Chapter 14

Appendix 14.1 Annual Operation and Maintenance Cost

Appendix 14.1 Annual Operation and Maintenance Cost

Kandy

Master Plan Alternative 1 (Not Applied)

Item	Electricity						Man-Power			Spare Parts	
	m3/day	m3/hr	hrs	kW	kWh	Rs/month	No.	Rs/month	Rs/month	Cost	Rs/month
1. Sewer							5	6,000	30,000		
2. Pumping Station											
Kandy											
P/S 1	632	44	14.2	2.2	31	10,919	0	6,000	0	2,185	1,821
P/S 2-1	1,492	104	14.3	30	429	65,759	1	6,000	6,000	4,211	3,509
P/S 2-2	1,492	104	14.3	30	429	65,759	0	6,000	0	4,211	3,509
STP	15,215	540	28.2	45	1,268	181,573	0		0	15,711	13,093
Katugastota											
STP											
3. Sewage Treatment Plant											
Kandy	18,000m3/day		24	332	7,968	1,106,184	7	6,000	42,000	666,558	555,465
Katugastota											
4. Chlorine	15,200	2 mg/l				27,862					
5. Maintenance							3	10,000	30,000		
6. Manager/Engineer							3	15,000	45,000		
Sub-Total						1,447,137	19		153,000	692,876	577,397

Total	
month	2,177,534
year	26,130,403

Chlorine	Electricity
334,339	17,031,304

Man-Power
1,836,000

Spare Parts
6,928,760

Master Plan Alternative 2 (Applied) -Operation Starting 2014

Item	Electricity						Man-Power			Spare Parts	
	m3/day	m3/hr	hrs	kW	kWh	Rs/month	No.	Rs/month	Rs/month	Cost	Rs/month
1. Sewer							5	6,000	30,000		
2. Pumping Station											
Kandy											
P/S 1	632	44	14.2	2.2	31	10,919	0	6,000	0	2,185	1,821
STP	13,853	492	28.2	37	1,042	150,365	0		0	14,729	12,274
Katugastota											
STP	1,492	104	14.3	15	214	36,180	0	6,000	0	2,438	2,032
3. Sewage Treatment Plant											
Kandy	17,000m3/day		24	322	7,728	1,073,064	7	6,000	42,000	636,899	530,749
Katugastota	1,700m3/day		24	31	744	109,272	3	6,000	18,000	35,242	29,368
4. Chlorine	15,200	2 mg/l				27,862					
5. Maintenance							3	10,000	30,000		
6. Manager/Engineer							3	15,000	45,000		
Sub-Total						1,407,662	21		165,000	691,493	576,244

Total	
month	2,148,906
year	25,786,869

Chlorine	Electricity
334,339	16,557,599

Man-Power
1,980,000

Spare Parts
6,914,930

Feasibility Study -Operation Starting 2004

Item	Electricity						Man-Power			Spare Parts	
	m3/day	m3/hr	hrs	kW	kWh	Rs/month	No.	Rs/month	Rs/month	Cost	Rs/month
1. Sewer							3	6,000	18,000		
2. Pumping Station											
Kandy											
P/S 1	632	44	14.2	2.2	31	10,919	0	6,000	0	2,185	1,821
STP	6,926	492	14.1	37	521	78,483	0		0	9,864	8,220
Katugastota											
STP											
3. Sewage Treatment Plant											
Kandy	8,500m3/day		24	174	4,176	582,888	5	6,000	30,000	320,246	266,872
Katugastota											
4. Chlorine	7,300	2 mg/l				13,381					
5. Maintenance							2	10,000	20,000		
6. Manager/Engineer							2	15,000	30,000		
Sub-Total						685,671	12		98,000	332,295	276,913

Total	
month	1,060,583
year	12,726,999

Chlorine	Electricity
160,571	8,067,478

Man-Power
1,176,000

Spare Parts
3,322,950

Chapter 15

Appendix 15.1 Initial Environmental Examination Findings and Conclusions
Appendix 15.2 Water Quality Survey (Wet Season)
Appendix 15.3 Water Quality Survey (Dry Season)
Appendix 15.4 Land Acquisition Procedures
Appendix 15.5 Wastewater Treatment Plants Monitoring and Reporting Program

Appendix 15.1

Greater Kandy – EIA – Appendix 15/A – IEE findings and conclusions

INITIAL ENVIRONMENTAL EXAMINATION

FINDINGS AND CONCLUSIONS

(EXECUTIVE SUMMARY)

1. Purpose of the Initial Environmental examination

The Initial Environmental Examination (IEE) is conducted as an integral part of the Water Supply and Environmental Improvement Master Plan for the Greater Kandy and Nuwara Eliya areas.

The IEE has the following specific objects:

1) to achieve a sound knowledge of the actual condition of the environment within the project impact areas;

based on this, to preliminarily assess the possible and/or potential environmental impacts which may be realized through the implementation of the proposed Water Supply (WS) and Waste Water (WW) projects, and

2) to assess the need of implementing a full Environmental Impact Assessment (EIA), which, if necessary, will be conducted as an integral part of the Feasibility Studies which will follow the Master Plan.

2. Served population and water demand

2.1 Kandy Municipal

1) Served population in 1998 is 554,310 persons;
2) Served population in 2015 will be 694,160 persons;
3) Present water demand is 117,200 m3/day (211 L/persons*day)
4) Water demand in 2015 will be 195,900 m3/day (282 L/persons*day)

2.2 Nuwara Eliya

1) Served population in 1998 is 25,500 persons;

2) Served population in 2015 will be 51,400 persons;
3) Present water demand is 6,161 m3/day (241.6 L/person*day)
4) Water demand in 2015 will be 16,320 m3/day (317.5 L/person*day)

3. *Project description*

3.1 Water supply

3.1.1 Kandy Municipal

1) Extraction of additional 42,500 m3/day at existing Kandy Municipal Plant (actual capacity 33,400 m^3/day);
2) Up to 118,000 m^3/day new treatment plant at Polgolla (actual capacity: 1440 m3/day)
3) Construction of 254 Km of transmission mains, ranging from 110 mm to 900 mm in diameter;
4) 61 reservoirs with a total storage capacity of 32,925 m^3;
5) 45 pump stations, most of which will be located adjacent to reservoirs or treatment facilities.

3.1.2 Nuwara Eliya

1) Expansion of groundwater water sources;
2) Expansion of existing stream supply at Bambarakele by construction of a new dam;
3) Expansion of existing Lovers Leap stream supply with construction of two new dams;
4) New supply from a stream near Jayalauka with a new dam and 10-12 Km transmission main.

Existing transmission and distribution system will require upgrade to handle additional supply.

3.2 Wastewater treatment

3.2.1 Greater Kandy

Three separate sub-areas are considered for priority interventions in the Greater Kandy Area: 1) Kandy Municipal, 2) Katugastota and 3) Akurana.

1) Kandy Municipal

1) New Treatment Plant, aerated lagoons, to be located in Getambe, with capacity of 90 L/s (about 8,000 m3/day). Required area is 2.7 ha.
2) Collection mains with diameter varying from 200 to 100m mm, for a total length of 20.13 km.
3) Two pump stations, with capacity of 8 L/sec and 100 L/sec, located at Lake side and Railroad.

2) Katugastota

1) New treatment plant, aerated lagoons, with capacity of 6.5 L/s. (561 m3/day). Total area required 0.5 ha.
2) 6.5 Km of collection mains, with diameter varying from 200 mm to 300 mm;
3) Two pump stations with capacity 3 L/s and 9 L/s, located at the bridge and at treatment plant site.

3) Akurana

1) New treatment plant, aerated lagoons, with capacity of 6.0 L/s. (518 m3/day). Total area required: 0.5 ha.
2) 1.9 Km of collection mains, with diameter varying from 200 mm to 300 mm.

3.2.2 Newara Eliya

The following WW treatment facilities are planned in Nuwara Eliya (**FIG 2.2**):

1) New treatment plant, aerated lagoons, with capacity of 20 L/sec (1728 m3/day), located in an area south of the Recreational Ground. Total required land is 0.5 ha;
2) 12.4 Km of collection mains, with diameter varying from 200 mm to 300 mm;
3) Two pump stations with capacity 9 L/s and 20 L/s, located at the brewery and at racetrack.

4. Summary review of beneficial/adverse impacts

1) The purpose of the present project is to prevent or alleviate the effect on the environment produced by the discharge of untreated or inadequately treated wastewater, and to improve the quality of life of resident people by increasing the amount of safe drinkable water supplied. When properly planned, designed, constructed and managed, the project will therefore have an overall beneficial impact on the environment.
2) The most important beneficial impacts will be:

- Reduction of public nuisance, because of increased safe water sources and reduction of open air sewers in urban areas;
- Improvement of public health, because of reduction of water vector diseases;
- Improvement of surface and underground water quality, because of reduction of untreated wastewater discharge.

3) The major permanent negative effect will be dislocation or resettlement of a few families actually living in the area selected for the new Polgolla water treatment plant. Resettlement, even if concerning a limited number of families, should be done in compliance with Sri Lankan Laws and regulations (see Par. 4.4). Compensation should be adequate in order to guarantee that dislocated/resettled families after the project will be "equal or better" than before.
4) Land acquisition for plant siting may also represent a problem, because almost all lands are private and chances of finding public lands where treatment plants or pumping stations may be sited are minimal.
5) Water quality in receiving surface and underground water bodies is likely to improve, because many raw sewage discharges will be replaced by a single treated waste water discharge, with strong reduction in the contaminants' content.
6) Major negative impact during construction will be on traffic and transportation, especially in densely populated urban areas, because of construction of mains. Kandy Municipal, Nuwara Eliya Municipal, and some of the minors town in Kandy District (Katugastota and Arakuna) will be affected.

7) A preliminary survey on traffic intensity in critical points of Kandy District has been carried out during the present study. Applicable mitigation measures (such as traffic diversion) will be studied in the EIA, but disturbances to population cannot be completely offset. A sound and thorough information campaign will also be helpful to mitigate the effects of public nuisance.
8) Noise and vibrations during construction are a routinely concern of EIA for projects which include deep trench excavation in urban areas, and may represent a critical issue in specific areas (high level residential areas, schools, hospitals). Mitigation measures will be provided in the EIA, but it is evident that negative impact cannot be completely offset. Again, an information campaign may help to overcame residents' complaints. Fortunately, this will be a temporary impact.
9) Offensive odors can be controlled at WS treatment plants, but are present at WW treatment plants, as a consequence of anaerobic decomposition. Impacts may be offset using adequate odor control techniques and with proper plant siting.
10) An important issue will be safety of workers and general public during construction, considering that all works will be conducted in densely populated areas. Suggestions on how to mitigate these effects will be given in the EIA. A specific Control and Monitoring Plan will be needed, establishing responsibilities as well as routinely and emergency procedures to be followed.
11) To make sure that the project will benefit the environment as expected, all domestic, public and commercial uses within the service areas should be required to connect to the system on a mandatory basis. The NWSDB, CEA and the Municipalities of Kandy and Nuwara Eliya, should be responsible for the enforcement of this measure.

5. *Intensity of Impacts*

Intensity of impacts is evaluated according to criteria established by CEA and reported at Para. 2.3, page 9 of "Guidance for Implementing the Environmental Impact Assessment (EIA) Process. Intensity is referred to permanent impacts only. An overall evaluation will be given for each criteria, turning for details to the previous Environmental Impact Matrix and/or to the specific chapters.

Intensity of impacts

Criteria for impacts' intensity evaluation	Degree of intensity
Degree to which the proposed action will affect public health or safety	Highly positive
Degree to which the proposed action will affect unique characteristics of a geographical area.	None
Degree to which the impacts on the environment and related social conditions are likely to be highly controversial:	Minor controversies may arise related to resettlement of families in Kandy and land acquisition procedures;
Degree to which the possible effects on environment are highly uncertain on involve unique or unknown risks	None
Anticipated cumulative significant impacts which cannot be avoided / offset or mitigated:	None
Degree to which the proposed action may affect the right of future generation to benefit from environmental and cultural resources:	None

6 *Conclusions about EIA requirement*

6.1 General

According to present Sri Lankan regulations, the water extraction, WS treatment plants, WW treatment plants and appurtenant works which are part of the present project, are subject to the EIA process only as plant siting is concerned.

The laying of pipeline in Kandy, Nuwara Eliya and minor town of Kandy District is not a prescribed project and therefore is not required to follow the EIA process.

However, because of the potential social and environmental impacts arising out of this activity, it is recommended to formulate a sound management plan for this activity which will minimize the adverse impacts on the society and the natural environment.

EIA requirement for the different project components are summarized in Table 6.2.

6.2 Recommendations of Central Environmental Authority

The following procedure is recommended by the Central Environmental Authority

1. NWSDB will officially submit the IEE to CEA;
2. CEA will examine the report, and will assess if an EIA is needed or not, and to which extent. This step is necessary because the regulations expressed in Gazette 722/22 are to be considered as a general reference, and are subject to interpretation of the CEA;
3. CEA, on the base of IEE findings, will officially communicate to the NWSDB, within a two weeks period, if an EIA is definitely required or not.
4. If an EIA is required, the PP will also officially apply to the CEA, to know which will be the PAA entitled for revision and approval of the EIA;
5. The CEA will name a PAA and will officially communicate the name of the Agency to the PP.

6.3 Consultant's recommendations and justification for an EIA

Considering the preliminary evaluation of anticipated environmental effects presented in Chapter 5, and the recommendations received by the CEA in Colombo, it's the Consultant's opinion that an EIA is fully justified and will be needed.

The EIA must comply with both JICA and Sri Lankan CEA regulations.

Terms of Reference are given in Chapter 7.

POSTGRADUATE INSTITUTE OF SCIENCE

UNIVERSITY OF PERADENIYA
PERADENIYA
SRI LANKA

Report on

WATER QUALITY EXAMINATION

In the Kandy and Nuwara-Eliya Districts

Second phase - Rainy Season

Submitted to

JICA study Team, NWSDB,Kandy

By

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September 8,98

INTRODUCTION

An agreement was signed between the JICA study team and the Postgraduate Institute of Science, University of Peradeniya in March 1998 for the chemical and biological analysis of water quality of springs, streams, ground water sources, raw sewage, water bodies (rivers and lakes) and sludge. This study was to take in two phases namely, the dry season and the rainy season . The report for the phase 1 of this project (dry season) has already been submitted and the present report is on the study carried out during the rainy season. This reason season from July to September was quite normal with intermittent dry days. The dry season in contrast was quite unusual in that it was an exceptionally warm dry season in the hill country. The study area covered the greater Kandy area and the Nuwara Eliya basin. The corresponding collection points are depicted in the attached maps.

Experimental

Samples were collected in cleaned acid washed bottles and sampling was carried out according to accepted methods. Sample preservation depending on the parameter to be analysed was carried out in situ. The general procedures employed for all analytical determinations are those given in " Standard Methods for the Examination of Water and Wastewater" 19th edition (1995) published by the American Public Health Association, Washington, D.C. The following table gives the analytical procedures followed.

Parameter	Method
BOD,COD	Standard titrimetric procedure
Chloride, Fluoride	Ion-selective electrodes
Total nitrogen	Kjeldhal method
Total phosphorus	Spectrophotometry (Vanadomolybdate method)
Sulphate	Turbidimetry
Nitrate, nitrite	Spectrophotometry (Azo dye method with cadmium reduction)
Cd,Fe,Pb,Mn,Co,Zn Cu	Atomic absorption spectrophotometry
As,Hg	Atomic absorption with hydride reduction
SS,TDS	Gravimetry

Microbiological examinations for *E.Coli* and coliforms were estimated according to the ISO 4831:1990 International standards using the most probable number counts. These gave far more accurate readings for sewege samples compared with the data reported in the first report.

Results and Discussion

(I) Raw water quality survey

Results of the raw water quality survey are given in tables 1-3 and the results of the pesticide analysis and their detection limits are given separately in annexure 1. There was total absence of any of the pesticides generally used in Sri Lanka in any of the water quality samples which were investigated (Annexure 1). In general these samples show increased turbidity and increased suspended solids compared to the values obtained during the dry season. The phosphate concentration also showed a significant increase in concentration during the rainy season specially in the Nuwara Eliya district. This is perhaps due to the washing of phosphate fertilisers which remain close to the ground during the dry season and gets leached into the streams and underground water resources during the rainy season. The total hardness of the water during the rainy season is about 50% of its values during the dry season.

The conductivity of ground water sources was high compared to those collected from springs from Nuwara-Eliya.This is probably due to high calcium and magnesium salts as indicated by total alkalinity and hardness. The sulphate contents of these samples were also high. Out of the bore hole wells, those at the Race course, Galway forest lodge, Interfashion, Hill club and Palladium had relatively high mineralisation as seen in higher conductivities. The nitrate and free ammonia contents of the Palladium bore hole was very high most probably due to faecal contamination. There was an unusual situation with respect of the analytical results of WQ/N/15.1 compared to analyses obtained later from the same bore hole. This is because this is a shallow bore hole and WQ/N/15.1 was collected when the weather was dry and samples WQ/N/15.2 and WQ/N/15.3 during very high rain. As a result its iron content was very high, turbidity was also high and Cl^- was also high. In particular, this particular bore hole has high iron content also for the same reason. The water from this bore hole appeared brownish and this explains its high TDS values. There was no significant variation of the water composition for samples collected from springs over a 24 h period indicating little human activity. There is also no evidence of pesticide contamination for any of these samples (both spring water & bore holes at Nuwara Eliya). It is also clear that the sample at Lovers leap and Pedro intake had relatively high contamination by coliforms indicating human faecal contamination. The residual coliform counts from bore hole water samples probably arises due to contamination of the rubber hoses used to collect the sample and attached to the bore hole well.

It is also clear that the Palladium bore hole water is also highly contaminated as seen in its high bacterial contamination, high iron content, high chloride etc. This is a shallow bore hole present in a highly contaminated area and it is not surprising that its water is highly polluted. The high iron content may arise due to corroding metallic pipes since this bore hole is situated in the heart of the city. Also because of close proximity to septic tanks it exhibits a high level of ammonia. The Brewery bore hole was not in

general use at the time samples were collected and the levels of heavy metals may be high for this reason.
The race course bore hole shows increased mineralisation (high conductivity) with higher concentrations of phosphate compared to other bore holes. This is due to it being close to an area which is intensively fertilised. Such fertiliser run-offs could explain its high phosphate level.

Samples from new bore holes WQ/N/18 and WQ/N/19 showed that the one near the golf course (WQ/N/19) has relatively high hardness and conductivity while that dug near Galway forest showed quite normal results.

Additional raw water quality samples were collected near the Gohagoda site where sample WQ/K/3 is the sample collected about 100 metres upstream of the sewage effluent flow. This sample clearly showed increased nitrate contamination but no big differences from other water quality samples.

Survey points and the keys to samples

Raw water quality

KANDY

WQ/K/1	Intake point of Kandy water treatment plant.
WQ/K/2	Polgolla dam intake

Additional sample for raw water quality was selected near the proposed intake at Gohagoda (near Katugastota) just up river from the sewage dumping site.

