JESS CONSULTANCY REPORT
ON WATER QUALITY AND
PUBLIC HEALTH ENGINEERING

JESS Report No. 7

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ACRONYMS AND ABBREVIATIONS

ARD	Associates in Rural Development, Inc.
DAP	disodium ammonium phosphate
EC	electrical conductivity
GSDR	Government of the Somali Democratic Republic
ha	hectare
JESS	Jubba Environmental and Socioeconomic Studies
JuDAS	Jubba Development Analytical Studies
MJVD	Ministry of Jubba Valley Development, GSDR
MOH	Ministry of Health, GSDR
MSL	mean sea level
NUS	National University of Somalia
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development

PREFACE

The Jubba Environmental and Socioeconomic Studies (JESS) (number 649-0134) are jointly funded by the government of the Somali Democratic Republic (GSDR) and U.S. Agency for International Development (USAID). JESS is part of a larger project funded by AID and the GSDR, the Jubba Development Analytical Studies (JuDAS) project. Technical assistance and JESS management are being provided to the Ministry of Jubba Valley Development (MJVD) by Associates in Rural Development, Inc. (ARD) of Burlington, Vermont, under AID contract number AFR-0134-C-00-5047-00. This report describes activities that occurred in the early part of Phase II of JESS, during an ARD consultancy by Dr. William R. Jobin of Blue Nile Associates.

NOTES TO THE READER

For most readers, the Executive Summary should provide sufficient information. The body of the report is quite detailed and will be of interest primarily to those who are directly involved with JESS. The appendices are a complete field and laboratory data record, not designed for the casual reader.

The table below provides typical values of selected water-quality parameters in the Jubba Valley as well as comparable norms for fresh water and salt water. This information will assist the reader in interpreting the data in the report.

Parameter	Minimum	Maximum	Normal Range for Fresh Water	Normal for Ocean
pH	5.0	9.0	7.5-8.5	
Temperature (^{o}C)	20	35	25-30	
Conductivity (EC)	100	5,000	200-3,000	5,000
Salinity (%0)	0	40	0-1	40
Secchi depth (cm)	0	500	1-200	
Color units	1	20	2-5	
Turbidity units	1	500	1-200	

Values below are in milligrams per liter or parts per million:

Parameter	Minimum	Maximum	Normal Range for Fresh Water	Normal for Ocean
Chlorides	1.0	19,000	1-500	19,000
Sulfates as SO_4	1.0	200	1-50	
Nitrates as N	0.1	20	1-5	
Phosphates as P	0.001	5	0.1-1	

I. EXECUTIVE SUMMARY

As part of comprehensive environmental and socioeconomic studies related to the proposed Baardheere Dam in the Jubba River Valley of Somalia, the author visited Somalia from 25 May 1986 to 2 July 1986. This consultancy on water quality and public health was part of Phase II of JESS. Phase II activities concentrate on collecting primary data in the Jubba Valley for the purposes of conducting environmental and socioeconomic assessments prior to construction of the Baardheere Dam, developing a long-term monitoring system, and designing guidelines for future development activities.

During this consultancy for ARD, three field trips were made within Somalia, two to the Irrigated Zone in the coastal portion of the valley and one to the Reservoir Zone (see map in Figure 1). In cooperation with the Faculty of Chemistry of the National University of Somalia (NUS), a complete system of collection, analysis and data processing was established for water quality on the Jubba River, to operate for the next 12 months. In addition, planning meetings were held in Mogadishu with Ministry of Health (MOH) and UNICEF personnel to develop proposals for monitoring water-associated diseases and disease vectors.

Preliminary results from surveys on three consecutive days indicated that the Jubba River had moderate levels of conductivity and chlorides during June. Chlorides ranged from eight to 161 milligrams per liter, while conductivity was between 173 and 650 micromhos per centimeter (see Table 1). Nutrient values were also moderate, with nitrates below five milligrams per liter. However, phosphates were found above 0.5 milligrams per liter at two stations, largely in organic form. Sulfate concentrations in the river near the proposed dam were about 25 milligrams per liter. The discharge rate of the river at Kamsuma Bridge was between 200 and 500 cubic meters per second during June, and gradually decreasing. This was near the average yearly discharge rate but varied considerably during the three days of the survey. Even at high tide there was no salt intrusion into the estuary at these flows. Light penetration into the water, as measured by Secchi disk readings, was virtually zero in the entire river from Luuq to the ocean. This low clarity, as well as high concentrations of suspended solids and moderately high velocities, made the river unsuitable as a habitat for disease-bearing snails or mosquitoes during June.

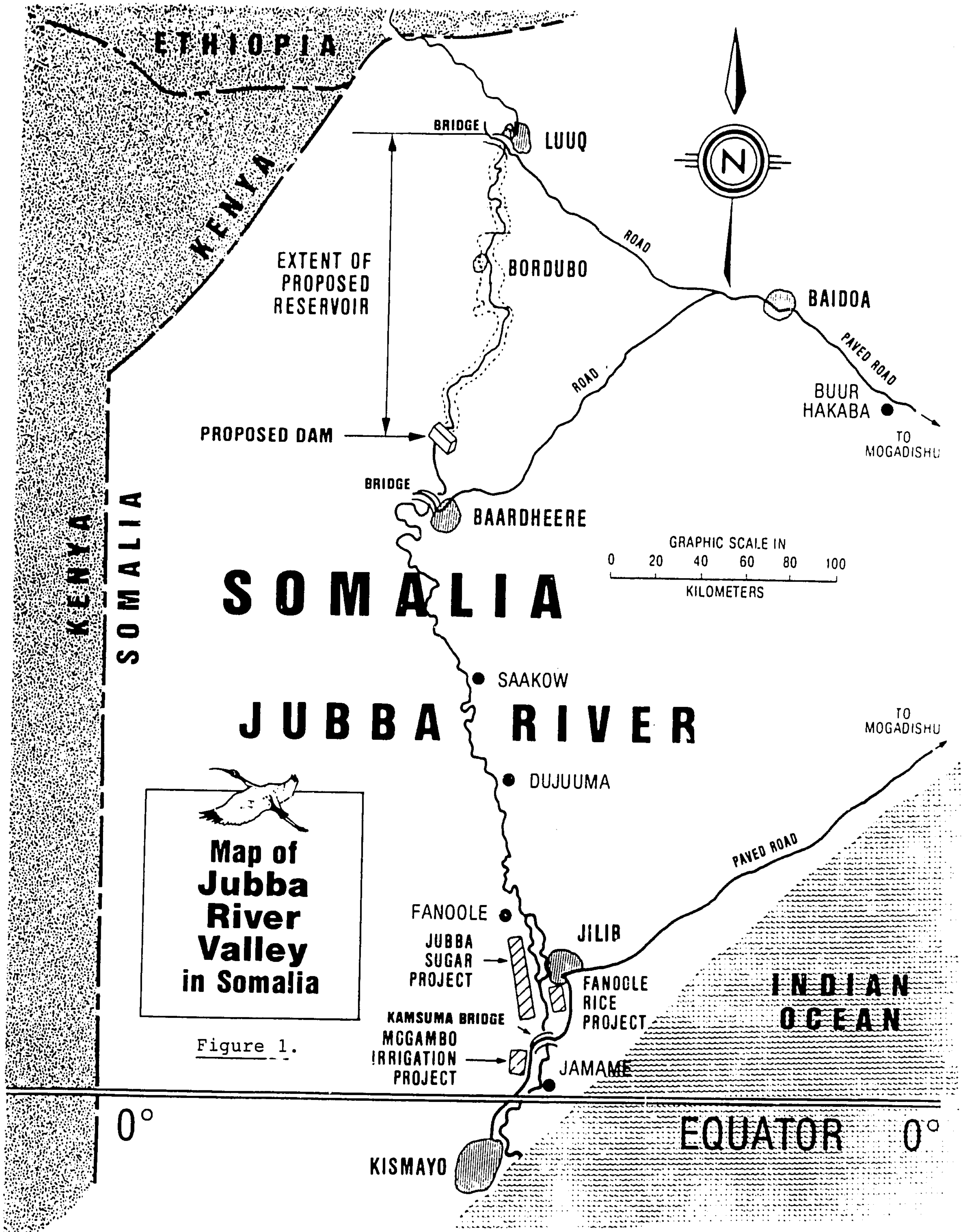
ETHIOPIA
KENYA
BRIDGE
LUUQ
EXTENT OF
PROPOSED
RESERVOIR
BORDUBO
ROAD
BAIDOA
PAVED ROAD
ROAD
BUUR
HAKABA
TO
MOGADISHU
PROPOSED DAM
BRIDGE
BAARDHEERE
GRAPHIC SCALE IN
0 20 40 60 80 100
KILOMETERS
KENYA
SOMALIA
SOMALIA
SAAKOW
JUBBA RIVER
TO
MOGADISHU
DUJUUMA
Map of
Jubba
River
Valley
in Somalia
PAVED ROAD
FANOOLE
JILIB
JUBBA
SUGAR
PROJECT
FANOOLE
RICE
PROJECT
INDIAN
OCEAN
KAMSUMA BRIDGE
MOGAMBO
IRRIGATION
PROJECT
JAMAME
0°
EQUATOR 0°
KISMAYO

Figure 1.

Table 1.

Water Quality in Lower Jubba River, 11-13 June, and at Baardheere,* 23-24 June 1986

(values given are means of three samples)

Sampling Location	Major Station (see map)	Temp oC	Secchi Disk cm	pH	EC micro-mhos/cm	Chlorides mg/l	Nitrates mg/l as N
Baardheere Bridge*	I	25.3	1	8.0	197	12	4.0
Jilib Ferry	II	26.3	1	7.9	512	102	2.4
Fanoole Drain	III	27.6	71	7.9	528	76	2.0
Arare Bridge	IV	27.5	1	8.0	457	101	5.6
Gob Weyn	V	28.5	1	7.9	382	86	4.6

The main irrigation canals were uninhabited by snails or mosquitoes due to the high turbidity of the water. No bilharzia snails were found in any of the irrigation canals, night storage ponds or drains during the June surveys. However, the bilharzia snails were found in standing water bodies outside the irrigation systems. Apparently this is where bilharzia transmission presently occurs in the Jubba River Valley, similar to the Shebelli River Valley. A large dheshek near Fanoole Barrage and also the main Fanoole drainage system were also free of the bilharzia snails, although many other species of snails were found.

