120	12.0	10.0				
M306	-	120	8.0	15.0				
M307	-	120	10.5	10.4				
M308	-	110	11.0	10.0				
M309	-	110	12.5	8.8				

ANNEX 10

DEMOGRAPHIC SURVEY OF REFUGEE CAMPS

Demographic Survey of the Refugee Camps

According to officially announced data, the refugee camps have a population of 41,000.

It is estimated, as a result of the preliminary survey however, that the refugee camps have approximately 20,000 population.

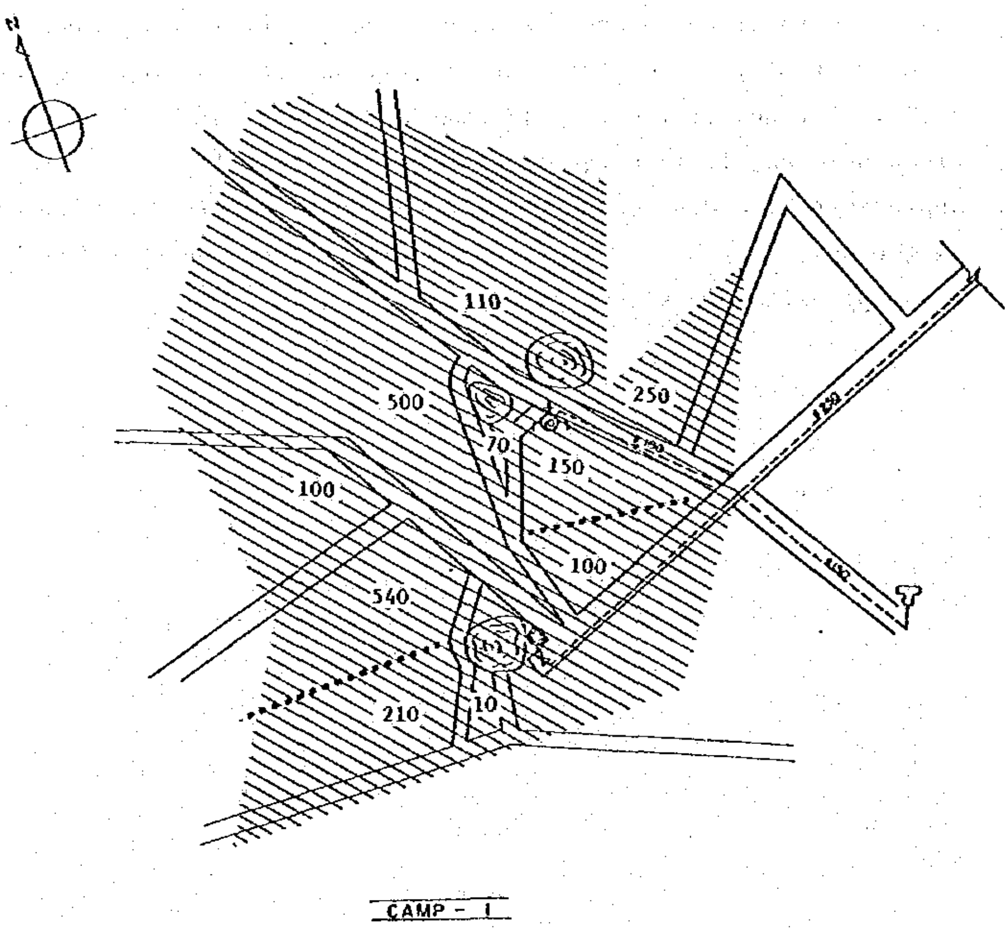
In this survey the population of the refugee camps as a whole was estimated based on the results of the field survey covering a number of houses and family compositions carried out at refugee camp 1 and the examination of the ledger of distribution cards for food relief of UNHCR.

From the results of the survey of a number of houses, there are 2,040 houses in refugee camp 1 as shown in Fig. A10-1. On the other hand, there are 1,831 cards of refugee camp 1 registered in the relief food distribution card ledger, as shown in Table A10-1. The distribution card is given to each refugee above a certain age, instead of one card per family. Therefore, one family may have various distribution cards. Furthermore, one family may occupy various houses. Under the circumstances, it is presumed that refugee camp 1 has a population of approximately 8,000, because the number of cards is practically the same as the number of houses. Therefore, it is presumed that the 3 camps have approximately 41,000 population.

Table A10-1 Demographic Survey of the Refugee Camps

	Camp 1		Camp 2A		Camp 2B		Camp 3	
	No. of Cards	No. of Refugees	No. of Cards	No. of Refugees	No. of Cards	No. of Refugees		No. of Refugees
1	83	83	262	262	403	403		
2	399	798	500	1,000	716	1,432		
3	231	693	405	1,215	382	1,146		
4	434	1,736	414	1,656	429	1,716		
5	138	690	274	1,370	260	1,300		
6	206	1,236	384	2,304	388	2,328		
7	174	1,218	55	385	52	364		
8	77	616	29	232	21	168		
9	43	387	9	81	2	18		
10	46	460	79	790				
Total	1,831	7,917	2,411	9,295	2,653	8,875		14,913
Refugees per card	4.3		3.86		3.35			

Fig. A10-1 Refugee House Quanity



CAMP - I

ANNEX 11

DATA OF PUMPING TEST

1. Result of stepped pumping test

The test results are shown in the following table.
For a relation of the water level to the time that has passed, refer to Fig. A11-1, 2.

Well No.	Test step	Initial level (GL-m)	Moving level (GL-m)	Drawdown (m)	Intaken water quantity (m^3/hr)	Specific rate of springing (m^3/hr/m)	Water level recovered?
M41	Step 1	5,520	9,170	3,650	102.86	28.2	When measured 55 min after a draw-down of 4.93m, the unrecovered portion was 46 cm.
	Step 2	5,520	10,020	4,500	144.00	32.0	
	Step 3	5,520	10,450	4,930	180.00	36.5	
M38	Step 1	4,845	9,300	4,455	160,00	35.9	When measured 85 min after a draw-down of 8.295m, the unrecovered portion was 11.5 cm.
	Step 2	4,845	11,300	6,455	180.00	27.9	
	Step 3	4,845	13,140	8,295	240.00	28.9	

2. Result of quantitative pumping test

The test results are shown in the following table.
For a relation of the water level to the time that has passed, refer to Fig. A11-3, 4.

Well No.	Initial level (GL-m)	Moving level (GL-m)	Drawdown (m)	Intaken water quantity (m^3/hr)	Specific rate of springing (m^3/hr/m)	Water level recovered?
M41	5,550	9,050	3,500	122.76	35.1	When measured 90 min after a drawdown of 3.5m, the unrecovered portion was 15 cm.
M38	4,690	13,135	8,445	237.60	28.1	When measured 120 min after a drawdown of 8.445m, the unrecover-ed portion was 10 cm.

3. Water level recovery

In order to examine how the water level recovers after a certain break in operation, the relation of the unrecovered portion (level difference from the initial one) to the recovery time is made up from the results of the quantitative pumping test and exhibited in Fig. All-5. As indicated in Fig. All-3, 4, the two existing wells M41 and M38 differ little from each other, but a recovery time of two hours allows the water surface in both cases to rise to within 10 cm of the initial level. Accordingly it can be judged that the water level is restituted substantially two hours after stopping the pumping operation.

Fig. All-1 Step Pumping Test Curve (M41)

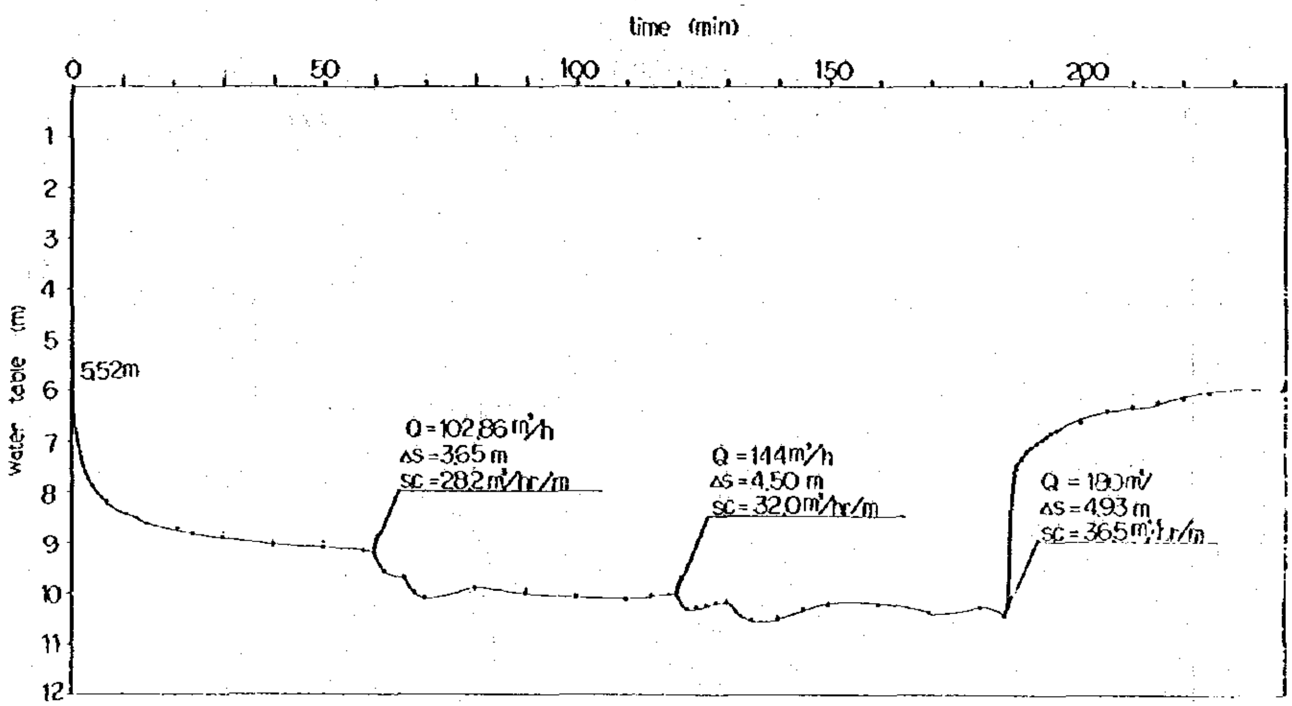


Fig. All-2 Step Pumping Test Curve (M38)

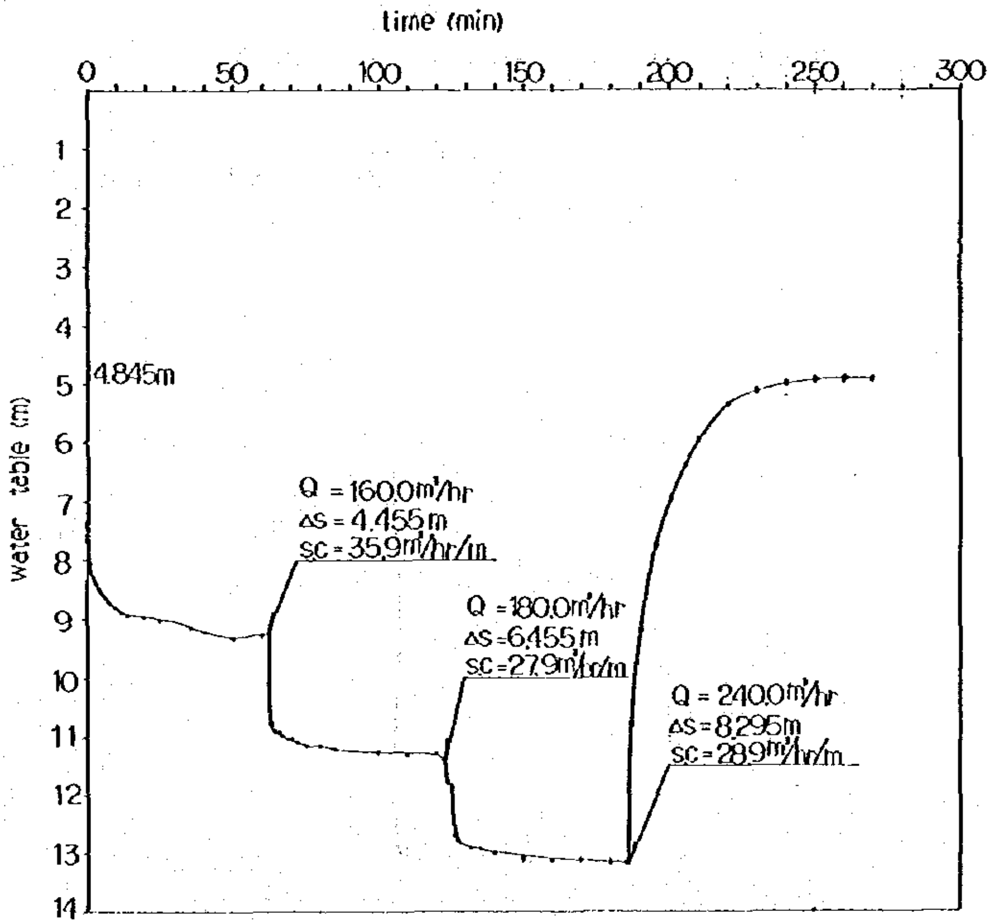


Fig. A11-3 Pumping Test Curve (M41)

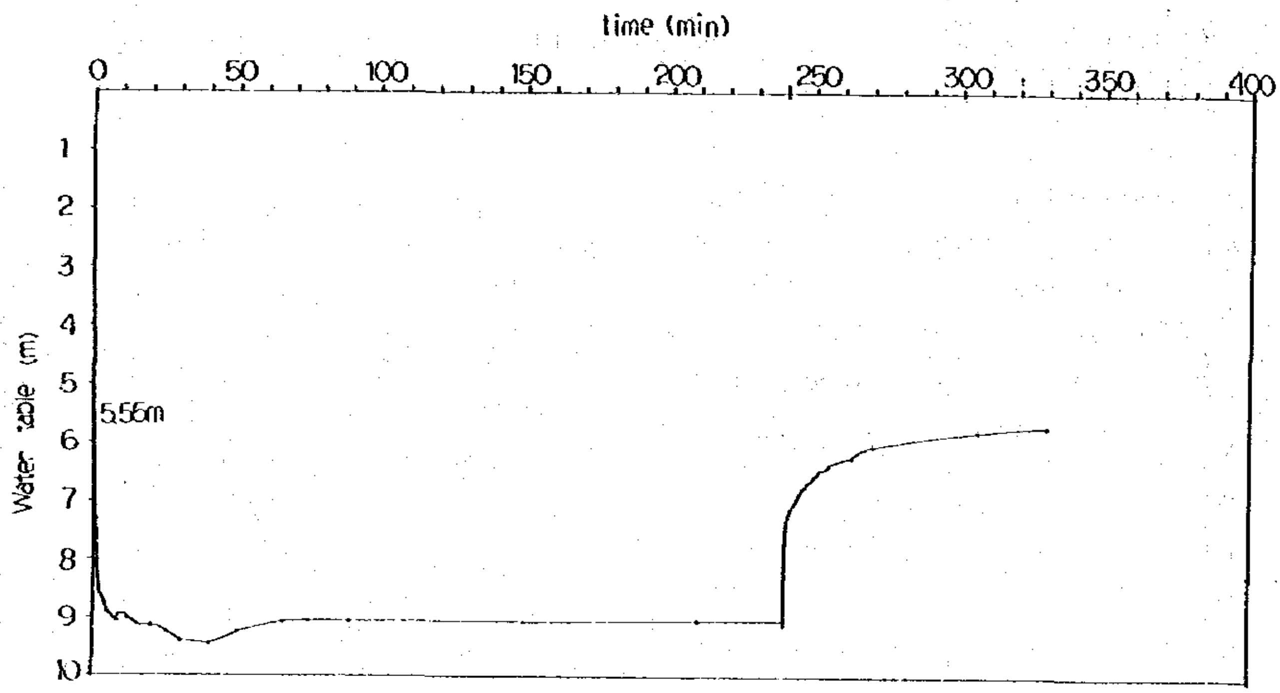


Fig. A11-4 Pumping Test Curve (M38)

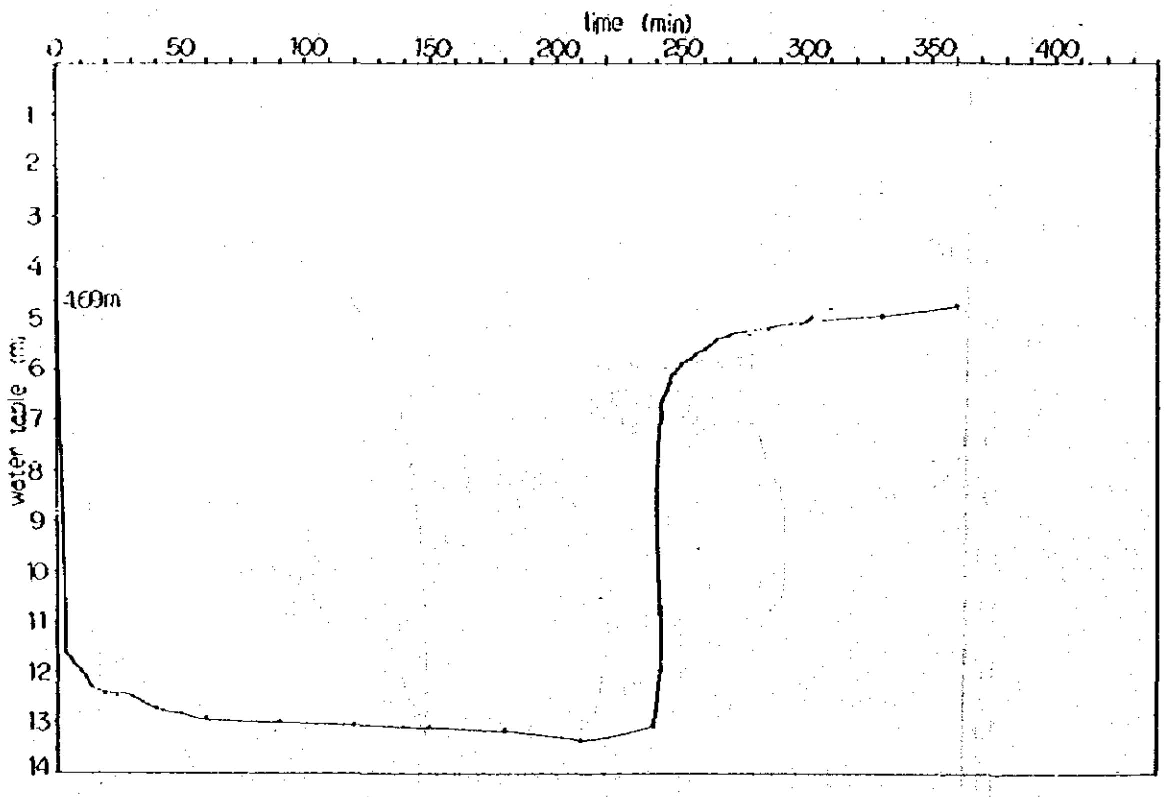
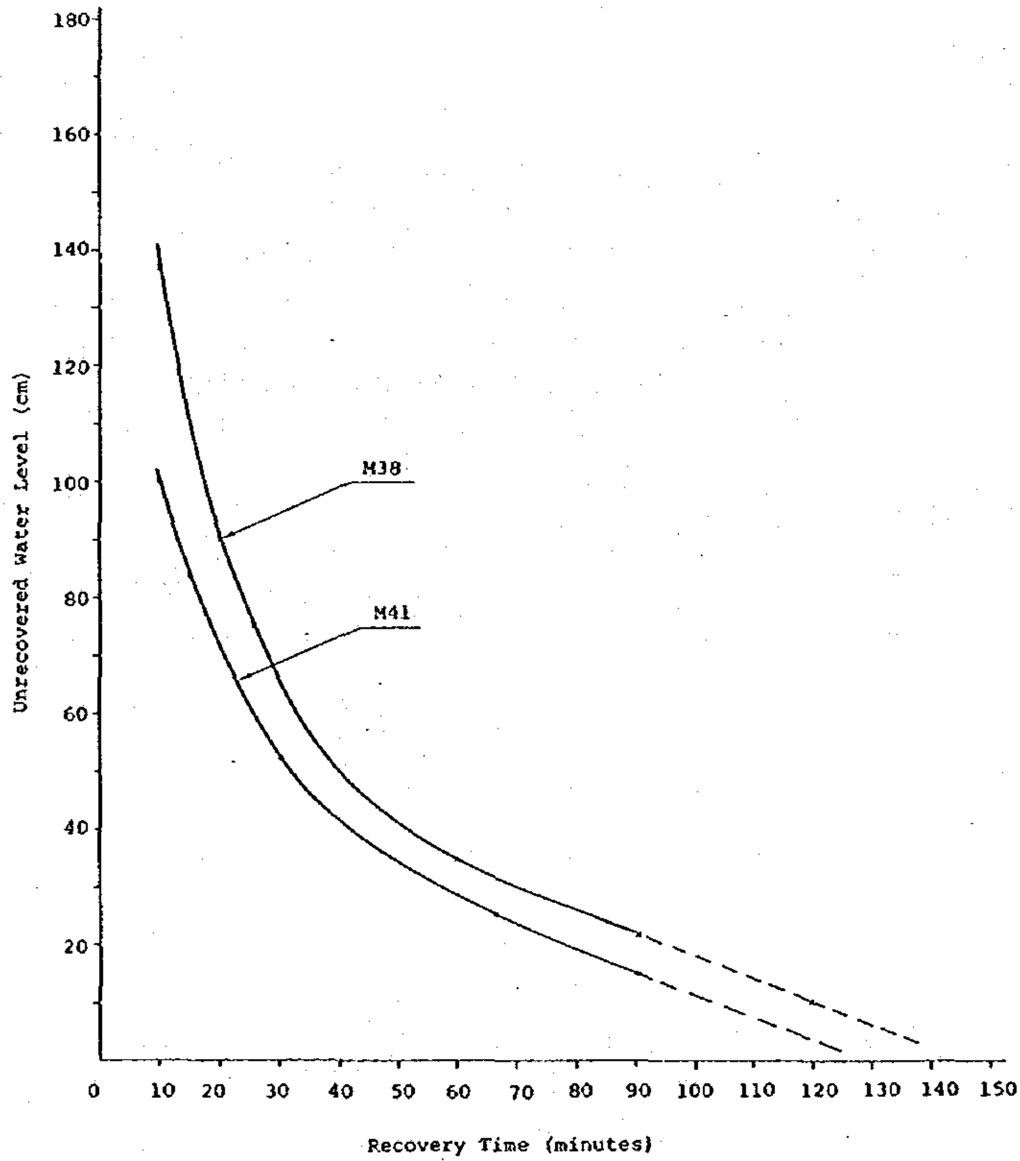


Fig. A11-5 Relation of Unrecovered Water Level to the Recovery Level



ANNEX 12

TABLE OF COMPARISON BY CLASS OF PIPE

Table A12-1 Comparison by Class of Pipe

(1)

		Ductile Pipe	Steel Pipe	Reinforced Plastic Pipe	Vinyl Chloride Pipe
Safety	1. Pipe strength	Pipe diameter: ø250, ø700 Tensile strength: 42 or over (kgf/mm) Bending strength: 60 or over (kgf/mm) Elongation (%) : 10 or over	Pipe diameter: ø200, ø300 Tensile strength: 30 or over, 30 or over (kgf/mm) Bending strength: 30 or over, 41 or over (kgf/mm) Elongation (%) : 20, 18	Pipe diameter: Tensile strength: 20 or over (kgf/mm) Bending strength: 20 or over (kgf/mm) Elongation (%) :	Pipe diameter: Tensile strength: (kgf/mm) Bending strength: (kgf/mm) Elongation (%) :
	2. Impact resisting characteristic	• This pipe is durable against the impact and has a resiliency to absorb the impact. • This pipe is covered by a mortar lining at its inner surface and so it is desirable not to apply a high impact force. • This pipe has a high safety due to a result of calculation of inner pipe pressure and outside pressure as well as a margin of casting and a surplus distance for corrosion.	• Although this pipe has a high flexibility, it has a low environmental deflected collage load, so that it has a low capacity of absorption of impact energy under the same flexing condition. • The outer surface of this pipe is apt to have its coating damaged, so a sufficient care should be made for its handling.	• Although this pipe has a sufficient toughness and is relatively durable against an impact, it should be avoided to accept large stones dropped from the above or a concentrated backfill of earth from a dump truck from a high position.	• This pipe has a sufficient mechanical strength against the inner and outer pressures, bending and shock or the like. This pipe has a sufficient flexibility and is durable against the flexibility as well as a vehicle load or a certain variation in displacement of the ground. • It should be avoided to accept the dropping stones or an instantaneous feeding of the back-fill from the high position.
	3. Water-sealing characteristic of coupling	• A superior water-sealing characteristic is kept by a self-sealing mechanism of rubber ring and so no leakage of water occurs until the pipe is broken.	• This requires a high skill in welding operation and a better welding condition.	• This has a superior accuracy in size of the pipe coupling and also has a superior water pressure resistance.	• This has an easy adhesion of the pipe and better connection of rubber rings, and has a high grade of water-proof characteristic.
	4. Elongation, shrinkage and flexibility	• This pipe enables a smooth adaptation to the displacement in the ground or variation in temperature without generating any stress in the pipe.	• When a variation in temperature or variation in soft ground or the like occurs, an excessive stress is generated in the pipe. In order to eliminate the stress, expensive elongated, retracted and flexible pipes are placed at some places.	• A coupling itself has an elongation or retraction characteristic and so the expansion joint is not particularly required.	• No expansion joint is required when rubber ring joint is used, because the pipe joint itself has flexibility.

