

社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER RESOURCES

No. 11

THE STUDY
ON
ELEVEN CENTERS WATER SUPPLY AND SANITATION
IN
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

APPENDIXES
DUPTI

(Volume III-I)

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FEBRUARY, 1996

SANYU CONSULTANTS INC.
KYOWA ENGINEERING CONSULTANTS CO., LTD.

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**GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES**

**THE STUDY
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**APPENDIXES
DUPTI**

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PREFACE

This is the Appendixes for Duptl presenting the results of the Study on Eleven Centers Water Supply and Sanitation (the Study) carried out in accordance with the Scope of Work agreed upon between the Government of Federal Democratic Republic of Ethiopia (GOE) through the Water Supply and Sewerage Agency (WSSA) of the Ministry of Natural Resources Development and Environmental Protection (MNRDEP), which was recently reorganized Water Supply and Sewerage Service Department (WSSD) under Ministry of Water Resources (MWR), on the one part and the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) on the other part dated April 8, 1994.

The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate a plan for sanitary education and the diffusion of sanitary facilities in order to raise peoples' awareness on hygiene and improve environmental sanitation, which will be able to prevent the contamination of water source(s) and to secure safe water supply, and 3) to transfer technologies to the Ethiopian counterpart personnel in order to strengthen the managerial aspects of water supply services.

The Study had been conducted over a two (2) Japanese fiscal year-period from 1994/95 to 1995/96 and divided into two (2) phases. The Phase I study was conducted between December 1994 and March 1995, and Phase II was conducted between May 1995 and February 1996, for a total study period of 15 months during which three (3) times of visit to Ethiopia were made.

The survey items and major activities are meteo-hydrological survey, geo-electric prospecting (GEP) survey, water quality, water use condition, sanitary and health condition and people's awareness, social background, socio-economy, initial environmental examination (IEE), environmental impact assessment (EIA), sanitary education practice, and existing pump investigation.

The Study Team extends heartiest thanks to WSSD especially those assigned counterparts for their close cooperation and hard work in both office and the field, and the officers of related agencies of Japan.

Table of Contents

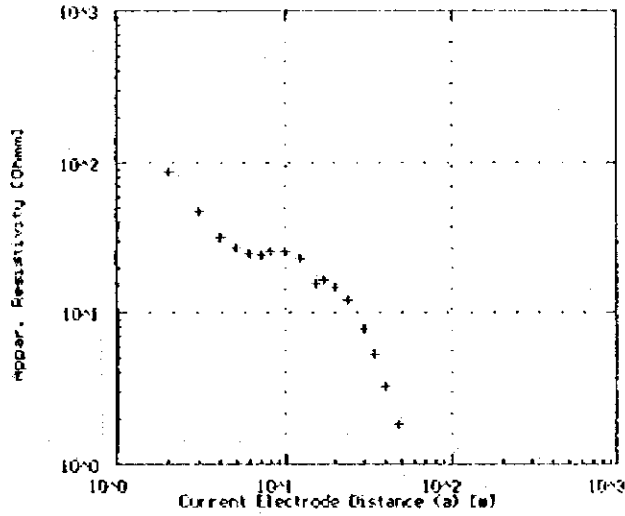
Appendix-1	Resistivity Interpretation of VEP	1-1
Appendix-2	Result of Water Quality Test	2-1
Appendix-3	Social and Gender Data	3-1
Appendix-4	Summary of Group Meeting	4-1
Appendix-5	Financial and Socio-Economic Data	5-1
Appendix-6	Result of Initial Environmental Examination	6-1
Appendix-7	Project Cost Break-Down (Water Supply)	7-1
Appendix-8	Meteorological Data	8-1
Appendix-9	Existing Pump Condition	9-1
Appendix-10	Calculation of Water Pipeline	10-1
Appendix-11	Geological Logs of Existing Boreholes	11-1

Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

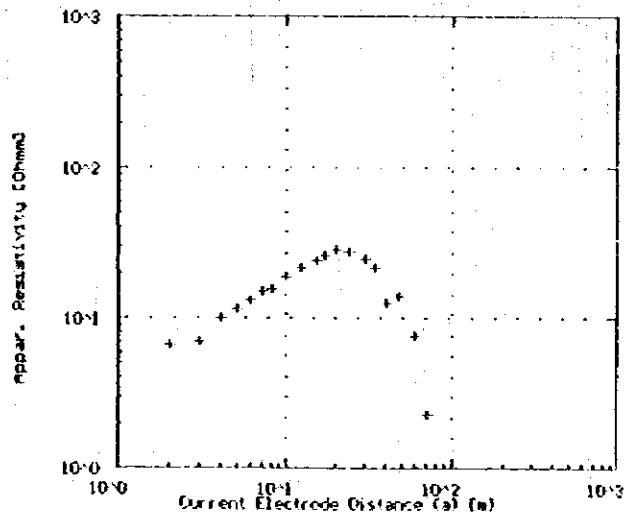
VES St. No.1 -DUPTI



PcLat (No)	AN/2 (Kv)	a (m)	Res (Ohm)
1	1.00	100.000	
2	2.00	07.950	
3	3.00	07.100	
4	4.00	31.050	
5	5.00	26.050	
6	6.00	26.190	
7	7.00	24.170	
8	8.00	25.020	
9	10.00	25.120	
10	12.00	27.010	
11	15.00	15.379	
12	17.00	15.360	
13	20.00	11.570	
14	24.00	02.210	
15	30.00	7.770	
16	35.00	5.240	
17	40.00	3.220	
18	44.00	1.010	
19	60.00	0.750	

Specific Resistivity(Ω-m)	107	71.33	17.2	33.3	6.08	1.29
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VES St. No.2 -DUPTI

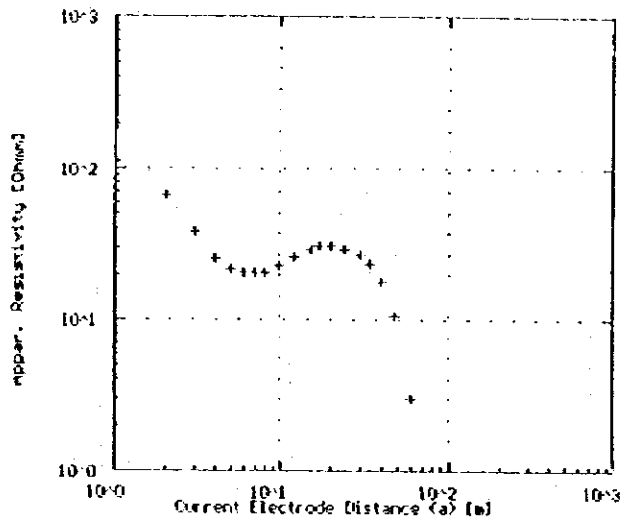


PcLat (No)	AN/2 (Kv)	a (m)	Res (Ohm)
1	1.00	5.780	
2	2.00	6.460	
3	3.00	6.970	
4	4.00	60.050	
5	5.00	11.020	
6	6.00	13.100	
7	7.00	14.950	
8	8.00	15.590	
9	10.00	19.050	
10	12.00	21.480	
11	15.00	24.120	
12	17.00	26.170	
13	20.00	28.070	
14	24.00	27.000	
15	30.00	24.000	
16	35.00	21.350	
17	40.00	12.500	
18	46.00	13.020	
19	60.00	7.550	
20	72.00	2.200	
21	84.00	0.500	

Specific Resistivity(Ω-m)	5.10	7.7	47.6	6.5	0.24
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36.6

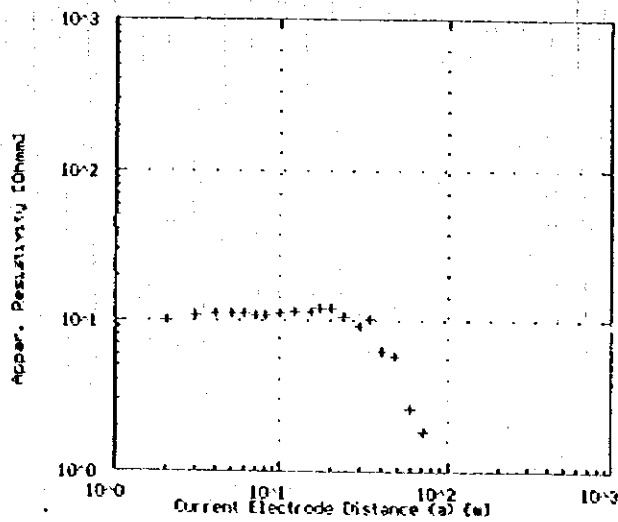
VES St. No.3 -DUPTI



Point No.	MX/2 [m]	a [m]	R _{as} [ohm-m]
1	1.00	110.530	
2	2.00	66.520	
3	3.00	34.680	
4	4.00	25.820	
5	5.00	21.620	
6	6.00	20.350	
7	7.00	20.220	
8	8.00	20.690	
9	10.00	22.610	
10	12.00	26.380	
11	15.00	30.290	
12	17.00	30.130	
13	20.00	30.900	
14	25.00	29.390	
15	30.00	26.750	
16	35.00	23.220	
17	40.00	17.580	
18	45.00	10.550	
19	60.00	3.010	
20	72.00	0.459	

Specific Resistivity (Ω·m)	160	40	11.5	27	53.75	20.2	3.57
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VES St. No.4 -DUPTI

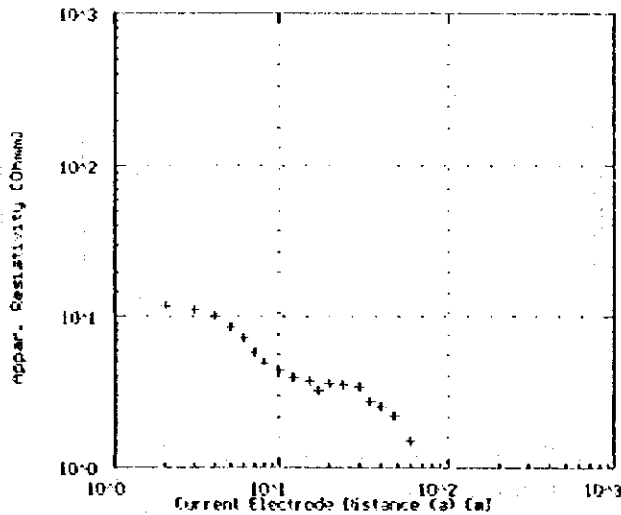


Point No.	MX/2 [m]	a [m]	R _{as} [ohm-m]
1	1.00	9.110	
2	2.00	10.950	
3	3.00	10.070	
4	4.00	11.300	
5	5.00	11.300	
6	6.00	11.300	
7	7.00	10.010	
8	8.00	10.850	
9	10.00	11.320	
10	12.00	11.300	
11	15.00	11.300	
12	17.00	12.240	
13	20.00	12.100	
14	25.00	10.550	
15	30.00	8.190	
16	35.00	10.250	
17	40.00	8.210	
18	45.00	5.330	
19	60.00	2.840	
20	72.00	1.810	
21	80.00	0.510	

Specific Resistivity (Ω·m)	7.2	10.8	4	0.22
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16.05

VES St. No.5 -DUPTI

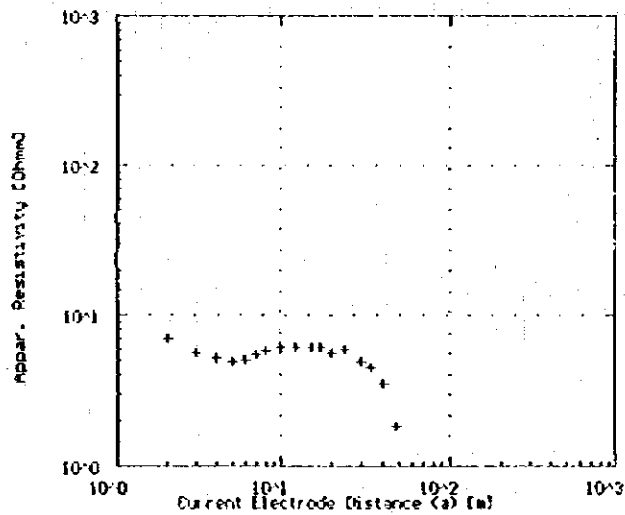


Point [No]	NS/2 [m]	a [m]	Res [ohm-m]
1	1.00	16.200	
2	2.00	11.970	
3	3.00	11.300	
4	4.00	10.050	
5	5.00	8.450	
6	6.00	7.230	
7	7.00	5.900	
8	8.00	4.970	
9	10.00	4.100	
10	12.00	3.920	
11	15.00	3.720	
12	17.00	3.240	
13	20.00	3.040	
14	24.00	3.000	
15	30.00	3.350	
16	36.00	2.700	
17	40.00	2.510	
18	49.00	2.210	
19	60.00	1.510	

Specific Resistivity ($\Omega \cdot m$)	10.85	2.95	3.7	1.85	0.98
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21.7

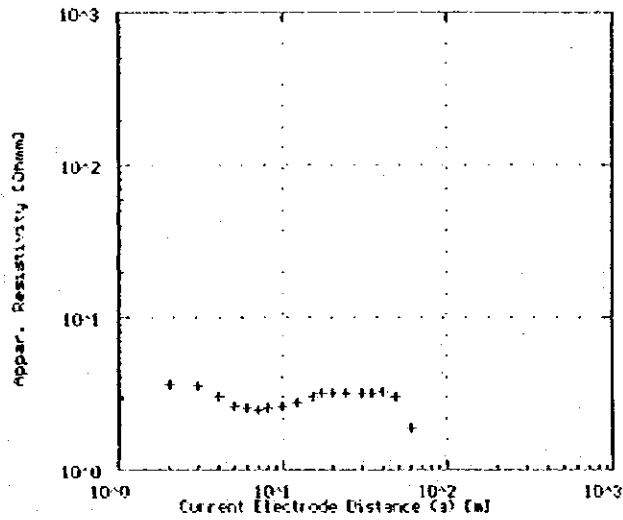
VES St. No.6 -DUPTI



Point [No]	NS/2 [m]	a [m]	Res [ohm-m]
1	1.00	14.700	
2	2.00	6.910	
3	3.00	5.650	
4	4.00	5.150	
5	5.00	4.970	
6	6.00	5.030	
7	7.00	5.590	
8	8.00	5.830	
9	10.00	6.150	
10	12.00	6.100	
11	15.00	6.120	
12	17.00	6.090	
13	20.00	5.650	
14	24.00	5.830	
15	30.00	4.900	
16	36.00	4.490	
17	40.00	3.520	
18	49.00	3.010	
19	60.00	0.700	

Specific Resistivity ($\Omega \cdot m$)	24	4.8	7.8	5.8	2.9	0.55
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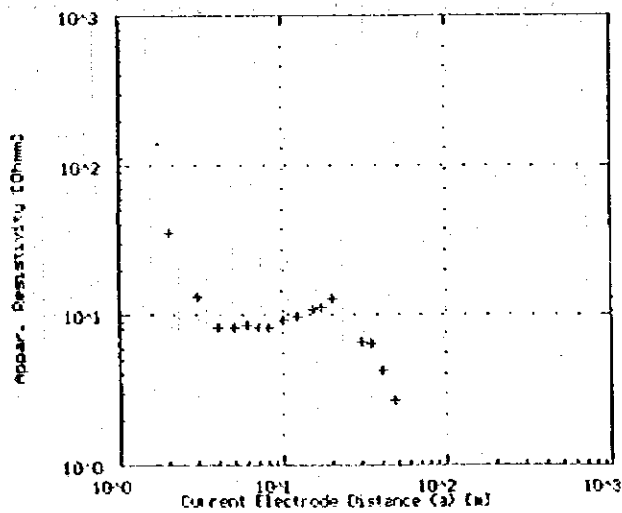
VES St. No.7 -DUPTI



Point (No)	HW/2 (M)	a (m)	R _{oc} (ohm-m)
1	1.00	2.890	
2	2.00	3.670	
3	3.00	3.490	
4	4.00	2.950	
5	5.00	2.860	
6	6.00	2.530	
7	7.00	2.660	
8	8.00	2.560	
9	10.00	2.520	
10	12.00	2.790	
11	15.00	3.810	
12	17.00	2.200	
13	20.00	3.140	
14	24.00	3.120	
15	30.00	3.290	
16	34.00	2.260	
17	40.00	3.220	
18	48.00	3.010	
19	60.00	1.480	
20	72.00	0.150	

Specific Resistivity (Ω-m)	2.5	6.25	1.65	3.5	1.16
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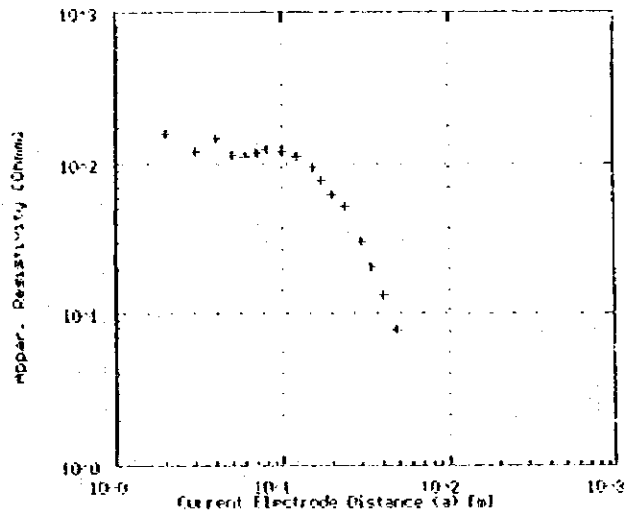
VES St. No.8 -DUPTI