WQ/K/3 Gohagoda -proposed intake point before sewage flow

NUWARA ELIYA

Surface intakes

WQ/N/ 1	Bambarakele
WQ/N/2	Shanthipura
WQ/N/3	Pedro intake
WQ/N/4	Water field (new)
WQ/N/5	Water field(old)
WQ/N/6	Piyatissapura
WQ/N/7	Brewery falls
WQ/N/8	Gemunupura
WQ/N/9	Lovers leap

Ground water resources

WQ/N/10	Hill club bore hole
WQ/N/11	Race course bore hole

Table 1. Raw water quality data (Kandy district)

Units employed: Tempertaure ^{0}C,COD,BOD,SS,TDS,Cl^{-},SO_4^{2-},As,Cd,Zn,Co ppm, Conductivity uscm^{-1}, Coliform total at 35 C/100ml, *E.Coli.* At 44 C/100ml

Sample	T air	T water	Turbidity	pH	onductivity	TDS	Cl^{-}	Total alkalinity	Free NH_3	NO_3^{-}	NO_2^{-}	F^{-}	PO_4^{3-}	Total hardness
WQ/K/1.1	24.8	22.9	14.9	5.5	57.1	28.5	4.2	7.8	ND	1.89	0.05	0.02	0.62	6.7
WQ/K/1.2	27.0	24.7	22.3	5.9	43.6	22.4	2.5	16.9	0.09	4.19	0.10	0.02	2.04	4.8
WQ/K/1.3	22.9	23.3	47.1	6.8	46.4	23.1	3.1	16.3	0.10	1.33	0.18	0.04	3.01	15.2
WQ/K/1.4	23.5	23.1	14.7	6.7	44.2	22.1	3.1	20.5	0.13	1.98	0.08	0.03	3.14	15.2
WQ/K/1.5	27.0	24.0	25.1	7.2	43.3	21.7	2.1	16.9	0.05	3.22	0.27	0.03	3.01	17.0
WQ/K/1.6	27.5	24.2	11.5	6.4	49.8	24.5	2.5	18.7	1.00	1.70	0.10	0.02	4.04	17.0
WQ/K/1.7	28.0	23.6	26.1	6.5	49.7	24.8	3.6	21.7	0.08	2.06	0.08	0.06	0.91	18.9
WQ/K/1.8	24.0	22.2	25.1	6.4	51.1	25.5	3.6	22.3	0.22	2.41	0.10	0.10	1.88	18.9
WQ/K/2.1	24.9	24.3	54.3	5.2	54.9	27.5	3.8	16.9	0.06	2.53	0.10	0.02	2.04	17.1
WQ/K/2.2	25.5	24.5	23.3	6.8	51.7	25.9	2.7	16.9	0.08	2.08	0.09	0.02	1.81	4.8
WQ/K/2.3	23.8	23.4	19.9	7.1	51.4	27.7	4.1	19.9	0.12	1.76	0.07	0.05	1.71	21.0
WQ/K/2.4	24.7	24.2	16.4	6.5	59.2	29.7	5.0	19.9	0.10	1.91	0.13	0.06	6.85	21.0
WQ/K/2.5	27.0	24.3	28.2	7.2	50.7	25.3	4.3	18.7	0.13	1.32	0.08	0.03	3.85	17.0
WQ/K/2.6	27.0	24.6	11.7	6.4	56.0	28.0	3.3	21.7	0.13	1.63	0.07	0.33	1.58	17.0
WQ/K/2.7	27.4	24.3	12.8	6.9	52.9	26.4	3.9	23.6	0.10	1.40	0.08	0.07	3.58	20.8
WQ/K/2.8	22.2	23.4	27.5	6.8	55.8	58.0	4.1	35.6	0.29	1.57	0.08	0.09	1.97	28.3
WQ/K/3.1	27.8	23.0	15.0	6.9	63.5	31.2	2.5	20.5	0.46	4.78	0.19	0.15	2.15	37.8
WQ/K/3.2	26.5	23.3	10.0	6.8	52.1	26.0	1.99	21.1	ND	3.52	0.13	0.16	1.51	39.6

Table 1. Raw water quality data (Kandy district)continued

Sample	SO_4^{2-}	CN^-	Total coliform	*E. coli*	Cu	Cd	Cr	Mn	Hg	As	Pb	Total iron
WQ/K/1.1	1.8	$<10^{-4}$	1800	1100	ND	ND	ND	ND	ND	ND	ND	ND
WQ/K/1.2	1.4	$<10^{-4}$	100	20	ND	ND	ND	ND	ND	ND	ND	ND
WQ/K/1.3	2.1	$<10^{-4}$	1100	260	ND	ND	ND	ND	ND	ND	ND	1.05
WQ/K/1.4	1.8	$<10^{-4}$	900	100	ND	ND	ND	ND	ND	ND	ND	0.35
WQ/K/1.5	2.2	$<10^{-4}$	3400	1600	ND	ND	ND	ND	ND	ND	ND	3.42
WQ/K/1.6	2.4	$<10^{-4}$	2200	190	ND	ND	ND	ND	ND	ND	ND	0.96
WQ/K/1.7	1.3	$<10^{-4}$	640	60	ND	ND	ND	ND	ND	ND	ND	1.38
WQ/K/1.8	1.9	$<10^{-4}$	800	80	ND	ND	ND	ND	ND	ND	ND	0.29
WQ/K/2.1	3.3	$<10^{-4}$	300	80	ND	ND	ND	ND	ND	ND	ND	0.23
WQ/K/2.2	1.4	$<10^{-4}$	200	70	ND	ND	ND	ND	ND	ND	ND	0.18
WQ/K/2.3	1.7	$<10^{-4}$	3600	480	ND	ND	ND	ND	ND	ND	ND	0.54
WQ/K/2.4	5.8	$<10^{-4}$	210	30	ND	ND	ND	ND	ND	ND	ND	0.35
WQ/K/2.5	2.6	$<10^{-4}$	2080	200	ND	ND	ND	ND	ND	ND	ND	0.54
WQ/K/2.6	0.7	$<10^{-4}$	2600	240	ND	ND	ND	ND	ND	ND	ND	0.29
WQ/K/2.7	1.3	$<10^{-4}$	800	250	ND	ND	ND	ND	ND	ND	ND	1.94
WQ/K/2.8	0.7	$<10^{-4}$	600	60	ND	ND	ND	ND	ND	ND	ND	0.6
WQ/K/3.1	0.7	$<10^{-4}$	100	30	ND	ND	ND	ND	ND	ND	ND	ND
WQ/K/3.2	0.7	$<10^{-4}$	1100	260	ND	ND	ND	ND	ND	ND	ND	ND

Table 2. Raw water quality data - Nuwara-Eliya district (Surface intakes)

Sample	T air	T water	Turbidity	pH	onductivity	TDS	Cl^-	Total alkalinity	Free NH_3	NO_3^-	NO_2^-	F^-	PO_4^{3-}	Total hardness
WQ/N/1.1	23.0	15.5	0.89	7.4	10.5	5.2	1.10	6.0	0.05	1.18	0.04	0.04	2.72	3.8
WQ/N/1.2	15.0	14.0	1.35	6.4	11.4	5.6	0.90	8.4	0.14	1.06	0.75	0.02	2.12	4.8
WQ/N/2.1	20.3	15.9	0.79	7.0	15.3	7.2	1.10	5.4	0.02	0.41	0.45	0.20	1.79	5.7
WQ/N/2.2	15.0	14.7	0.70	6.2	15.4	7.0	0.90	6.0	0.13	4.47	0.62	0.02	0.81	8.6
WQ/N/3.1	23.1	16.2	1.20	8.2	11.4	5.8	1.00	7.2	ND	0.20	0.30	0.02	1.96	7.6
WQ/N/3.2	17.0	15.2	1.35	6.2	11.0	5.4	0.85	9.1	0.01	1.94	0.56	0.02	1.82	4.8
WQ/N/4.1	20.3	15.9	1.85	6.2	11.3	5.6	1.10	6.6	0.01	1.26	0.42	0.03	2.64	5.7
WQ/N/4.2	15.0	14.6	1.15	6.8	10.6	5.3	1.00	7.2	0.27	0.93	0.75	0.02	3.21	4.8
WQ/N/5.1	18.8	15.6	0.78	7.1	12.7	6.3	1.10	9.2	0.02	0.27	0.17	0.01	1.20	7.6
WQ/N/5.2	15.4	14.7	1.25	6.2	11.2	5.6	1.00	8.4	0.27	0.84	0.95	0.02	1.25	5.7
WQ/N/6.1	23.4	15.8	0.85	6.7	12.1	6.0	1.07	7.8	ND	0.80	0.27	0.02	3.35	6.7
WQ/N/6.2	16.0	15.0	0.75	6.2	11.4	5.6	1.00	7.2	ND	1.37	0.11	0.02	3.16	4.8
WQ/N/7.1	16.2	15.2	1.00	8.2	13.1	6.5	1.00	8.4	0.02	0.87	0.18	0.02	2.80	4.8
WQ/N/7.2	16.1	14.8	1.40	6.7	11.8	5.9	0.90	9.1	0.19	0.52	0.88	0.02	1.69	4.8
WQ/N/8.1	21.0	15.7	0.95	7.2	12.8	6.3	1.20	8.4	0.02	0.96	0.27	0.05	2.30	8.6
WQ/N/8.2	17.3	14.2	0.82	6.8	11.2	5.5	0.90	7.8	0.23	0.60	0.69	0.03	2.73	7.6
WQ/N/9.1	20.9	15.1	1.84	6.5	11.1	5.5	1.10	8.5	0.02	0.20	0.24	0.05	2.82	5.7
WQ/N/9.2	18.4	14.8	1.20	6.0	10.8	5.0	1.00	7.2	0.38	2.02	0.62	0.02	0.30	4.8

Table 2. Raw water quality data - Nuwara-Eliya district (Surface intakes) continued

Sample	SO_4^{2-}	CN^-	Total coliform	*E. coli*	Cu	Cd	Cr	Mn	Hg	As	Pb	Total iron
WQ/N/1.1	1.30	$<10^{-4}$	36	12	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/1.2	1.10	$<10^{-4}$	200	50	ND	ND	ND	ND	ND	ND	ND	0.35
WQ/N/2.1	1.70	$<10^{-4}$	140	50	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/2.2	1.20	$<10^{-4}$	160	60	0.2	ND	ND	ND	ND	ND	ND	0.35
WQ/N/3.1	1.30	$<10^{-4}$	2400	1000	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/3.2	1.20	$<10^{-4}$	210	120	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/4.1	1.60	$<10^{-4}$	50	16	ND	ND	ND	ND	ND	ND	ND	0.11
WQ/N/4.2	1.40	$<10^{-4}$	40	20	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/5.1	1.70	$<10^{-4}$	36	10	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/5.2	1.50	$<10^{-4}$	20	4	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/6.1	1.20	$<10^{-4}$	110	40	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/6.2	1.40	$<10^{-4}$	240	100	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/7.1	1.40	$<10^{-4}$	40	Nil	ND	ND	ND	ND	ND	ND	ND	0.23
WQ/N/7.2	1.20	$<10^{-4}$	40	10	ND	ND	ND	ND	ND	ND	ND	0.2
WQ/N/8.1	1.30	$<10^{-4}$	72	32	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/8.2	0.90	$<10^{-4}$	170	50	ND	ND	ND	ND	ND	ND	ND	0.18
WQ/N/9.1	1.50	$<10^{-4}$	2100	1000	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/9.2	1.50	$<10^{-4}$	140	80	ND	ND	ND	ND	ND	ND	ND	0.35

Table 3. Raw water quality data - Nuwara-Eliya district (Ground water sources)

Sample	T air	T water	Turbidity	pH	conductivity	TDS	Cl⁻	Total alkalinity	Free NH_3	NO_3^-	NO_2^-	F^-	PO_4^{3-}	Total hardness
WQ/N/10.1	19.0	18.0	61.1	6.8	177.0	88.0	2.19	106.0	0.24	1.78	0.08	0.04	4.93	40.0
WQ/N/10.2	20.0	18.8	36.5	7.2	186.0	93.0	1.62	109.0	0.09	2.47	0.12	0.04	9.02	81.0
WQ/N/10.3	19.8	18.2	43.3	7.4	220.0	110.0	1.58	142.0	0.19	2.54	0.09	0.05	3.11	106.0
WQ/N/11.1	20.0	19.8	7.20	6.8	250.0	130.0	1.29	168.0	0.08	1.74	0.09	0.04	2.50	128.0
WQ/N/11.2	16.0	18.5	22.40	7.1	250.0	125.0	1.62	165.0	0.04	1.48	0.08	0.02	9.45	123.0
WQ/N/11.3	23.0	19.4	1.33	6.8	260.0	130.0	1.25	170.0	0.11	4.26	0.09	0.04	3.77	128.0
WQ/N/12.1	22.0	16.0	1.45	6.8	103.0	52.0	1.62	81.0	ND	2.72	0.18	0.03	2.73	55.0
WQ/N/12.2	16.5	16.7	1.28	6.9	99.0	49.0	1.81	54.0	0.07	4.26	0.09	0.02	6.21	43.0
WQ/N/12.3	24.0	16.5	0.96	6.0	99.0	49.0	1.58	57.0	0.10	3.06	0.12	0.07	2.08	40.0
WQ/N/13.1	19.0	17.0	2.18	5.8	176.0	89.0	15.49	11.0	0.13	9.00	0.12	0.06	3.47	60.0
WQ/N/13.2	17.5	17.1	1.15	5.5	176.0	89.0	26.91	12.0	0.07	7.41	0.10	0.04	5.77	53.0
WQ/N/13.3	21.0	17.4	0.54	4.9	180.0	90.0	25.11	12.0	0.16	8.74	0.11	0.05	1.94	54.0
WQ/N/14.1	20.0	19.0	2.34	7.8	260.0	130.0	2.04	171.0	0.07	2.78	0.09	0.04	1.44	128.0
WQ/N/14.2	19.0	24.0	6.90	7.5	260.0	130.0	1.81	169.0	0.01	3.59	0.57	0.04	8.20	128.0
WQ/N/14.3	22.0	20.2	1.57	7.0	250.0	125.0	1.54	166.0	0.21	3.30	0.54	0.05	2.91	124.0
WQ/N/15.1	19.0	17.9	775.0	5.2	1000.0	500.0	1.58	373.0	2.75	97.12	14.2	0.04	4.40	275.0
WQ/N/15.2	19.5	18.5	120.0	7.0	1020.0	490.0	124.00	391.0	0.16	32.17	2.06	0.02	3.45	294.0
WQ/N/15.3	19.0	18.9	800.0	6.3	1000.0	500.0	109.00	301.0	4.45	42.13	2.26	0.02	2.66	184.0
WQ/N/16.1	19.0	18.0	11.5	5.0	37.0	19.0	2.24	7.9	0.19	2.44	0.09	0.02	4.63	9.4
WQ/N/16.2	17.0	18.5	22.5	5.8	29.0	15.0	1.54	9.7	0.27	3.88	0.09	0.02	5.11	4.7
WQ/N/16.3	17.5	18.2	4.8	5.7	42.0	21.0	2.57	14.5	0.62	3.83	0.09	0.03	2.96	5.7
WQ/N/17.1	19.0	17.0	29.00	7.4	198.0	99.0	3.16	115.0	0.20	4.68	0.16	0.04	4.32	87.0
WQ/N/17.2	16.0	17.0	9.30	7.0	200.0	100.0	3.16	110.0	0.06	6.48	0.09	0.04	5.69	91.0
WQ/N/17.3	22.0	17.0	7.10	6.3	220.0	100.0	2.57	122.0	0.16	5.44	0.1	0.03	3.11	92.0
WQ/N/18	17.5	17.0	0.2	6.2	49.8	24.9	2.63	27.3	0.04	4.28	0.09	0.17	0.32	20.8
WQ/N/19	16.0	17.3	5.0	9.4	230.000	115.2	2.19	150.7	0.05	2.38	0.09	0.18	0.68	115.1

Table 3. Raw water quality data - Nuwara-Eliya district (Ground water sources)continued

Sample	SO_4^{2-}	CN^-	Total coliform	*E. coli*	Cu	Cd	Cr	Mn	Hg	As	Pb	Total iron
WQ/N/10.1	2.11	$<10^{-4}$	140	10	ND	ND	ND	0.40	ND	ND	ND	5.19
WQ/N/10.2	2.62	$<10^{-4}$	140	32	ND	ND	ND	0.33	ND	ND	ND	5.14
WQ/N/10.3	2.12	$<10^{-4}$	72	50	ND	ND	ND	0.07	ND	ND	ND	1.27
WQ/N/11.1	1.85	$<10^{-4}$	40	Nil	ND	ND	ND	ND	ND	ND	ND	0.35
WQ/N/11.2	1.65	$<10^{-4}$	50	nd	ND	ND	ND	ND	ND	ND	ND	0.72
WQ/N/11.3	3.78	$<10^{-4}$	40	10	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/12.1	1.45	$<10^{-4}$	90	10	ND	ND	ND	0.47	ND	ND	ND	ND
WQ/N/12.2	3.29	$<10^{-4}$	72	40	ND	ND	ND	ND	ND	ND	ND	1.05
WQ/N/12.3	5.28	$<10^{-4}$	50	20	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/13.1	7.04	$<10^{-4}$	Nil	Nil	ND	ND	ND	ND	ND	ND	ND	1.65
WQ/N/13.2	3.04	$<10^{-4}$	nil	nil	ND	ND	ND	ND	ND	ND	ND	0.50
WQ/N/13.3	8.83	$<10^{-4}$	nil	nil	ND	ND	ND	0.15	ND	ND	ND	0.24
WQ/N/14.1	2.45	$<10^{-4}$	110	30	ND	ND	ND	ND	ND	ND	ND	0.29
WQ/N/14.2	3.37	$<10^{-4}$	140	60	ND	ND	ND	ND	ND	ND	ND	0.44
WQ/N/14.3	2.95	$<10^{-4}$	90	20	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/15.1	2.75	$<10^{-4}$	100	40	ND	ND	ND	1.62	ND	ND	ND	10.20
WQ/N/15.2	3.58	$<10^{-4}$	72	20	0.54	ND	1.34	9.33	ND	ND	ND	418.50
WQ/N/15.3	1.75	$<10^{-4}$	60	30	0.45	ND	0.94	7.93	ND	ND	ND	342.00
WQ/N/16.1	1.61	$<10^{-4}$	20	Nil	ND	0.03	ND	0.07	ND	ND	ND	1.98
WQ/N/16.2	2.37	$<10^{-4}$	50	nd	0.08	ND	ND	0.13	ND	ND	ND	0.90
WQ/N/16.3	2.65	$<10^{-4}$	40	10	ND	ND	ND	0.07	ND	ND	ND	2.72
WQ/N/17.1	1.78	$<10^{-4}$	60	Nil	ND	ND	ND	ND	ND	ND	ND	0.56
WQ/N/17.2	1.12	$<10^{-4}$	110	60	ND	ND	ND	ND	ND	ND	ND	0.57
WQ/N/17.3	3.02	$<10^{-4}$	72	40	ND	ND	ND	0.05	ND	ND	ND	0.20
WQ/N/18	2.18	$<10^{-4}$	20	Nil	ND	ND	ND	ND	ND	ND	ND	ND
WQ/N/19	1.97	$<10^{-4}$	20	Nil	ND	ND	ND	ND	ND	ND	ND	ND

Raw water qualitysurvey

Sample points :

Kandy

1. Gatambe
2. Polgolla
3. Mahaweli river at Gohagoda

Nuwara - Eliya

Surface intakes

1. Bambarakelle
2. Shanthipura
3. Pedro intake
4. Water field - New
5. Water field - Old
6. Piyatissapura
7. Brewery intake
8. Gemunu Mawatha
9. Lovers slip

Ground water sources

10. Hill Club
11. Race Course bore hole
12. Upper Lake Road B.H.
13. Galway Forest Lodge
14. Interfashion
15. Palledium Hotel
16. Golf Club
17. Celon Brewery
18. Galway new bore hole
19. New bore hole near golf ground

WQ/N/12	Upper lake road bore hole
WQ/N/13	Galway forest bore hole
WQ/N/14	Interfashion bore hole
WQ/N/15	Palladium bore hole
WQ/N/16	Golf club bore hole
WQ/N/17	Brewery bore hole
WQ/N/18	Galway new bore hole
WQ/N/19	New bore hole near golf ground

The last two bore holes WQ/N/18 and WQ/N/19 are the newly dug wells and samples were collected once at the time they were dug and these data are also provided in the table for water quality (Nuwara-Eliya district)

2. Sewage quality survey

The location of sample collection and the key to sample numbers are given below:

Kandy K/1. High income house – Domestic sewage
K/2 Middle income house - Domestic sewage
K/3. Low income house - Domestic sewage
K/4. Hantana scheme - Before treatment
K/5. Office sewage - Education office, Kandy
K/6. High Income house- effluent from septic tank
K/7. Middle income house - Effluent from septic tank
K/8. Low income house – Effluent from septic tank
K/9 University office - Effluent from septic tank
K/10. Hantana scheme - After treatment
K/11. Hotel with treatment facility - Swiss Hotel Influent
K/12. Hotel with treatment facility - Swiss Hotel Effluent
K/13. Hotel (without treatment facility) Riverdale grey water
K/14. Industrial waste water - Chocolate company(before treatment
K/15. Industrial waste water - Chocolate company(after treatment)
K/16. Industrial waste water - Sun match company*
K/17. Hospital sewage - Peradeniya teaching hospital - Before treatment
K/18. Hospital sewage - Peradeniya teaching hospital - After treatment
K/19. Sewage effluent from the Gohagoda garbage at the dumping site
K/20. Sewage effluent from Gohagoda at the stream which flows into river just before entry into river

*Only one sample was collected from point 16 (Sun match company) since the effluent is discharged only at 3.00 p.m. from the factory.