(2)

		Ductile Pipe	Steel Pipe	Reinforced Plastic Pipe	Vinyl Chloride Pipe
Durability	1. Service life	• 40 years (enforced by the Law of Local Public Enterprise of the Ministry of Home Affairs). • This pipe may be considered as a semi-permanent unit so long as fluid is not acid. • Real use of the rubber ring continues more than 30 years.	• Real result of about 25 years. • There are some claims caused by the process of welding of a coupling at site and coating it, and further a small diameter pipe where a coating of the inner surface of the coupling is difficult shows a substantial care of corrosion.	• Real result of about 15 years. • Since this pipe has a superior corrosion-proof characteristic due to its physical properties, it has a long-years durability. • Service life of the pipe is more than 60 years in reference to the result of test of fatigue performed by the association of FRPM.	• Real result of 20 years. • Due to physical properties of the pipe itself, the pipe has a superior corrosion-proof characteristic, has no secular change and it has a low friction resistance and has scarcely adhered scales.
	2. Corrosion-proof characteristic	• Outer surface Since this pipe has a superior corrosion-proof characteristic in view of its material quality and has a coating of tar epoxy resin on its surface, it has a superior corrosion-proof characteristic. For the ground with a high corrosion, a process of using polyethylene sleeve is applied. • Inner surface A mortar lining is hard and well adhered to the inner surface of the pipe, and it has a coefficient of roughness of 0 and this value will not be changed in the future. The mortar lining has an effect of making a passive state of iron under an alkalization of cement and has the most effective effect for corrosion-proof feature.	• Outer surface This pipe is apt to have a damage during its handling and the coupling is applied to the pipe on site, resulting in that an incomplete assembling of the pipe is made. • Inner surface Tar epoxy resin coating under the standard (JWWA K115) has a thickness of 0.3mm and this thickness is not sufficient, but has a corrosion-proof effect as compared with that of the ductile pipe. H_2 gas from the welding beads may apply a bad influence generate a disturbance under a weather condition.	• This plastic pipe has no influence for its anti-corrosion and acid ground which is found in anti-sea water characteristic and which becomes a problem in iron and steel pipe system.	• This pipe has a superior characteristic against anti-acid and anti-alkali and this pipe is not decayed by strong acid such as sulfuric acid and hydrochloric acid and strong alkali such as caustic soda.

(3)

		Ductile Pipe	Steel Pipe	Reinforced Plastic Pipe	Vinyl Chloride Pipe
Execution	1. Workability	• Connecting work is simple and fast and a back-fill can be performed just after the connection of this pipe. • A mechanical joint is made such that the rubber ring is placed in a desired stuffing box and then it is bolted, resulting in requiring some skill. Therefore, it takes much time compared with that of the plastic pipe. • Its working can easily be performed even under a rain or a spring water condition.	• Welding on site and coating operations require a high skill and the work by the qualified person is required. • There are many steps such as indexing, temporary fixing, welding, gas removal, inspection and coating or the like and these make a long working period. • Since a low temperature and a moisture may affect bad influence against welding or coating operation, so a complete drying is required.	• Since a weight of the pipe is relatively light, its transportation by a person can be performed and no damage may occur even at a low temperature. However, be sure not to apply any impact to the pipe end where a machining is made.	• A pipe weight is 1/8 of a lead pipe and 1/5 of an iron pipe and is the lightest in all the classes of pipe. • This pipe can be treated with a simple facility and tool. • This pipe can easily be installed in the soft ground.
	2. Foundation work, back-fill	• In general, this pipe does not require any foundation work and a fixing may not be required when the back-fill is to be made. • Since this pipe has a superior strength and ductility, a high safety can be assured under the back-fill operation. Therefore, less restriction is made for the back-fill in the normal ground.	• In order to prevent a flexing of the pipe and damage of a coating of the outer surface of the pipe, both fixing of the bottom of this pipe and the back-fill around the pipe with sand are a condition. • The connected part should be kept large in order to have a working space.	• A sand foundation is an essential foundation in principle. • A ground above the pipe about 20 to 30 cm is back filled with earth of good quality.	• In principle, a sand foundation and a back-fill are applied.

(4)

		Ductile Pipe	Steel Pipe	Reinforced Plastic Pipe	Vinyl Chloride Pipe
Construction Cost	1. Earth work cost	• A special foundation work is not required and a duration of the back-fill is 10 minutes with excavated earth. The cost for working with remained earth and the back-fill is less expensive.	• A working step requires a longer period of time, so that a sheathing period also becomes elongated and a cost of the damage becomes high.	• Under a normal condition, an angle of supporting the work of sand foundation is sufficient with 120° and the purchased sand is less in volume. This pipe does not require such a coupling graving as found in the other classes of pipes, and a working cost is less expensive.	• A surplus excavation at the connected part is not required. • An angle of supporting of the work for the sand foundation is sufficiently 120° and a small amount of sand is required.
Maintenance Control	2. Maintenance control	• Cutting, branching and connecting pipes are easily performed, so that a fast treatment for unexpected troubles can be performed. • Since an inner diameter and a coefficient of flow rate are small, a cost of power for the pump during its feeding operation becomes expensive.	• Inner surface welding and inner surface coating at the connected parts are nearly impossible. • Maintenance cost such as one for preventing electrical corrosion or the like is required.	• Cutting of the pipe is easier than that of the ductile pipe. • A fast treatment can be attained at a layered part of FRP even for the unexpected trouble.	• Even if the pipe is damaged, its repair is easily performed.

Conclusion: As for costs of material, working and maintenance or the like, the reinforced plastic pipe and the vinyl chloride pipe show the most economical costs. Working characteristic and the maintenance work are facilitated, its strength and anti-corrosion are approximately the same as that of the ductile pipe and the steel pipe, and so the reinforced plastic pipe and the vinyl chloride pipe are used.

ANNEX 13

UNIT WATER CONSUMPTION

Investigation Data of Unit Water Consumption

Camp 1	10 liter x 2 times/2 person	= 10.0 lcd
	20 liter x (3 - 4) times/5 person	= 14.0
	20 liter x (2 - 4) times/4 person	= 12.5
	10 liter x 4 times/4 person	= 10.0
	20 liter x 3 times/5 person	= 12.0
	Average	11.7
Qoryooley Town Public Water Filling Station No.4	20 liter x 2 times/3 person	= 13.3
	20 liter x (3 - 4) times/6 person	= 11.7
	20 liter x 6 times/5 person	= 24.0
	20 liter x (6 - 8) times/5 person	= 23.3
	10 liter x (6 - 8) times/3 person	= 23.3
	Average	19.1
Qoryooley Town Public Water Filling Station No.2	20 liter x (3 - 4) times/5 person	= 14.0
	20 liter x (5 - 6) times/6 person	= 18.3
	15 liter x (4 - 6) times/4 person	= 18.75
	10 liter x 7 times/10 person	= 7.0
	20 liter x 4 times/10 person	= 8.0
	Average	13.2
Qoryooley Town Public Water Filling Station No.6	18 liter x 9 times/8 person	= 20.25
	20 liter x 2 times/2 person	= 20.0
	15 liter x (4 - 6) times/6 person	= 12.5
	Average	17.6
	Total Average	15.2 lcd

ANNEX 14

ANALYSIS OF SCALE OF WATER SUPPLY FACILITIES

As mentioned in section 4-2-14, there are two alternatives. The system in which water is pumped once to an elevated tank and then distributed by gravity to the ends of the system and the system provided with overhead relay tank. These systems are taken into consideration for examining the optimum scale of the water supply facilities. The parameters of the system, such as pipe diameter of the water supply facilities, pump capacity, peak-cut capacity of the elevated tank, etc., depend on the variation of the hourly water consumption (time coefficient). Results of the relevant survey for time coefficients are shown in Table 4-10 and Figuers 4-10 to 4-13 of section 4-2-13.

The water supply proportions, by pattern, in the served area as a whole are pattern (1) 33%, (2) 34.2%, (3) 8.5% and (4) 24.3%, respectively, as mentioned in section 4-2-13. On the other hand, in the served area after Qoryooley Town the said proportions are (1) 45.7%, (2) 28.3%, (3) 20% and (4) 19.0%, respectively. The variation of patterns of hourly water consumption of the said proportions do not necessarily have the same tendency and as a consequence the time coefficient in the served area is levelled off. The time coefficient of the served area as a whole is shown in Table 4-10, and the time coefficient of the served area after Qoryooley Town is shown in Table A12-1. Therefore, the pipe diameter, pump capacity, peak-cut capacity, etc., must be designed based on the said time coefficient. As shown in Table 2-5 in Section 2-3, however, the time coefficient for house connections in small urban areas for which the target value is set at 30% (i.e. the water supply amount for house connections aimed at by the Project accounts for 30% of the water supply amount in Qoryooley Town), has not been investigated yet. Therefore, as for the water supply amount for house connections, the maximum time coefficients, 1.64 and 1.31, of patterns (2) and (3), respectively, were adopted, while for water supply amounts other than for house connections, the time coefficients shown in Tables 4-10 and A12-1 mentioned above, were adopted.

Undermentioned cases examined by using this relation are mainly in connection with economical efficiency.

(1) Cases submitted comparative examination

Broadly speaking, two cases are taken into consideration, case (1) with relay facilities and case (2) without relay facilities.

- Case (1)
  Well pump --- Elevated tank --- Pipeline (by gravity flow) --- Relay facilities --- Pipeline (by gravity flow).

- Case (2)
  Well pump --- Elevated tank --- Pipeline (by gravity flow).

There are three distinct alternatives with different elevated tank heights, Case (2)-1, Case (2)-2 and Case (2)-3 are submitted for comparative examination in connection with Case (2).

- Case (2)-1
  The elevated tank height shall be sufficient to secure the head required to convey the water demand amount to the end of the transmission pipeline, when the pipeline diameter is assumed to be the same as that of Case (1), the height shall be approximately 40m.

- Case (2)-2
  In this case the elevated tank height is assumed to be 30m, which is presumed to be the construction limit in view of the technical capability of local contractors.

- Case (2)-3
  In this case it is assumed that the elevated tank height is determined by the capacity of the well pump which is assumed to be the same as that one used in Case (1). Therefore, this height shall be approximately 23m. In this case the construction is relatively easy.

(2) Method of study

The well pump, relay pump (when the system taken into consideration is provided with relay facilities), elevated tank (capacity and height), pipeline caliber, operation time of well pump and relay pump, etc., are designed for the 4 cases mentioned above. Then, the construction cost, operation and maintenance cost and the annual expenses (summation of the annual reimbursement, based on annual interest rate at 3% and a 20-year reimbursement period, and annual operation & maintenance cost) are submitted to comparative examination.

The maximum time coefficient for peak-cut capacities of 3%, 6% and 9% of each case are shown in Table A14-1.

Table A14-1 Relation between Peak-cut Capacity and Maximum Time Coefficient

Peak-cut Capacity	Case (1)		Case (2)-1	Case (2)-2	Case (2)-3
	Before Relay Point	After Relay Point			
3%	1.23	1.25	1.23	1.23	1.23
6%	1.16	1.17	1.16	1.16	1.16
9%	1.09	1.11	1.09	1.09	1.09

Figures A14-1 to A14-3, Figures A14-4 to A14-5, Figures A14-7 to A14-9 and Figures A14-10 to A14-12 are the design analysis diagrams of the scale of the water supply facilities for Case (1), Case (2)-1, Case (2)-2 and Case (2)-3, respectively.

(3) Results

The construction scope, construction cost, operation & maintenance cost and annual cost of the water supply facilities of each case are shown in Table A14-4 (Case 1), Table A14-5 (Case 2-1), Table A14-6 (Case 2-2) and Table A14-7 (Case 2-3). Comparing the case with relay facilities (Case 1) and the case without relay facilities (Case 2), it is concluded that the former one is more advantageous from the standpoint of economical efficiency. Of the said cases, the alternative, assuming 6% peak cut capacity, maximum time coefficient 1.16 before relay point and maximum time coefficient 1.17 after relay point, has the optimum scale of facilities.

As for the alternatives of Case (2), which are not provided with relay facilities, the Case (2)-3 is economically disadvantageous because it requires a larger pipeline diameter compared with Case (2)- and Case (2)-2.

In Case (2)-1 the water supply tower height becomes GL+41.5m, and considerable difficulty is expected in connection with the practicality of the construction work. Therefore, it is concluded that Case (2)-2 is the most advantageous one from the standpoints of economical efficiency and workability.

Table A14-2 Relations between Peak-cut Capacity and Time Coeffiecient

Served Area After Relay Point

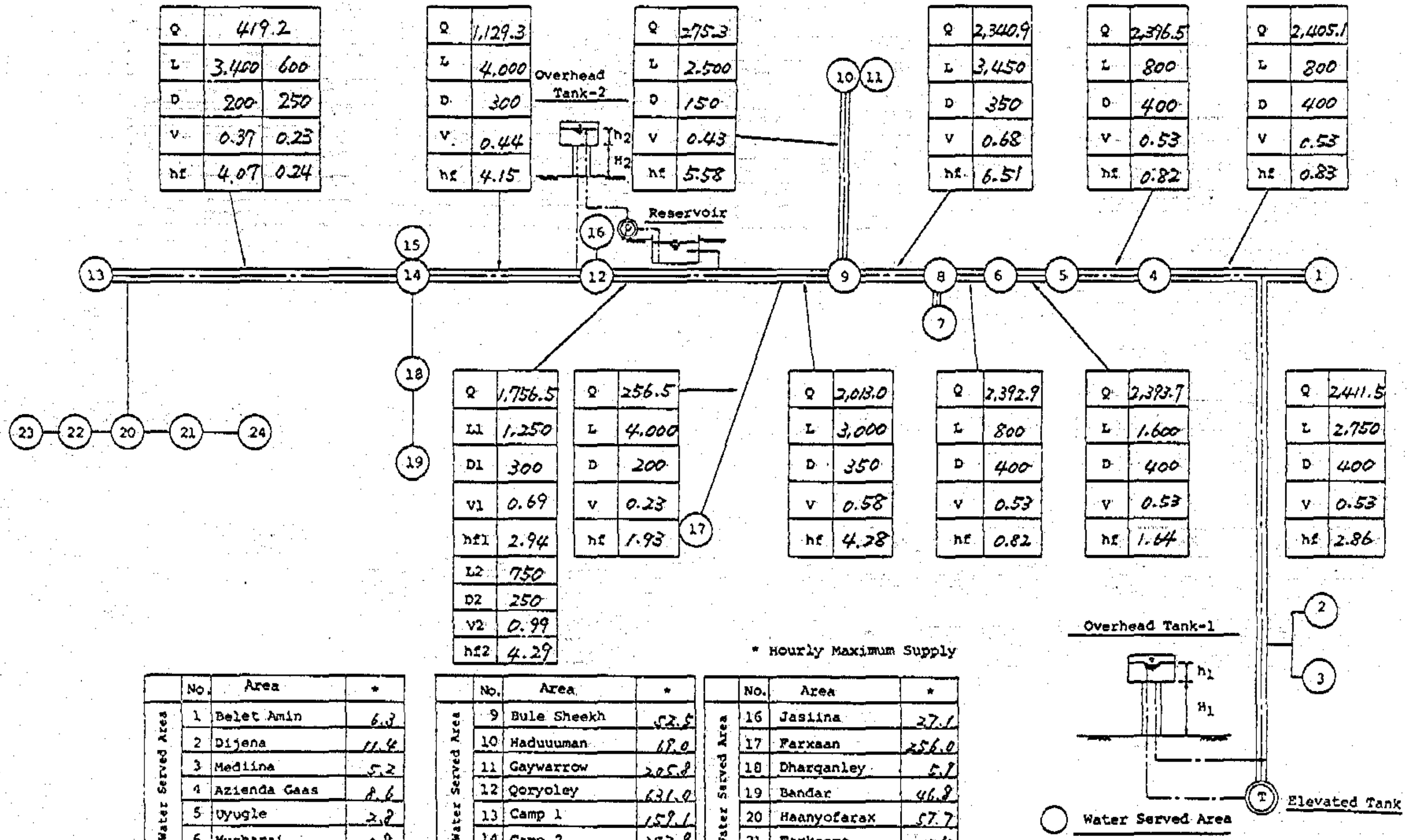
	House Connection		Served Area by Public Water Filling Station		Time Coefficient	
	Pattern 2	Pattern 3				
	0.265 x 0.3	0.088 x 0.3	0.894			
			Peak-cut Capacity	Time Coefficient	Peak-cut Capacity	Time Coefficient
7	1.64	1.31	9%	1.059	9%	1.112
8	"	"	6%	1.124	6%	1.170
9	"	"	3%	1.209	3%	1.246
10	"	"	0%	1.346	0%	1.368
11	"	"	0.932		1.156	
12	"	"	0.784		1.053	
13	"	"	0.700		0.994	
14	"	"	0.664		0.969	
15	"	"	0.850		1.099	
16	"	"	0.938		1.161	

Table A14-3 Relations between Peak-cut Capacity and Time Coefficient

Total Served Area

	House Connection		Served Area by Public Water Filling Station		Time Coefficient	
	Pattern 2	Pattern 3				
	0.192 x 0.3	0.064 x 0.3	0.923			
7	1.64	1.31	Peak-cut Capacity	Time Coefficient	Peak-cut Capacity	Time Coefficient
8	"	"	12%	0.978	12%	1.023
			9%	1.053	9%	1.092
9	"	"	6%	1.128	6%	1.161
			3%	1.203	3%	1.230
10	"	"	0%	1.394	0%	1.407
11	"	"	0.902		0.952	
12	"	"	0.791		0.850	
13	"	"	0.722		0.786	
14	"	"	0.684		0.751	
15	"	"	0.839		0.894	
16	"	"	0.759		1.005	

Fig. A14-1(1) Case (1) (Peak-Cut Capacity 9%) Sectional Head Loss



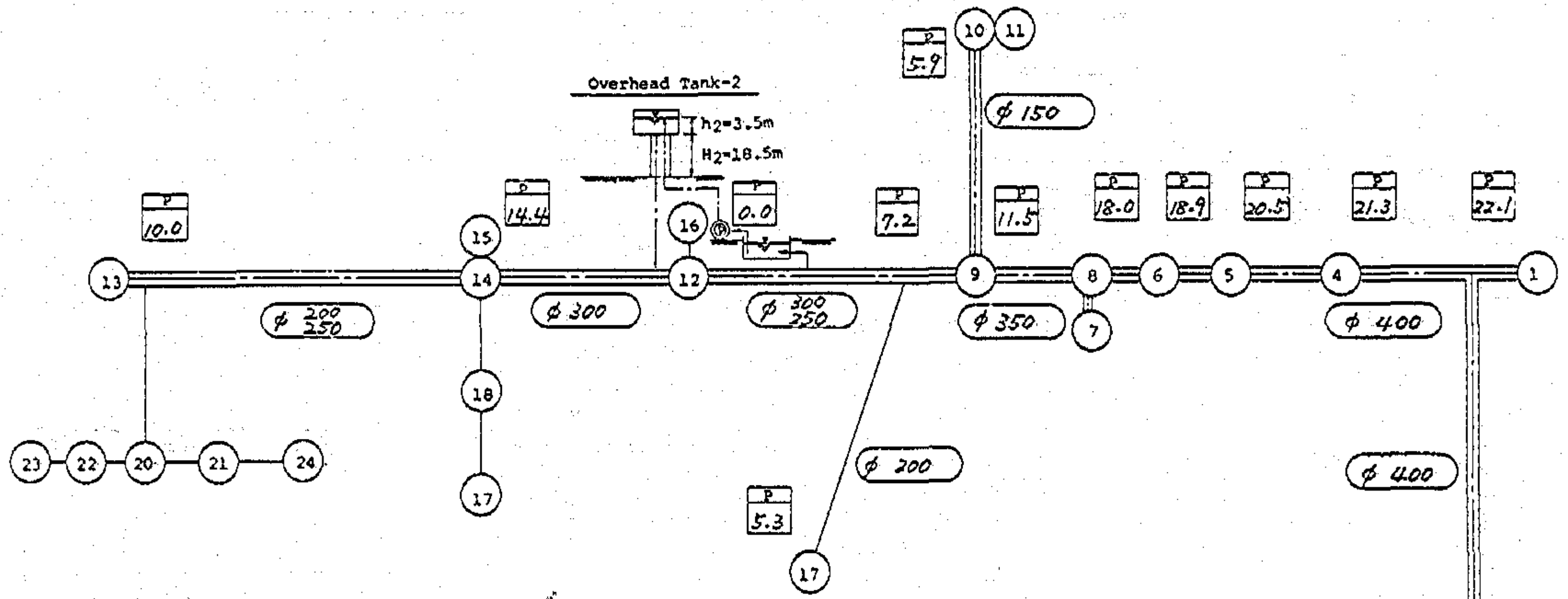
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	18.0
	11	Gaywarrow	205.8
	12	Qoryoley	631.0
	13	Camp 1	159.1
	14	Camp 2	357.9
	15	Camp 3	298.2

	No.	Area	*
Indirect Water Served Area	16	Jasiina	27.1
	17	Farxaan	256.0
	18	Dharqanley	5.8
	19	Bandar	46.8
	20	Haanyofarax	57.7
	21	Farkeero	3.4
	22	Gorgaol	74.5
	23	Aranay	23.2
	24	Cabdi Cali	100.6

Fig. A14-1 (2) Case (1) (Peak-Cut Capacity 9%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area	No.	Area	*
	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	1.6
	5	Dyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	52.5
	10	Haduuuman	69.0
	11	Gaywarrow	205.8
	12	Qoryoley	631.0
	13	Camp 1	152.1
	14	Camp 2	357.9
	15	Camp 3	298.2

Indirect Water Served Area	No.	Area	*
	16	Jasiina	27.1
	17	Farxaan	256.0
	18	Dharganley	5.9
	19	Bandar	46.8
	20	Mannyofarax	57.7
	21	Farkeero	3.4
	22	Gorgaol	74.5
	23	Aranay	23.2
	24	Cabdi Cali	100.6