Point (No)	HW/2 (M)	a (m)	R _{oc} (ohm-m)
1	1.00	13.810	
2	2.00	15.845	
3	3.00	12.530	
4	4.00	8.280	
5	5.00	8.320	
6	6.00	8.430	
7	7.00	8.350	
8	8.00	8.240	
9	10.00	9.110	
10	12.00	8.620	
11	15.00	10.830	
12	17.00	11.240	
13	20.00	12.840	
14	24.00	6.590	
15	34.00	6.410	
16	48.00	5.220	
17	60.00	2.310	
18	80.00	0.750	

Specific Resistivity (Ω-m)	90	6	8.2	16.4	1.44
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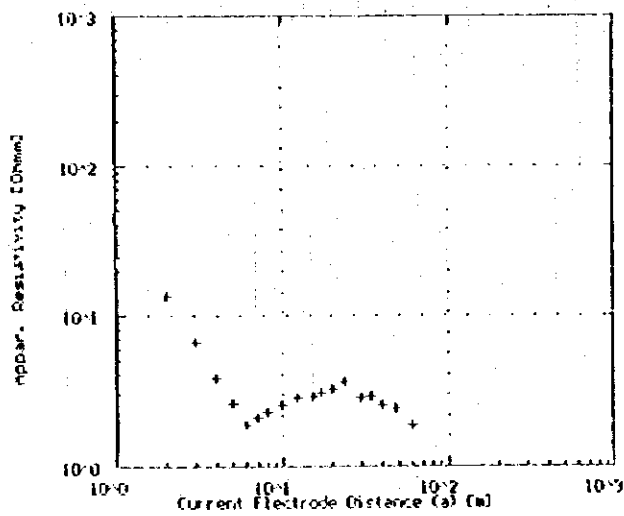
VES St. No.9 -DUPTI



Point [No]	WN/2 [Nr]	a [m]	R _{app} [ohm]
1	1.00	173.960	
2	2.00	157.720	
3	3.00	122.460	
4	4.00	115.700	
5	5.00	116.100	
6	6.00	113.010	
7	7.00	110.670	
8	8.00	123.090	
9	10.00	122.480	
10	12.00	111.530	
11	15.00	95.160	
12	17.00	78.000	
13	20.00	62.800	
14	25.00	52.250	
15	30.00	30.167	
16	36.00	20.270	
17	40.00	13.710	
18	49.00	7.810	
19	60.00	0.380	

Specific Resistivity(Ω-m)	21.8	10.9	17.25	4.88	0.39
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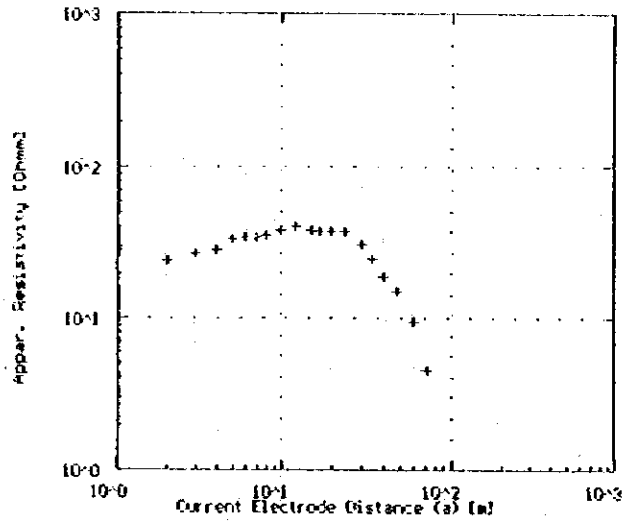
VES St. No.10 -DUPTI



Point [No]	WN/2 [Nr]	a [m]	R _{app} [ohm]
1	1.00	24.490	
2	2.00	17.630	
3	3.00	8.560	
4	4.00	7.020	
5	5.00	2.660	
6	6.00	1.600	
7	7.00	2.410	
8	8.00	2.260	
9	10.00	2.510	
10	12.00	2.060	
11	15.00	2.920	
12	17.00	3.100	
13	20.00	3.220	
14	24.00	3.020	
15	30.00	2.030	
16	36.00	2.960	
17	40.00	2.510	
18	49.00	2.410	
19	59.00	1.530	
20	72.00	0.450	

Specific Resistivity(Ω-m)	49	9.8	0.85	4.5	1.6
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VES St. No.11 -DUPTI

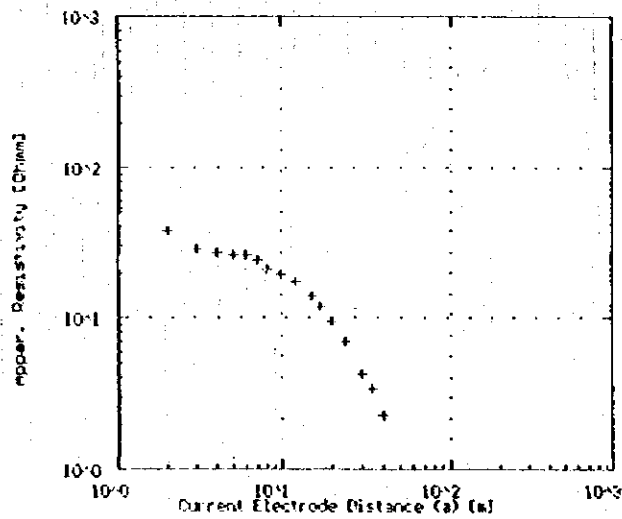


Point [No]	EN/2 [Nr]	a [m]	Res [ohm-m]
1	1.00	20.260	
2	2.00	23.880	
3	3.00	27.110	
4	4.00	28.840	
5	5.00	32.970	
6	6.00	34.870	
7	7.00	36.730	
8	8.00	35.870	
9	10.00	38.310	
10	12.00	40.880	
11	15.00	38.420	
12	17.00	37.370	
13	20.00	37.880	
14	24.00	37.880	
15	30.00	34.859	
16	36.00	24.560	
17	48.00	18.550	
18	60.00	15.970	
19	80.00	9.420	
20	120.00	4.510	
21	144.00	0.530	

Specific Resistivity (Ω-m)	31	20.67	46	37	1.97
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7.4

VES St. No.12 -DUPTI

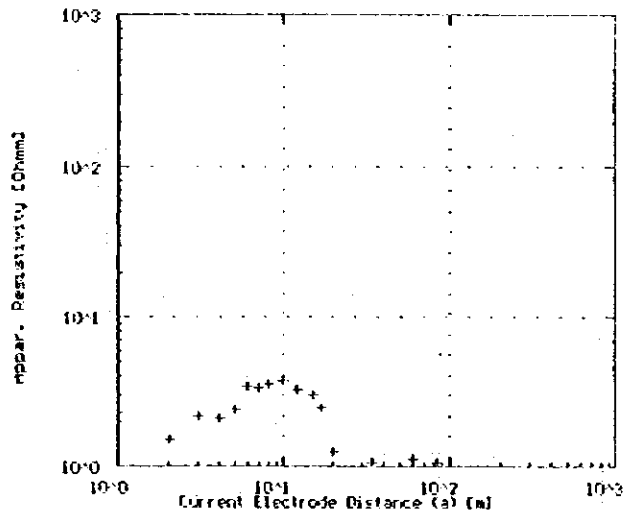


Point [No]	EN/2 [Nr]	a [m]	Res [ohm-m]
1	1.00	52.350	
2	2.00	37.880	
3	3.00	28.070	
4	4.00	28.870	
5	5.00	28.300	
6	6.00	28.380	
7	7.00	28.180	
8	8.00	21.300	
9	10.00	19.470	
10	12.00	17.250	
11	15.00	13.940	
12	17.00	11.740	
13	20.00	8.420	
14	24.00	7.080	
15	30.00	4.320	
16	36.00	3.420	
17	48.00	2.260	
18	60.00	0.920	

Specific Resistivity (Ω-m)	64	25.6	26	10.4	2.5
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15.75

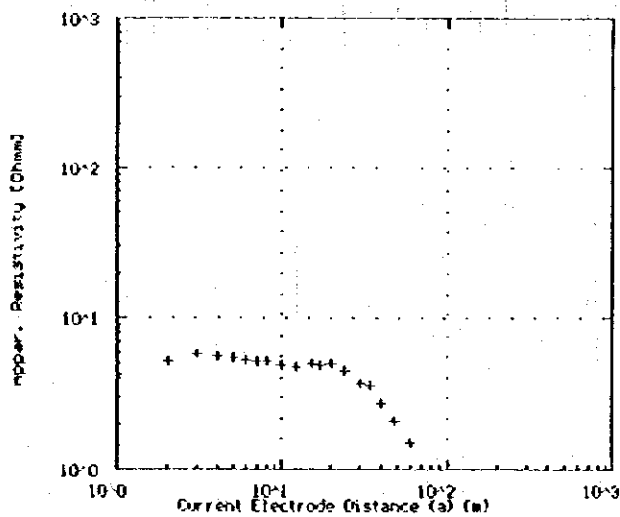
VES St. No.13 -DUPTI



Point No	MN/2 [M]	a [m]	Res [ohm-m]
1	1.00	2.760	
2	2.00	1.500	
3	3.00	2.150	
4	4.00	2.110	
5	5.00	2.380	
6	6.00	3.030	
7	7.00	3.300	
8	8.00	3.520	
9	10.00	3.710	
10	12.00	3.240	
11	15.00	3.010	
12	17.00	2.160	
13	20.00	1.250	
14	24.00	0.750	
15	30.00	0.070	
16	40.00	0.500	
17	60.00	0.300	
18	80.00	1.130	
19	100.00	1.050	

Specific Resistivity (Ω -m)	2.7	0.9	17.7	6.25	0.35	4.76
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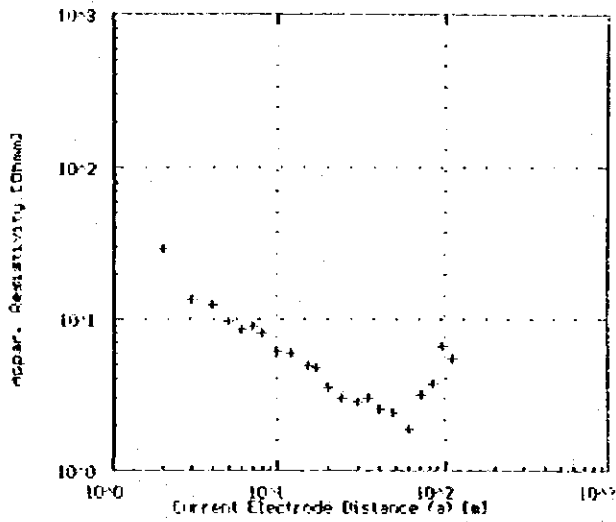
VES St. No.14 -DUPTI



Point No	MN/2 [M]	a [m]	Res [ohm-m]
1	1.00	6.270	
2	2.00	5.150	
3	3.00	5.040	
4	4.00	5.050	
5	5.00	5.590	
6	6.00	5.200	
7	7.00	5.180	
8	8.00	5.120	
9	10.00	6.950	
10	12.00	6.020	
11	15.00	4.910	
12	17.00	4.910	
13	20.00	5.020	
14	24.00	6.520	
15	30.00	3.720	
16	40.00	3.610	
17	60.00	2.160	
18	80.00	2.110	
19	100.00	1.510	

Specific Resistivity (Ω -m)	3.2	6.4	3.8	5.1	1.46
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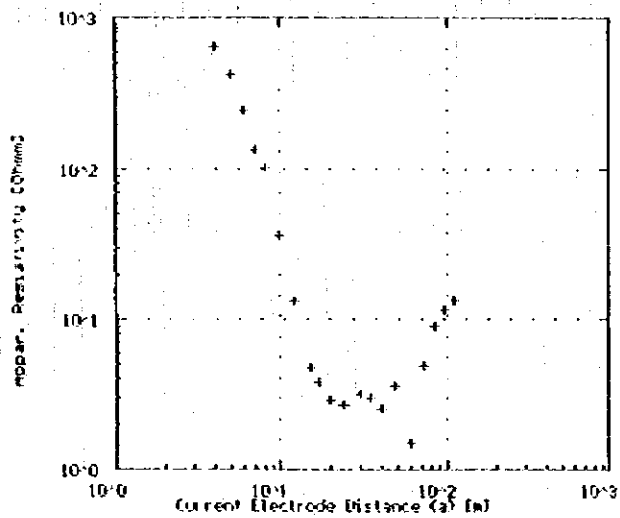
VES St. No.15 -DUPTI



Point (No)	AB/2 (M)	a (m)	ρ _{av} (ohm-m)
1	1.00	22.820	
2	2.00	20.894	
3	3.00	19.180	
4	4.00	17.310	
5	5.00	15.730	
6	6.00	14.180	
7	7.00	12.810	
8	8.00	11.640	
9	10.00	10.180	
10	12.00	8.850	
11	15.00	7.490	
12	17.00	6.490	
13	20.00	5.570	
14	24.00	4.610	
15	30.00	3.630	
16	36.00	2.930	
17	40.00	2.510	
18	50.00	2.110	
19	60.00	1.760	
20	72.00	1.470	
21	84.00	1.260	
22	96.00	1.110	
23	110.00	0.970	
24	130.00	0.820	

Specific Resistivity(Ω-m)	91	6.07	3	2.18	1	3.1
					12.1	

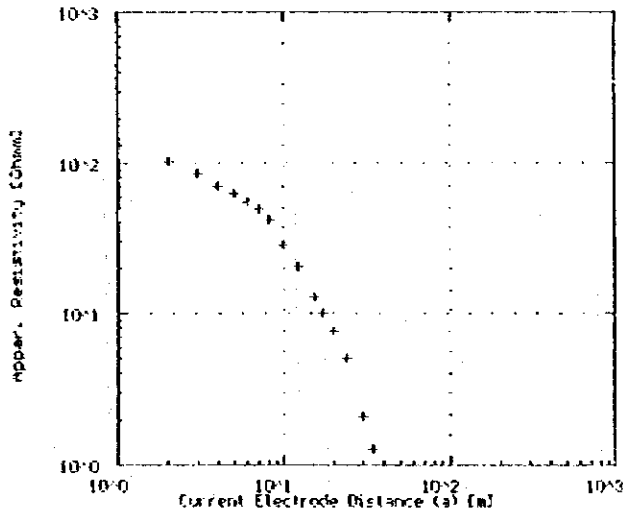
VES St. No.16 -DUPTI



Point (No)	AB/2 (M)	a (m)	ρ _{av} (ohm-m)
1	1.00	951.000	
2	2.00	1025.920	
3	3.00	1055.040	
4	4.00	657.420	
5	5.00	427.040	
6	6.00	264.970	
7	7.00	139.290	
8	8.00	101.400	
9	10.00	35.800	
10	12.00	13.060	
11	15.00	6.710	
12	17.00	3.560	
13	20.00	2.090	
14	24.00	2.710	
15	30.00	3.200	
16	36.00	2.920	
17	40.00	2.510	
18	50.00	3.020	
19	60.00	1.510	
20	72.00	0.910	
21	84.00	0.870	
22	96.00	11.009	
23	110.00	13.130	

Specific Resistivity(Ω-m)	620	1860	9.5	0.84	4.7	48.6
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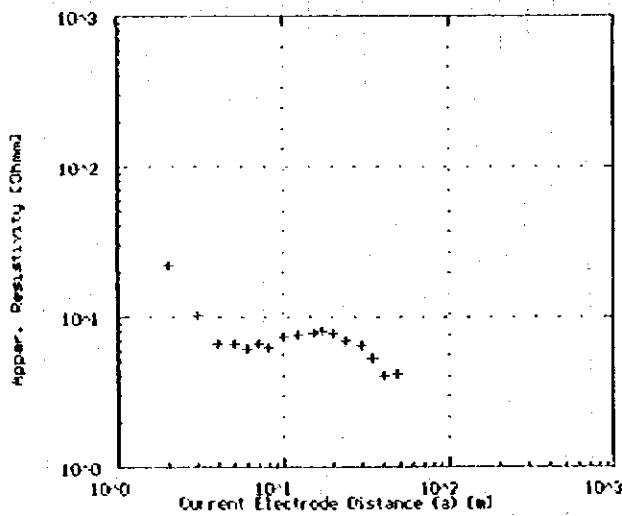
VES St. No.17 -DUPTI