Nuwara-Eliya N/1. Domestic sewage (middle income)
N/2. Domestic sewage (low income)
N/3 Domestic sewage (Ceybank hotel)
N/4. Municipality – Nuwara Eliya (office sewage)
N/5. Local eating house (domestic sewage)
N/6 Domestic sewage- hotel without treatment- Windsor hotel
N/7 Effluent from septic tank (middle income house)
N/8. Effluent from septic tank (Cey Bank Rest)
N/9 Effluent from septic tank (slum house)
N/10. Effluent from septic tank (municipality)
N/11.Hotel (with treatment facility) - before treatment (Grand Hotel)
N/12. Hotel (with treatment facility) - after treatment (Grand Hotel)
N/13. Industrial wastewater - drain (Ceylon Brewery)
N/14. Industrial wastewater - effluent after treatment (Ceylon Brewery)
N/15. Hospital sewage
N/16. Tea factory effluent

The analytical results are given in tables 4 & 5. The pH of the sewage samples were generally higher than 7.0 and hence within tolerance limits for disposal. Several had high sulphate contents (K/3,K/11,K/12 ,K/7,K/16). Contamination from chloride is very high in Suisse hotel influent (K/11), and those from K/16,K/19 and K/20 . Phosphates may be high in sewege samples due to increased use of detergents for washing dishes etc. while the treatment appears to reduce this concentration. Among heavy metals, only zinc appears in almost all samples while cadmium is present in the sample K/11 (Riverdale grey water) and K/13 (Sun match company). Zinc probably originates in the galvanised tubing used in most sewage disposal systems.

The sewage effluent from the Gohagoda dumping site is quite dark in colour with a lot of dissolved solids (K/19 & K/20) and also had high Zinc. It also high chloride content. Sample SQ/N/8 (effluent from septic tank at Ceybank Rest) showed very high chloride & phosphate values while industrial waste water from the drain (Brewery) showed high sulphate content perhaps coming from the alum used for the treatment process.

The sample SQ/K/3.1 showing very high values for COD,SS and TDS and total nitrogen is owing to the fact that this particular sample when collected had a lot of suspended solids (taken early morning from the slums area housing scheme). This is the time that the cattle-sheds are washed and the water is highly turbid and contaminated with the excreta and cow-dung. The other two samples had less of all these parameters since only routine washing of dishes was involved at other times when the samples were collected.

3. River water quality

The locations of sample collection and the keys to sample numbers is given below.

Table 4. Sewege Quality Survey (Kandy district)

Sample	T air	Tsewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	E. coli	As	Cd	Zn	Co
SQ/K/1.1	27.5	27.8	7.0	210	860	1200	420	35.2	8.2	213.0	1.78	$17x10^5$	<10	ND	ND	0.08	ND
SQ/K/1.2	27.8	28.2	7.1	220	720	1150	440	25.8	7.6	186.0	1.36	$18x10^5$	<10	ND	ND	0.12	ND
SQ/K/1.3	27.2	27.8	7.0	236	740	852	380	38.0	8.6	222.0	2.20	$17x10^5$	<10	ND	ND	0.1	ND
SQ/K/2.1	27.2	27.1	6.8	240	626	260	386	42.0	10.2	230.0	0.80	$24x10^5$	<10	ND	ND	0.22	ND
SQ/K/2.2	27.4	26.9	6.9	210	548	180	410	36.0	11.2	270.0	1.40	$20x10^5$	<10	ND	ND	0.24	ND
SQ/K/2.3	26.8	26.4	6.8	180	602	222	360	40.4	8.6	330.0	1.60	$18x10^5$	<10	ND	ND	0.16	ND
SQ/K/3.1	25.0	24.5	8.8	203	49	940	2680	269.0	43.8	105.2	42.90	$68x10^5$	$18x10^5$	ND	ND	0.64	ND
SQ/K/3.2	27.5	26.0	8.1	92.7	380	100	490	50.1	22.5	7.7	27.90	$32x10^5$	$10x10^5$	ND	ND	0.22	ND
SQ/K/3.3	27.0	25.0	6.9	123	49	270	650	7.9	7.5	34.5	8.34	$28x10^5$	$8x10^5$	ND	ND	0.13	ND
SQ/K/4.1	27.5	25.0	7.4	70	57	140	260	20.0	6.3	77.0	6.39	$35x10^4$	$18x10^4$	ND	ND	0.05	ND
SQ/K/4.2	28.0	25.0	7.2	90	300	250	190	25.1	10.8	15.4	10.65	$38x10^4$	$16x10^4$	ND	ND	0.05	ND
SQ/K/4.3	27.0	25.0	6.4	135	231	250	362	37.2	12.0	29.0	13.74	$26x10^4$	$14x10^4$	ND	ND	0.07	ND
SQ/K/4.4	27.0	25.1	8.2	120	180	160	212	25.2	8.2	54.5	10.10	$22x10^4$	$12x10^4$	ND	ND	0.04	ND
SQ/K/4.5	27.0	25.0	7.6	118	210	230	260	20.8	8.6	50.5	10.40	$26x10^4$	$12x10^4$	ND	ND	0.06	ND
SQ/K/4.6	26.8	24.9	7.2	90	226	240	320	26.2	8.8	48.6	11.20	$20x10^4$	$10x10^4$	ND	ND	0.05	ND
SQ/K/4.7	26.4	25.0	7.4	108	208	250	280	25.8	10.2	60.8	9.80	$22x10^4$	$10x10^4$	ND	ND	0.04	ND
SQ/K/4.8	26.4	24.9	6.8	132	280	230	276	25.8	8.8	54.6	12.80	$18x10^4$	$4x10^4$	ND	ND	0.12	ND
SQ/K/4.9	26.3	24.9	6.6	140	216	276	312	28.6	12.0	60.6	11.20	$24x10^4$	$5x10^4$	ND	ND	0.08	ND
SQ/K/4.10	26.1	24.6	7.2	128	202	190	210	30.2	11.2	58.2	10.50	$20x10^4$	$6x10^4$	ND	ND	0.04	ND
SQ/K/4.11	26.0	26.2	7.2	124	200	140	180.0	20.2	7.6	54.60	8.60	$22x10^4$	$6x10^4$	ND	ND	0.04	ND
SQ/K/4.12	25.8	26.0	7.1	130	210	150	200.0	22.4	8.8	60.80	9.20	$16x10^4$	$4x10^4$	ND	ND	0.04	ND
SQ/K/5.1	26.0	24.0	6.2	238	413	310	200	28.2	16.8	26.2	9.46	$13x10^4$	<10	ND	ND	0.02	ND
SQ/K/5.2	28.0	24.5	6.7	98	202	250	250	23.4	16.2	15.4	7.80	$10x10^4$	<10	ND	ND	0.03	ND
SQ/K/5.3	27.0	25.0	6.8	80	575	230	150	63.1	20.4	17.9	7.92	$12x10^4$	<10	ND	ND	0.02	ND
SQ/K/6.1	28.5	25.0	6.4	110	2866	2361	273	63.1	12.1	92.6	7.36	$4x10^5$	$4x10^5$	ND	ND	1.22	ND
SQ/K/6.2	28.8	25.6	6.5	120	2100	2020	320	50.5	10.9	86.4	6.46	$4x10^5$	$4x10^5$	ND	ND	0.8	ND
SQ/K/6.3	28.4	25.2	6.4	142	2200	2040	310	62.6	11.8	106.1	6.80	$2x10^5$	$2x10^5$	ND	ND	1.06	ND
SQ/K/7.1	27.0	25.0	6.9	15	613	353	220	794.3	33.2	53.3	22.87	$33x10^5$	$33x10^5$	ND	ND	0.49	ND
SQ/K/7.2	27.3	26.8	6.9	80	524	240	210	524.0	28.8	63.8	18.90	$30x10^5$	$30x10^5$	ND	ND	0.42	ND

Table 4. Sewage Quality Survey (Kandy district) contd..

Sample	T air	Tsewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	E. coli	As	Cd	Zn	Co
SQ/K/7.3	26.8	26.3	6.8	86	580	280	220	610.0	30.2	60.8	20.50	$28x10^5$	$28x10^5$	ND	ND	0.46	ND
SQ/K/8.1	28.5	24.5	6.2	20	1716	25931	330	199.5	6.1	85.5	7.08	$16x10^3$	$16x10^3$	ND	ND	1.20	ND
SQ/K/9.1	28.0	26.0	6.6	43	8	289	260	3.8	10.2	16.9	2.28	110	78	ND	ND	0.17	ND
SQ/K/10.1	27.5	26.0	7.5	41	65	190	240	22.4	1.8	31.0	11.89	$30x10^4$	$20x10^4$	ND	ND	0.03	ND
SQ/K/10.2	28.0	27.7	7.6	53	57	250	290	21.4	2.9	26.8	8.31	$28x10^4$	$18x10^4$	ND	ND	0.02	ND
SQ/K/10.3	27.0	25.5	7.5	8	8	280	267	22.4	2.4	24.0	12.20	$24x10^4$	$16x10^4$	ND	ND	0.02	ND
SQ/K/11.1	27.5	26.0	6.7	215	462	130	200	214.0	46.2	30.1	19.05	$76x10^2$	$42x10^2$	ND	ND	ND	ND
SQ/K/11.2	28.0	26.5	6.4	98	227	110	190	135.0	31.2	13.9	10.58	$60x10^2$	$32x10^2$	ND	ND	0.1	ND
SQ/K/11.3	27.0	26.5	6.2	143	121	200	270	126.0	49.8	36.6	15.34	$62x10^2$	$30x10^2$	ND	ND	0.09	ND
SQ/K/12.1	27.5	27.0	6.6	33	97	150	370	20.4	99.0	30.0	10.35	$30x10^2$	$10x10^2$	ND	ND	ND	ND
SQ/K/12.2	28.0	27.0	6.3	81	32	100	560	38.9	87.3	20.6	25.89	$32x10^2$	$12x10^2$	ND	ND	0.07	ND
SQ/K/12.3	27.0	27.5	6.3	30	777	200	323	29.5	69.9	37.1	18.75	$34x10^2$	$8x10^2$	ND	ND	0.17	ND
SQ/K/13.1	25.0	25.5	6.8	12.7	57	100	140	14.1	6.6	61.0	14.32	$30x10^3$	$22x10^2$	ND	ND	0.03	ND
SQ/K/13.2	27.5	25.5	6.6	107	33	90	180	13.5	4.8	20.7	11.44	$28x10^3$	$20x10^2$	ND	ND	0.07	ND
SQ/K/13.3	27.0	25.0	6.6	203	97	100	160	14.4	4.7	33.0	11.44	$32x10^3$	$18x10^2$	ND	ND	0.07	ND
SQ/K/14	30.0	29.5	6.2	340	976	201	296	17.4	3.6	63.2	17.70	$18x10^3$	<10	ND	ND	0.54	ND
SQ/K/15	31.0	29.5	5.2	345	219	681	270	26.9	1.3	31.1	5.40	$12x10^3$	<10	ND	ND	0.07	ND
SQ/K/16	29.5	27.2	6.2	290	202	175	198	380.0	74.5	63.4	13.00	130	<10	0.902	ND	0.13	ND
SQ/K/17.1	26.0	24.0	6.4	10.2	113	270	270	15.5	10.9	39.4	11.17	$48x10^6$	$3x10^6$	ND	ND	0.17	ND
SQ/K/17.2	28.0	26.0	7.2	150	251	450	240	30.9	12.9	44.3	6.13	$40x10^6$	$3x10^6$	ND	ND	0.14	ND
SQ/K/17.3	27.0	25.0	6.8	52.7	48	650	191	17.0	10.8	15.4	8.66	$42x10^6$	$4x10^6$	ND	ND	0.1	ND
SQ/K/18.1	26.0	24.0	10.8	20.2	57	560	260	93.3	21.3	23.1	7.67	$18x10^6$	$2x10^5$	ND	ND	0.06	ND
SQ/K/18.2	28.0	25.0	6.8	100	73	180	260	17.0	13.4	19.5	4.74	$16x10^6$	$3x10^5$	ND	ND	0.1	ND
SQ/K/18.3	27.0	25.0	5.9	75.2	130	160	361	17.0	5.4	19.0	15.52	$14x10^6$	$2x10^5$	ND	ND	0.37	ND
SQ/K/19	33.0	35.5	6.9	3.2	1246	273	5280	794.3	7.8	223.1	8.15	$45x10^4$	2x105	ND	ND	0.30	ND
SQ/K/20	33.0	28.8	7.9	31	1343	201	3100	676.1	17.7	174.2	8.00	4500	1200	ND	ND	0.57	ND
SQ/K/21.1	25.0	25.5	7.5	12.8	24	70	270	25.7	10.9	29.9	7.46	3000	140	ND	ND	0.03	ND
SQ/K/21.2	28.0	25.0	7.5	7.7	24	660	250	74.1	14.4	10.3	7.46	2500	100	ND	ND	0.05	ND
SQ/K/21.3	27.0	25.0	7.0	220	97	110	270	31.6	6.0	43.1	5.75	2500	100	ND	ND	0.06	ND

Sampling points

1. High Income house - domestic sewege
2.Middle income house- domestic sewege
3. Low income house - domestic sewege
4. Hantana scheme- beforte treatment
5.Education office
6. High Income house- effluent from septic tank
7. Middle income house -effluent fromseptic tank
8. Low income house- effluent from septic tank
9. University office -effluent from septic tank
10.Hantana scheme- after treatment
11.Hotel with treatment facility -Suisse hotel influent
12. Hotel with treatment plant Suisse hotel -effluent
13. Hotel without treatment facility - Riverdale grey water
14. Industrial waste water-Chocolate company before treatment
15. Industrial waste water- Chocolate factory after treatment
16.Industrial waste water -Sun match company
17. Hospital sewege- Peradeniya hospital- before treatment
18.Hospital sewege- Peradeniya hospital - after treatment
19. Sewage effluent from Gohagoda at the dumping site
20. Sewage effluent from Gohagoda at the stream which flows into river just before entry into river
21. NWSDB

Table 5. Sewage Quality survey(Nuwara-Eliya district)

Sample	T air	Tsewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	E. coli	As	Cd	Zn	Co
SQ/N/1.1	19.5	19.0	7.0	90.2	510.1	220	250	30.2	ND	31.6	7.47	$23x10^6$	<10	ND	ND	0.12	ND
SQ/N/1.2	17.0	18.5	6.8	275.2	866.3	210	270	239.0	13.6	50.8	13.01	$.23x10^6$	<10	ND	ND	0.14	ND
SQ/N/1.3	16.5	17.5	5.8	315	591	170	410	193.0	6.9	38.2	18.66	$18x10^6$	<10	ND	ND	0.02	ND
SQ/N/2.1	19.0	17.0	10.4	143	251	82	240	7.9	52.8	78.5	5.58	$11x10^3$	$2x10^3$	ND	ND	0.09	ND
SQ/N/2.2	18.5	16.5	10.2	50	194	67	250	33.9	53.8	23.0	10.33	$9x10^3$	$2x10^3$	ND	ND	0.06	ND
SQ/N/2.3	16.5	17.0	10.4	188	81	50	350	37.2	55.3	44.7	7.49	$11x10^3$	$2x10^3$	ND	ND	0.08	ND
SQ/N/3.1	20.0	21.5	6.2	150	146	150	253	7.1	1.2	52.2	7.97	$130x10^3$	<10	ND	ND	0.08	ND
SQ/N/3.2	23.5	21.0	6.4	120	40	70	225	7.9	1.3	25.1	7.92	$90x10^3$	<10	ND	ND	0.06	ND
SQ/N/3.3	17.0	21.0	6.2	38	81	30	190	6.8	1.9	62.4	10.31	$100x10^3$	<10	ND	ND	0.06	ND
SQ/N/4.1	19.5	17.5	6.6	115	16	80	160	50.1	2.8	15.3	5.80	$300x10^2$	$200x10^2$	ND	ND	0.05	ND
SQ/N/4.2	21.0	18.0	6.9	90	437	70	180	10.9	4.6	72.4	10.98	$250x10^2$	$180x10^2$	ND	ND	0.04	ND
SQ/N/4.3	16.5	17.0	8.0	5	65	60	240	53.7	10.6	28.6	12.50	$320x10^2$	$200x10^2$	ND	ND	0.44	ND
SQ/N/5	19.5	20.5	6.4	325.2	1846	336	350	166.0	17.5	74.5	7.54	$13x10^6$	$49x10^5$	ND	ND	0.28	ND
SQ/N/6	19.9	18.7	7.0	75.2	145.7	148	93	14.4	9.9	21.7	7.84	$33x10^5$	$26x10^3$	ND	ND	ND	ND
SQ/N/7.1	19.8	18.8	6.8	120	540	210	420	156.0	24.2	54.2	11.80	$5x10^6$	$5x10^5$	ND	ND	0.22	ND
SQ/N/7.2	20.2	19.0	6.8	140	526	180	430	128.0	20.2	50.8	10.20	$5x10^5$	$5x10^5$	ND	ND	0.18	ND
SQ/N/7.3	19.7	18.6	6.8	136	488	200	520	148.2	23.8	62.0	12.80	$4x10^5$	$4x10^5$	ND	ND	0.16	ND
SQ/N/8.1	20.0	20.0	6.9	180	809	350	510	299.0	21.8	69.9	21.54	$11x10^6$	$11x10^5$	ND	ND	0.22	ND
SQ/N/8.2	23.5	17.5	6.9	153	518	350	470	162.0	30.6	44.2	20.05	$10x10^6$	$10x10^6$	ND	ND	0.14	ND
SQ/N/8.3	17.0	19.5	6.9	73	243	320	430	229.0	30.9	33.1	21.39	$8x10^6$	$8x10^6$	ND	ND	0.07	ND
SQ/N/9.1	19.5	19.1	6.7	132	320	220	310	120.0	16.2	61.8	18.60	$14x10^3$	$14x10^3$	ND	ND	0.12	ND
SQ/N/9.2	20.1	19.2	6.5	110	276	178	382	110.6	20.4	58.6	17.40	$12x10^3$	$12x10^3$	ND	ND	0.14	ND
SQ/N/9.3	18.8	18.1	6.6	148	318	148	412	100.8	18.6	65.6	18.20	$16x10^3$	$16x10^3$	ND	ND	0.12	ND
SQ/N/10.1	19.0	18.2	6.8	230	710	82	190	100.6	10.2	80.4	6.80	$17x10^6$	$11x10^6$	ND	ND	0.22	ND
SQ/N/10.2	19.5	18.5	6.8	216	652	104	160	120.4	11.5	86.8	7.20	$13x10^6$	$10x10^6$	ND	ND	0.2	ND
SQ/N/10.3	18.5	18.1	6.8	208	720	120	182	110.5	10.8	75.8	5.80	$18x10^6$	$10x10^6$	ND	ND	0.14	ND
SQ/N/11.1	19.5	21.5	6.8	118	178	10	197	79.4	6.2	83.5	14.29	$94x10^2$	$94x10^2$	ND	ND	0.07	ND
SQ/N/11.2	17.0	21.5	6.9	75	219	10	230	44.7	4.2	31.1	12.43	$82x10^2$	$80x10^2$	ND	ND	0.08	ND
SQ/N/11.3	17.0	20.5	7.1	153	146	50	220	33.9	10.5	83.5	16.11	$86x10^2$	$86x10^2$	ND	ND	0.07	ND

Table 5. Sewege Quality survey (Nuwara-Eliya district) contd..

