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26/5/2022

REPUBLIC OF KENYA




THE NATIONAL ASSEMBLY

TWELFTH PARLIAMENT – SIXTH SESSION

DEPARTMENTAL COMMITTEE ON ENERGY

REPORT ON THE CONSIDERATION OF PUBLIC PETITION NO. 002 OF 2022 BY
MWANGAZA ABUNYA COMMUNITY DEVELOPMENT GROUP REGARDING
DEGRADATION OF THE ENVIRONMENT ALONG SONDU-MIRIU DAM DUE TO
FAILURE BY KENGEN COMPANY TO FULLY COMPLY WITH THE
ENVIRONMENTAL IMPACT ASSESSMENT OF 1995

 THE NATIONAL ASSEMBLY P. O. BOX 30010 NAIROBI	
DATE: 26 MAY 2022	
DAY: Thursday	
TABLED BY:	VICE-CHAIRPERSON Hon. Gladwell Jesire, MP
CLERK-AT-THE-TABLE:	Gertrude Chebet

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LIST OF ABBREVIATIONS AND ACCRONYMS

CSR	Corporate Social Responsibility
EIA	Environmental Impact Assessment
KENGEN	Kenya Electricity Generating Company
KPLC	Kenya Power and Lighting Company
MoE	Ministry of Energy
MW	Mega Watts
REREC	Rural Electrification and Renewable Energy Corporation

CHAIRPERSON'S FOREWORD

Public Petition No. 002 of 2022 by Mwangaza-Abunya Community Development Group regarding degradation of the environment along Sondu-Miriu dam due to failure by KENGEN Company to fully comply with the environmental impact assessment of 1995 was conveyed to the House by the Hon. Speaker on 1st February 2022.

Pursuant to the provisions of National Assembly Standing Order 227(1), the petition was committed to the Departmental Committee on Energy for consideration and reporting to the House within sixty (60) days of the committal.

While considering the Petition, the Committee on 16th May, 2022 undertook a fact-finding tour of the Sondu-Miriu Dam, which is largely in Nyakach Constituency and partly in Kabondo-Kasipul Constituency. During the tour, the Committee met and heard from the Petitioners. The Committee also met and heard from officials of Kenya Electricity Generating Company (KENGEN) regarding the Petition

The Committee thanks the offices of the Speaker and Clerk of the National Assembly for the logistical and technical support provided during consideration of the petition. The Committee also thanks the petitioners, Mwangaza-Abunya Development Group, as well as KENGEN, for engaging with it and providing complete information that has informed the findings of this report.

Pursuant to the provisions of Standing Order 227 and 199, it is my pleasant duty to Table in the House the Report of the Departmental Committee on Energy on its consideration of Public Petition No. 002 of 2022 by Mwangaza-Abunya Community Development Group regarding degradation of the environment along Sondu-Miriu dam due to failure by KENGEN Company to fully comply with environmental impact assessment of 1995.

Hon. Jeremiah Kioni, MP

Chairperson, Departmental Committee on Energy

EXECUTIVE SUMMARY

This report responds to the prayers sought by Petitioners in Public Petition No. 002 of 2022 by Mwangaza-Abunya Community Development Group regarding degradation of the environment along Sondu-Miriu dam due to failure by KENGEN Company to fully comply with environmental impact assessment of 1995.

The Petitioners requested the National Assembly, through the Departmental Committee on Energy to inquire into the matter to restore the environment along the banks of Sondu-Miriu dam and river for the sake of residents' livelihoods. The project has seen the rise of hippo grass that has formed a canopy on the river, impeding access to safe drinking water for domestic use. Moreover, the water has since become unsafe for human consumption. Further, KENGEN's activities have seen blockage of access roads to the river. The Petitioners averred that the communities living in the area had not benefitted from electricity produced by the power plant.

Regarding the first prayer, the Committee observed that since inception of the project, KENGEN had not done dredging on the dam and its banks, leading to a build-up of silt and subsequent growth of hippo grass. This impeded access to the river in some parts along the bank, and provided fertile ground for parasites, pests and wild animals. KENGEN submitted that being a recent project, the resultant silting was scheduled for the first dredging and removal exercise, and a tender to that effect had already been issued. The Committee recommends that this be done within 90 days of tabling of this report.

On the prayers to have KENGEN construct a health centre at Mamboleo grounds, provide electricity, facelift of public infrastructure and general corporate social responsibility, the Committee observed that KENGEN has been involved in several development projects in the community, as prioritized by a stakeholder's coordination committee which has residents of the area elected as among its members. KENGEN has no direct mandate compelling it to conduct these projects but the Committee recommends that they liaise with other government agencies to avail last mile electricity connection, construction of dispensaries and improve the road network.

On the prayer to have KENGEN release all title deeds and help in processing of titles for alternative parcels, the Committee observed that 306 out of 353 title deeds had been processed. The balance were in progress, save for succession issues in some. The Committee recommends that the company fast-tracks the process and finalize by 31st December 2022.

This report was unanimously adopted by the Committee on 23rd May 2022.

PART 1

1.0 PREFACE

1.1 Mandate of the Committee

1. The Departmental Committee on Energy is established pursuant to the provisions of Standing Order No. 216. The Committee is mandated to;
 - i) *investigate, inquire into, and report on all matters relating to the mandate, management, activities, administration, operations and estimates of the assigned Ministries and departments;*
 - ii) *study the program and policy objectives of Ministries and departments and the effectiveness of the implementation;*
 - iii) *study and review all legislation referred to it;*
 - iv) *study, assess and analyze the relative success of the Ministries and departments as measured by the results obtained as compared with their stated objectives;*
 - v) *investigate and inquire into all matters relating to the assigned Ministries and departments as they may deem necessary, and as may be referred to them by the House;*
 - vi) *to vet and report on all appointments where the Constitution or any law requires the National Assembly to approve, except those under Standing Order 204 (Committee on Appointments);*
 - vii) *examine treaties, agreements and conventions;*
 - viii) *make reports and recommendations to the House as often as possible, including recommendation of proposed legislation;*
 - ix) *make reports and recommendations to the House as often as possible, including recommendation of proposed legislation;*
 - x) *consider reports of Commissions and Independent Offices submitted to the House pursuant to the provisions of Article 254 of the Constitution; and*
 - xi) *examine any questions raised by Members on a matter within its mandate.*
2. In accordance with the Second Schedule of the Standing Orders, the Committee is mandated to consider matters relating to the Fossil Fuel Exploration, Development, Production, Maintenance and Regulation of Energy.
3. In executing this mandate, the Committee oversees the following State Departments:
 - i) The Ministry of Energy; and
 - ii) The Ministry of Petroleum and Mining (Petroleum Department).

1.2 Membership

4. The Departmental Committee on Energy comprises the following Members:

Chairperson

The Hon. Jeremiah Kioni, M.P.
Ndaragwa Constituency

Jubilee Party

Vice Chairperson

The Hon. Gladwell Cheruiyot, MP
Baringo County Women Representative
Kenya African National Union (KANU)

The Hon. Joseph Kirui Limo, MP
Kipkelion East
Jubilee Party

The Hon. Amina Gedow Hassan, MP.
Mandera County Women Representative
Economic Freedom Party

The Hon. Ekomwa Lomenen James, MP.
Turkana South Constituency
Jubilee Party

The Hon. Ali Wario, MP
Bura Constituency
Jubilee Party

The Hon. Joseph Wathigo Manje, MP.
Kajiado North Constituency
Jubilee Party

The Hon. Mary Wamaua Njoroge, MP.
Maragua Constituency
Jubilee Party

The Hon. Lemanken Aramat, MP.
Narok East Constituency
Jubilee Party

The Hon. Elisha Odhiambo, MP
Gem Constituency
Orange Democratic Movement (ODM)

The Hon. Rashid Kassim Amin, MP.
Wajir East Constituency
Wiper Democratic Movement- Kenya

The Hon. Elsie Muhanda, MP
Kakamega County Women Representative
Orange Democratic Movement (ODM)

The Hon. (Eng.) Vincent M. Musau, MP.
Mwala Constituency
Maendeleo Chap Chap Party

The Hon. Annie Wanjiku Kibeh, MP
Gatundu North Constituency
Jubilee Party

The Hon. Julius Mawathe, MP
Embakasi South Constituency
Wiper Democratic Movement – Kenya

The Hon. Michael Mwangi Muchira, MP
Ol Jorok Constituency
Jubilee Party

The Hon. Richard Ken Chonga, MP
Kilifi South Constituency
Orange Democratic Movement (ODM)

The Hon. Walter Owino, MP
Awendo Constituency
Orange Democratic Movement (ODM)

The Hon. Pavel Oimeke, MP
Bonchari Constituency
Orange Democratic Movement (ODM)

5. The following technical staff facilitate the Committee;

Mr. Victor Weke
Senior Clerk Assistant

Ms. Mary Lemerelle
Clerk Assistant II

Dr. Benjamin Ngimor
Senior Fiscal Analyst

Mr. Sidney Lugaga
Legal Counsel I

Ms. Noelle Chelagat
Media Relations Officer

Mr. Brian Njeru
Fiscal Analyst III

Ms. Mercyline Kerubo
Audio Recording Officer

Mr. David Ngeno
Research Officer II

Ms. Sheila Chebotibin
Sergeant at Arms I

PART II

2.0 CONSIDERATION OF THE PETITION

2.1 Background to the Petition

6. Construction of the Sondu-Miriu Hydropower station project began in 1999 and was officially commissioned in 2007. The station, unlike other stations in Kenya, does not have a major dam and associated large reservoir relies on the flow in the river with only a small storage capacity at the intake. Water is diverted from the Sondu River at the intake through a 6.2 km long tunnel down the Nyakach escarpment to the Power Station below. Thereafter, water is then returned to the Sondu River approximately 13km downstream of the intake via a 4.7km long outlet channel.
7. Environmental Impact Assessment (EIA) is one of the tools for environmental management under EMCA. It outlines a process which produces a written statement to be used to guide decision-making, which provides decision-makers with information on the environmental consequences of proposed activities, programmes, policies and their alternatives; requires decisions to be influenced by that information and ensures participation of potentially affected persons in the decision-making process.
8. The petitioners, Mwangaza-Abunya Self-help Group submitted that KENGEN Company has been in Charge of Sondu Miriu Hydro Power project for over a decade since the completion of the construction in 2009.
9. Since then, KENGEN had failed to comply to some of the recommendations which were highlighted in the EIA of 1995 as highlighted below;
 - i. Failure to remove the water weeds: Being that water weeds have not been removed to date, hippo grass has covered the bank of the river hence blocking the community from accessing the water for domestic use and for livestock.
 - ii. That Hippo grass has become a breeding environment for dangerous animals like python snakes which has caused panic and fear among the community as they go to draw water.
 - iii. Being that hippo grass has covered the whole water surface, movement across the river between Kisumu and Homabay Counties have been denied hence cutting the link between the two counties.
 - iv. That KenGen has failed to construct a permanent bridge across the river. Several accidents have been realized as people have been drowning inside the water. Five years ago, we had a tragedy where four people died as the boat they were using got stuck by hippo grass.