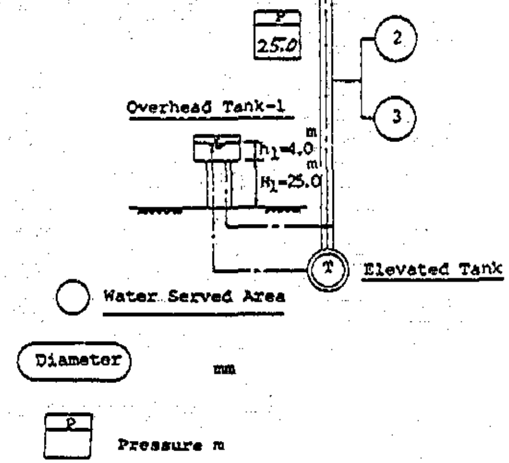
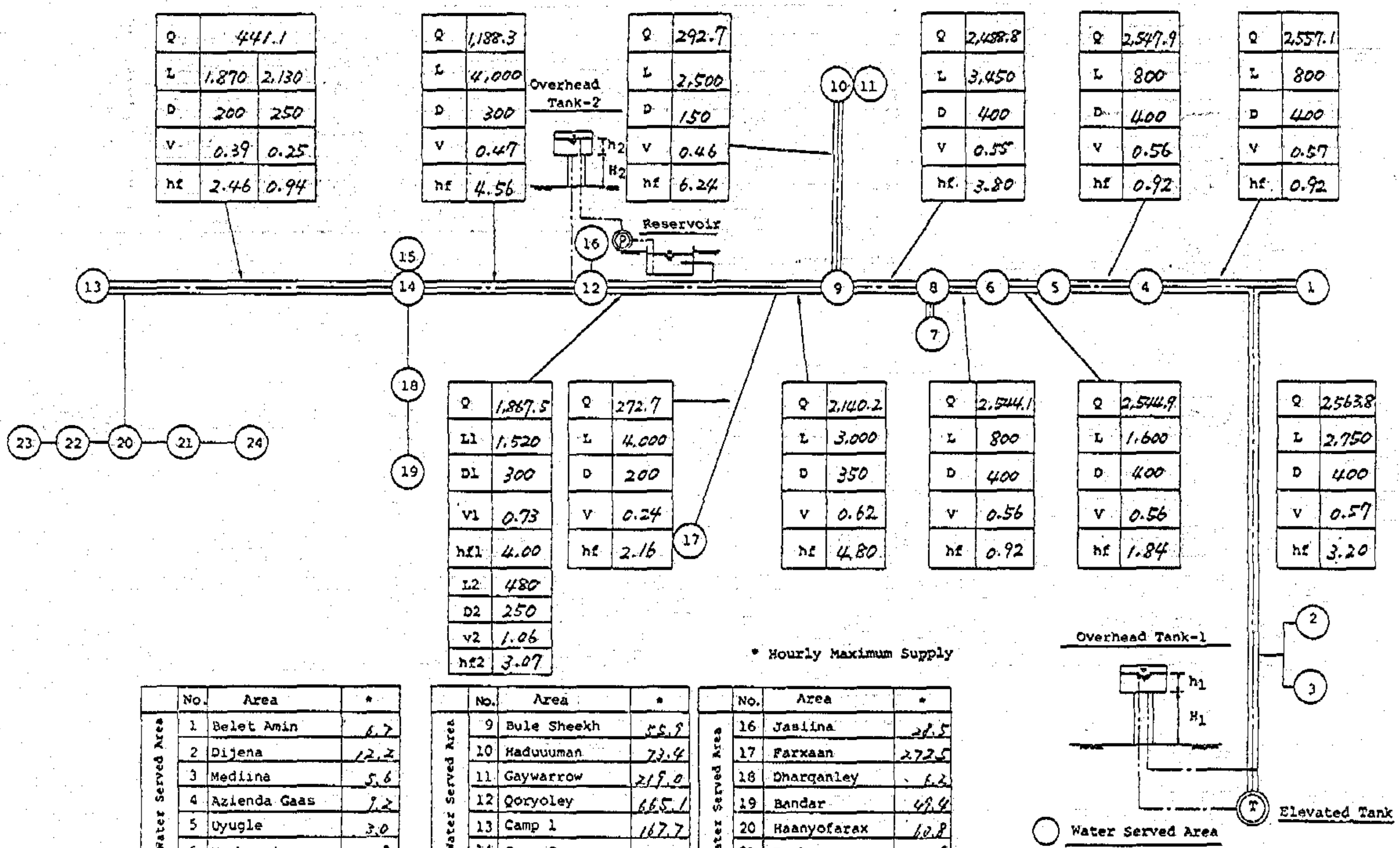


Fig. A14-2(1) Case (1) (Peak-Cut Capacity 6%) Sectional Head Loss



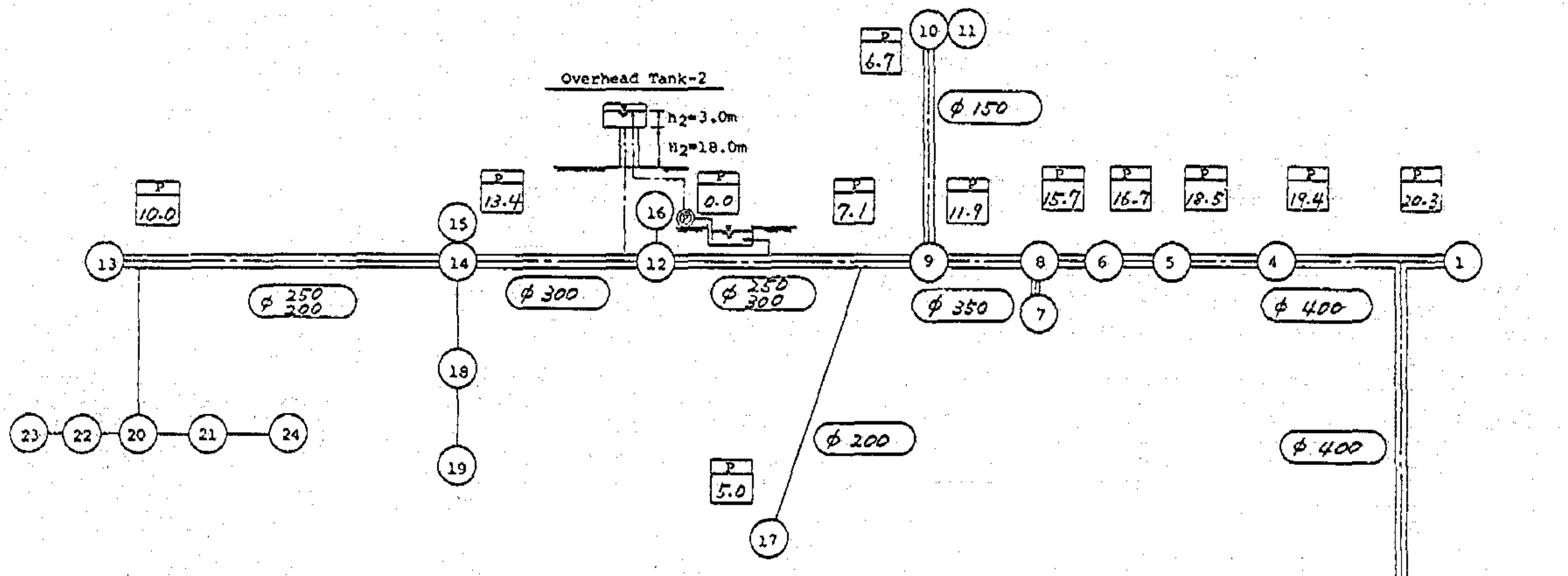
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	7.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	55.9
	10	Haduuuman	73.4
	11	Gaywarrow	219.0
	12	Qoryoley	665.1
	13	Camp 1	167.7
	14	Camp 2	977.2
	15	Camp 3	314.4

	No.	Area	*
Indirect Water Served Area	16	Jasiina	28.5
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	49.4
	20	Haanyofarax	10.8
	21	Farkeero	3.6
	22	Gorgaol	78.5
	23	Aranay	24.4
	24	Cabdi Cali	106.0

Fig. A14-2 (2) Case (1) (Peak-Cut Capacity 6%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area	No.	Area	*
	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	9.2
	5	Uyugle	3.0
	6	Musharai	2.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	55.9
	10	Haduuuman	73.4
	11	Gaywarrow	219.0
	12	Qoryoley	665.1
	13	Camp 1	167.7
	14	Camp 2	377.2
	15	Camp 3	314.4

Indirect Water Served Area	No.	Area	*
	16	Jasiina	28.5
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	49.4
	20	Mannyofarax	62.8
	21	Farkeero	3.6
	22	Gorgaol	78.5
	23	Aranay	24.4
	24	Cabdi Cali	106.0

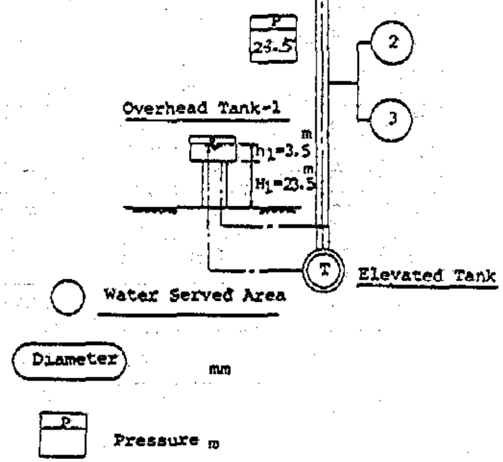
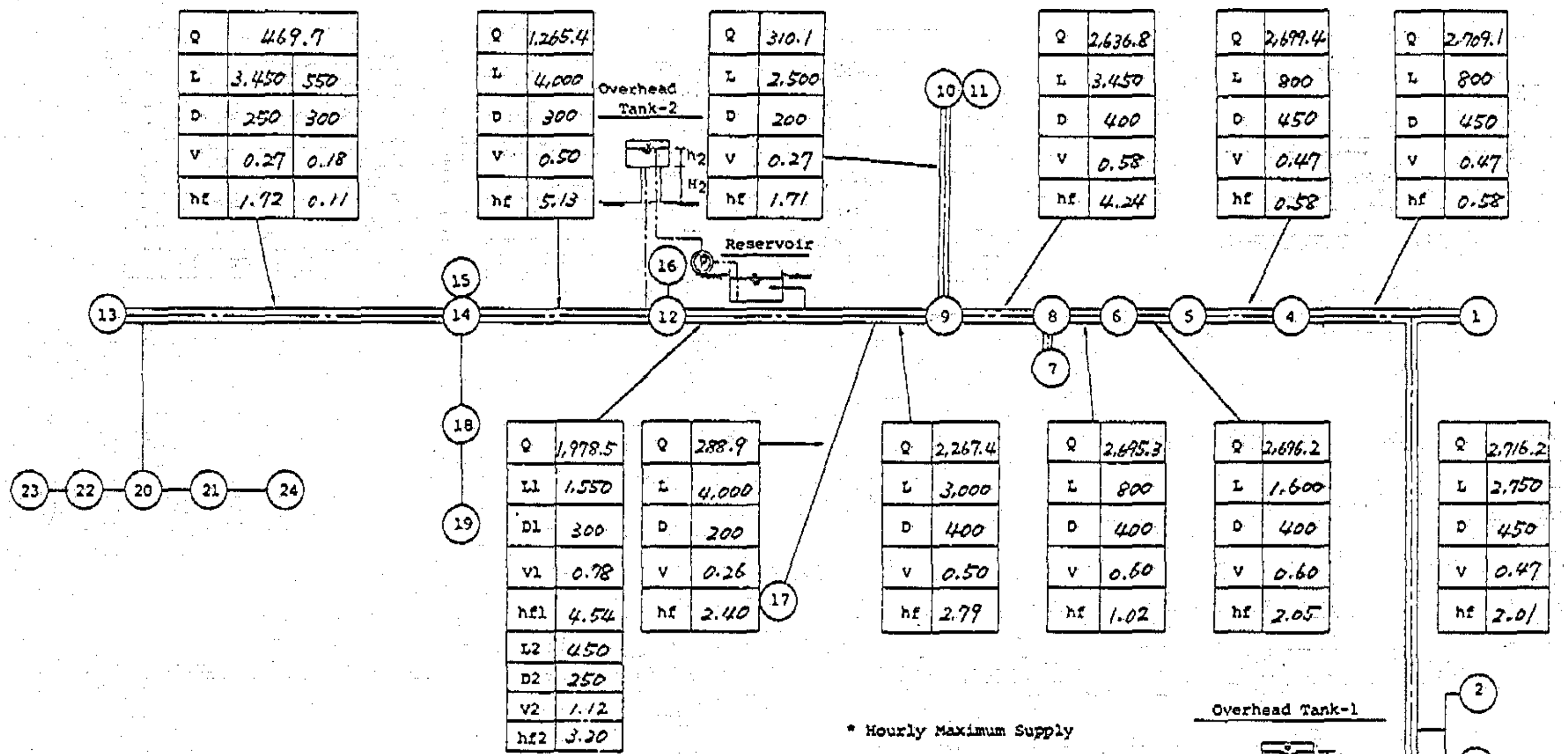


Fig. A14-3(1) Case (1) (Peak-Cut Capacity 3%) Sectional Head Loss



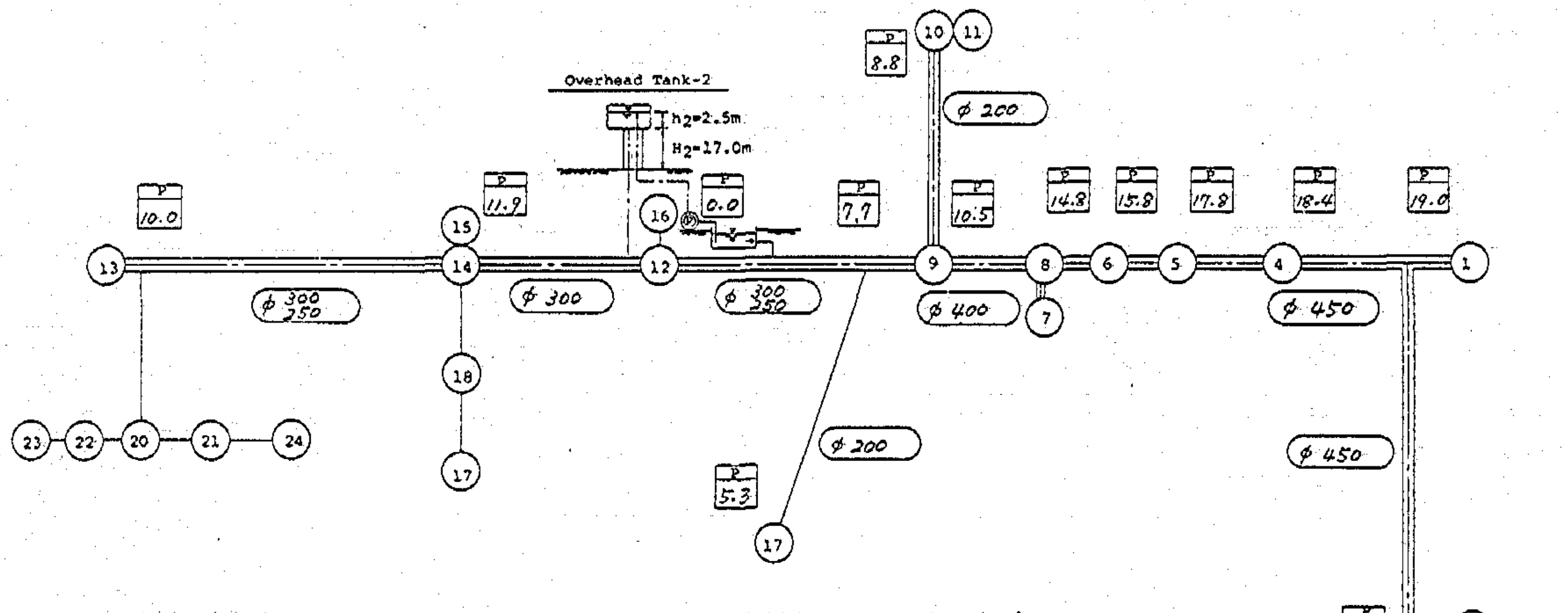
* Hourly Maximum Supply

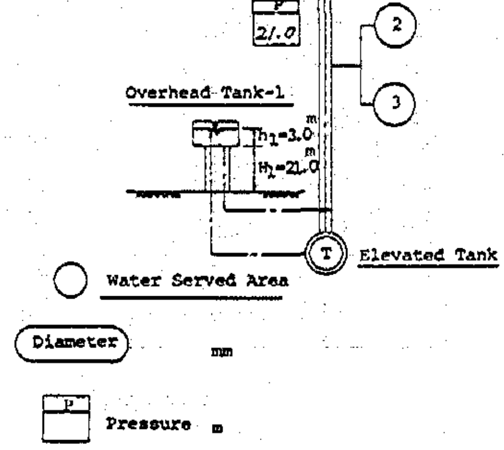
	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.9
	4	Azienda Gaas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	59.3
	10	Haduuuman	77.9
	11	Gaywarrow	232.2
	12	Qoryoley	710.6
	13	Camp 1	175.1
	14	Camp 2	407.0
	15	Camp 3	335.9

	No.	Area	*
Indirect Water Served Area	16	Jasiina	30.5
	17	Farxaan	258.9
	18	Dharqanley	6.6
	19	Bandar	52.7
	20	Haanyofarax	65.0
	21	Farkeero	3.9
	22	Gorgaol	83.9
	23	Aranay	26.1
	24	Cabdi Cali	113.2

Fig. A14-3 (2) Case (1) (Peak-Cut Capacity 3%) Dynamic Water Pressure at Each Point





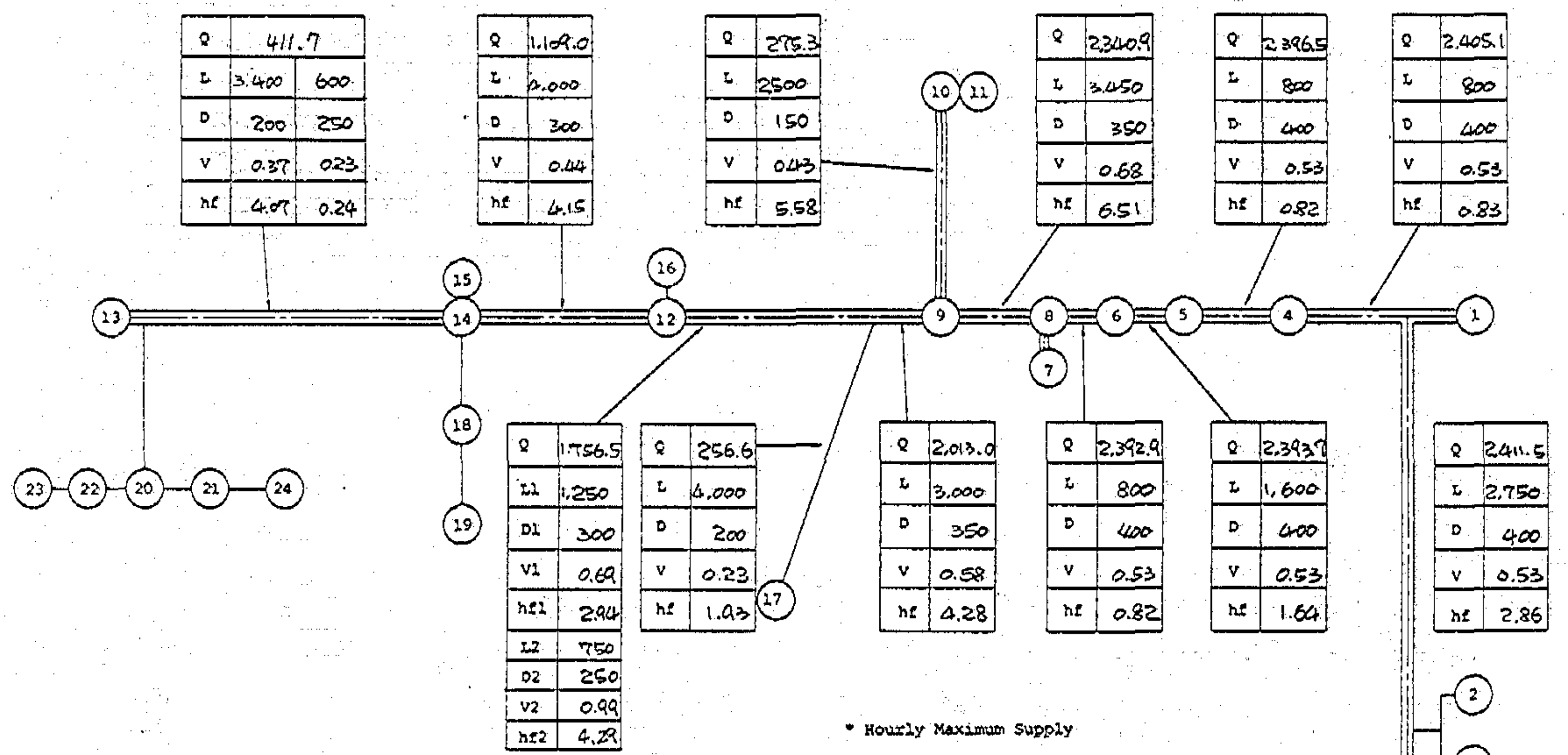
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.5
	3	Mediina	5.9
	4	Azienda Gaas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	57.3
	10	Haduuuman	77.9
	11	Gaywarrow	232.2
	12	Qoryoley	210.6
	13	Camp 1	179.1
	14	Camp 2	403.0
	15	Camp 3	335.5

	No.	Area	*
Indirect Water Served Area	16	Jasiina	30.5
	17	Farxaan	288.9
	18	Dharqanley	6.6
	19	Bandar	52.7
	20	Mannyofarax	65.0
	21	Farkeero	3.9
	22	Corgaol	83.9
	23	Aranay	26.1
	24	Cabdi Cali	113.2

Fig. A14-4(1) Case (2)-1 (Capacity 9%) Sectional Head Loss



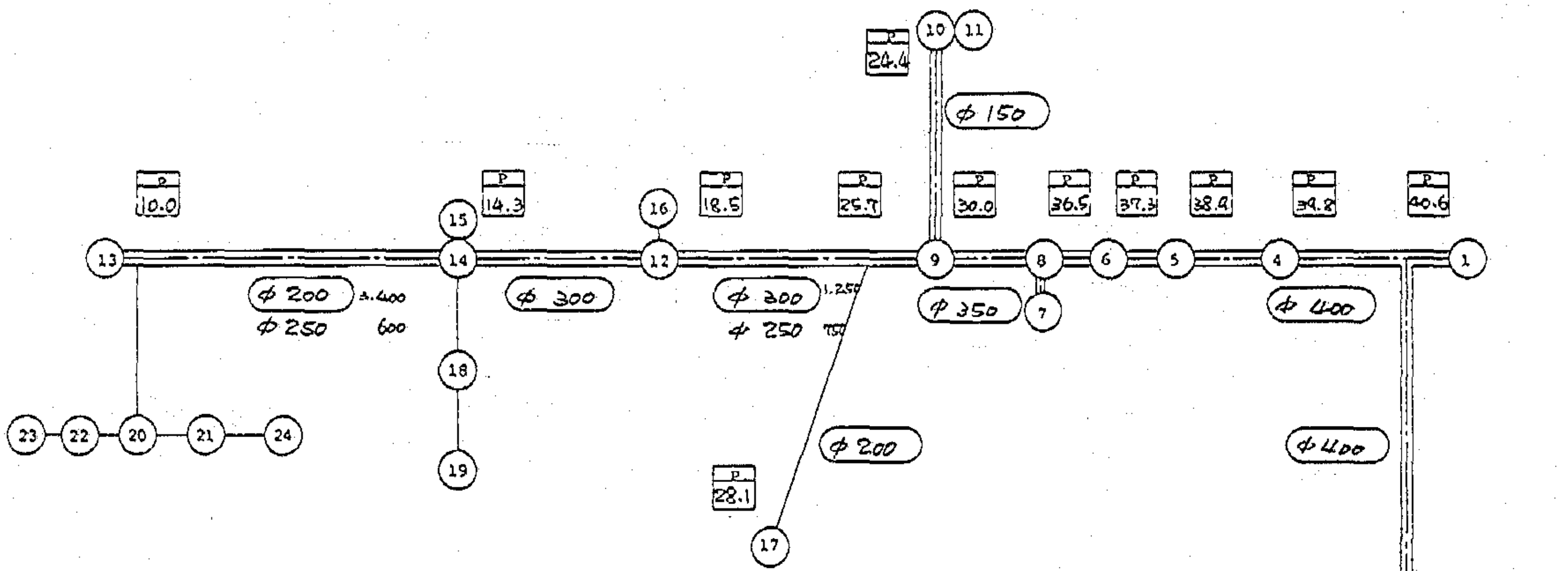
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	68.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.4
	15	Camp 3	292.9