The Irrigation Zone suffered from heavy flooding and rainfall in May and June, and thus mosquito habitats were found everywhere. This normally leads to a peak of malaria transmission in June and July. Breeding sites and mosquitoes were also prevalent below the proposed dam site at Baardheere, but not at mid-reservoir nor above the reservoir at Luuq. These vector habitat conditions were undoubtedly seasonal and will change considerably during the drier months.

In the existing agricultural systems in the valley, a wide variety of biocides were used, including chlorinated hydrocarbons, organophosphorus compounds and other potentially dangerous chemicals. The total amounts used during the last agricultural season were relatively low, due to the small area under cultivation at present. The widest variety of biocides were found in the Mogambo Irrigation Project for rice and sesame, and in the Jubba Sugar Project.

Fewer and smaller amounts of biocides were used by SomalFruit for bananas, by the Fanoole Project for rice, and by

Somaltex for cotton. Herbicides and urea fertilizer were used extensively in all projects except Somaltex.

Preliminary measurements were made of salinity in the river to locate the approximate extent of salt intrusion into the estuary. Preliminary results indicated that the intrusion did not reach Gob Weyn, about two kilometers upstream from the ocean.

A topographical survey to determine precise elevations of the ground surface was conducted in a 20-kilometer circuit from the river near Bordubo up to the western edge of the proposed reservoir, at an elevation 150 meters above mean sea level. The results verified that the existing 1977 contour maps made from aerial photogrammetry were fairly accurate. However, the field data indicated that the maps masked considerable undulations in the terrain because of their large contour interval of 10 meters. This may indicate that more vector control effort will be needed than that indicated by the 1977 maps. Small depressions of two- to five-meter depths do not show on the existing maps but could retain enough water to provide significant mosquito habitats as the reservoir level recedes.

Proposals were developed for epidemiological surveys on malaria, bilharzia and diarrheal disease prevalence, with options for collecting information on nutritional status of children, on snails and insect vectors of disease, on intestinal parasites, and on diseases of cattle, camels and goats. The data on malaria, bilharzia, diarrheal diseases and intestinal parasites could be collected quickly by surveys of school children. Data on nutritional status would have to be done by more laborious home visits. It might be advantageous to combine these home surveys with vector studies on mosquitoes, snails and flies.

II. INTRODUCTION

This report is based on a June 1986 JESS consulting visit concerning water quality and public health engineering aspects of the proposed Baardheere Dam on the Jubba River in southwestern Somalia (the scope of work is contained in Appendix A).

The main objective of this and other interim JESS reports is, to the extent possible, to meet the need for timely information for dam planning as MJVD, World Bank and other organizations begin to consider specific plans for construction and operation of the dam, as well as associated Jubba Valley development activities.

JESS is divided into three phases:

- Phase I (now completed) -- project start-up, design of environmental and socioeconomic studies and secondary data collection;

- Phase II (continuing until approximately April 1988) -- primary, baseline data collection in Jubba Valley; and

- Phase III (final six months of project) -- analysis of all data, and delivery to MJVD and USAID of socioeconomic and environmental assessments, development guidelines and plan for long-term socioeconomic and environmental monitoring.

The report summarizes the field activities, the general data collected, and the preliminary conclusions reached during this five-week consultancy. However, extensive analysis of the data remains to be completed, including computer simulation of water quality in the river, simulation of vector habitats and disease transmission in existing rain-fed agricultural, irrigation and drainage systems, as well as estimation of shoreline recession patterns and vector habitats in the proposed reservoir. This extensive analysis and reporting will be completed later in the year to meet the necessary planning deadlines for MJVD.

The June visit was the second in a series of five visits by Blue Nile Associates planned for ARD during the three phases of JESS. This visit included three field trips to the Jubba River Valley and, in cooperation with NUS, establishment of a water-quality monitoring system for the Jubba River. It was timed to match the peak of malaria and bilharzia transmission after the Gu rainy season of April through May. In addition, future Phase II visits are planned to occur during critical times for the collection of primary and/or baseline data on disease transmission or changes of water quality. Appendices B, D and E provide listings of primary water-quality data collected in the field during this consultancy.

In addition to completing the objectives in the original scope of work (see Appendix A), a topographical survey was conducted on the west bank of the proposed reservoir to verify available contour maps. Also, data collection on biocides and fertilizer usage in the irrigated zone was completed. At the request of the USAID project manager for JESS and with the concurrence of ARD, new proposals were developed for epidemiological surveys.

III. PUBLIC HEALTH ASPECTS OF AGRICULTURAL PRACTICES

The first trip for evaluating health implications of agricultural practices was made from 2 to 5 June. Interviews were held with the management of the Mogambo Irrigation Project, SomalFruit Corporation, Fanoole Rice Project and Somaltex Corporation. Details were collected on operation of the irrigation and drainage system, on cropping practices, and on the use of fertilizers and biocides.

A. Mogambo Irrigation Project

This new irrigation scheme was intended for rice cultivation but has diversified due to problems encountered with soil salinity when the rice was double cropped. On its initial irrigated area of 500 hectares (ha), the project was experimenting with two alternative crop rotations:

- rice, sesame and fallow; or
- rice, sesame, legumes and fallow.

The project's labor housing facilities were in a chaotic state, with the first site having been placed on clay soil near the river, without drains or sanitation facilities. The site was low and thus flooded half the year. The management hoped that a second housing area would be built near the southwest corner of the scheme on higher ground, but in the meantime most of the laborers had to find their own housing in local villages.

The rice being grown was a 150-day variety called IR-24. A change to a faster-growing, 100-day variety was expected in the near future to allow more time between crops. The canal system included five night storage ponds and one large drainage pump which discharged to the Marine Plain to the West. A large flood relief channel ran from the Jubba River to the same Marine Plain, parallel and south of the Mogambo main supply canal. This new flood relief channel offered protection to banana growers downstream, and went into operation for the first time for a few days in May prior to the author's visit.

The principal herbicides used were Propanyl and MCPA, with Avirosan to be used in the future (Table 2). Aldrin was used for seed dressing. Principal insecticides included Basudin, Primextra and Malathion. Quailtox was sprayed from the air by the Nairobi Locust Control Unit against populations of quelea birds. DDT was supplied to settlers.

Table 2.

Principal Biocides Used in Irrigated Zone, 1986

	Mogambo Project	Fanoole Rice Project	SomalFruit	Somaltex	Jubba Sugar Project
HERBICIDES	Propanyl Roundup Erbitox MCPA Avirosan	Propanyl	None	None	Gesapak Diuron Paraquat 2,4-D Roundup Velpar Gramuron
INSECTICIDES	Primextra Malathion Dieldrin Damfin Nuvacron Atrin Basudin	None	None	Cytox Bomex Nuvacron	Aldrin Dieldrin Suscon
OTHERS	Quailtox		Furadan Calixin Bavistin		Tillex

Small amounts of other biocides were used, including rat poison, Damfin and Atrin.

The main fertilizers used were disodium ammonium phosphate (DAP) and urea, with soil supplements of zinc and copper sulfate (see Table 3).

Table 3.

Principal Fertilizers Used in Irrigated Zone, 1986

	Mogambo Project	Fanoole Rice Project	SomalFruit	Somaltex	Jubba Sugar Project
Nitrogen	Urea	Urea	Urea and Ammonium Sulfate	None	Urea
Phosphorus	DAP	DAP			None
Others	Zinc and Copper Sulfate	NPK Complex	Potassium Sulfate		None

B. <u>SomalFruit</u>

This semi-private banana export agency dealt with 51 individual farms covering a total of 2,200 ha of bananas, with a potential of up to 4,000 ha by 1988 and eventually 6,000 ha. There were 120 pumps in use to pump water from the river to earthen canals all year, except during the rainy season when the pumps were used for drainage. The management was changing over much of the system to a buried PVC pipe distribution network to avoid seepage losses and increase land availability. The principal fertilizers were urea and sulfates of potassium and ammonium. The main biocides were Furadan for nematodes and Calizin, sprayed aerially against fungus. They also used Bavistine, a fungicide (see Table 2).

C. <u>Fanoole Rice Project</u>

Although only 630 ha were planted to rice (double cropped), the potential for the complete Fanoole Barrage system was for gravity irrigation of 48,000 ha, including the Jubba Sugar Project. The rice was of the 150-day variety, planted in February and late September. Planting occurred about two weeks before the dates of planting in the Mogambo Scheme because the Fanoole Project controls the water upstream of Mogambo. The fertilizers used were urea, DAP and an NPK complex. Propanyl was used for weed control in the fields, but aquatic weeds in the canals and drains were removed manually. No insecticides were used but Quailtox was sprayed aerially against the birds. Salinity problems were occurring in this first limited stage of the Fanoole Rice Project. The supply canals were used for night storage. There was a large drainage system with a pump that discharged to the river, located slightly south of the village of Mobarek. The pump operated intermittently during the irrigation season to handle seepage water as well as excess rain. About 1,500 people were employed permanently, with 500 to 800 seasonal workers, all of whom came from local villages.

D. Somaltex

This was a government-operated cotton marketing scheme which included about 3,000 small farms of one to two ha each. The cotton was rain-fed, there was no drainage, and the only biocides used were Bomex and Cytox, applied by hand sprayers. Most farms were located near Jamaame between Kismaayo and Jilib, on the east side of the river.

E. Jubba Sugar Project

Although two visits were made to the offices of the Jubba Sugar Project, very little information was obtained. However, the management promised to mail to the JESS team leader the desired information on biocides, fertilizers and water quality.

The only potential snail or mosquito habitats found in the Jubba Sugar Project system were the main canal and an unfinished drainage system. Two options were being considered for improving the drains. The original plan was to dig deep drains to leach out anticipated salt accumulations. These drains would have flowed to the southwest and been pumped to the Marine Plain. The second plan, under active consideration because of its low cost, was for a shallow set of drains flowing to the southeast, to be pumped over the flood dike, into the Jubba River. The second option was favored because salt accumulations in the cane fields have been much lower than originally expected, probably due to the low rate of irrigation.

No bilharzia snails were found in the Jubba Main Canal or in the Little Jubba River, probably because of high turbidity. Several other species of snails were present, however, indicating a general potential as a bilharzia snail habitat.

