社会開発調査部報告書

No. P 1

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER RESOURCES

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

APPENDIXES
NEFAS MEWCHA

(Volume III-VII)

FEBRUARY, 1996

SANYU CONSULTANTS INC.

KYOWA ENGINEERING CONSULTANTS CO., LTD.

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

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

APPENDIXES
NEFAS MEWCHA

(Volume Ⅲ-Ⅶ)

FEBRUARY, 1996

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

PREFACE

This is the Appendixes for Nefas Mewcha 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

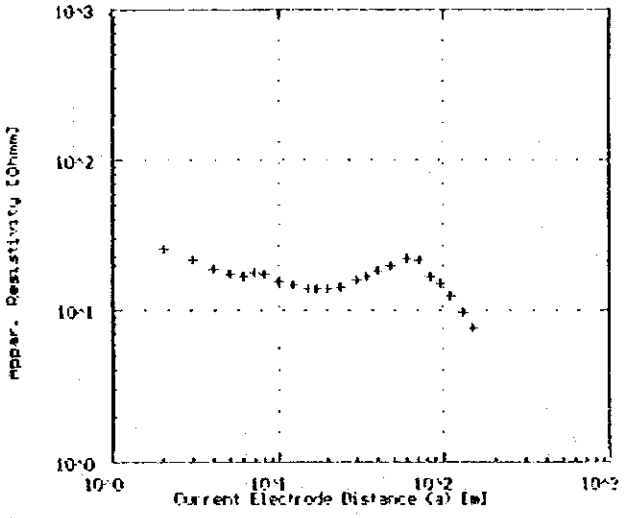
Appendix-1	Resistivity Interpretation of VEP	1-1
Appendix-2	Result of Water Quality Test	2-1
Appendix-3	Social and Gender Data	3-1
Appendix-4	Summary of Group Meeting	4-1
Appendix-5	Financial and Socio-Economic Data	5-1
Appendix-6	Result of Initial Environmental Examination	6-1
Appendix-7	Project Cost Break-Down (Water Supply)	7-1
Appendix-8	Meteorological Data	8-1
Appendix-9	Hydrological Data	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

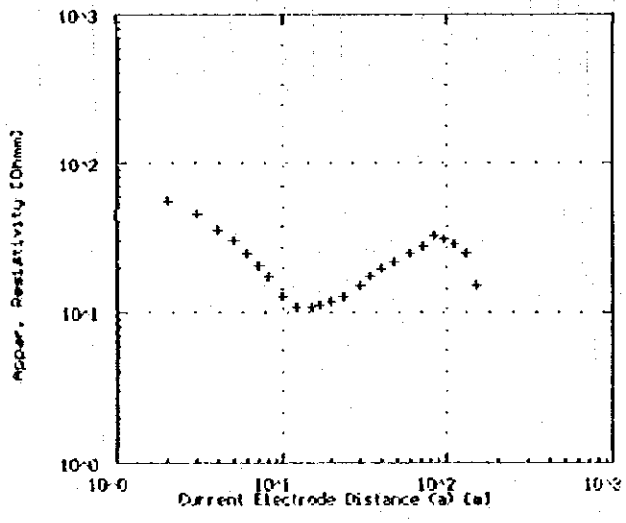
VES St. No.1 -NEFAS MEWCHA



Point (No)	AN/2 (Mr)	a (m)	Res (ohm)
1	1.00	22.810	
2	2.00	25.620	
3	3.00	27.870	
4	4.00	18.550	
5	5.00	17.270	
6	6.00	16.950	
7	7.00	17.500	
8	8.00	17.990	
9	10.00	15.640	
10	12.00	14.550	
11	15.00	13.540	
12	17.00	13.590	
13	20.00	13.020	
14	24.00	14.470	
15	30.00	14.010	
16	34.00	13.650	
17	40.00	13.360	
18	48.00	13.900	
19	60.00	21.050	
20	72.00	21.100	
21	85.00	18.880	
22	98.00	15.870	
23	110.00	12.930	
24	130.00	9.800	
25	150.00	7.510	

Specific Resistivity(Ω-m)	48	16	12.53	39	2.75

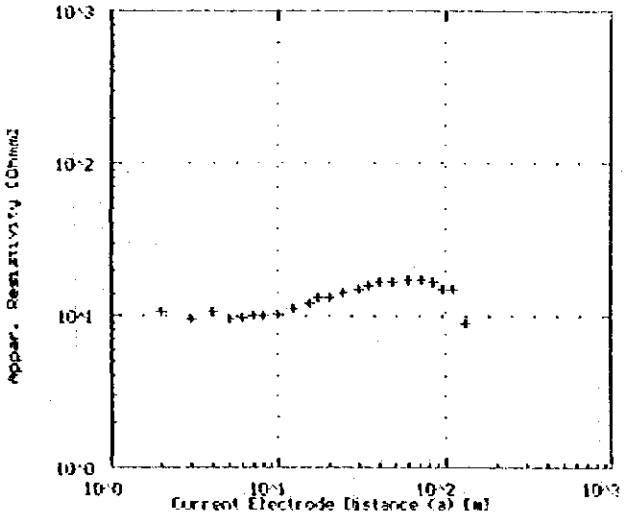
VES St. No.2 -NEFAS MEWCHA



Point (No)	AN/2 (Mr)	a (m)	Res (ohm)
1	1.00	53.380	
2	2.00	55.250	
3	3.00	45.780	
4	4.00	35.470	
5	5.00	29.020	
6	6.00	26.690	
7	7.00	26.560	
8	8.00	27.080	
9	10.00	22.910	
10	12.00	21.009	
11	15.00	20.930	
12	17.00	21.100	
13	20.00	21.930	
14	24.00	22.950	
15	30.00	25.070	
16	34.00	27.050	
17	40.00	29.050	
18	48.00	28.490	
19	60.00	26.490	
20	72.00	27.550	
21	85.00	32.100	
22	96.00	30.250	
23	110.00	28.320	
24	130.00	26.490	
25	150.00	25.070	

Specific Resistivity(Ω-m)	60	8.57	97	10.55

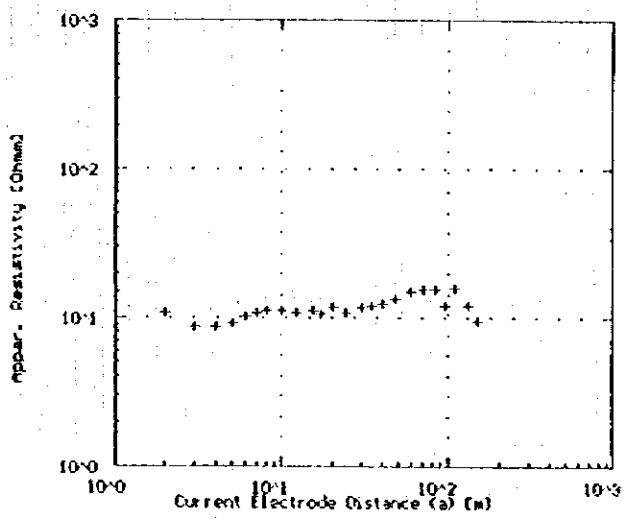
VES St. No.3 -NEFAS MEWCHA



Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	33.750	
2	2.00	10.630	
3	3.00	8.420	
4	4.00	10.550	
5	5.00	9.420	
6	6.00	9.810	
7	7.00	9.950	
8	8.00	9.950	
9	10.00	10.360	
10	12.00	11.030	
11	15.00	12.250	
12	17.00	13.030	
13	20.00	13.310	
14	24.00	14.470	
15	30.00	15.260	
16	34.00	15.800	
17	40.00	16.030	
18	50.00	16.030	
19	60.00	17.330	
20	72.00	17.100	
21	86.00	16.000	
22	95.00	15.970	
23	110.00	15.200	
24	120.00	0.000	

Specific Resistivity(Ω-m)	15.2	7.6	12.9	21.8	17	8.5

VES St. No.4 -NEFAS MEWCHA

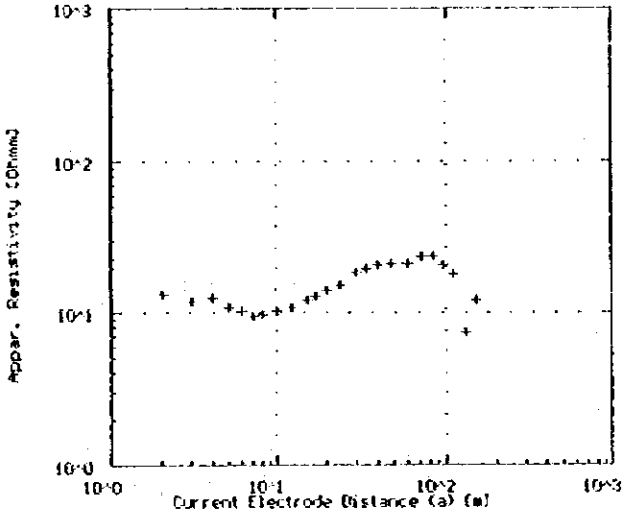


Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	15.070	
2	2.00	10.000	
3	3.00	8.070	
4	4.00	8.790	
5	5.00	9.110	
6	6.00	10.600	
7	7.00	10.860	
8	8.00	11.200	
9	10.00	11.120	
10	12.00	10.930	
11	15.00	11.120	
12	17.00	10.600	
13	20.00	11.930	
14	24.00	11.800	
15	30.00	11.070	
16	34.00	11.950	
17	40.00	12.310	
18	50.00	13.420	
19	60.00	15.070	
20	72.00	15.570	
21	86.00	15.300	
22	96.00	12.000	
23	110.00	15.090	
24	120.00	12.250	
25	150.00	0.020	

Specific Resistivity(Ω-m)	17.2	5.73	11.7	18	21.6	6.2

10.8

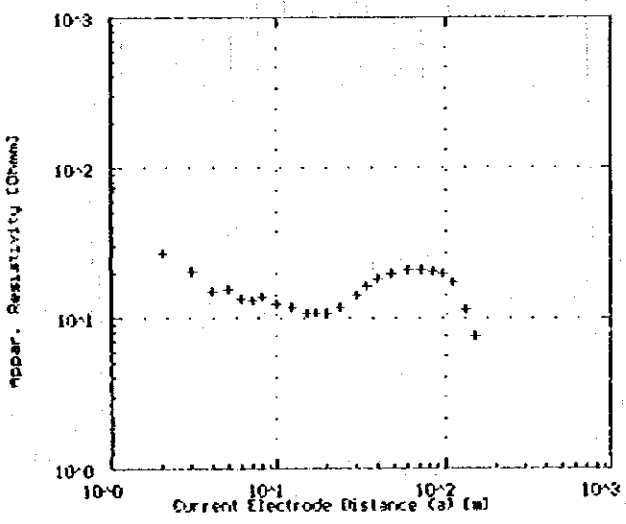
VES St. No.5 -NEFAS MEWCHA



Point (No)	AB/2 (Mc)	a (m)	Rss (ohm)
1	1.00	22.610	
2	2.00	13.060	
3	3.00	11.680	
4	4.00	12.560	
5	5.00	10.030	
6	6.00	10.210	
7	7.00	9.550	
8	9.00	9.500	
9	10.00	10.300	
10	12.00	10.700	
11	15.00	12.150	
12	17.00	12.810	
13	20.00	13.940	
14	24.00	15.229	
15	30.00	18.060	
16	34.00	19.223	
17	40.00	20.350	
18	50.00	24.100	
19	60.00	26.720	
20	72.00	23.510	
21	86.00	23.210	
22	96.00	28.500	
23	110.00	17.960	
24	130.00	3.350	
25	150.00	12.250	