Point [No]	NY/2 [Nr]	a [m]	Res [ohm-m]
1	1.00	10.169	
2	2.00	101.748	
3	3.00	41.789	
4	4.00	69.320	
5	5.00	52.000	
6	6.00	54.640	
7	7.00	49.260	
8	8.00	41.260	
9	10.00	20.260	
10	12.00	20.350	
11	15.00	12.920	
12	17.00	10.000	
13	20.00	7.000	
14	26.00	4.990	
15	30.00	2.990	
16	40.00	1.700	
17	60.00	1.010	
18	80.00	0.300	

Specific Resistivity ($\Omega\cdot m$)	130	43.33	2.6	0.56
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VES St. No.18 -DUPTI

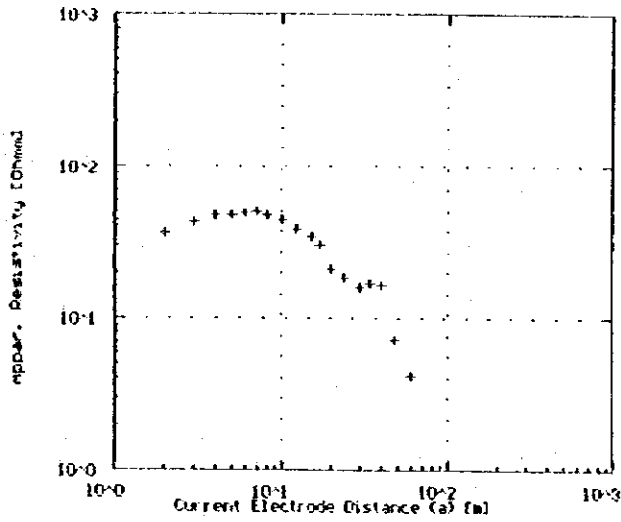


Point [No]	NY/2 [Nr]	a [m]	Res [ohm-m]
1	1.00	50.210	
2	2.00	22.410	
3	3.00	10.360	
4	4.00	6.590	
5	5.00	6.570	
6	6.00	6.100	
7	7.00	6.590	
8	8.00	6.200	
9	10.00	7.620	
10	12.00	7.010	
11	15.00	7.020	
12	17.00	6.010	
13	20.00	7.790	
14	24.00	7.000	
15	30.00	6.610	
16	36.00	5.340	
17	40.00	6.020	
18	48.00	6.210	
19	60.00	6.300	

Specific Resistivity ($\Omega\cdot m$)	64.5	10.56	4	9	0.87
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3.95

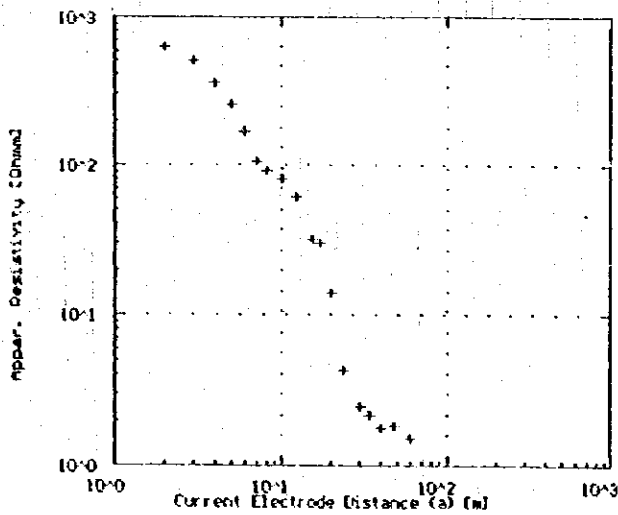
VES St. No.19 -DUPTI



Point (No)	PA/2 (m)	a (m)	Ras (ohm-m)
1	1.00	63.960	
2	2.00	36.020	
3	3.00	63.330	
4	4.00	67.230	
5	5.00	67.160	
6	6.00	69.380	
7	7.00	50.550	
8	8.00	67.730	
9	10.00	63.960	
10	12.00	30.610	
11	15.00	33.010	
12	17.00	20.090	
13	20.00	21.230	
14	20.00	10.090	
15	30.00	10.010	
16	31.00	11.020	
17	40.00	10.330	
18	40.00	7.210	
19	60.00	6.150	
20	72.00	0.450	

Specific Resistivity (Ω-m)	47	31.33	55.5					0.78
				32.67	20.5	4.57	312.5	

VES St. No.20 -DUPTI

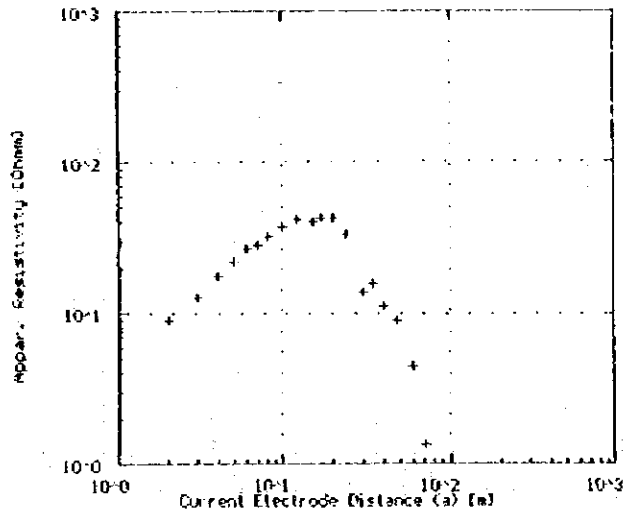


Point (No)	PA/2 (m)	a (m)	Ras (ohm-m)
1	1.00	571.680	
2	2.00	620.560	
3	3.00	499.260	
4	4.00	354.840	
5	5.00	254.340	
6	6.00	169.560	
7	7.00	105.560	
8	8.00	94.660	
9	10.00	80.360	
10	12.00	61.840	
11	15.00	37.030	
12	17.00	29.090	
13	20.00	19.020	
14	20.00	6.220	
15	30.00	2.650	
16	31.00	2.160	
17	40.00	1.760	
18	40.00	1.010	
19	60.00	1.510	

Specific Resistivity (Ω-m)	460	690	42.3				0.6
				12.6			

12.6

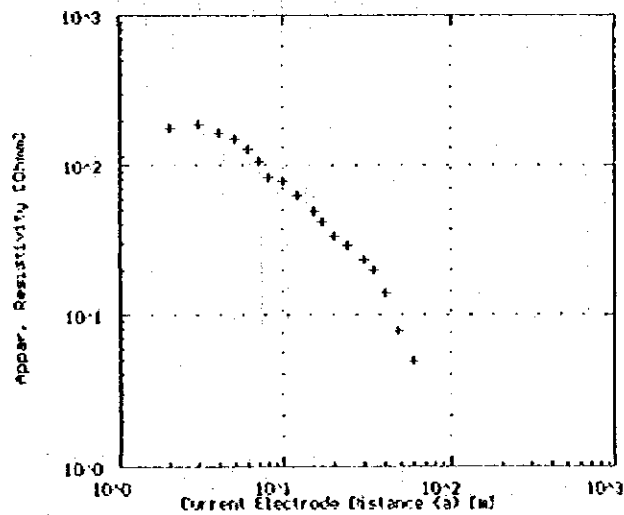
VES St. No.21 -DUPTI



Point [No]	HR/2 [hr]	a [m]	Res [ohm]
1	1.00	2.500	
2	2.00	8.920	
3	3.00	12.170	
4	4.00	17.500	
5	5.00	22.290	
6	6.00	28.250	
7	7.00	29.520	
8	8.00	32.150	
9	10.00	37.690	
10	12.00	41.450	
11	15.00	48.510	
12	17.00	47.700	
13	20.00	47.700	
14	24.00	33.050	
15	30.00	16.030	
16	34.00	16.030	
17	40.00	11.300	
18	48.00	8.010	
19	60.00	4.520	
20	72.00	1.360	

Specific Resistivity(Ω-m)	4.6	72	93.9	2.73	0.63
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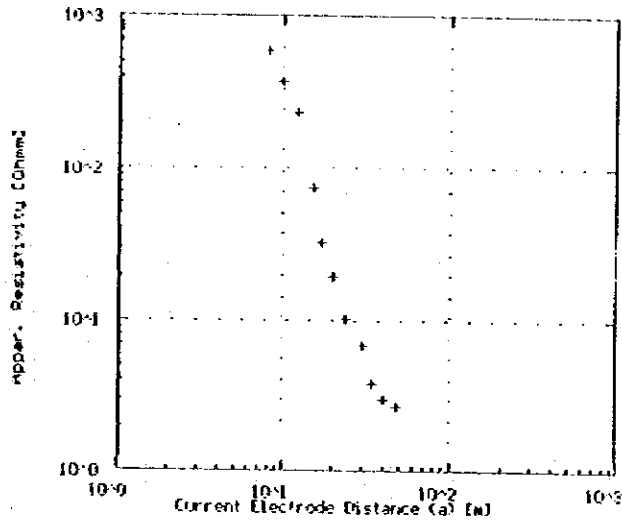
VES St. No.22 -DUPTI



Point [No]	HR/2 [hr]	a [m]	Res [ohm]
1	1.00	116.100	
2	2.00	172.100	
3	3.00	180.400	
4	4.00	185.700	
5	5.00	159.920	
6	6.00	128.410	
7	7.00	105.500	
8	8.00	82.920	
9	10.00	70.120	
10	12.00	62.550	
11	15.00	49.100	
12	17.00	41.660	
13	20.00	33.200	
14	24.00	24.770	
15	30.00	21.170	
16	34.00	20.070	
17	40.00	16.070	
18	48.00	7.910	
19	60.00	4.900	

Specific Resistivity(Ω-m)	66	430	43.6	11.5	0.61
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VES St. No.23 -DUPTI

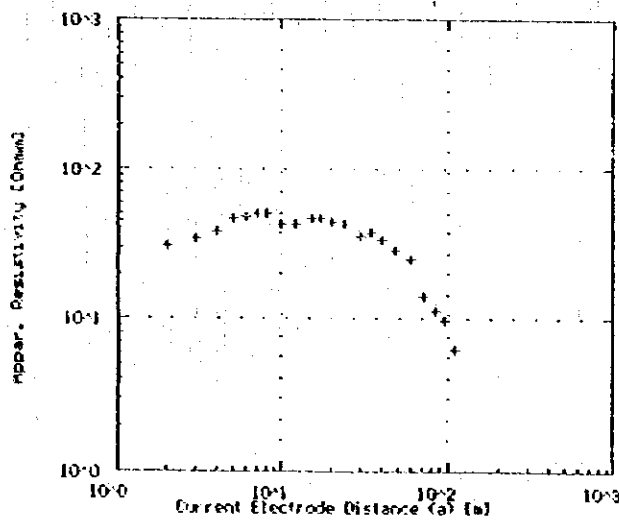


Point (No)	NI/2 [Mr]	a [m]	Res [Ohm]
1	1.00	054.000	
2	2.00	110.000	
3	3.00	158.560	
4	4.00	184.600	
5	5.00	196.000	
6	6.00	198.000	
7	7.00	197.620	
8	8.00	197.000	
9	10.00	170.520	
10	12.00	133.620	
11	15.00	74.920	
12	17.00	37.320	
13	20.00	19.310	
14	24.00	10.250	
15	30.00	6.780	
16	40.00	3.850	
17	60.00	2.010	
18	60.00	0.200	

Specific Resistivity(Ω-m)	560	2800	933	6.4
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91.6

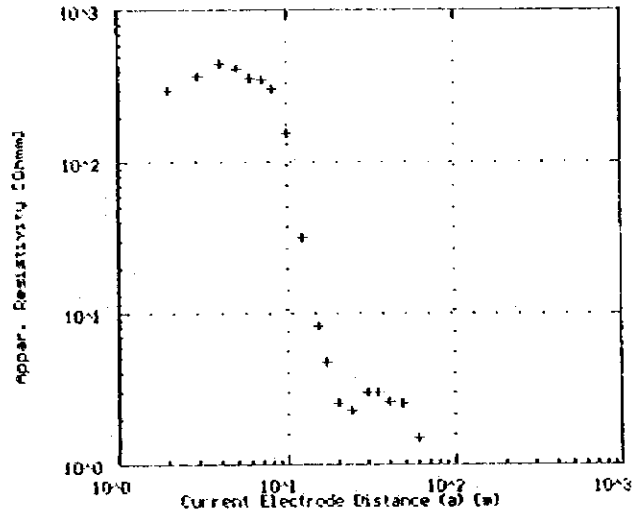
VES St. No.24 -DUPTI



Point (No)	NI/2 [Mr]	a [m]	Res [Ohm]
1	1.00	64.500	
2	2.00	30.520	
3	3.00	34.610	
4	4.00	30.190	
5	5.00	45.010	
6	6.00	40.200	
7	7.00	50.550	
8	8.00	50.290	
9	10.00	42.730	
10	12.00	42.200	
11	15.00	45.100	
12	17.00	46.920	
13	20.00	43.060	
14	24.00	43.110	
15	30.00	35.420	
16	40.00	36.010	
17	60.00	33.060	
18	60.00	20.330	
19	60.00	20.416	
20	77.00	17.090	
21	81.00	11.000	
22	84.00	9.650	
23	110.00	0.220	

Specific Resistivity(Ω-m)	70	23.3	83.1	34.33	14.0	0.76
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VES St. No.25 -DUPTI



Point [No]	MR/2 [Mr]	a [m]	Ra [ohm-m]
1	1.00	257.480	
2	2.00	261.440	
3	3.00	375.000	
4	4.00	452.190	
5	5.00	620.160	
6	6.00	357.960	
7	7.00	351.600	
8	8.00	306.450	
9	10.00	156.320	
10	12.00	14.650	
11	15.00	8.290	
12	17.00	6.000	
13	20.00	2.540	
14	24.00	2.280	
15	30.00	1.010	
16	36.00	2.190	
17	40.00	2.550	
18	47.00	2.510	
19	60.00	1.510	

Specific Resistivity (ohm-m)	235	352	885	1.66	2.73	0.49
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2280

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Dupiti

Sample No.1

Origin of Sample : Borehole No.2 (WSS)
Date of Collection: 16/Jan./95
Date of Analysis : 02/Feb./95

Physical Characteristics

Appearance : Clear
Odor : Odorless
Taste : -
Color : Nil
Settleable Solids : Absent
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: 860
Turbidity : Nil
Temperature : -
Conductivity : 1.72 ms/cm

General Chemical Characteristics

Total Hardness as CaCO₃ : 70
Carbonate Hardness as CaCO₃ : 70
Non Carbonate Hardness as CaCO₃: Nil
Total Alkalinity as CaCO₃ : 290
Bicarbonate Alkalinity as CaCO₃: 290
Carbonate Alkalinity as CaCO₃ : Nil
PH : 8.30
Silica : -
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: -	Cl ⁻	: 215.00
Na ⁺	: -	NO ₂ ⁻	: Nil
K ⁺	: -	NO ₃ ⁻	: 0.40
Ca ⁺⁺	: 16.00	F ⁻	: 2.10
Mg ⁺⁺	: 7.19	HCO ₃ ⁻	: 353.80
Fe(Total)	: 2.20	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: Nil	SO ₄ ⁻⁻	: 240.00
Cu ⁺⁺	: 0.01	PO ₄ ⁻⁻⁻	: 2.10

Remarks; Fluoride and Iron concentrations are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.2

Origin of Sample : Borehole (in Russian Camp)
Date of Collection: 21/Feb./95
Date of Analysis : 16/Mar./95

Physical Characteristics

Appearance : Clear
Odor : Odorless
Taste : -
Color : 8 Pt-Co
Settleable Solids : Absent
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: 630
Turbidity : 2 FTU
Temperature : -
Conductivity : 1.28 ms/cm at 21.4°C

General Chemical Characteristics

Total Hardness as CaCO₃ : 70
Carbonate Hardness as CaCO₃ : 70
Non Carbonate Hardness as CaCO₃ : Nil
Total Alkalinity as CaCO₃ : 280
Bicarbonate Alkalinity as CaCO₃ : 280
Carbonate Alkalinity as CaCO₃ : Nil
PH : -
Silica : -
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: -	Cl ⁻	: 125.00
Na ⁺	: -	NO ₂ ⁻	: 0.0231
K ⁺	: -	NO ₃ ⁻	: 1.76
Ca ⁺⁺	: 16.00	F ⁻	: 1.70
Mg ⁺⁺	: 7.30	HCO ₃ ⁻	: 341.6
Fe(Total)	: 0.13	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: 0.20	SO ₄ ⁻⁻	: 475.00
Cu ⁺⁺	: 0.02	PO ₄ ⁻⁻⁻	: 0.16

Remarks; Fluoride and Sulfate concentrations are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.3

Origin of Sample : Borehole (in Tendaho Plantation)
Date of Collection: 20/Feb./95
Date of Analysis : 16/Mar./95

Physical Characteristics

Appearance : Clear
Odor : Odorless
Taste : -
Color : 31 Pt-Co
Settleable Solids : Present
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: 1400
Turbidity : 6 FTU
Temperature : -
Conductivity : 2.89 ms/cm at 21.2 °C