F. Vector Habitat Survey

The purpose of the survey of vector habitats was to determine the seasonal suitability of water bodies as habitats for bilharzia snails, malaria mosquitoes, the blackflies which transmit river blindness, and other disease-transmitting insects or snails. The only species of bilharzia snail of interest for human and animal health in the Jubba Valley was Bulinus abyssinicus, which transmits Schistosoma haematobium and perhaps also Schistosoma bovis, a parasite of cattle. The author and other field staff used Appendix C (Key to Identification of Principal Freshwater Snails in the Jubba River Valley) for field identification purposes. The mosquito species of primary interest for malaria transmission is Anopheles gambiae. A blackfly similar to Simulium neavei may be present in restricted areas in Somalia as well. Natural and manmade bodies of water which might support these organisms were given special attention in this survey.

General inspections were made of 18 aquatic habitats selected to cover all major water bodies in the agricultural systems of the Irrigated Zone, measuring basic physical parameters of volume, area and depth, temperature, conductivity, clarity and velocity. General observations were made on aquatic vegetation, macrobiota and snails, and one-liter samples of water were taken at some sites to be analyzed for water quality by NUS.

The habitats surveyed included a dheshek south of Fanoole Barrage, two points in the Fanoole Main Canal, a roadside seepage ditch next to the Fanoole Main Canal, four points in the Fanoole drainage system, five places on the Jubba Main Canal, one place on the Mogambo Main Canal, two night-storage reservoirs in the Mogambo system, and two small ponds near the highway at the southern end of the Mogambo Scheme.

Dheshek Fanoole appeared to be a suitable habitat for aquatic snails and mosquitoes, and supported extensive stands of aquatic vegetation, including submerged ceratophylum and floating lily pads (Table 4). It also contained large numbers of fish, birds, insects and snails, but not the bilharzia snails. The absence of the bilharzia snails in the presence of ceratophylum was unusual, and might be due to the large numbers of ampullarid snails present, species which are thought to be competitors and predators of the bilharzia snails.

Table 4.

Vector Habitats in Irrigated Zone, June 1986

(parentheses indicate estimated values)

Scheme	Habitat	Velocity cm/s	Depth m	Secchi cm	Temp °C
Fanoole	Main Canal	31	1.0	6	26.2
	standing water	0	0.3	>30	30.5
	drain	0	1-2	20-50	28.0
Mogambo	Main Canal	25	1.4	10	29.5
	night storage	0	1.5	10	26.6
Jubba	Main Canal	0	0.5	20	29.0
SomalFruit	standing water	0	0.2	20	--
Dheshek	near Fanoole	0	0.5	7	29.2
Jubba River	at Jilib	(100)	2-3	1	27.0
	at Gob Weyn	80	2.0	1	27.0
Rain pond	near Gob Weyn	0	1.0	(20)	(30)

Fanoole Main Canal was highly turbid, although running much below capacity. It contained extensive growths of reeds and other emergent vegetation, but only *Melanoides* snails.

The Fanoole drains were less turbid and generally free of vegetation, but did not harbor bilharzia snails. However, a roadside ditch about five kilometers north of Jilib along Fanoole Main Canal did contain clear water, small lily pads, abundant emergent grasses, and adult *Bulinus abyssinicus*, the intermediate snail host for urinary bilharzia.

Water in the new Mogambo Main Canal and night storage reservoirs was highly turbid and contained no snails or vegetation. These sites appeared unsuitable for mosquitoes as well, due to waves produced by strong winds.

Two roadside ponds near the southern end of the Mogambo scheme contained lilies and cattails but no bilharzia snails. These ponds were anaerobic at the bottom but contained large *Pila* and *Lanistes* snails, with dead shells of the bilharzia snail *Bulinus abyssinicus* and dead shells of another small, unidentified planorbid snail.

A large rainwater pond across the highway from Gob Weyn appeared to be a suitable habitat for anopheline mosquitoes. The pond was first filled about 1 June with a perimeter from two to five kilometers, and by 14 June it was shrinking noticeably, with a large amount of grass and thin reeds beginning to emerge. It would probably be dry by early July, five or six weeks after filling.

IV. WATER-QUALITY MONITORING

Water quality of the Jubba River and related water bodies was sampled during two trips to the Irrigated Zone and one trip to the Reservoir Zone.

A. Cooperation with National University of Somalia

In order to develop the system for collecting and processing the water-quality samples from the Jubba River, a series of discussions was held with Prof. Abukar, director of the Analytical Chemistry Laboratory of NUS, Prof. Ali Warsame of the same faculty, and the three students working on the project. These discussions were held prior to and after each of the field trips, with two final meetings to review the data and reach agreement on details for continuation of the monthly sampling.

B. Field Sampling

A trip was made to the Irrigated Zone (10-16 June) to conduct three consecutive days of water-quality sampling in the river, survey snail and mosquito habitats in the agricultural systems, and collect additional information on the Jubba Sugar Project.

1. Survey in Irrigated Zone

The river surveys were run on 11, 12 and 13 June, collecting samples at five stations on the main river, at the Fanoole main drain, and at a dug well in the village of Buulo Burwako in the Mogambo scheme. The five river stations were at Jilib town, Kamsuma Bridge, Arare Bridge (leading to Jamaame) Yontoy and Gob Weyn.

Field measurements were made of conductivity, salinity and temperature with a YSI brand SCT meter, of clarity with a Secchi disk, and of the following chemical parameters, using Hach colorimetric kits:

--pH,
--chlorides,
--dissolved oxygen,
--carbon dioxide,
--hardness, and
--alkalinity.

Because of high turbidity and color in the Jubba River water, the Hach colorimetric values of oxygen, carbon dioxide and alkalinity in river samples were discarded. Perhaps they should only be used in the dry season when the water is clear. Two bottles of one liter each were filled and tagged for each sample, one bottle being acidified with two milliliters of H_2SO_4 for nitrate measurements. The bottles were taken to the NUS chemistry laboratory in Mogadishu and analyzed for 21 parameters, primarily salts and solids. The conductivity and pH recorded in the field were repeated in the laboratory analysis for general verification of procedures. Three samples were taken at each site for estimation of variances. The field and laboratory measurements agreed closely in all but one instance, an obvious case of acid contamination of the sample bottle.

One graduate student (Abdel Khafar) accompanied the consultant during the sampling, became familiar with access routes to the sampling stations, and was trained in field procedures. He then returned to the NUS lab and participated in the chemical analyses with two other students, under supervision of the director of the Analytical Chemistry Laboratory, Prof. Abukar. Guidance in laboratory analyses was also provided by Prof. Ali Warsame of the Faculty of Chemistry.

Laboratory results were compared with field observations and generally found to be satisfactory. Data sheets were designed, filled and taken to the JESS computer room, where the data were to be entered onto a spread-sheet file for storage and later retrieval and analysis. The field and laboratory procedures for processing of the samples were simple and efficient, but the computer processing of field data for analysis purposes was still pending due to difficulties in retrieving the file established for the water-quality data.

The river water was generally suitable for agricultural use in June, with conductivity from 200 to 500 micromhos per centimeter and mean chlorides of 100 mg/l or less (see Table 1). Complete data on all parameters for June 1986 can be found in Appendix E, and summaries will be provided when the full year of data is available.

Because sulfate concentrations in water can affect the durability of concrete, this parameter was also monitored. Sulfate concentrations in the Jubba River during late June at Baardheere Bridge ranged from 14 to 34 mg/l with a mean of 25 mg/l.

2. Survey in Reservoir Zone

A trip to Luuq, Bordubo and Baardheere was made 21-24 June to collect water quality data on the river and to obtain an accurate topographical profile near Bordubo, along the west bank of the proposed reservoir. For each water sample, two bottles of one liter each and one bottle of 0.5 liters were collected, the smaller sample being acidified with one milliliter of sulfuric acid for nitrate and phosphate analyses. Three samples were collected at Luuq, one at Bordubo, and three at Baardheere. A second NUS student (Bashir Musa) was given field training while he assisted in the sampling. He then returned with the samples to NUS and assisted in their analysis.

Field measurements of clarity, temperature, salinity, conductivity and chlorides were made at the time of collection, as well as Secchi depth. In the laboratory, 21 parameters were measured, including verification of the chemical parameters from the field (Appendix E). The water quality of the river in the Reservoir Zone was similar to that observed in the Irrigated Zone downstream, except it was more dilute, probably due to the two-week interval since the sampling downstream (see Table 1).

C. Plan for Water-Quality Monitoring System

In establishing the system for monitoring of water quality in the Jubba River, the initial field surveys, laboratory analyses and data processing went well, and arrangements were completed to continue with monthly sampling at Baardheere Bridge and at four stations in the Irrigated Zone: on the river at Jilib, Arare Bridge and Gob Weyn, and at the intake to the Fanoole main drainage pumping station.

The schedule includes monthly sampling in June, July, August and September, weekly sampling in October and November, again monthly in December, January, February and March, and then--at Baardheere only--daily and weekly sampling from 1 April through early May. This daily sampling can be terminated when it is clear that the early flushes of salt are past. The daily sampling during these early flood peaks is to be only for determination of conductivity and Secchi disk penetration, whereas the data to be collected in the monthly samples are to be complete, and the weekly samples are to cover all parameters except metals.

For monthly and weekly sampling the crew should stay overnight in Baardheere at the USAID house. For the Irrigated Zone it would be best to drive to Jilib and begin the sampling run there, finishing at Gob Weyn, then spending the night at Kismaayo and returning the next day to Mogadishu.

For the July sampling, Bashir Musa and Abdel Khafar (NUS students) should be on both sampling runs, preferably with Abdilla as the driver. When all three thus learn the locations of all stations and the housing arrangements for both runs, they can then alternate on the following months. One student and one driver are adequate for collecting the samples. All samples should be 2.5 liters or more, including a 0.5-liter sample in a separate bottle for acidification.

Copies of the final field log cards, laboratory data summaries and data listings are included in Appendix E, and a detailed procedure to be followed in running the surveys and reporting the data are included in Appendix D. A copy of each monthly report from the NUS laboratory should be mailed to William Jobin in Foxboro, Massachusetts, for use in river simulations.

V. SALINITY INTRUSION IN ESTUARY

Preliminary measurements were made of salinity in the river to locate the approximate extent of salt intrusion into the estuary. Preliminary results indicated that the intrusion did not reach Gob Weyn, about two kilometers upstream from the ocean. Discussions with banana farmers indicated that the maximum intrusion during high tides in the dry season (March) may be as far as Worcoy, 10 kilometers south of the equator and 29 road kilometers from Gob Weyn. The saline intrusion thus reaches 40 to 50 kilometers up the winding river. This was also the limit of observable tidal effects in the river.