Specific Resistivity(Ω-m)	53	10.6	7	32.4	30.3	7.67

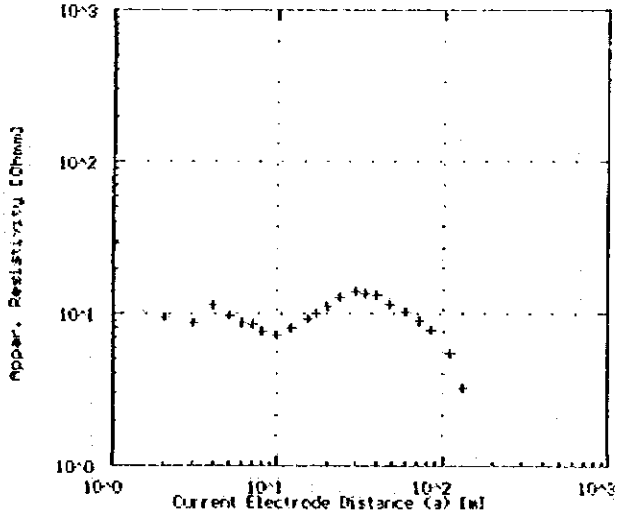
VES St. No.6 -NEFAS MEWCHA



Point (No)	AB/2 (Mc)	a (m)	Rss (ohm)
1	1.00	24.100	
2	2.00	23.000	
3	3.00	20.460	
4	4.00	15.070	
5	5.00	15.700	
6	6.00	13.570	
7	7.00	13.480	
8	8.00	13.010	
9	10.00	12.560	
10	12.00	11.760	
11	15.00	10.930	
12	17.00	10.090	
13	20.00	10.930	
14	24.00	11.760	
15	30.00	14.320	
16	34.00	16.210	
17	40.00	18.090	
18	50.00	19.590	
19	60.00	20.320	
20	72.00	20.000	
21	86.00	20.570	
22	96.00	18.990	
23	110.00	17.270	
24	130.00	11.030	
25	150.00	3.510	

Specific Resistivity(Ω-m)	82	13.67	7.5	15	44.8	32.4	3.39

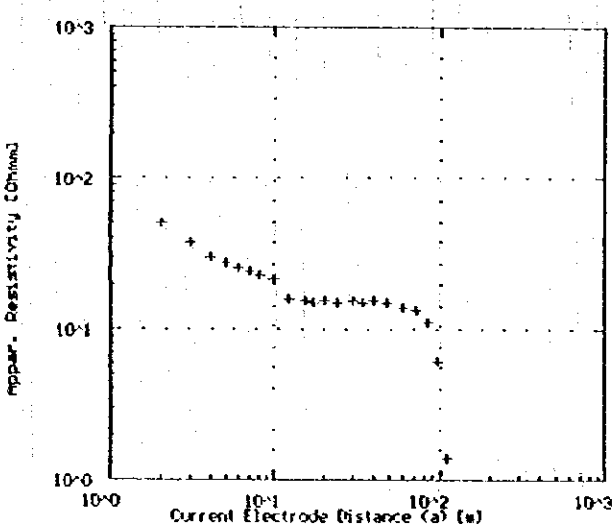
VES St. No.7 -NEFAS MEWCHA



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	20.850	
2	2.00	9.620	
3	3.00	6.670	
4	4.00	10.430	
5	5.00	8.230	
6	6.00	8.020	
7	7.00	8.460	
8	8.00	7.540	
9	10.00	7.220	
10	12.00	8.050	
11	15.00	8.330	
12	17.00	10.060	
13	20.00	10.120	
14	24.00	12.960	
15	30.00	13.940	
16	34.00	13.620	
17	40.00	13.060	
18	44.00	11.460	
19	50.00	10.120	
20	72.00	9.060	
21	84.00	7.510	
22	110.00	5.530	
23	130.00	3.270	

Specific Resistivity(Ω-m)	157	7.85	6	27.2	23	3.5	1.01

VES St. No.8 -NEFAS MEWCHA

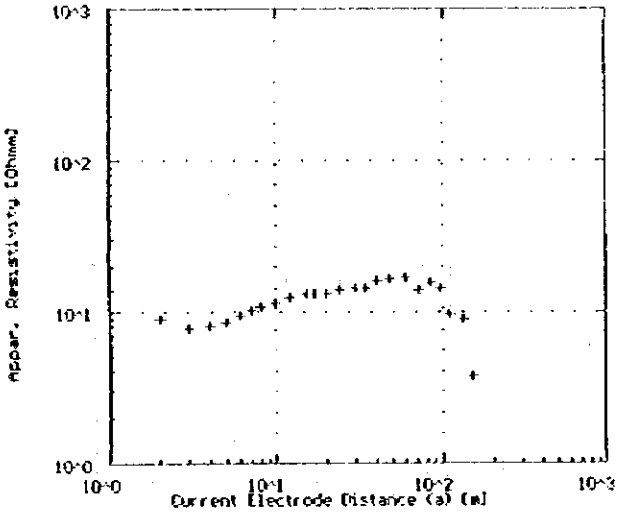


Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	50.750	
2	2.00	50.240	
3	3.00	37.200	
4	4.00	30.560	
5	5.00	27.950	
6	6.00	25.250	
7	7.00	23.760	
8	8.00	22.610	
9	10.00	21.670	
10	12.00	15.800	
11	15.00	15.650	
12	17.00	15.220	
13	20.00	15.570	
14	24.00	15.220	
15	30.00	15.650	
16	34.00	14.950	
17	40.00	15.570	
18	44.00	15.070	
19	50.00	13.960	
20	72.00	13.570	
21	84.00	11.600	
22	96.00	8.030	
23	110.00	1.300	

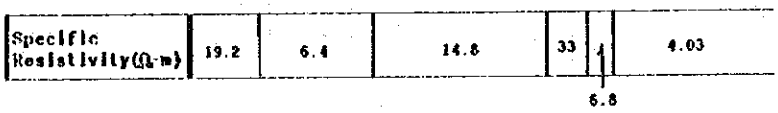
Specific Resistivity(Ω-m)	86	21.5	14	1.76

9.67

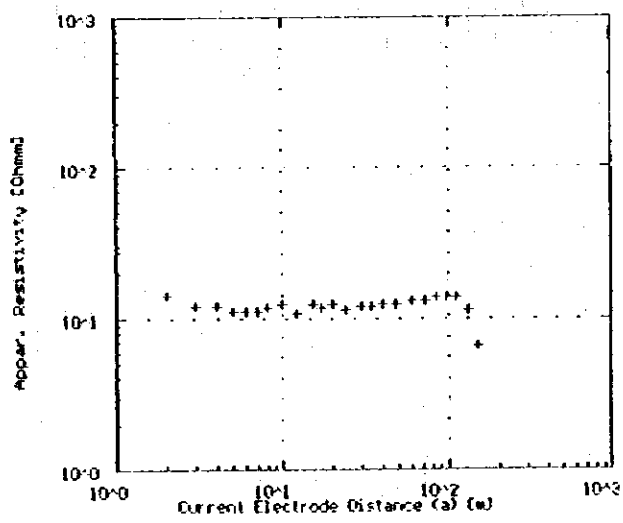
VES St. No.9 -NEFAS MEWCHA



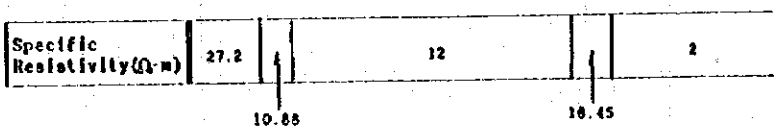
Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	13.750	
2	2.00	8.920	
3	3.00	7.720	
4	4.00	8.960	
5	5.00	8.600	
6	6.00	9.120	
7	7.00	10.230	
8	8.00	10.750	
9	10.00	11.520	
10	12.00	12.630	
11	15.00	13.000	
12	17.00	13.250	
13	20.00	13.310	
14	24.00	13.070	
15	30.00	14.130	
16	34.00	14.310	
17	40.00	14.000	
18	46.00	14.599	
19	60.00	14.950	
20	72.00	14.020	
21	84.00	15.300	
22	96.00	14.019	
23	110.00	9.620	
24	120.00	8.590	
25	150.00	3.770	



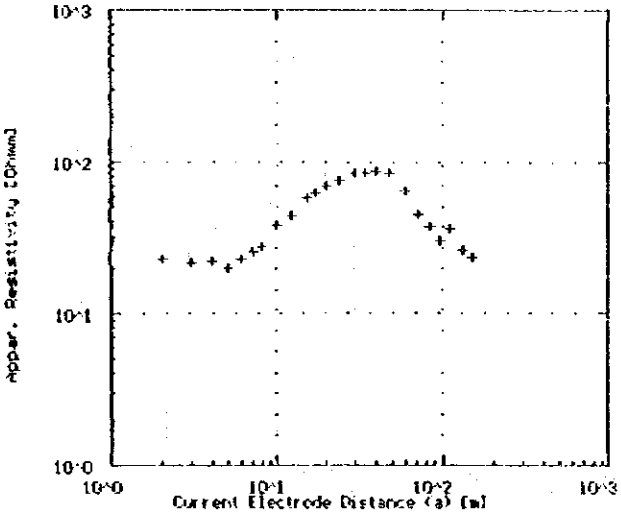
VES St. No.10 -NEFAS MEWCHA



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	27.630	
2	2.00	16.640	
3	3.00	12.060	
4	4.00	12.060	
5	5.00	10.300	
6	6.00	11.350	
7	7.00	10.250	
8	8.00	11.010	
9	10.00	12.020	
10	12.00	10.930	
11	15.00	12.670	
12	17.00	11.760	
13	20.00	12.310	
14	24.00	11.660	
15	30.00	12.050	
16	34.00	11.960	
17	40.00	12.260	
18	48.00	12.360	
19	60.00	13.190	
20	72.00	13.010	
21	84.00	13.220	
22	98.00	13.010	
23	110.00	13.020	
24	120.00	11.030	
25	150.00	8.599	



VES St. No.11 -NEFAS MEWCHA

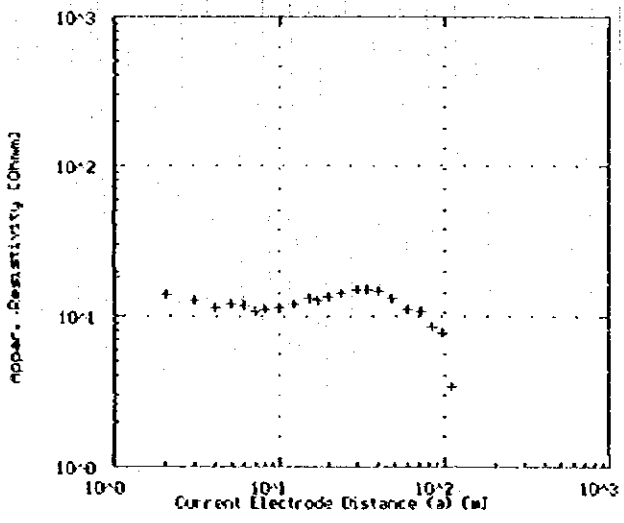


Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	32.630	
2	2.00	22.730	
3	3.00	21.290	
4	4.00	21.050	
5	5.00	19.780	
6	6.00	22.010	
7	7.00	25.050	
8	8.00	27.005	
9	10.00	30.310	
10	12.00	43.710	
11	15.00	57.410	
12	17.00	83.520	
13	20.00	78.340	
14	24.00	76.070	
15	30.00	84.700	
16	36.00	85.010	
17	40.00	87.020	
18	50.00	84.060	
19	60.00	66.000	
20	72.00	65.220	
21	84.00	38.930	
22	95.00	30.160	
23	110.00	30.010	
24	130.00	26.130	
25	150.00	23.550	

Specific Resistivity(Ω-m)	40	20	61.5		24

115.5

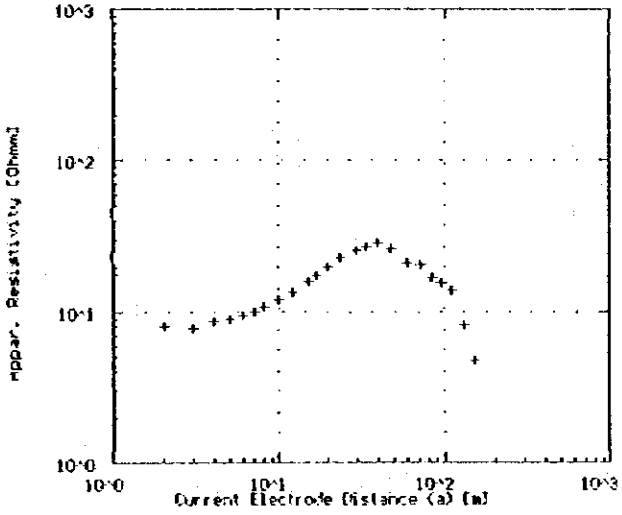
VES St. No.12 -NEFAS MEWCHA



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	10.460	
2	2.00	13.940	
3	3.00	12.010	
4	4.00	11.560	
5	5.00	12.250	
6	6.00	11.600	
7	7.00	10.950	
8	8.00	11.150	
9	10.00	12.490	
10	12.00	11.980	
11	15.00	13.050	
12	17.00	12.920	
13	20.00	13.690	
14	24.00	14.320	
15	30.00	15.020	
16	36.00	14.950	
17	40.00	14.020	
18	50.00	13.270	
19	60.00	11.300	
20	72.00	10.050	
21	84.00	8.440	
22	95.00	7.040	
23	110.00	3.050	