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.6
	17	Farxaan	256.0
	18	Dharganley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	3.4
	22	Gorgaol	73.1
	23	Aranay	22.6
	24	Cabdi Cali	58.7

Fig. A14-4 (2) Case (2)-1 (Capacity 9%) Dynamic Water Pressure at Each Point



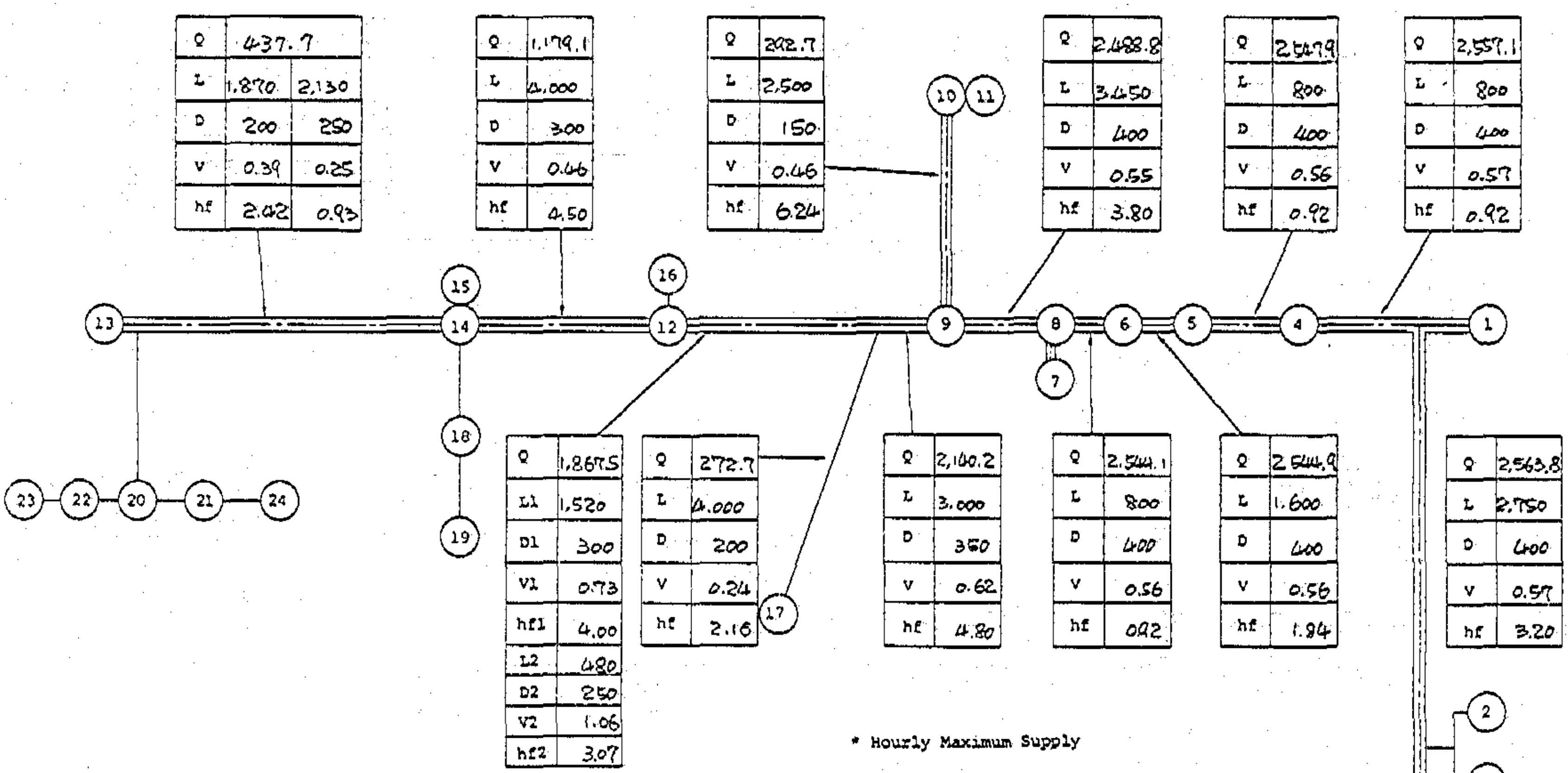
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	69.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.4
	15	Camp 3	292.9

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.6
	17	Farxaan	256.0
	18	Dharqanley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	3.4
	22	Gorgaol	73.1
	23	Aranay	22.8
	24	Cabdi Cali	58.7

Fig. A14-5(1) Case (2)-1 (Capacity 6%) Sectional Head Loss



* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Medilna	5.6
	4	Azienda Gaas	9.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

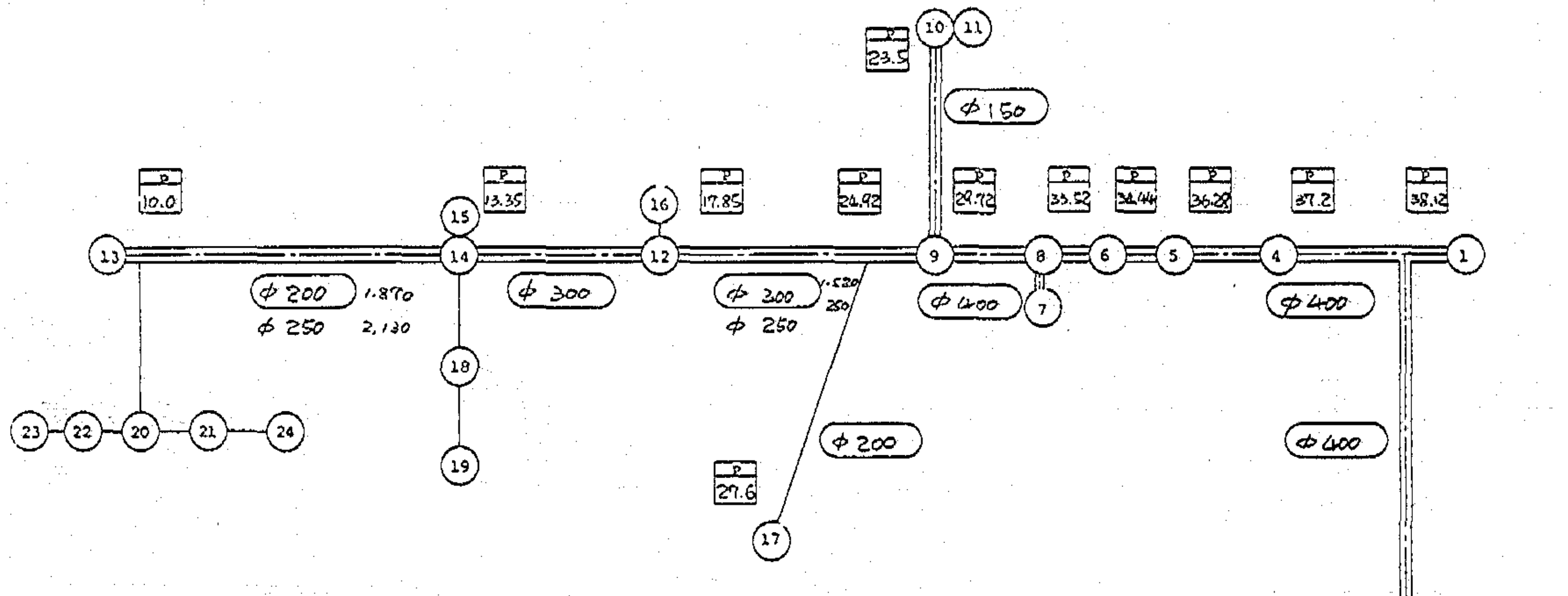
	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	55.5
	10	Haduuuman	73.4
	11	Gaywarrow	219.0
	12	Qoryoley	158.5
	13	Camp 1	166.2
	14	Camp 2	374.0
	15	Camp 3	311.7

	No.	Area	*
Indirect Water Served Area	16	Jasiina	28.3
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	48.9
	20	Maanyofarax	60.3
	21	Farkeero	3.6
	22	Gorgaol	77.8
	23	Aranay	24.2
	24	Cabdi Cali	105.1

○ Water Served Area

(T) Elevated Tank

Fig. A14-5 (2) Case (2)-1 (Capacity 6%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area	No.	Area	*
	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	9.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	55.9
	10	Haduuuman	73.4
	11	Gaywarrow	219.0
	12	Qoryoley	159.5
	13	Camp 1	166.2
	14	Camp 2	374.0
	15	Camp 3	311.7

Indirect Water Served Area	No.	Area	*
	16	Jasiina	28.3
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	48.9
	20	Maanyofarax	60.3
	21	Farkeero	3.6
	22	Gorgaol	77.8
	23	Aranay	24.2
	24	Cabdi Cali	105.1

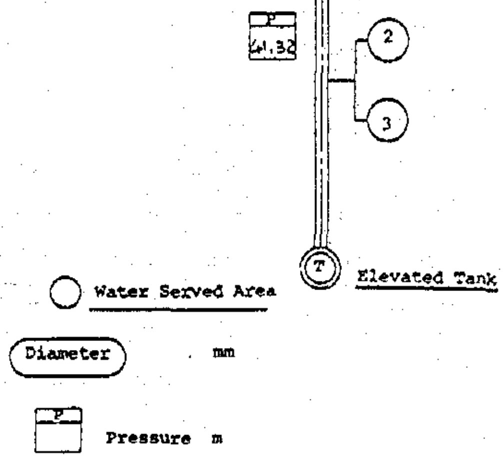
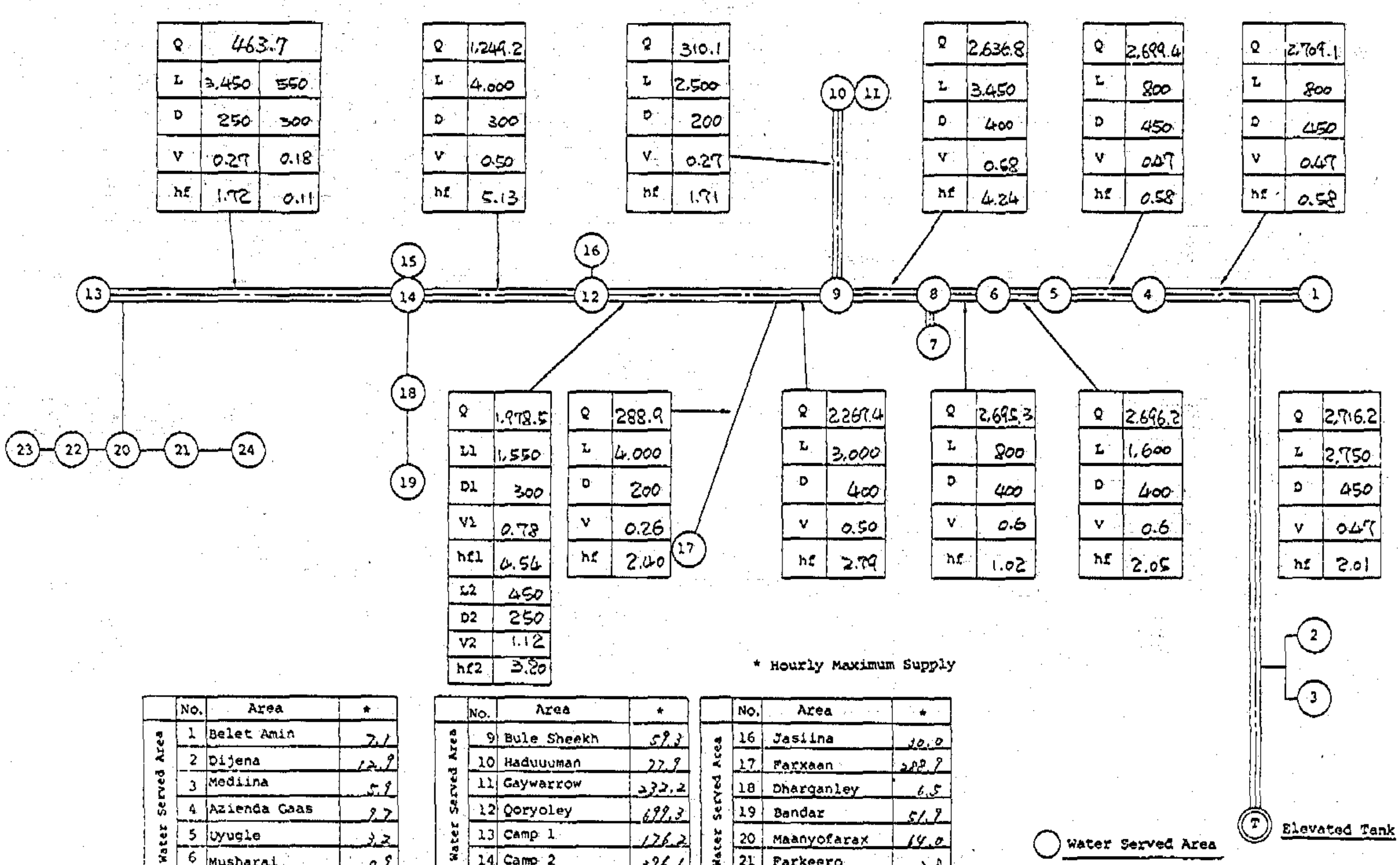


Fig. A14-6(1) Case (2)-1 (Capacity 3%) Sectional Head Loss



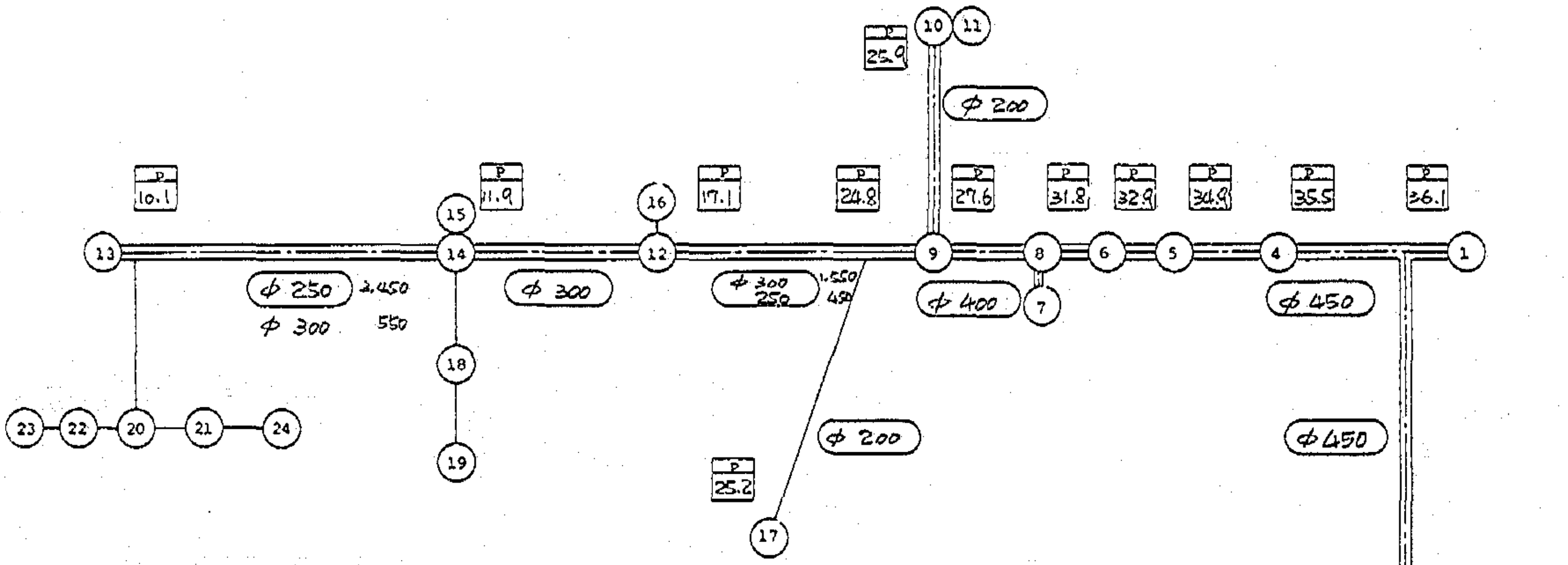
* Hourly Maximum Supply

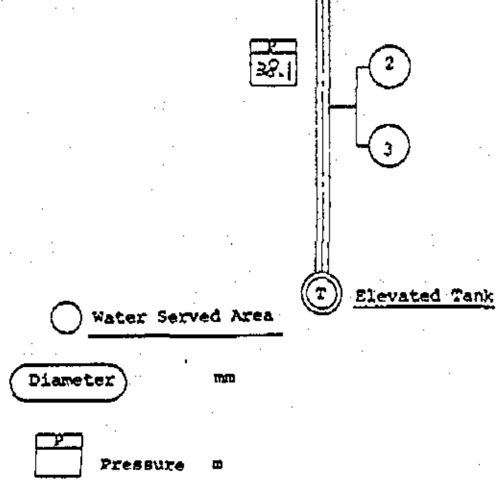
Direct Water Served Area	No.	Area	*
	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.9
	4	Azienda Gaas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	59.3
	10	Haduuuman	22.9
	11	Gaywarrow	232.2
	12	Qoryoley	699.3
	13	Camp 1	176.2
	14	Camp 2	396.6
	15	Camp 3	330.5

Indirect Water Served Area	No.	Area	*
	16	Jasiina	10.0
	17	Farxaan	288.9
	18	Dharganley	6.5
	19	Bandar	51.9
	20	Maanyofarax	14.0
	21	Farkeero	3.8
	22	Gorgaol	82.5
	23	Aranay	25.7
	24	Cabdi Cali	111.9

Fig. A14-6 (2) Case (2)-1 (Capacity 3%) Dynamic Water Pressure at Each Point





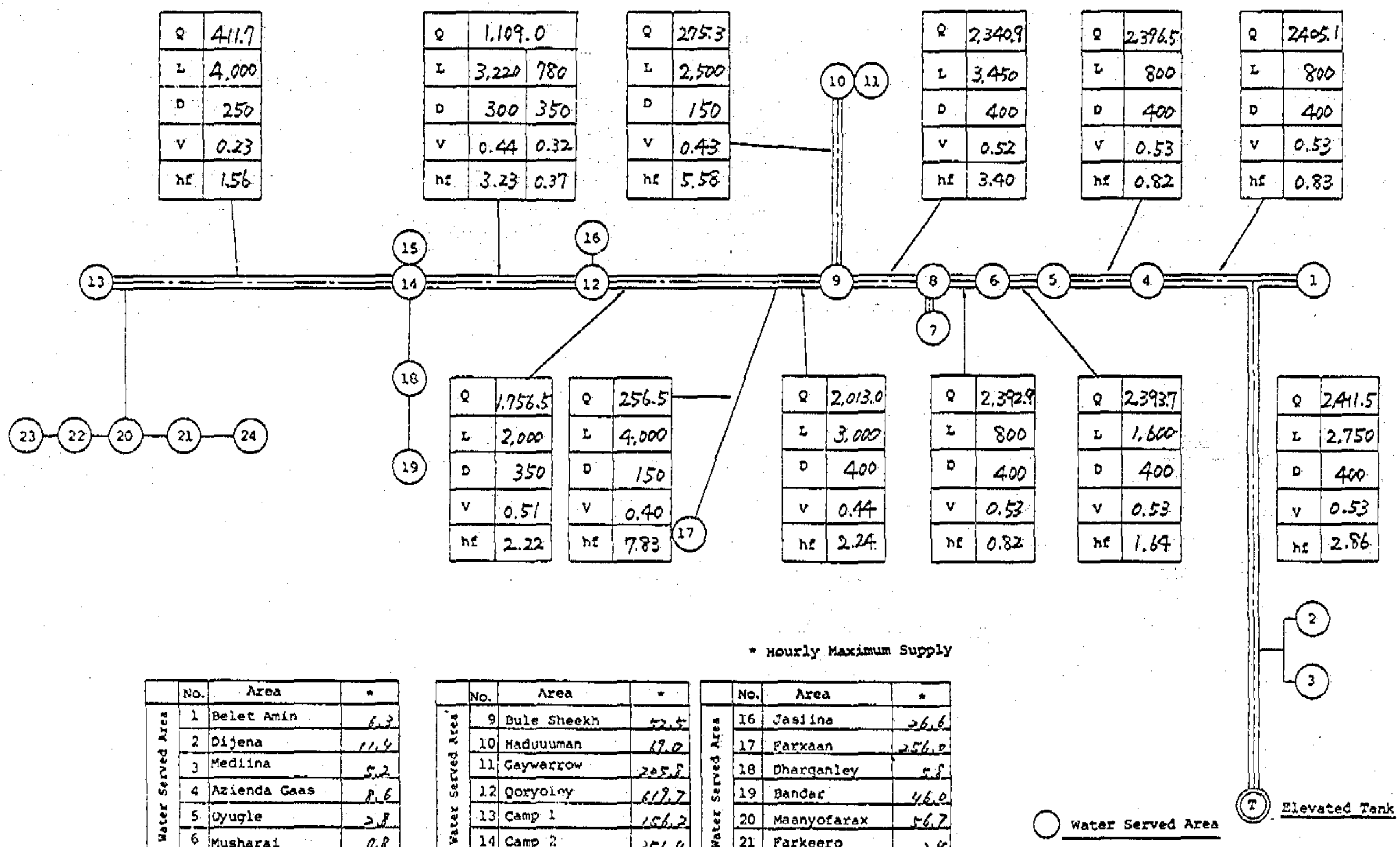
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.5
	4	Azienda Caas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	59.3
	10	Haduuuman	72.9
	11	Gaywarrow	232.2
	12	Qoryoley	699.3
	13	Camp 1	126.2
	14	Camp 2	376.6
	15	Camp 3	330.5

	No.	Area	*
Indirect Water Served Area	16	Jasiina	20.0
	17	Farxaan	288.9
	18	Dharqanley	6.5
	19	Bandar	51.9
	20	Maanyofarax	64.0
	21	Farkeero	3.8
	22	Gorgaol	82.5
	23	Aranay	25.7
	24	Cabdi Cali	111.6

Fig. A14-7(1) Case (2)-2 (Capacity 9%) Sectional Head Loss



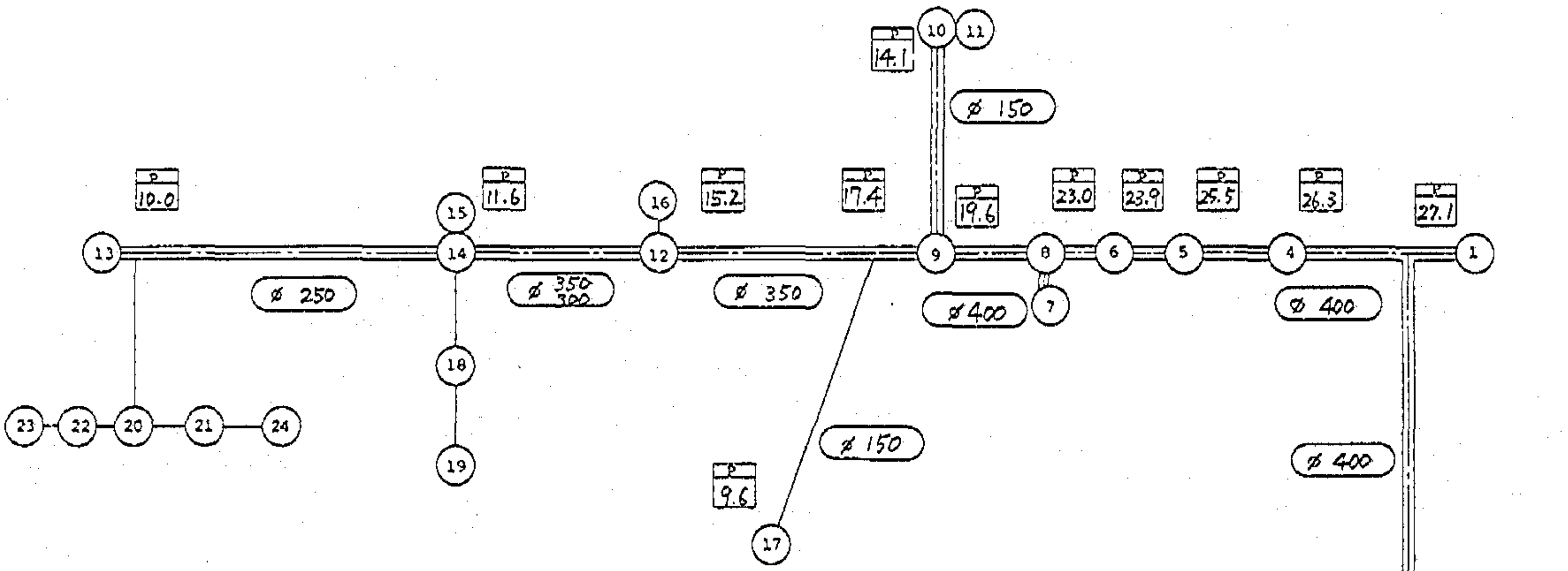
* Hourly Maximum Supply

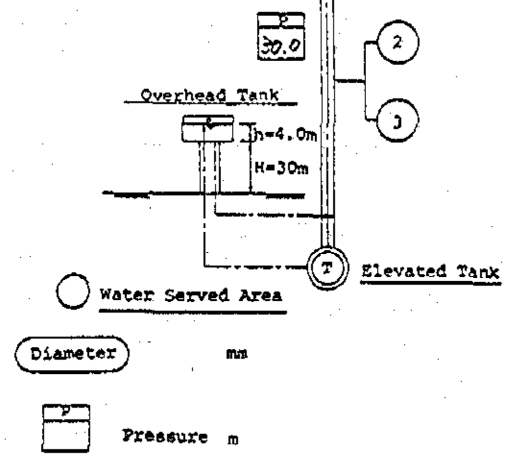
	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Oyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	95.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	69.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.4
	15	Camp 3	272.9