- v. That despite the prevalence of diseases like malaria being high since then, KenGen has failed to provide mitigation measures to these diseases more so to malaria and other waterborne diseases more so typhoid and amoeba and these have led to loss of so many lives in these regions.
 - vi. That KenGen has failed to open up access roads along the dam and ending up blocking access roads which were available hence blocking accessibility. KenGen blocked the road connecting the community of Abuoye and Nyandolo from accessing Kabondo Sub County Hospital Ramula hence brought a lot of problems more so at the time of emergencies to access the hospital.
10. Despite KenGen generating electricity from the community, the affected people living around the dam have never enjoyed the benefits of electricity as the whole region is in total darkness.
 11. Since the start of the project when water was blocked, there has been high rate of siltation which has compromised water quality. Currently the community uses the water which is coloured as observed which is totally different from the time before construction when water was very clear.
 12. The affected communities have been losing their livestock due to high rate of liver flukes and hookworms in the river. The petitioners have sought redress from the KENGEN Company to have their concerns addressed but to date, nothing has been done. They confirmed that the matters in this petition are not before any Court of law.

2.2 Prayers sought

13. From the foregoing, the petitioners sought the following prayers;
 - i. Considers this petition and is dealt with honourably and justice to be served fairly.
 - ii. Investigate the issues raised over the current state of the dam and the effects it has caused to the Communities living around it and make Recommendations to KENGEN to:
 - a) Supply clean, safe and adequate water to the communities living both on the Left and Right banks for domestic use.
 - b) Remove all the hippo grass that has covered the bank of the river to ensure safety and security of the members.
 - c) To clear all the bushes within the forested along the river bank areas to ensure safety and security.
 - d) To construct a Health Centre at Mamboleo Grounds to provide health services to the local community due to increased disease prevalence in the Region caused by stagnant water along the bank.
 - iii. To find out the extent to which EIA OF 1995 was implemented and Recommend to KENGEN:

- a) To open up all the access roads along the dam, grade them and marram more so to the roads which were blocked due to outward extension of the water from the dam.
 - b) Construct bridges and culverts to these access roads to ease movement along the dam and its environs.
 - c) Construct a bridge in Kawuor Location between Kisumu and Homabay Counties at Wath Karoko Canoe Point to link Abuoye Primary and St Anthony's Secondary School Kajimbo to prevent frequent deaths arising due to hippo grass.
- iv. To find out all the projects KENGEN has implemented under Corporate Social Responsibility to the affected communities living majorly in Kodhoch West and Kawuor Locations since its inception to date and recommend to KENGEN to:
- a) Link with Last Mile Connectivity Project to supply Electricity to the affected communities so as the community to at least gain the advantage of the project around us.
 - b) Uplift the faces of the schools in the affected areas namely Abuoye, Nyandolo and Ogeka Primary Schools by constructing of classrooms and provision of learning materials.
 - c) Release all the tittle deeds for the communities held in their offices since they were taken to date. We also pray that they help the community in processing of tittle deeds to the parcels which had not been finalized.

3.0 HEARING ON THE PETITION

14. The Committee heard from the Petitioners and the Respondents on 16th May 2022 at the company's offices in Sondu, Kisumu County. They submitted as follows-

3.1 Mwangaza-Abunya Self Help Group

15. The Petitioners were represented by the following officials of the self-help group;

- | | | |
|------------------------------|---|-----------|
| i. Mr. Woowill Odhiambo Lala | - | Chairman |
| ii. Ms. Millicent Opiyo | - | Treasurer |
| iii. Mr. Barack Ondanya | - | Secretary |

16. Other than the prayers contained in the petition, the Petitioners expounded that even though the project covers both Kisumu (Nyakach Constituency) and Homa-Bay (Kabondo-Kasipul Constituency) counties, the later was disadvantaged in terms of benefits accruing from the project.
17. The Petitioners claimed that KENGEN did not fully comply with the EIA report of 1995. The Committee's findings on this allegation are listed in the observations below.

3.2 Kenya Electricity Generating Company

18. The team from KENGEN comprised the following;

- i. Mr. Alfred Abiero - Regional Manager, Western Region
- ii. Mr. Joshua Were - Manager, Environment and Sustainable Development
- iii. Ms. Grace Chepkwony - Manager, Community Relations
- iv. Mr. Frank Ochieng' - Manager, Communications

19. Sondu was one of four hydro-stations and two gas turbines covered under the Western Region of the company. Sondu had an installed capacity of 60 MW, and is a run of the river scheme with an intake weir and holding pond that discharges the required water with a net head of 178m via a 6.2 km tunnel, and a 1.2 km penstock, to the vertical turbines. Water from the turbines is discharged into an open outlet channel 4.7 km long, to Sang'oro Plant which in turn generates 21 MW before returning the water back into the river.

20. Power generated from the plant is fed into the national grid through a 50 km, 132 Kv transmission line into Mamboleo sub-station in Kisumu. The project is overseen by four technical sub-committees as follows, drawing representation from community leaders, elected leaders, NGOs, professionals, national government officials and KENGEN staff;

- i. Resettlement and land compensation
- ii. Employment and economic opportunities
- iii. Environment
- iv. Health and safety

21. In response to the specific issue raised on their failure to remove weeds sprawling the river, rendering the water unfit for domestic use, hampering water transport, and creating breeding ground for mosquitoes and other dangerous animals, the company submitted that section 5.3 of the EIA report concluded that it was unlikely that emergence of the aquatic weeds in the reservoir would pose health hazards or danger. Therefore, no design features were required to mitigate the problem.

22. However, due to the emergent challenge that also posed a risk to power generation, the company had now scheduled a 5 km dredging exercise. The tender had closed on 10th May 2022 and evaluation was ongoing. Once the dredging exercise will have been completed, liver fluke, a common parasite prevalent in wet areas, will have been eliminated.

23. As for provision of safe and clean piped water, KENGEN submitted that they had constructed two water supply projects at a cost of Kshs. 149 million and handed over to the community. These projects comprised 6 boreholes drilled on the left bank of the river in Homa Bay County

and a raw water treatment plant in the Kisumu County side. The two county governments had engaged an NGO to manage the water projects.

24. The company further submitted that section 4.5.6 of the EIA report identified malaria as being common in the area, while section 5.5 concluded that pollution of water by organic matter was associated in an increase in water borne diseases. Sanitation measures were therefore under the purview of the Ministry of Health and county governments.
25. KENGEN denied blocking access roads, especially the cited road to Kabondo sub-county hospital. They stated that before the project, the only means of access was through canoes. They had since constructed a 7-tonne bridge that serves the community. Moreover they have rehabilitated roads and conducted improvements to the road network around.
26. They were however constrained in capital project constructions including roads and health centres. They could only chip in through CSR activities.
27. On supply of electricity to the local community, KENGEN submitted that they were constrained by the Energy Act that did not allow them to distribute power. This was under the purview of KPLC and REREC.
28. On the processing and release of title deeds, the company submitted that a total of 353 title deeds had been earmarked for processing, out of which 306 had been completed and issued to the holders. The balance of 47 had been impeded by succession issues but was being addressed by the office of the public trustee and a surveyor had been engaged for the purpose.
29. 90% of the power project lie in Nyakach Constituency, hence the impression that their activities were skewed towards the Constituency.
30. The company concluded by submitting that they had been engaged in several discussions with various stakeholders prior to the petition, and they endeavored to continue with the engagements.

PART III

4.0 ISSUES FOR DETERMINATION AS PER THE PRAYERS SOUGHT IN THE PETITION

31. Based on submissions from the petitioners, KENGEN, and the fact-finding visit, the Committee made the following determination as per the prayers sought;

- (i) **On current state of the dam and the effects it has caused to the Communities living around it as regards safe and clean water, removal of hippo grass, bush clearing and construction of health centres**

32. The EIA report cited notes that a number of residents would have been affected by the project and they would have to be compensated in cash or alternative settlements. Despite the report noting that surveys were unreliable, there were no disputes regarding compensation, save for the balance of remaining title deeds.

33. The EIA report further notes under clause 4.5.5, that under infrastructure and services, the area had poor communication network limiting the growth of small trading centres. None of the roads were tarmacked and most were impassable during the rainy season. KENGEN can therefore not be held liable for the state of the roads in the area since post-project, they had in fact rehabilitated and improved some of the roads.

34. The EIA report notes under clause 4.5.5 still, that Sondu-miriu River is the main source of water for all purposes in the area. The growth of hippo grass, attributed to the silting of the dam has therefore impeded unrestricted access to the water by residents.

35. Under the same clause, the report notes that there was no electricity supply in the project area. Being hosts of the project, the Committee observes that it is noble for KENGEN to assist the residents enjoy benefits of this project, despite not having the direct mandate to supply/ distribute electricity.

36. On education and sanitation, the report under clause 4.5.6 noted low standards to schools and health facilities, with poor road access to them. Malaria was observed as being of high incidence, as well as water borne vectors and liver parasites. The Committee observes that clause 6.2.5 noted that fluctuation of water levels in the reservoir may in fact serve as a semi-effective management technique for the control of vectors. Furthermore, the prerogative to preventive and curative health initiatives lay with the Ministry of Health and the County Governments, as is educational facilities the mandate of national government.

37. Although clause 6.2.6 discounts the possibility of restricted access to the reservoir water by residents, the petitioners demonstrated steep edges that made it risky for residents in some of the areas along the banks access water.

(ii) On the extent to which recommendations of EIA report OF 1995 was implemented

38. Specific to the EIA report recommendations, the Committee observes that recommendations A, B, C, D, E, F, H, I, J, K, L, M had no demonstratable infractions on the part of KENGEN.

39. The EIA report recommendations G, N which calls for an irrigation component and removal of aquatic weeds (in this case hippo grass) have not been addressed by KENGEN.