Specific Resistivity(Ω-m)	21.7	10.85	16.5	7.15	3.9

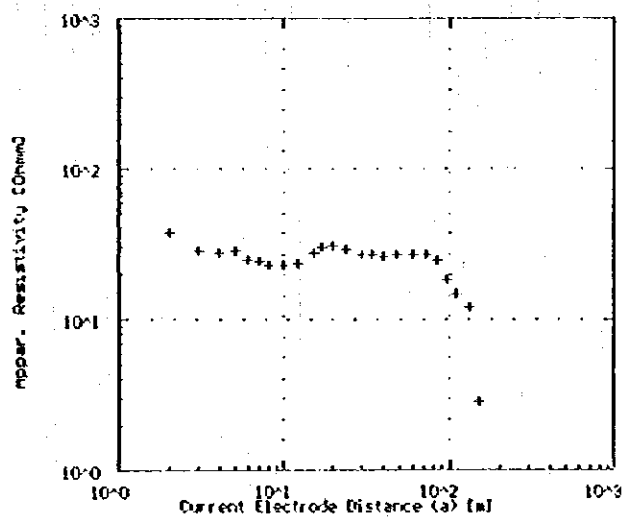
VES St. No.13 -NEFAS MEWCHA



Point [No]	MN/2 [Mr]	a [m]	Res [ohms]
1	1.00	17.780	
2	2.00	9.940	
3	3.00	7.720	
4	4.00	8.290	
5	5.00	8.920	
6	6.00	9.570	
7	7.00	10.070	
8	8.00	10.350	
9	10.00	12.250	
10	12.00	13.690	
11	15.00	15.170	
12	17.00	17.090	
13	20.00	19.720	
14	24.00	22.610	
15	30.00	25.620	
16	34.00	26.900	
17	40.00	28.130	
18	48.00	25.920	
19	60.00	26.720	
20	72.00	28.350	
21	84.00	16.880	
22	96.00	15.593	
23	110.00	13.820	
24	130.00	8.150	
25	150.00	6.710	

Specific Resistivity(Ω-m)	30	4.29	12.6	40.12	6.55	1.42

VES St. No.14 -NEFAS MEWCHA

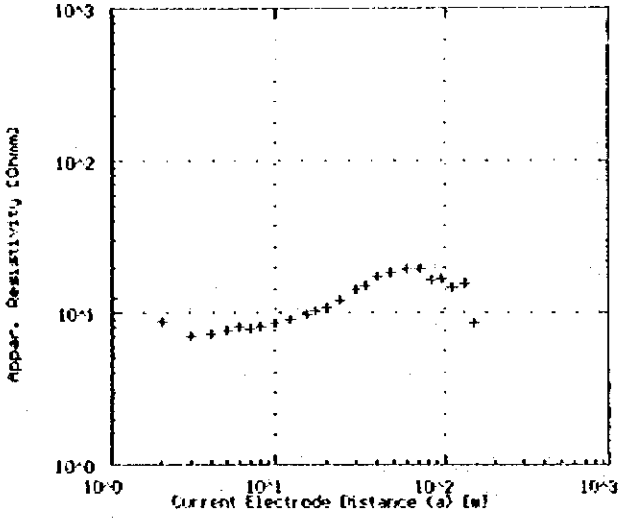


Point [No]	MN/2 [Mr]	a [m]	Res [ohms]
1	1.00	66.570	
2	2.00	37.680	
3	3.00	28.640	
4	4.00	27.630	
5	5.00	28.260	
6	6.00	26.970	
7	7.00	26.180	
8	8.00	22.610	
9	10.00	22.860	
10	12.00	23.360	
11	15.00	22.420	
12	17.00	25.230	
13	20.00	30.520	
14	24.00	28.099	
15	30.00	22.130	
16	34.00	28.000	
17	40.00	26.380	
18	48.00	26.530	
19	60.00	26.250	
20	72.00	28.000	
21	84.00	26.250	
22	96.00	18.695	
23	110.00	16.510	
24	130.00	12.250	
25	150.00	2.030	

Specific Resistivity(Ω-m)	93	23.25	31.5	20		7.54

35.25

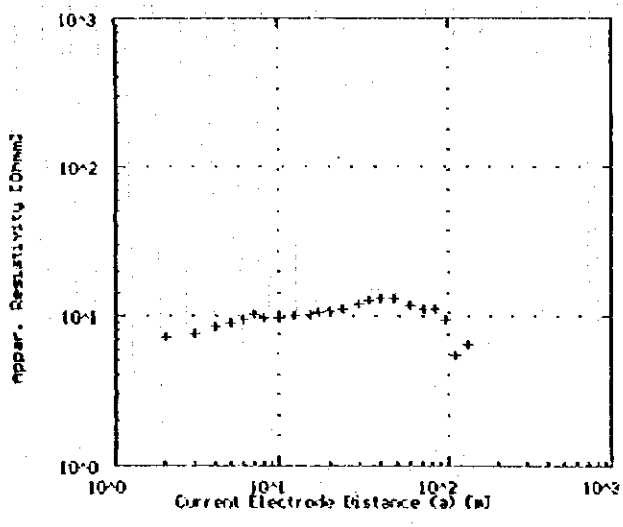
VES St. No.15 -NEFAS MEWCHA



Point (No)	MN/2 (Mr)	a (m)	Res (ohmm)
1	1.00	12.670	
2	2.00	9.070	
3	3.00	8.070	
4	4.00	7.290	
5	5.00	7.550	
6	6.00	8.050	
7	7.00	7.740	
8	8.00	7.950	
9	10.00	8.650	
10	12.00	9.060	
11	15.00	9.800	
12	17.00	10.040	
13	20.00	10.020	
14	24.00	12.210	
15	30.00	16.130	
16	34.00	15.160	
17	40.00	17.080	
18	48.00	18.350	
19	60.00	19.270	
20	72.00	19.660	
21	84.00	16.350	
22	96.00	15.080	
23	110.00	14.510	
24	130.00	15.510	
25	150.00	0.000	

Specific Resistivity(Ω-m)	15.7	5.23	9.6	24.9	9.25

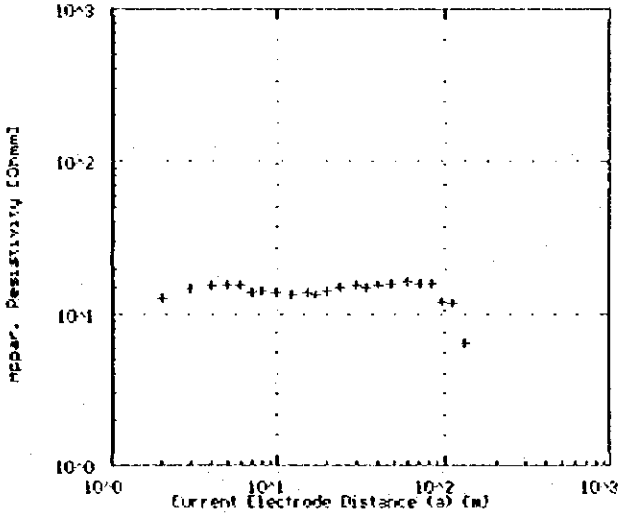
VES St. No.16 -NEFAS MEWCHA



Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	16.190	
2	2.00	7.290	
3	3.00	7.560	
4	4.00	8.540	
5	5.00	8.950	
6	6.00	9.530	
7	7.00	10.330	
8	8.00	8.650	
9	10.00	9.070	
10	12.00	10.020	
11	15.00	10.360	
12	17.00	10.650	
13	20.00	10.800	
14	24.00	11.300	
15	30.00	12.250	
16	34.00	12.810	
17	40.00	13.660	
18	48.00	13.260	
19	60.00	11.600	
20	72.00	11.300	
21	84.00	11.000	
22	96.00	9.350	
23	110.00	8.530	
24	130.00	8.520	
25	150.00	8.340	

Specific Resistivity(Ω-m)	22.8	4.56	15	11.7	15.75	6.65	3.96

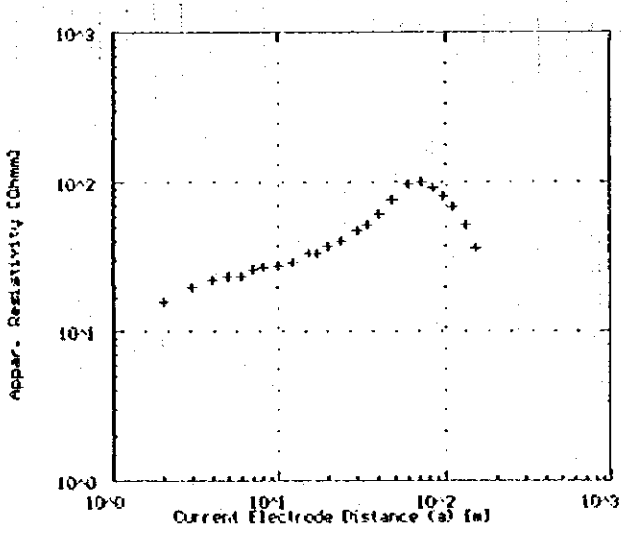
VES St. No.17 -NEPAS MEWCHA



Point [No]	AB/2 [Mr]	a [m]	Res (ohm)
1	1.00	15.070	
2	2.00	15.010	
3	3.00	16.700	
4	4.00	15.570	
5	5.00	15.390	
6	6.00	15.660	
7	7.00	16.070	
8	8.00	15.020	
9	10.00	13.960	
10	12.00	13.640	
11	15.00	13.250	
12	17.00	12.670	
13	20.00	10.660	
14	24.00	14.320	
15	30.00	15.060	
16	34.00	14.950	
17	40.00	15.320	
18	48.00	15.980	
19	60.00	16.200	
20	72.00	15.930	
21	84.00	15.030	
22	96.00	12.060	
23	110.00	11.740	
24	130.00	8.530	
25	150.00	8.960	

Specific Resistivity(Ω-m)	16	10.67	18.3	10.27	18	7.24

VES St. No.18 -NEPAS MEWCHA



Point [No]	AB/2 [Mr]	a [m]	Res (ohm)
1	1.00	16.640	
2	2.00	15.030	
3	3.00	19.970	
4	4.00	21.059	
5	5.00	21.550	
6	6.00	23.350	
7	7.00	26.300	
8	8.00	26.630	
9	10.00	27.630	
10	12.00	29.330	
11	15.00	32.970	
12	17.00	33.100	
13	20.00	37.630	
14	24.00	40.630	
15	30.00	47.670	
16	34.00	51.250	
17	40.00	61.540	
18	48.00	70.870	
19	60.00	87.970	
20	72.00	93.059	
21	84.00	91.260	
22	95.00	81.390	
23	110.00	67.700	
24	130.00	52.250	
25	150.00	35.900	

Specific Resistivity(Ω-m)	16	32	115.2	430	360	12.86

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Nefas Mewcha

Sample No.1

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 25/Jan./95
Date of Analysis : 07/Feb./95

Physical Characteristics

Appearance	: Very Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 120
Turbidity	: 1 FTU
Temperature	: -
Conductivity	: 0.26 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 140
Carbonate Hardness as $CaCO_3$	: 140
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 110
Bicarbonate Alkalinity as $CaCO_3$	: 110
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.50
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 5.00
Na^+	: -	NO_2^-	: 0.18
K^+	: -	NO_3^-	: 3.70
Ca^{++}	: 28.00	F^-	: 0.33
Mg^{++}	: 16.79	HCO_3^-	: 134.20
Fe(Total)	: 0.01	CO_3^{--}	: Nil
Mn^{++}	: 0.02	SO_4^{--}	: 14.00
Cu^{++}	: 0.12	PO_4^{---}	: 1.07