A salinity survey was repeated in the estuary at Gob Weyn about 2 km from the ocean, at high tide on 14 June. Measurements at the surface and bottom of the river (two meters deep) showed no evidence of salt intrusion from the ocean. Although the rating curve for the river gauge at Kamsuma bridge was not available, a crude estimate indicated a discharge of probably 200 to 500 cubic meters per second. Velocities at Gob Weyn at 0.6 depth in the center of the river were 80 cubic meters per second. The river width at this point was 100 to 150 meters.

VI. TOPOGRAPHY SURVEY OF RESERVOIR NEAR BORDUBO

Field measurements of ground surface elevation were made along the road which crosses the center of the proposed reservoir between Bordubo and Garba Harrey, using precision surveying instruments. The ground elevations were measured at intervals of about 300 meters, proceeding from the bank of the river westward for about 10 kilometers, then returning to the starting point to verify the accuracy of the measurements. For the circuit surveyed, the ground elevations were accurate within 0.5 meters, which the author believes to be adequate for planning purposes. The results indicated that the extreme maximum high water level for the reservoir of 150 meters MSL would reach about nine kilometers west of the river, confirming the topographical map from Technital of 1977.

The reference marker #21 established by Technital south of the ferry crossing at Bordubo had been destroyed. Instead, the road in front of the UNHCR gate in Bordubo was used as a reference point, based on a spot elevation from the 1977 map of 131.8 MSL.

The field measurements confirmed the existence of very flat slopes which would cause large expanses of shallow water at the western edge of the reservoir. These shallow edges would be important mosquito and snail transmission sites, and could be eliminated by construction of a carefully designed berm or dike. However, there were several undulations in the terrain along this route which were not indicated by the 1977 map, as it contained contour lines at only 10-meter intervals. These undulations involved elevation changes of less than 10 meters and included natural drainage courses which crossed the flat plain, draining northeastward toward the river. Earthworks along this edge of the reservoir would also need to accommodate the existing drainage pattern.

The irregular geographical variation indicated that the slope at many points on the reservoir shore would be greater than the average slope indicated by the 10-meter contours, and in some places the slope would be locally away from the river. Detailed analysis of proposed operating schedules and of shoreline modifications to the reservoir should be based on careful inspection of a complete contour map with one- or two-meter intervals. This would show if any of these drainage depressions are closed and would cause isolated impoundments to retain water after the lake was drawn down. These small impoundments could be important in determining the species of anopheline mosquito which will inhabit the area, the required drawdown rates for stranding mosquitoes and snails, and the cost of remedial control measures.

VII. FUTURE CONSULTING VISITS

According to the Work Plan for Phase II, the consultant will make three additional visits in late November 1986, April 1987 and January 1988, each lasting about one month.

The next visit, in November 1986, will be for reviewing the water-quality sampling program, monitoring of mosquito and snail habitats in the Irrigated Zone, and a brief survey of the Shebelli irrigation area for water quality and vector habitats.

VIII. PROPOSALS FOR VECTOR AND EPIDEMIOLOGICAL SURVEYS

During the consultancy, preliminary discussions were held with public health officials regarding proposed surveys or disease vectors and epidemiology of malaria, bilharzia and other diseases.

A. Cooperation with UNICEF

Dr. Christopher Bentley, Health Programme Officer of UNICEF was contacted regarding the organization's expressed interest in collecting nutritional data as part of the epidemiological surveys. He said that UNICEF would be opening district primary health care offices in Kismaayo and Jamaame by the end of this year, and that they would be very interested in having some surveys made on height and weight of children under five years of age, as well as on anemia in mothers, as measures of nutritional status. However, he did not offer any assistance except perhaps in the immediate locale of the district offices.

B. Cooperation with National Veterinary Laboratory at Kismaayo

This well-established laboratory conducts parasitological, bacterial and other examinations for animal diseases in the Kismaayo region, and also incidentally examines blood and urine samples from human patients referred by local doctors for malaria and bilharzia. The facilities, technical personnel and records were reviewed informally during a short visit. Although the director, Dr. Hussein, was away, it seemed to be a good laboratory and should be considered for use in epidemiological surveys.

C. Vector Surveys

Although considerable published data are available on the snails which transmit urinary bilharzia, almost nothing is published on other snails, including competitors or those which transmit cattle parasites, or on insects, including mosquitoes, blackflies and tsetse flies. Some of this information can be obtained by cooperation with the Malaria Division of the MOH and with the Tsetse Fly Control Group. However, consultants on malacology, blackflies and non-malaria mosquitoes could be brought in to make surveys after the two rainy seasons to search for unsuspected vectors, and to expand the seasonal data on the important disease vectors.

D. Epidemiological Surveys

At the request of the USAID project manager for JESS and with the concurrence of ARD, a new proposal was developed for possible epidemiological surveys on malaria, bilharzia and malnutrition. This proposal, entitled PROPOSAL FOR EPIDEMIOLOGICAL SURVEYS, was submitted to ARD on 18 September 1986 by Blue Nile Associates. It will be discussed during the author's next visit to Somalia (late November 1986), which coincides with a technical review by ARD's home office technical manager, Dr. Gus Tillman.

APPENDIX A

Scope of Work #2 -- JESS Phase II,
William Jobin, Blue Nile Associates, 20 May 1986

1. The consultant (William Jobin) will conduct a six-week consultancy in Somalia beginning on or about 25 May 1986 for Associates in Rural Development, Inc. (ARD).

2. The general focus of this consultancy will be on providing training in water-quality analysis to the personnel from the Ministry of Jubba Valley Development (MJVD) and the National University of Somalia (NUS) and to establish a water-quality testing program in the Jubba Valley. The consultant will also focus on public health issues relating to water quality in the Jubba River and a proposed reservoir upstream from Baardheere. This consultancy is a part of ARD's Jubba Environmental and Socioeconomic Studies (JESS).

3. Prior to departure for Somalia, the consultant will hold a final telephone briefing with ARD project manager Richard Donovan or project technical manager Gus Tillman.

4. Upon arrival in Somalia, the consultant will hold briefing meetings with USAID project manager Sally Patton and JESS chief of party E. Drannon Buskirk, Jr., to discuss the consultant's scope of work. At this meeting, a means for progress reporting during this consultancy will be defined.

5. The consultant will interact with staff from the Faculty of Chemistry at NUS to plan and execute a program for collecting and analyzing water samples from the Jubba River.

6. The consultant will instruct field technicians from NUS and/or MJVD in standard techniques for water collection and analysis at Baardheere Bridge during a one-week intensive sampling period.

7. The consultant will also work with NUS laboratory technicians in developing analysis procedures for water samples taken from Baardheere to an extent necessary for mastery of analysis and reporting.

8. The consultant will go to the Jubba River estuary to make measurements on salinity, river flow and tidal exchanges in this area.

9. While in the lower Jubba Valley, the consultant will perform basic water-quality spot samples within irrigation systems, desheks and at Fanoole Barrage.

10. While traveling between the lower Jubba and Mogadishu, the consultant will also take spot water samples from parts of the Shebelli River.

11. The consultant will make certain measurements of surface water systems for calibration of preliminary computer models. These measurements will include, but not be limited to, temperature, Secchi disk trials, turbidity and geometry of waterbodies.

12. If time allows, the consultant will begin preliminary studies on use of biocides in the lower Jubba Valley.

13. The consultant will attempt to collect salinity records in the Jubba River and to determine operating schedules of irrigation systems in the lower Jubba Valley.

14. A draft report for this consultancy should be delivered to the JESS chief of party one full day prior to departure from Somalia. This report should be written in a format which meets guidelines that the consultant should obtain from the JESS chief of party. This report will be the basis of a final briefing with the USAID project manager and JESS chief of party. Revisions to the final report should be completed within two weeks after the consultant's return to the United States.

15. At the discretion of ARD project manager Richard Donovan, a final briefing may be required at ARD's home office in Burlington, Vermont.

APPENDIX B

Public Health and Water-Quality Field Data Sheets

The following pages are transcripts of original data records taken in Somalia during the June 1986 field trip. The original data sheets and pertinent maps are on file with Blue Nile Associates in Massachusetts, and photocopies are on file with the JESS chief of party in Mogadishu. The data sheets cover the following subjects:

Sheet No.	Date 1986	Subject
1	2 June	Odometer readings, Mogadishu to Kismaayo
2	2 June	Map estimates of distances in lower valley
3	3 June	Mogambo IP - operations calendar
4	3 June	Mogambo IP - biocide list, A B C
5	3 June	Jubba River Salinity Survey
6	4 June	Fanoole Rice Project - operations calendar
7	5 June	Somaltex cooperating villages
8	5 June	Somaltex - biocide list
9	11 June	Field data - Jubba River water-quality survey
10	14 June	Jubba Sugar Project -water quality
11	14 June	Jubba Sugar Project - biocide list
12	14 June	Jubba Sugar Project - operations calendar
13	14 June	Habitat Survey A and B
14	16 June	Salinity check on estuary
15	15 June	Levels at Deshek Fanoole
16	15 June	Visit to National Veterinary Lab at Kismaayo
17	23 June	Level circuit near Bordubo

Data Sheet #1 Odometer readings from Mogadishu to washout, then back to Mogadishu again (Medina) to Kismaayo, in kilometers, 2 June 1986, William Jobin and A/Gadir Hagi Ibrahim

Place	Time	Vehicle Odometer	Distances on Highway from Gob Weyn	Distances on Highway from Kismayo
Mogadishu	0730	09855		(585 km)
Washout	0930	09908		
Medina	1100	09959		481 km
Shalambood ar	1230	10055		
Shalambood lv	1345	10055		
Jilib	1700	10326		
Kamsuma Bridge	1730	10355	70 km	85 km
Rd to Jubba Sugar		10365	60	75
Mogambo Canal		10367	58	73
Road-River		10373	52	67
Road-River		10382	43	58
Rd to Jamaame-Arare Br		10386	39	54
Buulo Gaduud - Ck Pt		10405	20	35
Yontoy		10411	14	29
Gob Weyn		10425	0	15
Kismaayo	1830	10440		0

Data Sheet #2 Map estimates of distances in lower valley, 2 June 1986, William Jobin

Place on Map	Distance on Map in cm	Estimated Distance in km
Fanoole Barrage	11.5	123
Jilib Town	8.2	88
Kamsuma Bridge	5.5	58
Mogambo	4.5	49
River- behind Mana Mofi	3.7	40
Jamaaame - east of River		
Kabon	3.5	38
Across River from Inkas		
Yontoy - behind town	1.5	16
Gob Weyn	0*	0*
Kismaayo		(-10?)