General Chemical Characteristics

Total Hardness as CaCO₃ : 200
Carbonate Hardness as CaCO₃ : 200
Non Carbonate Hardness as CaCO₃ : Nil
Total Alkalinity as CaCO₃ : 300
Bicarbonate Alkalinity as CaCO₃ : 300
Carbonate Alkalinity as CaCO₃ : Nil
PH : -
Silica : -
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: -	Cl ⁻	: 375.00
Na ⁺	: -	NO ₂ ⁻	: 0.019
K ⁺	: -	NO ₃ ⁻	: 2.20
Ca ⁺⁺	: 40.00	F ⁻	: 1.34
Mg ⁺⁺	: 24.30	HCO ₃ ⁻	: 366.00
Fe(Total)	: 0.01	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: 0.10	SO ₄ ⁻⁻	: 900.00
Cu ⁺⁺	: 0.02	PO ₄ ⁻⁻⁻	: 0.18

Remarks; Chloride, Sulfate and TDS concentrations are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.4

Origin of Sample : Borehole (in RRC)

Date of Collection: 20/Feb./95

Date of Analysis : 16/Mar./95

Physical Characteristics

Appearance : Clear
Odor : Odorless
Taste : -
Color : 26 Pt-Co
Settleable Solids : Absent
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: 680
Turbidity : 3 FTU
Temperature : -
Conductivity : 1.37 ms/cm at 21.4 °C

General Chemical Characteristics

Total Hardness as CaCO₃ : 50
Carbonate Hardness as CaCO₃ : 50
Non Carbonate Hardness as CaCO₃ : Nil
Total Alkalinity as CaCO₃ : 270
Bicarbonate Alkalinity as CaCO₃ : 270
Carbonate Alkalinity as CaCO₃ : Nil
PH : -
Silica : -
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: -	Cl ⁻	: 150.00
Na ⁺	: -	NO ₂ ⁻	: 0.0264
K ⁺	: -	NO ₃ ⁻	: 4.84
Ca ⁺⁺	: 12.00	F ⁻	: 1.37
Mg ⁺⁺	: 4.80	HCO ₃ ⁻	: 329.40
Fe(Total)	: 0.01	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: 0.10	SO ₄ ⁻⁻	: 500.00
Cu ⁺⁺	: 0.02	PO ₄ ⁻⁻⁻	: 0.20

Remarks; Sulfate concentration is above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.5

Origin of Sample : Awash River
Date of Collection: 21/Feb./95
Date of Analysis : 16/Mar./95

Physical Characteristics

Appearance : Colored (Slightly)
Odor : Odorless
Taste : -
Color : 13,900 Pt-Co (Apparent)
Settleable Solids : Present
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: 230
Turbidity : 2,550 FTU
Temperature : -
Conductivity : 0.48 ms/cm at 21.2 °C

General Chemical Characteristics

Total Hardness as CaCO₃ : 100
Carbonate Hardness as CaCO₃ : 100
Non Carbonate Hardness as CaCO₃ : Nil
Total Alkalinity as CaCO₃ : 230
Bicarbonate Alkalinity as CaCO₃ : 230
Carbonate Alkalinity as CaCO₃ : Nil
PH : -
Silica : -
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: -	Cl ⁻	: 35.00
Na ⁺	: -	NO ₂ ⁻	: 0.009
K ⁺	: -	NO ₃ ⁻	: 33.40
Ca ⁺⁺	: 28.00	F ⁻	: 0.67
Mg ⁺⁺	: 7.30	HCO ₃ ⁻	: 280.60
Fe(Total)	: 0.30	CO ₃ ⁻	: Nil
Mn ⁺⁺	: 0.20	SO ₄ ⁻	: 15.00
Cu ⁺⁺	: 2.13	PO ₄ ⁻	: 0.36

Remarks; All the analyzed chemical constituents, except Turbidity and Color, are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.6 (Carried out by Ministry of Health)

Origin of Sample : Borehole No.1 (Near Mosque)

Date of Collection: 4/Apr./93

Date of Analysis : 18/May /93

Physical Characteristics

Appearance : Colorless
Odor : Odorless
Taste : Salty
Color : Colorless
Settleable Solids : Present
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: -
Turbidity : Clear
Temperature : -
Conductivity : -

General Chemical Characteristics

Total Hardness as CaCO₃ : 104
Carbonate Hardness as CaCO₃ : 104
Non Carbonate Hardness as CaCO₃ : Nil
Total Alkalinity as CaCO₃ : 440
Bicarbonate Alkalinity as CaCO₃ : 440
Carbonate Alkalinity as CaCO₃ : Nil
PH : 8.1
Silica : 58.0
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: 0.40	Cl ⁻	: 382.90
Na ⁺	: 550.80	NO ₂ ⁻	: 0.05
K ⁺	: 7.90	NO ₃ ⁻	: 88.60
Ca ⁺⁺	: 30.50	F ⁻	: 2.50
Mg ⁺⁺	: 6.80	HCO ₃ ⁻	: 536.80
Fe(Total)	: 0.14	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: Nil	SO ₄ ⁻⁻	: 248.50
Cu ⁺⁺	: -	PO ₄ ⁻⁻⁻	: 0.13

Remarks; Sodium, Chloride, Nitrate, and Fluoride are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.7 (Carried out by Ministry of Health)

Origin of Sample : Borehole No.4 (New borehole)
This borehole started the service
in April, 1995.

Date of Collection: Unknown

Date of Analysis : Unknown

Physical Characteristics

Appearance : Colorless
Odor : Odorless
Taste : Salty
Color : Colorless
Settleable Solids : Present
Floating Solids : Absent
Suspended Solids : Present
Total Dissolved Solids: -
Turbidity : Clear
Temperature : -
Conductivity : 1531 $\mu\text{m}/\text{cm}$

General Chemical Characteristics

Total Hardness as CaCO_3 : 74
Carbonate Hardness as CaCO_3 : 74
Non Carbonate Hardness as CaCO_3 : Nil
Total Alkalinity as CaCO_3 : 300
Bicarbonate Alkalinity as CaCO_3 : 300
Carbonate Alkalinity as CaCO_3 : Nil
PH : 7.7
Silica : 57.5
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 269.40
Na^+	: 347.00	NO_2^-	: 0.02
K^+	: 4.50	NO_3^-	: 1.00
Ca^{++}	: 12.80	F^-	: 1.90
Mg^{++}	: 10.20	HCO_3^-	: 366.00
Fe(Total)	: 0.06	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 141.60
Cu^{++}	: -	PO_4^{---}	: 0.10

Remarks; Sodium, Chloride, and Fluoride are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Dupiti

Sample No.8

Origin of Sample : Borehole No.2 (WSS)
Date of Collection: 4/Apr./93
Date of Analysis : 28/Apr./93

Physical Characteristics

Appearance : Colorless
Odor : Odorless
Taste : Salty
Color : Colorless
Settleable Solids : Present
Floating Solids : Absent
Suspended Solids : Absent
Total Dissolved Solids: -
Turbidity : Nil
Temperature : -
Conductivity : -

General Chemical Characteristics

Total Hardness as CaCO₃ : 80
Carbonate Hardness as CaCO₃ : 80
Non Carbonate Hardness as CaCO₃: Nil
Total Alkalinity as CaCO₃ : 370
Bicarbonate Alkalinity as CaCO₃: 370
Carbonate Alkalinity as CaCO₃ : Nil
PH : 8.10
Silica : 65.0
Sulphide as Hydrogen Sulphide : -
Carbondioxide : -
Residual Chlorine : -
Dissolved Oxygen : -

Ionic Contents

Cations		Anions	
NH ₄ ⁺	: 0.40	Cl ⁻	: 249.60
Na ⁺	: 380.80	NO ₂ ⁻	: 0.12
K ⁺	: 5.30	NO ₃ ⁻	: 2.30
Ca ⁺⁺	: 16.00	F ⁻	: 2.10
Mg ⁺⁺	: 7.70	HCO ₃ ⁻	: 451.40
Fe(Total)	: 0.24	CO ₃ ⁻⁻	: Nil
Mn ⁺⁺	: Nil	SO ₄ ⁻⁻	: 178.00
Cu ⁺⁺	: -	PO ₄ ⁻⁻⁻	: 0.06

Remarks; Sodium and Fluoride are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Faecal Coliform Test in Dupiti, Sampled and Analyzed on Feb./18,19/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	1	BH1	BH1	2	Sampled fr the borehole directly
2	1	BH1	Reservoir	TMTC	Uncovered and not iron resistant paint
3	1	BH1	P.Foun.2	25	From the tap just after the reservoir
4	1	BH1	P.Conn.	2	Directly fr the pressure line
5	1	BH1	P.Conn.	TMTC	Directly fr the pressure line
6	1	BH1	Barrel	29	Plastic Barrel, Covered
7	1	BH1	Clay pot	3	Covered
8	1	BH1	Jerry-can	TMTC	Dirty Jerry-can
9	2	Tendaho	Reservoir	44	Sampled at tap 50m away fr reservoir
10	2	Tendaho	P.Foun.	30	Tendaho public fountain
11	2	Tendaho	Y.Conn.	6	Sampled fr the tap with a hose
12	2	Tendaho	Y.Conn.	4	Sampled fr the tap without a hose
13	2	Tendaho	Barrel	1	Clean and covered plastic Barrel
14	2	Tendaho	Barrel	TMTC	Retested but the result was same
15	2	Tendaho	Barrel	TMTC	Not properly covered
16	2	Tendaho	Clay pot	TMTC	Covered
17	2	Tendaho	Jerry-can	3	Sampled fr plastic Jerry-can
18	2	Tendaho	Jerry-can	TMTC	Sampled fr plastic Jerry-can
19	1	RRC	Y.Conn.	4	50m away fr the borehole
20	1	RRC	Barrel	TMTC	Not well covered and dirty Barrel
21	1	RRC	Clay pot	5	Covered

There are four sources (BH1, BH2, Tendaho and RRC), of which BH1&BH2 are for WSS.

Note; "F.C. means Faecal Coliform.

"BH" means borehole.

"HDW" means hand-dug-well.

"P.Conn." means private connection.

"Y.Conn." means yard connection.

"P.Foun." means public fountain.

"Barrel" means Barrel-container made of steel.

"TMTC" means too many to count.

Appendix - 3

Social and Gender Data

DUPTI - Activity Profile by gender

Private Connection Users

Activity	Gender		Remarks	Time	Place
	M	F			
Fetches drinking water	y	y	mostly women	seldom	at home at river
Does the laundry	n	y	men do their own laundry at home		
Waters livestock	y	n			
Takes water from container	y	y			
Teaches children hygiene	y	y	whoever at home		
Disposes of solid waste	n	y			
Digs a compost pit	y	n			
Constructs a latrine	y	n	mostly paid labor		
Digs a drainage channel/pit	-	-	some pits		
Tends a kitchen garden	-	-	none		
Disposes of animal waste	n	y			
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	n	y			

y = Yes, n = No

Public Fountain/Vendor Users

Activity	Gender		Remarks	Time	Place
	M	F			
Fetches drinking water	y	y	queues can take more than one day. Men women and children (often boys) fetch water		home Afar-river
Does the laundry	y	y	Single and Afar men do laundry		
Waters livestock	y	n			
Takes water from container	y	y			
Teaches children hygiene	y	y	whoever is at home		
Disposes of solid waste	n	y	Rubbish sometimes burned/buried		
Digs a compost pit	y	n	town compost pit also available		
Constructs a latrine	y	n	mostly paid labor		
Digs a drainage channel/pit	y	n	some pits		
Tends a kitchen garden	-	-	none		
Disposes of animal waste	n	y			
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	n	y			

y = Yes, n = No

DUPTI - Daily Schedule

Private Connection Users/Vendors

Man	Time	Woman
* Gets up, goes to latrine, bathes	6	Gets up, goes to latrine, bathes and supervises maid
Eats breakfast with wife	7	Eats breakfast with husband
Works (at home)	8	Supervises maid cleaning house etc.
"	9	"
"	10	"
"	11	"
Eats lunch	12	"
Takes rest	13	Eats lunch with husband
"	14	Drinks coffee with neighbor
"	15	Rests
"	16	"
Business activities at home	17	"
Drinking with friends in town	18	"
"	19	Prepares dinner with maid
Eats supper with wife	20	Eats supper with husband
Drinking with friends in town	21	Visits friends
"	22	"
Returns home, showers, sleeps	23	Goes to sleep

* "I get up when I like and do as I please."
 "If I want to get up at 4pm it is up to me".

Public Fountain/Vendor Users

Man	Time	Woman
Gets up and eats breakfast	4	Gets up, prepares breakfast and eats with husband
Goes to plantation for work	5	Cleans house and surroundings
Guard duties	6	" (Son fetches water)
"	7	Wash clothes, look after children
"	8	"
"	9	"
"	10	"
"	11	"
"	12	"
"	13	Prepares lunch
Off duty and goes home	14	Eats lunch, drinks coffee
Eats lunch, drinks coffee	15	Spins cotton thread
Goes to Awash river area to collect wood for home and sometimes for selling	16	"
"	17	"
"	18	Looks after children
Returns home, plays with children	19	Reheats leftover food for supper
Eats supper	20	Eats supper with family
Relaxes with family	21	Cleans dishes
Goes to sleep	22	Goes to sleep
	23	

Note - Family members have clear roles and both work hard for common good.

DUPTI - Daily Schedule

School children : 7-11 Grades

Boy	Time	Girl
Get up, go to toilet, bathe	5	Get up, go to toilet, bathe
Eats breakfast	6	Prepares and eats breakfast
Fetches water		
Goes to school (30 mins)	7	Goes to school (30 mins)
"	8	"
"	9	"
"	10	"
"	11	"
Walks back from school	12	Walks back from school
Takes shower, eats lunch	13	Takes shower, eats lunch
Fetches water (2 hours)	14	Housework, sleeping
"	15	Fetching water
Watch video, study, go for walks, look after shops, daily labor etc	16	Study, do household chores
"	17	"
"	18	"
"	19	Prepare supper
Eat supper	20	Eat supper after male family members
Study until electricity goes off	21	Clean dishes, study until light goes out
Goes to sleep	22	Goes to sleep
	23	

Fetching water takes 1-2 hours on average each day.
 Fetching water is mostly done by boys.

DUPTI - Access and Control Profile

Private Connection Users/Vendors

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	
Money for soap	y	y	y	n	
Money for water container	y	y	y	n	
Money for water pot cover	-	-	-	-	
Money for building materials for drying shelf	y	y	y	y	both men and women organized
Money for building latrine	y	y	y	n	
Money for medicine	y	y	y	n	
Money for school fees	-	-	-	-	free school
Tools for digging pits	y	y	y	n	some have
Tools for constructing latrine	y	y	y	n	paid labor
Seeds and tools for vegetable gardens	-	-	-	-	none have
Land for digging pits	y	y	y	y	some have
Land for digging latrines	y	y	y	y	
Land for digging drains	n	n	n	n	few have
Land for vegetable gardens	-	-	-	-	none have
Income from selling water	y	y	y	y	Household head
Income from selling vegetables	y	y	y	y	provisional
Improved health	y	y	y	y	
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	men/women

y=Yes, n=No

DUPTI - Access and Control Profile

Public Fountain/Vendor Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	n	Household head
Money for soap	y	y	y	n	
Money for water container	y	y	y	n	
Money for water pot cover	y	y	y	y	
Money for building materials for drying shelf	y	y	y	y	more women organize
Money for building latrine	y	y	y	y	paid labor
Money for medicine	n	n	n	n	most can not afford
Donkey/cart for carrying water	y	y	n	n	Most hire or borrow
Tools for digging pits	y	y	n	n	few have
Tools for constructing latrine	y	y	n	n	paid labor
Seeds and tools for vegetable gardens	-	-	-	-	none have
Land for digging pits	n	n	n	n	some have
Land for digging latrines	y	y	y	y	land not available for new latrines
Land for digging drains	-	-	-	-	
Land for vegetable gardens	-	-	-	-	
Income from selling water	-	-	-	-	
Income from selling vegetables	y	y	y	y	provisional
Improved health	y	y	y	y	
Reduced time spent collecting water	n	y	n	y	males/ females
Reduced time spent caring for sick	y	y	y	y	mostly women