Remarks; All the analyzed chemical constituents 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 Nefas Mewcha

Sample No.2

Origin of Sample : Zenti Spring
Date of Collection: 13/Jun./95
Date of Analysis : 20/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 15 Pt-Co
Settleable Solids	: Present (Very small)
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 180
Turbidity	: 3 FTU
Temperature	: 19.0 °C
Conductivity	: 0.30 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 140
Carbonate Hardness as $CaCO_3$	: 140
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 160
Bicarbonate Alkalinity as $CaCO_3$	: 160
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.17
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 50.00
Na^+	: -	NO_2^-	: 0.03
K^+	: -	NO_3^-	: 12.32
Ca^{++}	: 40.00	F^-	: 0.362
Mg^{++}	: 9.76	HCO_3^-	: 195.20
Fe(Total)	: 0.03	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: Nil
Cu^{++}	: 0.05	PO_4^{---}	: 0.44

Remarks; All the analyzed chemical constituents 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 Nefas Mewcha

Sample No.3

Origin of Sample : Borehole (Not yet served)
Date of Collection: 13/Jun./95
Date of Analysis : 20/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 123 Pt-Co
Settleable Solids	: Present
Floating Solids	: Present (Plant debris)
Suspended Solids	: Absent
Total Dissolved Solids	: 192
Turbidity	: 23 FTU
Temperature	: 19.1 °C
Conductivity	: 0.32 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 50
Carbonate Hardness as $CaCO_3$	: 50
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 100
Bicarbonate Alkalinity as $CaCO_3$	: 100
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.37
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 1.26	Cl^-	: 50.00
Na^+	: -	NO_2^-	: 0.04
K^+	: -	NO_3^-	: 0.44
Ca^{++}	: 12.00	F^-	: 0.208
Mg^{++}	: 4.88	HCO_3^-	: 122.00
Fe(Total)	: 0.06	CO_3^{--}	: Nil
Mn^{++}	: 0.10	SO_4^{--}	: Nil
Cu^{++}	: Nil	PO_4^{---}	: 1.84

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 Faecal Coliform Test in Nefas Mewcha, Sampled and Analyzed on June/8,13/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	2	BH1	BH1	NIL	From the tap installed at Borehole No.1
2	1	BH1	Reservoir	NIL	
3	1	BH1	P.Foun.11	NIL	
4	2	BH1	P.Foun.12	NIL	
5	1	BH1	P.Foun.13	NIL	
6	1	BH1	Y.Conn.	NIL	
7	2	BH1	Y.Conn.	NIL	
8	2	BH1	Y.Conn.	NIL	
9	2	BH1	P.Conn.	NIL	
10	2	BH1	P.Conn.	NIL	
11	1	BH1	Barrel	NIL	Fetched at the private connection
12	2	BH1	Barrel	NIL	Fetched at Adeyababa Hotel connection
13	2	BH1	Barrel	NIL	Fetched at the yard connection
14	2	BH1	Barrel	1	Fetched at the private connection
15	1	BH1	Clay pot	94	Fetched 1 day before, Not covered
16	1	BH1	Clay pot	35	Fetched 1 day before, Not Covered
17	1	BH1	Clay pot	0	Fetched 4 days before
18	2	BH1	Clay pot	0	Fetched on the day, Covered by Papyrus
19	2	BH1	Clay pot	0	Fetched 1 day before, Covered by Papyrus
20	2	BH1	Clay pot	0	Fetched 1 day before, Covered by tin
21	1	BH1	Plant pot	12	Fetched 1 day before, Not covered
22	2	BH1	Jerry-can	0	Fetched on the day at P.Foun.13
23	2	BH1	Jerry-can	0	Fetched 1 week before at a p.conn.
24	2	BH1	Bottle	0	Fetched 4 days before
25	2	Spring	Spring	0	Protected spring
26	2	Spring	Spring	0	Protected spring, Retested for No.25
27	2	Spring	Spring	242	Not protected
28	1	Spring	Jerry-can	172	Fetched on the day at No.25
29	1	Spring	Jerry-can	TMTC	Fetched 1 day before at No.25
30	1	Spring	Jerry-can	156	Fetched on the day at No.25
31	2	Spring	Jerry-can	71	Fetched on the day at No.25
32	2	Spring	Jerry-can	2	Fetched 1 day before at No.25
There is only one water source (BH1) operated by 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

NEFAS MEWCHA - Activity Profile by gender

Public Fountain Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	mostly women		tap/spring
Does the laundry	n	y	mostly women		tap/spring
Waters livestock	y	n			spring
Takes water from container	y	y	all do	anytime	
Teaches children hygiene	y	y			
Disposes of solid waste	n	y	some is burned		
Digs a compost pit	-	-			
Constructs a latrine	-	-	none		
Digs a drainage channel	y	n	some have 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	y	y	mostly women		

y = Yes, n = No

Private Connection Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	not enough supply from PCs		tap/spring
Does the laundry	n	y			home/spring
Waters livestock	y	n	paid labor		stream
Takes water from container	y	y		anytime	
Teaches children hygiene	n	y	mostly women		
Disposes of solid waste	n	y	some burn waste		
Digs a compost pit	y	n	very few		compound
Constructs a latrine	n	n	pays for labor		
Digs a drainage channel	y	n	some pits		
Tends a kitchen garden	y	n	not enough water		
Disposes of animal waste	n	y	labor/servants		
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	n	y			

y = Yes, n = No

NEFAS MEWCHA - Daily schedule

Public Fountain User

Man	Time	Woman
	6	Gets up and goes to church
Gets up and goes to church	7	"
"	8	Returns home, makes breakfast
Returns home for breakfast	9	Eats breakfast with family
Rests in chair outside	10	Cleans home, does washing
Works in garden compound	11	Coffee ceremony
"	12	" (with friend)
Eats lunch	13	Eats lunch
Rests in chair	14	Spins cotton
Talks with neighbors	15	"
"	16	**Collects water from PF or**
Talks with children	17	**from spring**
"	18	Prepares supper
Eats supper	19	Gives supper to family
Talks with family	20	Clears up
Goes to sleep	21	Talks with family
	22	Goes to sleep
	23	

He is chairman on one EDER group and a retired policeman

she is frail and not very well

Couple are not necessarily representative of all public fountain users.

Private Connection Users

Man	Time	Woman
	6	Gets up, washes
Gets up and eats breakfast	7	Eats breakfast
Goes to work	8	Supervises staff of business
(trading clothes)	9	(Tea and other drinks)
"	10	"
"	11	"
"	12	"
Returns home for lunch	13	Eats lunch
Returns to work	14	Supervises staff
"	15	Drinks coffee with household
"	16	"
"	17	Relaxes with customers
Meets with friends in town	18	"
Comes home	19	Eats supper
Eats supper	20	Does accounts
Goes to sleep	21	Closes shop
	22	Goes to sleep
	23	

He is a member of Eder which takes up a little time each month

Not enough water available at the tap, so workers go to spring for additional water

NEFAS MEWCHA - Access and Control Profile

Private Connection Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	n	some women have control
Money for soap	y	y	y	n	of money,
Money for water container	y	y	y	n	but most do
Money for water pot cover	y	y	y	n	not earn
Money for building materials for drying shelf	y	y	y	y	Women and men organize
Money for building latrine	y	y	y	n	
Money for medicine	y	y	y	n	
Tools for digging pits	y	y	n	n	paid labor
Tools for constructing latrine	y	y	n	n	paid labor
Seeds and tools for vegetable gardens	-	-	-	-	none have
Land for digging pits	y	y	y	y	few have
Land for digging latrines	y	y	y	y	
Land for digging drains	y	y	y	y	
Land for vegetable gardens	y	y	y	y	
Income from selling water	y	y	y	n	provisional
Income from selling vegetables	y	y	y	y	"
Improved health	-	-	-	-	
Reduced time spent collecting water	n	n	y	y	
Reduced time spent caring for sick	y	y	y	y	

Money and resources are seen as a shared pot

PF Users/Spring Users/Other Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	
Money for soap	y	y	y	y	
Money for water container	y	y	y	y	
Money for water pot cover	y	y	y	y	
Money for building materials for drying shelf	y	y	y	y	women and men organize
Money for building latrine	y	y	y	y	not all have
Money for medicine	y	y	y	y	not all have
Tools for digging pits	y	y	y	y	most burn solid waste
Tools for constructing latrine	y	y	y	y	
Seeds and tools for vegetable gardens	-	-	-	-	none have
Land for digging pits	y	y	n	n	some have
Land for digging latrines	y	y	n	n	access to
Land for digging drains	y	y	n	n	land
Land for vegetable gardens	y	y	y	y	
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	n	y	y	
Reduced time spent caring for sick	y	y	y	y	

Private Connection Users

		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	Upgrading standard of existing household latrines, and improve pit linings and emptying system	y	y	All have latrines already, some have collapsed or are filled
	Improve sanitation situation for other user groups nearby	y	y	Other user groups use surrounding area for defecation
Health Education	More health education by trained appropriate personnel	y	y	Have been going to existing health education sessions
Strategic needs				
Water	Water managed by Government and not community/committee	y	y	Already done
Sanitation	Private latrines to be managed by households	y	y	Already done

y = Yes, n = No

NEFAS MEWCHA - Needs Analysis

Public Fountain/Vendor Users/Spring Users

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate and reliable quantities of water from the water supply system each day	y	y	Currently many different sources are used by most households
	Reduced time spent queuing for water	y	y	Reduced queues and reduced distance to water supply facilities
Sanitation	Assistance with household and community latrine construction, latrines must have pit linings to stop collapse	y	y	Community managed latrines would require some support and enforcement form 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 labor and with transportation of materials.
Sanitation	Community latrines to be managed by the community	y	y	Need support/enforcement from Authorities for improvements in sanitation, including the use and management of community latrines.
Health Education	Sanitary education to go alongside income generation activities	y	y	Reasonable health awareness but lack resources to take action

y = Yes, n = No

NEFAS MEWCHA - Social and Gender Considerations

Social/Gender differences	Underlying factors	Impact of the project	Possible measures to be taken
Richer people tend to have better access to piped water and poorer people have longer distances and require more time for fetching water	Richer people have private connections and public fountains have limited opening times	Middle income people will benefit most from any improvements in water supply facilities or operating service	Involve community in selection of public fountian locations. Initiate income generation activities for low income households
Riche people tend to have better access to sanitation facilities and poored people, particularly Muslims do not have access	Only the wealthy have disposable income for latrines, and can afford to invest in pit linings required	Middle income peolple will benefit most from any improvements in latrine facilities	Involve the community in selection of sites for community managed latrines for low income households, particularly Muslims
Women only defaecate under cover of darkness	The need for privacy determines the time that women can defaecate	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
Women fetch water most of the time and women usually do the laundry. Girls and occasionally boys help in collection of water from PFs and springs	Water collection and laundry are the roles undertaken mostly by women and sometimes by girls	Women and to a lesser extent girls will benefit most from time and energy savings from having a reliable water supply available near their homes	The project needs to help women and girls identify how to spend any time released through improved water supply and assist with initiatives as required

Appendix - 4

Summary of Group Meeting

NEFAS MEWCHA - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Amhara, Christian, Kebele 1, Outskirts of town, 23 women, 10 men, many children	1-Nutrition, 2-Water, 3-Health
Water	Spring water users, women fetch water, laundry done at home by women, use public fountain 1:4 days	Additional public fountain near to homes, prepared to manage it themselves and contribute to construction with labour and materials
Sanitation	Open field defaecation. Women go at different times to men (dawn and dusk only for women) All use the same area	Community latrines shared between six families, must be sited near to homes
Health	Prevalent diseases are pneumonia, intestinal parasites and diarrhoea (inc. some deaths from diarrhoea). Fully aware of health risks from contaminated water and open defaecation	Lack of affordability was sited as the reason for not having and using latrines. Sanitary education is unlikely to improve sanitary conditions without tangible imputs.