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.6
	17	Farxaan	256.0
	18	Dharganley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	2.4
	22	Gorgaol	23.1
	23	Aranay	22.8
	24	Cabdi Cali	98.7

Fig. A14-7 (2) Case (2)-2 (Capacity 9%) Dynamic Water Pressure at Each Point





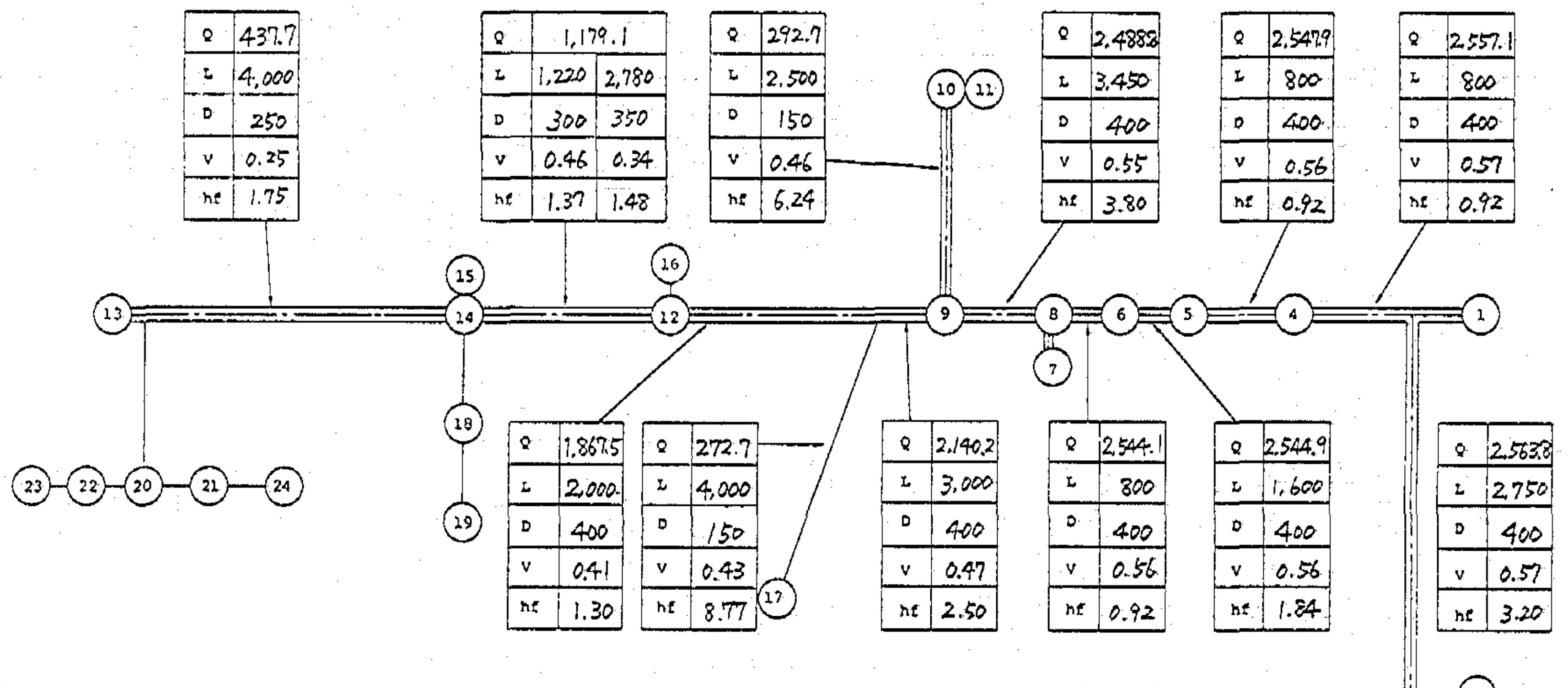
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.3
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	1.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	62.5
	10	Haduuuman	68.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.4
	15	Camp 3	293.8

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.6
	17	Farxaan	256.0
	18	Dharqanley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	3.4
	22	Gorgaol	23.1
	23	Aranay	22.8
	24	Cabdi Cali	18.7

Fig. A14-8(1) Case (2)-2 (Capacity 6%) Sectional Head Loss



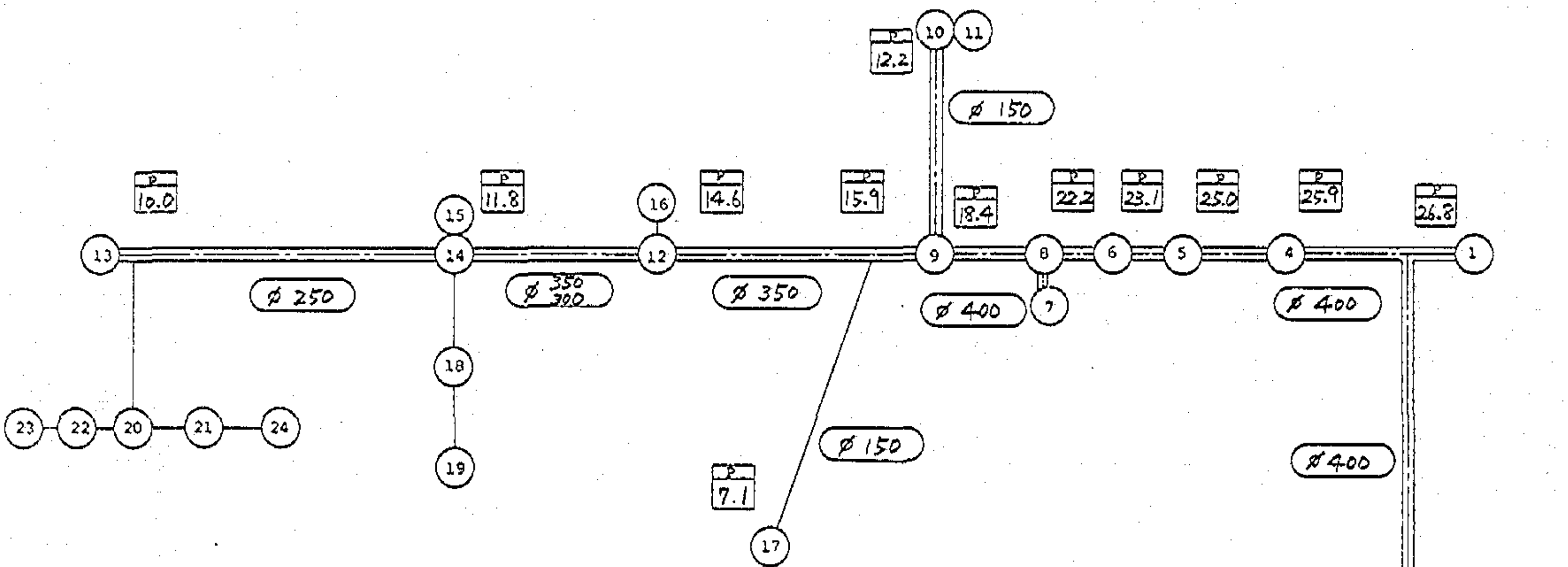
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	2.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	55.9
	10	Maduuuman	73.4
	11	Caywarrow	219.0
	12	Qoryoley	659.5
	13	Camp 1	166.2
	14	Camp 2	374.0
	15	Camp 3	311.7

	No.	Area	*
Indirect Water Served Area	16	Jasiina	28.3
	17	Farxaan	272.5
	18	Dharganley	6.2
	19	Bandar	48.9
	20	Maanyofarax	60.3
	21	Farkeero	3.6
	22	Gorgaol	77.8
	23	Aranay	24.2
	24	Cabdi Cali	105.1

Fig. A14-8 (2) Case (2)-2 (Capacity 6%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area	No.	Area	*
	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	9.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	55.9
	10	Haduuuman	23.4
	11	Gaywarrow	219.0
	12	Qoryoley	659.5
	13	Camp 1	166.2
	14	Camp 2	374.0
	15	Camp 3	311.7

Indirect Water Served Area	No.	Area	*
	16	Jasiina	28.3
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	48.5
	20	Maanyofarax	60.3
	21	Farkeero	3.6
	22	Gorgaol	77.8
	23	Aranay	24.2
	24	Cabdi Cali	105.1

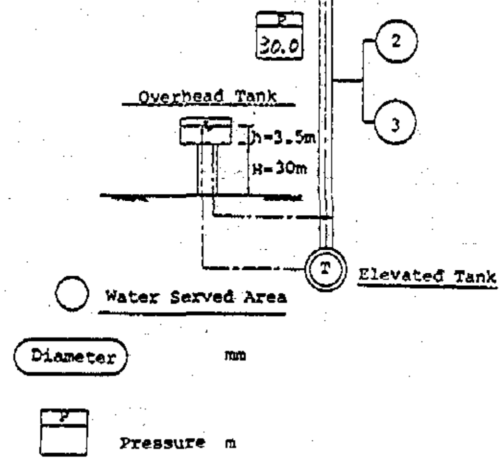
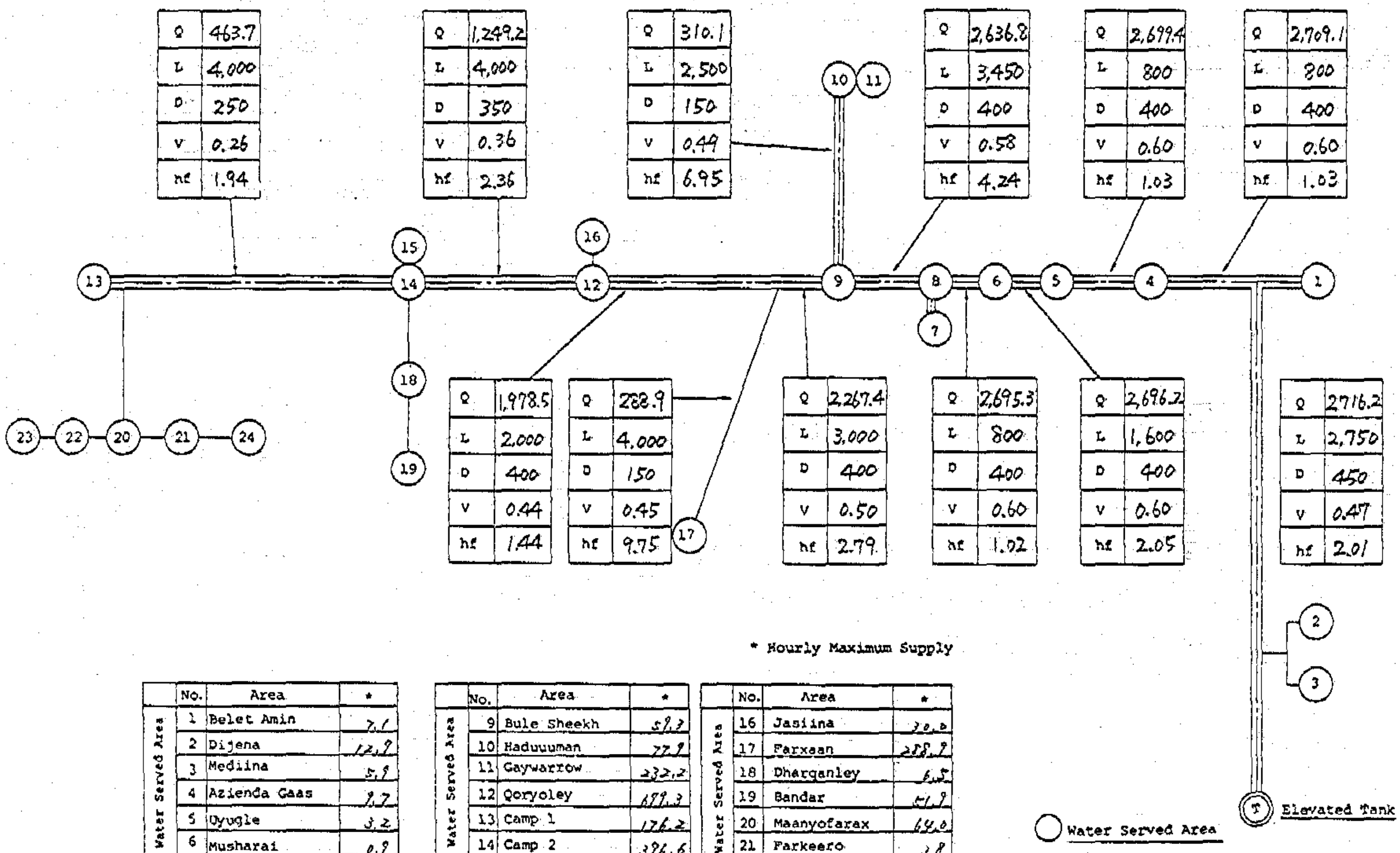


Fig. A14-9(1) Case (2)-2 (Capacity 3%) Sectional Head Loss



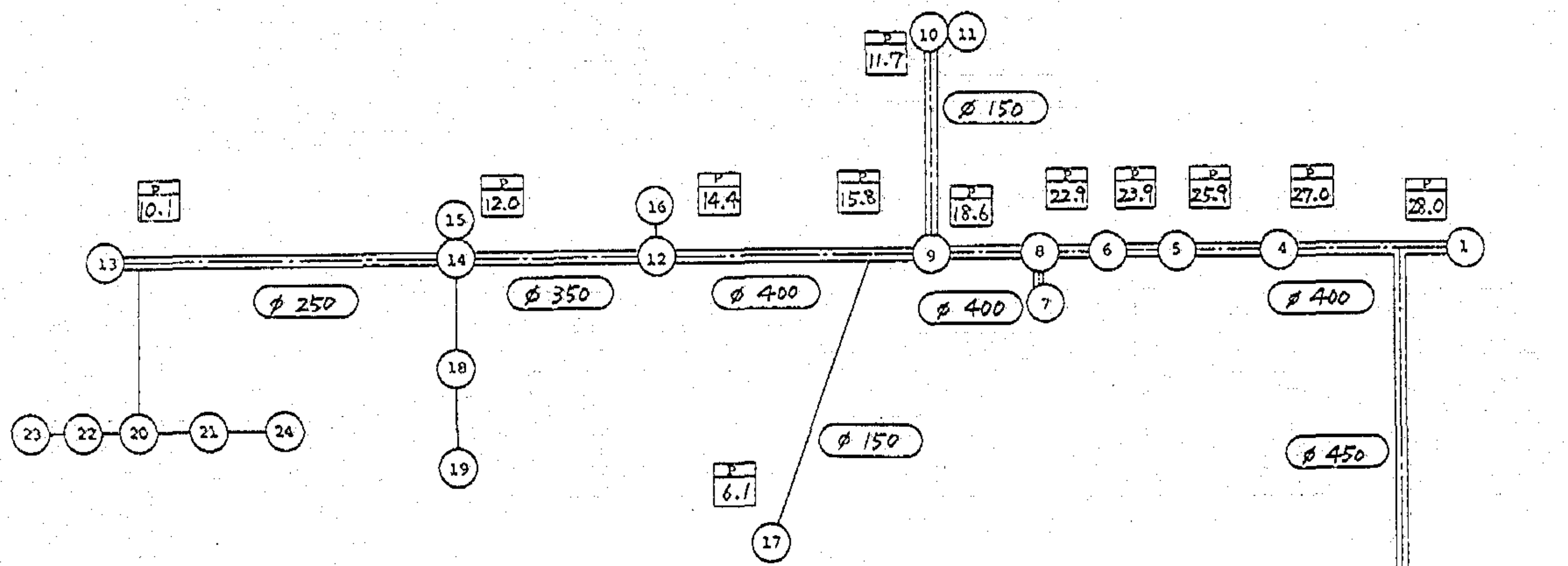
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.9
	4	Azienda Gaas	8.7
	5	Oyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	59.3
	10	Haduuuman	77.9
	11	Gaywarrow	232.2
	12	Qoryoley	689.3
	13	Camp 1	176.2
	14	Camp 2	396.6
	15	Camp 3	330.5

	No.	Area	*
Indirect Water Served Area	16	Jasiina	30.0
	17	Farxaan	288.9
	18	Dharqanley	6.5
	19	Bandar	51.9
	20	Maanyofarax	64.0
	21	Farkeero	2.8
	22	Gorgaol	82.5
	23	Araney	25.7
	24	Cabdi Cali	111.4

Fig. A14-9 (2) Case (2)-2 (Capacity 3%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area	No.	Area	*
	1	Belet Amin	7.6
	2	Dijena	12.9
	3	Mediina	5.9
	4	Azienda Gaas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

Direct Water Served Area	No.	Area	*
	9	Bule Sheekh	59.3
	10	Haduuuman	77.9
	11	Gaywarrow	232.2
	12	Qoryoley	699.3
	13	Camp 1	176.2
	14	Camp 2	326.6
	15	Camp 3	330.5

Indirect Water Served Area	No.	Area	*
	16	Jasiina	30.0
	17	Farxaan	288.9
	18	Dharqanley	6.5
	19	Bandar	51.9
	20	Maanyofarax	64.0
	21	Farkeero	3.8
	22	Gorgaol	82.5
	23	Aranay	25.7
	24	Cabdi Cali	111.4

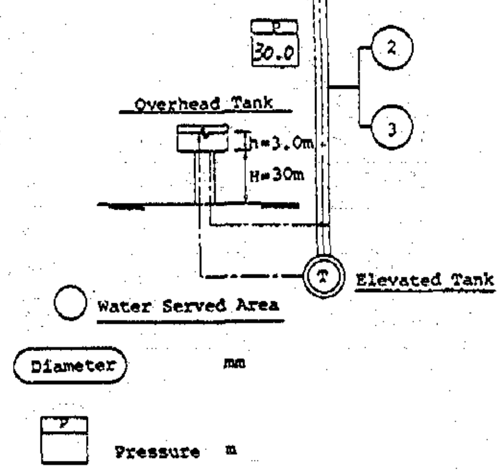
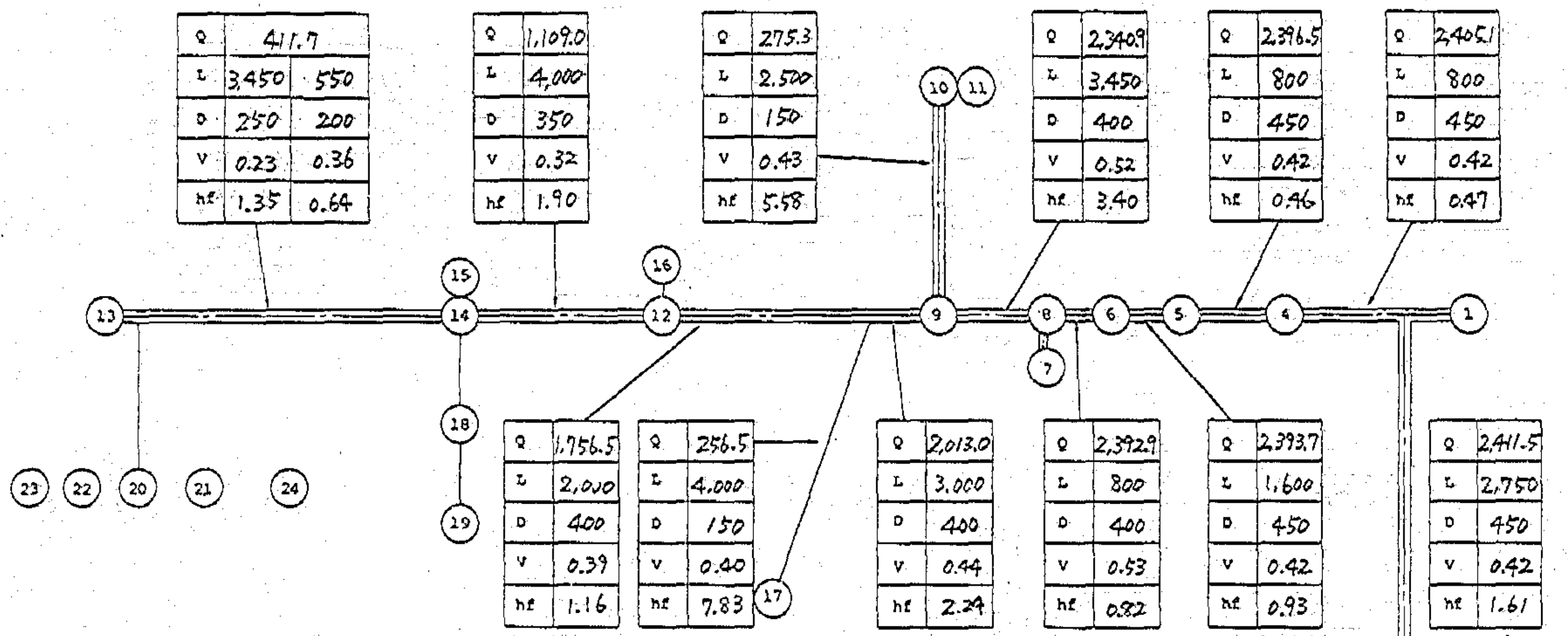
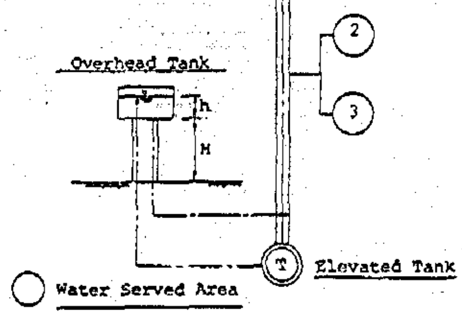