*1 to 2 km upstream from mouth of river.

Data Sheet #3 Mogambo Irrigation Project Operations Calendar, 3 June 1986, acting deputy manager Rick Chisolm, irrigation engineer Robyn Walley, agricultural manager John Deas

In Sir M. MacDonald and Partners office, David Higgens, Mike Cohan, Paul, Simon.

All canals unlined.

Main canal - flows 24 hrs up to first ns reservoir at max of 3.7 cumecs and 25 cm/s for Phase I, 6.5 cumecs and 50 cm/s for Phase II. From first ns reservoir to second ns reservoir, also 24 hr flowing at 1.6 cumecs in Phase I. See map for further details.

Distribution canals M1/C1 max flow is 1.7 cumecs with peak flows in April-May and October-November for rice irrigation.

Flood relief canal has max flow up to 1 meter/sec during Gu season for maximum of 6 weeks, during peak of floods only.

Night storage reservoirs are designed to store 75 cm of depth but have an initially constructed depth up to 4 m in places, making complete drainage impossible.

Drains - flow is by gravity to two 1.1 cumec pumps, then to marine plain west of project. Flow during Gu and Der to handle excess irrigation water and also rain runoff. Drains not yet completed.

Rice germinates mid-April, soaked in damp soil for 6-8 weeks, then permanent flooding until 3 weeks pre-harvest (150-day strain). Expect to switch to 100-day strain in future, same starting date. Rice field is maximum of 5 cm deep at top end, 15 cm deep at bottom.

Sesame: pre-irrigate in November, planting last third November, irrigate again at flare (120 days) then dry until harvest--about March.

Cowpeas: Plant mid-June, harvest 60 days, intermittent soaking.

<u>Data Sheet #4</u> Mogambo Irrigation Project Biocide List, 3 June 1986, from storekeeper and John Deas, agricultural manager

Chemical	Company	Active Ingred	Used Last Year	Stock Now
Propanil	Siapa Italy	95% propanil 35 g of pure (A-1)	10,716 kg	4,284 kg
Fernasan D	UK		70 kg	140 kg
Malathion	Denmark	50% ec	6 l	194 l
Damfin 950 EC seed dressing	Ciba Geigy of Basle	950 g methacrifos/1	6 l	4 l
Roundup	Twiga Kenya	glyco phosphate	180 l	--
MCPA			502 l	698 l
Nuvacron	Ciba Geigy of Basle	300 g 0,0 dimethyl methyl carbamoyl methylvinyl phosphate 100 g monocrotophos, DDT tech	10 l	30 l
Atrin-L(S1)	Siapa	98% tech	18 l	433 l
Erbitox S40	Siapa	Sodium salt of 2-4D in acid 93%	--	58 kg
Rat Poison	Ciba Geigy of Italy	50 kg tin	--	50 kg
Basudin 10G			70 kg	3,105 kg
Primextra	Ciba Geigy of Basle	metolachlor = 2ethyl-6-methyl-N-1-methyl-2 methoxyaethyl chloroacetanilid atrazin = 4 aethylamino 2 chlor-6 ispropylamino-s-trazin 160 g atrazin, 10 g atrain verwandte 330 g metolachlor	1,000 l	2,500 l
Fostogas	Siapa	Pure phosphine - 100 gm, in form of aluminum phosphide - 333 gm	0	3,840 g

Data Sheet #4 continued

Chemical	Company	Active Ingred	Used Last Year	Stock Now
Aldrin	Shell of Kenya	chlorinated hydrocarbon insecticide 40%-95%	25 kg	0
Dieldrin	Shell of Kenya		?	80 l

Data Sheet #5 Salinity Survey of Jubba River, 3 June 1986, A/Gadir Hagi Ibrahim and William Jobin

Sta	Descrip	Odometer in km	Dist km	Time	Temp °C	Salinity ‰	Conductivity micromhos/cm
1	Kamsuma	10612		1600	29	0	332
	Bridge - Gage staff = 570 + or -5						
2	Lily pond	630					
3	Kobon Vill	638		1645	29	0	340
4	Equatore	646					
5	Yontoy (turned in 1 km)	667		1730	28	0	320
6	Gob Weyn	685		1800	29	0	280
7	Ocean			1830	28	33	off scale
6	Gob Weyn repeated 4 June near high tide (at depth of short probe -- almost 2 m)			1615	29	0	

On 3 June at Gob Weyn, river was highly turbid, fast (maybe 2 or 3 m/s). Secchi disk would have been zero. Would need 40-HP motor to navigate river at Gob Weyn. Cable ferry at Yontoy with barge.

River at Kamsuma bridge was nearing channel capacity, perhaps 2/3. MJVD rated capacity for flow under bridge is 800 cumecs, thus flow may have been 500 or so.

Approx width = 100 m approx velocity = 2 or 3 m/s
So if Q = 500 cumecs, then depth = 2 m

Data Sheet #6 Fanoole Rice Irrigation Scheme operations calendar, 4 June 1986, A/Gadir Hagi Ibrahim and William Jobin

Main canal designed for 33.2 cumecs from Barrage to Yontoy diversion gate at km 26. Thereafter designed for 22 cumecs to end at 56 km. Flow maximum during Gu and Der, base flow in dry season to keep canals from drying and cracking.

Pump in Drain #1 during June was running about 8 hours per day, off on Fridays.

Data Sheet #7 Villages where Somaltex has cooperating cotton farms, A/Gadir Hagi Ibrahim

Note: Degmada = district; beel = cluster of small villages; tuulo = small villages.

Degmada	Beel or Beesha	Tuulo
	Turdho	4 small villages
Jamaame		3
	Kamsuma	5
Mid Jubba	Hoonbooy	10
Jilib		10
	Xananka	4
Mid Shebelli		2

Data Sheet #8 Somaltex Biocide list, 5 June 1986, A/Gadir Hagi Ibrahim and William Jobin

1. Cytox 75PB

Against soil insect pests. Replaced Nuvacron (100 g monocrotophos and 400 g DDT). Cytox was supplied from Somaltex headquarters in Mogadishu. Used 600 kg in 1985, mixed with seed and also sprayed on emerging cotton plant. Inquiry sent to Somaltex HQ 28 June 1986.

2. Bomex

Carbaryl 95% ai produced by Siapa of Italy. Applied 375 kg in 1985 as insecticide. Each ha is sprayed once at planting and again at first flowering of cotton. One darab (1 ha) gets 4 cans of 100 g in 10 l = 400 gm per spray.

Data Sheet #9 Field Data from Jubba River Water Quality Survey, 11 June 1986. A/Khafar Abdullahi Sheikh, William Jobin

The chemical data was obtained with a Hach field kit.

Sample No.	Station	pH Hach	Chlorides mg/l NaCl	Oxygen in mg/l *	Carbon Dioxide mg/l *	Total Hardness *	Alkalinity *	Secchi Depth Meters
001	JR-01	7.8	200	12	60	35	28	0.01
002	FD-01	7.8	62	21	115	34	27	*** 0.48
003	JR-02	7.8	88	17	45	29	26	0.01
	TR-01	(Far Awys is a dry tributary now)						
004	JR-03	8.0	25	17	100	21	32	0.01
005	JR-05	7.8	38	22	60	23	28	0.01
	second day							
006	JR-01	8.0	88	22	125	25	46	0.01
007	FD-01	7.5	100	8	140	31	32	*** 0.90
008	JR-02	7.8	150	7	110	36	38	0.01
009	Buulo Burwako	well conductivity = 4,700 micromhos/cm and chlorides = 900**						
010	JR-03	8.0	150	17	100	33	24	0.01
011	JR-04	6.0	50	12	190	22	31	0.01
012	JR-05	8.0	38	15	120	27	38	0.01
	third day							
013	JR-01	8.0	38	10	85	22	38	0.01
014	FD-01	7.8	162	13	65	36	7	*** 0.75
015	JR-02	8.0	62	29	75	21	33	0.01
016	JR-03	8.0	88	25	100	30	34	0.01
017	JR-04	8.5	138	36	150	36	32	0.01
018	JR-05	8.0	162	30	50	35	28	0.01

*NOTE: Due to high turbidity and color of Jubba River, these parameters--except total hardness--are very unreliable for Jubba River stations when obtained with the colorimetric Hach kit. Data from Fanoole Drain are probably okay, however, due to clear water. Hardness and alkalinity are in grains per gallon as $CaCO_3$.

**NOTE: Maximum for this Hach test is 250 mg/l as NaCl, thus this value is way off scale.

***NOTE: Station FD-01 is the tail of the main Fanoole Drain, which is fairly clear due to slow velocities and sedimentation.

Data Sheet #10 Water-quality information for Jubba Sugar Project, senior agronomist Gelle Farah Almi and Keith Ward, agricultural manager. William Jobin, Drannon Buskirk and A/Gadir Hagi Ibrahim

Since 1976 they have been taking conductivity readings at the intake to the pumping station at Mareerey at 0630 every morning. Their policy is to stop pumping above 750 or 800 microS/cm.

As of July 1985 they also began to measure sodium, calcium, copper and manganese, carbonate, bicarbonate, silt and to calculate the sodium absorption ratio.

Mr. Gelle promised to summarize the monthly means for conductivity and send them to us. He also offered to give us the water-quality data when it is summarized in July.

His memory on conductivity peaks was that highest was about 3000 micromhos/cm in April 1983. His records showed the following variations:

gradual increase from 750 on 9 April 1983

peak at 1200 on 23 April, then dropped to 950 on 24th

peak at 1756 on 5 May, 950 on 6 May, 2,335 on 7 May

1,226 on 8 May and 786 on 9 May

Data Sheet #11 Biocide and fertilizer list of Jubba Sugar Project, 14 June 1986, from Mr. Gelle. Also, operational calendar.

Sugar harvest is usually from early July through March, not harvesting in Gu.

Main pumps are usually off during Gu and Der; April, May, June and October, November. They are also off during January, February and March because of low water in river.