Group 2 details	Group characteristics	Group needs
General	Amhara, mostly Christian, 40 women, 10 men and many children, daily labourers	1-Food, 2-Water, 3-Sanitation, 4-Health
Water	Public fountain users, PF open once in four days. Women fetch water from public fountain for drinking. Laundry done by women at river/spring. Not easy to get water at river/spring - long queues and sometimes fighting. Cost from PF of 10 cents per pot	PFs only work once in four days. Water shortage exacerbated by lack of fuel. If PFs worked each day for two hours, there would be adequate water for the needs of the town. Prepared to pay more money for better service.
Sanitation	All use open field defecation. Men and women go at different times. No latrines due to lack of control over money and land (Kebele rented houses).	Would like community latrines, to share by sex not by groups of families. Could not pay for water charge at the latrine if it was supplied. Would also like to have public shower facility.
Health	Health awareness is good, people clear of the link between poor sanitation and disease. Diseases include TB, diarrhoea, typhoid.	Improved health facilities required.

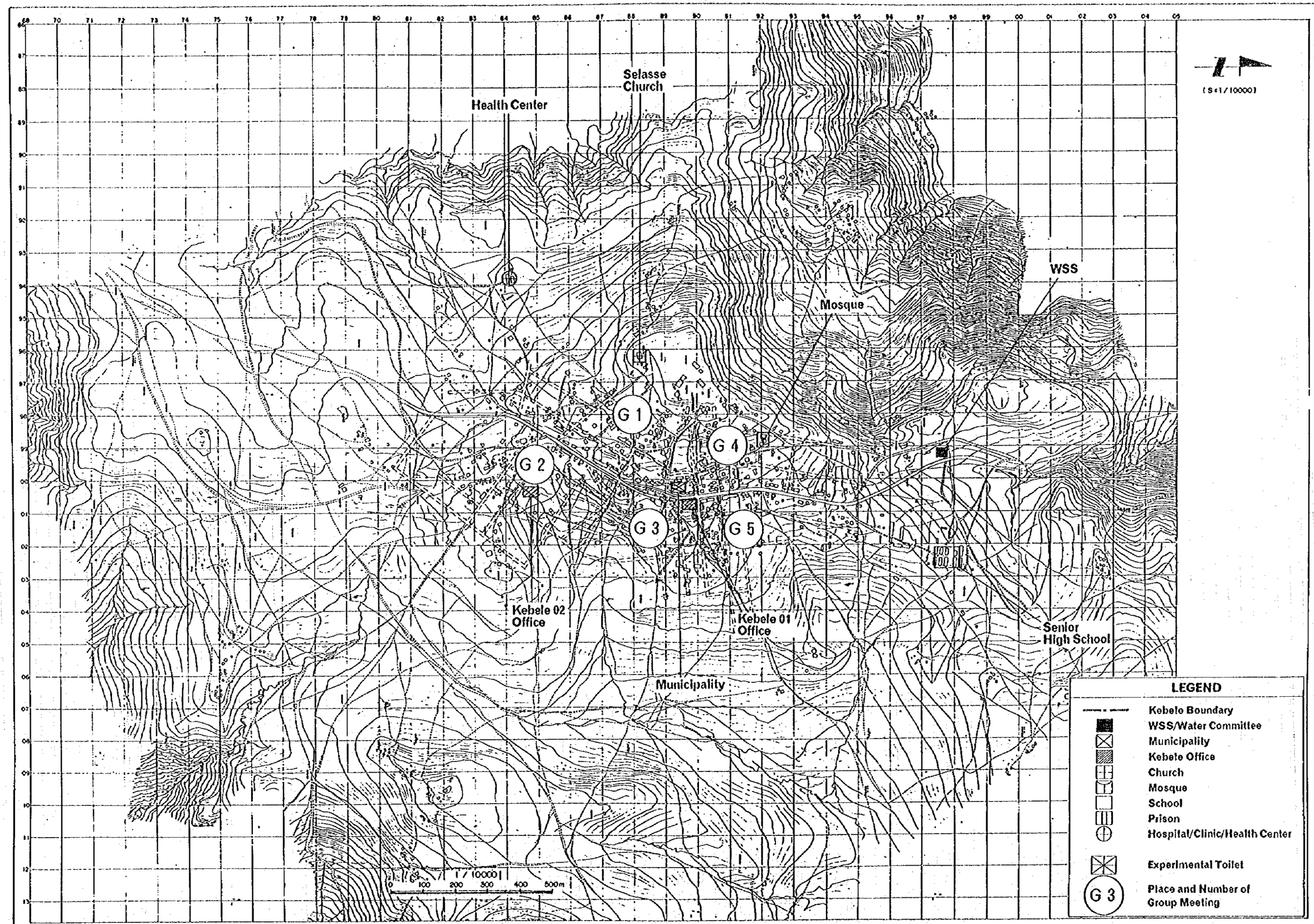
NEFAS MEWCHA - Summary of group meetings (continued)

Group 3 details	Group characteristics	Group needs
General	Mostly Amhara, mostly Christian, 18 women, 13 men several children,	1-Food (One man said "If we have food, we can drink from the river"), 2-Water, 3-Health and access to medicines
Water	Public fountain users once in four days, some have private connections, all use unprotected springs on other days. Mostly women fetch water, sometimes men also. Laundry done at springs. Price is reasonable for water.	Would like additional public fountains and would help in their construction but the Government should manage them.
Sanitation	Some use latrines, most use open field. Both sexes said they go to the same place at same time. Those with latrines had them constructed using paid labour. Women clean the latrines. Latrines require lining for pit or else they collapse.	Those with out latrines mostly in rented housing, would like community latrines. Prepared to help with the construction. Paying for water at the latrine would be difficult to arrange but might be possible as a monthly rate. Unable to afford desludging
Health	Health awareness not good. Health problems include pneumonia, stomach problems due to food shortage, TB and diarrhoea	No health need identified.

Group 4 details	Group characteristics	Group needs
General	Mostly Amhara, mostly Christian, 19 women, 13 men, many children,	1-Food and Water, 2-Jobs so people can support themselves
Water	Public fountain users, one day in four, otherwise use unprotected spring which is difficult and has large queue. Women fetch water, women do laundry at spring. Men and women water livestock at spring. Some vendors selling water from PCs.	Would like existing public fountain to operate each day for two hours. Prepared to manage the existing public fountain themselves and to pay more for a better water service. Think the problem not a shortage of water but a problem with Water Department.
Sanitation	Most people use open field sites for defaecation as they have no control over land. Also a lack of wood for slabs. Solid waste disposed of in open field sites too and this is a recognised problem. Kebele need to allocate area for waste disposal.	Would like community latrines to be managed by themselves. Would keep them clean and organise payment of the water service perhaps by a monthly payment. Would subsidise those who could least afford to pay. No demand for public shower.
Health	Reasonable awareness of sanitation related diseases. Health problems include TB.	No identified health need

NEFAS MEWCHA - Summary of group meetings (continued)

Group 5 details	Group characteristics	Group needs
General	Mostly Amhara, mostly Christian, 15 women, 12 men and some children.	1-Water, 2-Electricity, 3-Hospital, 4-Food and Work
Water	Private connection users but have to supplement with spring water as sometimes only get water from taps once in a week. Women go to spring, men will go too after dark. Some are private connection vendors.	Water supply form private connections would be adequate if they functioned each day for two hours.
Sanitation	Most people have latrines, some have problems with collapsing soil/latrines. Other latrines are full and it is difficult to get the truck to empty them form Bahir Dar. They pay taxes for sanitation to the Authorities so they should organise emptying	Authorities to sort out emptying of existing latrines using money already collected from sanitation taxes.
Health	Health awareness is good. Health Education is undertaken at health centre but would like more health education to be available. Diseases include TB (from dust) children's malnutrition, and diarrhoea	More health education through health workers at all levels which is appropriate to the needs of the local people and their culture.


Selasse Church
Health Center
WSS
Mosque
G 1
G 2
G 3
G 4
G 5
Kebele 02 Office
Kebele 01 Office
Senior High School
Municipality
1 / 10000
0 100 200 300 400 500m
LEGEND
Kebele Boundary
WSS/Water Committee
Municipality
Kebele Office
Church
Mosque
School
Prison
Hospital/Clinic/Health Center
Experimental Toilet
G 3
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	42,216	74,219	66,278	17,810	46,409
& consumption in	31,206	55,045	55,008	15,826	41,201
1993/1994 (m3)					
*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-	56,457	68,590	66,791	34,679	62,089
ture in 1993/1994	79,567	72,172	102,309	71,591	67,846
(birr)					
*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,	19	17	22	20	17
female, tempo-	5	6	7	6	3
rary/contract	1	2	0	2	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/	383	327	478	238	390
yard connections,	14(13)	12	13(12)	7	7
public fountains, hydrants					

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 Nefas Mewcha

1. Official Water Price: 1 birr/m3 for all clients

2. Production and Consumption of Water, 1993/94

1) Production : 42,216 m3

2) Consumption: 31,206 m3

* Daily water consumption as divided by total population = 6.2 litre

* Leakage ratio = 26.1%

3. Income and Expenditure

1) Income : 56,457 birr

Major sources of income

(1) House Connections	27,413 birr	(48.6%)
(2) Public fountains	10,782 birr	(19.1%)
(3) Service charge	7,808 birr	(13.8%)

* Bill collection rate = 91.7%

* Income per unit consumption of water = 1.81 birr/m3

2) Expenditure: 79,567 birr

Major items of expenditure

(1) Salaries	32,964 birr	(41.4%)
(2) Fuel	21,128 birr	(26.6%)
(3) Fittings and water meters	5,733 birr	(7.2%)
(4) Uniform	3,975 birr	(5.0%)

* Expenditure per unit production of water: 1.88 birr/m3

* Income-expenditure ratio: 71.0%

4. Organization and Personnel

1) No. of personnel: 19 (5) [2]

Table 2 (2) Financial Condition of Water Supply Service in Nefas Mewcha

(1) Head, WSS	1
(2) Administration 4 guards, 1 archives clerk, 1 (1) [1] clerk, 1 store keeper	7 (1) [1]
(3) Finance 1 accounting clerk, 1 [1] cashier, 1 (1) meter reader, 5 (3) water sellers	8 (4) [1]
(4) Urban water supply & sewerage 1 plumber, 1 assistant plumber, 1 motor operator	3

Note: Parenthesized and bracketed figures denote the number of female and temporary/contract workers respectively.

* Production per worker = 2,222 m3/year

* Income and expenditure per worker = 2,971 birr, 4,188 birr/year

2) Average monthly salaries of employees: 153 birr

5. No. of Distribution Facilities

1) Yard connections : 383

(1) Household	:	337
(2) Governmental & public	:	16
(3) Commercial	:	30

2) Public fountains : 14 (13 functional)

Note: There is no hand-dug well.

6. Problems and Bottlenecks

1) Income and expenditure are not balanced.
2) Shortage of water sources.
3) Insufficient office facilities.
4) Shortage of ,especially technical, manpower.
5) Shortage of pipes and fittings.
6) Lack of transport.
7) Lack of tool kits.

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. Ethinic 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. Ethinic 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 Nefas Mewcha

I. Administrative Conditions

1. Administrative Classification: Region 3, Zone = South Gonder

2. Government Organizations
1) Agricultural Bureau
2) Natural Resources Development and Environmental Protection (NRDEP)
3) Weroda Council
4) Financial Bureau
5) Educational Bureau
6) Municipality
7) Health Center
8) Ethiopian Electric Light and Power Authority (EELPA)
9) Police
10) Post Office
11) Telecommunications
12) Weroda Court
13) Weroda Attorney
14) Prison
15) Adult Education Office
16) Relief and Rehabilitation Commission (RRC)
17) Meteorological Service
18) Sharia Court
19) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There are three NGO's, namely Food For Hungry Aid, Canadian Physician Relief (CPR) and Ethiopian Orthodox Church (EOC).