40. The Committee also noted that the cited EIA report of 1995 was done pre-project.

(iii) On all the projects KENGEN has implemented under Corporate Social Responsibility to the affected communities living majorly in Kodhoch West and Kawuor Locations

41. Through CSR, the following had been done by the company so far, in the subject locations;

- i. 7-tonne bridge connecting the two counties at Kshs. 25 million
- ii. 20 university scholarships at Kshs. 6.4 million
- iii. Donation of 5000 litre water tank to Ogeka Primary School and twelve 1000 litre water tanks to the community
- iv. Rehabilitation of Kolweny-Nyamarimba-Sondu intake road at Kshs. 16 million
- v. Construction of girls' dormitory at St. Anthony Kajimbo Secondary School at Kshs. 1.7 million
- vi. Two classrooms at St. Mary's Nyamarimba Girls School at Kshs. 3 million
- vii. Roofing of four classrooms at Apoko Primary School at Kshs. 1 million

42. On the issue of title deeds, the Committee observed that that a total of 353 title deeds had been earmarked for processing, out of which 306 had been completed and issued to the holders. The balance of 47 had been impeded by succession issues but was being addressed by the office of the public trustee and a surveyor had been engaged for the purpose.

43. The Committee also noted that there was intention to escalate the project to small-holder irrigation activities.

PART IV

5.0 COMMITTEE RECOMMENDATIONS

5.1 Specific to prayers

44. From the foregoing, the Committee recommends the following as per prayers sought;

45. On the 1st prayer, the Committee recommends as follows;

- i. KENGEN should conclude the tender process towards dredging of the silt, and removal of all resultant hippo grass, along the intake area and along the banks, within 90 days of tabling of this report;**
- ii. KENGEN should construct safe access points to the reservoir by residents for human and domestic use, by 31st December 2022;**
- iii. The petitioners should further canvass priority CSR projects to include construction of a health centre at Mamboleo grounds, with the stakeholder's coordination committee, and the County Government of Homa-bay.**

46. On the 2nd prayer, the Committee recommends as follows;

- i. KENGEN should construct adequate bridges as part of the discharge channel construction, as noted under clause 6.2.2 of the EIA report, within the next financial year;**
- ii. KENGEN should repair patches of untarmacked sections on the Kolweny-Nyamirimba-Anding'o Opanga road;**
- iii. KENGEN should consider rehabilitation, construction of other feeder and access roads, bridges and culverts in Kodhoch West and Kawuor Locations, in the next financial year.**

47. On the 3rd prayer, the Committee recommends as follows;

- i. KENGEN should liaise with KPLC and REREC towards ensuring neighbouring communities, especially those in Kodhoch West and Kawuor Locations, are connected to the grid through last mile connectivity, in the next financial year;**
- ii. The petitioners should canvass for priority CSR projects with the stakeholder's coordination committee;**
- iii. KENGEN should hasten the process of issuance of all pending title deeds and ensure they are issued by 31st December 2022.**

5.2 Other recommendations

48. Committee recommends that KENGEN should within 90 days of tabling of this report, liaise with Lake Basin Development Authority, who have been involved in a number of conservation and small holder irrigation activities in the region and actualize this intention.
49. The Committee recommends that the EIA study being done for the proposed dredging be completed within 90 days of tabling of the report, and provisions for mitigating measures for unforeseen negative consequences of the project done within the next financial year.
-

SIGNED: _____


FOR

DATE: _____

26/05/2022

HON. JEREMIAH KIONI M.P.
CHAIRPERSON, THE DEPARTMENTAL COMMITTEE ON ENERGY

MINUTES OF THE 13TH SITTING OF THE DEPARTMENTAL COMMITTEE ON ENERGY HELD ON MONDAY 16TH MAY, 2022 IN KISUMU

PRESENT

1. The Hon. Gladwell Cheruiyot, MP- **Vice-Chairperson**
2. The Hon. Elisha Odhiambo, MP
3. The Hon. Joseph Wathigo Manje, MP
4. The Hon. Richard Chonga, MP
5. The Hon. Pavel Oimeke, MP
6. The Hon. Walter Owino, MP
7. The Hon. Amina Gedow Hassan, MP
8. The Hon. Julius Musili Mawathe, MP

APOLOGIES

1. The Hon. Jeremiah Kioni, M.P- **Chairperson**
2. The Hon. Mary Wamaua Njoroge, MP
3. The Hon. Ekomwa Lomenen James, MP
4. The Hon. Lemanken Aramat, MP
5. The Hon. Ann Wanjiku Kibeh, MP
6. The Hon. Michael Mwangi Muchira, MP
7. The Hon. Joseph Kirui Limo, MP
8. The Hon. Elsie Muhanda, MP
9. The Hon. Rashid Kassim, MP
10. The Hon. Ali Wario, MP
11. The Hon. (Eng.) Vincent Musyoka Musau, MP

IN-ATTENDANCE

MWANGAZA-ABUNYA SELF-HELP GROUP

1. Mr. Woowill Odhiambo Lala – Chairman
2. Ms. Millicent Opiyo - Treasurer
3. Mr. Barack Ondanya - Secretary

KENGEN WELFARE STAFF

1. Mr. Alfred Abiero - Regional Manager, Western Region
2. Mr. Joshua Were - Manager, Environment and Sustainable Development
3. Ms. Grace Chepkwony - Manager, Community Relations
4. Mr. Frank Ochieng' - Manager, Communications

COMMITTEE SECRETARIAT

- | | | |
|--------------------------|---|------------------------|
| 1. Mr. Victor Weke | - | Senior Clerk Assistant |
| 2. Ms. Mary L. Lemerelle | - | Clerk Assistant II |
| 3. Mr. David Ng'eno | - | Research Officer |
| 4. Ms. Sheila Chebotibin | - | Sergeant- At- Arms |

AGENDA

1. Prayers
2. Preliminaries/Introductions/Communication from the Chair
3. Confirmation of Minutes
4. Pending Business before Committee
 - i. Inquiry into cost of power purchased by KPLC from KenGen and IPPs
 - ii. Joint inquiry with Delegated Legislation on the cost of Petroleum Products

- iii. Petition regarding operations of the open tender systems for importation of refined petroleum products
- 5. **Consideration of the petition to KenGen on Sondu Miriu dam**
- 5. Any Other Business
- 6. Adjournment/ Date of the next meeting

MIN. NO. NA/ENERGY/2022/072: PRELIMINARIES

The Vice-chairperson called the meeting to order at ten minutes past ten o'clock and said the prayer. Self- introductions were made and the agenda of the meeting was adopted as meeting with the petitioners' representatives and KENGEN to deliberate on the petition to KENGEN regarding degradation of environment along Sondu Miriu dam.

MIN. NO. NA/ENERGY/2022/073: CONFIRMATION OF MINUTES

Confirmation of Minutes was deferred.

MIN. NO. NA/ENERGY/2021/074: PRESENTATION OF THE PETITION ON SONDU MIRIU DAM BY PETITIONERS' REPRESENTATIVES

The Members were taken through the concerns raised by the petitioners as follows:

1. THAT, KenGen Company has been in Charge of Sondu Miriu Hydro Power project for over a decade since the completion of the construction in 2009.
2. THAT since then, KenGen has failed to comply to some of the recommendations which were highlighted in the EIA of 1995 as highlighted below:
 - i. Failure to remove the water weeds: Being that water weeds have not been removed to date, hippo grass has covered the bank of the river hence blocking the community from accessing the water for domestic use and for livestock.
 - ii. That Hippo grass has become a breeding environment for dangerous animals like python snakes which has caused panic and fear among the community as they go to draw water.
 - iii. Being that hippo grass has covered the whole water surface, movement across the river between Kisumu and Homabay Counties have been denied hence cutting the link between the two counties.
 - iv. That KenGen has failed to construct a permanent bridge across the river. Several accidents have been realised as people have been drowning inside the water. Five years ago, we had a tragedy where four people died as the boat they were using got stuck by hippo grass.
 - v. That despite the prevalence of diseases like malaria being high since then, KenGen has failed to provide mitigation measures to these diseases more so to malaria and other waterborne diseases more so typhoid and amoeba and these have led to loss of so many lives in these regions.

- vi. That KenGen has failed to open up access roads along the dam and ending up blocking access roads which were available hence blocking accessibility. KenGen blocked the road connecting the community of Abuoye and Nyandolo from accessing Kabondo Sub County Hospital Ramula hence brought a lot of problems more so at the time of emergencies to access the hospital.
3. **THAT**, despite KenGen generating electricity from the community, the affected people living around the dam have never enjoyed the benefits of electricity as the whole region is in total darkness.
 4. **THAT**, since the start of the project when water was blocked, there has been high rate of siltation which has compromised water quality. Currently the community uses the water which is coloured as observed which is totally different from the time before construction when water was very clear.
 5. **THAT** the affected communities have been losing their livestock due to high rates of liver flukes and hookworms in the river.
 6. **THAT** the petitioners have sought redress from the KENGEN Company to have our ^{their} concerns addressed but to date, nothing has been done.
 7. **THAT** the matters in this petition are not before any Court of law.

MIN. NO. NA/ENERGY/2021/074: PRESENTATIONS OF THE RESPONSES REGARDING THE PETITION BY KENGEN

1. In response to the specific issue raised on their failure to remove weeds sprawling the river, rendering the water unfit for domestic use, hampering water transport, and creating breeding ground for mosquitoes and other dangerous animals, the company submitted that section 5.3 of
2. the EIA report concluded that it was unlikely that emergence of the aquatic weeds in the reservoir would pose health hazards or danger. Therefore, no design features were required to mitigate the problem.
3. However, due to the emergent challenge that also posed a risk to power generation, the company had now scheduled a 5 km dredging exercise. The tender had closed on 10th May 2022 and evaluation was ongoing. Once the dredging exercise will have been completed, liver fluke, a common parasite prevalent in wet areas, will have been eliminated.
4. As for provision of safe and clean piped water, KENGEN submitted that they had constructed two water supply projects at a cost of Kshs. 149 million and handed over to the community. These projects comprised 6 boreholes drilled on the left bank of the river in Homa Bay County and a raw water treatment plant in the Kisumu County side. The two county governments had engaged an NGO to manage the water projects.