Assume that male is earning the primary income

DUPTI - Needs Analysis

Private Connection Users/Vendors

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate quantities of water from the water supply system each day	y	y	PCs also not fully reliable
Sanitation	Prefer household latrines to community latrines	y	y	Many already have latrines and would prefer upgraded models
	Prefer water seal latrines to other types	y	y	Such latrines with adequate water reduces smell
Strategic needs				
Water	Water managed by Government and not community/committee	y	y	Had bad experiences with committees before
Sanitation	Private latrines to be managed by households	y	y	

y = Yes, n = No

DUPTI - Needs Analysis

Public Fountain/Vendor Users

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate and reliable quantities of water from the water supply system each day, at fair price	y	y	Even repair of former PCs and PFs would be an improvement
	Reduced time spent queuing for water	y	y	Reduced queues and reduced distance to water supply facilities
Sanitation	Increased privacy between men and women, reduction of smell nuisance, prefer water seal latrines. Latrines must have pit linings to stop collapse	y	y	Community managed latrines would require some support and enforcement from the Kebele/Municipality
	Kebele to allocate areas for refuse disposal and provide training and support for the safe disposal of refuse.	y	y	All groups felt that garbage disposal was an important issue to be addressed.
Health	Improved health	y	y	
Strategic needs				
Water	Involvement with management of public fountains	y	y	Ready to take responsibility with WSS collecting the money. Would need support
	Additional public fountains to be constructed with the help of community labor.	y	y	All groups could assist with labour and with transportation of materials.
Sanitation	Community latrines to be managed by the community	y	y	All groups expressed the need to have support and even enforcement from Authorities for improvements in sanitation, including the use and management of community latrines.
Ethnic Tension	Need for control/respect of different ethnic groups from all other ethnicities	y	y	Some groups feel vulnerable because of changing power roles

y = Yes, n = No

DUPTI - Social and Gender Considerations

Social/Gender differences	Underlying factors	Impact of the project	Possible measures to be taken
Variation in type and level of water service demanded	Variations in social and economic status	Richer households will not be satisfied without private connections	Improvements to the water system should include both public fountains and private connections
Water vendors and water carriers also keen on improvements in public water supply system	Vendors generate some income from their PCs and some laborers generate income from cartage of water	The improvements to the town water supply will take away a market for these groups	Discuss and develop ways of ensuring employment or income generation for poor members of these groups
Women only defecate under cover of darkness where reasonable latrines not available	The need for privacy determines the time that some women can defecate	Women may all require latrine facilities at the same time thus putting pressure on resources	Sharing and management of community latrines must be facilitated with discussion of all community members
Dupti inhabitants are mostly highland settlers living in town surrounded by nomadic herders	Differences in culture between highland ethnic groups and Afar nomadic groups	Incomprehension between nomads and settlers results in mistrust and has a potential for tensions	Establish clear responsibilities between all ethnic groups including elders and family heads. Provide adequate training and support for community representatives in their roles in the project. Initiate support through Kebele/Municipality.
All groups fetch water but women usually do the laundry. Adult males and young males help in collection of water	Water collection and laundry are undertaken mostly by all men, women, boys and girls	Males and females will benefit from time and energy savings from having a reliable water supply available near their homes	The project needs to make sure that women and girls benefit equally from the time and energy savings and provide options for use of that extra time as they require

Appendix - 4

Summary of Group Meeting

DUPTI - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Mixed ethnicity, mixed religions, 12 men, Kebele 01, Business people, Traders and Government workers	1-Water, 2-Electricity, 3-Health
Water	PF, PC and PC Vendor Users and PC Vendors. Water available infrequently and of insufficient quantity. Men and women fetch water but mostly boys and girls. Queue for PF starts at 4am, and because of queuing people go to Tendaho Plantation or river	Would like Government managed water supply system which worked 24 hours each day, with additional PCs and reopening of existing closed public fountains. Would prefer to pay less for water.
Sanitation	Most people practice open defecation, women going to the same place but at different times. Some have latrines and use them. Can not afford concrete for improved types of latrines	Would like improved types of private household latrines with no smell, i.e. septic tanks. Prepared to contribute labour but not money or materials for the project.
Health	Common diseases include Malaria and Giardia, people aware of link between poor water and sanitation and disease. Health education is given to pregnant women and at vaccination times	Expect the project to help them improve personal hygiene and to improve health

Group 2 details	Group characteristics	Group needs
General	Mixed ethnicity, Mixed religions, 19 women, some infants, Kebele 01, Business people and hotel proprietors	1-Water, 2-Health, 3-Money (jobs and pension)
Water	Public Fountain, Private Connections and Private Connection Vendor Users. Critical water shortage which affects Private Connection and Public Fountain users.	Would like more Public fountains and for the closed PFs to be reopened. Would like Government management with the Kebele officials to check they are functioning
Sanitation	Most have latrines but due to lack of water and smell they prefer to practice open defecation.	Interested in latrine construction but think that management of communal latrines would be difficult.
Health	Common diseases include Malaria and diarrhoea, and seem aware of the health link between these diseases and water/sanitation	No health needs identified

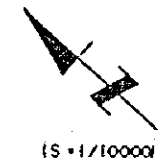
DUPTI - Summary of group meetings (Continued)

Group 3 details	Group characteristics	Group needs
General	Afar, Muslims, 20 Men including elders, mostly cattle herders and traders	1-Water,
Water	Men and women wash own clothes at river, drinking water taken from vendors (river water) for 5B/4 barrels.	Prefer functional PFs, including for rural areas. Could manage themselves but need support from Municipality. Could have tapstand committee and representatives trained on maintenance. Prefer subsidised water system where rich pay more for the service.
Sanitation	If no water, sanitation is also a problem. Most people use open field. Traditionally Afar cover excreta with soil after defecation. Women in particular require privacy.	Prefer communal latrines shared by sex. Would consider paying someone from the community to keep it clean and even keep it locked so that outside people do not dirty them. Would like to have water available in latrines for anal cleansing.
Health	Health not mentioned	Health needs not identified
Group 4 details	Group characteristics	Group needs
General	Highlanders, mixed religions, 5 men, 8 women, some children, School teachers and traders	1-Water Would like the project to be implemented quickly and to be sure that what they have requested will happen
Water	Public fountain and yard connection users, community buys fuel for pump (3B/household/month) and one man voluntarily services the generator and pump. Laundry and bathing done at home. Tensions between them and nearby Afar who use water but do not pay.	Community prepared to pay for someone to look after the PF and to contribute money for spare parts, but not major costs. Would like slab for clothes washing. Need Authorities to help with the tension between Afar and themselves on payment for the water
Sanitation	Most use open defecation, children's excreta is thrown outside by women. Women use water for anal cleansing. Women use same place as men but go early morning. Lack of latrines because of soil collapse and great expense	Communal latrines would be an option with separate facilities for men and women. Would not use public shower, but prefer to bath at home (2-4 times daily) or on a bring your own water public shower system
Health	Common diseases include malaria, diarrhoea, pneumonia. They are aware of the link between diarrhoea and water/sanitation but less clear about faecal oral route	No additional health needs expressed

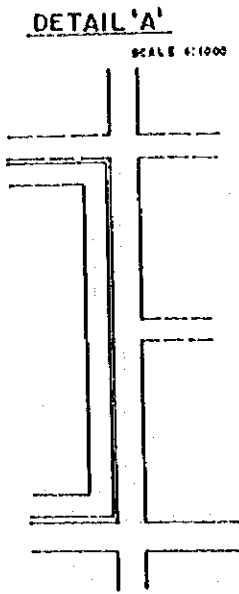
DUPPI - Summary of group meetings (Continued)

Group 5 details	Group characteristics	Group needs
General	Highlanders, Mixed religions, 10 women and some children, Daily labourers and wood collectors	1-Water,
Water	Most obtain water on request to Tendaho Plantation workers or dwellers. There is no other piped water supply in area. Carry the water in jerry cans by hand carts shared among the community	Would like additional public fountains, but as the community is mixed with Afar, there is likely to be a problem over community management, hence prefer Government management.
Sanitation	All have latrines, built by the men and cleaned by the women. Children's excreta is cleared up and put into latrines. Women burn the rubbish	Not interested in community latrines
Health	Common diseases include malaria, TB and pneumonia. Diarrhoea not common.	No health needs identified

Group 6 details	Group characteristics	Group needs
General	Mostly highlanders, mixed religions, 10 women, 10 men, many children, Most are permanent employees of Tendaho plantation	1-Town water supply
Water	Most get water free of charge from the plantation yard connections. Most collect water by barrow, mostly children especially boys. Quality is good. Town supply suffers with some unscrupulous vendors.	Would like additional public fountain in the area with community management, but there is fear that Afar will not co-operate.
Sanitation	All have latrines built by the men and women keep them and the compounds clean. All live in own private housing. Think that density of housing has been an influence on high latrine coverage.	Improved sanitation in other parts of the town
Health	Health benefits do not come from high latrine coverage because of wind blowing contamination from other areas. Common diseases include TB malaria, pneumonia and diarrhoea. Some awareness on the link between diarrhoea and water/sanitation.	Could learn more about health but would not be able to utilise the information without improvements to the water supply system

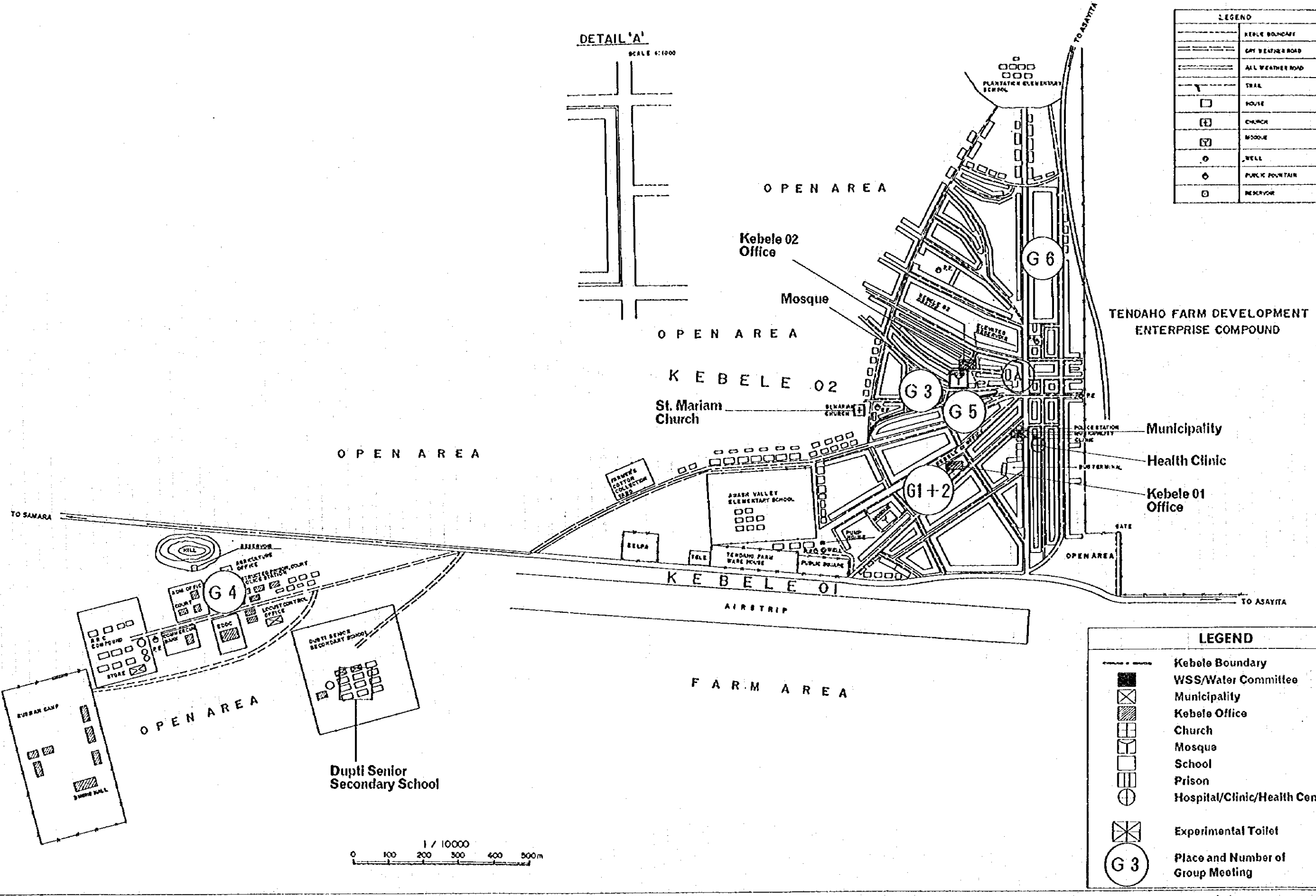


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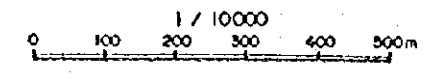
LEGEND

[Symbol]	KEBELE BOUNDARY
[Symbol]	DAY WEATHER ROAD
[Symbol]	ALL WEATHER ROAD
[Symbol]	TRAIL
[Symbol]	HOUSE
[Symbol]	CHURCH
[Symbol]	MOSQUE
[Symbol]	WELL
[Symbol]	PUBLIC FOUNTAIN
[Symbol]	RESERVOIR



LEGEND

[Symbol]	Kebele Boundary
[Symbol]	WSS/Water Committee
[Symbol]	Municipality
[Symbol]	Kebele Office
[Symbol]	Church
[Symbol]	Mosque
[Symbol]	School
[Symbol]	Prison
[Symbol]	Hospital/Clinic/Health Center
[Symbol]	Experimental Toilet
[Symbol]	Place and Number of Group Meeting



Appendix - 5

Financial and Socio-Economic Data

Table 1 (1) Summary of Financial Aspects of WSS in Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Water production & consumption in 1993/1994 (m3)	n.a. 35,565e	n.a. 29,232e	113,523 90,218	58,318 46,104	11,303e 10,173e	11,930 9,773
*Water consumption/population/day (l)	6.6e	20.5e	17.2	5.8	2.4e	1.0
*Leakage ratio (%)	n.a.	n.a.	20.5	20.9	10.0e	18.1
3. Income & Expenditure in 1993/1994 (birr)	51,267 60,188	48,818 38,182	131,144 132,245	64,648 53,304	50,863e 22,560e	31,337 78,328
*Bill collection rate (%)	85.7	79.1	94.4	99.9	-	67.8
*Income/consumption (birr/m3)	1.44e	1.67e	1.45	1.40	5.00e	3.21
*Expenditure/production (birr/m3)	n.a.	n.a.	1.16	0.91	2.00e	6.57
*Income/Expenditure (%)	85.2	127.9	99.2	121.3	225.5e	40.0
4. No. of personnel, female, temporary/contract	10 1 10	11 5 11	25 5 8	18 4 0	13 4 8	18 5 0
*Production/worker (m3)	n.a.	n.a.	4,541	3,240	3,478e	663
*Income/worker (birr)	5,126	4,438	5,246	3,592	3,913e	1,741
*Expenditure/worker (birr)	6,019	3,471	5,290	2,961	1,735e	4,352
5. Average monthly salaries (birr)	129	96	204	217	70	173
6. No. of house/yard connections, public fountains, hydrants	190(70) 8(2) 1	89 8(5) 1	852 12	396 7(6)	- 5(3)	320 13(2)

Notes: 1. e = estimates or assumptions 2. n.a. = not available
3. parenthesized figure = functional

Table 1 (2) Summary of Financial Aspects of WSS in Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
1. Population	13,726	26,823	14,742	14,629	10,250
2. Water production & consumption in 1993/1994 (m3)	42,216 31,206	74,219 55,045	66,278 55,008	17,810 15,826	46,409 41,201
*Water consumption/ population/day (l)	6.2	5.6	10.2	3.0	11.0
*Leakage ratio (%)	26.1	25.8	17.0	11.1	11.6
3. Income & Expendi- ture in 1993/1994 (birr)	56,457 79,567	68,590 72,172	66,791 102,309	34,679 71,591	62,089 67,846
*Bill collection rate (%)	91.7	85.8	98.2	96.8	89.0
*Income/consumption (birr/m3)	1.81	1.25	1.21	2.19	1.51
*Expenditure/pro- duction (birr/m3)	1.88	0.97	1.54	4.02	1.46
*Income/Expenditure (%)	71.0	95.0	65.3	48.4	91.5
4. No. of personnel, female, tempo- rary/contract	19 5 1	17 6 2	22 7 0	20 6 2	17 3 0
*Production/worker (m3)	2,222	4,366	3,013	891	2,745
*Income/worker (birr)	2,971	4,035	3,035	1,735	3,652
*Expenditure/ worker (birr)	4,188	4,245	4,650	3,580	3,991
5. Average monthly salaries (birr)	153	143	241	170	211
6. No. of house/ yard connections, public fountains, hydrants	383 14(13)	327 12	478 13(12)	238 7	390 7

Notes: 1. e = estimates or assumptions 2. n.a. = not available
3. parenthesized figure = functional

Table 2 (1) Financial Condition of Water Supply Service in Dupti

-
1. Official Water Price: 1.5 birr/m³ for owners of yard connections
1.25 birr/m³ for public fountain users
 2. Production and Consumption of Water, 1993/94
 - 1) Production : not available
 - 2) Consumption: 35,565 m³
 - * Daily water consumption as divided by total population = 6.6 litre
 - * Leakage ratio = not available
 3. Income and Expenditure
 - 1) Income : 51,262.25 birr

Major sources of income

(1) Yard connection customers	34,788.00 birr	(67.9%)
(2) Public fountain users	15,466.27 birr	(30.2%)
(3) Technical service	879.78 birr	(1.7%)

 - * Bill collection rate = 85.7%
 - * Income per unit consumption of water = 1.44 birr/m³
 - 2) Expenditure: 60,187.79 birr

Major items of expenditure

(1) Fuel	29,886.89 birr	(49.7%)
(2) Salaries	15,422.15 birr	(25.6%)
(3) Per diem	5,010.07 birr	(8.3%)
(4) Lubricant	4,023.25 birr	(6.7%)

 - * Expenditure per unit production of water = not available
 - * Income-expenditure ratio = 85.2%
 4. Organization and Personnel
 - 1) No. of personnel: 10 (1) [10]

Table 2 (2) Financial Condition of Water Supply Service in Dupti

-
- | | |
|-----------------------------------|-----------|
| (1) Administration | 3 [3] |
| 3 [3] guards | |
| (2) Finance | 5 (1) [5] |
| 5 (1) [5] water sellers | |
| (3) Urban water supply & sewerage | 2 [2] |
| 2 [2] operators | |
- Note: Parenthesized and bracketed figures denote the number of female and contract workers respectively.
- * Production per worker = not available
 - * Income and expenditure per worker = 5,126 birr, 6,019 birr/year
- 2) Average monthly salaries of employees: 129 birr
 5. No. of Distribution Facilities
 - 1) Yard connections : 190 (70 functional)
 - 2) Public fountains : 8 (2 functional)
 - 3) Hydrant : 1
 6. Problems and Bottlenecks
 - 1) The diameter of pipelines are not enough.
 - 2) No reservoir.
 - 3) No spare pumps.
 - 4) The generator is overloaded.
 - 5) No transportation facilities for maintenance.