3. No. of Government Employees and Their Average Monthly Salaries: 641, 297 birr

* No. of government employees per 1,000 population: 39

4. No. of Kebele: 2

II. Socio-Economic Conditions

1. Population
1) Total population: 13,726

2) Ethnic composition: Amhara (100.0%)

3) Religious composition: Christians (94.0%), Moslems (6.0%)

Table 4 (2) Socio-Economic Condition of Nefas Mewcha

4) Average family size: 5.9 persons

2. Area: 648 ha * Population density: 21.2 persons/ha

3. Educational Conditions
1) No. of schools, class rooms, teachers and pupils/students

Items	Kinder-garten	Elementary School	Junior and Senior High School
(1) No. of schools	2	2	1
(2) No. of class rooms	-	-	-
(3) No. of teachers	2	88	43
(4) No. of pupils/students	144	2,489	1,110

* No. of pupils/students per 100 population: 27

2) Literacy ratio: 70.2% (1984)

3) Primary school enrollment ratio: 58.5% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Health Center (5 beds), 2 private pharmacies

2) No. of medical personnel:
2 doctors, 6 nurses, 1 laboratory technician, 1 pharmacy technician, 2 leprosy control personnel, 19 health assistants, 12 junior health assistants ... 43 in total

Other related personnel: 2 sanitarians, 1 statistician

3) Incidence of diseases (Jul. 1993 - Jun. 1994)

(1) Top ten diseases

i.	Pneumonia	4,444 cases
ii.	Intestinal parasitism	3,729
iii.	Scabies	2,998
iv.	Sexually transmitted diseases	2,214
v.	Diarrheal diseases	2,002
vi.	Conjunctivitis (eye diseases)	1,644
vii.	Gastritis	1,435
viii.	Upper respiratory tract infection	1,386

Table 4 (3) Socio-Economic Condition of Nefas Mewcha

ix. Acute feverile illness	1,199	i. to x.
x. Rheumatism	1,050	= 22,001

(2) Estimated number of cases per year as percentage of population:
(22,001 x 1.5) / (13,726 x 5) = 48.1%

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

4) Under 5 mortality rate: 195.8/1000 (1984)

5) Life expectancy: 49.0 years (1984)

6) Households more or less using septic tank and pit latrine: 58.0%

5. No. of Holy Places: 6 churches, 1 mosque

6. Economic Conditions
1) No. of commercial and industrial establishments

Classification	Annual Income (birr)			
	< 1,000	1,000 - 3,000	3,000 <	Total
1. Hotels and restaurants				
Hotels	0	31	10	41
Restaurants	0	63	0	63
Bars	0	13	0	13
Tea rooms	0	72	0	72
Tej houses	0	0	20	20
Sub-total	0	179	30	209
2. Shops	100	263	266	629
3. Cottage industry (flour mill)	0	0	22	22
Total	100	442	318	860

Notes: 1. 50% of households are local drink producers.

* No. of commercial and industrial establishments per 1,000 population: 63

Table 4 (4) Socio-Economic Condition of Nefas Mewcha

2) Major occupations
(1) Trade (2) Government employees (3) Day laborers (4) Peasants

3) Major products: -

4) Market
(1) Major marketable items: household items, grains, livestock, vegetables, fruit, clothes, etc.

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

tef	barley	wheat	beans
215	180-200	230	200

Livestock (unit: birr/one)

ox	cow	sheep	horse	mule	donkey
700	500	80-90	600	1,500	200

Consumers' items (unit: birr)

butter (kg)	honey (kg)	milk (litre)
14	8	1.5

(3) Market day - Saturday (80,000 people gather.)

4) Average monthly household income: 202.3 birr

Sources: Water Supply Service, Weroda Council, Financial Bureau, Educational Bureau and Health Center in Nefas Mewcha; Socio-Economic Sampling Questionnaire Survey by JICA; Central Statistical Authority

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Nefas Mewcha

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Background	Insufficient water supply and low per-capita-consumption due mainly to lack of water source.
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition.
Location	Nefas Mewcha, South Gonder Zone, Gaint Province, Region-3
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 13,700 of the population to be benefited.
Dimensions of the Plan	Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network.
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
Water Quality	The present water source is within WHO guidelines. Few clay pot showed coliform contaminat'n
Main Facilities	Boreholes with pumping system.
Water Storage Facilities	Reservoir (ground tank) with enough capacity.
Filtration Plant	Not to be considered.
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 in Ethiopia.

Site Description on Initial Environmental Examination in Nefas Mewcha

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 13,700, mostly Amhara and orthodox Christian.
Facilities related to life (electricity, etc.)	The electricity is currently generated from 18:00 to 24:00.
Health and Sanitation (diseases, clinic, etc.)	0 hospital, 1 health center, 2 drug stores, The common diseases are scabbies, parasites, STDs, and diarrhea.
Natural Environment	
Topography, Geology and Hydrogeology	Located in mountainous area with altitude of more than 3000m. Alkaline basalt dominates the area. Less groundwater potential.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 1160m. There are small springs located south of the town.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	Because of shortage of water, people have to go to springs, which spent about 1 hour for the fetching.
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	1. Because of serious shortage of water, it is strictly prohibited to sell water privately. 2. Among 5 boreholes drilled so far, only 2 are productive, indicating low potential of groundwater.

Scoping Format for Initial Environmental Examination in Nefas Mewcha

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.
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.
1.8 Waste Disposal	B	During construction works, there will be little waste disposal from the view of the small construction scale. After commissionning, 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.
2. Natural Environment		
2.1 Geographic and Geological Condition	B	No effect is expected to geographic and geological condition.
2.2 Soil Erosion	C	The earth work gives little soil erosion, judging from the construction scale.

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

to be continued.....

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, overpumpimg must be checked.
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	B	The new borehole are designed away from the dwelling area. Little land subsidence is expected in term of basalt foundation.
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 Nefas Mewcha

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	100,000	150,000	250,000
	Excavation and Earth-work	8,240	27,700	35,940
	Trench excavation	362,710	815,510	1,178,220
	Pipe-work	355,410	355,410	710,820
	Reservoir	234,000	234,000	468,000
	Pumping station, R.C.pump house	176,064	117,312	293,376
	Access road	178,000	414,000	592,000
	Bore-hole (200mm casing)	144,000	216,000	360,000
	Water purifiction unit	10,000	15,000	25,000
	Booster pump and necessary works	480,000	800,000	1,280,000
	Electric submersible pump and necessary works	100,000	150,000	250,000
	Power supply	55,700	58,550	114,250
	Concrete work	111,700	193,500	305,200
	Masonsy work	12,000	49,000	61,000
	Structure	120,060	280,160	400,220
	Temporary work(10% of above total)	244,788	387,614	632,402
	Total of civil work	2,692,672	4,263,756	6,956,428
2	Material & Equipment	8,662,972	606,408	9,269,380
	Sub Total	11,355,644	4,870,165	16,225,809
3	Engineering cost(12% of sub tatal)	1,947,097		1,947,097
4	Contingency(5% of above cost)	665,137	243,508	908,645
	Total(birr)	13,967,878	5,113,673	19,081,551
	Total(Yen:1birr=15yen)			286,223,000
5	Buildings		1,718,575	1,718,575
6	WSSD's mannagement cost		416,003	416,003
	Total		2,134,578	2,134,578
7	Prise escalation(6%)	838,073	434,895	1,272,968
	Grand Total	14,805,951	7,683,146	22,489,097
II.	Target year of 2010			
1	Morbilization and demorbilization			300,000
2	Rising line			690,000
3	Distribution network			1,350,000
4	New borehole with pumps & material			1,977,000
5	Booster pump with house			534,000
6	Power supply facilities			170,000
7	Chamber and structures			324,000
8	Buildings			937,000
9	Others			579,000
	Sub total			6,861,000
10	Engineering cost (10%)			686,100
11	Contingency (10%)			754,710
	Total			8,302,000
	Prise escalation(42%)			3,487,000
	Grand Total			11,789,000

Cost Estimation of Construction & Materials/Equipment of Nefas Mew: Target year of 2005 1/3

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
1.	Mobilization and Demobilization	LS				100,000	150,000	
2.	Excavation and Earth-work							
2-1	Clearing and grubbing the site	ha	3	480	2,400	1,440	7,200	to remove bushes, small forest and trees
2-2	Clear off the site	sqm	3,000	1	4	3,000	12,000	to remove top soil to an average depth of 20cm
2-3	Bulk excavation							
	a) Earth excavation	cum	100	6	14	600	1,400	
	b) Excavation of weathered rock	cum	100	10	20	1,000	2,000	
	c) Soft rock excavation	cum	50	14	32	700	1,600	
	d) Sound rock excavation	cum	50	30	70	1,500	3,500	
3.	Trench excavation							
3-1	Trench excavation for water pipe							
	1) Single pipe in trench							
	a) 0.6~1.0m depth	m	20,270	4	8	81,080	162,160	
	b) 1.0~1.5m depth	m	8,910	7	17	62,370	151,470	
3-2	Trench, Rock excavation	cum	500	30	70	15,000	35,000	
3-3	Back-fill with the same material	m	14,590	5	11	72,950	160,490	
3-4	Selected soil bedding	m	14,590	2	5	29,180	72,950	150mm thick below barrel
3-5	Back-fill with selected material	m	14,590	7	16	102,130	233,440	compacted in layers not more than 20cm thick
4.	Pipe-work							
4-1	Presure pipe NP 10							with push-in flexible joints
	1) PVC pipe							
	a) DN 50mm	m	15,620	5	5	78,100	78,100	
	b) DN 75mm	m	4,650	8	8	37,200	37,200	
	c) DN 100mm	m	760	10	10	7,600	7,600	
	d) DN 150mm	m	7,400	17	17	125,800	125,800	
4-2	Pressure steal pipe							fitting and supports for bridge and road
	a) DN 200mm	m	420	137	137	57,540	57,540	
	b) DN 250mm	m	330	149	149	49,170	49,170	
5.	Reservoir							
5-1	Ground level reservoir	m3	260	900	900	234,000	234,000	
6.	Pumping station, R.C.pump house	sqm	96	1,834	1,222	176,064	117,312	with accessaries

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

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
7.	Access road	m	2,000	89	207	178,000	414,000	3m wide gravel road with draine ditch
8.	Bore-hole							
8-1	New driling	m	400	320	480	128,000	192,000	including, casing, packing and pumping test
8-2	Rehabiritation	set	1	16,000	24,000	16,000	24,000	
9.	Water purifiction unit	No.	1	10,000	15,000	10,000	15,000	
10.	Booster pump	No.	8	60,000	100,000	480,000	800,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	5	20,000	30,000	100,000	150,000	foundation, and pump with accessories
12.	Power supply							
12-1	Generating set	No.	2	5,850	8,775	11,700	17,550	gererater with accessaries
12-2	High tension line	m	3,000	8	7	24,000	21,000	
12-3	Low tension line	m	2,000	6	4	12,000	8,000	
12-4	Trensformer	No.	2	4,000	6,000	8,000	12,000	transformer with accessaries
13.	Concrete work							
13-1	Normal concrete (250kg of cement per cum)	cum	100	250	500	25,000	50,000	including form-work, vibration and curing
13-2	Reinforced concrete (360kg of cement per cum) Water retaining structure	cum	200	275	642	55,000	128,400	including vibration and curing
13-3	Form-work Wall	sqm	100	37	87	3,700	8,700	including all necessary works
13-4	Reinforcement bars; Steel bars	kg	4,000	7	2	28,000	6,400	including cutting, bending and placing
14.	Masonsy work							
14-1	Roughly dressed 40cm thick stone elevation wall	sqm	200	60	245	12,000	49,000	up to 3m height
14-2	Brick work with mortor 25cm thick	sqm		23	92	0	0	
15.	Structure							
15-1	Construction of public fountains	No.	2	1,580	3,680	3,160	7,360	
15-2	Construction of hydrant	No.	10	230	540	2,300	5,400	
15-3	Construction of R.C.C. aeration chamber	No.	5	5,730	13,370	28,650	66,850	
15-4	Construction of R.C.C. valve chamber	No.	15	5,730	13,370	85,950	200,550	
	Sub-Total of Construction work					2,447,884	3,876,142	

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					8,662,972		
16-2	Inland transportation cost						606,408	CIF cost x 7 %
	Sub-Total of Material & Equipment					8,662,972	606,408	
	Total					11,110,856	4,482,550	
17.	Building							
17-1	Office	sqm	160		1,910		305,600	
17-2	Workshop	sqm	105		1,624		170,520	
17-3	Store	sqm	175		1,337		233,975	
17-4	Residence	sqm	480		2,101		1,008,480	
	Total						1,718,575	