5. The company further submitted that section 4.5.6 of the EIA report identified malaria as being common in the area, while section 5.5 concluded that pollution of water by organic matter was associated in an increase in water borne diseases. Sanitation measures were therefore under the purview of the Ministry of Health and county governments.
6. KENGEN denied blocking access roads, especially the cited road to Kabondo sub-county hospital. They stated that before the project, the only means of access was through canoes. They had since constructed a 7-tonne bridge that serves the community. Moreover they have rehabilitated roads and conducted improvements to the road network around.
7. They were however constrained in capital project constructions including roads and health centres. ~~They could only chip in through CSR activities.~~
8. On supply of electricity to the local community, KENGEN submitted that they were constrained by the Energy Act that did not allow them to distribute power. This was under the purview of KPLC and REREC.
9. On the processing and release of title deeds, the company submitted that a total of 353 title deeds had been earmarked for processing, out of which 306 had been completed and issued to the holders. The balance of 47 had been impeded by succession issues but was being addressed by the office of the public trustee and a surveyor had been engaged for the purpose.
10. 90% of the power project lie in Nyakach Constituency, hence the impression that their activities were skewed towards the Constituency.
11. The company concluded by submitting that they had been engaged in several discussions with various stakeholders prior to the petition, and they endeavored to continue with the engagements

MIN. NO. NA/ENERGY/2021/075: COMMITTEE RECOMMENDATIONS


Committee recommends as follows;

- i. KENGEN should conclude the tender process towards dredging of the silt, and removal of all resultant hippo grass, along the intake area and along the banks, within 90 days of tabling of report
- ii. KENGEN should construct safe access points to the reservoir by residents for human and domestic use, by 31st December 2022
- iii. The petitioners should further canvass priority CSR projects to include construction of a health centre at Mamboleo grounds, with the stakeholder's coordination committee, and the County Government of Homa-bay.
- iv. On the 2nd prayer, the Committee recommends as follows; KENGEN should construct adequate bridges as part of the discharge channel construction, as noted under clause 6.2.2 of the EIA report, within the next financial year;

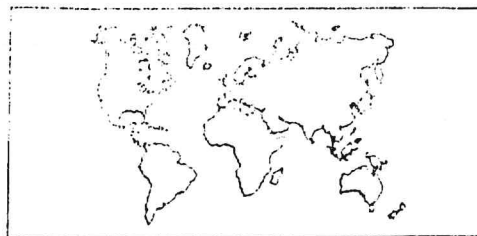
- v. KENGEN should repair patches of untarmacked sections on the KolwenyNyamarimba-Anding'o Opanga road; iii. KENGEN should consider rehabilitation, construction of other feeder and access roads, bridges and culverts in Kodhoch West and Kawuor Locations, in the next financial year

MIN. NO. NA/ENERGY/2022/076: ADJOURNMENT/ DATE OF NEXT MEETING

There being no other business, the meeting was adjourned at forty minutes past eleven o'clock. The next meeting will be held on 20th May, 2022.

SIGNED.......... DATE 26/05/2022
(VICE-CHAIRPERSON)

Environmental Assessment/Analysis Reports



Kenya Energy Sector Investment Project EA Category A

Environmental
Assessment
3 of 3
January 1995

Report E0064

This report has been prepared by the Borrower or its Consultant

KENYA

ENVIRONMENTAL ASSESSMENT SUMMARY

**SONDU-MIRIU
HYDROELECTRIC PROJECT**

The Environmental Assessment and this EA Summary have been prepared by the borrower and have not been evaluated or endorsed by the Bank and are subject to review and possible change during project processing.

SONDU-MIRIU HYDROELECTRIC PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

EXECUTIVE SUMMARY

**NIPPON KOEI Co. LTD.
CONSULTING ENGINEERS**

SEPTEMBER 1993

Compiled by:



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**SONDU-MIRIU HYDROELECTRICAL PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT
EXECUTIVE SUMMARY**

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OVERVIEW

The Kenya Power Company (KPC) intends to construct a hydroelectric facility by diverting water from the Sondu river in Western Kenya through a power house. An Environmental Impact Assessment (EIA) for the project was prepared. The present study presents the results of supplemental socioeconomic studies required to complete the EIA.

The population of the project area is estimated at 55,400. The project development will be on land which is owned by local residents and used for subsistence farming purposes. The majority of the households live on their plot, of which the average size is around 2 hectares. In some cases, however, the plot is too small for subsistence purposes.

The attitude of the local residents towards the project is very positive, as evidenced by the high turn-out at the public meetings, and the responses provided to the Consultants.

A total of 191 plots (estimated 1,700 people) will be directly affected in the reservoir and discharge channel areas, of which 48 will lose more than 50% of their area. 36 of the affected plots will be bisected by the discharge channel. In addition some 62 temporary and 52 permanent houses will be affected.

Other negative impacts anticipated include loss of earnings of the ferry owners, exposure of residents to the danger of falling into the discharge channel, the importation of undesirable sociocultural habits into the project area, possible interference with the Koguta forest and the abandonment of an important secondary school.

A number of positive benefits are expected, the most definite and significant being an estimated 402 new unskilled jobs available to residents of the project area for a four-year period. This will double the number of job opportunities in the area. The locally spent earnings of the immigrant labour combined with the total earnings of the locally recruited labour will represent a 15% increase in the local economy, and locally spent money is expected to total to Shs 48 million per annum in a cash economy of Shs 109 million per annum, an increase of 44%. Thus the multiplier effect for local trading and the small business sector will be very high.

In addition, improvements to the road network will provide a significant benefit to the local residents; between 50% and 100% improvement in productivity is anticipated for plots in the reservoir area as a result of better access to markets.

The residents are keen for the project to go ahead, so that they can enjoy the positive benefits and because they are looking forward to the second, irrigation phase of the project. They will cooperate in regard to possible relocation or land loss, so long as adequate compensation is given. In the case of plots reduced less than 50% this means cash compensation. In the case of plots reduced more than 50% it means land-for-land, or cash plus the guarantee of a suitable plot.

The residents are generally unwilling to move out of the area altogether, and the number of plots likely to come up on the open market may not be sufficient. Furthermore, the residents exhibit some degree of mistrust of officialdom, and do not have a strong background of community organisation and development. In view of this, the Consultants have made a number of recommendations designed to facilitate the dialogue between the community and the project proponents, to limit the number of families obliged to relocate and to minimise the disruption to other plot owners:

An NGO should be approached to assist the arrangements and negotiating of compensation, land redistribution, establishing management guidelines for the labour camp, positioning of fences and bridges for the discharge channel etc and other social issues arising from implementation of the project.

The Consultants consider that installation of satisfactory institutional arrangements constitutes the single most important factor in resolving any potential negative impacts of a socioeconomic nature.

The alignment of the discharge channel should be adjusted if possible, to minimise the number of bisected plots. In addition, a land redistribution exercise should be conducted with the residents to ensure that as many whole plots as possible can be retained, and spoil banks should be avoided as far as possible. It is expected that removal of the spoil banks will reduce the number of households earmarked for potential relocation from 48 to 25, and the redistribution exercise will reduce it still further.

In order to minimise as far as possible the relocation of residents to locations outside the project area or adjacent sub-locations, the Ministry of Lands and the District Development Committee should be approached with a view to making some new land available to accommodate relocated families.

In order to avoid the dangers and problems of uncontrolled abstraction of water from the discharge channel, a gravity feed community water project should be installed in the discharge channel area for human consumption and livestock.

In addition a number of recommendations are made regarding forest protection, clearing of the reservoir area, the dumping of waste material, rehabilitation and health control.

The Consultants are satisfied that if these recommendations are implemented, the project can be implemented in a satisfactory and fair manner, with no residents worse off than they were before, and with a significant net positive benefit to the project area, which has for many years suffered from an almost total lack of development.

**SONDU-MIRIU HYDROELECTRICAL PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT
EXECUTIVE SUMMARY**

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INTRODUCTION

The Kenya Power Company (KPC) intends to construct a hydroelectric facility in Western Kenya by diverting water from the Sondu River through a power house at the base of Nyandach escarpment. An Environmental Assessment for the project was prepared by Nippon Koei Company Limited. ("Detailed Design and Preparation of Tender Documents for Sondu/Miriu Hydropower Project: Environmental Impact Assessment, Data Book (5)," July 1991). KPC decided that supplemental socioeconomic studies were required to complete the Environmental Assessment, following which an additional study was carried out: "Sondu-Miriu Hydroelectric Project: Supplemental Socioeconomic Studies" - RPS International, August 1993.

The 1991 study focused primarily on the sectors where the greatest impacts of project operation were expected, notably water, health and land use. The 1993 socioeconomic report was based on:

- i) A baseline survey, in order to be able to assess positive and negative impacts based on:
 - a) Household interviews;
 - b) Data collected from local officials, institutions, public meetings and other residents in the locality;
 - c) Published data.
- ii) Field studies of the number of households and people affected by the creation of the reservoir and access road, and the discharge channel;
- iii) Maps showing the location of the affected plots, including dwellings which may have to be replaced or relocated;
- iv) Public meetings held with the community at large;
- v) 214 household interviews
- vi) The affected people's views and attitudes, regarding the issues of relocation, compensation and project benefits;
- vii) An analysis of project benefits
- viii) an estimation of land values, in order to be able to indicate the financial implications of a compensation programme, and to reinforce the calculations of project impacts on the local economy.

The present report combines both of the above studies to form an integrated EIA summary of the project. It has been compiled by RPS International Limited for Nippon Koei Company Limited

BACKGROUND

The power system of Kenya is composed of the following six entities:

The Kenya Power Company Limited (KPC),
 The Kenya Power & Lighting Company Limited (KPLC),
 The Tana River Development Authority (TRDC),
 The Kerio Valley Development Authority (KVDA),
 The Tana and Athi Rivers Development Authority (TARDA), and
 The Lake Basin Development Authority (LBDA).

The KPC, counterpart agency of the Sondu/Miriu Hydropower Project, and other entities, own generating facilities in the national power system, but actual operation and maintenance of the facilities are carried out by the KPLC under the management agreement.

The country is divided into five regions in terms of the power supply, ie. Nairobi, Coast, Rift Valley, Western and Mt Kenya regions as shown in DWG-02.

KPLC, which is a 60% government-owned entity, coordinates the national power network, purchases power in bulk from the KPC, TRDC and TARDA, and distributes power to consumers. Besides, the KPLC is importing energy from Uganda through the Lessos substation via the intermediate Muhoroni switching station.

Total installed capacity of the generating facilities was 735.6 MW in the country as of 30 June 1990, as listed below:

Sources	Installed Capacity (MW)	Effective Capacity (MW)	1989/90 Production (GWh)
Hydro	492.5	479.0	2,517.0
Conventional Thermal	145.9	69.8	107.0
Geothermal	45.0	43.0	336.0
Diesel	18.3	8.0	2.0
Isolated Diesel	3.9	3.9	12.0
Imports from Uganda	30.0	0.0	174.0
Total	735.6	603.7	3,148.0

Hydropower plants share 67% of the total installed capacity, 79% of the total effective capacity and 80% of the total annual energy production. Imports from Uganda are equivalent to about 6% of energy production in the country.