Sample	T air	Tsewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	E. coli	As	Cd	Zn	Co
SQ/N/12.1	19.5	21.0	6.8	125	57	20	80	25.1	15.3	36.6	13.80	$6.8x10^2$	<10	ND	ND	0.04	ND
SQ/N/12.2	17.0	21.5	6.8	65	49	30	180	32.4	14.4	22.0	12.10	$6.4x10^2$	<10	ND	ND	0.04	ND
SQ/N/12.3	17.0	20.5	6.8	25	97	10	60	15.8	15.6	27.1	8.82	$5.2x10^2$	<10	ND	ND	0.06	ND
SQ/N/13.1	22.5	21.5	2.9	63	980.7	3300	1090	6.3	97.7	29.6	6.05	$23x10^2$	<10	ND	ND	0.51	ND
SQ/N/13.2	17.0	18.0	3.7	13	1174	370	160	3.1	89.4	32.1	9.74	$18x10^2$	<10	ND	ND	0.27	ND
SQ/N/13.3	17.0	20.0	6.2	80	57	196	120	5.0	8.1	42.7	9.33	$26x10^2$	<10	ND	ND	0.34	ND
SQ/N/14.1	22.5	25.0	6.5	298	820.1	2556	1322	16.2	29.4	31.1	22.51	$17x10^3$	<10	ND	ND	0.09	ND
SQ/N/14.2	17.0	25.0	6.9	190	712	1186	896	16.2	28.8	28.0	13.30	$12x10^3$	<10	ND	ND	0.19	ND
SQ/N/14.3	17.0	24.0	6.9	288	777	2545	1332	7.4	7.8	69.9	15.26	$18x10^3$	<10	ND	ND	0.19	ND
SQ/N/15.1	20.0	17.0	6.2	37	49	90	180	14.1	1.6	44.2	6.82	$79x10^6$	$2x10^6$	ND	ND	0.05	ND
SQ/N/15.2	19.0	17.5	7.4	5	49	110	240	53.7	1.6	31.1	16.98	$82x10^6$	$2x10^6$	ND	ND	0.06	ND
SQ/N/15.3	17.0	17.5	6.6	3	24	180	340	4.4	1.7	44.1	10.17	$86x10^6$	$2x10^6$	ND	ND	0.09	ND
SQ/N/16	24.5	21.5	7.0	60.2	372.4	37	79	5.0	0.3	29.1	4.67	<10	<10	ND	ND	0.82	ND
SQ/N/17	21.0	23.2	7.3	100.2	170	427	346	19.9	0.5	31.3	4.77	$35x10^4$	$18x10^2$	ND	ND	0.19	ND

Sample points

Nuwara - Eliya
1. Domestic sewage (Middle income)
2. Domestic sewage (Low income)
3. Domestic sewage (ceybank hotel)
4.Office sewege-Municipality
5. Local eating house
6. Domestic sewage - hotel without treatment facility- Windsor hotel
7. Effluent from septic tank (Middle income house)
8. Effluent from septic tank (Ceybank rest)
9. Effluent from septic tank (slum house)
10. Effluent from septic tank (municipality)
11. Hotel with treatment facility - Grand Hotel Before treatment
11. Hotel with treatment facility - Grand Hotel After treatment
13. Industrial waste water- drain (Ceylon Brewery)
14. Industrial waste water- effluent after treatment (Ceylon Brewery)
15. Hospital sewage
16. Tea Factory effluent
17.Factory effluent -Interfashion

Kandy:	RWQ/K/1	Gangawata Korale- near University Gymnasium
	RWQ/K/2	Intake point of Kandy water treatment plant
	RWQ/K/3	Katugastota district (Pinga oya near meda-ela bridge)
	RWQ/K/4	Polgolla dam site intake
	RWQ/K/5	Stream near Polgolla University
	RWQ/K/6	Kundasale intake
	RWQ/K/7	Meda Ela
	RWQ/K/8	Down stream of the Gohagoda dumping site
Nuwara-Eliya		
	RWQ/N/1	Upstream of city's borders
	RWQ/N/2	Victoria park
	RWQ/N/3	Influent point to Gregory lake
	RWQ/N/4	Upstream of Hospital and Brewery
	RWQ/N/5	Influent point to Barrack's plain reservoir

The analytical data for samples are given in tables 6 & 7. The samples were most of the times brownish and muddy showing an increase in suspended solids and sometimes even high total dissolved solids during this season compared to the previous dry season data.The samples taken from Meda Ela which is a highly polluted canal show increased nitrate, sulphate, coliforms, suspended solids, etc. Dissolved oxygen was also very low for these samples.

Those samples collected from Nuwara Eliya were highly contaminated compared to Kandy samples. In particular, those samples collected at the influx point to Barracks Plain reservoir had very little dissolved oxygen with relatively high pH values. Also RWQ/N/4 and RWQ/N/5 showed high suspended and dissolved solids, high total nitrogen and high BOD values. These samples also had high COD values indicating increased contamination from organic wastes. This can be easily explained since sewage from the hospital, factories and even households are directly added to the stream feeding the Barracks Plain reservoir. There is also intensive agricultural activities and a lot of houses dumping septic tank wastes direct into this stream which explains the abnormal values for COD,SS, TDS and chloride for sample N/4.1. However apart from zinc which probably originate from rusting galvanized iron, heavy metal contamination is virtually non-existent.

It is also clear that the sample RWQ/N/3at the Victoria Park is highly contaminated due to coliforms and *E. coli* compared to RWQ/N/1 and RWQ/N/2. This is due to increased faecal contamination from human activity in the city.

Out of the Kandy samples RWQ/K/3 and RWQ/K/7 are those collected from Pinga-Oya and Meda-Ela and these are highly polluted streams which feed the Mahaweli river and this is the cause of their high level of contamination. The sample collected

Table 6.River Water Quality Survey (Kandy district)

Sample	T air	T water	pH	COD	SS	TDS	SO_4^{2-}	T-N	T-P	Total	E. coli	Cl^-	Cd	As	Zn	Co	Condu	BOD	DO
RWQ/K/1.1	23.1	23.6	5.4	8.1	60	34.3	1.2	9.9	0.62	2200	600	4.3	ND	ND	0.02	ND	67.8	3.7	7.5
RWQ/K/1.2	24.6	23.7	5.4	8.1	10	24.6	1.6	3.6	0.23	1700	1000	3.2	ND	ND	ND	ND	49.2	4.2	7.4
RWQ/K/1.3	23.9	24.3	5.7	8.1	30	25.5	2.1	8.2	0.67	2400	1200	3.6	ND	ND	0.05	ND	51.0	3.2	7.3
RWQ/K/2.1	24.8	22.9	5.5	8.1	10	28.5	1.8	11.0	0.62	1800	1100	4.2	ND	ND	0.02	ND	57.1	1.7	7.2
RWQ/K/2.2	26.4	23.7	5.4	16.2	80	25.5	1.6	6.2	0.64	2200	800	3.5	ND	ND	ND	ND	50.9	1.2	7.4
RWQ/K/2.3	23.7	23.9	5.0	32.4	110	26.7	1.6	5.1	0.86	1300	800	4.0	ND	ND	ND	ND	53.3	1.7	7.9
RWQ/K/3.1	25.5	25.4	6.2	32.4	70	63.3	2.3	2.6	0.85	700	90	6.9	ND	ND	0.02	ND	126.0	4.7	4.8
RWQ/K/3.2	27.3	27.3	5.2	24.3	70	72.2	1.3	6.2	0.79	1300	400	7.1	ND	ND	ND	ND	145.0	4.7	3.4
RWQ/K/3.3	24.9	26.2	5.2	4.0	70	58.0	1.5	9.2	0.50	1450	1200	6.3	ND	ND	ND	ND	116.0	4.2	3.8
RWQ/K/4.1	27.4	25.0	5.1	8.1	20	29.1	4.0	11.3	0.85	2000	800	3.8	ND	ND	0.14	ND	58.4	4.7	6.4
RWQ/K/4.2	24.9	24.1	5.2	8.1	20	28.9	1.9	1.5	0.65	1300	200	13.5	ND	ND	ND	ND	58.0	3.2	7.0
RWQ/K/4.3	24.8	23.6	5.0	16.2	20	29.3	5.5	16.4	0.80	1600	1100	3.2	ND	ND	ND	ND	58.4	4.2	6.4
RWQ/K/5.1	26.4	26.3	5.4	8.1	20	130.0	1.4	12.3	1.07	1900	1200	17.9	ND	ND	ND	ND	260.0	6.4	4.5
RWQ/K/5.2	27.0	26.5	5.4	16.2	20	130.0	1.6	11.3	0.78	2200	1000	7.1	ND	ND	0.01	ND	260.0	4.2	3.4
RWQ/K/5.3	26.0	26.1	5.6	32.4	30	129.0	1.7	2.5	0.70	1750	1000	7.9	ND	ND	0.02	ND	260.0	3.2	3.8
RWQ/K/6.1	26.4	26.6	5.0	8.1	150	26.8	2.4	12.7	0.81	1300	1050	2.8	ND	ND	0.13	ND	53.7	4.2	7.6
RWQ/K/6.2	27.1	26.0	5.0	8.1	120	28.2	6.2	7.1	0.93	1900	1350	3.1	ND	ND	ND	ND	56.2	3.7	7.3
RWQ/K/6.3	23.4	24.0	5.0	8.1	130	27.3	4.1	12.8	1.61	800	100	2.8	ND	ND	ND	ND	54.7	3.2	7.3
RWQ/K/7.1	25.0	25.1	6.4	48.6	20	200.0	6.6	12.0	0.92	3000	1200	17.8	ND	ND	ND	ND	400.0	7.7	3.6
RWQ/K/7.2	26.0	26.1	5.6	32.4	30	270.0	13.0	10.7	0.41	1750	1100	44.7	ND	ND	0.21	ND	540.0	7.8	8.0
RWQ/K/7.3	24.5	25.2	5.6	24.3	30	220.0	6.4	5.6	0.95	1400	1000	33.1	ND	ND	0.21	ND	450.0	8.2	0.3
RWQ/K/8.1	33.0	24.2	7.4	16.8	113	143.0	1.5	6.27	1.19	2600	1200	6.9	ND	ND	ND	ND	110.8	1.2	7.6

River water quality
Sample points Kandy

1. Gymnasium
2. Gatambe intake
3. Pinga-Oya
4. Doragamuwa junction
5. Open University - Polgolla
6. Kundasale
7. Meda ela
8. After Gohagoda intake

Table 7. River Water Quality (Nuwara-Eliya district)

Sample	T air	T water	pH	COD	SS	TDS	SO_4^{2-}	T-N	T-P	tal colifor	E. coli	Cl^-	Cd	As	Zn	Co	Conductivity	BOD	DO
RWQ/N/1.1	20.0	14.0	6.6	48.6	40	14	0.95	1.27	3.91	70	Nil	6.8	ND	ND	0.19	ND	15.3	0.6	7.9
RWQ/N/1.2	18.0	14.2	6.6	218.6	50	28	1.60	5.30	4.73	100	20	5.1	ND	ND	0.21	ND	12.3	0.5	8.4
RWQ/N/1.3	16.0	18.0	6.8	12.1	33	44	1.10	13.36	7.16	120	40	5.9	ND	ND	0.03	ND	12.7	0.5	7.7
RWQ/N/2.1	20.0	17.0	6.4	36.4	200	53	1.13	13.36	6.98	150	60	15.8	ND	ND	0.05	ND	53.0	6.8	5.5
RWQ/N/2.2	16.5	16.0	5.8	16.2	180	7	1.18	3.30	2.73	20	20	10.9	ND	ND	0.07	ND	62.0	3.7	5.1
RWQ/N/2.3	16.0	17.0	6.6	291.4	62	63	1.12	8.66	10.56	400	30	17.8	ND	ND	0.39	ND	76.0	25.7	3.5
RWQ/N/3.1	16.0	15.6	6.3	8.1	30	13	4.75	0.59	3.40	2400	600	11.2	ND	ND	0.06	ND	66.0	0.7	5.1
RWQ/N/3.2	17.0	16.2	6.5	40.5	120	83	4.00	1.30	6.26	3000	1180	12.3	ND	ND	0.02	ND	70.0	3.2	5.1
RWQ/N/3.3	16.5	16.5	6.8	680.0	30	69	6.10	20.08	10.86	2000	760	15.8	ND	ND	0.43	ND	84.0	21.7	4.8
RWQ/N/4.1	17.6	17.5	6.6	81.0	46	21	3.60	5.97	8.61	340	70	26.9	ND	ND	0.21	ND	126.0	25.2	5.4
RWQ/N/4.2	19.5	18.2	6.8	307.6	380	121	5.15	3.60	6.46	210	30	26.9	ND	ND	0.10	ND	144.6	18.7	5.3
RWQ/N/4.3	16.8	17.0	6.8	202.4	620	133	6.00	2.61	7.03	110	10	20	ND	ND	0.69	ND	116.0	25.2	3.7
RWQ/N/5.1	18.0	19.2	6.6	60.7	220	290	8.13	20.08	7.41	120	10	22.9	ND	ND	0.25	ND	58.4	28.2	2.2
RWQ/N/5.2	20.0	19.7	6.5	153.8	300	141	8.25	1.90	6.46	4500	1000	46.8	ND	ND	0.15	ND	58.0	28.5	1.9
RWQ/N/5.3	16.0	18.0	7.3	121.4	591	310	16.30	1.94	4.60	1000	650	20.9	ND	ND	0.23	ND	58.4	21.7	4.7

Nuwara - Eliya
1. Top Pass
2. Victoria Park
3. Gregory Lake
4. Hawa Eliya
5. Vajira Mawatha

from a stream near Polgolla (RWQ/K/5) was also polluted which is reflected in the analytical data with high total nitrogen, chloride and BOD.

4. **Lake water quality**

The location from where samples were collected and the key to samples is given below.

Kandy: LWQ/K/1, LWQ/K/2, LWQ/K/3, LWQ/K/4 Kandy Lake water samples along the length of the Lake on the Temple of the Tooth side (locations shown in the attached map)
LWQ/K/5, LWQ/K/6, LWQ/K/7, LWQ/K/8 Kandy lake samples along the length of the Lake opposite the Temple of the Tooth side

LWQ/N/1	Gregory lake (near playground)
LWQ/N/2	Gregory lake (middle of the lake –southern end)
LWQ/N/3	Barrack Plains Reservoir (at the beginning)
LWQ/N/4	Barrack Plains Reservoir (end)
LWQ/N/5	Barrack Plains Reservoir (middle)
LWQ/N/6	Barracks Plains Reservoir (middle)
LWQ/N/7	Gregory lake(middle)
LWQ/N/8	Gregory lake(middle)

Note : More samples were collected from the lakes this season compared to the last season since it was felt that two samples collected in the first phase may not be enough to give a representative picture of the entire lake.

The analytical data are given in table 8 & 9.
The Kandy lake is relatively unpolluted compared to Nuwara Eliya lake system as seen in its higher DO values and lower COD values.
However, the total dissolved solids of the Kandy lake samples was relatively high due to more electrolytes dissolved in it and clearer water (less suspended solids). The barracks Plains reservoir which was virtually dry during the first phase was quite full of water at this time of collection.
Nuwara- Eliya lakes in general had high phosphate, high total nitrogen and high sulphate compared to Kandy lake. This is due to leaching of fertilizer residues sprayed on to vegetable plots during the dry season and which gets washed into lakes during the rainy season. The bacteria counts also show significant enhancement in spite of the dilution effects due to rain. This is because a lot of sewege and human waste get washed down with the rain and increase both coliform and E.Coli counts in the reservoirs.

Table 8. Lake Water Quality survey- Kandy district

SAMPLE	Tair	Twater	pH	DO	COD	BOD	SS	TDS	SO_4^{2-}	T-N	T-P	Total coliform	E.Coli	As	Total Iron	Cd	Zn	Co	Elec Con	Cl^-
LWQ/K/1.1	27.5	28.0	8.2	10.2	32.4	3.2	9	63.0	6.2	9.46	1.83	4500	4500	Nil	0.06	Nil	Nil	Nil	260.0	14.8
LWQ/K/1.2	28.5	29.0	8.6	9.8	36.2	3.6	12	60.0	5.8	8.68	1.76	4500	2000	Nil	0.1	Nil	Nil	Nil	250.0	12.8
LWQ/K/1.3	28.0	28.7	8.0	10.4	34.8	2.8	10	58.0	6.6	8.9	1.68	4500	3000	Nil	0.08	Nil	Nil	Nil	248.0	13.6
LWQ/K/2.1	27.5	27.8	8.2	9.8	32.8	1.9	10	56.0	13.9	16.38	1.23	3000	1000	Nil	0.23	Nil	Nil	Nil	260.0	14.5
LWQ/K/2.2	28.5	29.0	8.4	8.6	34.8	2.8	16	60.2	10.8	12.68	1.26	4500	2200	Nil	0.2	Nil	Nil	Nil	230.0	11.5
LWQ/K/2.3	28.0	28.2	8.2	9.6	30.4	2.2	12	50.2	11.2	15.6	1.42	3600	2000	Nil	0.26	Nil	Nil	Nil	250.0	10.8
LWQ/K/3.1	27.5	28.2	8.4	11.1	40.5	0.2	31	52.0	10.8	14.86	1.36	7600	1200	Nil	0.64	Nil	Nil	Nil	250.0	12.8
LWQ/K/3.2	28.5	29.0	8.2	10.2	46.5	0.2	46	48.0	12.2	12.84	1.32	6800	1400	Nil	0.52	Nil	Nil	Nil	276.0	11.6
LWQ/K/3.3	28.0	29.0	8.4	10.6	38.6	0.2	34	54.0	9.6	11.86	1.23	7600	1200	Nil	0.68	Nil	Nil	Nil	240.0	11.8
LWQ/K/4.1	27.5	28.4	8.4	11.2	42.8	0.5	32	52.0	12.8	14.8	1.2	3000	800	Nil	0.32	Nil	Nil	Nil	240.0	13.5
LWQ/K/4.2	28.5	29.2	7.8	10.8	40.6	0.8	38	48.2	10.8	15.6	1.3	3200	1200	Nil	0.36	Nil	Nil	Nil	244.0	12.5
LWQ/K/4.3	28.0	29.2	8.4	11.0	48.2	0.5	30	50.0	11.2	12.6	1.24	3600	1000	Nil	0.3	Nil	Nil	Nil	238.0	12.8
LWQ/K/5.1	27.5	28.0	8.6	8.4	62.8	3.2	48	73.0	2.8	10.00	1.44	9200	1700	Nil	0.25	Nil	0.96	Nil	260.0	13.2
LWQ/K/5.2	28.5	29.0	8.3	6.3	68.4	2.8	60	80.0	2.2	9.80	1.56	7600	1200	Nil	0.26	Nil	0.78	Nil	250.0	13.0
LWQ/K/5.3	28.0	28.0	8.6	8.4	54.8	3.4	40	66.2	2.4	10.00	1.36	6800	1100	Nil	0.3	Nil	0.88	Nil	244.0	10.2
LWQ/K/6.1	27.5	28.0	8.4	9.4	63.8	4.2	46	78.0	3.2	11.80	1.86	9000	1700	Nil	1.25	Nil	1.96	Nil	261.0	14.2
LWQ/K/6.2	28.5	29.0	8.6	7.8	66.4	4.8	49	74.0	3.8	11.00	2.44	9200	1700	Nil	1.25	Nil	1.96	Nil	250.0	12.8
LWQ/K/6.3	28.0	28.5	8.6	7.9	72.8	3	59	85.0	3.6	9.86	1.48	3000	1700	Nil	1.28	Nil	1.86	Nil	256.0	12.6
LWQ/K/7.1	27.5	28.2	8.0	11.7	34.3	6	63	68.0	4.2	12.46	1.56	30000	14000	Nil	1.2	Nil	Nil	Nil	266.0	11.5
LWQ/K/7.2	28.5	29.0	8.1	12.8	36.4	6.2	78	66.0	3.2	11.8	1.42	35000	14000	Nil	1.2	Nil	Nil	Nil	276.0	11.5
LWQ/K/7.3	28.0	28.2	8.4	12.2	34.2	6.8	56	60.0	3.8	10.46	1.28	28000	14000	Nil	1.2	Nil	Nil	Nil	276.0	11.5
LWQ/K/8.1	27.5	27.8	7.8	8.3	68.2	1.2	59.6	64.2	4.7	12.66	2.49	20000	12000	NIL	2.38	Nil	Nil	Nil	260	12.5
LWQ/K/8.2	28.5	29.2	8.2	8.6	68.3	2.4	48.8	56.8	4.2	13.4	2.56	24000	12000	NIL	1.78	Nil	Nil	Nil	270	14.6
LWQ/K/8.3	28.0	28.6	8	8.3	76.2	1.8	46.8	60.8	3.8	12.8	2.38	26000	10000	NIL	1.68	Nil	Nil	Nil	256	14.5