Imported Cost (Material & Equipment) of Nefas M: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	16,400	15	246,000
	b) DN 75mm	m	4,890	30	146,700
	c) DN 100mm	m	800	40	32,000
	d) DN 150mm	m	7,770	80	621,600
1.2	Suspended pressure steel pipe				
	a) DN 200mm W/O gilt and screw	m	440	288	126,720
	b) DN 250mm	m	350	334	116,900
1.3	Fitting cost Total cost × 20%	m			257,984
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 0.59m3/min H= 100m HP= 30 kw	set	2	500,000	1,000,000
	b) Q= 0.23m3/min H= 100m HP=18.5kw	set	4	400,000	1,600,000
	c) Q= 1.3 m3/min H= 15m HP= 5.5kw	set	2	300,000	600,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m3/min H= 100m HP= 3.5kw	set	1	130,000	130,000
	b) Q= 0.3m3/min H= 100m HP= 5.5kw	set	4	171,000	684,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set				
	50 KVA	set	2	450,000	900,000
3.2	Tension line				
	a) High tension over head line 15KV	m	3,000	50	150,000
	b) Low tension over head line	m	2,000	28	56,000
3.3	Plate-form mounted transformer				
	Supply of transformer wiht acccessories				
	Transformer 100 KVA (H-Type)	set	2	75,800	151,600
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) ϕ75	set	2	1,300	2,600
	b) ϕ150	set	4	1,700	6,800
4.2	High speed air valve				
	a) ϕ50	set	5	7,000	35,000
	e) ϕ250				
4.3	Pressure reducing valve				
	a) ϕ75	set	3	7,000	21,000
	b) ϕ150	set	2	10,000	20,000
4.4	Check valve				
	a) 75mm	set	1	8,000	8,000
	b) 100mm	set	1	10,000	10,000
5	Flow meter (Meter with accessories ϕ100)	set	2	50,000	100,000
6	Reservoir equipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe FRP DN 200	m	276	2,093	577,668
7.2	Screen FRP DN 200	m	124	5,700	706,800
7.3	Riser pipe, stainless DN 65	m	420	180	75,600
8	Water purification unit	set	1	80,000	80,000
	Total				8,662,972

Investment Cost of Target Year 2010 in Nefas Mewcha

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			300,000
2	Rising line	Km	2.3	300,000	690,000
3	Distribution network	Km	9	150,000	1,350,000
4	New borehole with pumps & material	Set	3	659,000	1,977,000
5					
6	Booster pump with house	Set	1	534,000	534,000
7	Power supply facilities	Site	1	170,000	170,000
8	Chamber and structures	Set	12	27,000	324,000
9	Buildings	M2	10	93,700	937,000
	Others	LS			579,000
	Sub total				6,861,000
11	Enginering cost (10%)				686,100
12	Contingency (10%)				754,710
	Total				8,301,810

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Nefas Mewcha

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1986	--	--	--	--	--	--	--	--	--	--	--	7.7	--
1987	8.6	18.3	71.1	26.5	140.8	29.8	85.6	283.9	46.0	13.2	5.4	33.1	762.3
1988	4.8	86.8	0.0	34.2	28.6	42.1	451.8	239.0	142.1	68.0	14.5	5.7	1117.6
1989	10.6	5.6	96.6	60.5	8.5	52.5	265.4	184.5	--	--	--	--	--
1991	--	--	--	--	--	--	--	--	--	--	6.0	56.5	--
1992	20.6	10.4	49.7	116.4	91.4	72.1	381.7	690.1	169.5	138.7	115.8	76.3	1932.7

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Debre Tabor

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	42	44	46	44	45	51	54	60	59	57	57	56	
2nd 10 days	57	57	52	51	46	42	40	36	36	37	37	39	
3rd 10 days	40	42	43	43	44	43	41	40	40	40	40	41	
Total	139	143	141	138	135	136	135	136	135	134	134	136	1642

Table 3 Monthly Average Maximum Air Temperature

Station: Nefas Mewcha

Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1986	--	--	--	--	--	--	--	--	--	--	--	18.7
1987	18.3	19.3	19.2	22.5	19.8	19.8	18.7	16.0	18.1	19.9	20.5	20.4
1988	20.3	18.2	23.3	22.0	22.3	20.3	16.5	15.8	17.4	20.4	20.7	19.3
1989	20.2	19.6	18.3	18.0	20.4	19.2	16.4	15.9	--	--	--	--
1991	--	--	--	--	--	--	--	--	--	--	17.8	17.1
1992	16.9	18.6	20.2	19.7	19.8	19.7	15.4	13.6	14.9	15.2	14.9	16.3

Note: - = not calculated due to missing data

Table 4 Monthly Average Minimum Air Temperature

Station: Nefas Mewcha

Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1987	--	0.0	2.5	6.1	6.9	7.8	7.7	6.7	6.8	6.2	5.7	5.7
1988	6.0	--	9.2	9.9	9.6	9.4	8.5	8.0	7.7	6.7	6.2	5.8
1989	6.2	6.6	7.7	7.3	8.4	8.6	7.8	7.5	--	--	--	--
1992	6.9	7.9	9.5	9.3	9.5	9.6	8.1	7.9	7.5	7.3	6.0	--

Table 5 Monthly Average Air Temperature

Station: Nefas Mewcha

Unit: ℃

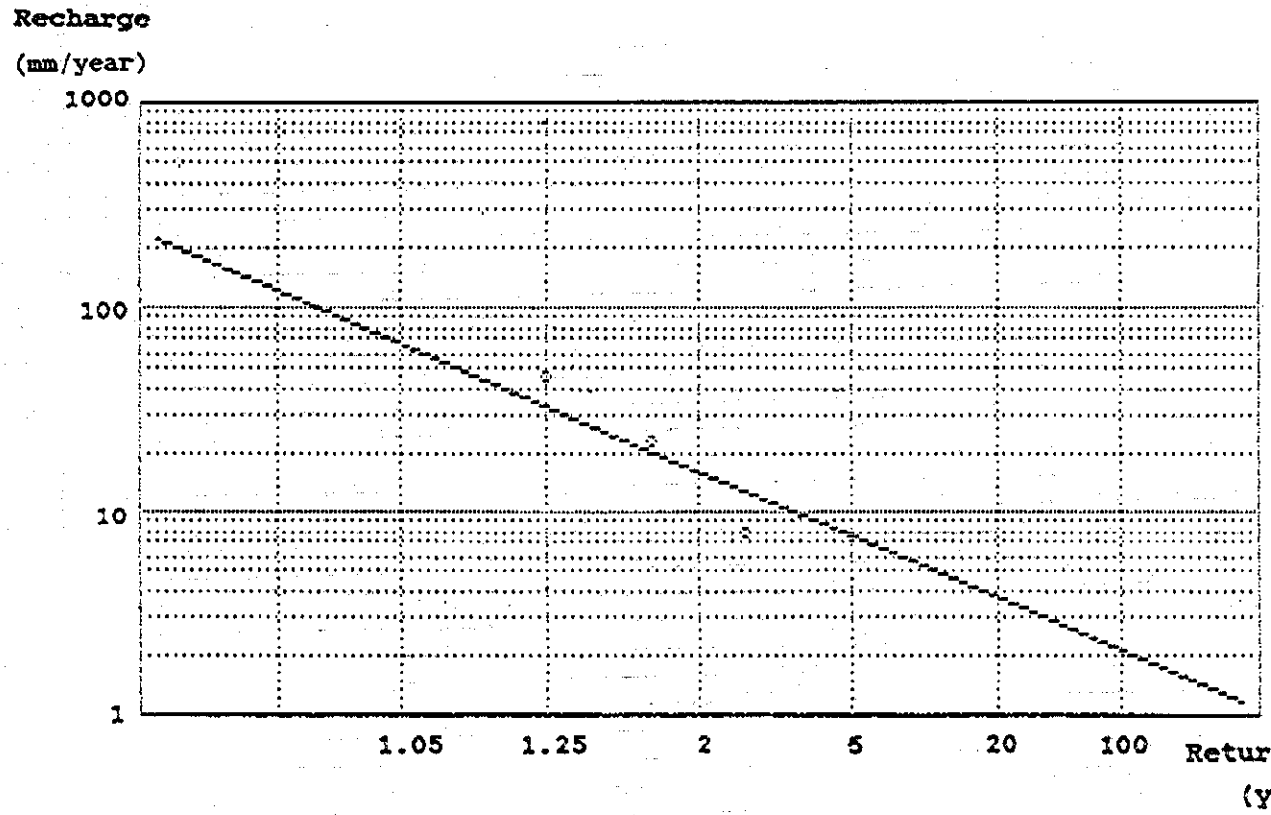
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1986	--	--	--	--	--	--	--	--	--	--	--	8.7
1987	8.4	9.7	10.9	14.3	13.4	13.8	13.2	11.4	12.5	13.1	13.1	13.1
1988	13.2	--	16.3	16.0	16.0	14.9	12.5	11.9	12.6	13.6	13.5	12.6
1989	28.4	13.1	13.0	12.7	14.4	13.9	12.1	11.7	--	--	--	--
1992	11.9	13.3	14.9	14.5	14.7	14.7	11.8	10.8	11.2	11.3	10.5	--

Note: - = not calculated due to missing data

Appendix - 9

Hydrological Data

Figure 1 Probability Analysis on Annual Ground Water Recharge



Results of Analysis

Return Period (year)	Probability of Exceedance	Theoretical Values
2	.5	158.02
5	.2	75.822
10	.1	51.657
20	.05	37.638

Table 1 Monthly Water Balance Sheet for Ground Water Recharge

1987

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	8.6	18.3	71.1	26.5	140.8	29.8	85.6	283.9	46.0	13.2	5.4	33.1	762.3
Q	3.4	7.3	28.4	10.6	56.3	11.9	34.2	113.6	18.4	5.3	2.2	13.2	304.8
P - Q	5.2	11.0	42.7	15.9	84.5	17.9	51.4	170.3	27.6	7.9	3.2	19.9	457.5
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,736
ET crop	97.3	100.1	98.7	97.1	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,215.2
ETa	3.4	7.3	28.4	10.6	56.3	11.9	34.2	95.2	18.4	5.3	2.2	13.2	286.4
ΔS	0	0	0	0	0	0	0	75.1	0	0	0	0	75.1

1988

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	4.8	86.8	0.0	34.2	28.6	42.1	451.8	239.0	142.1	68.0	14.5	5.7	1,117.6
Q	1.9	34.7	0.0	13.7	11.4	16.8	180.7	95.6	56.8	27.2	5.8	2.3	446.9
P - Q	2.9	52.1	0.0	20.5	17.2	25.3	271.1	143.4	85.3	40.8	8.7	3.4	670.7
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,736
ET crop	97.3	100.1	98.7	97.1	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,215.2
ETa	2.9	52.1	0.0	20.5	17.2	25.3	94.5	95.2	85.3	40.8	8.7	3.4	445.9
ΔS	0	0	0	0	0	0	176.6	48.2	0	0	0	0	224.8

1989

Uint:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	10.6	5.6	96.6	60.5	8.5	52.5	265.4	184.5	--	--	--	--	--
Q	4.2	2.2	38.6	24.2	3.4	21.0	106.2	73.8	--	--	--	--	--
P - Q	6.4	3.4	58.0	36.3	5.1	31.5	159.2	110.7	--	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	135	134	136	1,736
ET crop	97.3	100.1	98.7	97.1	94.5	95.2	94.5	95.2	94.5	94.5	93.8	95.2	1,215.2
ETa	6.4	3.4	58	36.3	5.1	31.5	94.5	95.2	--	--	--	--	--
ΔS	0	0	0	0	0	0	64.7	15.5	--	--	--	--	80.2

Note: - = not calculated due to missing data or distorted data

1992

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	20.6	10.4	49.7	116.4	91.4	72.1	381.7	690.1	169.5	138.7	115.8	76.3	1,932.7
Q	8.2	4.2	19.9	46.6	36.6	28.8	152.7	276.0	67.8	55.5	46.3	30.5	773.1
P - Q	12.4	6.2	29.8	69.8	54.8	43.3	229.0	414.1	101.7	83.2	69.5	45.8	1,159.6
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,736
ET crop	97.3	100.1	98.7	97.1	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,215.2
ETa	12.4	6.2	29.8	69.8	54.8	43.3	94.5	95.2	94.5	83.2	69.5	45.8	699.0
ΔS	0	0	0	0	0	0	134.5	318.9	7.2	0	0	0	460.6