Historic demand records in each region are summarised as follows:

Region	Historical Energy Demand (GWh/year)					Annual Growth (%)		
	1972	1975	1979	1985	1987/88	72-85	79-85	79-88
Nairobi	505	627	790	1,052	1,245	5.81	4.89	5.50
Coast	190	238	344	440	536	6.67	4.18	5.36
Rift Valley	39	51	71	99	126	7.43	5.70	6.98
Western	61	85	168	269	338	12.09	8.16	8.57
Mt Kenya			37	87	95		15.32	11.73
Total	795	1,001	1,410	1,947	2,340	7.12	5.51	6.14

Per capita consumption was 96.41 kWh/year in 1985, which was rather high compared with other East African countries such as 15 kWh of Ethiopia, 46 kWh of Sudan, 35 kWh of Tanzania and 55 kWh of Malawi in the same year.

A review and updating of the demand forecast was made regionwise and nationwide in each consumer group for three scenarios of Median, Low and High growth. Total energy (GWh) required was forecast including energy losses. Peak power (MW) was calculated by adopting a load factor. The results of the Median forecast for the interconnected system are summarised as follows:

Region	1987/88	1988/89	1995/96	2000/01	2005/06	2014/15	Ave Annual Growth (%)
Energy (GWh)							(1987-2015)
Nairobi	1,245.0	1,275.0	1,845.9	2,312.2	2,879.9	4,263.9	4.49
Coast	536.0	564.0	785.8	964.4	1,178.2	1,673.3	4.25
Rift Valley	126.0	137.0	214.3	276.1	355.4	558.8	5.35
Western	338.0	340.0	593.7	846.7	1,199.4	2,205.7	7.11
Mt Kenya	95.0	101.0	188.5	198.9	472.9	1,066.1	8.99
Total	2,340.0	2,418.0	3,628.2	4,698.3	6,087.7	9,767.8	5.28
Peak Load (MW)							
Nairobi							
Coast	231.0	238.0	351.2	439.9	547.9	811.2	4.76
Rift Valley	107.0	98.0	140.2	172.0	210.2	298.5	3.87
Western	30.0	35.0	48.9	63.0	81.1	127.6	5.51
Mt Kenya	79.0	78.0	130.3	185.9	263.3	484.2	6.95
Total	22.0	25.0	47.8	75.8	120.0	270.5	9.74
	469.0	474.0	718.4	963.7	1,222.5	1,992.0	5.50

<u>National Energy Require- ment (GWh)</u>							
Network Losses	407.0	448.0	587.8	761.1	985.9	1,582.4	-
Station Use	43.0	27.0	59.0	76.4	99.0	158.9	-
Gross Generation	2,790.0	2,893.0	4,275.0	5,535.8	7,170.6	11,509.1	528

On the basis of the power demand forecast, a planning-up study was carried out to seek the least cost sequence in the long term plan to 2010. The result of the study revealed an optimum installation sequence comprising the Sondu/Miriu hydropower plant with an installed capacity of 60MW and commissioning time in 1997 (net Appendix II).

The draft final report entitled "1990 Interim Update of the National Power Development Plan 1991 to 2010" prepared in April 1991 recommends the Sondu/Miriu project for commissioning in the mid-1997 in the recommended generation development plan in Kenya.

PROJECT DESCRIPTION

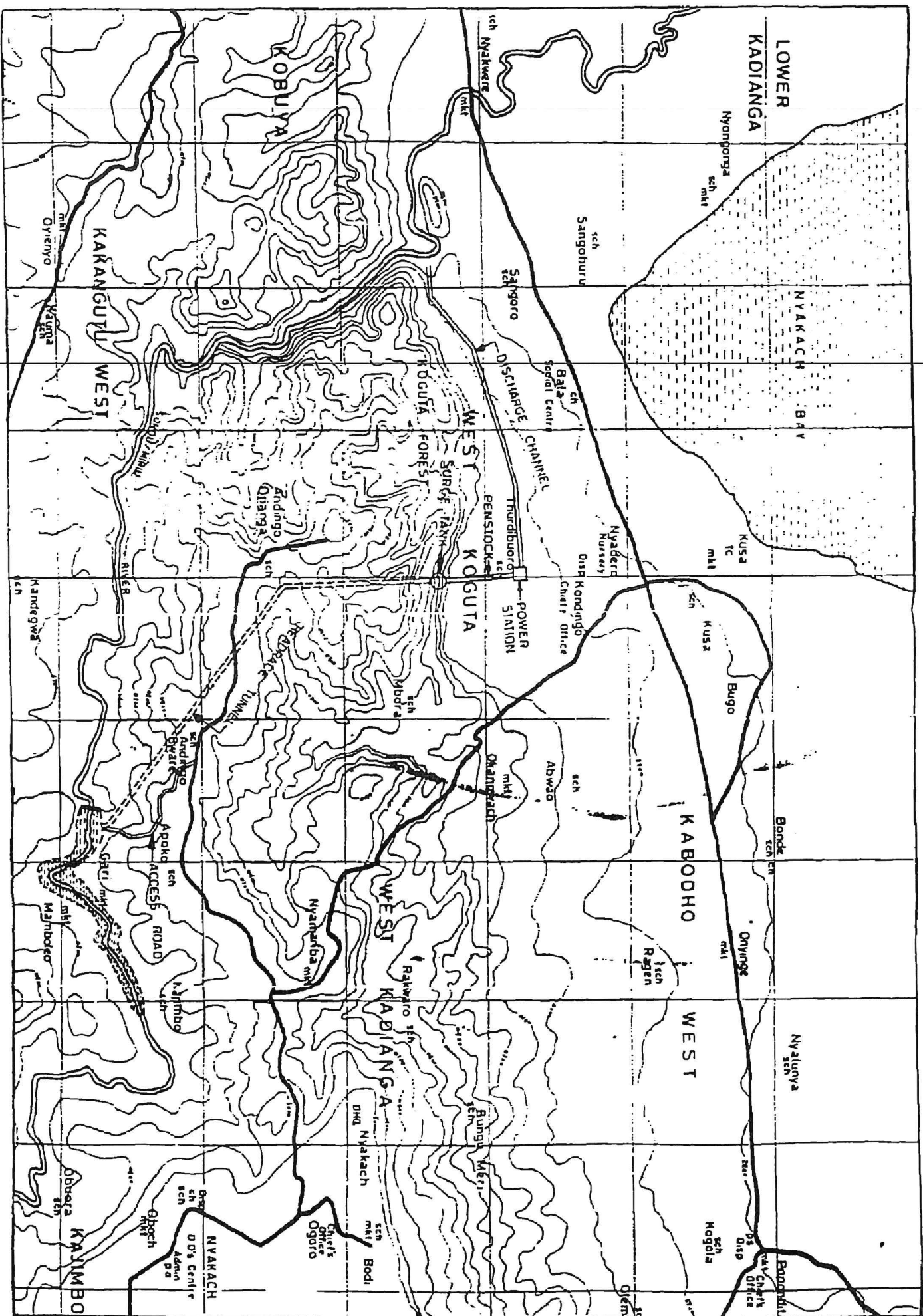
The Sondu-Miriu Hydroelectric Project is a river diversion project which will create a small impoundment behind a 18 metre high intake weir. An intake structure will divert the river into a tunnel which joins with the main powerhouse via a headrace tunnel and penstock. Pressure in the tunnel is regulated by a surge tank located on the crest of the Koguta Forest escarpment.

Compensation water will by-pass the weir to maintain adequate flow ($0.5\text{m}^3/\text{sec}$) in the river below the weir.

After passing through the powerhouse the water is returned to the Sondu/Miriu river along a 4.5 km long outlet channel. The channel has trapizoidal section of concrete lining, bottom width of 2.5 m connects the tailrace to the outlet near the gorge of the Sondu river. The channel, which runs in westward direction along the foot of the escarpment, releases the maximum of $40\text{m}^3/\text{sec}$ used for the power generation to the Sondu river.

The diagram overleaf shows the project layout.

SONDU / MIRIU HYDROELECTRIC PROJECT: LAYOUT PLAN



4

BASELINE STUDY

4.1

Topography, Physical and Climate

The project area lies mainly within the former Nyakach Division of Kisumu District. The altitude varies from around 1,250 m to 1,500 m. Mean annual maximum temperatures range from 25° C to 30° C, and mean annual minimum temperatures from 9° C to 18° C. Mean annual rainfall at nearby Papondoti is 712 mm.

The project area can be divided into two physiographic regions; the low-lying almost level delta region adjacent to Lake Victoria, and the upper region part of the Sondu-Miriu River catchment zone. The two regions are separated by an escarpment (Nyakach Escarpment) and partly the Koguta Forest Reserve which lies in West Koguta Sub-location of West Nyakach Location. The vegetation in the delta region is largely grass, shrubs and natural trees including acacia and other semi-arid species in the drier parts. Koguta Forest Reserve, which is unsurveyed, covers a substantial area and is planted with cedar and casuarina trees. The headrace tunnel will be surfacing on the edge of this forest as well as the surge tank. The soils are a mixture of sandy clay and murram types.

The upper region, in which the reservoir and access road will be located, receives more rain and the vegetation is thicker and broadly similar in species to that in delta region. The soil is mainly red with pockets of murram and clay types.

The Sondu-Miriu River is the major river on the region and is a source of domestic and livestock water. It is an alternative source of water for the population living in the delta region, especially in the drought period. Like all the other rivers in the district, the Sondu-Miriu flows into the Nyanza Gulf of Lake Victoria.

The reservoir lies on pre-cambrian intrusives, which are mainly granite rocks extending across the escarpment. The discharge channel will lie in a more recent colluvium occurring from wash accumulation.

4.2

Hydrology and Water Quality

Efforts were made to investigate which, if any, international agreements presently govern the use of water flowing into Lake Victoria with particular reference to the project:

- 1) The Ministry of Water Development and the National Water Conservation and Pipeline Corporation have no knowledge of any such agreements.
- 2) The United Nations Environmental Programme, Section of the Environmental Law has no records of a Nile Waters Agreement.
- 3) The Lake Basin Development Authority's official position is that Kenya is not bound by any international agreements and only Kenyan legislation applies. The LBDA noted that there has been a recent meeting of some of the riparian states to discuss the River Nile but Kenya was not party to these talks.
- 4) The Ministry of Foreign Affairs has no knowledge of any new agreements or other treaties relating to the use of water entering Lake Victoria.