Sample points: Kandy : 8 points to cover the full area of lake
points shown in the attached map

Table 9. Lake Water Quality (Nuwara-Eliya district)

SAMPLE	Tair	Twater	pH	DO	COD	BOD	SS	TDS	SO_4^{2-}	T-N	T-P	Total coliform	E.Coli	As	Total Iron	Cd	Zn	Co	Elec Con	Cl^-
LWQ/N/1.1	16.0	17.0	6.1	7.0	8.1	2.7	17	48.6	8.4	11.06	3.32	280	160	Nil	0.62	Nil	Nil	Nil	87.5	3.6
LWQ/N/1.2	20.0	17.5	6.7	6.8	48.6	1.2	27	48.5	8.4	11.59	3.54	860	100	Nil	0.25	Nil	Nil	Nil	96.7	4.2
LWQ/N/1.3	15.5	17.5	6.4	6.7	32.4	0.7	23	48.3	8.4	2.02	4.32	670	100	Nil	Nil	Nil	Nil	Nil	96.5	4.0
LWQ/N/2.1	16.0	16.5	6.2	5.8	24.1	1.2	29	65.5	11.7	6.28	1.53	320	180	Nil	0.53	Nil	0.24	Nil	130.9	5.8
LWQ/N/2.2	16.5	17.5	6.4	6.2	8.1	0.7	93	58.9	11.7	13.19	1.15	1100	160	Nil	0.39	Nil	Nil	Nil	117.7	5.5
LWQ/N/2.3	16.0	17.5	6.7	6.0	40.5	0.7	51	50.8	11.7	11.25	0.83	1600	400	Nil	0.62	Nil	Nil	Nil	101.6	4.7
LWQ/N/3.1	19.0	17.5	6.4	0.7	32.4	7.2	250	69.6	13.5	7.87	3.12	1960	960	Nil	1.15	Nil	Nil	Nil	138.0	6.8
LWQ/N/3.2	20.0	17.5	6.3	1.3	8.1	8.0	176	68.1	13.5	0.42	4.02	2200	560	Nil	3.11	Nil	Nil	Nil	136.1	6.3
LWQ/N/3.3	20.0	18.5	6.5	0.5	80.9	5.7	166	67.8	13.8	2.02	3.65	1850	720	Nil	1.43	Nil	0.09	Nil	135.6	6.8
LWQ/N/4.1	20.5	17.0	6.4	1.7	32.4	6.7	237	66.8	13.3	0.95	1.09	2400	600	Nil	0.87	Nil	Nil	Nil	133.4	6.0
LWQ/N/4.2	21.0	16.0	6.4	1.5	8.1	5.8	163	66.9	13.6	7.87	2.32	1700	280	Nil	1.21	Nil	Nil	Nil	133.5	6.0
LWQ/N/4.3	20.5	16.5	6.7	Nil	16.2	1.7	147	68.1	13.6	5.74	2.73	2400	700	Nil	2.05	Nil	Nil	Nil	135.8	8.3
LWQ/N/5.1	19.0	22.5	6.4	1.2	97.2	0.2	89	70.1	9.7	0.42	3.84	$35x10^3$	2300	Nil	1.91	Nil	Nil	Nil	139.8	8.1
LWQ/N/5.2	19.5	20.8	6.4	1.0	90.8	0.3	78	76	8.4	0.8	3.7	$30x10^3$	2300	Nil	1.67	Nil	Nil	Nil	147.1	7.8
LWQ/N/5.3	19.3	20.5	6.6	1.6	68.6	0.7	58	58.5	7.8	0.65	3.64	$32x10^3$	2000	Nil	1.78	Nil	Nil	Nil	138.7	6.8
LWQ/N/6.1	18.5	21.0	6.8	1.0	251.0	35.2	103	89.5	10.8	15.85	2.59	$13x10^5$	$1.4x10^5$	Nil	2.1	Nil	Nil	Nil	179.0	19.9
LWQ/N/6.2	19.2	20.6	6.7	1.2	230.2	36.7	87	82.5	9.8	14.7	2.7	$10x10^5$	$1.2x10^5$	Nil	1.8	Nil	Nil	Nil	186.0	17.6
LWQ/N/6.3	18.5	19.8	6.9	1.4	210.6	38.5	82	80.8	9.2	13.8	2.67	$9x10^5$	$1.0x10^5$	Nil	1.7	Nil	Nil	Nil	167.8	16.8
LWQ/N/7.1	16.5	19.0	7.8	10.0	113.3	0.7	68	35.3	5.1	5.74	3.81	580	<100	Nil	0.73	Nil	Nil	Nil	70.9	4.6
LWQ/N/7.2	17.6	19.5	7.6	9.2	98.6	1.0	78	35.6	5.2	5.68	3.56	780	<100	Nil	0.67	Nil	Nil	Nil	67.8	3.8
LWQ/N/7.3	16.3	18.2	7.6	9.8	110.6	0.9	63	34.5	5.6	5.8	3.24	480	<100	Nil	0.65	Nil	Nil	Nil	70.9	4.6
LWQ/N/8.1	16.5	18.5	8.4	10.5	24.3	2.2	107	36.4	6.6	13.19	1.88	130	<100	Nil	0.65	Nil	Nil	Nil	72.3	4.6
LWQ/N/8.2	16.8	18.9	8.2	7.8	20.6	2.4	110	37.8	6.5	12.83	1.9	300	<100	Nil	0.65	Nil	Nil	Nil	72.3	4.6
LWQ/N/8.3	16.0	17.8	8.2	8.7	22.4	2.0	98	36.8	6.8	13.56	1.94	230	<100	Nil	0.65	Nil	Nil	Nil	72.3	4.6

Samples: Nuwara - Eliya

1. Gregory Lake
2. Gregory Lake - near the bridge
3. Barrack plains - middle
4. Barrack plains
5. Barrack plains
6. Barrack plains
7. Gregory Lake- middle
8. Gregory lake -middle

There was no significant variation in the Kandy lake samples collected at different locations except for bacterial counts and this is perhaps due to the close proximity to hotels which discharge raw effluent into this waterbody without any treatment.

5. **Sludge quality survey**

Samples were collected from both Kandy and Nuwara-Eliya. However there were problems collecting samples during the first survey for this analysis as planned in the schedule of work since septic pits are either permanently sealed or the sludge form septic tanks is regularly cleaned by the municipalities. We were however able to complete the leftover sludge samples from the first survey during this period.

The samples points and the key to samples is given below:

Kandy	SQ/K/1	Septic tank sludge-office complex (University)
	SQ/K/2	Hospital sludge
	SQ/K/3	Sludge from septic tank- middle income house
Nuwara Eliya	SQ/N/1	Sludge from septic tank- middle income house
	SQ/N/2	Public toilet

The analytical results are given in table 10. One notable feature is the presence of Zn as a heavy metal in all these samples. Perhaps this originates from the galvanised piping used in plumbing etc. The high phosphate content in domestic sewege may be a reflection of the increased use of phosphate based detergents.

Table 10.Sludge Quality survey (Kandy and Nuwara-Eliya districts)

SAMPLE	Tair	Tsludge	Water content mg/g	VSSmg/kg	SS mg/g	T-N g/kg	T-P mg/kg	As	Cd	Co	Zn mg/kg
SQ/K/1	28.7	28.3	462.1	20.2	369.2	8.3	6.00	Nil	Nil	Nil	0.19
SQ/K/2	28.6	28.2	172.2	30.7	385.1	5.38	13.00	Nil	Nil	Nil	0.67
SQ/K/3	29.1	28.3	517.3	8.6	174.3	5.95	2.35	Nil	Nil	Nil	0.01
SQ/N/1	21	20.3	547.7	10.5	320.2	8.7	7.5	Nil	Nil	Nil	0.22
SQ/N/2	20.8	20	476.2	14.5	410.4	8.1	8.5	Nil	Nil	Nil	0.12

Sludge quality survey

Sample points:

Kandy
1. Senate
2. Hospital
3. Meewatura

Nuwara Eliya
1. Sludge from septic tank- middle income house
2. Public toilet

Annexure 1- Pesticide analysis on water samples

Parameter	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7	SP 8	SP 9	SP 10	SP 11	SP 12	SP 13	SP 14	SP 15	SP 16	SP 17	SP 18	SP 19	SP 20	SP 21
α - HCH	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
β - HCH	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
γ - HCH(Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
δ - HCH	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlorepoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p'p, DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o'p, DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p'p, DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o'p, DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p'p, DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethoate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fenitrothion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monocrotophos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methamidaphos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Parathion Methyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pirimiphos Methyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Profenofos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Quinalphos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorothalonil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Captan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metalaxyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propanil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Atrazine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Parameter	Limit of Determination µg/l
α - HCH	0.2
β - HCH	0.4
γ - HCH(Lindane)	0.2
δ - HCH	0.2
Aldrin	0.5
Dieldrin	0.5
Heptachlorepoxide	0.5
Endosulfan	0.5
p'p, DDE	0.5
o'p, DDT	0.5
p'p, DDT	0.5
o'p, DDD	0.5
p'p, DDD	0.5
Chlorpyrifos	1
Dimethoate	5
Diazinon	2
Fenthion	2
Fenitrothion	2
Malathion	2
Monocrotophos	5
Methamidaphos	5
Parathion	2
Parathion Methyl	2
Pirimiphos Methyl	2
Profenofos	2
Quinalphos	2
Carbofuran	5
Chlorothalonil	5
Captan	1
Metalaxyl	5
Alachlor	2
Propanil	2
Atrazine	5
Permethrin	10

SP1 WQ/K/1.1
SP2 WQ/K/2.1
SP3 WQ/N/1.1
SP4 WQ/N/2.1
SP5 WQ/N/3.1
SP6 WQ/N/4.1
SP7 WQ/N/5.1
SP8 WQ/N/6.1
SP9 WQ/N/7.1
SP10 WQ/N/8.1
SP11 WQ/N/9.1
SP12 WQ/N/12
SP13 WQ/N/13
SP14 WQ/N/14
SP15 WQ/N/11.2
SP16 WQ/N/10.2
SP17 WQ/N/15.2
SP18 WQ/N/17.2
SP19 WQ/N/16.2
SP20 Golf ground - New
SP21 galway - New

POSTGRADUATE INSTITUTE OF SCIENCE

UNIVERSITY OF PERADENIYA
PERADENIYA
SRI LANKA

Report on

WATER QUALITY EXAMINATION

In the Kandy and Nuwara-Eliya Districts

Submitted to

JICA study Team, NWSDB,Kandy

By

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INTRODUCTION

An agreement was signed between the JICA study team and the Postgraduate Institute of Science, University of Peradeniya in March 1998 for the chemical and biological analysis of water quality of springs, streams, ground water sources, raw sewage, water bodies (rivers and lakes) and sludge.The study area covered the greater Kandy area and the Nuwara Eliya basin. The corresponding collection points are depicted in the attached maps.

Experimental

Samples were collected in cleaned acid washed bottles and sampling was carried out according to accepted methods. Sample preservation depending on the parameter to be analysed was carried out in situ. The general procedures employed for all analytical determinations are those given in " Standard Methods for the Examination of Water and Wastewater" 19th edition (1995) published by the American Public Health Association, Washington, D.C.

The BOD, COD were analysed by standard titrimetric procedures. Cl- & F- were analysed using ion-selective electrodes. Total nitrogen was analysed using the Kjeldhal method and total phosphorus (T-P) using colorimetry (vanadomolybdate method. Cd, Zn and Co were determined using atomic absorption. As was determined by conversion into the hydride and Hg by converting into elemental form by borohydride reduction followed by atomic absorption spectrometry.

Results and Discussion

(I) Raw water quality survey

Results of the raw water quality survey are given in tables 1-6 and the results of the pesticide analysis and their detection limits are given separately in annexure 1. There was total absence of any of the pesticdes generally used in Sri Lanka in any of the water quality samples which were investigated.
The conductivity of ground water sources was high compared to those collected from springs from Nuwara-Eliya.This is probably due to high calcium and magnesium salts as indicated by total alkalinity and hardness. The sulphate contents of these samples were also high. Out of the bore hole wells, those at Upper Lake road, Galway forest and golf club had relatively low mineralization. The free ammonia contents of bore holes of Inter-fashion, golf club & brewery were also high which is perhaps due to the high level of fertilizer application in the surrounding areas. There was no significant variation of the water composition for samples collected from springs over a 24h period indicating little human activity except for the sample at the Water field(new) upstream with respect of these samples. There is also no evidence of pesticide contamination for any of these samples (both spring water & bore holes at Nuwara

Eliya). It is also clear that the sample at Water field (new) is contaminated by coliforms indicating human faecal contamination of this source upstream.

It is also clear that the Palladium bore hole water is also highly contaminated as seen in its high bacterial contamination, high iron content, high chloride etc. This is a shallow bore hole present in a highly contaminated area and it is not surprising that its water is highly polluted. The high iron content may arise due to corroding metallic pipes since this bore hole is situated in the heart of the city. Also because of close proximity to septic tanks it exhibits a high level of ammonia. The hill club bore hole has exceptionally high concentrations of minerals as seen from the hardness and conductivity data and the bed rock may be of a dolomitic type.

Survey points and the keys to samples

Raw water quality

KANDY

WQ/K/1	Intake point of Kandy water treatment plant.
WQ/K/2	Polgolla dam intake

NUWARA ELIYA

Surface intakes

WQ/N/ 1	Bambarakele
WQ/N/2	Shanthipura
WQ/N/3	Pedro intake
WQ/N/4	Water field (old)
WQ/N/5	Water field (new)
WQ/N/6	Piyatissapura
WQ/N/7	Brewery falls
WQ/N/8	Gemunupura
WQ/N/9	Lovers leap

Ground water resources

WQ/N/10	Hill club
WQ/N/11	Old bore hole
WQ/N/12	Upper lake road bore hole
WQ/N/13	Galway forest bore hole
WQ/N/14	Interfashion bore hole
WQ/N/15	Palladium bore hole
WQ/N/16	Golf club bore hole
WQ/N/17	Brewery bore hole

2. Sewage quality survey

The location of sample collection and the key to sample numbers are given below:

Kandy K/1. Middle income house - Domestic sewage
K/2. Low income house - Effluent from septic tank
K/3. Low income house - Domestic sewage
K/4. Hantana scheme - Before treatment
K/5. Office sewage - Education office, Kandy
K/6. Middle income house - Effluent from septic tank
K/7. Hantana scheme - After treatment
K/8 NWSDB ***
K/9. Hotel with treatment facility - Swiss Hotel Influent
K/10. Hotel with treatment facility - Swiss Hotel Effluent
K/11. Hotel (without treatment facility) Riverdale grey water
K/12. Industrial waste water - Chocolate company
K/13. Industrial waste water - Sun match company
K/14. Hospital sewage - Peradeniya teaching hospital - Before treatment
K/15. Hospital sewage - Peradeniya teaching hospital - After treatment

Notes: Sample 12 could not be collected because the company refused entry to Premises.
Only one sample was collected from point 13 (sun match company) since the effluent is discharged only at 3.00 p.m. from the factory.

Nuwara-Eliya N/1. Domestic sewage (middle income) **
N/2. Domestic sewage (low income) *
N/3. Effluent from septic tank (Cey Bank Rest) *
N/4. Hotel (with treatment facility) - before treatment (Grand Hotel)
N/5. Hotel (with treatment facility) - after treatment (Grand Hotel)
N/6. Hotel (without treatment facility)- Cey Bank Rest *
N/7. Industrial wastewater - drain (Ceylon Brewery)
N/8. Industrial wastewater - effluent after treatment (Ceylon Brewery)
N/9. Hospital sewage
N/10. Municipality - NuwaraEliya *

* no flow
** adequate amount of sample was available only <u>once</u>
*** No sample was available to be collected

The analytical results are given in tables 7-9. The pH of the sewage samples were generally higher than 7.0 and hence within tolerance limits for disposal. Several had

high sulphate contents (K/7,K/10,K/13,K/14,K/15,N/7,N/10). Among heavy metals, only zinc appears in almost all samples while cadmium is present in the sample K/11 (riverdale grey water) and K/13 (Sun match company). Zinc probably originates in the galvanised tubing used in most sewage disposal systems.

The bacterial and E.Coli counts for samples N/7 and N/8 are low for a sewage sample since these two samples are from the Brewery (before and after treatment). The relatively low values of bacterial counts observed from hospital sewage may be due to the extensive use of disinfectants at the hospital.

The sample 3.1 showing very high values for COD,SS and TDS is owing to the fact that this particular sample when collected had a lot of suspended solids (taken early morning from the slums area housing scheme). This is the time that the cattle-sheds are washed and the water is highly turbid contaminated with the excreta and cow-dung. The other two samples had less of all these parameters since only routine washing of dishes was involved at other times when the samples were collected.

3. River water quality

The locations of sample collection and the keys to sample numbers is given below.

Kandy:	RWQ/K/1	Gangawata Korale- near University Gymnasium
	RWQ/K/2	Intake point of Kandy water treatment plant
	RWQ/K/3	Katugastota district (Pinga oya near meda-ela bridge)
	RWQ/K/4	Polgolla dam site intake
	RWQ/K/5	Stream near Polgolla University
	RWQ/K/6	Kundasale intake
	RWQ/K/7	Meda Ela
Nuwara-Eliya		
	RWQ/N/1	Upstream of city's borders
	RWQ/N/2	Victoria park
	RWQ/N/3	Influent point to Gregory lake
	RWQ/N/4	Upstream of Hospital and Brewery
	RWQ/N/5	Influent point to Barrack's plain reservoir

The analytical data for samples are given in tables 10-11. These samples show increased contamination with the time of the day they were collected. The samples collected very early in the morning showed high DO, lower BOD & COD and total coliforms. The samples taken from Meda Ela which is a highly polluted canal show increased nitrate, sulphate, coliforms, suspended solids, etc. Dissolved oxygen was also very low for these samples.