Table 3 (1) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
I. Administrative Conditions						
1. No. of gov't employees	500e	336	366	322	412	1,674
*No. of gov't employees/1,000 population	34	86	25	15	35	65
2. Average salaries of gov't employees (birr)	311	311	355	308	391	397
II. Population						
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Ethnic composition for top two (%) [Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]	Amh.84 Afa. 6	Amh.69 Oro.14	Amh.49 Oro.28	Amh.97 Tig. 3	Amh.73 Kim.20	Amh.100
3. Religious composition, Christians & Moslems (%)	42 58	43 57	12 88	80 19	81 19	95 5
4. Family size	4.5	4.6	6.2	6.3	5.5	5.7
5. Area (ha)	1,600e	68	260	640	322	1,402
*Population density (persons/ha)	9.2e	57.4	55.2	34.1	36.4	18.2
III. Educational Conditions						
1. No. of pupils/students	3,182	457	2,500	3,817	3,944	7,950
*No. of pupils/students per 100 population	22	12	17	17	34	31
2. Literacy ratio (%)	70	62	48	63	80e	74
3. Primary school enrollment ratio (%)	62	53	53	57	85e	75
IV. Medical Conditions						
1. No. of medical personnel	36	4	22	9	18	81

Table 3 (2) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
*No. of medical personnel per 1,000 population	2.4	1.0	1.5	0.4	1.5	3.2
2. No. of cases for top ten diseases	14,943	1,611	11,642	18,084	13,683	21,318
*Estimated No. of cases per year as percentage of population (%)	30.4	12.4	24.3	24.8	35.0	25.0
3. Under 5 mortality rate (/1000)[n.a.=not available]	213	154	163	95	n.a.	73
4. Life expectancy (years)	47	53	52	61	55e	64
5. Households using septic tank / pit latrine (%)	86	45	68	61	39	65
V. Economic Conditions						
1. No. of commercial/industrial establishments [parenthesized figures=No. of hotels/restaurants]	1,105 (331)	204 (162)	243 (68)	812 (201)	450 (115)	1,672 (574)
*No. of establishments per 1,000 population	75 (22)	52 (42)	17 (5)	37 (9)	38 (10)	65 (22)
2. Monthly household income (birr)	334	223	306	262	182	248

Note: e=estimates

Table 3 (3) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
I. Administrative Conditions					
1. No. of gov't employees	541	727	845	499	378
*No. of gov't employees/1,000 population	39	27	57	57	37
2. Average salaries of gov't employees (birr)	297	368	292	374	407
II. Population					
1. Population	13,726	26,823	14,742	14,629	10,250
2. Ethnic composition for top two (%) [Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]	Amh.100	Amh.74 Age.19	Amh.94 Age. 4	Amh.99 Oro. 1	Amh.99 Tig. 1
3. Religious composition, Christians & Moslems (%)	94 6	44 56	92 7	67 33	65 35
4. Family size	5.9	6.1	6.8	6.2	6.8
5. Area (ha)	648	920	1,280	200	280
*Population density (persons/ha)	21.2	29.2	11.5	73.1	36.6
III. Educational Conditions					
1. No. of pupils/students	3,743	5,339	4,388	3,465	2,661
*No. of pupils/students per 100 population	27	20	30	24	26
2. Literacy ratio (%)	70	74	61	69	61
3. Primary school enrollment ratio (%)	59	77	69	68	64
IV. Medical Conditions					
1. No. of medical personnel	43	25	22	27	5

Table 3 (4) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
*No. of medical personnel per 1,000 population	3.1	0.9	1.5	1.8	0.5
2. No. of cases for top ten diseases	22,002	11,782	15,112	7,441	3,790
*Estimated No. of cases per year as percentage of population (%)	48.1	13.2	30.7	15.3	11.1
3. Under 5 mortality rate (/1000)[n.a.=not available]	196	144	131	173	155
4. Life expectancy (years)	49	54	56	52	53
5. Households using septic tank / pit latrine (%)	58	61	58	45	54
V. Economic Conditions					
1. No. of commercial/industrial establishments	860 (209)	546 (91)	246 (65)	414 (47)	345 (74)
[parenthesized figures=No. of hotels/restaurants]					
*No. of establishments per 1,000 population	63 (15)	20 (3)	17 (4)	28 (3)	34 (7)
2. Monthly household income (birr)	202	203	253	324	312

Note: e=estimates

Table 4 (1) Socio-Economic Condition of Dupiti

- I. Administrative Conditions
 1. Administrative Classification: Region 2, Zone 1
 2. Government Organizations
 - 1) Tendaho Agricultural Enterprise
 - 2) Water Resources Development Authority (WRDA)
 - 3) Agricultural Bureau
 - 4) Natural Resources Development and Environmental Protection (NRDEP)
 - 5) Weroda Administration
 - 6) Merchandise Wholesale Trading and Import Enterprise
 - 7) Financial Bureau
 - 8) Educational Bureau
 - 9) Municipality
 - 10) Health Clinic
 - 11) Hospital
 - 12) Health Station
 - 13) Malaria Control and Eradication Office
 - 14) Police
 - 15) Post Office
 - 16) Telecommunications
 - 17) Commercial Bank of Ethiopia
 - 18) Weroda Court
 - 19) Weroda Attorney
 - 20) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There is no NGO.

 3. No. of Government Employees and Their Average Monthly Salaries: 500 (estimates), 311 birr
 - * No. of government employees per 1,000 population: 34
 4. No. of Kebele: 2
- II. Socio-Economic Conditions
 1. Population
 - 1) Total population: 14,737
 - 2) Ethnic composition: Amhara (83.6%), Afar (5.8%), Tigre (5.8%), Oromo (2.9%), Others (1.9%)

Table 4 (2) Socio-Economic Condition of Dupiti

- 3) Religious composition: Christians (42%), Moslems (58%)
- 4) Average family size: 4.5 persons
2. Area: 1,600 ha (estimates) * Population density: 9.2 persons/ha
3. Educational Conditions
 - 1) No. of schools, teachers and pupils/students

Items	Elementary School	Junior and Senior High School
(1) No. of schools	5	1
(2) No. of teachers	88	43
(3) No. of pupils/students	1,844	1,338

 - * No. of pupils/students per 100 population: 22
 - 2) Literacy ratio: 70% (1984)
 - 3) Primary school enrollment ratio: 62% (1984)
4. Medical Conditions
 - 1) No. of medical institutions/establishments: 1 Hospital, 1 Health Clinic, 1 Health Station, 1 Malaria Control and Eradication Office, 11 private drug stores
 - 2) No. of medical personnel:
 - (1) Dupiti Hospital
 - 3 general practioners, 6 nurses, 13 health assistants, 1 laboratory technician, 1 assistant laboratory technician, 1 pharmacy technician, 2 X-ray technicians, 1 pharmacist, 1 dispensary staff ... 29 in total
 - Other related personnel: 2 sanitarians
 - (2) Dupiti Clinic
 - 2 health assistants, 3 practioner health assistants ... 5 in total
 - 3) Incidence of diseases (Jul. 1993 - Jun. 1994)

Table 4 (3) Socio-Economic Condition of Dupiti

(1) Top ten diseases

(Dupiti Hospital)		
i.	Tuberculosis of all forms	1,137 cases
ii.	All other diseases of genito-urinary system	755
iii.	Acute bronchitis	590
iv.	Amoebiasis of other unspecified dysentery	520
v.	Acute upper respiratory infection	519
vi.	Malaria	479
vii.	All other types of skin and musculo-skeletal diseases	460
viii.	Gastritis & duodenitis	397
ix.	Skin infection	307
x.	Rheumatism	260
		i. to x. = 5,224

(Dupiti Clinic)		
i.	Malaria	2,271 cases
ii.	Unknown febrile illness	1,573
iii.	Pneumonia	1,267
iv.	Sexually transmitted diseases	792
v.	Rheumatism	780
vi.	Diarrhea	657
vii.	Gastritis	656
viii.	Common cold	604
ix.	Skin infection	565
x.	Otitis	554
		i. to x. = 9,719

(2) Estimated number of cases per year as percentage of population:
 $(14,943 \times 1.5) / (14,737 \times 5) = 30.4\%$

Notes: 1.5 = coefficient to estimate the total number of cases,
 5 = coefficient to estimate covered population

- 4) Under 5 mortality rate: 213/1000 (1984)
- 5) Life expectancy: 47 (1984)
- 6) Households more or less using septic tank and pit latrine: 86%
- 5. No. of Holy Places: 1 church, 4 mosques

Table 4 (4) Socio-Economic Condition of Dupiti

6. Economic Conditions

1) No. of commercial and industrial establishments

Classification	Annual Income (birr)			Total
	< 1,000	1,000 - 3,000	3,000 <	
1. Hotels, bars, restaurants and tea rooms	319	9	3	331
2. Shops (excl. below-mentioned)	274	50	21	345
Tailors	39	0	0	39
Fruit & vegetables traders	35	0	0	35
Crops & flour retailers	0	19	0	19
Chat traders	0	9	0	9
Photo houses	1	1	0	2
Drug stores	0	11	0	11
Coffee distributors	0	101	0	101
Beverage retailer	183	20	0	203
Sub-total	532	211	21	764
3. Cottage industry				
Furniture manufacturers	0	1	0	1
Grain mills	0	5	0	5
Bakeries	0	2	0	2
Workshops	0	2	0	2
Sub-total	0	10	0	10
Total	851	230	24	1,105

* No. of commercial and industrial establishments per 1,000 population: 75

2) Major occupations

- (1) Government employees
- (2) Merchants
- (3) Day laborers

3) Market

- (1) Major marketable items: vegetables, fruit, oil and other processed and semi-processed household items, crops such as cotton and maize, and animals

Table 4 (5) Socio-Economic Condition of Dupiti

(2) Prices of major marketable items			
Agricultural Products (unit: birr/100 kg)			
cotton (/band)	maize	cotton seed	
1,050	150	85	
Livestock (unit: birr/one)			
ox	cow	sheep	goat
450	400	100	90

(3) Market day - every day

4) Average monthly household income: 334 birr

- Sources:
1. Asayta Water Supply Service
 2. Weroda Administration in Dupiti
 3. Dupiti Hospital, Dupiti Clinic
 4. Educational Bureau in Dupiti
 5. Socio-Economic Sampling Questionnaire Survey by JICA
 6. Central Statistical Authority

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Dupiti

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Background	1. Insufficient water supply and low per-capita-consumption due mainly to high population growth , aged facilities and poor O&M. 2. Poor sanitation prevailing the Project site which could contaminate the water source(s).
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition.
Location	Dupiti, Region-2, New Dupiti to be considered.
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 14,700 of the population to be benefited.
Dimensions of the Plan	Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network. Awash river to be considered in future use.
Type of Work	Rehabilitation and new construction work
Purpose	1. To provide domestic water and improve sanitation facilities. 2. To initiate people's awareness on water use and sanitation.
Water Resource	Groundwater, Surface water of Awash river to be considered in future use.
Water Quality	Fluoride and high saline for the groundwater, High turbidity for Awash river.
Main Facilities	Boreholes with pumping system. Filtration plant in case of using Awash river.
Water Storage Facilities	Reservoir (elevated tank to be considered if constructed within town because of flat land)
Filtration Plant	In case of using Awash river, filtration scheme with disinfection plant be adopted.
Related facilities	Distribution pipes, public fountains, drainage system and latrines
Remarks	1. Chlorine or its derivatives such as mainly calcium hypochlorite is used for disinfection. 2. Treatment of fluoride and saline is expensive

Site Description on Initial Environmental Examination in Dupiti

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 14,700, mostly Amhara with utmost 10% of Afar.
Facilities related to life (electricity, etc.)	The electricity is currently generated at night, but new hydropower line to be given soon.
Health and Sanitation (diseases, clinic, etc.)	1 hospital, 1 health clinic, 1 health station, kidney problem because of salinity of the water and fluorosis teeth are observed.
Natural Environment	
Topography, Geology and Hydrogeology	Located in lower Awash valley. Basaltic lava covered by recent alluvial sediments. Economic aquifer is expected 20-25m below ground level.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 230mm, perennial Awash river is flowing near town, groundwater table is considered low because of no hand dug well.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	Among 8 public fountains, only 2 are functioning as of Feb. 1995 and many private connections are not supplied water because of low pressure. During rainy season many stagnant waters appear specially in the center of town.
Regulations and Compensation	Although the land is officially owned by the state, those who lose their dwelling and commercial area because of the project will be given substitute land. Also, Compensation will be made for properties such as houses and trees, which will be damaged.
Remarks	<ol style="list-style-type: none"> 1. Afar people express their own land right. 2. They are aware of that the improvement of water supply is vital since they are suffering from serious water shortage as of Feb. 1995. 3. They have awareness of sanitation, mostly they have individual or common pit latrine and also drainages along the road are under construction by the municipality. 4. There is inequality of the accessibility to the water between the population in the town and the people living in outskirts of the town.

Scoping Format for Initial Environmental Examination in Dupiti

Environmental Components	Classification	Description
1. Social Environment		
1.1 Resettlement	B	The facilities are small and expected to give no resettlement.
1.2 Economic Activities	D	The economic activities will be enhanced by the water supply and sanitation improvement.
1.3 Facilities	B	The construction work and the facilities have little impact on existing facilities such as schools and hospitals.
1.4 Collapse of Communities	B	Nil. If a water users committee was organized by the community itself to look after the facilities especially public fountains, the community would be enhanced
1.5 Archaeological and Cultural Heritage	B	Nil
1.6 Vested Rights	C	Compensation shall be given for land and properties if these were affected by the Project. Water vendors may lose their income source by the newly supplied water. Afar claiming of their owing to land be considered.
1.7 Public Health and Hygienic Condition	D/C	Sanitary improvement will enhance the condition. Drainage system must be accompanied with the improvement of water supply. In terms of water quality, attention be paid to the fluoride and salinity.
1.8 Waste Disposal	B	During construction works, there will be little waste disposal from the view of the small construction scale. After commissioning, no waste disposal is expected.
1.9 Accidental Damages to Facilities	C	Consideration be paid to the alignment of pipelines in order to avoid public nuisance to dwellers. Due to soil formation (silty sand) minor accidental collapse might be expected.
2. Natural Environment		
2.1 Geographic and Geological Condition	B	No effect is expected to geographic and geological condition.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

to be continued.....