Appendix - 10

Calculation of Water Pipeline

Output data on distribution network for Nefas Mewcha 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	17	250	80	21.67	0.44	0.10	1.27	110	
2	2	17	18	75	670	1.10	0.25	1.20	1.80	110	
3	3	18	5	150	215	-1.07	-0.06	-0.01	-0.06	110	
4	4	5	3	150	455	-6.19	-0.35	-0.69	-1.51	110	
5	5	3	4	75	305	1.46	0.33	0.93	3.05	110	
6	6	3	2	150	95	-8.69	-0.49	-0.27	-2.83	110	
7	7	2	17	250	220	-19.77	-0.40	-0.24	-1.07	110	
8	8	18	6	150	310	1.73	0.10	0.04	0.14	110	
9	9	5	7	75	775	2.50	0.57	6.39	8.24	110	
10	10	2	8	200	378	8.82	0.28	0.27	0.72	110	
11	11	8	9	75	95	1.97	0.45	0.50	5.30	110	
12	12	9	10	75	345	0.68	0.15	0.26	0.74	110	
13	13	9	11	75	445	0.90	0.20	0.55	1.25	110	
14	14	8	12	150	90	6.51	0.37	0.15	1.66	110	
15	15	12	13	150	690	1.18	0.07	0.05	0.07	110	
16	16	12	14	150	120	4.23	0.24	0.09	0.75	110	
17	17	14	15	150	430	2.29	0.13	0.10	0.24	110	
18	18	14	16	150	600	1.09	0.06	0.04	0.06	110	

Output data on distribution network for Nefas Mewcha Case: Fire Fighting, 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	17	250	80	30.19	0.62	0.19	2.35	110	
2	2	17	18	75	670	0.90	0.20	0.84	1.25	110	
3	3	18	5	150	215	-0.46	-0.03	-0.00	-0.01	110	
4	4	5	3	150	455	-3.66	-0.21	-0.26	-0.57	110	
5	5	3	4	75	305	0.91	0.21	0.39	1.27	110	
6	6	3	2	150	95	-5.22	-0.30	-0.10	-1.10	110	
7	7	2	17	250	220	-28.79	-0.59	-0.47	-2.15	110	
8	8	18	6	150	310	1.08	0.06	0.02	0.06	110	
9	9	5	7	75	775	1.56	0.35	2.67	3.44	110	
10	10	2	8	200	378	22.16	0.71	1.49	3.93	110	
11	11	8	9	75	95	1.22	0.28	0.21	2.19	110	
12	12	9	10	75	345	0.42	0.10	0.10	0.30	110	
13	13	9	11	75	445	0.56	0.13	0.23	0.52	110	
14	14	8	12	150	90	20.73	1.17	1.27	14.11	110	
15	15	12	13	150	690	0.74	0.04	0.02	0.03	110	
16	16	12	14	150	120	19.30	1.09	1.48	12.36	110	
17	17	14	15	150	430	18.09	1.02	4.72	10.97	110	
18	18	14	16	150	600	0.68	0.04	0.02	0.03	110	

Output data on distribution network for Nefas Mewcha 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	17	250	80	36.67	0.75	0.27	3.37	110	
2	2	17	18	75	670	1.56	0.35	2.30	3.44	110	
3	3	18	5	150	215	-2.96	-0.17	-0.08	-0.39	110	
4	4	5	3	150	455	-8.08	-0.46	-1.12	-2.47	110	
5	5	3	4	75	305	2.28	0.52	2.12	6.95	110	
6	6	3	2	150	95	-11.39	-0.64	-0.44	-4.66	110	
7	7	2	17	250	220	-34.31	-0.70	-0.66	-2.98	110	
8	8	18	6	150	310	4.08	0.23	0.22	0.70	110	
9	9	5	7	75	775	2.50	0.57	6.39	8.24	110	
10	10	2	8	200	378	21.46	0.68	1.40	3.71	110	
11	11	8	9	75	95	4.78	1.08	2.60	27.34	110	
12	12	9	10	75	345	3.49	0.79	5.27	15.28	110	
13	13	9	11	75	445	0.90	0.20	0.55	1.25	110	
14	14	8	12	150	90	16.34	0.92	0.82	9.09	110	
15	15	12	13	150	690	4.46	0.25	0.57	0.82	110	
16	16	12	14	150	120	10.78	0.61	0.51	4.21	110	
17	17	14	15	150	430	5.56	0.31	0.53	1.24	110	
18	18	14	16	150	600	4.37	0.25	0.48	0.79	110	

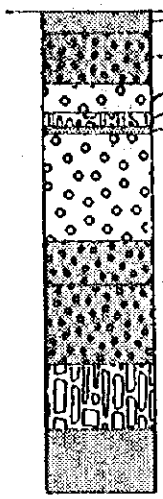
Output data on distribution network for Nefas Mewcha Case: Fire Fighting, 2010

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	17	250	80	56.28	1.15	0.60	7.44	110	
2	2	17	18	75	670	3.50	0.79	10.29	15.35	110	
3	3	18	5	150	215	-16.00	-0.91	-1.88	-8.74	110	
4	4	5	3	150	455	-19.20	-1.09	-5.57	-12.25	110	
5	5	3	4	75	305	1.43	0.32	0.89	2.93	110	
6	6	3	2	150	95	-21.28	-1.20	-1.41	-14.81	110	
7	7	2	17	250	220	-52.28	-1.07	-1.43	-6.49	110	
8	8	18	6	150	310	19.22	1.09	3.80	12.27	110	
9	9	5	7	75	775	1.56	0.35	2.67	3.44	110	
10	10	2	8	200	378	30.09	0.96	2.62	6.93	110	
11	11	8	9	75	95	2.98	0.67	1.08	11.41	110	
12	12	9	10	75	345	2.18	0.49	2.21	6.40	110	
13	13	9	11	75	445	0.56	0.13	0.23	0.52	110	
14	14	8	12	150	90	26.89	1.52	2.06	22.84	110	
15	15	12	13	150	690	2.79	0.16	0.24	0.35	110	
16	16	12	14	150	120	23.41	1.32	2.12	17.67	110	
17	17	14	15	150	430	20.15	1.14	5.76	13.39	110	
18	18	14	16	150	600	2.73	0.15	0.20	0.33	110	

Appendix - 11

Geological Logs of Existing Boreholes

WSS Borehole No.1 in Nefas Mewcha



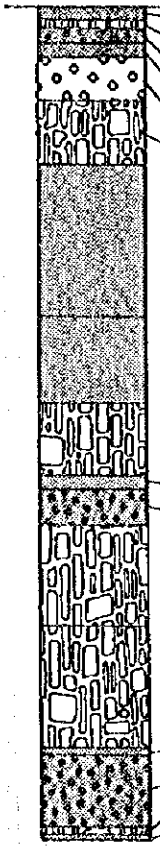
Depth	Lithology
0 - 3 m	Clay
3 - 10 m	Clay with gravel and boulders
10 - 14 m	Gravel, angular clasts
14 - 16 m	Basalt (boulder?)
16 - 17 m	Clay with gravel
17 - 32 m	Gravel
32 - 38 m	Clay, Laminated, with gravel
38 - 49 m	Clay with sand and gravel
49 - 58 m	Basalt, weathered, hard(51-56m)
58 - 67 m	clay

Note : Water was struck at 10 m, the main yield being derived from the interval 16.5-32 m.

Location : 200 m south from Borehole No.1

Source : from "REPORT ON PUMPING TEST OF NEFAS MEWCHA, BORE NO.2 (23-25 APRIL 1983)" BY J.C.Barnett

Borehole No.1 in Nefas Mewcha



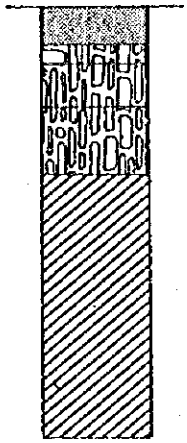
Depth	Lithology
0 - 2 m	Clay, gray
2 - 3 m	Weathered basalt
3 - 5 m	Clay with gravel, yellowish
5 - 7 m	Clay with sand, fractured layer
7 - 13 m	Gravel, rounded
13 - 22 m	Weathered basalt, quartz bearing
22 - 43 m	Clay, reddish
43 - 55 m	Clay, gray
55 - 65 m	Fresh basalt
65 - 67 m	Clay, gray
67 - 72 m	Clay with gravel
72 - 86 m	Fresh basalt
86 -103 m	Weathered basalt
103-104 m	Clay, reddish
104-114 m	Clay with sand and gravel
114-115 m	Fresh basalt
115-116 m	Clay, soft

Location : About 1 km east from the town center

Source : from the drilling report by Demissie Wagayemu August 21, 1982

Note : This hole was abandoned due to low yield.

Borehole No.1c in Nefas Mewcha



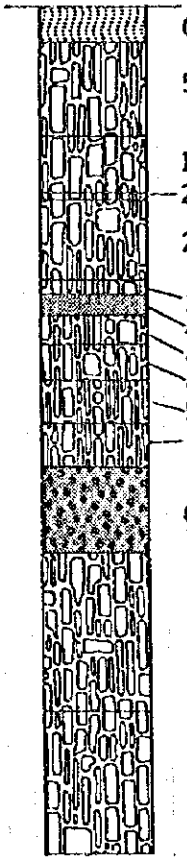
Depth	Lithology
0 -5.5 m	Clay
5.5- 8 m	Weathered basalt
8 - 14 m	Slightly weathered basalt
14 -23.5m	Fresh basalt
23.5-60 m	Volcanic tuff with clay

Note : This hole was abandoned due to the accident that the drilling bit stuck down into the hole.

Location : About 1 km east from the town center

Source : from the drilling report by Demissie Wagayemu August 31, 1982

Borehole No.4 in Nefas Mewcha



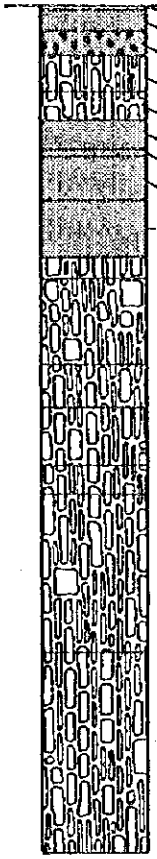
Depth	Lithology
0 - 5 m	Top soil
5 - 18 m	Weathered basalt
18 - 26 m	Slightly weathered basalt
26 - 27 m	Intensively weathered basalt
27 - 38 m	Slightly weathered basalt
38 - 40 m	Intensively weathered basalt
40 - 43 m	Clay, reddish
43 - 47 m	Intensively weathered basalt
47 - 52 m	Slightly weathered basalt
52 - 58 m	Intensively weathered basalt
58 - 64 m	Slightly weathered basalt with sec. minerals
64 - 76 m	Clay with boulders
76 - 98 m	Moderately weathered basalt
98 -118 m	Slightly weathered basalt

Note : This borehole is abandoned due to little yield.

Location : about 4 km from the town, Doromeda Village

Source : from "Geological log of Nefas Mewcha BH #3" by EWWCA, 1992

Borehole No.5 in Nefas Mewcha



Depth	Lithology
0 -0.5 m	Top soil
0.5-3.5 m	Clay, black
3.5- 7 m	Clay with some weathered rock
7 - 12 m	Weathered basalt
12 - 16 m	Intensively weathered basalt
16 - 20 m	Clay, brownish gray
20 - 21 m	Clay, reddish
21 - 27 m	Clay, dark brown
27 - 35 m	Clay, brown
35 - 38 m	Intensively weathered basalt, reddish
38 - 50 m	Moderately weathered basalt
50 - 56 m	Slightly weathered basalt with sec. minerals
56 - 64 m	Moderately weathered basalt
64 - 68 m	Slightly weathered basalt
68 - 90 m	Fresh basalt
90 -118 m	Intensively weathered basalt

Location : About 7km southwest from the town Kabaromega Village

Source : from "Geological log of Nefas Mewcha BH #3" by EWWCA, 1992