Those samples collected from Nuwara Eliya were highly contaminated compared to Kandy samples. In particular, those samples collected at the influx point to Barracks

Plain reservoir had zero dissolved oxygen with relatively high pH values. Also RWQ/N/4 and RWQ/N/5 showed high suspended and dissolved solids, high total nitrogen and high BOD values. These samples also had high COD values indicating increased contamination from organic wastes. This can be easily explained since sewage from the hospital, factories and even households are directly added to the stream feeding the Barracks Plain reservoir. There is also intensive agricultural activities and a lot of houses dumping septic tank wastes direct into this stream which explains the abnormal values for COD,SS, TDS and chloride for sample N/4.1. However apart from zinc which probably originate from rusting galvanized iron, heavy metal contamination is virtually non-existent.

Out of the Kandy samples RWQ/K/3 and RWQ/K/7 are those collected from Pinga-Oya and Meda-Ela and these are highly polluted streams specially during the dry season and this is seen from their high level of contamination. The sample collected from a stream near Polgolla (RWQ/K/5) was also highly polluted and being the dry season did not show any appreciable flow. This again is reflected in the analytical data with high total nitrogen, chloride and BOD.

4. **Lake water quality**

The location from where samples were collected and the key to samples is given below.

Kandy:	LWQ/K/1	Kandy lake near Mahamaya college
	LWQ/K/2	Kandy lake near lakefront hotel
Nuwara-Eliya		
	LWQ/N/1	Gregory lake (near playground)
	LWQ/N/2	Gregory lake (middle of the lake)
	LWQ/N/3	Barrack Plains Reservoir (middle)
	LWQ/K/4	Barrack Plains Reservoir (end)

The analytical data are given in table 12.
The Kandy lake is relatively unpolluted compared to Nuwara Eliya lake system. However, the total dissolved solids of the Kandy lake samples was relatively high. However Kandy lake had more electrolytes dissolved in it and clearer water (less suspended solids). Samples numbers LWQ/N/4.1 to 4.3 show high BOD and virtually no dissolved oxygen and these are the samples taken from the Barrack's plains which is extremely highly polluted. At the time of sample collection it could be hardly called a lake since no water was visible from a distance. Samples were collected under the vegetation at several places perhaps owing to the prevailing drought at that time.

5. Sludge quality survey

Samples were collected from both Kandy and Nuwara-Eliya. However there were problems collecting samples for this analysis as planned in the schedule of work since septic pits are either permanently sealed or the sludge form septic tanks is regularly cleaned by the municipalities.

The samples points and the key to samples is given below:

Kandy	SQ/K/1	Hantana Housing scheme treatment plant
	SQ/K/2	Suisse Hotel
	SQ/K/3	Sun Match company
Nuwara Eliya	SQ/N/1	Ceylon brewery
	SQ/N/2	Grand Hotel

The analytical results are given in table 13. In certain cases the sludge was fairly dry and in others mostly wet. Also, the sludge collected from the Brewery is contaminated with silica used in the sand filters since the sludge is disposed along with the silica used in the filter. This may account for the fact that there is significant non-organic matter in the analytical data. The same is true for Hantana housing scheme sludge where sludge is inevitably contaminated with sand or soil. The type of sludge from the sun match factory is mainly of the inorganic raw materials used for the match manufacturing process and is has very little organic matter .One notable feature is the presence of Zn as a heavy metal in all these samples. Perhaps this originates from the galvanised piping used in plumbing etc. The high phosphate content may be a reflection of the increased use of detergents specially in the hotel industry.

Water Quality
Sample points:

Kandy
- WQ/K/1. Kandy water treatment plant (Getambe)
- WQ/K/3. Polgolla dam

Nuwara-Eliya

Surface intakes:
- WQ/N/1. Bambarakele
- WQ/N/2. Shanthipura
- WQ/N/3. Pedru intake
- WQ/N/4. Water field - old
- WQ/N/5. Water field - new
- WQ/N/6. Piyatissapura
- WQ/N/7. Brewery falls
- WQ/N/8. Gemunupura
- WQ/N/9. Lovers leap

Ground water resources:
- WQ/N/10. Hill Club
- WQ/N/11. Old bore hole
- WQ/N/12. Upper Lake Road
- WQ/N/13. Galway Forest bore hole
- WQ/N/14. Interfashion
- WQ/N/15. Palladium bore hole
- WQ/N/16. Golf Club bore hole
- WQ/N/17. Brewery bore hole

Table 1. Raw Water Quality Data (Kandy district)

Units employed : Temperature- °C, COD,BOD,SS,TDS(mg/l), free ammonia,Cl^-,NO_3^-,NO_2^-,PO_4^{3-} SO_4^{2-}, Cu,Mn,Pb,Hg,Cr,Fe,As,Cd,Zn,Co - ppm
Total hardness and alkalinity (mg/l), Conductivity µs cm^{-1}, Coliform Total at 35°C/100ml, *E.Coli* at 44°C/100ml

SAMPLE	Turbidity NTU	pH	Cond. µs/cm	TDS	Cl^-	Total Alkalinity	Free NH_3	NO_3^-	NO_2^-	F^-	PO_4^{3-}	Total Hardness	SO_4^{2-}	Total coliform	*E,Coli*
WQ/K/1.1	8.2	6.2	61.4	22	4.2	24.8	Nil	1.28	0.02	0.04	0.80	23.3	3.31	280**	170**
WQ/K/1.2	46.3	7.0	69.3	40	7.4	24.2	Nil	1.28	0.01	0.20	1.10	25.2	3.41	800**	150**
WQ/K/1.3	4.4	7.0	81.7	35	4.6	32.7	Nil	2.38	0.03	0.05	0.38	31.0	1.13	100**	70**
WQ/K/1.4	5.0	6.8	80.0	44	7.8	36.3	Nil	2.80	Nil	0.10	0.47	32.9	2.98	>1000*	200*
WQ/K/1.5	4.4	7.1	74.1	54	5.0	36.3	Nil	2.61	Nil	0.05	0.32	27.2	2.53	400**	150**
WQ/K/1.6	31.0	7.5	75.1	74	5.6	29.1	Nil	2.91	Nil	0.17	0.52	29.1	2.68	>1000**	>1000**
WQ/K/1.7	4.9	6.5	75.1	81	5.4	39.3	Nil	3.02	0.24	0.05	0.93	38.8	2.31	400**	20**
WQ/K/1.8	5.6	6.5	70.4	87	7.6	27.8	0.20	2.16	0.27	0.11	0.83	27.2	2.53	400**	150**
WQ/K/2.1	20.9	6.6	66.7	13	5.0	26.6	Nil	1.52	0.01	0.05	1.00	25.2	2.50	180**	40**
WQ/K/2.2	6.5	6.8	73.8	50	7.9	23.6	0.02	2.14	0.01	0.12	0.75	23.3	2.31	960**	340**
WQ/K/2.3	3.8	6.5	84.5	55	7.4	35.1	Nil	5.05	0.01	0.04	0.81	31.0	2.68	250**	40**
WQ/K/2.4	2.7	6.6	69.6	51	7.4	38.1	Nil	2.67	Nil	0.07	0.81	31.0	1.21	600**	120**
WQ/K/2.5	14.8	8.2	71.8	51	9.3	30.3	Nil	3.97	Nil	0.05	0.86	36.9	2.34	960**	340**
WQ/K/2.6	50.0	7.0	76.8	56	6.5	29.1	Nil	2.50	Nil	0.05	0.64	27.2	2.41	160**	100**
WQ/K/2.7	22.4	7.5	59.8	80	6.7	39.9	0.03	4.17	0.96	0.06	0.91	38.8	2.58	180**	40**
WQ/K/2.8	4.5	6.8	77.8	73	8.4	28.4	0.19	2.09	0.27	0.04	0.85	27.2	2.67	200**	40**

* per 10 ml

** per 100ml

Table 2. Raw Water quality (Kandy district) heavy metals and cyanides (mol/l)

SAMPLE	Cu	Mn	As	Cd	Pb	Hg	Cr	Total iron	CN^-
WQ/K/1.1	Nil	0.06	Nil	Nil	Nil	Nil	Nil	0.5	$< 10^{-4}$
WQ/K/1.2	Nil	0.10	Nil	Nil	Nil	Nil	Nil	0.5	$< 10^{-4}$
WQ/K/1.3	Nil	0.10	Nil	Nil	Nil	Nil	Nil	0.4	$< 10^{-4}$
WQ/K/1.4	Nil	0.11	Nil	Nil	Nil	Nil	Nil	0.4	$< 10^{-4}$
WQ/K/1.5	Nil	0.06	Nil	Nil	Nil	Nil	Nil	0.4	$< 10^{-4}$
WQ/K/1.6	Nil	0.22	Nil	Nil	Nil	Nil	Nil	0.6	$< 10^{-4}$
WQ/K/1.7	Nil	0.13	Nil	Nil	Nil	Nil	Nil	0.4	$< 10^{-4}$
WQ/K/1.8	Nil	0.12	Nil	Nil	Nil	Nil	Nil	0.5	$< 10^{-4}$
WQ/K/2.1	Nil	0.06	Nil	Nil	Nil	Nil	Nil	0.6	$<10^{-4}$
WQ/K/2.2	Nil	0.10	Nil	Nil	Nil	Nil	Nil	0.6	$<10^{-4}$
WQ/K/2.3	Nil	0.06	Nil	Nil	Nil	Nil	Nil	0.2	$<10^{-4}$
WQ/K/2.4	Nil	0.07	Nil	Nil	Nil	Nil	Nil	0.2	$< 10^{-4}$
WQ/K/2.5	Nil	0.09	Nil	Nil	Nil	Nil	Nil	0.5	$< 10^{-4}$
WQ/K/2.6	Nil	0.07	Nil	Nil	Nil	Nil	Nil	1.0	$< 10^{-4}$
WQ/K/2.7	Nil	0.25	Nil	Nil	Nil	Nil	Nil	1.0	$< 10^{-4}$
WQ/K/2.8	Nil	0.20	Nil	Nil	Nil	Nil	Nil	0.7	$< 10^{-8}$

Table 3. Raw Water Quality (Nuwara-Eliya district) Ground water sources

SAMPLE	Turbidity	pH	Cond	TDS	Cl^-	Tot alkalinity	Free NH_3	NO_3^-	NO_2^-	F^-	PO_4^{3-}	Total Hardness	SO_4^{2-}	CN^-	Total Coliform	*E. coli*
WQ/N/1.1	2.06	7.3	18.8	16	0.76	9.1	Nil	0.26	0.05	0.03.	0.89	5.8	0.75	$<10^{-4}$	44	28
WQ/N/1.2	2.36	6.1	12.8	15	1.98	7.3	Nil	0.48	Nil	0.03	0.57	5.8	0.06	$<10^{-4}$	10	Nil
WQ/N/2.1	8.20	6.6	17.6	12	0.79	3.0	Nil	2.11	0.05	0.03	1.31	5.8	1.38	$<10^{-4}$	60	04
WQ/N/2.2	0.72	6.6	15.0	10	1.04	4.8	Nil	2.36	0.05	0.03	0.85	4.6	0.01	$<10^{-4}$	60	Nil
WQ/N/3.1	0.65	6.7	17.5	13	1.14	7.3	Nil	0.57	0.05	0.03	0.82	4.9	0.63	$<10^{-4}$	40	12
WQ/N/3.2	1.87	6.8	17.1	12	0.91	7.3	Nil	0.44	0.05	0.03	0.60	5.8	0.31	$<10^{-4}$	100	20
WQ/N/4.1	1.18	7.2	18.1	14	1.10	7.9	Nil	0.21	0.05	0.03	0.55	3.9	0.88	$<10^{-4}$	60	Nil
WQ/N/4.2	0.52	6.1	16.6	12	1.02	7.9	Nil	0.14	0.05	0.03	1.28	5.8	Nil	$<10^{-4}$	80	Nil
WQ/N/5.1	1.43	7.2	17.6	10	1.41	7.3	Nil	2.28	0.05	0.03	0.54	3.9	0.60	$<10^{-4}$	>1000	>1000
WQ/N/5.2	1.21	7.7	12.6	11	1.31	7.5	0.21	0.58	0.05	0.03	1.16	4.5	0.48	$<10^{-4}$	80	Nil
WQ/N/6.1	0.56	7.8	13.7	10	1.20	7.9	Nil	0.17	0.05	0.03	0.85	5.8	0.01	$<10^{-4}$	40	Nil
WQ/N/6.2	2.10	5.0	15.9	12	1.31	8.5	0.28	0.63	Nil	0.05	0.93	5.9	Nil	$<10^{-4}$	60	Nil
WQ/N/7.1	2.43	6.4	20.6	17	1.20	7.3	Nil	2.45	0.05	0.03	0.84	7.8	0.63	$<10^{-4}$	700	320
WQ/N/7.2	1.83	4.5	17.1	11	2.15	9.1	0.28	1.02	Nil	0.03	0.90	8.7	0.04	$<10^{-4}$	600	280
WQ/N/8.1	1.09	7.2	13.6	8	2.95	7.3	Nil	0.43	0.05	0.03	0.65	4.9	0.56	$<10^{-4}$	800	40
WQ/N/8.2	1.50	4.6	14.2	6	2.13	7.9	0.54	0.54	Nil	0.03	0.73	6.8	0.09	$<10^{-4}$	100	Nil
WQ/N/9.1	0.47	6.6	14.5	8	1.09	6.1	Nil	0.37	0.05	0.03	1.21	4.9	0.31	$<10^{-4}$	400	30
WQ/N/9.2	1.20	5.5	17.3	6	1.51	7.9	0.35	1.21	Nil	0.03	1.43	6.8	0.57	$<10^{-4}$	140	Nil
WQ/N/10.1	0.83	7.5	222.0	119	1.20	138.0	0.02	1.27	0.05	0.07	0.57	107.0	4.06	$<10^{-4}$	12	06
WQ/N/10.2	0.89	7.3	222.0	120	3.30	132.0	Nil	3.31	Nil	0.09	0.45	111.0	1.68	$<10^{-4}$	06	Nil
WQ/N/10.3	7.00	5.2	220.0	122	2.50	137.0	0.27	3.18	Nil	0.05	0.53	108.0	3.21	$<10^{-4}$	02	Nil

Table 4. Raw Water Quality (Nuwara-Eliya district) Ground water sources-heavy metals

SAMPLE	Cu	Cr	Mn	Hg	As	Cd	Pb	Total iron
WQ/N/1.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/1.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/2.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/2.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/3.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/3.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
WQ/N/4.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/4.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/5.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/5.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/6.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/6.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/7.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.3
WQ/N/7.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/8.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
WQ/N/8.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/9.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/9.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/10.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.5
WQ/N/10.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.0
WQ/N/10.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.0

Table 5. Raw Water Quality (Nuwara-Eliya district) bore holes

SAMPLE	Turbidity	pH	Cond	TDS	Cl^-	Total -Alkalinity	Free NH_3	NO_3^-	NO_2^-	F^-	PO_4^{3-}	Tot hard ness	SO_4^{2-}	CN^-	Total Coli form	*E. coli*
WQ/N/11.1	0.42	7.8	270.0	142	1.30	169.0	Nil	0.59	0.05	0.10	1.31	136.0	2.13	$<10^{-4}$	10	04
WQ/N/11.2	0.41	7.7	260.0	136	1.60	163.0	0.08	1.55	0.05	0.07	1.25	136.0	0.78	$<10^{-4}$	Nil	Nil
WQ/N/11.3	2.01	7.2	262.0	139	2.80	162.0	Nil	1.99	0.06	0.07	1.31	132.0	2.18	$<10^{-4}$	Nil	Nil
WQ/N/12.1	0.45	6.5	134.0	81	1.90	58.0	Nil	2.00	0.05	0.10	0.73	49.0	2.13	$<10^{-4}$	Nil	Nil
WQ/N/12.2	0.47	6.8	111.0	74	2.40	54.0	Nil	2.21	0.05	0.04	0.75	49.0	1.88	$<10^{-4}$	Nil	Nil
WQ/N/12.3	0.67	6.1	108.0	44	3.30	54.0	Nil	3.75	Nil	0.04	0.91	47.0	1.86	$<10^{-4}$	Nil	Nil
WQ/N/13.1	0.81	5.1	142.0	121	21.38	5.5	Nil	5.39	0.02	0.06	0.94	46.0	20.13	$<10^{-4}$	Nil	Nil
WQ/N/13.2	0.36	5.0	151.0	128	22.90	10.3	0.26	7.08	0.05	0.07	0.68	50.0	1.63	$<10^{-4}$	Nil	Nil
WQ/N/13.3	0.71	6.2	151.0	120	30.90	7.3	Nil	5.04	Nil	0.12	0.94	47.0	4.78	$<10^{-4}$	Nil	Nil
WQ/N/14.1	3.68	6.9	250.0	72	1.99	151.0	Nil	0.76	0.04	0.13	1.70	138.0	0.13	$<10^{-4}$	Nil	Nil
WQ/N/14.2	1.28	5.8	134.0	86	3.20	30.5	2.69	2.69	0.04	0.09	0.41	124.2	0.07	$<10^{-4}$	Nil	Nil
WQ/N/14.3	3.30	4.3	254.0	146	2.75	154.0	2.17	2.17	Nil	0.08	0.58	135.8	3.72	$<10^{-4}$	140	Nil
WQ/N/15.1	5.30	5.6	142.0	87	143.00	43.6	0.05	0.56	Nil	0.05	0.08	162.4	0.32	$<10^{-4}$	200	80
WQ/N/15.2	25.70	5.2	138.0	83	144.54	30.3	5.49	0.16	Nil	0.05	0.17	205.6	11.14	$<10^{-4}$	>1000	>1000
WQ/N/15.3	5.80	6.2	143.0	90	155.24	37.8	4.16	0.17	0.26	0.05	0.23	194.0	0.98	$<10^{-4}$	>1000	>1000
WQ/N/16.1	1.20	7.3	110.0	21	1.58	8.5	Nil	1.78	Nil	0.03	0.27	Nil	0.60	$<10^{-4}$	Nil	Nil
WQ/N/16.2	1.20	4.8	65.1	18	8.12	12.7	2.39	4.49	Nil	0.03	0.37	6.79	2.46	$<10^{-4}$	Nil	Nil
WQ/N/17.1	2.30	4.7	220.0	165	3.98	122.84	5.03	5.03	Nil	0.05	0.38	110.5	2.68	$<10^{-4}$	16	Nil

Table 6. Raw Water Quality (Nuwara-Eliya district) Bore holes - heavy metals

SAMPLE	Cu	Cd	Cr	Mn	Hg	As	Pb	Total iron
WQ/N/11.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
WQ/N/11.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/11.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/12.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
WQ/N/12.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
WQ/N/12.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.3
WQ/N/13.1	Nil	Nil	Nil	0.20	Nil	Nil	Nil	0.2
WQ/N/13.2	Nil	Nil	Nil	0.22	Nil	Nil	Nil	Nil
WQ/N/13.3	Nil	Nil	Nil	0.24	Nil	Nil	Nil	0.2
WQ/N/14.1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
WQ/N/14.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.1
WQ/N/14.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.3
WQ/N/15.1	Nil	Nil	Nil	0.17	Nil	Nil	Nil	1.5
WQ/N/15.2	Nil	Nil	Nil	0.22	Nil	Nil	Nil	1.8
WQ/N/15.3	Nil	Nil	Nil	0.20	Nil	Nil	Nil	1.7
WQ/N/16.1	Nil	Nil	Nil	0.10	Nil	Nil	Nil	Nil
WQ/N/16.2	Nil	Nil	Nil	0.13	Nil	Nil	Nil	Nil
WQ/N/17.1	Nil	Nil	Nil	0.06	Nil	Nil	Nil	0.5