Fig. A14-10(1) Case (2)-3 (Capacity 9%) Sectional Head Loss





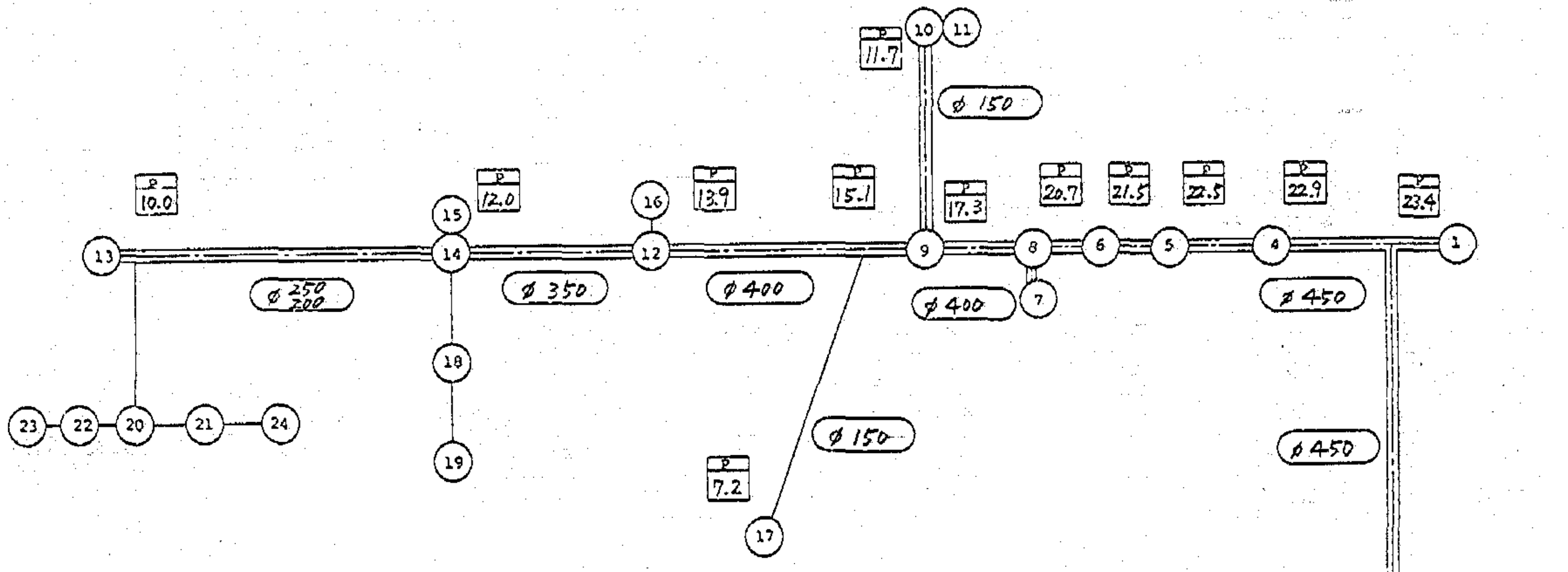
* Hourly Maximum Supply

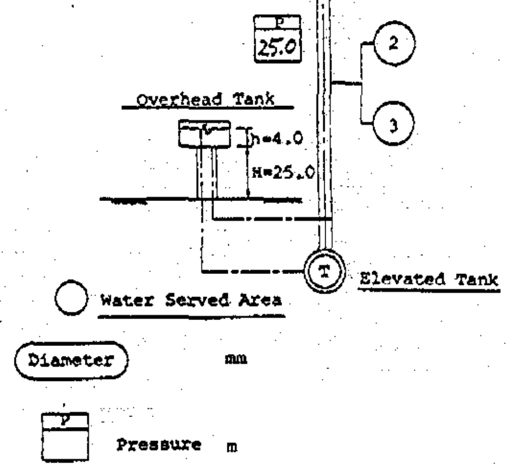
	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.2
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	1.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	69.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.4
	15	Camp 3	292.1

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.6
	17	Farxaan	256.0
	18	Dharqanley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	3.4
	22	Gorgaol	73.1
	23	Aranay	22.8
	24	Cabdi Cali	98.7

Fig. A14-10 (2) Case (2)-3 (Capacity 9%) Dynamic Water Pressure at Each Point





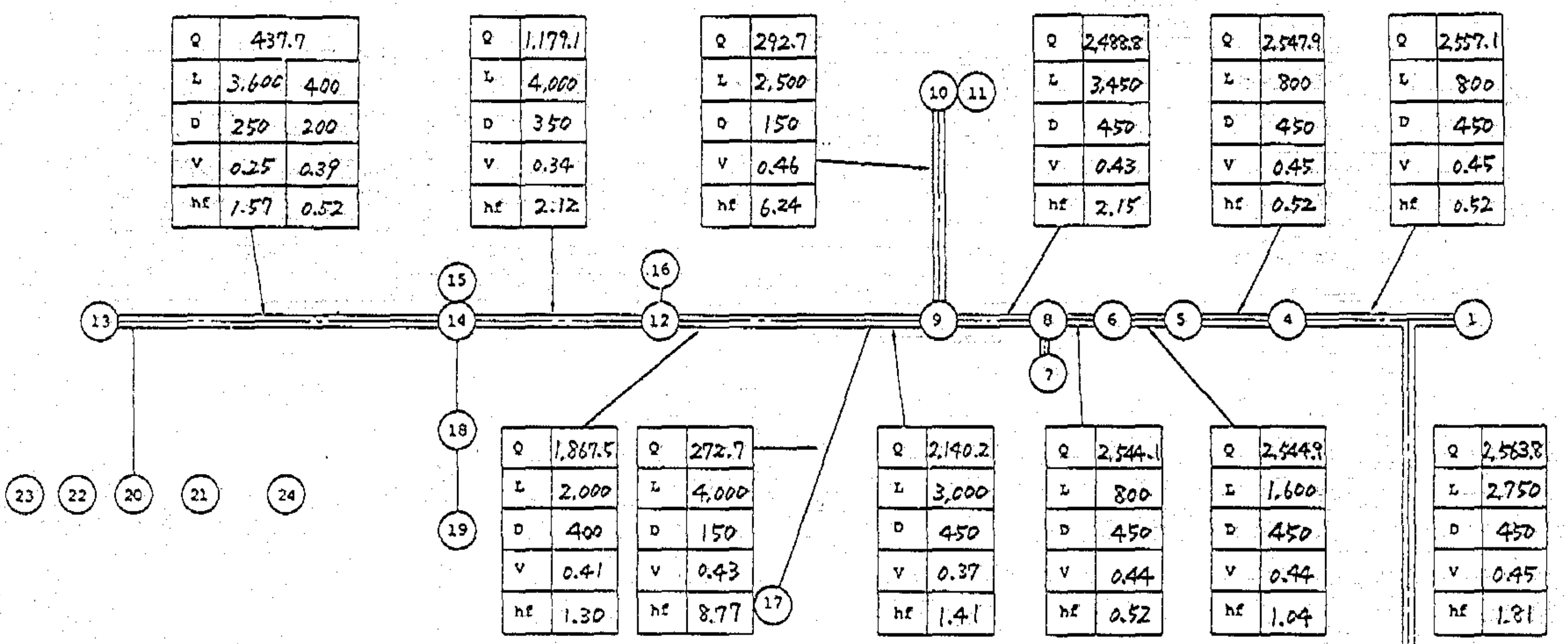
* Hourly Maximum Supply

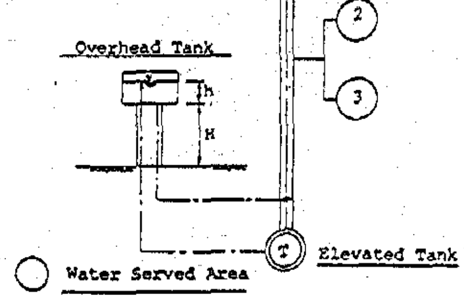
	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.2
	2	Dijena	11.4
	3	Mediina	5.2
	4	Azienda Gaas	8.6
	5	Uyugle	2.8
	6	Musharai	0.8
	7	Bullow Cusbooley	45.7
	8	Dhanada	6.2

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	52.5
	10	Haduuuman	69.0
	11	Gaywarrow	205.8
	12	Qoryoley	619.7
	13	Camp 1	156.2
	14	Camp 2	351.6
	15	Camp 3	292.9

	No.	Area	*
Indirect Water Served Area	16	Jasiina	26.1
	17	Farxaan	256.0
	18	Dharqanley	5.8
	19	Bandar	46.0
	20	Maanyofarax	56.7
	21	Farkeero	3.4
	22	Gorgaol	73.1
	23	Aranay	22.8
	24	Cabdi Cali	98.7

Fig. A14-11(1) Case (2)-3 (Capacity 6%) Sectional Head Loss





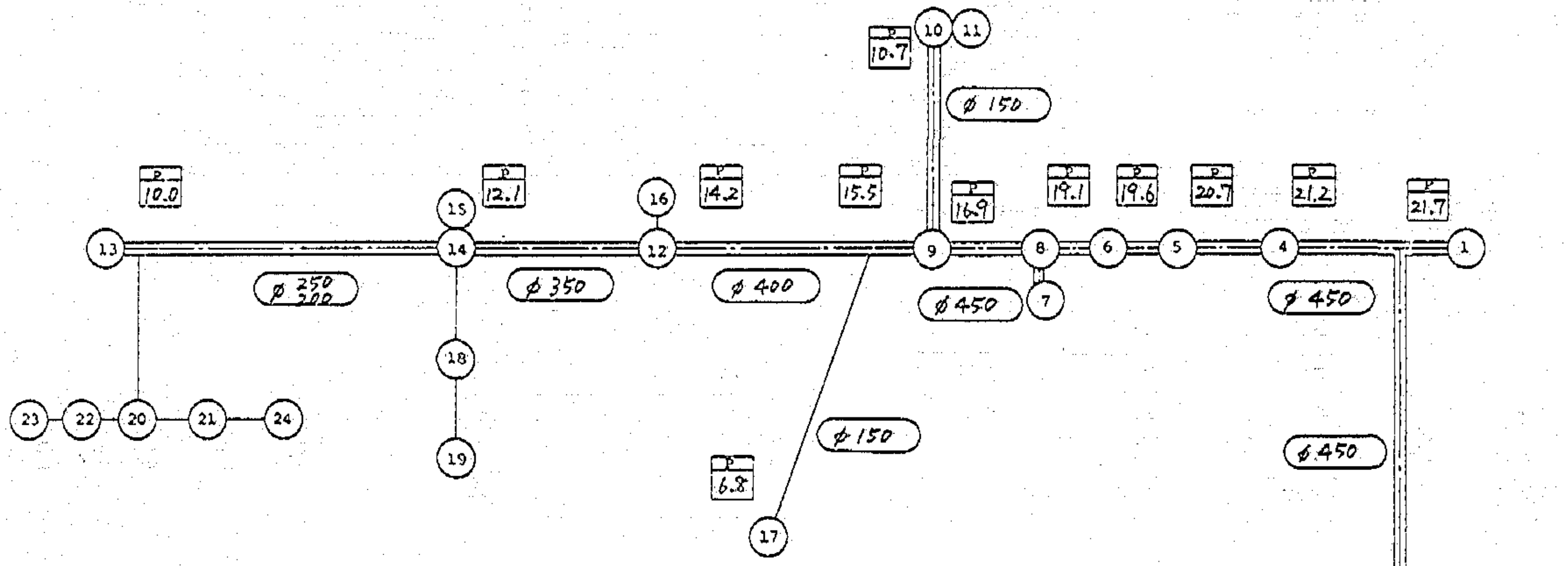
* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	6.7
	2	Dijena	12.2
	3	Mediina	5.6
	4	Azienda Gaas	2.2
	5	Uyugle	3.0
	6	Musharai	0.8
	7	Bullow Cusbooley	48.6
	8	Dhanada	6.6

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	55.8
	10	Haduuuman	73.4
	11	Gaywarrow	219.0
	12	Qoryoley	155.5
	13	Camp 1	166.2
	14	Camp 2	374.0
	15	Camp 3	311.7

	No.	Area	*
Indirect Water Served Area	16	Jasiina	28.3
	17	Farxaan	272.5
	18	Dharqanley	6.2
	19	Bandar	98.9
	20	Maanyofarax	60.3
	21	Farkeero	3.6
	22	Gorgaol	72.8
	23	Aranay	34.2
	24	Cabdi Cali	105.1

Fig. A14-11 (2) Case (2)-3 (Capacity 6%) Dynamic Water Pressure at Each Point



* Hourly Maximum Supply

Direct Water Served Area No.	Area	*
1	Belet Amin	6.7
2	Dijena	12.2
3	Mediina	5.6
4	Azienda Gaas	7.2
5	Oyugle	3.0
6	Musharai	0.8
7	Bullow Cusbooley	48.6
8	Dhanada	6.6

Direct Water Served Area No.	Area	*
9	Bule Sheekh	55.9
10	Haduuuman	73.4
11	Gaywarrow	219.0
12	Qoryoley	157.5
13	Camp 1	166.2
14	Camp 2	174.0
15	Camp 3	311.7

Indirect Water Served Area No.	Area	*
16	Jasiina	28.3
17	Farxaan	272.5
18	Dharqanley	6.2
19	Bandar	48.9
20	Maanyofarax	60.3
21	Farkeero	3.6
22	Gorgaol	77.8
23	Aranay	34.2
24	Cabdi Cali	105.1

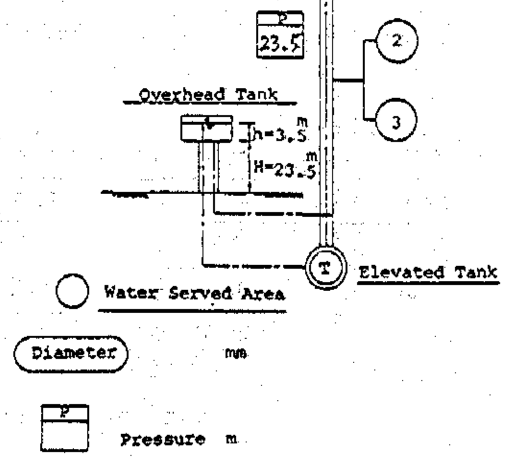
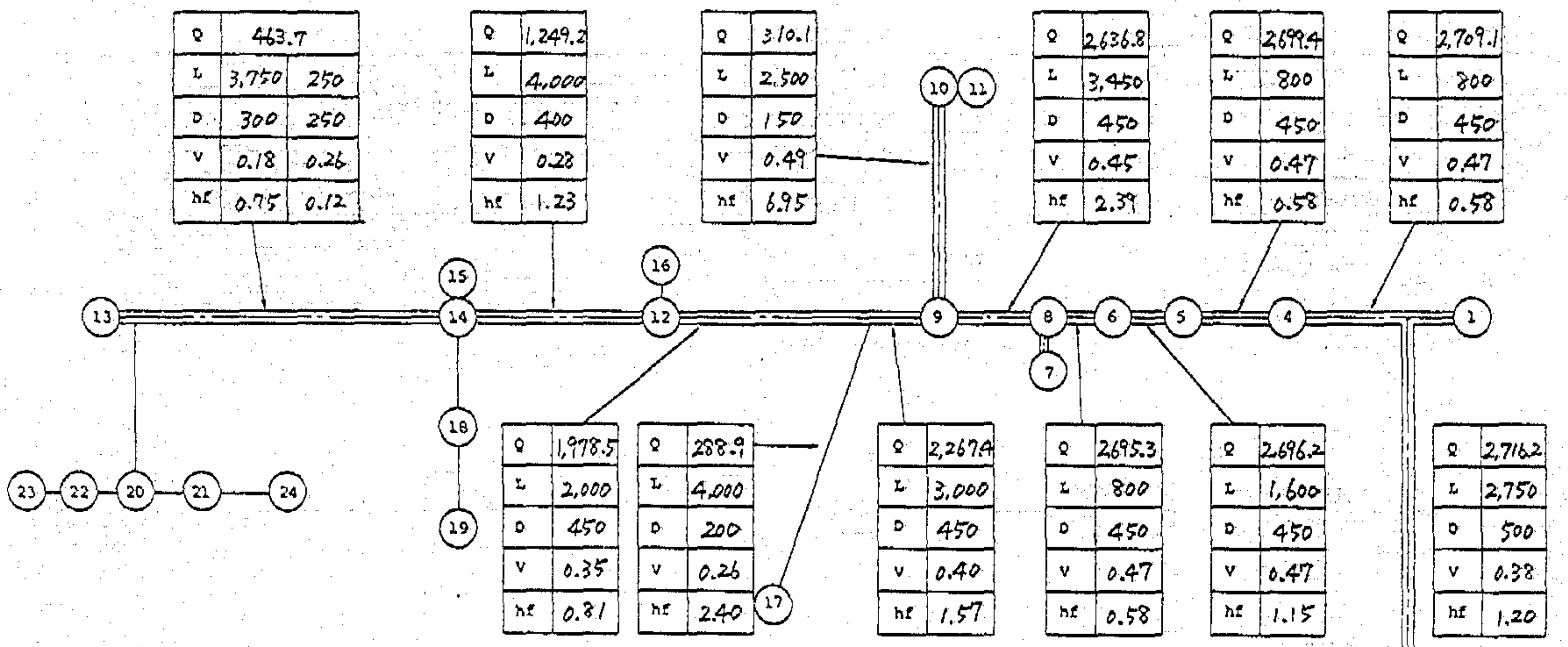
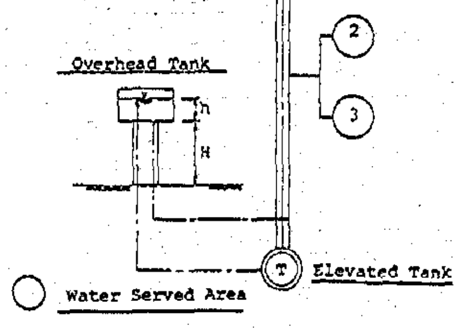


Fig. A14-12(1) Case (2)-3 (Capacity 3%) Sectional Head Loss





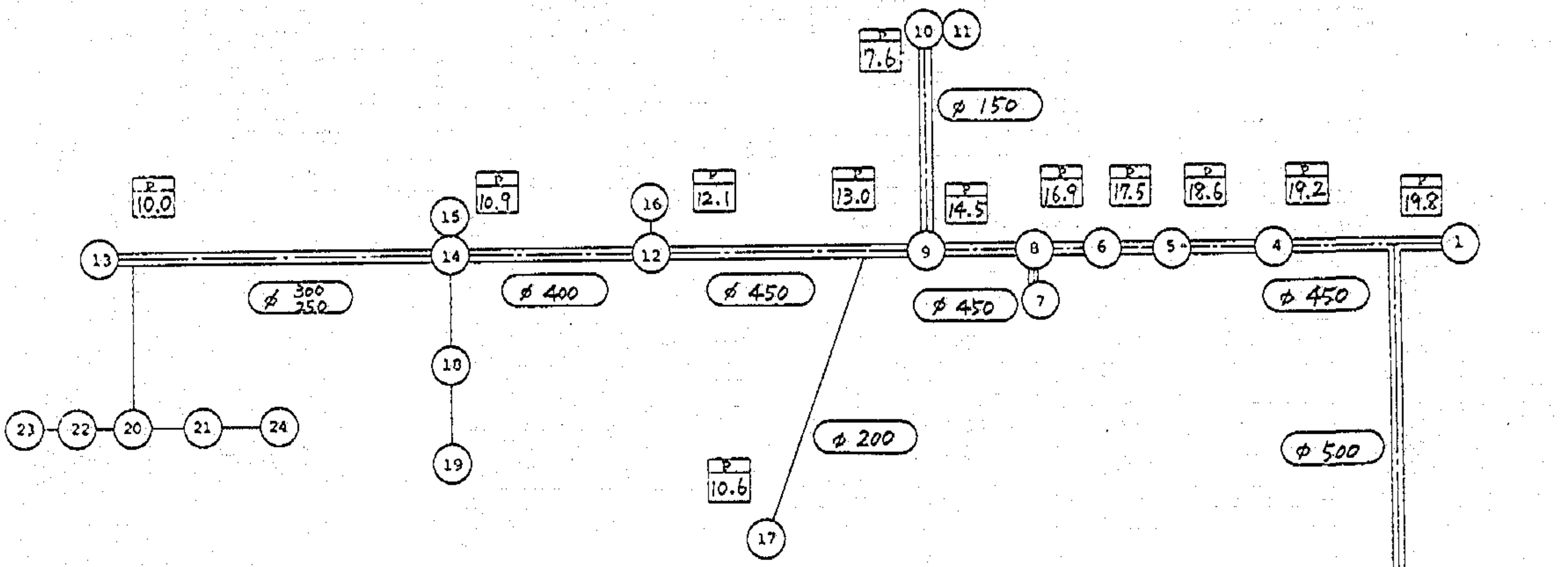
* Hourly Maximum Supply

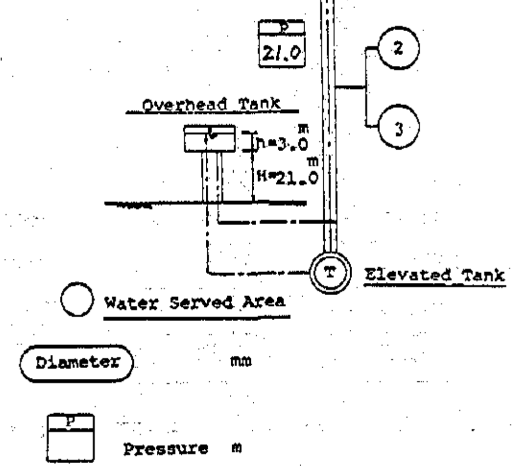
	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.9
	4	Azienda Gaas	3.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	59.3
	10	Haduuuman	77.9
	11	Gaywarrow	232.2
	12	Qoryoley	699.3
	13	Camp 1	176.2
	14	Camp 2	396.6
	15	Camp 3	330.5

	No.	Area	*
Indirect Water Served Area	16	Jasiina	30.0
	17	Farxaan	288.9
	18	Dharqanley	6.5
	19	Bandar	51.9
	20	Maanyofarax	64.0
	21	Farkeero	3.8
	22	Gorgaol	82.5
	23	Aranay	25.7
	24	Cabdi Cali	111.4

Fig. A14-12 (2) Case (2)-3 (Capacity 3%) Dynamic Water Pressure at Each Point





* Hourly Maximum Supply

	No.	Area	*
Direct Water Served Area	1	Belet Amin	7.1
	2	Dijena	12.9
	3	Mediina	5.5
	4	Azienda Gaas	9.7
	5	Uyugle	3.2
	6	Musharai	0.9
	7	Bullow Cusbooley	51.5
	8	Dhanada	7.0

	No.	Area	*
Direct Water Served Area	9	Bule Sheekh	58.3
	10	Haduuuman	77.5
	11	Gaywarrow	232.2
	12	Qoryoley	659.3
	13	Camp 1	176.2
	14	Camp 2	396.6
	15	Camp 3	330.5

	No.	Area	*
Indirect Water Served Area	16	Jasiina	30.0
	17	Farxaan	258.9
	18	Dharqanley	6.5
	19	Bandar	51.9
	20	Maanyofarax	64.0
	21	Packeero	3.8
	22	Gorgaol	82.5
	23	Aranay	25.7
	24	Cabdi Cali	111.4

Table A14-4 Comparison by Annual Cost (Case 1)

Case	Construction Cost (¥1000)								Cost for Mainte-nance and Management (¥1000/year)	Annual Cost (¥1000/ year)
	Pipeline			Overhead Tank		Pump Facilities		Grand Total		
	Pipe Diameter	Length (m)	Cost	Scale	Cost	Scale	Cost			
9%	ø400 (Paved)	4,000	170,560			2.03³/min x55m x3Units	27,000	1,003,538.7	23,439.8	88,872.3
	ø400 (Unpaved)	2,750	98,686.5	H_1=25.0m	183,000	(ø200)				
	ø350 (Paved)	6,450	233,677.05	V_1=240m³				Grand Total		
	ø300 (")	1,250	31,418.75					÷ 15.337		
	ø300 (Unpaved)	4,000	77,116	H_2=18.5				= 65,432.5		
	ø250 (Paved)	750	14,850	V_2=160m³		1.49m³/ x39m x3Units	12,600			
	ø250 (Unpaved)	600	8,241.6		82,000	(ø150 x ø100)				
	ø200 (")	7,400	68,908.8							
	ø150 (")	2,500	15,480							
	Total		718,938.7	Total	265,000	Total	39,600			
6%	ø400 (Paved)	7,450	317,668		86,000	2.15m³/min x53.5m x3Units	27,000	944,865.8	23,639.8	85,246.8
	ø400 (Unpaved)	2,750	98,686.5	H_1=23.5m		(ø200)				
	ø350 (Paved)	3,000	108,687	V_1=160m³				Grand Total		
	ø300 (")	1,520	38,205.2					÷ 15.337		
	ø300 (Unpaved)	4,000	77,116	H_2=18.0m				= 61,607.0		
	ø250 (Paved)	480	9,504	V_2=120m³		1.57m³/min x38.5m x3Units				
	ø250 (Unpaved)	2,130	29,257.68		70,000	(ø150 xø100)				
	ø200 (")	5,870	54,661.44							
	ø150 (")	2,500	15,480							
	Total		749,265.82	Total	156,000	Total	39,600			
3%	ø450 (Paved)	1,600	79,952							
	ø450 (Unpaved)	2,750	118,087.75	H_1=21.0m	67,000	2.61m³/min x51m x3Units	27,000	983,509.7	23,839.8	87,966.4
	ø400 (Paved)	8,850	337,364	V_1=80m³		(ø200)				
	ø300 (")	1,550	38,959.25	H_1=20.5m			12,600	Grand Total		
	ø300 (Unpaved)	4,550	87,719.45	H_2=17.0m	60,000	1.67m³/min x38m x3Units		÷ 15.337		
	ø250 (Paved)	450	8,910	V_2=60m³		(ø150 x ø100)		= 64,126.6		
	ø250 (Unpaved)	3,450	47,389.2							
	ø200 (")	6,500	60,528							
	Total		818,909.65	Total	127,000	Total	39,600			

