1 Laboratory Analyses

1.1 Objectives

In order to enable the laboratories in the three countries to handle an increased number of analyses - some of which are new - and to improve the quality of analyses the consultancy focused on providing advice and assistance:

• In implementation of new analyses
• In improving analyses quality
• In data quality management

Reference is made to Part I: Administrative Report, and Chapter 12 of this report where the subject of the assistance to the laboratories is also addressed.

1.2 Methods

A combination of on-the-job-training and special courses were implemented by the Consultant. A brief list of the activities follows with more details given in Part I: Administrative Report, and Chapter 12 of this report.

• Three working sessions (Kampala November 2000, Mwanza June 2001, Entebbe November 2001) with focus on data quality assurance, data validation and adjustment and co-ordination of methods.

• Short limnology course at Makarere University, Kampala in February 2001 with focus on expected levels and variations in water quality parameters.

• On-the-job-training by COWI and DHI laboratory specialists during:

    - 5 visits to Kisumu (Sept. 2000, Nov.-Dec. 2000, Dec. 2000, May-June 2001 and Sept.-Oct. 2001)

    - 5 visits to Mwanza (Sept. 2000, Dec. 2000, Jan. 2001, May-June 2001, Sept.-Oct. 2001)

    - 3 visits to Entebbe (Sept. 2000, Nov.-Dec. 2000, Jan. 2001)

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- Training of two chemists from Tanzania and two from Kenya at the DHI, Denmark in general laboratory practices in relation to lake water analyses.

- Training of laboratory managers from Tanzania and Kenya at the DHI, Denmark focusing on Quality Management.

- Implementation of an inter-laboratory calibration using international certified reference material.

- Ad-hoc assistance via correspondance on laboratory issues.

1.3   Conclusions

At the inception seminar and the Kick-off working session it was agreed that the analyses shown in Table 1.1 should be made.

Within the LVEMP it was agreed back in 1996 that analyses should be performed according to Standard Methods 18th ed. After reviewing the analysis requirements and methods, the Consultant introduced the following changes:

- The phenate method for NH4 should follow Standard Methods 19th ed.

- The chlorophyll analyses should be made by ethanol extraction at room temperature or in refrigerator according to Danish Standards.

- PBSi should be analysed by sodium hydroxide extraction according to Krause et al.

- TPN and TPP could be analysed by persulfate oxidation of filters suspended in distilled water.

- Alternatively, TPP could be extracted with hydrochloric acid from the ash from the LOI determination according to Møller Andersen.

Initially, the laboratory in Entebbe was found well equipped and the adjustment of methods and introduction of new methods were accomplished without problems. In Mwanza and in Kisumu almost all methods had to be introduced but the purchase of equipment and chemicals has delayed a fully working analysis programme. At present only a Muffle furnace is lacking at the laboratory in Mwanza.

Table 1.1   List of laboratory analyses for the study.

Parameter	Description	Lake Water	Waste water	Sediments	Wet deposition	Dry deposition
TPN	Total particulate nitrogen	■				
DON	Dissolved organic nitrogen	■				
NO2	Nitrite	■				
NO3	Nitrate	■				
NH4	Ammonia	■				
TPP	Total particulate phosphorus	■	■	■	■	■
DOP	Dissolved organic phosphorus	■				
PO4	Phosphates	■				
TBSi	Total biogenic silica	■				
Si	Silicon	■				
TPC	Total particulate carbon	■	■			
Chl	Chlorophyll	■				
TSS	Total suspended solids	■		■		
TON	Total organic nitrogen	■		■	■	■
TP	Total phosphorus	■	■	■	■	■
LoI	Loss on ignition	■	■	■		
Alk	Alkalinity	■				
$BOD_{5\,(20)}$	Biological oxygen demand		■			
COD	Chemical oxygen demand		■			

In the period December 2000 - October 2001 a total of more than 8000 analyses of lake water were made along with additional analyses from the programmes on sedimentation, point and non-point loadings and wet and dry deposition (Table 1.2). A full analysis programme carried out on all 1500 samples would have resulted in app. 20,000 analyses. The reasons why analyses not have been made are the initial lack of equipment, chemicals, filters and training. The completion of the analytical programme has steadily improved in all three countries.

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Table 1.2   *Number of lake water analyses*

Analyses statistics

Sediments

	Kenya	Uganda	Tanzania	Total
Number of samples	42	159	114	315
Actual analyses	106	391	173	670
Expected analyses	168	636	456	1260
% Analyses	63	61	38	53

Non point sources

	Kenya	Uganda	Tanzania	Total
Number of samples	290	36	85	411
Actual analyses	2070	198	340	2608
Expected analyses	3510	504	768	4782
% Analyses	59	39	44	55

Point sources

	Kenya	Uganda	Tanzania	Total
Number of samples	173	884	543	1600
Actual analyses	653	3536	2172	6361
Expected analyses	865	3536	3072	7473
% Analyses	75	100	71	85

Lake water

	Kenya	Uganda	Tanzania	Total
Number of samples	155	650	711	1516
Actual analyses	1110	3772	3304	8186
Expected analyses	2015	8450	9242	19707
% Analyses	55	45	36	42

Analyses performance

Countries	Tanzania	Uganda	LVEMP	Kenya
Samples				
Sediment	38	61	53	63
Lake water	36	45	42	55
Point sources	71	100	85	75
Non-point sources	44	39	55	59

1.4   Recommendations

- The efficiency in the laboratories (ie. the ability to handle large numbers of samples) can be improved by more automatisation (autoanalyzers in Kisumu and Mwanza, a silicate module in Entebbe, zipper systems on all spectrophotometers and general use of syringe dispensers).

- Completion of the Kisumu laboratory is urgent.

- Improved maintenance and servicing of equipment is required.

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- A more reliable supply of purified water in all three laboratories (reverse osmosis systems) is required.

- Improved management and planning of daily laboratory work is necessary.

- The purchase of consumables such as chemicals, filters and glassware as well as equipment shoud be possible on a day-to-day basis.

- Long-term training of the laboratory staff as described in Chapter 12 is required.

- Motivation of laboratory staff should be addressed

- Additional personnel should be recruited to alleviate staffing problems

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