2.3.2 Sewage quality

Sample points:

Kandy

K/1. Middle income house - Domestic sewage
K/2. Low income house - Effluent from septic tank
K/3. Low income house - Domestic sewage
K/4. Hantana scheme - Before treatment
K/5. Office sewage - Education office, Kandy
K/6. Middle income house - Effluent from septic tank
K/7. Hantana scheme - After treatment
K/8. NWSDB ***
K/9. Hotel with treatment facility - Swiss Hotel Influent
K/10. Hotel with treatment facility - Swiss Hotel Effluent
K/11. Hotel (without treatment facility) Riverdale grey water
~~K/12. Industrial waste water - Chocolate company~~
K 12 K/13. Industrial waste water - Sun match company
K 13 ~~K/14~~. Hospital sewage - Peradeniya teaching hospital - Before treatment
K 14 ~~K/17~~. Hospital sewage - Peradeniya teaching hospital - After treatment

Notes: Sample 12 could not be collected because the company refused entry to premises
Only one sample was collected from point 13 (sun match company)

Nuwara-Eliya

N/1. Domestic sewage (middle income) **
N/2. Domestic sewage (low income) *
N/3. Effluent from septic tank (Cey Bank Rest) *
N/4. Hotel (with treatment facility) - before treatment (Grand Hotel)
N/5. Hotel (with treatment facility) - after treatment (Grand Hotel)
N/6. Hotel (without treatment facility)- Cey Bank Rest *
N/7. Industrial wastewater - drain (Ceylon Brewery)
N/8. Industrial wastewater - effluent after treatment (Ceylon Brewery)
N/9. Hospital sewage
N/10. Municipality - NuwaraEliya *

* no flow
** adequate amount of sample was available only once

Table 7. Sewage Quality Survey (Kandy district)

Sample	T air	T sewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	*E. coli*	As	Cd	Zn	Co
Sewage																	
K/1.1	28.3	27.4	7.2	172.7	244	159	127	32	3.5	80	1.63	>1000	>1000	Nil	Nil	0.16	Nil
K/1.2	29.5	28.1	7.7	70.2	52	195	98	38	13.2	40	1.31	>1000	>1000	Nil	Nil	0.18	Nil
K/1.3	31.3	28.5	6.9	230.2	262.9	179	90	37	5.4	103	1.37	>1000	>1000	Nil	Nil	0.20	Nil
K/2.1	28.5	27.5	6.6	67.7	64	102	125	46	13.8	85	1.02	>1000*	>1000*	Nil	Nil	0.20	Nil
K/2.2	27.5	28.0	7.0	35.2	72	136	162	84	14.6	92	1.03	>1000*	>1000*	Nil	Nil	0.17	Nil
K/2.3	27.0	27.5	6.7	35.2	48	116	68	18	14.9	109	1.17	>1000*	>1000*	Nil	Nil	0.18	Nil
K/3.1	31.0	28.0	10.0	318	3288	1578	2584	117	24.83	529	1.03	>1000	>1000	Nil	Nil	0.06	0.2
K/3.2	29.5	30.0	9.0	127	360	172	220	151	2.78	144	1.13	600	200	Nil	Nil	0.02	0.3
K/3.3	31.0	28.5	7.4	17.7	256	522	329	201	34.81	187	1.05	700	80	Nil	Nil	0.15	0.2
K/4.1	31.5	29.5	8.4	90.2	160	101	229	117	0.98	55	1.23	>1000*	>1000*	Nil	Nil	0.05	Nil
K/4.2	31.2	29.6	8.7	120.3	384	184	352	199	0.03	61	1.35	>1000*	>1000*	Nil	Nil	0.03	Nil
K/4.3	29.5	27.5	7.8	70.2	184	188	300	158	0.65	63	1.41	>1000*	>1000*	Nil	Nil	0.05	Nil
K/5.1	30.0	28.5	6.4	50.2	130	120	172	58	13.20	57	0.98	>1000	>1000	Nil	Nil	0.12	Nil
K/5.2	31.5	29.5	7.4	65.2	182	123	158	125	18.40	112	0.83	>1000	>1000	Nil	Nil	0.05	0.01
K/5.3	32.0	29.0	7.6	85.2	126	119	171	48	4.60	73	0.88	>1000	>1000	Nil	Nil	0.10	Nil
K/6.1	28.5	27.0	7.1	240.2	1736	5804	568	41	10.00	323	0.93	>1000*	>1000*	Nil	0.05	4.20	Nil
K/6.2	27.5	28.0	7.2	202.7	1804	4276	480	45	10.90	283	0.98	>1000*	>1000*	Nil	0.04	4.60	Nil
K/6.3	27.0	27.0	7.3	120.2	535	990	510	39	12.80	245	1.31	>1000*	>1000*	Nil	0.04	4.50	Nil

* per 10 ml

Table 8. Sewage Quality Survey (Kandy district) contd..

Sample	T air	T sewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total coliform	*E. coli*	As	Cd	Zn	Co
Sewage																	
K/7.1	31.5	30.5	7.8	10.20	32	94	244	199	24.93	81	1.65	>1000*	>1000*	Nil	Nil	0.04	Nil
K/7.2	31.4	30.0	7.5	11.50	40	116	283	200	0.98	88	1.43	>1000*	>1000*	Nil	Nil	0.03	Nil
K/7.3	29.5	29.0	8.0	60.20	108	79	205	199	12.96	117	1.53	>1000*	>1000*	Nil	Nil	0.03	Nil
K/8.1	30.0	29.0	7.2	5.20	42	174	117	42	13.40	104	1.27	>1000	>1000	Nil	Nil	0.06	Nil
K/9.1	28.9	27.1	8.3	90.20	424	170	318	147	3.61	226	1.63	>1000	>1000	Nil	Nil	0.05	Nil
K/9.2	29.1	27.2	8.7	120.50	636	342	352	150	2.43	48	1.73	>1000	>1000	Nil	Nil	0.06	Nil
K/9.3	29.5	28.1	8.5	135.05	848	253	383	142	2.86	61	1.55	>1000	>1000	Nil	Nil	0.05	Nil
K/10.1	28.9	27.2	7.7	0.20	120	94	389	117	24.83	60	1.28	>1000*	>1000*	Nil	Nil	0.07	Nil
K/10.2	29.8	27.6	7.4	12.70	144	119	450	151	2.78	99	1.65	>1000*	>1000*	Nil	Nil	0.06	Nil
K/10.3	29.1	28.5	7.8	15.30	120	135	398	114	7.36	47	1.35	>1000*	>1000*	Nil	Nil	0.07	Nil
K/11.1	31.0	27.5	7.6	160	148	168	142	147	3.61	92	1.56	>1000	>1000	Nil	0.05	0.10	Nil
K/11.2	29.5	28.0	7.2	120	56	181	153	150	2.43	58	1.68	>1000	>1000	Nil	0.06	0.05	Nil
K/11.3	31.0	29.5	7.0	333	1200	188	802	210	3.68	64	1.58	>1000	>1000	Nil	0.05	0.07	Nil
K/12.1	31.5	30.0	8.6	2.70	78	500	614	119	107.80	44	1.53	>1000	>1000	Nil	0.05	0.60	Nil
K/13.1	28.5	30.0	7.0	85.20	208	281	159	84	13.90	145	1.01	>1000*	>1000*	Nil	Nil	0.60	Nil
K/13.2	29.0	29.5	7.1	45.20	192	247	168	24	17.30	122	1.02	>1000*	>1000*	Nil	Nil	0.40	Nil
K/13.3	29.5	28.0	6.5	15.20	344	80	144	26	14.10	124	1.31	>1000*	>1000*	Nil	Nil	0.22	Nil
K/14.1	28.5	29.0	6.7	40.20	152	300	133	29	25.20	81	1.38	>1000*	>1000*	Nil	Nil	0.25	0.4
K/14.2	29.0	29.0	6.8	35.20	144	273	119	23	23.40	104	1.41	>1000*	>1000*	Nil	Nil	0.27	0.4
K/14.3	29.5	28.0	6.6	10.20	144	108	135	26	24.30	115	1.46	>1000*	>1000*	Nil	Nil	0.25	0.4

* per 10 ml

Table 9. Sewage Quality Survey (Nuwara-Eliya district)

SAMPLE	T air	T sewage	pH	BOD	COD	SS	TDS	Cl^-	SO_4^{2-}	T-N	T-P	Total Coliform	*E. coli*	As	Cd	Zn	Co
Sewage																	
N/1.1	21.0	22.3	5.2	320	1616	1059	277	198.2	3.71	180	0.94	>1000	>1000	Nil	Nil	0.38	0.01
N/2.1	20.0	18.0	7.2	258	640	470	586	37.2	2.79	249	1.56	>1000	>1000	Nil	Nil	0.15	Nil
N/3.1	22.0	21.0	7.4	236	336	207	262	152.1	4.31	116	1.53	>1000	>1000	Nil	Nil	0.03	Nil
N/4.1	20.0	24.0	7.2	95	340	131	192	41.7	3.68	134	0.95	>1000	>1000	Nil	Nil	0.10	Nil
N/4.2	23.0	24.0	6.8	103	296	142	204	39.9	3.50	158	0.87	>1000	>1000	Nil	Nil	0.10	Nil
N/4.3	20.0	25.0	7.3	75	388	136	194	43.9	3.79	169	0.93	>1000	>1000	Nil	Nil	0.12	Nil
N/5.1	20.0	23.0	8.1	20	160	223	191	87.1	2.44	129	1.98	>1000	>1000	Nil	0.06	0.16	Nil
N/5.2	22.0	23.5	8.3	40	176	242	202	76.1	3.14	144	1.73	>1000	>1000	Nil	0.07	0.12	Nil
N/5.3	20.0	23.0	7.9	75	240	253	187	93.4	2.95	98	1.84	>1000	>1000	Nil	0.06	0.14	Nil
N/6.1	22.0	24.0	6.2	30	280	450	80	97.7	0.98	68	1.23	>1000	>1000	Nil	Nil	1.20	Nil
N/7.1	26.0	23.0	6.2	298	1192	386	151	148.1	33.87	155	1.53	140	20	Nil	Nil	0.80	Nil
N/7.2	22.5	26.0	5.0	290	804	386	151	158.9	33.47	104	1.63	400	270	Nil	Nil	0.38	Nil
N/7.3	20.0	24.0	6.0	305	908	351	172	160.5	32.76	137	1.67	300	100	Nil	Nil	0.40	Nil
N/8.1	26.0	23.0	7.2	283	1860	325	683	186.9	43.63	183	1.78	1000	800	Nil	Nil	0.60	Nil
N/8.2	22.5	26.0	6.1	355	1952	401	708	164.8	46.83	107	1.63	140	20	Nil	Nil	0.50	Nil
N/8.3	20.0	25.0	7.6	305	1876	375	695	175.8	45.23	151	1.78	100	70	Nil	Nil	0.50	Nil
N/9.1	22.0	20.0	10	29	72	151	269	21.4	1.63	84	0.98	600	230	Nil	Nil	0.10	Nil
N/9.2	22.0	19.0	8.4	40	112	164	274	24.5	3.45	104	1.03	62	6	Nil	Nil	0.07	Nil
N/9.3	20.0	22.0	7.8	18	260	158	282	22.6	2.86	99	0.94	100	40	Nil	Nil	0.07	Nil
N/10.1	24.0	21.0	5.5	12	880	142	87	202.8	90.69	140	1.23	700	450	Nil	Nil	0.10	Nil

2.3.3. River Water Quality

Sample points :

Kandy:	RWQ/K/1. Gangawata District (University)
	RWQ/K/2. Intake point of Kandy water treatment plant (Gatambe) --
	RWQ/K/3. Katugastota District (Pinga Oya - near Meda ela bridge)
	RWQ/K/4. Polgolla dam
	RWQ/K/5. Ela near Polgolla dam
	RWQ/K/6. Kundasale District (Kundasale intake)
	RWQ/K/7. Meda Ela
Nuwara - Eliya:	RWQ/N/1. Upstream of city's border
	RWQ/N/2. Victoria Park
	RWQ/N/3. Influent point to Gregory Lake
	RWQ/N/4. Upstream of Hospital and Brewery
	RWQ/N/5. Influent point to Barrack Plains reservoir

Table 10. River Water Quality Survey (Kandy district)

Sample	T air	T water	pH	Elec. Cond	COD	BOD	DO	SS	TDS	SO_4^{2-}	T-N	T-P	Total coliform	*E. coli*	As	Cd	Zn	Co	Cl^-
RWQ/K/1.1	24.9	25.3	6.4	63	24	2.45	7.5	133	38	1.9	3.72	1.3	250	100	Nil	Nil	0.02	Nil	5.40
RWQ/K/1.2	29.6	29.0	6.8	63	32	3.20	5.3	130	42	2.3	4.30	1.5	>1000	500	Nil	Nil	0.02	Nil	4.07
RWQ/K/1.3	29.1	29.4	7.1	64	24	2.95	5.6	142	44	2.0	3.70	1.3	800	150	Nil	Nil	0.02	Nil	5.49
RWQ/K/2.1	25.2	25.4	6.2	61	32	5.70	5.5	149	31	3.3	2.22	0.8	100	70	Nil	Nil	0.01	Nil	4.17
RWQ/K/2.2	33.0	29.4	6.8	64	32	1.95	2.2	130	40	2.5	5.26	0.8	800	150	Nil	Nil	0.01	Nil	4.57
RWQ/K/2.3	28.1	28.4	7.1	62	24	4.70	5.8	175	35	2.1	4.60	0.8	600	150	Nil	Nil	0.01	Nil	3.98
RWQ/K/3.1	30.5	28.3	6.6	184	40	4.20	2.2	201	67	1.6	6.44	1.5	>1000	>1000	Nil	Nil	0.02	Nil	22.90
RWQ/K/3.2	32.2	32.5	6.5	193	32	4.70	1.2	172	50	3.4	6.58	1.8	>1000	>1000	Nil	Nil	0.06	Nil	21.30
RWQ/K/3.3	28.5	29.7	6.7	200	28	4.70	1.0	188	98	4.1	6.06	1.6	>1000	>1000	Nil	Nil	0.01	Nil	21.30
RWQ/K/4.1	31.1	29.2	6.4	70	48	5.45	4.5	143	18	2.6	4.97	1.4	140	20	Nil	Nil	0.02	Nil	4.89
RWQ/K/4.2	32.5	31.0	6.8	69	24	3.45	4.9	151	9	2.1	4.48	1.7	>1000	>1000	Nil	Nil	0.01	Nil	4.00
RWQ/K/4.3	29.5	28.4	6.8	73	24	4.70	4.4	158	35	2.4	4.92	1.4	>1000	>1000	Nil	Nil	0.01	Nil	4.26
RWQ/K/5.1	30.5	31.0	6.8	280	24	3.70	3.4	121	151	1.3	7.06	1.9	600	250	Nil	Nil	0.01	Nil	20.89
RWQ/K/5.2	32.5	31.0	6.8	69	24	2.20	3.6	129	162	1.4	7.58	1.7	>1000	>1000	Nil	Nil	0.01	Nil	19.95
RWQ/K/5.3	27.4	28.4	6.7	290	32	4.70	1.4	145	169	1.4	6.96	1.9	>1000	>1000	Nil	Nil	0.01	Nil	21.34
RWQ/K/6.1	31.0	31.2	6.8	82	28	2.45	5.3	110	40	3.4	4.06	1.8	220	80	Nil	Nil	0.01	Nil	5.55
RWQ/K/6.2	32.0	31.0	7.2	92	24	3.20	6.4	123	46	2.9	4.24	2.4	250	100	Nil	Nil	0.01	Nil	6.02
RWQ/K/6.3	26.0	27.8	7.0	82	44	1.70	6.3	115	38	3.1	3.88	1.2	220	80	Nil	Nil	0.01	Nil	5.12
RWQ/K/7.1	27.6	26.5	6.5	404	40	7.80	3.6	258	191	10.4	18.40	1.7	>1000	>1000	Nil	Nil	0.02	Nil	50.11
RWQ/K/7.2	32.3	32.4	6.5	470	52	8.20	0.3	273	187	6.8	15.42	1.3	200	40	Nil	Nil	0.02	Nil	75.86
RWQ/K/7.3	28.6	28.0	6.6	500	60	5.96	0.3	268	201	10.4	16.22	1.8	250	80	Nil	Nil	0.06	Nil	93.30

Table 11. River Water Quality Survey (Nuwara-Eliya district)

SAMPLE	T air	T water	pH	Elec. Cond	BOD	DO	COD	SS	TDS	SO_4^{2-}	T-N	T-P	Total coliform	*E. coli*	Cl^-	Cd	As	Zn	Co
RWQ/N/1.1	18.5	14.0	5.6	20	0.93	7.8	24	145	29	0.1	7.20	0.3	1600	400	1.41	Nil	Nil	Nil	Nil
RWQ/N/1.2	18.0	20.6	4.0	20	1.49	7.0	24	152	32	0.2	7.42	0.4	800	120	1.67	Nil	Nil	Nil	Nil
RWQ/N/1.3	26.0	19.8	5.2	20	1.68	7.7	16	152	40	0.1	6.68	0.3	>1000	250	1.80	Nil	Nil	Nil	Nil
RWQ/N/2.1	16.0	15.5	6.2	190	8.10	0.9	32	124	70	0.1	8.34	0.4	>1000	>1000	21.38	Nil	Nil	0.02	Nil
RWQ/N/2.2	25.0	22.6	5.2	200	5.21	1.5	36	130	78	0.3	9.20	0.5	>1000	>1000	24.54	Nil	Nil	0.02	Nil
RWQ/N/2.3	28.0	22.6	4.5	200	8.30	0.9	16	128	65	0.1	8.88	0.4	>1000	>1000	24.55	Nil	Nil	0.02	Nil
RWQ/N/3.1	18.5	16.9	4.8	230	8.10	2.1	56	92	177	0.1	10.1	2.1	>1000	>1000	27.54	Nil	Nil	0.18	Nil
RWQ/N/3.2	30.0	23.8	5.7	150	12.10	7.8	36	98	150	0.3	12.6	2.0	>1000	>1000	21.30	Nil	Nil	0.06	Nil
RWQ/N/3.3	28.5	25.2	5.6	200	4.10	6.6	24	5	165	1.4	11.6	2.0	>1000	>1000	21.37	Nil	Nil	0.05	Nil
RWQ/N/4.1	25.0	20.9	7.5	720	40.20	1.9	416	1123	406	Nil	21.6	0.3	>1000	>1000	158.45	Nil	Nil	0.06	Nil
RWQ/N/4.2	28.0	23.8	6.0	420	47.70	2.7	60	905	425	0.1	23.6	0.4	>1000	>1000	61.66	Nil	Nil	0.12	Nil
RWQ/N/4.3	28.0	21.9	5.9	470	55.20	2.3	116	1075	402	Nil	21.7	0.3	250	60	61.66	Nil	Nil	0.13	Nil
RWQ/N/5.1	24.0	23.8	5.6	400	135.20	Nil	532	389	321	0.6	20.2	0.5	240	60	57.59	Nil	Nil	0.20	Nil
RWQ/N/5.2	25.0	27.9	4.8	400	~~0~~	Nil	1084	315	305	Nil	23.0	0.5	300	40	69.61	Nil	Nil	0.11	Nil
RWQ/N/5.3	26.0	27.1	4.8	370	105.20 ~~0~~ 75.20	0.2	324	370	312	0.1	28.6	0.4	80	Nil	72.44	Nil	Nil	0.15	Nil