2.2 Soil Erosion	C	The earth work gives little soil erosion, judging from the construction scale.
2.3 Surface Water Quality and Quantity	B	Nil
2.4 Groundwater Quality and Quantity	C	During construction, no effect is expected but after commissioning, the salinity might increase because of overpumping.
2.5 Hydrological Situation	B	No effect is expected to hydrological situation.
2.6 Terrestrial Fauna	B	Nil
2.7 Aquatic Fauna	B	Nil
2.8 Vegetation	B	Little effect is expected to vegetation.
2.9 Climatic Conditions	B	No effect is expected to climatic conditions.
2.10 Aesthetic Condition	B	The facilities would give little change to the condition judging from the size.
3. Public Nuisance		
3.1 Air Pollution	B	Nil
3.2 Water Pollution	B	Nil
3.3 Soil Pollution	B	Nil
3.4 Noise and Vibration	B	The construction works do not give rise to noticeable noise and vibration.
3.5 Land Subsidence	C	Excessive groundwater pumping might cause land subsidence because the formation is accompanied with silty sand.
3.6 Odour	B	Nil
3.7 Traffic Nuisance	C	In case of pipeline being laid across road, the traffic will be interrupted.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

Appendix - 7

Project Cost Break-Down (Water Supply)

Summary of Cost Estimation of Water Supply in Dupiti

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	150,000	220,000	370,000
	Excavation and Earth-work	12,800	46,200	59,000
	Trench excavation	224,090	481,770	705,860
	Pipe-work	318,230	318,230	636,460
	Reservoir	324,000	324,000	648,000
	Pumping station, R.C.pump house	88,032	58,656	146,688
	Access road	89,000	207,000	296,000
	Bore-hole	1,632,000	648,000	2,280,000
	Water purification unit	10,000	15,000	25,000
	Booster pump and necessary works	120,000	200,000	320,000
	Electric submersible pump and necessary works	60,000	88,000	148,000
	Power supply	39,450	41,175	80,625
	Concrete work	483,400	897,900	1,381,300
	Masonry work	30,000	122,500	152,500
	Structure	103,620	241,770	345,390
	Temporary work(10% of above total)	368,462	391,020	759,482
	Total of civil work	4,053,084	4,301,221	8,354,305
2	Material & Equipment	4,025,396	281,777	4,307,173
	Sub Total	8,078,480	4,582,998	12,661,478
3	Engineering cost(12% of sub total)	1,519,377		1,519,377
4	Contingency(5% of total cost)	479,893	229,150	709,043
	Total	10,077,750	4,812,148	14,889,898
	Total(Yen:1birr=15yen)			223,000,000
5	Buildings		3,368,921	3,368,921
6	WSSD's management cost		365,176	365,176
	Total		3,734,097	3,734,097
7	Prise escalation(6%)	604,665	512,775	1,117,440
	Total(birr)	10,682,415	9,059,020	19,741,435
II.	Target year of 2010			
1	Mobilization and demobilization			1,000,000
2	Rising line			540,000
3	Distribution network			1,200,000
4	Now borehole with materials			1,100,000
5	Pump			300,000
6	Booster pump with house			1,068,000
7	Power supply facilities			340,000
8	Chamber and structures			189,000
9	Buildings			1,124,400
10	Others			2,792,600
	Sub total			9,654,000
11	Engineering cost (10%)			965,400
12	Contingency (10%)			1,061,940
	Total			11,681,000
13	Prise escalation			4,906,000
	Grand Total			16,587,000

No.	Description	Unit	Q'ty		Unit-Rate		Amount		Remarks
			F.C.(B)	L.C.(B)	F.C.(B)	L.C.(B)	F.C.(B)	L.C.(B)	
1.	Mobilization and Demobilization	LS					150,000	220,000	
2.	Excavation and Earth-work	ha	480	2,400			0		to remove bushes, small forest and trees
2-1	Clearing and grubbing the site	sqm	10,000	4			10,000	40,000	to remove top soil to an average depth of 20cm
2-2	Clear off the site								
2-3	Bulk excavation	cum	300	6	14		1,800	4,200	
	a) Earth excavation	cum	100	10	20		1,000	2,000	
	b) Excavation of weathered rock	cum		14	32		0	0	
	c) Soft rock excavation	cum		30	70		0	0	
	d) Sound rock excavation								
3.	Trench excavation	m	22,050	4	8		88,200	176,400	
3-1	Trench excavation for water pipe	m	390	7	17		2,730	6,630	
	1) Single pipe in trench	cum	100	30	70		3,000	7,000	
	a) 0.6~1.0m depth	m	17,950	5	11		89,750	197,450	
	b) 1.0~1.5m depth	m	4,490	2	5		8,980	22,450	150mm thick below barrel
	Trench, Rock excavation	m	4,490	7	16		31,430	71,840	compacted in layers not more than 20cm thick
	Back-fill with the same material	m		14	32		0	0	
	Selected soil bedding								
	Back-fill with selected material								
	b) 1.0~2.0m depth								
4.	Pipe-work	m	11,630	5	5		58,150	58,150	with push-in flexible joints
4-1	Pressure pipe NP 10	m	4,850	8	8		38,800	38,800	
	1) PVC pipe	m	1,270	10	10		12,700	12,700	
	a) DN 50mm	m	3,730	17	17		63,410	63,410	
	b) DN 75mm								
	c) DN 100mm								
	d) DN 150mm								
4-2	Pressure steal pipe	m	570	137	137		78,090	78,090	fitting and supports for bridge and road
	a) DN 200mm	m	390	172	172		67,080	67,080	
	b) DN 300mm								
5.	Reservoir	cum	360	900	900		324,000	324,000	
	Ground level reservoir								

Cost Estimation of Construction & Materials/Equipment of Duputi : Target year of 2005

No.	Description	Unit	Qty	Unit-Rate			Amount			Remarks
				F.C.(B)	L.C.(B)	F.C.(B)	F.C.(B)	L.C.(B)		
6.	Pumping station, R.C.pump house	sqm	48	1,834	1,222	88,032	58,656	with accessories		
7.	Access road	m	1,000	89	207	89,000	207,000	3m wide gravel road with drainage ditch		
8.	Bore-hole	set	2	300,000	300,000	1,600,000	600,000	including, casing, packing and pumping test		
8-1	New drilling	set	2	16,000	24,000	32,000	48,000			
8-2	Rehabilitation									
9.	Water purification unit	No.	1	10,000	15,000	10,000	15,000			
10.	Booster pump	No.	2	60,000	100,000	120,000	200,000	foundation, pump, and motor with accessories		
11.	Electric submersible pump	No.	2	20,000	30,000	40,000	60,000	foundation, and pump with accessories		
	Shallow Well	No.	2	10,000	14,000	20,000	28,000			
12.	Power supply	No.	1	5,850	8,775	5,850	8,775	generator with accessories		
12-1	Generating set	m	2,000	8	7	16,000	14,000			
12-2	High tension line	m	1,600	6	4	9,600	6,400			
12-3	Low tension line	No.	2	4,000	6,000	8,000	12,000	transformer with accessories		
12-4	Transformer									
13.	Concrete work	cum	1,000	250	500	250,000	500,000	including form-work, vibration and curing		
13-1	Normal concrete (250kg of cement per cum)							including vibration and curing		
13-2	Reinforced concrete (360kg of cement per cum)	cum	500	275	642	137,500	321,000	including all necessary works		
13-3	Form-work	sqm	700	37	87	25,900	60,900			
13-4	Reinforcement bars; Steel bars	kg	10,000	7	2	70,000	16,000	including cutting, bending and placing		
14.	Masonry work	sqm	500	60	245	30,000	122,500	up to 3m height		
14-1	Roughly dressed 40cm thick stone elevation wall	sqm								
14-2	Brick work with mortar 25cm thick	sqm		23	92	0	0			
15.	Structure	No.	9	1,580	3,680	14,220	33,120			
15-1	Construction of public fountains	No.	15	230	540	3,450	8,100			
15-2	Construction of hydrant	No.	5	5,730	13,370	28,650	66,850			
15-3	Construction of R.C.C. aeration chamber	No.	10	5,730	13,370	57,300	133,700			
15-4	Construction of R.C.C. valve chamber									

No.	Description	Unit	Q'ty	Unit-Rate		Amount		Remarks
				F.C.(B)	L.C.(B)	F.C.(B)	L.C.(B)	
	Sub-Total of Construction work					3,684,622	3,910,201	
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					4,025,396	281,777	CIF cost x 7 %
16-2	Inland transportation cost							
	Sub-Total of Material & Equipment					4,025,396	281,777	
	Total					7,710,018	4,191,978	
17.	Building							
17-1	Office	sqm	320	1,910		0	611,200	
17-2	Workshop	sqm	126	1,624		0	204,624	
17-3	Store	sqm	401	1,337		0	536,137	
17-4	Residence	sqm	960	2,101		0	2,016,960	
	Total						3,368,921	

Imported Cost (Material & Equipment) of Dupli :Target year of 2005

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1.	Pipe material including joint and accessories				
1.1	PVC pipe NP-10				
	a) DN 50mm	m	12,200	15	183,000
	b) DN 75mm	m	5,090	30	152,700
	c) DN 100mm	m	1,340	40	53,600
	d) DN 150mm	m	3,920	80	313,600
	e) DN 200mm	m		125	0
1.2	Suspended pressure steel pipe				
	a) DN 200mm W/O gilt and screw	m	600	288	172,800
	b) DN 250mm	m		334	0
	c) DN 300mm	m	410	418	171,380
	d) DN 350mm	m		611	0
1.3	Fitting cost Total cost × 20%				209,416
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 2m ³ /min H= 34m HP=18.5kw	set	2	280,000	560,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m ³ /min H= 100m HP= 5.5kw	set	2	130,000	260,000
	b) Q= 1.2m ³ /min H= 20m HP= 10 kw	set	2	200,000	400,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set 50 KVA	set	1	450,000	450,000
3.2	Tension line				
	a) High tension over head line 15KV	m	2,000	50	100,000
	b) Low tension over head line	m	1,600	28	44,800
3.3	Plate-form mounted transformer Supply of transformer wiht accessories Transformer 20 KVA	set	2	40,000	80,000
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) φ50	set		1,000	0
	b) φ75	set	3	1,300	3,900
	c) φ150	set		1,700	0
	d) φ200	set	3	2,200	6,600
4.2	High speed air valve φ50	set	5	7,000	35,000
4.3	Check valve				
	a) 100mm	set	1	10,000	10,000
	b) 150mm	set	2	17,000	34,000
5	Flow meter (Meter with accessories φ100)	set	1	50,000	50,000
6	Reservoir equipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe DN 2000	m	37	10,000	370,000
7.2	Screen Steel DN 100	m	64	150	9,600
7.3	Riser pipe, stainless DN 65	m	300	250	75,000
8	Water purification unit	set	1	80,000	80,000
	Total				4,025,396

Investment Cost of Target Year 2010 in Dupli

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			1,000,000
2	Rising line	Km	2	300,000	540,000
3	Distribution network	Km	8	150,000	1,200,000
4	Now borehole with materials	Set	1	1,100,000	1,100,000
5	Pump	Set	1	300,000	300,000
6	Booster pump with house	Set	2	534,000	1,068,000
7	Power supply facilities	Site	2	170,000	340,000
8	Chamber and structures	Set	7	27,000	189,000
9	Buildings	M2	12	93,700	1,124,400
	Others	LS			2,792,600
	Sub total				9,654,000
11	Engineering cost (10%)				965,400
12	Contingency (10%)				1,061,940
	Total				11,681,340

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Dupti

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1981	--	--	--	--	--	0.0	83.5	49.0	16.5	--	0.0	0.0	--
1982	2.0	5.0	67.0	0.0	10.5	0.0	25.0	14.0	2.0	26.1	23.2	0.0	174.8
1983	22.0	4.5	42.5	--	23.0	--	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	0.0	0.0	--	--	--	--	--
1986	0.0	0.3	31.0	191.8	6.1	9.1	51.3	23.8	10.0	0.0	0.0	2.0	325.4
1988	0.2	0.7	0.0	59.3	0.0	0.0	121.0	50.4	46.6	4.0	0.0	0.0	282.2
1989	0.0	17.4	38.0	81.5	0.0	0.0	27.9	6.1	5.8	0.0	0.0	4.2	180.9
1990	0.2	--	--	35.7	0.0	0.0	27.5	19.2	5.2	--	--	--	--
1991	0.0	2.2	46.9	--	--	--	--	--	--	--	--	--	--
1992	--	0.0	0.0	0.0	0.0	0.0	78.2	75.4	32.7	0.0	0.0	0.0	--
1993	--	27.1	--	56.0	25.0	0.0	--	--	--	--	--	0.0	--
1994	0.0	--	--	6.1	7.5	0.0	--	--	33.0	0.0	--	--	--

Table 2 Long Term Monthly Mean Potential Evapotranspiration

Station: Dupti

Unit: mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	65	67	69	69	72	78	79	85	92	95	102	100	
2nd 10 days	95	93	98	104	109	102	98	91	88	92	88	78	
3rd 10 days	70	60	64	71	75	72	69	65	65	65	64	65	
Total	230	220	231	244	256	252	246	241	245	252	254	243	2914

Note: -- = not calculated due to missing data

Table 3 Monthly Average Maximum Air Temperature

Station: Dupti

unit: °C

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1981	--	--	--	--	--	--	--	--	--	--	34.9	32.4
1982	32.3	33.5	35.8	37.7	39.5	42.5	41.4	40.5	40.4	36.0	34.5	32.9
1983	31.5	32.5	34.8	--	40.2	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	41.7	--	--	--	--	--
1986	31.6	33.6	35.9	35.8	--	42.0	40.5	39.9	38.7	36.3	34.1	32.1
1988	32.5	34.8	36.4	38.8	41.5	42.7	39.7	--	39.6	37.8	34.5	32.7
1989	--	--	34.3	34.7	39.9	42.5	41.1	40.8	39.5	37.7	34.4	32.5
1990	32.4	--	--	36.7	41.5	42.9	40.8	40.7	39.9	--	--	--
1991	33.1	33.9	36.1	--	--	--	--	--	--	--	--	--
1992	--	31.2	35.2	38.2	40.3	42.2	40.3	37.4	38.1	36.3	33.9	33.3
1993	--	31.6	--	36.2	38.8	42.5	--	--	--	--	--	32.7
1994	32.5	--	--	38.2	40.6	42.8	--	--	38.5	36.4	--	--

Table 4 Monthly Average Minimum Air Temperature

Station: Dupti

unit: °C

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1981	--	--	--	--	--	25.7	25.4	25.0	24.4	--	15.8	15.4
1982	18.3	22.0	21.7	23.3	23.8	26.2	27.1	25.5	25.2	20.8	20.9	19.1
1983	17.1	21.1	22.7	--	24.8	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	28.9	--	--	--	--	--
1986	14.1	20.5	19.7	21.7	22.2	21.4	19.4	21.4	22.0	17.5	16.1	16.3
1988	19.5	22.5	20.0	24.7	25.6	28.1	26.2	--	--	--	--	--
1989	--	--	21.2	22.9	24.2	26.0	26.6	26.3	26.6	22.1	18.7	21.7
1990	18.6	--	--	23.1	24.8	26.2	26.9	27.0	26.6	--	--	--
1991	19.9	21.8	--	--	--	--	--	--	--	--	--	--
1992	--	22.3	22.8	24.4	26.5	28.3	26.9	24.9	25.1	22.1	19.9	20.7
1993	--	20.0	--	24.2	25.8	26.9	--	--	--	--	--	16.3
1994	16.4	--	--	24.0	25.4	27.8	--	--	--	19.6	--	--

Note: -- = not calculated due to missing data

Table 5 Monthly Average Air Temperature

Station: Dupti

unit: °C

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1981	-	-	-	-	-	-	-	-	-	-	25.4	23.9
1982	25.3	27.8	28.8	30.5	31.7	34.4	34.3	33.0	32.8	28.4	27.7	26.0
1983	24.3	26.8	28.8	-	32.5	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	35.3	-	-	-	-	-
1986	22.9	27.1	27.8	28.8	-	31.7	30.0	30.7	30.4	26.9	25.1	24.2
1988	26.0	28.7	28.2	31.8	33.6	35.4	33.0	-	-	-	-	-
1989	-	-	27.8	28.8	32.1	34.3	33.9	33.6	33.1	29.9	26.6	27.1
1990	25.5	-	-	29.9	33.2	34.6	33.9	33.9	33.3	-	-	-
1991	26.5	27.9	-	-	-	-	-	-	-	-	-	-
1992	-	26.8	29.0	31.3	38.4	35.3	33.6	31.2	31.6	29.2	26.9	27.0
1993	-	25.8	-	30.2	32.3	34.7	-	-	-	-	-	24.5
1994	24.5	-	-	31.1	33.0	35.3	-	-	-	28.0	-	-

Note: - = not calculated due to missing data

Appendix - 9

Existing Pump Condition

Survey Site: DUBTI

Date: 16/11/87 E.C.