Table A14-5 Comparison by Annual Cost (Case 2-1)

Case	Construction Cost (¥1000)								Cost for Mainte-nance and Management (¥1000/year)	Annual Cost (¥1000/ year)
	Pipeline			Overhead Tank		Pump Facilities		Grand Total		
	Pipe Diameter	Length (m)	Cost	Scale	Cost	Scale	Cost			
9%	ø400 (Paved)	4,000	170,560	H_1=41.5m	300,000	2.03m³/min x70m x3Units	34,800	1,053,778	21,721.7	90,427.4
	ø400 (Unpaved)	2,750	98,686.5	V_1=240m³						
	ø350 (Paved)	6,450	233,677.05					Grand Total		
	ø300 (")	1,250	31,418.75					÷ 15,337		
	ø300 (Unpaved)	4,000	77,116					= 43,844.4		
	ø250 (Paved)	750	14,850							
	ø250 (Unpaved)	600	8,241.6							
	ø200 (")	7,400	68,908.8							
	ø150 (")	2,500	15,480							
	Total		718,938.7							
6%	ø400 (Paved)	7,450	317,668	H_1=40.0m	196,000	2.15m³/min x68.5m x3Units	34,800	980,061.8	21,921.7	85,823.8
	ø400 (Unpaved)	2,750	98,686.5	V_1=160m³						
	ø350 (Paved)	3,000	108,687					Grand Total		
	ø300 (")	1,520	38,205.2					÷ 15,337		
	ø300 (Unpaved)	4,000	77,116					= 63,902.1		
	ø250 (Paved)	480	9,504							
	ø250 (Unpaved)	2,130	29,257.68							
	ø200 (")	5,870	54,661.44							
	ø150 (")	2,500	15,480							
	Total		749,265.82							
3%	ø450 (Paved)	1,600	79,952	H_1=39.0m	156,000	2.61m³/min x67.5m x3Units	34,800	1,009,709.7	22,121.7	87,956.6
	ø450 (Upnaved)	2,750	118,087.75	V_1=80m³						
	ø400 (Paved)	8,850	377,364					Grand Total		
	ø300 (Paved)	1,550	38,959.25					÷ 15,337		
	ø300 (Unpaved)	4,550	87,719.45					= 65,834.9		
	ø250 (Paved)	450	8,910							
	ø250 (Unpaved)	3,450	47,389.2							
	ø200 (")	6,500	60,528							
	Total		818,909.65							

Table A14-6 Comparison by Annual Cost (Case 2-2)

Case	Construction Cost (¥1000)								Cost for Mainte-nance and Management (¥1000/year)	Annual Cost (¥1000/year)
	Pipeline			Overhead Tank		Pump Facilities		Grand Total		
	Pipe Diameter	Length (m)	Cost	Scale	Cost	Scale	Cost			
9%	ø400 (Unpaved) ø400 (Paved) ø350 (") ø350 (Unpaved) ø300 (") ø250 (") ø150 (") Total	2,750 10,450 2,000 780 3,220 4,000 6,500	98,686.5 445,588 72,458 23,262.72 62,078.38 54,944 40,248 797,265.6	H=30.0m V=240m³	199,000	2.03m³/min x60m x3Units (ø200)	34,800	1,031,065.6 Grand Total ÷ 15,337 = 67,227.3	21,070	88,297.3
6%	ø400 (Unpaved) ø400 (Paved) ø350 (Unpaved) ø300 (") ø250 (") ø150 (") Total	2,750 12,450 2,780 1,220 4,000 6,500	98,686.5 530,868 82,910.72 23,520.38 54,944 40,248 831,177.6	H=30.0m V=160m³	118,000	2.15m³/min x60m x3Units (ø200)	34,800	983,977.6 Grand Total ÷ 15,337 = 48,446.9	21,270	85,427.1
3%	ø450 (Unpaved) ø400 (Paved) ø350 (Unpaved) ø250 (") ø150 (") Total	2,750 12,450 4,000 4,000 6,500	118,087.75 530,868 119,296 54,944 40,248 863,443.75	H=30.0m V=80m³	99,000	2.61m³/min x60m x3Units	34,800	997,243.75 Grand Total ÷ 15,337 = 65,022.1	21,470	86,492.1

Table A14-7 Comparison by Annual Cost (Case 2-3)

Case	Construction Cost (¥1000)								Cost for Mainte-nance and Management (¥1000/year)	Annual Cost (¥1000/year)
	Pipeline			Overhead Tank		Pump Facilities		Grand Total		
	Pipe Diameter	Length (m)	Cost	Scale	Cost	Scale	Cost			
9%	ø450 (Paved)	3,200	159,904	H=25.0m V=240m³	177,000	2.03m³/min x 55m x3Units (ø200)	27,000	1,088,466.6	20,480.2	91,450.2
	ø450 (Unpaved)	2,750	118,087.75							
	ø400 (Paved)	9,250	394,420					Grand Total		
	ø350 (Unpaved)	4,000	119,296					÷ 15,337		
	ø250 (")	3,450	47,389.2					= 70,970.0		
	ø200 (")	550	5,121.6							
	ø150 (")	6,500	40,248							
	Total		884,446.55							
6%	ø450 (Paved)	10,450	522,186.5	H=23.5m V=160m³	86,000	2.15m³/min x53.5m x3Units (ø200)	27,000	1,051,272.7	20,680.2	89,942.3
	ø450 (Unpaved)	2,750	118,087							
	ø400 (Paved)	2,000	85,280					Grand Total		89,225.1
	ø350 (Unpaved)	4,000	119,296					÷ 15,337		
	ø250 (")	3,600	49,449.6					= 68,544.9		
	ø200 (")	400	3,724.8							
	ø150 (")	6,500	40,248							
	Total		1,027,204.00							
3%	ø500 (Unpaved)	2,750	133,075.25	H=21.0m V=80m³	67,000	2.5m³/min x46m x2Units (ø200)	27,000	768,021.1	20,880.2	93,984.7
	ø450 (Paved)	12,450	622,126.5							
	ø400 (Unpaved)	4,000	143,554					Grand Total		
	ø300 (")	3,750	72,296.25					÷ 15,337		
	ø250 (")	250	3,434					= 73,104.5		
	ø200 (")	4,000	37,248							
	ø150 (")	2,500	15,480							
	Total		1,027,204.00							

ANNEX 15

CALCULATION OF N-VALUE

o Relation between unconfined compression strength q_u and N-value

$$q_u = \frac{N}{8} \qquad (1)$$

where: q_u : Kg/cm^2

o Relation between q_c and q_u (Soil exploration method)

$$q_c = 5 \cdot q_u = 10 \cdot C \qquad (2)$$

(cohesion)

where: c : Kg/cm^2

o Relation between q_c and N-value (from expressions (1) and (2))

$$q_c = 5 \cdot \frac{N}{8} \qquad (3)$$

$$\therefore \quad N = \frac{8qc}{5} = 1.6q_c \qquad (4)$$

Estimation of the N-value for design.

Test results indicate that $q_c = 15$ at the water supply tower construction site. Therefore, the N-value is:

$$N = 1.6 \times 15 = 24.0$$

The N-value adopted for the sake of design is 75% of the value estimated from the measurement results.

N-value for design = 24 x 0.75 = 18.0

ANNEX 16

CALCULATION FOR FOUNDATION AND STRUCTURE OF ELEVATED TOWER

1. Calculation for Foundation of Elevated Tower

(1) Selection of the foundation work method

The direct foundation, pile foundation, caisson foundation, soil improvement works, are the possible alternatives of foundation work method. From the standpoint of the scale of the structure and result of soil investigation data, the direct foundation or the pile foundation seems appropriate for this project in view of the workability, economical efficiency and state of things at the construction site. There are three alternatives for the pile foundation, factory pre-fabricated concrete pile, steel pipe pile and cast-in-place concrete pile. Factory pre-fabricated concrete pile and steel pipe pile are not appropriate from the standpoint of construction cost because the former one is not manufactured in Somalia and the later one consists of imports. Foundation consisting of cast-in-place concrete foundation can be constructed by using machinery for well drilling, and is more economical compared with importing pile-driving machine for steel pipe pile and factory pre-fabricated concrete pile.

In view of the aforestated considerations the cast-in-place concrete foundation shall be adopted in the Project.

(2) Estimation of the bearing capacity and the allowable stress of the cast-in-place concrete pile

The design N-value taken into consideration in ANNEX 14 is 18, and the permissible bearing capacity is $q_a = 15.0\ t/m^2$.

Assuming a pile length of L = 8,000, the permissible bearing capacity of the cast-in-place concrete pile in the form of friction pile will assume 8.8T/pile (long term = short term).

(3) Foundation of the elevated tank

1) No boring test was carried out at the foundation ground, but results of tests carried out with cone penetrometer at 5 m depth from the existing ground level indicate that the permissible bearing capacity is relatively high, $q_a = 15.0\ t/m^2$, and therefore it is decided to adopt the direct foundation.

2) Stability of the Elevated Tank

In general the stability is examined in terms of wind load and earthquake load, but in this case the earthquake load is not taken into consideration because there are no earthquakes in Somalia, and the stability is examined only in terms of wind load. The maximum wind speed recorded in the Lower Shabelle district is 3.5 m/sec, and the wind load is relatively small. The stability was examined by taking into consideration thrice that value, 10.5 m/sec., for the sake of safety. The number of piles, the maximum load, etc., of the elevated tank calculated on the said premises are summarized in the following table.

Permissible Bearing Capacity 11.25 T/m^2

	Effective volume 160 m^3 (Nominal volume 200 m^3)
Dead weight (t)	2,327.3 t
Water weight (t)	200
Vertical load (t)	2,527.3
Wind load (horizontal load, t)	2.3
Number of piles (units)	16
Overturning moment (t·m)	50.5
Resisting moment (t·m)	218.4
Safety factor	4.3
Pile reaction (Maximum 1 pile , t/pile)	16.8 (short term)
Contact pressure (full, t/m^2)	13.6
Contact pressure (empty, t/m^2)	12.5

In view of the aforestated considerations, it is concluded that a foundation consisting of 16 piles sized ϕ400 mm and L = 8,000 length will be sufficient to support the elevated tank.

2. Calculation for Structure of Elevated Tower

(1) Outline of the construction

a) Use: Elevated Tank (capacity 200 tons)

b) Maximum height: GL + 34.5 m

c) Water tank unit: Diameter D = 10 m, Height H = 4.5 m

d) Supporting unit: Diameter D = 4.0 m (provided with rib)

e) Main structure: Reinforced concrete structure

f) Construction system: Independent shaft construction

g) Foundation system: Independent foundation + cast-in-place concrete piles

(2) Design policy

a) Water tank unit

The design of the water tank unit will be examined by taking into consideration the bending of the water tank bottom slab and the like due to the water pressure, in conformity with the Shell Theory.

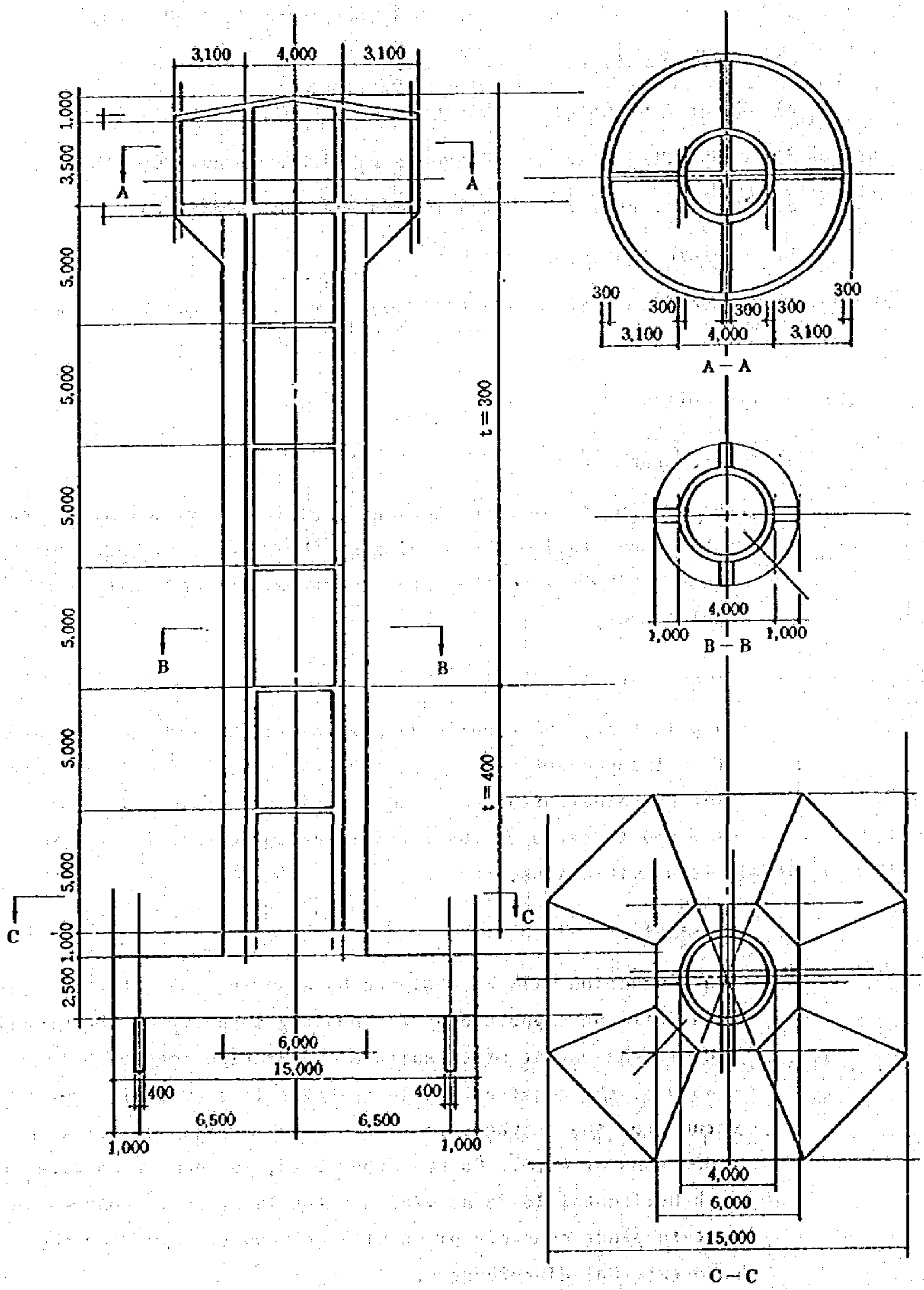
b) Tower unit

In principle, the tower body design will be examined in terms of an independent shaft with 4.0 m diameter and wall thickness t of the order of 30 mm to 40 mm, and the 4 ribs will be examined in terms of their reinforcement effect to cope with twists, vibrations, etc.

c) Foundation

The foundation will be designed by assuming that the vertical loads will be supported by the bearing capacity of the ground, because the extent of subsurface exploration reaches only GL-5.0 m, the construction in question is a typical tower-type structure, and furthermore it has a huge weight mounting to 2,000 tons or more. On the other hand, in connection with such horizontal loads as wind and the like, it is assumed that cast-in-place concrete piles will be used to cope with the said external disturbances.

(3) Outline of the construction



(4) Loads and external forces

a) Fixed load — Total

i) Roof

- Finishing	25	
- Concrete slab (t = 300)	720	845 ⟶ 850 kg/m^2
- Waterproofing	100	

ii) Water tank floor

- Water proofing	100	1,300 kg/m^2
- Concrete slab (t = 500)	1,200	

iii) Tower body intermediate floor

- Concrete slab (t = 300)	720	820 kg/m^2
- Applied load	100	

iv) External shaft wall

- t = 300	720	840 kg/m^2
- Finishing 50	120	
- t = 400	960	1,080 kg/m^2
- Finishing 50	120	

b) Water pressure W_w = 200 ton

Water tank surface area $S_T = 56.5\ m^2$

Pressure at the deepest part $W_p = \frac{W_w}{S_T} = \frac{200}{56.5} = 3.55\ t/m^2$

c) Wind load

The velocity pressure q is calculated by taking into consideration the wind speed data at the project site (V_{max} = 3.5 m/s) and a safety factor of 3 times, which results into V_{design} = 3 x 3.5 m/s = 10.5 m/s.

$q = \frac{1}{2} \cdot \rho \cdot V^2$ (ρ: air density = 0.125)

$= \frac{1}{2} \times 0.125 \times 10.5^2 = 6.9\ kg/m^2 \longrightarrow 7.0\ kg/m^2$

The wind load P_w is calculated with the following formula.

$P_w = q \cdot C \cdot G_f \cdot A$

where:

q: Wind speed pressure (kg/m^2)

C: Wind force coefficient

G_f: Gustonde influence coefficient (2.2)

A: Apparent aprea (m^2)

$P_w = 7.0 \times 1.2 \times 2.2 \times A \doteq 18.5A$ (kg)

(5) Permissible stress intensity of the used materials

a) Concrete

- 4-week compressive strength $F_{28} \geqq 210\ kg/cm^2$
- Long-term permissible compressvie stress intensity
  Lfc = 70 kg/cm^2
- Short-term permissible compressive stress intensity
  Sfc = 140 kg/cm^2
- Long-term permissible shearing stress intensity
  Lfs = 7.0 kg/cm^2
- Short-term permissible shearing stress intensity
  Sfs = 10.5 kg/cm^2
- Long-term permissible adhesion stress intensity
  Uppermost node Lfa = 14.0 kg/cm^2
  Other reinforcement Lfa = 21.0 kg/cm^2
- Short-term permissible adhesion stress intensity
  Uppermost node Sfa = 21.0 kg/cm^2
  Other reinforcement Sfa = 30.5 kg/cm^2

b) Reinforcement: Material (SD 30)

- Long-term permissible tensile stress intensity
  Lft = 2,000 kg/cm^2
- Short-term permissible tensile stress intensity
  Sft = 3,000 kg/cm^2
- Long-term permissible shearing stress intensity
  Lfs = 2,000 kg/cm^2
- Short-term permissible shearing stress intensity
  Sfs = 3,000 kg/cm^2

c) Permissible bearing capacity:

N-value 18 $D_f = 3.5\ m$ $\gamma = 1.7$

$$qa = \frac{1}{3}(\alpha C N_c + \beta \gamma_1 B N r + \gamma_2 D_f \cdot N q)\ (t/m^2)$$
$$= \frac{1}{3}(1.3 \times 11.2 \times 5.3 + 0.3 \times 1.7 \times 0 + 1.7 \times 3.5 \times 3.0)$$
$$= \frac{1}{3}(77.1 + 17.85) = 31.6\ t/m^2$$

Therefore long-term permissible bearing capacity is 15.0 t/m^2.

d) Calculation of the bearing power of the cast-in-plce concrete pile

Diameter of pile: 400ϕ $(W = 0.2^2 \times \pi \times 2.4 \times 8.0 = 2.5\ t)$

Bearing power of ground: Sandy clay of N-value 18

Bearing capacity of pile: $Ra = \frac{1}{3} \times 15 \times N \times Ap - W$

$$= \frac{1}{3} \times 15 \times 18 \times 0.126 - 2.5\ t$$
$$= 11.3 - 2.5 = 8.8\ t/1\ \text{pile}$$

(6) Calculation of the vertical stress

a) Calculation of the tower weight

i) Z_4 to Z_3

Roof:	0.85 x 5.12 x π	= 69.5
Water tank floor:	1.3 x 5.12 x π	= 106.2
Wall:	0.94 x 9.9 x π x 3.5	= 102.3
	0.92 x 3.7 x π x 3.93	= 42.0
	0.92 x (2.8 x 3.7 x 4 + 3.7 x 4.08 x 2)	= 66.0
Water:		= 200.0
		586.0

(ΣN_3 = 586.0 t)

ii) Z_3 to Z_2

Floor:	0.82 x 1.72 x π x 3	= 22.4
Wall:	0.84 x 3.7 x π x 19.5	= 190.4
	1.08 x (1.0 x 19.5 x 4 + 2.12 x 4/2)	= 93.8
		306.6

(ΣN_2 = 892.6 t)

iii) Z_2 to Z_1

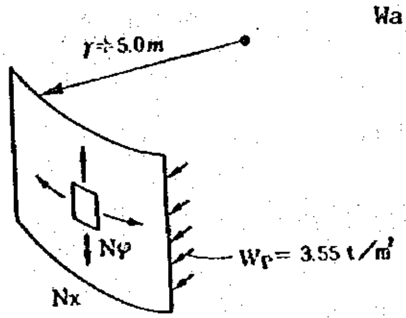
Floor:	$0.82 \times 1.6^2 \times \pi \times 2$	= 13.2
Wall:	$1.08 \times (3.6 \times \pi \times 10 + 1.0 \times 10 \times 4)$	= 165.4
		178.6
		(ΣN_1 = 1,071.2 t)

iv) Z_1 to Z_0

Foundation:	$2.4 \times 3.5 \times 0.828 \times 6.0^2$	= 250.5
	$2.2 \times 3.5 \times 0.828 \times (15.0^2 - 6.20)$	= 1,205.6
		1,456.1
		(ΣN_0 = 2,527.3 t)

b) Stress in the water tank due to water pressure

i) Membrane stress working on the side wall



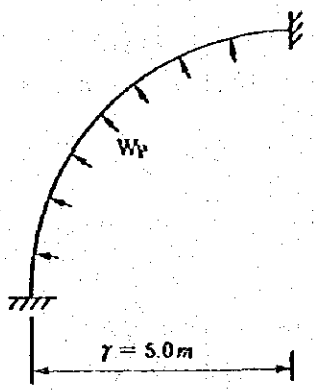
Water pressure

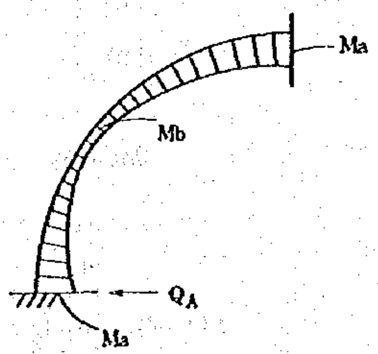
$W_p = 3.55\ t/m^2$

$N_x = \frac{1}{2} W_p \cdot \gamma = \frac{1}{2} \times 3.55 \times 5.0 = 8.9\ t$

$N_\varphi = W_p \cdot \gamma = 3.55 \times 5.0 = 17.8\ t$

ii) Bending stress in the direction of the circumference and shearing stress working on the side wall