2.3.4. Lake Water Quality

Sample points

LWQ/N/1	Gregory Lake (near the play ground)
LWQ/N/2	Gregory Lake (middle)
LWQ/N/3	Barrack Plains Reservoir (middle)
LWQ/N/4	Barrack Plains Reservoir (end)
LWQ/K/1	Kandy Lake (point 1) Near Mahamaya College
LWQ/K/2	Kandy Lake (point 2) Near Lakefront Hotel

Units

Temperature	°C	
COD, BOD, SS, TDS, Cl^-, SO_4^{2-}, As, Cd, Zn, Co		ppm
Conductivity	: s cm^{-1}	
Coliform	Total	at 35°C/ 100ml
	E. coli	at 44°C/ 100ml

Table 12. Lake Water Quality (Kandy and Nuwara-Eliya districts)

SAMPLE	T air	T water	pH	Elec cond	DO	COD	BOD	SS	TDS	SO_4^{2-}	T-N	T-P	Total coliform	*E. coli*	As	Total Iron	Cd	Zn	Co	Cl^-
LWQ/N/1.1	21.0	22.3	6.2	128	7.0	28	3.2	145	60	0.6	37.0	0.2	180	50	Nil	1.4	Nil	0.02	Nil	10.7
LWQ/N/1.2	25.5	20.2	4.2	139	9.0	28	6.3	150	150	0.4	51.0	0.3	180	80	Nil	1.5	Nil	0.02	Nil	9.8
LWQ/N/1.3	25.5	25.1	6.6	128	9.4	28	3.5	148	60	0.6	58.0	0.3	70	06	Nil	1.5	Nil	0.01	Nil	11.8
LWQ/N/2.1	23.0	22.2	6.0	133	7.8	44	5.9	122	66	0.6	23.0	0.8	180	60	Nil	1.2	Nil	0.01	Nil	11.2
LWQ/N/2.2	25.0	22.6	5.2	132	8.8	8	5.2	130	100	0.1	48.0	0.8	200	80	Nil	1.5	Nil	0.02	Nil	11.8
LWQ/N/2.3	28.0	23.9	7.0	130	8.1	12	4.7	142	70	0.7	38.0	0.8	230	60	Nil	1.8	Nil	0.02	Nii	14.1
LWQ/N/3.1	24.0	20.0	4.4	125	0.3	24	12.3	236	60	5.0	40.0	0.6	>1000	740	Nil	1.8	Nil	0.07	Nil	3.8
LWQ/N/3.2	29.0	21.2	4.9	132	0.2	44	12.1	260	80	3.9	30.6	0.7	300	160	Nil	2.0	Nil	0.10	Nil	6.2
LWQ/N/3.3	27.0	21.1	4.8	125	0.1	28	14.8	271	70	4.8	36.2	0.8	>1000	>1000	Nil	3.1	Nil	0.07	Nil	10.7
LWQ/N/4.1	25.5	20.2	4.2	293	Nil	152	31.6	222	150	0.9	44.8	1.5	>1000	>1000	Nil	3.0	Nil	0.07	Nil	36.3
LWQ/N/4.2	26.0	22.2	4.9	325	0.2	124	28.7	287	160	0.4	51.0	1.4	>1000	>1000	Nil	3.2	Nil	0.07	Nil	36.3
LWQ/N/4.3	27.0	20.1	4.7	368	Nil	128	30.1	174	160	0.3	59.0	1.4	>1000	>1000	Nii	4.0	Nil	0.07	Nil	33.9
LWQ/K/1.1	31.6	29.2	8.6	250	5.2	28	11.0	60	134	6.1	35.0	1.4	200	70	Nil	0.5	Nil	0.08	Nil	43.6
LWQ/K/1.2	34.9	30.6	7.4	260	5.0	20	8.5	62	130	6.2	32.0	1.4	250	12	Nil	0.6	Nil	0.09	Nil	42.6
LWQ/K/1.3	31.8	29.5	7.3	260	4.8	16	6.5	64	134	5.0	38.0	1.3	500	50	Nil	0.5	Nil	0.10	Nil	39.8
LWQ/K/2.1	29.5	30.5	7.3	230	6.8	8	9.5	62	132	6.2	20.0	1.0	600	40	Nil	0.4	Nil	0.07	Nil	38.9
LWQ/K/2.2	37.1	32.2	8.5	250	7.1	8	9.2	73	148	7.7	22.0	0.9	800	50	Nil	0.4	Nil	0.06	Nil	43.7
LWQ/K/2.3	30.9	30.5	8.9	250	7.4	12	11.8	76	118	5.4	24.0	1.4	40	10	Nil	0.4	Nil	0.07	Nil	39.8

Table 13. Sludge quality survey (Kandy and Nuwara-Eliya Districts)

SAMPLE	T_{air}	T_{sludge}	Water content(%)	SS (%)	VSS(%)	T-N g/Kg	T-P mg/Kg	As	Cd	Co	Zn mg/kg
SQ/K/1	28.7	28.5	5.84	52.82	5.18	24.10	14.35	Nil	Nil	Nil	0.27
SQ/K/2	29.5	29.7	60.38	24.01	2.27	38.40	12.56	Nil	Nil	Nil	0.05
SQ/K/3	29.1	28.2	3.32	2.28	2.20	1.96	19.30	Nil	Nil	Nil	0.26
SQ/N/1	23.0	20.5	67.53	4.96	0.73	11.32	11.86	Nil	Nil	Nil	0.10
SQ/N/2	22.2	20.6	93.99	4.06	0.29	9.88	13.50	Nil	Nil	Nil	0.04

Sludge quality survey

Sample points:

Kandy SQ/K/1. Hantana Housing Scheme
SQ/K/2. Suisse Hotel
SQ/K/3. Sun Match Company

Nuwara-eliya: SQ/N/1. Ceylon Brewery
SQ/N/2. Grand Hotel

/Annexure 1. Pesticide analysis results of raw water samples

Parameter	SP. 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7	SP 8	SP 9	SP 10	SP 11	SP 12	SP 13	SP 14	SP 15	SP 16	SP 17	SP 18	SP 19	SP 20	Det. Limit µg/l
α-HCH	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.2
β-HCH	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.4
γ-HCH(Lindane)	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.2
δ-HCH	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.2
Aldrin	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
Dieldrin	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
Heptachlorepoxide	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
Endosulfan	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
p'p,DDE	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
o'p,DDT	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
p'p,DDT	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
o'p,DDD	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
p'p,DDD	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.5
Chlorpyrifos	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	< 1	N.D	1
Dimethoate	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Diazinon	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Fenthion	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Fenitrothion	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Malathion	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Monocrotophos	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Methamidaphos	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Parathion	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Parathion Methyl	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Pirimiphos Methyl	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Profenophos	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Quinalphos	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Carbofuran	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Chlorothalonil	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Captan	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	1
Metalaxyl	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	5
Alachlor	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2
Propanil	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	2

N.D not detected

Key to sample numbers in the pesticide analysis

SP1=WQ/N/3.1
SP2=WQ/N/13.1
SP3= WQ/N/10.1
SP4= WQ/N/5.2
SP5= WQ/N/6.2
SP6= WQ/K/3.1
SP7= WQ/K/1.1
SP8= WQ/N/2.2
SP9= WQ/N/12.1
SP10= WQ/N/9.2
SP11= WQ/N/4.2
SP12= WQ/N/11.1
SP13= WQ/N/8.2
SP14= WQ/N/1.2
SP15= WQ/N/8.2
SP16= WQ/N/7.1
SP17=WQ/N/14.1
SP18=WQ/N/ 15.1
SP19=WQ/N/16.1
SP20=WQ/17.1

Appendix 15.4 Land Acquisition Procedures

Annex A1

Land Acquisition

There are two procedures described for land acquisition for a public purpose, namely; (i) when land acquisition to be undertaken under normal conditions and (ii) when the land acquisition is urgently required. Two procedures are described in detail in the Land Acquisition Act of 1950 (as amended in 1954, 1955, 1961, 1964, 1969, 1971 and 1979). Stepwise procedures are laid down in the Act and is shown in the schematic diagram annexed. The salient features of the Land Acquisition Act is given below.

i When a Government Department or Agency require to acquire a particular land for a public purpose, an application is made to the Secretary of the Ministry in charge of the subject of Land.

ii The Ministry issues a directive to the Land Commissioner and the Commissioner in tern issues a directive to his representative in the district (District Secretary, Asst. Land Commissioner, District land Officer or Divisional Secretary to give notice.

iii Under normal circumstances the land acquisition procedure begin with a Preliminary Investigation and Declaration of the intention to acquire the identified land for a public purpose as required by the Section 2 to 5 of Chapter 460 of the Land Acquisition Ordinance. Notices are posted near the land to be acquired and adequate time is given to the owners or claimants to register objections to the take over of the land and or to place claims for compensation. After these initial procedures if the Minister in Charge of the subject of land makes the decision to acquire the particular land area, the minister directs the acquiring officer to publish in the Government Gazzette the intentions to acquire said land.

If the exact location of the land to be acquired is not know, the Secretary of the Ministry in charge of the subject of Land will direct the Land Acquisition officer post a notice in the area, where the land is required. Then the Acquisition Officer will authorize the interested Agency/Department to make the investigations.

iv Objections to take over of land will be inquired in to and the Minister in charge of the subject of lands will make a final decision in this regard .

v If the Minister decides to acquire the land, the decision will be communicated to the Surveyor General who will take action to prepare a plan of the said land ,if there is no such plan already available.

vi The copy of the plan is sent to the chief valuer for valuation of the said land/property. If the value of the land is more than Rs.500/ the notice should be published in news papers all three languages. The notice require that persons

affected or interested to appear before the Acquiring Officer on a date specified not less than 21 days from the date of the notice. The interested parties should notify in writing, at least 7 days prior the date specified, giving particulars of compensation. The acquiring officer can on good cause shown extend the date for notification of claims and appearance before him up to a period of 28 days. A copy of the claim is forwarded to the chief valuer.

vii On the fixed date or the new date fixed, the Acquiring Officer will cause an inquiry in to the claims for compensation. After the inquiry the Acquiring Officer will give a decision regarding any dispute among claimants. In the even that the claimants are not satisfied with the compensation determined by the Acquiring Officer, those who are affected are allowed to appeal to the Board of Review. The decision of the Board of Review is final.

viii Payment of compensation arise at two stages in the process of land acquisition, namely; (1) At preliminary Investigation stage and (II) at the stage of taking over of possession of land by the State.

In the first stage any damage caused to movable and immovable property on the land at the preliminary investigations, for each owner the Officer responsible for land acquisition determines the compensation. Land Acquisition Officer in the Division/ District then inform the possible claimants about the compensation by posting a notice at the site

The second and the final compensation is determined by the Officer in charge of land acquisition in the district after considering the claims made by the affected , current market value, claimants ownership relation to the land and any other factor that may be required for the valuation under Section 17 of the Chapter 460 of the Land Acquisition Ordinance.

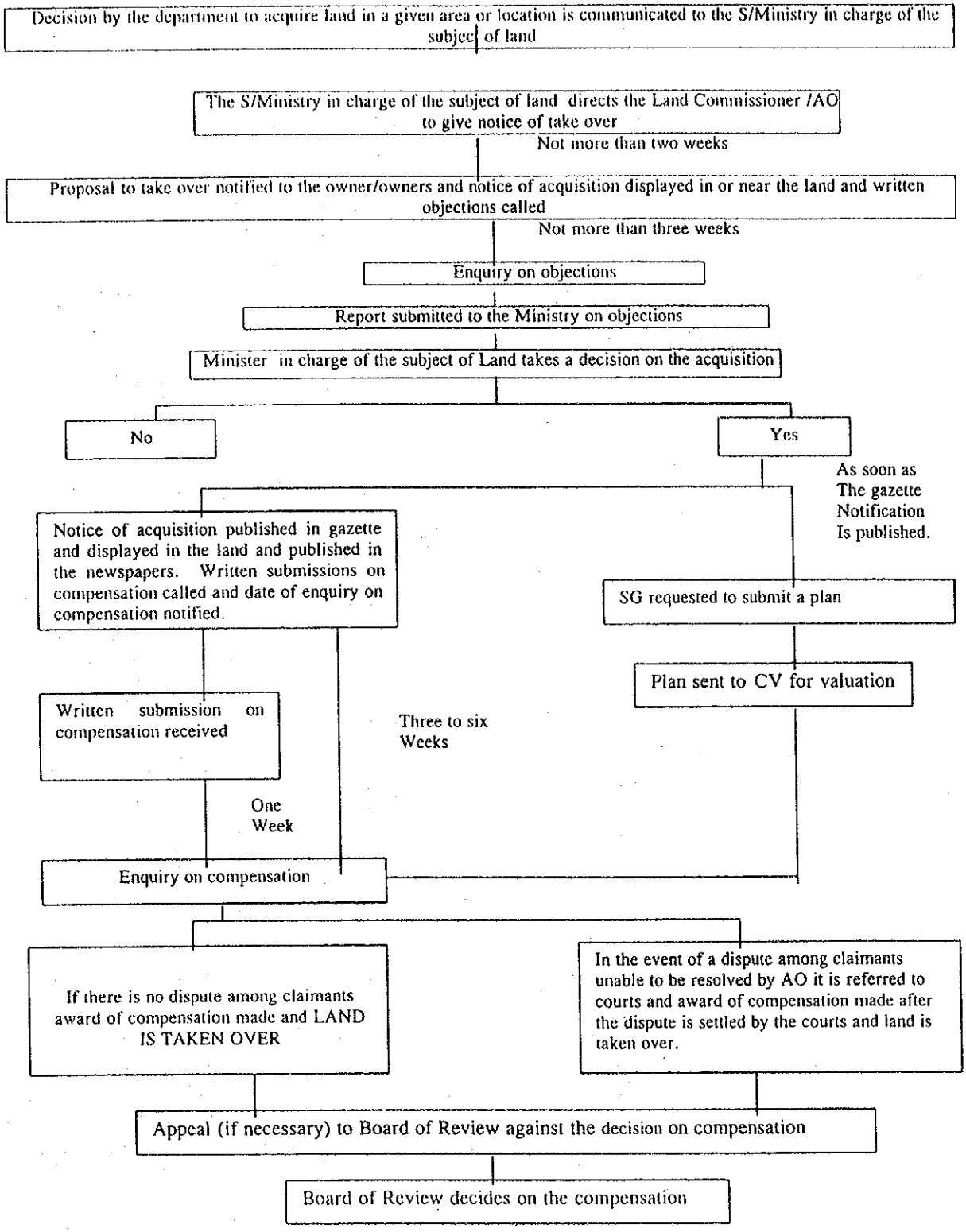
ix Where no interested persons appear on the date of the inquiry the inquiry will be postponed for at least 14 days and a notice will be posted in or near the land stating that the amount of compensation will be determined on the adjourned date whether the interested persons appears or not.

x At any time after the award the Minister may publish an order in the gazette directing the acquiring officer to take possession of the land and from the date of the publication of the order the land will vest absolutely in the hands of the State. The possession of an occupied house can not be taken without giving the occupant at least 48 hrs notice.

Annex A2

Land Acquisition Procedure

Procedure adopted when land is not urgently required.



AO - Land Commissioner or representative / Land Acquisition Officer / District Representative / Divisional Secretary
SG - Survey Genera
CV - Chief Valuer

Annex A2

Urgent Land Acquisition

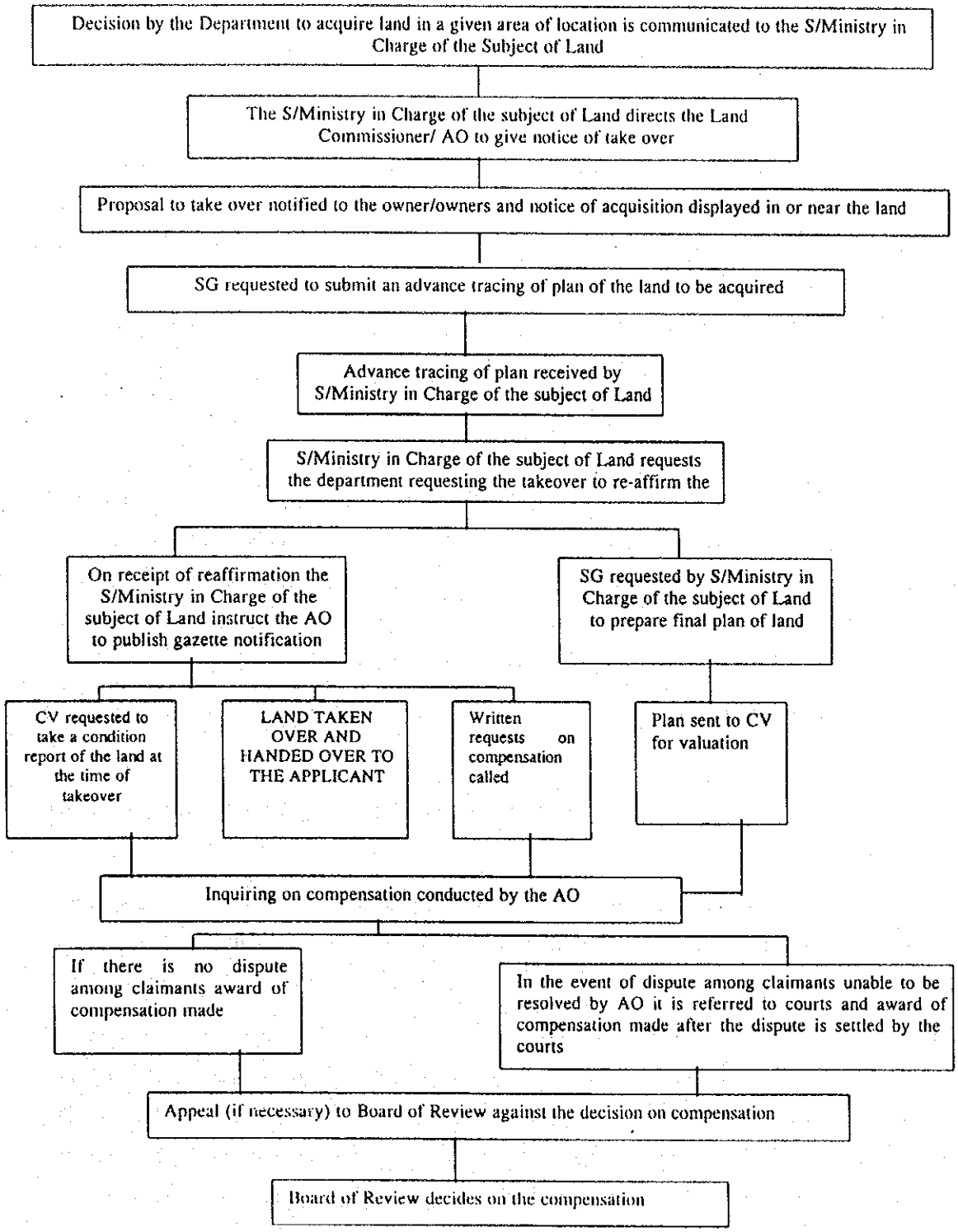
This procedure deviates from the normal, because of the urgency to take over an specified land area. Deviation is from the step of posting the notices.

Soon after posting of notice under Section 2 of the Chapter 460 of the Land Acquisition Ordinance that is after posting of a notice on the identified land and in the neighbouring area indicating the intended acquisition under Section 4 of the said Ordinance, if a need arises for immediate possession of the said land Minister has the power to Publish in the Government Gazette an Order to take over the possession of the said land for the State. The step by step procedure is given in the attached chart 2.

(Deviation from the time frame indicated is common for Urgent Acquisition)

Land Acquisition Procedure

Procedure adopted when land is urgently required



AO - Land Commissioner or Representative/ Acquiring Officer / District Representative/ Divisional Secretary
SG - Survey Genera
CV - Chief Valuer