- 5) The Attorney General's Office, Treaties and Agreements Department is aware of the International Nile Waters Agreement, which concerns the White Nile and was signed by Kenya, Uganda, Tanzania, Sudan and Egypt, and governs, among other things, the usage of inflows into Lake Victoria. Their information is that this agreement was signed "in the 1920's" and expired "in the 1980's".
- 6) Copies of the original Agreement could not be found in either the Ministry of Foreign Affairs or the Attorney General's Office.
- 7) The Embassy of Egypt have no information regarding any agreements solely between Kenya and Egypt but do have some correspondence and other indirect information on agreements made since 1890's about various international agreements concerning the River Nile and Lake Victoria.

Information on water quality in the Sondu/Miriu River is very sparse and some of it is of dubious reliability. What is available is summarized in Appendix I. These results are based on very few samples so variations due to season and time of day of sampling are not revealed. These data should therefore be regarded as indicative rather than definitive and treated with due caution.

These data do not indicate excessive pollution of the river at present; all parameters recorded are within acceptable limits.

4.3

Biological

As mentioned above, the vegetation in the delta region is grass, shrubs and natural trees including acacia and other semi-arid species in the drier parts. The escarpment incorporates the Koguta Forest Reserve, which contains cedar and casuarina trees.

The intended reservoir area is at present lightly to moderately covered with scrub and a few larger nature trees. Most of the land is under subsistence cultivation of annual crops consisting mainly of maize, beans and cassava.

The area is densely populated, and contains no reserves for wildlife.

Two important and potentially harmful free-floating aquatic weeds are known to exist in the lower Sondu/Miriu and Lake Victoria; these are Pistia (the Nile Cabbage) and Azolla (the water fern). Neither of these two species are known to exist in the Upper Sondu above the weir site.

Fisheries are based principally on Lake Victoria. The extent of fishing activity in the Sondu-Miriu is unknown; upstream of the township is in any case in Kalenjin territory, and these people do not traditionally catch or eat fish. The District Development Plan nonetheless highlights the potential of Nyakach Division for fish farming.

4.4

Protected Areas

Development projects which involve the construction of roads, reservoirs or irrigation schemes pose a threat to the continuing well being of the environment. Areas which may be inundated, graded or levelled during construction may contain natural and man-made resources of considerable cultural and economic value.

Awareness of the potential destruction of objects and sites of historical, cultural or archaeological importance in Kenya resulted in the gazetting of the Antiquities and Monuments Act in 1983. The Act defines and seeks to protect objects of archaeological, palaeontological and historical interest from damage or destruction. However, there are no protected areas in the project area, apart from the Koguta Forest, and no game parks or national parks.

4.5 Socioeconomic

4.5.1 Project Area

The proposed project lies within six sub-locations, which taken together can be regarded as constituting the project area so far as socioeconomic impacts are concerned. The area so defined encompasses all of the directly affected households, and defines the area regarded as "local" so far as the residents are concerned in their desire that unskilled project jobs should be reserved for "local" residents. It is considered that those households indirectly affected are also contained well within the project area.

4.5.2 Population and Land Use

The population of the project area in 1993 is estimated at 55,400. The population density in the sub-locations in which the project will principally lie is 400-500 people per sq km, the density in the sub-locations containing the reservoir being somewhat higher than in the sub-locations containing the discharge channel.

The project development will be entirely on land which is used by local residents for agricultural and residential purposes. All of the land to be acquired is privately owned by individual households.

Plot sizes vary from a fraction of a hectare to around 4 hectares, with a few reaching in excess of 12 hectares. The average plot size is 2 hectares.

4.5.3 Settlement and Land Tenure Pattern

The project area has been settled for a long time; it is not a recent settlement scheme. The earliest dates of settlement mentioned by respondents was 1907 in the reservoir area, and the 1930's in the case of the discharge channel area.

Not all of the households live on their plot. In the case of the discharge channel area, the proportion living on their plot is around 90%; in the case of the reservoir area the proportion is rather lower. In many cases it was apparent to the Consultants that the plot concerned is not the only plot owned by the household; several of the households own other plots, often outside the project area. This is not surprising, as many of the plots are in fact too small for household subsistence. In other cases, households own other plots within the project area. There are several examples of this in the discharge channel area, to which some families migrated from the river area near the proposed discharge point, due to flooding of their plots. The original plots have, however, been retained, so far as the Consultants were able to ascertain.

The mapping of the project area is not entirely satisfactory. The Government cadastral maps are clearly marked as not being valid for legal purposes; only 5% of respondents actually hold the legal title document to their plot, and only 3% had acquired maps or plans showing the location of their plot. There are no beacons in place. Not surprisingly, very few owners have borrowed money using their land as security. For the reasons given, the survey and mapping carried out by the Consultants, while meeting the stated objective, cannot be used as a legal basis for finalising individual compensation claims. In all cases it is a statutory requirement for Government surveyors to establish plot boundaries at the time of the subdivision or transaction.

4.5.4 Local Economy and Income Levels

The vast majority of households in the project area live off the land, selling their surplus production, if any, in the local markets. There is very little formal sector employment in the area. However, a small but significant proportion of the householders also engage in small-scale business activities such as fishing, basket weaving or pottery, although in many cases interviewees were reluctant to reveal such supplementary forms of income generation.

Food crops commonly grown are millet, groundnuts, cassava and maize. Almost all of the households keep livestock; a typical livestock owning pattern is two cows, three goats, five sheep and ten chickens.

Respondents were reluctant to declare cash income except for a very few cases, which were insufficient as a basis for estimation.

The Consultants instead estimated total value of produce by multiplying production by commodity price, regardless of whether or not there is any surplus sold in the local markets. Using this method, households in the reservoir area are estimated to be typically producing agricultural produce valued at around Shs 53,000 per annum. Given an average plot size of around 2 hectares, this implies an average income from crops equivalent to Shs 26,500/ha/annum.

In the case of the discharge channel area, the estimate is Shs 33,600/plot/annum or Shs 16,800/ha/annum.

Some households also have a business income, which in some cases reaches several hundred thousand shillings per annum. When added to the value of agricultural production, this brings the effective mean household income from crops and business to around Shs 60,000 per annum, presently equivalent to US\$750 per annum.

These income levels, while of the expected order of magnitude, could be slightly exaggerated, due to the assumption on the part of most residents that the team were there to negotiate individual compensation claims. It should be noted that they represent gross, not net income (ref 4.5.9)

4.5.5 Infrastructure and Services

The communication network in the project area is poor, which limits the growth of the small trading centres. None of the roads are tarmacked, and several are almost impassable in places during the wet season. The Consultants noted that this situation constitutes a marked disincentive for the plot owners to grow fruit and vegetables for the markets.

Of particular concern is the water situation. The Sondu-Miriu river is the main source of water for all purposes. When there is a shortage, residents walk to Lake Victoria to collect water, a distance of up to 6 km. Part of the project area was provided with an (incomplete) water supply system, but it appears to seldom operate.

There is no electricity supply in the project area. The nearest point of power supply is at Sondu, some 20 km from the proposed reservoir area.

There is no telephone service in the project area.

4.5.6 Education, Sanitation and Health

The area is well provided with primary schools; attendance, as in Kenya generally, is very high at almost 100%. Secondary schools, as is also typical in Kenya, are fewer, there being five in the project area. The notable characteristic in respect of the facilities in the project area is the poor access to some of the schools, and the generally low standard of the facilities themselves, the exception being Thurdibuoro School.

There are three health centres and a dispensary in the project area; by far the commonest cause of morbidity is malaria. There is no public sewage system in the area; households have individual pit latrines.

It should be noted that in the case of bilharzia the presence of the bilharzia snails does not necessarily mean that the disease is also present; data on the out-patient morbidity (Table 2.2) from Kisii, Kisumu and South Nyanza Districts suggests a low incidence of the disease in these Districts. However, although the morbidity statistics indicate that bilharzia is not a significant disease in the project area, surveys shown that the vector snail Biomphalaria pfeifferi is present in Sondu River above the weir site and this could transmit Schistosoma mansoni. Also present is Lymnaea natolensis which is the intermediate host of the liver parasite Fasciola hepatica.

The mosquito Anopheles gambiae is also present in the Project area as is a high incidence of malaria.

The project area lies within a high HIV prevalence area, estimated to be well in excess of the national level and possibly considerably more. Some parts of Nyanza Province Area reporting HIV infection rates of over 20%. The present 5 year plan for AIDS control in Kenya is focused principally on preventing the further spread of the epidemic by getting individuals to make use of knowledge about AIDS to change their behaviour.

4.5.7 Community Activities

There is a general lack of community collaboration in development projects in the area; there is a marked absence of village-level projects such as water schemes, roof catchment, cattle dips etc. despite the long-standing nature of the community. An atmosphere of some degree of mistrust of local officialdom was notable in the area of the proposed discharge channel, although the turn-out for the Consultants' public meetings was very high, and was commented on by the Administration officials.

4.5.8 Perceived Problems

Respondents were asked to name the three most pressing socioeconomic problems. The following table sets out the five issues most frequently raised, together with the percentage of respondents mentioning each issue.

Problem	Reservoir Area	Discharge Channel Area
Poor Access Roads	100%	80%
Lack of Clean Drinking Water	77%	98%
Poor Medical Services and Sanitation	72%	6%
Lack of Employment Opportunities	18%	18%
Soil Erosion	66%	7%

Other problems were noted by a small number of people, such as lack of telephone, livestock diseases and lack of electricity.

The difference in the response pattern between the two areas reflects:

- (i) The easier access which the reservoir area has to water;
- (ii) The easier access which the discharge channel area has to the facilities on the main road;
- (iii) The soil erosion problems of the sloping land of the reservoir area.

4.5.9 Land Values

A detailed study of economic land values is beyond the scope of this study. However, as an indicator of likely compensation requirements and as a check on declared income levels, it is a useful parameter to estimate. The Consultants have therefore carried out some basic calculations using data gathered during the survey:

i) Economic Value

In the reservoir area, the typical value of crops which can be produced was estimated above at around Shs 26,500/ha/ann. Allowing additional income from livestock, the farmers' time and a transport cost component due to the distance from the main road, then based on a 2 hectare plot, the estimate of effective net income per hectare is Shs 17,600/ha/ann. The NPV of the land based on a 25 year period and a 20% discount rate is Shs 87,078, which can then be adopted as a rough estimate of land value to an owner-occupier subsistence farmer.