Biocides/Insecticides

Aldrin Shell wp against white grub @ 3 kg/ha and sprayed about 60 ha

Dieldrin Shell susp 2.5 l/ha once per year

Suscon Consolidated Fertilizers of Australia Fungicide

In past used Tillex for seed dressing

Herbicides

Gesapax-combi Ciba Geigy
Gesapax-H
Diuron
Paraquat
2,4-D amine 3 l/ha against floating water lettuce
Roundup
Velpar
Gramuron

Fertilizers

Urea - major fertilizer at present
150-250 kg/ha as Nitrogen at replanting time, repeated after 8 weeks at 100 kg/ha. Perhaps again at ratoon at 100 kg/ha.

The following were discontinued after 1984:

Diammonium phosphate
Triple super phosphate
Muriate of potash @ 200 kg/ha
Ammonium sulphate @ 45 kg/ha on ratoon

Data Sheet #12 Jubba Sugar Project, 14 June 1986, agricultural manager Keith Ward

General Comments:

Two pumping stations.

Their base pumping station is at Labadad	5 pumps	x1.5 cu m/s
Topping up station at Mareerey	2	x1.5
	2	x0.75
Maximum =		12 cu m/s

Presently irrigated 6,500 ha with 470 by gravity, the rest by pressure sprinklers.

There is one main spine canal with 5 distribution canals.

Each block has a relift pump to power the sprinkler sets.

In two years they expect to complete the main drain.

Present interim drainage proposal is to complete shallow gravity drains to 2-3 pumping stations, over flood bund to river (low expected salinity).

Future system (original plan) is to dig deep gravity drains with pumps to evaporation basins to west of project (2-3 km), in case of high salinity.

Main canal could be extended up to Fanoole Barrage by 1 km extension of Little Jubba River (now blocked). Then water would flow by gravity through main canal.

Sugar mill waste is largely recycled but some can be drained to waste in the Marine Plain, a saline clay area.

Diesel fuel shortage limits irrigation at present. Instead of ideal of 1 sprinkle per 10 days (18 per season), they are sometimes limited to only one sprinkle per season.

They burn trash in fields, thus minimizing insecticide need.

<u>Data Sheet #13</u> Habitat Surveys in Jubba Sugar Project, Mogambo Irrigation Project, Deshek Fanoole and Fanoole Rice Project, 14 June 1986, E. Drannon Buskirk, A/Gadir Hagi, William Jobin

Sta	Description	width	depth	Secchi	velocity	temp	conduct	veg	snails
JS-01	Main Canal, bed of Little Jubba River	10m	0.5m	20cm	0cm/s	29.5C	300	no	no
JS-02	Main Canal, South End	20	0.6	20	0	29.0	400	no	no
MG-01	Main Canal Mogambo, leading to N11 night storage pond	10	1.4	10	0	29.5	370	no	no
MG-02	Storage Pond at Mogamboe (N11) thin grasses on n edge	500x200	1-1.7	10	waves	26.6	465		no

In Jubba Main Canal near Mareerey we found one large Lanistes snail, many small thiarids - possibly amphibious or Melanoides.

All habitats above were highly turbid, no algae, no vegetation, unsuitable for snails of any kind. JS-01 was surveyed about 1400 hours, last survey at MG-02 was at sundown, 1800 hours.

Data Sheet #13 Continued -- 15 June 1986

Station Description
width depth Secchi velocity temp conduct veg/snails

DF-01 Deshek North of Jilib at Km 14
See DS #15 7cm 0cm/s 29.2C 700 *
FC-01 Fanoole Main Canal, at bridge near deshek km 14
trapezoidal canal, 1:1 sideslope
15m 1.0m 6 31 26.2 282 cattails no
FC-02 Roadside ditch rainfed, under power line, along canal
5 km n of Jilib compound
5 0.3 >30 0 30.5 435 lilies **
FC-03 Fanoole canal 2.5 km south of Jilib Highway T. Diversion
to Phase I ricefields. Water very turbid
10 2.4 10 low(10) grasses on edge, young
Melanoides snails
FD-02 Fanoole Drain 1 m below full level, recently dropped
20 1.5 20 0 29.2 490 1% grasses on
edge, few large Melanoides - 1500 hours
FD-03 Fanoole Drain at first curve
7 1.2 20 0 28.0 490 1% grasses on
edge, medium and small Melanoides
FD-04 Drain at second curve (crossing) 1.85 km from FD-03
4 2.0 50 0 28.5 505 5% grasses on
edges. few small B. forskalii, also Melanoides
FD-01 Sump of Main Fanoole Drain
6 1.8 1% woody shrubs
on edges, few adult and small Melanoides
(this station is 13.5 km in from main canal)

*Heavy Ceratophylum, water lilies, emergent reeds. Vegetation coverage about 25% Large intersection line Bulinus forskalii snails, also Pila and Lanistes which were at least one year old, plus large cohort of very young Lanistes, primarily in the Ceratophylum.

**Bulinus abyssinicus and Bulinus forskalii. Water very clear, few large B. abyssinicus, small B. forskalii, indicates adults survived recent dry season but no second generation visible yet. Surface about 30 percent covered vegetation, mostly lilies and emergent grasses but no Ceratophylum.

Data Sheet #14 Salinity Check on Estuary, 16 June 1986

JR-05 Center of River at Gob Weyn 10 am high tide

width	depth	Secchi	velocity	temp	conduct	snails
150m	2.0 m	1cm	79cm/s	27.0C	260*	no

*from top of river to bottom

JR-02 Kamsuma bridge staff = 530 26.0C 270 no

Data Sheet #15 Levels at Fanoole Deshek, 15 June 1986, William Jobin, A/Gadir and Drannon Buskirk

To determine shore slope and depth with Kern level.

Sta	Description	Arbitrary elevation in m	Distance in m
Instrument set up on east bank of deshek			0
1	Edge of water	99.382	18
2	Bottom of deshek	99.232	50
3	"	99.077	84
4	"	99.057	90
5	"	99.037	142
TP#1 near sorghum		99.517	
New Instrument set up		HI = 101.355	
BM ground elev at center pole in entrance of hut by tobacco		100.000 arbitrary reference	

Data Sheet #16 Discussion at National Veterinary Laboratory in Kismayo, 17 June 1986, William Jobin

Director Dr. Hussein Ismael - absent.

They do cattle fecal smears and bloods, also do human urines, fecal smears and bloods. Orderly, well-equipped laboatory.

Records for cattle during 1985-86 show very few Schistosoma bovis or Fasciola infections, but heavy Strongyloides and Trichuris. Rare Echinococcus in camels.

I left card and said I would contact them again in November to see if we could cooperate.

I imagine we could summarize their lab data if they don't already have an annual report. We could send letter now through channels to get this information.

Thus, in November we could organize malaria survey, in March do bilharzia and intestinal parasites.

Data Sheet #17 Level Circuit at Bordubo on west bank of river, 23 June 1986, Abdilla Hussein Guri, Bashir Musa, William Jobin

Sta Description	Arb. Elevation in meters	Location
BM#1 Rock at Ground level gate to UNHCR compound near high water	70.000	Eastern masonry post at tower, Bordubo.
BM#2 Top of Post	72.47	Center high point
tp#1 shoulder of road	71.57	
tp#2 shoulder road	71.16	bend in road to left
tp#3 shoulder road	69.93	20 m east of swale
tp#4 edge road	72.03	bend in road to right
tp#5 edge road	74.07	
tp#6 edge road	75.97	
tp#7 shoulder road	77.44	start bend road to r.
tp#8	77.95	mid bend to l, also fork to right
tp#9 ctr road	80.96	
tp#10 ctr road	83.61	
tp#11 ctr road	85.97	
BM #3 rock at ground level	87.26	highest point of 3 rocks middle of curve to left

Road continues gradual climb. If road had gone straight it would have hit high ridge (about 50 m rise).

Return circuit

BM#3	87.26	
BM#1 UNHCR	70.38	acceptable for verification of aerial photos only.

Second Level Circuit from UNHCR to River, Bordubo

BM#1	70.000	arbitrary
tp#23	68.02	
tp#24	67.58	intersect road to ferry
tp#25	64.16	curve to right
tp#26	63.59	
tp#27	60.66	
river level at ferry	59.64	water's edge

Return circuit

BM#1 UNHCR	70.03	acceptable for verification of aerial photos only.

Data Sheet #17 - continued

Distance check with jeep odometer

BM#1 to BM#3

	odometer	distance
Bm#1 UNHCR	503.5 km	0 meters
first curve to l.	504.4	900
curve to r. small swale	505.0	1500
curve to right	505.7	2200
curve to right	507.4	3900
large swale	507.8	4300
curve to left, fork to right	508.0	4500
center of curve to left BM#3	510.3	6800

BM#1 to River

BM#1 UNHCR	517.2 km	0 meters
swale	518.0	800
T intersection, road to ferry	518.3	1100
Curve to right	518.9	1700
River	519.4	2200

Total distance - river to BM#3 is thus 9 kilometers

Elevation differential is 27.6 meters

Thus if river elevation is 120.8 msl, then BM#3 is 148.4 MSL.

APPENDIX C

Key to Identification of Principal Freshwater Snails in the Jubba River Valley

1. Does it have an operculum covering the opening?

   yes - go to #2
   no - go to #3

2. Is the opening on left? Lanistes
   right? Pila

(These are both large ampullarids, possible competitors with the bilharzia snails.)

3. Is opening on left? Go to #4
   right? Go to #7

4. If crushed alive, is there red blood?

   yes - go to #5
   no - go to #6

5. Is it small and thin?

   yes - then it is Bulinus forskalii
(does not transmit human schistosomes)
   no (it has globose shape) - then it is Bulinus abyssinicus
(transmitter of urinary form of human schistosomes)

6. It is Physa, a harmless snail.

7. Is shell a clear golden brown color and globose?

   yes - it is Lymnaea, transmitter of liver fluke to cows and goats
   no - it is striped, called Melanoides, a harmless snail

NOTE: For a more complete guide, refer to: "A Practical Guide to the Identification of African Freshwater Snails", 1980, by the World Health Organization and the Danish Bilharziasis Laboratory, Jaegersborg Alle 1D, 2920, DK-290 Charlottenlund, Denmark.