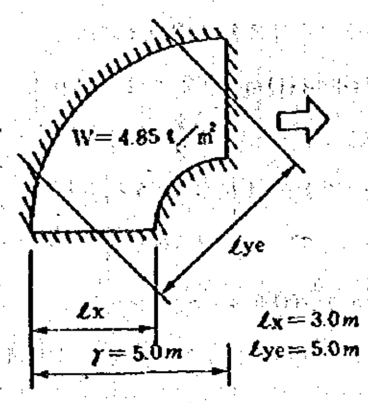


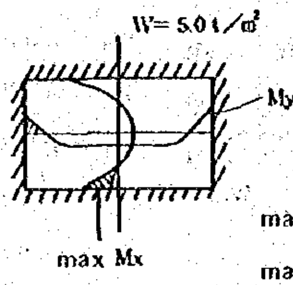
$M_a = 1.1\ t \cdot m$

$M_b = 0.61\ t \cdot m$

$Q_A = Q_{max} = 2.8\ t$

iii) Stress of the water tank floor slab





$W = 1.3+3.55=4.85\ t/m^2$

$We = 5.0\ t/m^2$

$\lambda = \frac{\ell ye}{\ell x} = \frac{5.0}{3.0} = 1.67$

$\max Mx = 0.074\times5.0\times3.0^2= 3.33$

$\max My = 0.042\times5.0\times3.0^2= 1.89$

$Ws\,Q\max = 0.52\times5.0\times3.0 = 7.8\ t/m$

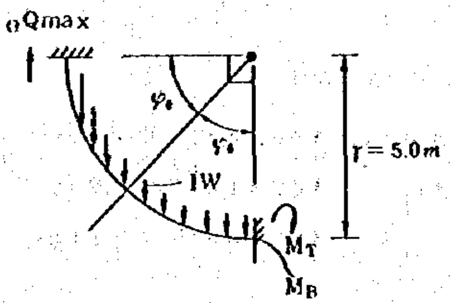
iv) Stress of the roof slab (In conformity with iii))

$\max Mx = 0.074\times0.85\times3.0^2 = 0.57\ t\cdot m/m$

$\max My = 0.042\times0.85\times3.0^2 = 0.33$ 〃

$Rs\,Q\max = 0.52\times0.85\times3.0 = 1.4\ t/m$

v) The stress is calucalated by regarding the external peripheral wall of the water tank as a bending beam



$\Sigma W = Nx+ws\,Q\max+Rs\,Q\max+Wd$

$= 8.9+7.8+1.4+3.6 = 21.7\ t/m$

$B_\lambda D = 30\times4\phi0 \quad Wd = 0.84\times4.3 \fallingdotseq 3.6\ t/m$

$\varphi o = 45°(=\frac{\pi}{4})$

$M_B = X\cos\varphi_0 - \Sigma W\cdot\gamma^2(1-\cos\varphi_0)$

$M_T = X\sin\varphi_0 - \Sigma W\cdot\gamma^2(\varphi_0-\sin\varphi_0)$

$$X = \Sigma W\cdot\gamma^2\times\frac{(4\sin\varphi_0-2\varphi_0)(U+1)+\sin2\varphi_0(U-1)-4U\varphi_0\cos\varphi_0}{2\varphi_0(U+1)-\sin2\varphi_0(U-1)}$$

$$\fallingdotseq 0.071\Sigma W\cdot\gamma^2 - 0.071\times21.7\times5^2=38.52$$

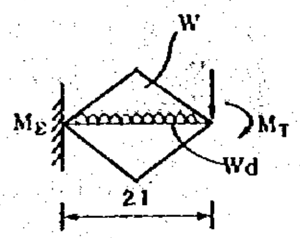
$$U=\frac{22}{1.2}\left\{\left(1+\left(\frac{430}{30}\right)^2\right)\left(3.645-0.06\frac{430}{30}\right)\right\}=105.2$$

Therefore $M_B = 38.52\times0.707-21.7\times5.0^2\times(1-0.707) = -131.8\ t\cdot m$

$M_T = 38.52\times0.707-21.7\times5.0^2\times(0.785-0.707) = 16.2\ t\cdot m$

$GQ\max = \frac{1}{2}\times2W\times\frac{\pi D}{4} = \frac{1}{2}\times21.7\times7.85 = 85.3\ t$

vi) Stress of the rib wall of the water tank



$W_B = 0.3 \times 5.35 \times 2.4 = 3.9\ t/m$

$P = 85.3\ t\ (=GQmax)\ 2 = 170.6\ t$

$M_E = P \times 2.1 + W \times 1.05 + \frac{1}{2} \times Wd \times 2.1^2 + M_T$

$= 170.6 \times 2.1 + (1.05^2 \times 2 \times 5.7) \times 1.05 + \frac{1}{2} \times 3.9 \times 2.1^2 + 16.2$

$= 358.3 + 13.2 + 8.6 + 16.2 = 396.3\ t \cdot m$

$Q_E = P + W + Wd \times 2.1$

$= 170.6 + 12.6 + 3.9 \times 2.1 = 191.4\ t$

(7) Calculation of the horizontal stresses

a) Calculation of the compressed area

i) $Az_{3} \sim {}_{4} = 10.2 \times 0.7/2 = 3.57 m^2$ ⎫
$10.2 \times 4.3 = 43.86 m^2$ ⎭ $47.5 m^2$

ii) $Az_{2} \sim {}_{3} = 6.0 \times 19.5 = 117.0 m^2$ ⎫
$2.1 \times 2.1 \times \frac{1}{2} \times 2 = 4.41 m^2$ ⎭ $121.5 m^2$

iii) $Az_{1} \sim {}_{2} = 6.0 \times 10 = 60.0 m^2$

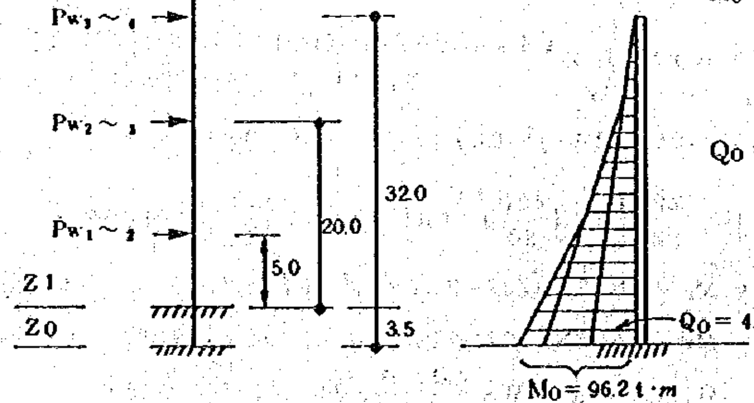
b) Calculation of the wind pressure

i) $P_{w3} \sim {}_{4} = 18.5 \times Az_{3} \sim {}_{4} = 18.5 \times 47.5 \doteqdot 880 kg \rightarrow 0.9\ t$

ii) $P_{w2} \sim {}_{3} = 18.5 \times Az_{2} \sim {}_{3} = 18.5 \times 121.5 \doteqdot 2{,}250 kg \rightarrow 2.3\ t$

iii) $P_{w1} \sim {}_{2} = 18.5 \times Az_{1} \sim {}_{2} = 18.5 \times 60 \doteqdot 1{,}110 kg \rightarrow 1.2\ t$

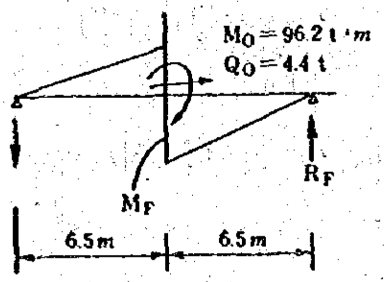
c) Calculation of the stress of the tower due to the wind pressure



$M_0 = 0.9 \times 35.5$
$+ 2.3 \times 23.5$
$+ 1.2 \times 8.5 = 96.2\ t \cdot m$

$Q_0 = 0.9 + 2.3 + 1.2 = 4.4\ t$

d) Calculation of the pile reaction due to the wind pressure



$$M_F = \frac{1}{2} M_O = 96.2 / 2 = 48.1\ t \cdot m$$

$$R_F = \frac{M_F}{6.5} = \frac{48.1\ t \cdot m}{6.5} = 7.4\ t < 8.8\ t$$

e) Caluclation of max due to twist of the water tank external wall

$$J_P = \frac{1}{3} \times 430 \times 35^2 + \frac{1}{3} \times 120 \times 30^2 + \frac{1}{3} \times 120 \times 50^2$$

$$= 1.75 \times 10^5 + 0.36 \times 10^5 + 1.0 \times 10^5$$

$$= 3.11 \times 10^5$$

$$\tau max = \frac{Mt}{J_P} = \frac{16.2 \times 10^5}{3.11 \times 10^5} = 5.2\ kg/cm^2 < 7.0\ kg/cm^2$$

f) Examination of the cross-shaped internal wall of the water tank

i) Examination of the bend reinforcing

$B \times D = 30 \times 570 \quad j = 481.2\ cm$

$M_{design} = 396.3\ t \cdot m$

$Q_{design} = 191.4\ t \qquad \alpha = \dfrac{4}{\dfrac{39{,}630}{191.4 \times 55.0} + 1} = 2.9 \rightarrow 2.0$

$$at = \frac{39630}{2.0 \times 481.2} = 41.2\ cm^2 \qquad 9 - D25\phi$$

$$\tau = \frac{Q}{b \cdot j} = \frac{191.4 \times 10^3}{30 \times 481.2} = 13.3\ kg/cm^2$$

stp D13−200@ $\quad$ PW = 0.0042

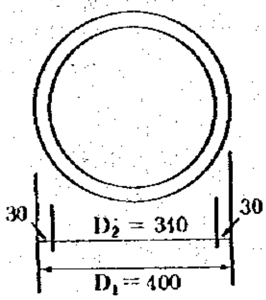
$Q_{design} = 30 \times 481.2 \{ 2.0 \times 7.0 + 1{,}000 (0.0042 - 0.002) \} = 233{,}863.2\ kg > 191.400\ kg$ O.K

g) Design of water tower body

i) Z_2 level $N_L = 892.6\ t$ $M_H^W = 0.9 \times 27 + 2.3 \times 15 = 58.8\ t \cdot m$

$Q_H^W = 0.9 \times 2.3 = 3.2\ t$

Cross Section



$$A = \pi \left\{ \left(\frac{D_1}{2}\right)^2 - \left(\frac{D_2}{2}\right)^2 \right\} = \pi \times (200^2 - 170^2)$$

$$\doteqdot 34{,}870\ cm^2$$

$$Z = \frac{\pi}{32} (D_1^3 - D_2^3) = \frac{\pi}{32} (400^3 - 340^3)$$

$$\doteqdot 2.42 \times 10^6\ cm^3$$

$$L\sigma c = \frac{892.6 \times 10^3}{34.87 \times 10^3} = 25.6\ kg/cm^2 < 70\ kg/cm^2$$

$$H\sigma b = \pm \frac{58.8 \times 10^5}{2.42 \times 10^6} = \pm 2.5\ kg/cm^2$$

Therefore water tower body's stress condition under the wind load is as follows.

$\max \sigma c = 25.6 + 2.5 = 28.1\ kg/cm^2 < 70\ kg/cm^2$

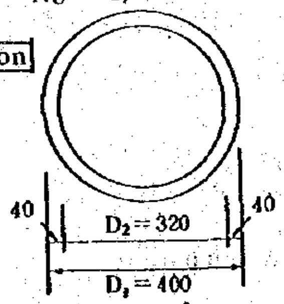
$\min \sigma c = 25.6 - 2.5 = 23.1\ kg/cm^2 < 70\ kg/cm^2$

Accordingly concrete is always in pressed condition and never occur bending moment. That is to say, supporting reinforcing bar is safficient.

ii) $Z\phi$ level $N_O = 1{,}071.2\ t$ $M_H^W = 96.2\ t \cdot m$

$Q_H^W = 4.4\ t \cdot m$

Cross Section



$D_1 = 400\ cm$ $D_2 = 320\ cm$

$A = \pi (200^2 - 160^2) = 4.52 \times 10^4\ cm^2$

$Z = \quad (400^3 - 320^3) = 3.06 \times 10^6\ cm^3$

$$L\sigma c = \frac{1{,}071.2 \times 10^3}{45.2 \times 10^3} = 23.7\ kg/cm^2$$

$$L\sigma b = \pm \frac{96.2 \times 10^5}{3.06 \times 10^6} = \pm 3.2\ kg/cm^2$$

$\max \sigma c = 23.7 + 3.2 = 26.9\ kg/cm^2 < 70.0\ kg/V^2$

$\min \sigma c = 23.7 - 3.2 = 20.5\ kg/cm^2$

Therefore same above Z_2 level supporting reinforcing bar is quite enough.

h) Design of tooting

1) Calculation of contact pressure (full tank)

$N_L = 2{,}527.3\ t \qquad A_f = 186.4\ m$

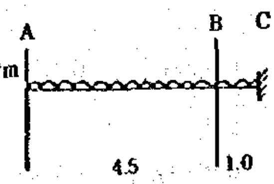
$$\sigma_C = \frac{N_L}{A_f} = \frac{2{,}527.3}{186.4} = 13.6\ t/m^2 < 15.0\ t/m^2$$

2) Calculation of contact pressure (empty)

$N_L = 2{,}327.3 \qquad A_f = 186.4$

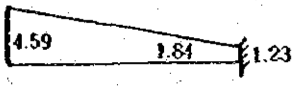
$$\sigma_2 = \frac{N_L}{A_f} = \frac{2{,}327.3}{186.4} = 12.5\ t/m^2 < 15.0\ t/m^2$$

3) Design of pressure slab

Long-term


$W = 1{,}071.2/186.4$

$W_S = 45.9,\ 1.84,\ 1.23$

Wind load


A.

$$MB(L) = \frac{5.75 \times 4.5^2}{2} = 58.2\ t \cdot m \qquad Q = 25.9$$

$$MB(S) = 58.2 + \frac{1.84}{2} \times 4.5^2 + \frac{2.35 \times 4.5 \times 2}{2 \times 1} = 58.2 + 18.6 = 95.4$$

$Q = 25.9 + 14.5 = 40.4$

$M_C\ (L) = 87.0 \qquad Q = 31.6$

$$M_C\ (S) = 87.0 + \frac{1.23}{2} \times 5.5^2 + \frac{3.36 \times 5.5^2 \times 2}{2 \times 3} = 87.0 + 18.6 + 33.9 = 139.5$$

$Q = 31.6 + 16.0 = 47.6$

$Q = 31.6 + 16 = 47.6$

B. $b = 250 \quad d = 240 \quad j = 210$

(L) $a_t = 13.9$

(S) $= 15.15 \qquad$ D22−200C

$\varphi = 6.1$

$\tau = 1.92 < 7.0$

c. $D=350$ $d=340$ $j=297$

$L\ at=14.7$

$S\ at=15.7$ D22−200@

$\varphi = 7.7$

$\tau = 1.6$

(8) Calculation of the cross sections of the members

a) Water tank roof

$D=30\,cm$ $d=25\,cm$ $j=21.8\,cm$

$M_{design}=1.5\times \max M_x=1.5\times 0.57=0.86\ t\cdot m/m$

$Q_{design}=1.5\times R_s Q\max=1.5\times 1.4=2.1\ t/m$

$$at=\frac{M}{ft\cdot j}=\frac{86}{20\times 21.8}=1.98\,cm^2$$ D13−643Q→200@

$$\tau=\frac{Q}{b\cdot j}=\frac{2.1\times 10^3}{1\ \ \times 21.8}=0.97\,kg/cm^2<7.0\,kg/cm^2$$ O.K

b) Water tank floor

$D=50\,cm$ $d=45\,cm$ $j=39.3\,cm$

$M_{design}=1.5\times \max M_x=1.5\times 3.33\doteqdot 5.0\ t\cdot m/m$

$Q_{design}=1.5\times Ws\ Q\max=1.5\times 7.8=11.7\ t/m$

$$at=\frac{M}{ft\cdot j}=\frac{500}{20\times 39.3}=6.4\,cm^2$$ D15−199@

$$\tau=\frac{Q}{b\cdot j}=\frac{11.7\times 10^3}{100\times 39.3}=3.0\,kg/cm^2<7.0\,kg/cm^2$$ O.K

c) Water tank wall

$D=30\,cm$ $d=27\,cm$ $j=23.6\,cm$

i) Vertical $M_{design}=3.33\ t\cdot m$

$Q_{design}=7.8\ t$

$$at=\frac{M}{ft\cdot j}=\frac{333}{20\times 23.6}=7.1\,cm^2$$ D13−180@

$$\tau=\frac{Q}{b\cdot j}=\frac{7.8\times 10^3}{100\times 23.6}=3.3\,kg/cm^2<7.0$$ O.K

ii) Longitudinal

$$\text{Outside}\quad at = \frac{N\varphi}{2.0} = \frac{17.8}{2.0} = 8.9cm^2 \qquad D13-142@$$

$$\text{Inside}\quad at = \frac{Ma}{2.0\times 23.6} = \frac{110}{47.2} = 2.4cm^2 \qquad D13-544@$$

d) Calculation of the bend reinforcing bar of the water tank external wall

$$B\times B = 35\times 430 \qquad j = 350$$

$$M_{design}B = 131.8\ t\cdot m \quad Q_{design} = 85.3\ t$$

$$at = \frac{M}{ft\cdot j} = \frac{13{,}180}{2.0\times 350} = 18.9cm^2 \qquad S-D22\phi$$

$$\tau = \frac{Q}{b\cdot j} = \frac{85{,}300}{35\times 350} = 6.97kg/cm^2 < 7.0kg/cm^2$$

ANNEX 17

BREAKDOWN OF COSTS TO BE BORNE BY THE GOVERNMENT OF SOMALIA

Breakdown of the Project Cost Portion to Be Borne by the Government of Somalia

1. Cost to Lay Gravel on the Rural Roads to Be Used as Pipeline Route

Access roads	Removal and Construct anew	1 set	2,626,733 So.Sh. (¥1,776,600)
Peripheral roads of wells and water supply towers	"	"	2,000,050 So.Sh. (¥5,670,000)
			4,626,783 So.Sh. (¥7,446,600)

2. Cost to be Borne Regarding Custom Charges and the Like Imposed on Materials and Equipment Imported from Japan

(Unit: Yen)

	Name	Purchase Price	CIF	Tax Rate	Total
(1)	Cement	8,050,000	37,720,000	60%	22,632,000
(2)	Reinforcing Bars	11,220,000	20,700,900	35%	7,245,315
(3)	Form Materials	15,045,000	30,957,000	50%	15,478,500
(4)	Vehicles	15,465,935	19,962,773	52 - 120	16,862,935
(5)	Articles for Field Management	1,478,080	1,775,000	10	177,500
(6)	Scaffolding and Timbering Materials	12,045,100	45,474,148	30	13,642,244
(7)	Materials for General Purpose Temporary Facilities	2,871,750	2,996,550	10	299,655
	Electric Equipment for Temporary Facilities	4,201,960	4,888,360	35 - 86	3,320,736
	Materials for temporary Facilities	4,574,250	10,096,650	50	5,048,325

	Name	Purchase Price	CIF	Tax Rate	Total
(8)	Pump House Machinery	36,000,000	38,815,440	35	13,585,404
(9)	Well Digging	798,150	1,354,650	30	406,395
(10)	Machinery for Working Reinforcing Bars	3,754,000	4,066,000	62	2,520,920
(11)	Other Miscellaneous Materials	1,254,570	3,407,370	30	1,022,211
(12)	Pipes	346,524,370	606,415,570	60	363,849,342
	TOTAL				(466,091,482)
					164,410,329 So.Sh.

3. Cost of Maintenance and Administrative Equipment

(Unit: Yen)

(1)	Vehicles		
	Bulldozer	1 unit	1,950,000
	Pick-up	1 unit	1,250,000
(2)	Transportation Cost (Ocean and Inland Transportation)	1 set	1,378,600
(3)	Import Tax (83%)	1 set	3,796,918
			(8,375,518)
			2,954,402 So.Sh.
	Total of aforementioned cost items		171,991,514 So.Sh.

ANNEX 18

BREAKDOWN OF COST FOR OPERATION AND MAINTENANCE

Operation and Maintenance Cost

Breakdown

(1) Personnel expenditure

Superintendent	1 x 20,000 =	20,000 Shilling
Section Chief	2 x 15,000 =	30,000 "
Pump Operator	4 x 12,000 =	48,000 "
Maintenance Personnel	3 x 12,000 =	36,000 "
P.R. Supervisor	2 x 9,000 =	18,000 "
Driver	2 x 7,500 =	15,000 "
Water Supply Center Caretaker	36 x 9,000 =	324,000 "
Total		491,000 Shilling/month
		5,892,000 Shilling/year
		(16,674,360 Yen/year)

(2) Opeeration and maintenance annual cost

1) Pump fuel

- Production well pump

$$160 \text{ g/ps/hr} \times 60 \text{ ps} \times \frac{1}{830} = 11.6 \text{ liter/hr}$$

11.6 liter/hr x 17.95 hr/day = 208.2 liter/day
208.2 liter/day x 14.84 Shilling/liter x 365 days
= 1,127,736 Shilling/year (3,191,493 Yen/year)

2) Oil

- Production well pump
52.9 Shilling/hr x 17.95 hr/day x 365 days
= 346,587 Shilling/year (980,841 Yen/year)

3) Chemicals = 29,400 Yens/year
(10,389 Shilling/year)

4) Vehicle operation and maintenance cost

(a) Vehicle fuel cost

- Gasoline for round trip to construction site

$$5 \text{ times/day} \times 30 \text{ km} \frac{1}{5 \text{ km/liter}} \times 14.84 \times 365 \text{ days}$$

= 162,498 Shilling/year (459,869 Yen/year)

- Gasoline for patrolling work site

$$4 \text{ times/day} \times 60 \text{ km} \frac{1}{5 \text{ km/liter}} \times 14.84 \times 365 \text{ days}$$

= 259,997 Shilling/year (735,791 Yen/year)

- Change of lubricating oil of vehicles

= 84,499 Shilling/year (29,828 Yen/year)

(b) Spare parts

= 640,000 Yen/year (226,148 Shilling/year)

(c) Vehicle depreciation cost (2 units, 5-year life)

$$\frac{2,985,000 - 298,500}{5} = 537,300 \text{ Shilling/year}$$

(1,520,559 Yens/year)

5) Expendables of pumps and the like

30,580,000 Yens x 5% = 1,529,000 Yens

(540,283 Shilling/year)

TOTAL 9,187,437 Shilling/year

(26,000,447 Yen/year)

ANNEX 19

PLAN FOR PROCUREMENT OF MATERIALS AND EQUIPMENT

Table A19-1 Plan for Procurement of Materials and Equipment

	Study on the price and various conditions	
	Purchased from Japan	Purchased on site or lease
Iron bars	° Materials + packing + transportation 60,000 + 3,300 + 66.000 = 129,300 yen/T ° Standard of quality is unified. ° Few variations in prices.	° Purchased on site: 183,600 yen/T ° Due to importing from each of European countries, a standard, price and quality are not uniform and have a variation. ° Required amount of materials may not be attained.
Result of study	O	Δ
Cement	° Materials + packing + transportation 14,000 + 4,200 + 66,000 = 84,200 yen/T ° Standard of quality is unified. ° Few variations in price.	° Purchased on site: 63,600 yen/T ° Similar as the iron bars, the Product has less reliability and its variation in price is also high.
Result of study	O	Δ
Plywood & Wooden material	° Materials + packing + transportation 59,200 + 15,000 + 66,000 = 140,200 yen/T ° Product of required amount and quality can be obtained with a low price.	° Purchased on site: 250,000 yen/m^3 ° Due to imported products, their price is high, a lack of products occurs and obtaining of products is difficult.
Result of study	O	Δ
Ram	° 8,235,000 yen/unit ° Easy maintenance is assured. ° Standards can be unified and quality of the product can be assured.	° 9,350,000 yen/unit. ° Purchasing of spare parts is difficult. ° Due to a lack of spare parts, sufficient maintenance is not assured.
Result of study	O	Δ

(Cont.)

	Purchsed from Japan	Purchased on site or lease
Water plug	° Universal water plug 20 mm ¥2,660 ° Standards can be unified.	° Universal water plug 20 mm ¥6,000 ° Price is high and its purchasing is difficult. Some variation in standards.
Result of study	O	Δ
Valves	° Partition valve ¥112,000/pc. ° Standards can be unified.	° Partition valve ¥250,000/pc. ° Price is high and purchasing is difficult. Some variation in standards.
Result of study	O	Δ
Construction machines	° Unit price of excavation in case that the excavators are imported from Japan and then the machines are sent back to Japan: 668 yen/m^3 ° It is expensive. See the attached data.	° Unit price of excavation: 326 yen/m^3 (lease) ° Entire management is performed by a leasing company and plentiful types of machines are available.
Result of study	O	Δ