In the discharge channel area there is only one wet season, and the land is less fertile, so agricultural production is typically lower than in the reservoir area. In this case the average annual net income is estimated at Shs 9,200/ha/ann, which yields a NPV of Shs 45,518.

ii) **Nominal Market Value**

Land in this area does not change hands very often. Nonetheless, from speaking to property agents and officials in the area, the nominal market value of the land is generally considered to be Shs 12,000 - 15,000 per acre in the discharge channel area, and around Shs 20,000 - 25,000 per acre in the reservoir area. In terms of hectares, this is equivalent to Shs 30,000 - 45,000 per hectare in the discharge channel area, and Shs 50,000 - 75,000 per hectare in the reservoir area.

iii) **Summary**

These results may be summarised as follows:

Location	Economic Value	Nominal Market Value
	(Shs/ha)	(Shs/ha)
Discharge Channel	45,518	30,000 - 45,000
Reservoir	87,078	50,000 - 75,000

These land value figures generally follow the pattern found elsewhere in Kenya, that land values to owner-occupier subsistence farmers are somewhat higher than typical market values. Government "guideline" prices are not shown here, but they are normally below nominal market prices.

5

BIOPHYSICAL IMPACT ASSESSMENT

5.1

Koguta Forest

Some disturbance to the Koguta Forest is inevitable during the construction of the surge tank but with care this impact can be minimised. Material excavated during the construction of the surge tank shaft, adits and headrace tunnel will have to be disposed of and the Koguta Forest seems the most likely location for the dump. Permission for dumping will doubtless be required from the Forestry Department.

Examination of the proposed location of the surge tank on large scale maps coupled with field observation suggest that although the tank is sited within the official boundary of the Koguta Forest few trees will be affected. The tank site area appears to be already badly degraded and most of trees in the site are introduced softwood varieties.

Perhaps less obvious, but more crucial, will be the impact of improved vehicular access to the forest afforded to firewood collectors, loggers and charcoal burners by the access road. The probable extent or magnitude of this encroachment cannot be assessed and it is uncertain how it can best be mitigated other than by closing the road below the forest with a suitable barrier.

5.2

Submerged Vegetation

The decay of submerged vegetation can lead to reduced levels of dissolved oxygen, and the release of plant nutrients into the water. The additional nutrients released into the water can be a blessing, however, since they may stimulate plant and algal growth in the reservoir which sustains some fish species: on the other hand too much nutrient in the water may cause eutrophication and produce undesirable quantities and species of algae or aquatic weeds which may then become a nuisance and detrimental to potable water supply.

In the present context it seems that neither deoxygenation or eutrophication are likely to occur in the reservoir to any great extent because the flow of water through the reservoir will be sufficiently high to ensure that dilution, downstream transportation and reoxygenation will prevent such adverse conditions developing.

Submerged trees which remain standing in the reservoir can interfere with fishing by snagging nets and entangling other fishing gears to the overall detriment of the fishery: in contrast such trees will simultaneously benefit the fishery by providing refuge for the fish and fertilizing the water as described above.

In the long term, if trees are not removed, they will ultimately decay and may become uprooted. They may then pose a hazard to the Project by blocking the intake structure to the headrace tunnel with unpredictable but deleterious consequences.

5.3

Aquatic Weeds

Should free floating aquatic weeds gain access to the upper reaches of the Sondu or the reservoir conditions may or may not prove favourable depending upon the extent of water level fluctuations produced by peak power generation operations. If favourable conditions prevail in the weir, either species might develop nuisance population levels especially in the drier months when river flow is insufficient to carry them over the weir. At this time they would be washed out from the reservoir with the compensation flow. Neither plant is likely to cause significant operational problems by passing through the turbines. The quantities shredded are likely to be quite small, as the reservoir is a small run-of-the-river reservoir, not a storage reservoir.

Overall it seems unlikely that the development of aquatic weeds in the reservoir will pose significant problems to the Project or become serious health hazards by harbouring disease vectors such as snails or mosquitos. The potential impact of aquatic weeds on the Project is therefore assessed as insignificant and no design features are required to mitigate the problem.

5.4

Fisheries

Fish tagging experiments are currently underway at the Sangoro Riverine Laboratory but no recapture data are available at the time of writing. No fishery statistics are available for the Sondu/Miriu river above the Odino Falls so the importance of the fishery cannot be assessed. However, it is considered that the falls effectively blocks fish migration from Lake Victoria to the project site, so no additional impact from the weir is expected.

So far as fishery in the reservoir is concerned, several of the fish species known to inhabit the lower Sondu are known to have adapted successfully to conditions created in the new reservoirs elsewhere in Kenya. These include the important food fishes belonging to the "tilapia" group, and the catfishes (Clariidae). In the Sondu/Miriu reservoir the possibility exists for the fishery to be further enhanced by artificial stocking of the reservoir with fry produced at the Sangoro Riverine Laboratory.

What is uncertain in the present situation at the Sondu weir site is the nature and the effects of the drawdown of water level which will occur in the reservoir. Whether the fluctuating water level will stimulate or retard fish production and assist or hinder fishing methods is unclear. However, since fishing in standing (lake) waters is generally more efficient, easier, and less dangerous, and the fish more plentiful than in river fisheries, the reservoir fishery most likely will provide an important and improved local benefit.

The reservoir fishery will also offer alternative employment for those ferry operators made redundant by the pedestrian and vehicular crossing point afforded at the weir site. Since several of the ferryman are already part-time fishermen on Lake Victoria, they would not need to learn new skills. The number of fishermen that the new fishery will be able to support will, however, be very few, perhaps only two to three at most.

5.5 Water Quality

Changes in water quality attributable to the implementation of the Project will be minimal since this is essentially a water diversion project with no long term storage of water. Retention of water in the reservoir will be too short to allow significant alteration of water. Retention of water in the reservoir will be too short to allow significant alteration of chemical, physical or biological parameters on a permanent basis.

After closure of the weir the only immediate long term impact will be the reduction of the suspended solids load in the river below the weir through sedimentation in the weir, with concomitant decrease in turbidity. Since this silt will be returned to the river below the weir during periods of high water discharge when turbidity is naturally very high the impact is unlikely to be detectable.

Some temporary changes in water quality are to be expected during the immediate post-filling stage of the reservoir development when nutrients are leached from inundated vegetation and soils. The impact of nutrient release is not expected to lead to serious or long lasting adverse effects on water quality. Similarly any deoxygenation resulting from decay of inundated vegetation will be minimized by the fast flow of water through the reservoir.

Water quality may be degraded, however, by secondary consequences of project implementation. For example should human settlement increase in the vicinity of the reservoir chemical and biological contamination of the water is to be expected especially if the reservoir is used for livestock watering and domestic ablutions. Water in the outlet channels from the main powerhouse may be affected in the same way.

Pollution of the water by organic matter including livestock and human wastes is highly probable with associated increase in water-borne disease.

5.6 Evaporation and Seepage

Since the surface area and capacity of the regulation pond are small (0.5 km² and 1.1 million m³), water losses via evaporation and seepage are judged to be negligible comparing to the discharge of the Sondu river.

5.7 Lake Victoria

Even if an active agreement does exist concerning the use of water entering Lake Victoria, the impact of the Project on water quality, volume and timing of water flows will be negligible.

There will be no detectable adverse water quality effects on Lake Victoria or the River Nile.

5.8 Cultural, Mineral and Fish Spawning Sites

Sections of the Act which relate to the Project are given verbatim in the Annex attached to this section. Only the main points of the Act as they affect the project are highlighted below:

- 1) The Act is concerned only with sites and objects of interest which are already known and have a protected status. Enquiries at the National Museum, Department of Archaeology (Dr Kiriama), have not revealed indications that any protected sites are located within the area to be effected by the Project.
- 2) The Act does not contain any section instructing those development projects, which have the potential to disrupt or destroy sites or objects of interest, to conduct ground surveys to establish the presence or absence of such objects or sites as defined in the Act, prior to commencement of the Project.
- 3) The Act does, however, lay down procedures in the event of the discovery of such sites or objects by persons or groups of persons not officially engaged in exploration for such sites and issued with the appropriate exploration licence. These procedures are contained in section 8 (1) of the Act along with penalties for infringement of the Act.

There are no known cultural sites or mineral resources which will be lost by implementation of the project. The relatively short section of the river which will be converted from flowing to standing water is unlikely to contain unique fish spawning sites. The inevitable loss of some spawning sites and reduction in fish production in the river will be compensated by the creation of new sites within the impoundment and the development of a small reservoir fishery.

5.9 Bird and Wildlife Habitats

The new reservoir with shoreline and drawdown floodplain zones will provide new habitats for a wide variety of wildlife and especially birds which will compensate for habitat destroyed by inundation and the conversion of some 5 kilometres of river from running to standing water. Afforestation of the reservoir catchment for soil conservation purposes would provide further habitat for birds and wildlife.

5.10 Construction Impacts

Identifiable impacts are soil erosion during the construction of the weir and its access roads and those originating in the temporary construction camp which may include water and soil pollution from the camp wastewaters outflows. These impacts will be temporary and can be mitigated by conventional preventive measures.

5.11 Reduced Silt Load

The construction of the weir will inevitably influence the silt load carried by the Sondu-Miriu but since most of the silt collected by the desilting basins will be returned to the river below the weir during the periods of high discharge the loss of silt to the system below the weir will be minimal.

A reduction in current velocity and discharge volume due to water abstraction, might lessen the carrying capacity of the river, and more silt may be deposited in the lower Sondu-Miriu before it reaches the delta region. Some slight erosion of the outer perimeter of the delta by wave action from the lake may therefore result. However, these effects are expected to be very minimal.

5.12 Hydrology

Forty (40) cubic metres of water per second will be abstracted at the Sondu/Miriu weir for power generation for a period of eight day-time hours each day. For the remaining 16 hours the river inflow will either refill the reservoir or spill into the River Sondu below the weir.

The abstraction and diversion of this volume of water ($1.1 \times 10^6 \text{ m}^3/\text{day}$) is unlikely to be a major problem for much of the year when the mean monthly discharge of the river greatly exceeds $40 \text{ m}^3/\text{sec}$ or $3.46 \times 10^6/\text{day}$. Only during February and possibly January and March the daily demand for water generation will exceed the daily flow, and at this time draw down from the Sondu reservoir could be used to supply the compensation flow. At this time a flow will be produced in the river below the weir.

The Water Act does not give an explicit guidance to determine the amount of river maintenance flow, indicating that the MOWD is responsible to monitor the appropriate allocation of river maintenance flow, when water diversion schemes are planned.