APPENDIX D

Procedures, Forms and June 1986 Data for Water-Quality Surveys

1. Before each sampling trip, JESS Chief of Party Dr. E. Drannon Buskirk gives NUS laboratory supervisor, Prof. Abukar, the field logbook with adequate number of log cards, consecutively numbered with unique set of sample numbers and sufficient bottle tags. He also gives all the equipment to the lab supervisor and arranges for vehicle, fuel, driver and letters for police and housing.

2. Field crew fills one log card at a time for each sample collection, adds sample number to tags and fixes tags to bottles, collecting two liters, plus 0.5 liters for acidification.

3. At end of trip, field crew returns to NUS and gives logbook with tagged bottles to lab supervisor.

4. Lab supervisor checks tags against log cards, with field crew--sample number, station number, date, acidified?

5. Lab supervisor checks that all field data are completed.

6. Lab supervisor marks type of analysis desired--daily, weekly or monthly?

7. Lab analyst adds stickers to bottles with sample number, but keeps tags on bottles also.

8. Lab analyst records his primary data on his own laboratory record.

9. Lab analyst copies data from his laboratory record to laboratory summary data form, checked by lab supervisor.

10. When all samples for month are analyzed, lab supervisor writes one-page summary indicating how many samples were collected during month, from where and by whom. Also reports how many days the people were in the field, for allowances. Indicates any problems with sampling or analyses and any unusual results. Makes general evaluation of river condition. Submits report with laboratory summary data form and log cards to JESS chief.

11. JESS chief makes photocopies of laboratory summary data and log cards and returns originals to lab supervisor.

12. JESS chief gives photocopies to data-entry clerk, who enters data in JESS computer.

13. After entry is completed, JESS chief lists data and has entry corrections made.

14. JESS chief gives copy of corrected listing with comments to Lab supervisor for checking or verification of problems.

15. Lab supervisor makes corrections and returns forms to JESS chief.

16. JESS chief supervises corrections and lists three copies, sending them to lab supervisor, JESS file and William Jobin.

17. When lab supervisor receives final listing from JESS chief, he has tags removed from sample bottles and files tags with data listing. He then has bottles emptied, cleaned with acid rinse, and stickers removed.

18. JESS leader makes monthly payment to lab supervisor based on monthly report.

Data Check

Ranges to be expected for data on water quality.

parameter	minimum	maximum	normal range
pH	5.0	9.0	7.5-8.5
temperature	20	35	25-30
conductivity	100	5000*	200-3000
salinity %	0	40*	0-1
Secchi depth cm	0	500	1-200
in mg/l:			
chlorides	1	19,000*	1-500
sulfates as SO_4	1	200	1-50
nitrates as N	0.1	20	1-5
phosphates as P	0.001	5	0.1-1
calcium	1	200	10-100
sodium	1	500	1-100
magnesium	1	100	1-20
total diss. solids	1	5000	10-1000
suspend. solids	1	5000	10-300
color	1	20	2-5
turbidity	1	500	1-200
settleable solids in ml/l	0	10	0.1-2
Arsenic mg/l	0	0.05	0-0.01
Boron mg/l	0.1	4	0.7-2
Selenium mg/l	0.001	0.02	0.001-0.005

*ocean

List of Data Items from Laboratory Sheets

1. Sample number
2. Settleable solids in milliliters per liter
3. Electrical conductivity at 25^{o}C in micromhos per centimeter (identical to microSiemens per centimeter)
4. pH in standard units
5. Turbidity in nephelometer turbidity units
6. Chlorides in milligrams per liter
7. Total hardness as $CaCO_3$ in milligrams per liter
8. Calcium in milligrams per liter
9. Magnesium in milligrams per liter
10. Nitrates in milligrams per liter as nitrogen
11. Phosphates in milligrams per liter as phosphorus
12. Suspended solids in milligrams per liter
13. Color in standard units
14. Alkalinity as $CaCO_3$ in milligrams per liter
15. Sodium in milligrams per liter
16. Sulfates in milligrams per liter as sulfate
17. Sediment nitrates in milligrams per liter
18. Sediment phosphates in milligrams per liter
19. Selenium in milligrams per liter
20. Arsenic in milligrams per liter
21. Boron in milligrams per liter
22. Laboratory supervisor
23. Laboratory analyst

List of Data Items from Field Log Sheets

24. Desired analysis code
25. Code number for field supervisor
26. Second code number for field crew
27. Sample code number
28. Station code number
29. Time as four digits
30. Date as DDMMYY
31. pH
32. Temperature in degrees centigrade
33. Conductivity in micromhos per centimeter
34. Salinity in percent
35. Depth of sample in meters
36. Secchi disk depth in meters
37. Total depth in meters
38. Weather code
39. Code for rain on previous day
40. Tide code
41. River stage reading
42. Date of data entry
43. Code number for data entry clerk
44. Date of data verification
45. Second code number for data verifier
46. Project code (optional)

BLANK FORMS USED IN FIELD FOR WATER QUALITY SAMPLING

LOG CARD

JUBBA RIVER COOPERATIVE STUDY ON WATER QUALITY IN SOMALIA

FIRST DIGIT IN PERSONNEL CODE - INSTITUTION

MINISTRY OF JUBBA VALLEY DEVELOPMENT 1
NUS - FACULTY OF CHEMISTRY 2
ASSOCIATES IN RURAL DEVELOPMENT - JESS 3
BLUE NILE ASSOCIATES - RUMFORD RIVER LABORATORIES 4

OPTIONAL PROJECT CODE ☐☐☐☐☐

(SUPERVISORI) ANALYSIS DESIRED? ☐
1-DAILY, 2-WEEKLY, 3-MONTHLY

FIELD DATA

PERSONNEL CODE FOR FIELD CREW — INSTIT. PERSON — NAME

SAMPLE NO. ☐☐☐
STATION NO. ☐☐ – ☐☐
COLLECTION TIME ☐☐☐☐
WATER TEMP ☐☐ . ☐ °C
SAMPLE DEPTH ☐☐ . ☐ M

SOURCE ______
DESCRIPTION ______
DATE (D D M M Y Y) ☐☐☐☐☐☐ pH ☐☐ . ☐
CONDUCTIVITY ☐☐☐☐ MS/CM SALINITY ☐☐ 0/00
SECCHI DEPTH ☐☐ . ☐☐ M TOTAL DEPTH ☐☐ . ☐ M

WEATHER CODE ☐ 1 - CLEAR, 2 - LIGHT CLOUDS, 3 - HEAVY CLOUDS, 4 - RAIN
RAIN ON PREVIOUS DAY? ☐ 1 - YES, 2 - NO
TIDE CODE ☐ 1 - HIGH, 2 - LOW, 3 - EBB, 4 - FLOOD
RIVER STAGE READING AT ______ ☐☐☐

DATA PROCESSING

FILE NAME ______

DATES (D D M M Y Y)
ENTERED ☐☐☐☐☐☐
VERIFIED ☐☐☐☐☐☐

PERSONNEL CODE — INSTIT. PERSON — NAME

Blue Nile Assocs / Rumford River Labs

LABEL

Project No.
Project Name

DATE: D /MO/YR
TIME
STATION NO.
SOURCE OF SAMPLE
SAMPLE NO.
SUB NO.
PRESERVATIVE
SAMPLING CREW (FIRST, INITIAL, LAST NAME)
AMOUNT
ANALYSIS

SAMPLE

APPENDIX E

Jubba River Water-Quality Data for June 1986

Key to symbols on following water-quality data sheets (numbered D1-D9):

A = acidified sample

E = obvious error, datum not to be used

SJR01 = monthly mean from station (JR-01). These are only calculated for important parameters, and only at the five major stations (I through V).

Blank spaces in tables indicate analyses are not completed.

Personnel codes:

Personnel codes indicate institutions (first digit) and individuals (second digit). Double codes such as 41.21 indicate a team of two people, the supervisor first.

Institutions	Individuals
1. MJVD	
	1. Abdel Gadir Hagi Ibrahim, agronomist
2. NUS - Faculty of Chemistry	
	1. Abdel Khafar Abdellahi, student
	2. Professor Abukar, head of chem lab
	3. Bashir Musa, student
3. ARD - JESS	
	1. E. Drannon Buskirk, Jr., team leader
4. Blue Nile Associates	
	1. William R. Jobin, consultant

Data Sheet D1: Definition of Sampling Stations for Jubba River Valley

Sampling Station Code	Main Station Number	Description (see map in Figure 1, main text)
JR-01	II	Ferry crossing of Jubba River at Jilib
FD-01	III	End of main Fanoole drain near Mobarek at entrance to pumping station
JR-02		Jubba River at Kamsuma Bridge
JR-03	IV	Jubba River at Arare Bridge, near Jamaame
JR-04		Ferry crossing of Jubba River at Yontoy
JR-05	V	Jubba River at Gob Weyn
WELL-01		Village well at Buulo Barwako in Mogambo IS
JS-01		Main Canal of Jubba Sugar Scheme (Little Juba River) just north of Mareerey
JS-02		Main Canal of Jubba Sugar Scheme at south end
MG-01		Mogambo Irrigation Scheme Main Canal
MG-02		Mogambo IS Night Storage Reservoir N11
DF-01		Deshek Fanoole, south of Fanoole Barrage
FC-01		Fanoole Main Canal at bridge near deshek
JR-06		Jubba River at bridge in Luuq
JR-07		Jubba River at ferry near Bordubo
JR-08	I	Jubba River at bridge in Baardheere