1. # 1 Well

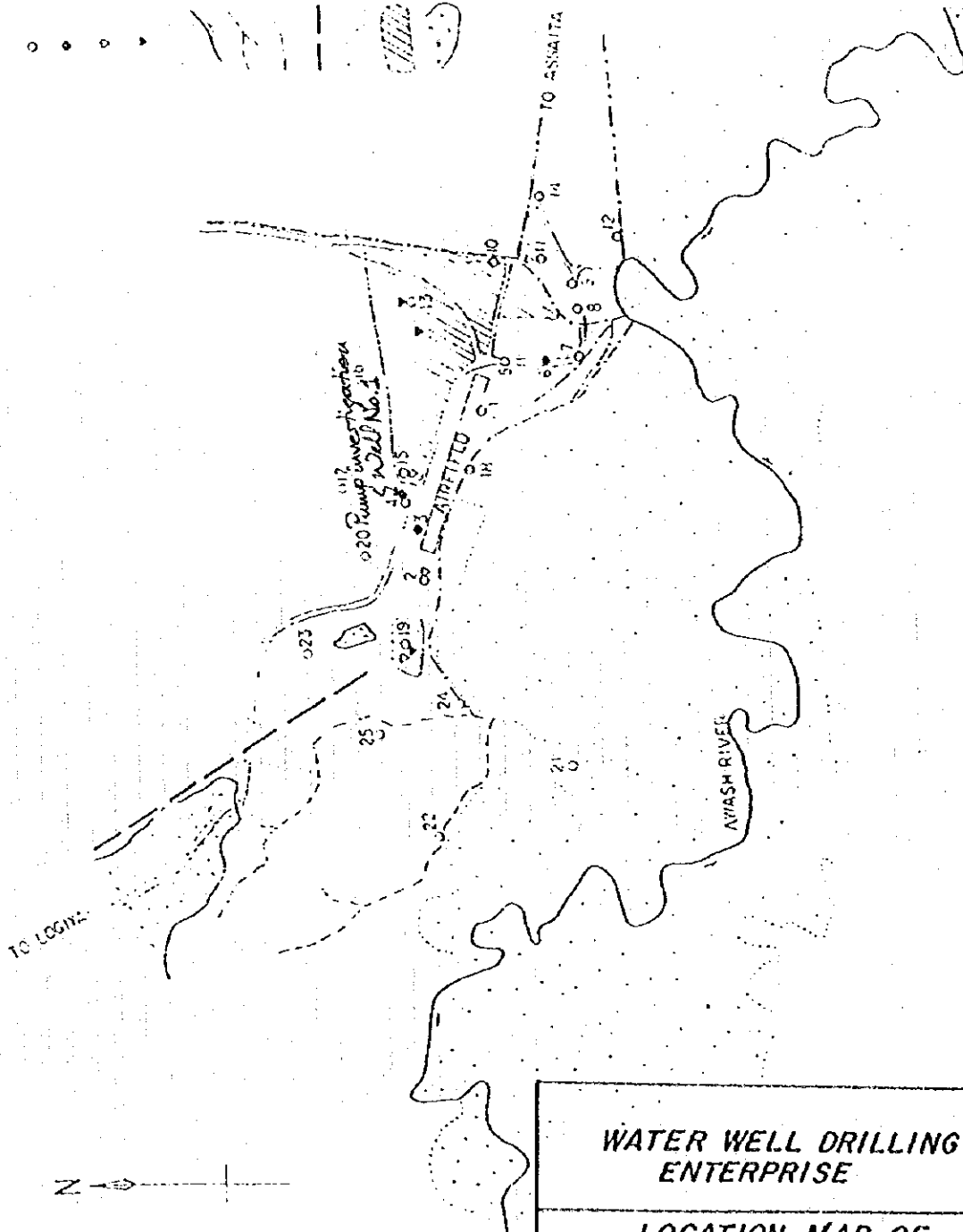
Well Accessories		Submersible Pump	
Check valve	50.8 mm	Manufacturer: Calama submersible pumping set India	
Pressure gauge	kg/cm ²	Type Q61/x II V6-68	
Flow meter	m ³ /sec	Head: 100 m	
Gate valve	mm	Capacity: 60 vl/min	
Conveyance pipe	mm	R.P.M: 2900	
		Hz: 50	
		Stage: 12	
		Others: Year = 1991	
Well Data		Others	
Static Water Level	18.0m	Power = 14 HP	
*Dyanamic Water Level	m	Voltage = 380 V	
Dia. & Length of a riser pipe		Ampere = 21.0A	
50.8 mm	39 m	Connection = Y/	
Total number of riser pipes		No. = 3911136361	
(of 6 mts. long)	6.5 nos.	Dev. Stage = 29-3 + 531-1	
Relay cable	Yes No		
Well Dia.	152.4 mm		

2. # 2 Well

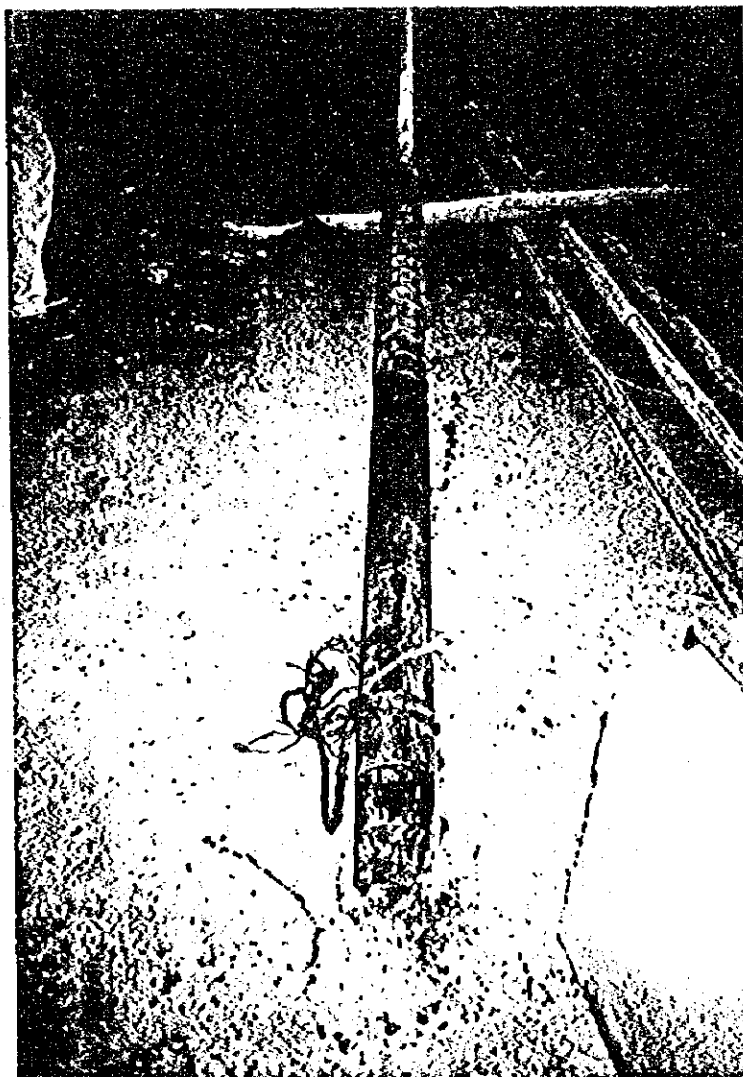
Well Accessories		Submersible Pump	
Check valve	mm	Manufacturer:	
Pressure gauge	kg/cm ²	Head:	m
Flow meter	m ³ /sec	Capacity:	
Gate valve	mm	R.P.M:	
Conveyance pipe	mm	Hz:	
		Stage:	
		Others:	
Well Data		Others	
Static Water Level	m		
Dyanamic Water Level	m		
Dia. & Length of a riser pipe			
	m		
Total number of riser pipes			
	nos.		
Relay cable	Yes No		
Well Dia.	mm		

LEGEND

- VES stations
- Proposed drilling site
- ◊ Existing borehole
- ▼ Abandoned borehole
- Road
- ~ River
- Wadi
- - - Irrigation canal
- Lineation
- ▨ Flood plain
- ▩ Town area
- ◌ Basalt outcrop

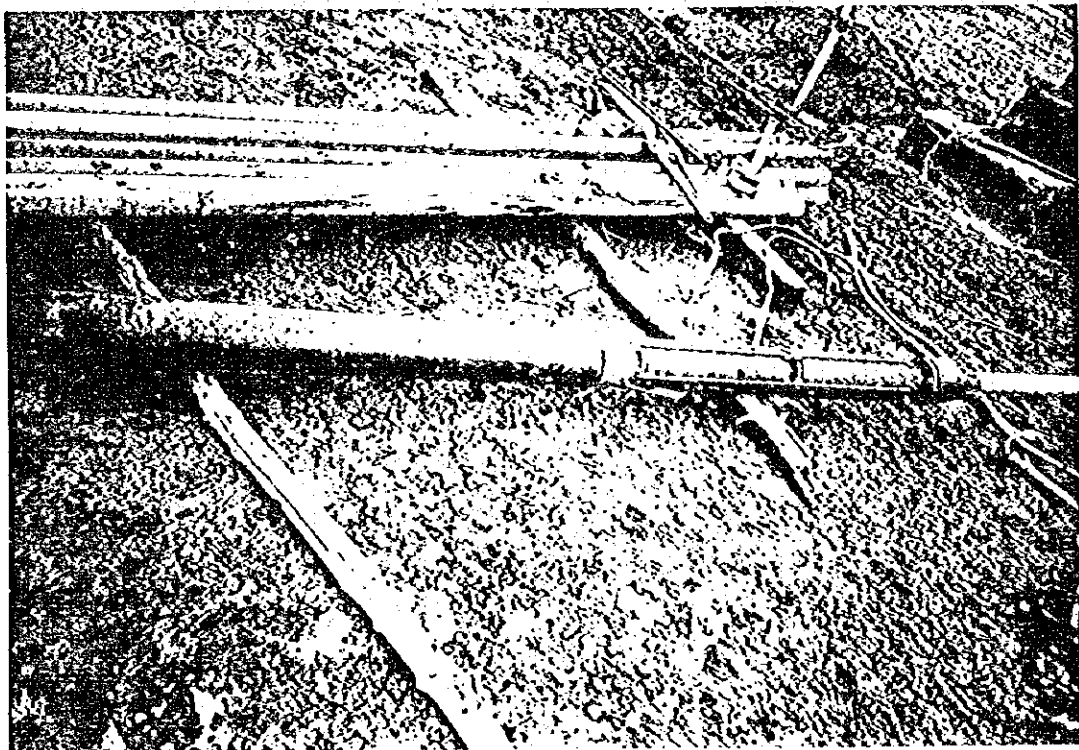


WATER WELL DRILLING ENTERPRISE	
LOCATION MAP OF DUBTI	
SCALE 1:5,000	ADDIS ABABA JULY, 1995



Picture 2 the investigated pump an new well

DUBPI



Picture 3 The spare pump which is installed in the new well

DUBFI

Appendix - 10

Calculation of Water Pipeline

Output data on distribution network for Dupli Case: Ordinary, 2005

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	20	32.24	0.46	0.02	1.09	110	
2	2	2	9	75	130	3.49	0.79	1.99	15.32	110	
3	3	9	10	75	520	1.64	0.37	1.96	3.78	110	
4	4	10	11	75	515	0.57	0.13	0.27	0.53	110	
5	5	11	12	75	265	-1.43	-0.32	-0.78	-2.94	110	
6	6	12	13	75	240	-2.03	-0.46	-1.35	-5.61	110	
7	7	13	3	150	310	-12.91	-0.73	-1.82	-5.88	110	
8	8	3	2	300	330	-28.26	-0.40	-0.28	-0.86	110	
9	9	3	5	200	315	8.55	0.27	0.21	0.68	110	
10	10	5	7	75	230	1.91	0.43	1.16	5.03	110	
11	11	7	8	75	200	1.28	0.29	0.48	2.40	110	
12	12	8	9	75	600	-0.37	-0.08	-0.14	-0.24	110	
13	13	3	4	200	100	6.19	0.20	0.04	0.37	110	
14	14	5	6	200	100	6.15	0.20	0.04	0.37	110	
15	15	11	14	75	920	0.88	0.20	1.10	1.19	110	
16	16	14	13	150	985	-9.41	-0.53	-3.22	-3.27	110	
17	17	14	15	100	220	8.32	1.06	4.13	18.78	110	
18	18	15	16	75	790	0.78	0.18	0.75	0.96	110	
19	19	15	17	100	430	6.28	0.80	4.80	11.16	110	

Output data on distribution network for Dupri Case: Fire Fighting, 2005

Serial Number	Pipeline Number	Nord Number	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	300	20	36.88	0.52	0.03	1.40	110	
2	2	2	75	130	3.31	0.75	1.80	13.83	110	
3	3	9	75	520	2.53	0.57	4.40	8.46	110	
4	4	10	75	515	1.85	0.42	2.44	4.74	110	
5	5	11	75	265	-1.83	-0.41	-1.23	-4.63	110	
6	6	12	75	240	-2.21	-0.50	-1.58	-6.56	110	
7	7	13	150	310	-23.36	-1.32	-5.45	-17.59	110	
8	8	3	300	330	-33.26	-0.47	-0.38	-1.16	110	
9	9	3	200	315	5.72	0.18	0.10	0.32	110	
10	10	5	75	230	1.62	0.37	0.85	3.68	110	
11	11	7	75	200	1.22	0.28	0.44	2.18	110	
12	12	8	75	600	0.17	0.04	0.03	0.06	110	
13	13	3	200	100	3.81	0.12	0.02	0.15	110	
14	14	5	200	100	3.79	0.12	0.01	0.15	110	
15	15	11	75	920	2.98	0.67	10.46	11.37	110	
16	16	14	150	985	-20.21	-1.14	-13.27	-13.47	110	
17	17	14	100	220	5.28	0.67	1.78	8.10	110	
18	18	15	75	790	0.49	0.11	0.32	0.40	110	
19	19	15	100	430	3.99	0.51	2.07	4.82	110	

Output data on distribution network for Dupri Case: Ordinary, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	20	61.69	0.87	0.07	3.63	110	
2	2	2	9	75	130	4.01	0.91	2.57	19.76	110	
3	3	9	10	75	520	1.68	0.38	2.05	3.94	110	
4	4	10	11	75	515	0.61	0.14	0.31	0.60	110	
5	5	11	12	75	265	-1.41	-0.32	-0.76	-2.85	110	
6	6	12	13	75	240	-2.01	-0.45	-1.32	-5.50	110	
7	7	13	3	150	310	-12.87	-0.73	-1.81	-5.84	110	
8	8	3	2	300	330	-57.19	-0.81	-1.04	-3.15	110	
9	9	3	5	200	315	22.81	0.73	1.31	4.15	110	
10	10	5	7	75	230	1.44	0.33	0.68	2.96	110	
11	11	7	8	75	200	0.81	0.18	0.20	1.02	110	
12	12	8	9	75	600	-0.84	-0.19	-0.66	-1.10	110	
13	13	3	4	200	100	20.91	0.67	0.35	3.53	110	
14	14	5	6	200	100	20.88	0.66	0.35	3.52	110	
15	15	11	14	75	920	0.90	0.20	1.14	1.24	110	
16	16	14	13	150	985	-9.39	-0.53	-3.21	-3.26	110	
17	17	14	15	100	220	8.32	1.06	4.13	18.78	110	
18	18	15	16	75	790	0.78	0.18	0.75	0.96	110	
19	19	15	17	100	430	6.28	0.80	4.80	11.16	110	

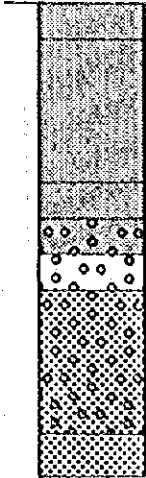
Output data on distribution network for Dupli Case: Fire Fighting, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	20	55.26	0.78	0.06	2.96	110	
2	2	2	9	75	130	3.66	0.83	2.17	16.69	110	
3	3	9	10	75	520	2.55	0.58	4.44	8.53	110	
4	4	10	11	75	515	1.87	0.42	2.47	4.80	110	
5	5	11	12	75	265	-1.82	-0.41	-1.22	-4.59	110	
6	6	12	13	75	240	-2.20	-0.50	-1.56	-6.51	110	
7	7	13	3	150	310	-23.34	-1.32	-5.45	-17.58	110	
8	8	3	2	300	330	-51.29	-0.73	-0.85	-2.58	110	
9	9	3	5	200	315	14.57	0.46	0.57	1.81	110	
10	10	5	7	75	230	1.28	0.29	0.55	2.38	110	
11	11	7	8	75	200	0.88	0.20	0.24	1.19	110	
12	12	8	9	75	600	-0.17	-0.04	-0.04	-0.06	110	
13	13	3	4	200	100	13.00	0.41	0.15	1.47	110	
14	14	5	6	200	100	12.98	0.41	0.15	1.46	110	
15	15	11	14	75	920	2.98	0.67	10.48	11.40	110	
16	16	14	13	150	985	-20.21	-1.14	-13.26	-13.47	110	
17	17	14	15	100	220	5.28	0.67	1.78	8.10	110	
18	18	15	16	75	790	0.49	0.11	0.32	0.40	110	
19	19	15	17	100	430	3.99	0.51	2.07	4.82	110	


Appendix - 11

Geological Logs of Existing Boreholes

WSS Borehole No.1 in Dupiti

	<u>Depth</u>	<u>Lithology</u>
	0 - 5 m	Silty Clay
	5 - 25 m	River Deposit Clay
	25 - 30 m	Silty Clay
	30 - 35 m	Clay and Gravel
	35 - 40 m	Basaltic Gravel
	40 - 60 m	Sandy Gravel with Clay
	60 - 66 m	Coarse Sand

WSS Borehole No.2 in Dupiti

	<u>Depth</u>	<u>Lithology</u>
	0 - 5 m	Silty Clay
	5 - 20 m	Gray Coloured Clay
	20 - 40 m	Clay, Sand and Gravel
	40 - 55 m	Laminated Clay with Volcanic Aggregate
	55 - 67 m	Silty Clay and Sand

JICA