Data Sheet D2: June Water-Quality Data

Station	Sample	C R E W S Field	Lab	Analysis	Date DDMMYY	Time	Project
JR-01	1	41.21	22.21	3	110686	830	JESS86
FD-01	2	41.21	22.21	3	110686	1115	JESS86
JR-02	3	41.21	22.21	3	110686	1404	JESS86
JR-03	4	41.21	22.21	3	110686	1620	JESS86
JR-05	5	41.21	22.21	3	110686	1740	JESS86
JR-01	6	41.21	22.21	3	120686	800	JESS86
FD-01	7	41.21	22.21	3	120686	900	JESS86
JR-02	8	41.21	22.21	3	120686	1014	JESS86
WELL01	9	41.21	22.21	3	120686	1200	JESS86
JR-03	10	41.21	22.21	3	120686	1330	JESS86
JR-04	11	41.21	22.21	3	120686	1450	JESS86
JR-05	12	41.21	22.21	3	120686	1550	JESS86
JR-01	13	41.21	22.21	3	130686	1048	JESS86
FD-01	14	41.21	22.21	3	130686	1150	JESS86
JR-02	15	41.21	22.21	3	130686	1300	JESS86
JR-03	16	41.21	22.21	3	130686	1400	JESS86
JR-04	17	41.21	22.21	3	130686	1500	JESS86
JR-05	18	41.21	22.21	3	130686	1600	JESS86
JS-01	19	41.11	22.21	3	140686	1438	JESS86
JS-02	20	41.11	22.21	3	140686	1638	JESS86
MS-01	21	41.11	22.21	3	140686	1750	JESS86
MS-02	22	41.11	22.21	3	140686	1750	JESS86
DF-01	23	41.11	22.21	3	150686	1005	JESS86
FC-01	24	41.11	22.21	3	150686	1245	JESS86
JR-06	25	41.23	22.23	3	210686	1600	JESS86
JR-06	26	41.23	22.23	3	210686	1745	JESS86
JR-06	27	41.23	22.23	3	220686	745	JESS86
JR-07	28	41.23	22.23	3	220686	1400	JESS86
JR-08	29	41.23	22.23	3	230686	1800	JESS86
JR-08	30	41.23	22.23	3	240686	730	JESS86
JR-08	31	41.23	22.23	3	240686	830	JESS86

Summary for June

S-JR-01
S-FD-01
S-JR-03
S-JR-05
S-JR-08

Data Sheet D3: June Water-Quality Data

Sample	Codes for: Weather	Rain	Tide	River Stage m	River Q Cu m/s	Data in #.DDMMYY	Verify #.DDMMYY	File Name
1	3	1				41.120986	41.150986	JUBBA.WQ
2	2	1				41.120986	41.150986	
3	3	1		430		41.120986	41.150986	
4	3	1				41.120986	41.150986	
5	3	1				41.120986	41.150986	
6	1	2				41.120986	41.150986	
7	1	2				41.120986	41.150986	
8	1	2		430		41.120986	41.150986	
9	1	2				41.120986	41.150986	
10	1	2				41.120986	41.150986	
11	1	2				41.120986	41.150986	
12	2	2				41.120986	41.150986	
13	1	2				41.120986	41.150986	
14	1	2				41.120986	41.150986	
15	2	2		480		41.120986	41.150986	
16	2	2				41.120986	41.150986	
17	1	2				41.120986	41.150986	
18	1	2				41.120986	41.150986	
19	1	2				41.120986	41.150986	
20	1	2				41.120986	41.150986	
21	1	2				41.120986	41.150986	
22	1	2				41.120986	41.150986	
23	1	2				41.120986	41.150986	
24	1	2				41.120986	41.150986	
25	2	2		29		41.120986	41.150986	
26	2	2				41.120986	41.150986	
27	3	2		29		41.120986	41.150986	
28	3	2				41.120986	41.150986	
29	2	2				41.120986	41.150986	
30	3	2				41.120986	41.150986	
31	4	2				41.120986	41.150986	

Summary for June

S-JR-01
S-FD-01
S-JR-03
S-JR-05
S-JR-08

Data Sheet D4: June Water-Quality Data

Sample	Field pH	Temp °C	Field Conduct ms/cm	Salinity %0	Secchi Disk m	Total Depth m	Sample Depth m
1	7.80	26.0	650	0.0	.01		.1
2	7.80	27.0	435	0.0	.48	1.35	.1
3	7.80	27.0	350	0.0	.01		.1
4	8.00	27.0	250	0.0	.01		.1
5	7.80	27.5	275	0.0	.01		.1
6	8.00	26.5	610	0.0	.01		.1
7	7.50	27.8	560	0.0	.90	1.30	.1
8	7.80	24.5	600	0.0	.01		.1
9		30.0	4700	2.7			
10	8.00	28.0	700	0.0	.01		.1
11	E6.00	28.0	239	0.0	.01		.1
12	8.00	28.1	250	0.0	.01		.1
13	8.00	26.5	275	0.0	.01		.1
14	7.80	28.1	590	0.0	.75	1.05	.1
15	8.00	27.4	315	0.0	.01		.1
16	8.00	27.6	420	0.0	.01		.1
17	8.50	27.9	590	0.0	.01		.1
18	8.00	30.0	620	0.0	.01		.1
19	8.00	29.5	300	0.0	.20	.50	.1
20	8.00	29.0	400	0.0	.20	.60	.1
21	8.00	29.5	370	0.0	.10	1.40	.1
22	8.00	26.6	465	0.0	.10		.1
23		29.2	700	0.0	.07		.1
24		26.2	282	0.0	.06	1.00	.1
25	8.00	27.0	180	0.0	.02		.1
26	8.00	26.5	178	0.0	.02		.1
27	8.00	24.5	173	0.0	.02		.1
28	8.00	26.5	195	0.0	.02		.1
29		26.5	202	0.0	.01		.1
30		24.5	195	0.0	.01		.1
31	8.00	25.0	193	0.0	.01		.1

Summary for June

Sample	Field pH	Temp °C	Field Conduct ms/cm	Secchi Disk m
SJR01	7.93	26.3	512	.01
SFD01	7.70	27.6	528	.71
SJR03	8.00	27.5	457	.01
SJR05	7.93	28.5	382	.01
SJR08	8.00	25.3	197	.01

Data Sheet D5: June Water-Quality Data

Sample	Settled Solids ml/l	EC25 ms/cm	Lab pH	Turbd NTU	Chloride mg/l	Chloride meq/l	T Hard as $CaCo_3$ mg/l
1	1.7	674	8.09	217	161	4.530	
2	0.0	446	8.15	4	59	1.660	
3	3.6	384	8.04	230	73	2.050	
4	5.2	286	8.05	298	17	.470	
5	.4	304	8.14	160	33	.940	
6	5.0	403	8.43	316	59	1.660	
7	0.0	525	8.04	2	76	2.130	
8	12.0	568	8.11	320	137	3.860	
9	.2	4219	8.05	7	1040	29.260	
10	5.8	618	7.97	274	181	5.099	
11	.6	618	8.31	264	18	.495	
12	.7	251	8.23	290	22	.619	
13	2.2	A	A	202	85	2.388	
14	0.0	A	A	2	93	2.624	
15	2.5	A	A	169	50	1.411	
16	5.6	A	A	220	106	2.970	
17	1.7	A	A	156	160	4.505	
18	5.2	A	A	240	203	5.718	
19	.8	282	7.97	118	53	1.485	
20	.2	393	8.19	39	49	1.386	
21	.2	561	8.32	42	135	3.787	
22	0.0	465	8.21	15	49	1.388	
23	.4	566	8.75	52	112	3.150	
24	.2	278	8.23	180	17	.475	
25	.6	222		57	8	.228	189
26	.6	202		66	7	.200	170
27	.5	216		63	7	.208	180
28	.8	202		84	10	.272	206
29	.6	225		163	11	.317	184
30	.6	224		98	11	.310	176
31	.7	205		115	12	.348	169

Summary for June

SJR01	3.0	538		245	102	2.859	
SFD01	0.0	486		3	76	2.138	
SJR03	5.5	452		264	101	2.846	
SJR05	2.1	278		230	86	2.426	
SJR08	.6	218		125	12	.325	176

Data Sheet D6: June Water-Quality Data

Sample	Calcium mg/l	Magnesm mg/l	Nitrate as N mg/l	Phosphate as P mg/l	Sus Sds mg/l	Color su
1			3.0	.080	1140	
2			1.9	.010	5	
3			.7	.100	2080	
4			4.4	.090	4775	
5			.6	.100	435	
6			3.9	.090	805	
7			2.0	.040	55	
8			2.8	.010	3395	
9			3.4	.080	70	
10			2.4	.002	2455	
11			3.0	.060	1810	
12			2.9	.002	1750	
13			5.4	.360	1300	
14			2.0	.040	30	
15			4.3	.240	935	
16			5.6	.340	2000	
17			4.4	.320	1050	
18			4.6	.600	4420	
19			1.4	.040	590	
20			1.0	.180	4	
21			2.6	.080	55	
22			2.4	.060	40	
23			2.1	.060	55	
24			2.2	.040	470	
25	62.10	8.26	4.0	.500	115	
26	56.50	7.05	3.0	.600	255	
27	60.10	7.29	5.4	.400	130	
28	73.80	5.35	4.4	.700	215	
29	58.90	8.99	4.8	1.100	795	
30	59.70	6.56	3.6	.900	195	
31	50.10	10.69	4.0	1.200	335	

Data Sheet D7: June Water-Quality Data

Sample	Calcium mg/l	Magnesm mg/l	Nitrate as N mg/l	Phosphate as P mg/l	Sus Sds mg/l	Color su
Summary for June			natural	pH		
SJR01			3.5	.085	1082	
SFD01			1.9	.025	30	
SJR03			3.4	.046	3077	
SJR05			1.8	.051	2202	
SJR08	56.23	8.75	4.2	1.000	442	
			ACIDIFIED			
SJR01-ACIDIFIED			2.4	.360		
SFD01-ACIDIFIED			2.0	.040		
SJR03-ACIDIFIED			5.6	.340		
SJR05-ACIDIFIED			4.6	.600		
SJR08-ACIDIFIED			4.0	1.200		

Data Sheet D8: June Water-Quality Data

Sample	Alkalinity mg/l	Sodium mg/l	Sulfate mg/l	TDS mg/l	Sed NO_3 as NO_3 mg/l	Sed PO_4 as P mg/l
1		58.5				
2		47.5				
3		16.0				
4		11.5				
5		11.0				
6		25.0				
7		37.5				
8		45.0				
9		400.0				
10		48.0				
11		10.8				
12		14.0				
13	E	1200.0				
14		40.0				
15		14.0				
16		38.0				
17		34.0				
18		40.0				
19		10.0				
20		14.0				
21		40.0				
22		21.3				
23		52.0				
24		4.0				
25		8.8	14	589		
26		8.4	19	577		
27		8.2	16	529		
28		10.2	18	631		
29		9.5	21	1118		
30		9.7	34	694		
31		9.9	20	734		

Summary for June

S-JR-01		41.8				
S-DF-01		41.7				
S-JR-03		32.5				
S-JR-05		21.7				
S-JR-08		9.7	25	849		

Data Sheet D9: June Water-Quality Data

Sample	SelinimM mg/l	Arsenic mg/l	Boron mg/l
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
281			
29			
30			
31			

Summary for June

S-JR-01
S-FD-01
S-JR-03
S-JR-05
S-JR-08