According to MOWD, the standard criteria to determine the amount of river maintenance flow is based on the following three categories:

- 1) To guarantee the amount of existing water abstraction rights of the downstream reaches,
- 2) In addition to (1), to release water for the domestic use of riparians, the amount of which is equivalent to 95% dependability discharge in the river flow duration curve.
- 3) In addition to (1) and (2), to release 30% of the amount of (2) for aquatic lives.

In case of Sondu/Miriu Hydropower Project, the amount of river maintenance flow becomes $5.43 \text{ m}^3/\text{s}$ for (3).

The greatest effect of abstraction will be experienced when the volume diverted to the powerhouse represents a large portion of, or exceeds the total discharge; at such times the turning on and off of the $40 \text{ m}^3/\text{sec}$ will be noticeable and produce a pulsed flow in the river below the weir and outlet channel of the main powerstation.

A possible adverse impact of reduced dry weather flow lies in the fact that at this time the several river channels through the delta region will contain insufficient water for the velocity to prevent growth of scrub and bush within the channels. If this growth is not cleared before the river rises during the rainy season this vegetation will encourage flooding. This is already happening to a certain extent and blocking of the channels is now blamed for the recent (April 1990) very extensive flooding in the delta. In the past, such clearance was performed manually each year but this practice has now been discontinued.

The volume of compensation water discharged from the weir is expected to be sufficient to adequately provide for all domestic water use demand during all seasons, and provide a surplus to properly dilute and disperse pollutants and to help maintain open river channels through the delta as a flood amelioration mechanism.

Aeration of the water through the spillway or through the compensation water channel (if suitably designed) will be beneficial in maintaining a high level of dissolved oxygen in the river below the weir. This will boost the self-cleansing capacity of the river and its ability to combat the deoxygenating effects of organic pollution which may result for communities and livestock living in the catchment above and below the reservoir.

6 SOCIOECONOMIC IMPACT

6.1 Agricultural and Residential Plots

Socioeconomic impact studies were carried out to identify the extent of the expected impact in the project sections of most concern: the reservoir access road and discharge channel. Similar findings may be assumed to relate to the Work Camp area. In the case of the power station, the issues concerning Thurdibuoro Secondary School are covered in Section .

The definition of a *directly affected plot* is one which will lose some part of its area to the land acquisition shown in the maps of the discharge channel and the reservoir/access road.

Every household which was available and willing to be interviewed was met, either in personal or group meetings.

Those who were not interviewed fell into one of the following categories:

- (i) Those who were not available in the locality;
- (ii) Those who were in the locality but who could not be traced (eg at a funeral);
- (iii) Those who do not dwell on the plot, but own it as an absentee farmer (in some cases the Consultants were nonetheless able to interview a worker);

The number of directly affected plots is as follows:

Discharge channel:	76
Reservoir & Access Road:	115
TOTAL	191 plots

Of the 191 directly affected plots, 100% (191) were covered by physical inspection, noting key features. In total, 214 plot owners or their representatives were interviewed. 153 of these were plots directly intersected by the proposed development. The balance of 61 plots were adjacent, nearby or otherwise indirectly affected, or were in a position to substitute for the owner of a directly affected plot for purposes of the survey.

The population density in the project area is high, at 400-500 people per sq km, and all the land taken up by the project constructions is utilised by farmers. With 193 directly affected plots, and with a typical household size of 9 persons, this means a directly affected population of around 1,700 people.

6.1.1 Land Loss

Not all of the plots are seriously affected in terms of land loss. In the discharge channel area, the breakdown is as follows:

% Loss	<25%	25-49%	50-74%	75-99%	100%	Total
No of Plots	47	11	10	3	5	76

In the reservoir and access road area, the breakdown is as follows:

% Loss	<25%	25-49%	50-74%	75-99%	100%	Total
No of Plots	67	18	6	2	22	115

The total affected plots is then as follows:

% Loss	<25%	25-49%	50-74%	75-99%	100%	Total
No of Plots	114	29	16	5	27	191

6.1.2 Buildings Affected

Land loss is not the only direct impact. Some plots have buildings (houses) which will have to be demolished, either because they are standing partly or wholly within proposed project structures, or they are so close as to make their use impractical:

Reservoir Area: 24 plots, containing 22 permanent, and 22 temporary houses.

Discharge Channel Area: 20 plots, containing 30 permanent and 40 temporary houses.

6.1.3 Bisected Plots

32 plots will be bisected by the discharge channel, of which 18 would have substantial pieces on either side, rendering them very difficult to utilise.

6.1.4 Access Affected

20 of the direct impact plots will also be cut off from direct access to the river for their livestock, for which the proposed bridges will be necessary.

6.1.5 Crops Affected

Since all of the plots are used for agricultural purposes, the entire area is liable to support crops, depending on the rotation system employed, and the time of year. At the time of the survey, some planting was going in the Discharge Channel area. It is not possible to state what specific crops will be in place at a point in the future when the project commences, since there are virtually no permanent crops in the area. This can be assessed at the time of the land acquisition. From the data presently available, the Consultants have assessed typical production levels for a typical mix of crops for the plots concerned. The value of this typical annual crop production is Shs 26,500/ha in the case of the reservoir area, and Shs 16,800/ha in the case of the discharge channel area.

6.2 Other negative impacts

Other expected negative impacts perceived by the local people are:

6.2.1 Loss of earnings for the ferry owners as a result of the proposed bridge over the weir

There are 12 households operating the ferry, which, according to the owners, earns a gross income of Shs 159,000 (US\$ 2,000) per year. Taking into account the value of labour and maintenance costs, it is estimated that each family has an average net income from the business of Shs 552 per month. The NPV of this net income stream over a 25 year period at 25% is Shs 32,778 for each of the concerned families.

6.2.2 Interference with access, by the discharge channel

24% of the respondents in the discharge channel area mentioned this problem. It will, however, be largely resolved by the incorporation of several bridges as part of the discharge channel construction.

6.2.3 Danger posed to children and livestock by the discharge channel, which the residents had been led to believe would be underground.

50% of the respondents in the discharge channel area mentioned this problem, which arises because there is private land on both sides of the discharge channel. The only solution would appear to be to fence the sides, to align it as close to the forest as possible, and to warn the residents of surges in volume.

Another safety issue, not mentioned by the residents, is that although fishing in the reservoir should be safer than traditional river fishing, and also more efficient and productive, a potential danger exists of boats and fishermen being swept over the weir during periods of high discharge.

The anticipated fluctuation in water level in the Sondu intake reservoir caused by the daily variation in discharges will also produce some minor negative impact on public safety.

Between the weir and the discharge into the river, the water level in the river will fall as power generation commences and rise again when it ceases at about 8.00 pm. Thus in this section the danger as the weir rises occurs at a time when few people will be at risk along the river and the hazard is therefore less.

A similar slight hazard exists in the section of the river, in the delta region below the out-fall of the additional power station. This is because the fluctuation of the river flow will begin in these sections in mid-afternoon (about 3.00 pm) when the local residents will be making use of the river and they may be caught in the river when the surge comes. This fluctuation of the river flow will continue until the evening (about 10.00 pm).

6.2.4 The division of land into two parcels

30% of respondents in the discharge channel area mentioned this problem. The extent to which it renders the plots impractical to farm will depend on the number and positioning of the bridges. However, even with bridges provided, the bisection will still be a problem for most of the plot owners, particularly as almost all of the plots in the discharge channel area are residential.

6.2.5 Health Issues: Water-borne Diseases

Several of the respondents in the reservoir area expressed concern about malaria. This topic came up in group meetings, where it was not appropriate to have a "show of hands", so no percentage figure can be attached to the response. The provision of standing water to which people and their livestock have access does generally increase the incidence of water-borne infective diseases and also water related insect vector diseases. However, the probability is that because of the fluctuating water level which will be produced by the intermittent abstraction of water for power generation combined with the short residence time of water in the reservoir, conditions in the reservoir will not be particularly conducive to the establishment of water-based or water-related vector species. Any increase in the exposure to health hazards due to the Project is assessed as of minor significance and no design inputs are required to mitigate such problems.

Changes in water level are, in fact, recognised and recommended as a semi-effective management technique for the control of the snail vectors involved in the transmission of bilharzia. It is less clear what effect changing water level would have on other vectors especially mosquito larvae. As noted above the very swift passage of water through the reservoir (about a 6 hour renewal time) will mitigate potential disease problems by flushing out pathogens and vectors.

Some water will flow permanently through the weir in all but the driest periods of the year and this could create suitable habitat for the larvae of the fly Simulium which is the insect vector for the eye disease onchocerciasis. This disease is not however, widely spread nor common in Kenya and is therefore, not regarded as a serious problem although Simulium is known to occur in the Upper Sondu Miriu River. In the outpatient morbidity statistics for Kisumu, Kisii and South Nyanza Districts onchocerciasis is not listed but since total of many different eye diseases in general varies in incidence from 2 to 2.9% the portion of the total caused by onchocerciasis is by inference judged to be extremely low.

In relation to the Sondu/Miriu Project the adverse impact of the Project on promoting river-blindness is considered to be very low and no engineering design is required to mitigate this potential.

6.2.6 Possible Denial of Access to the Reservoir

This concern was raised by people in the reservoir area, who regularly draw water or take livestock to the river banks. It is understood that access will not be prohibited.

6.2.7 Impact of Immigrant Workers

Some residents in the reservoir area expressed concern about possible importation of disease, crime and unacceptable cultural habits into the area. It is also likely that these will be significant permanent increase in population, for which social services, such as medical, need to be provided.

6.2.8 Sand Mining Business

No residents mentioned this issue. As far as can be established, very little sand mining takes place in Sondu/Miriu river because the sediments deposited in the lower reaches contain high proportions of fine silt and mud which makes it unsuitable for construction work. Also, the Sondu/Miriu is usually too deep and fast flowing even in the dry season for the sand to be extracted either safely or economically.

Sand mining is thus generally confined to the smaller temporary stream channel to the north of the Sondu where better quality, mud free and drier sand be mined. Although limited sand mining is carried out in the vicinity of Nyakwere Bridge the scale of the operations is so small that impacts of the project are assessed as negligible.

6.2.9 Quarries, Borrow Pits and Waste Dumps

No residents mentioned in this issue. Quarries, borrow pits and waste dumps are potentially hazardous sites from a public health and safety point of view. Quarries and borrow pits should be left in a safe condition to avoid physical injury and also provided with adequate drainage to prevent the formation of stagnant pools which can become foci for water-related diseases.

Of particular concern will be the evacuation of around 130,000m³ of bedrock from the headrace tunnel.

6.2.10 Thurdibuoro Secondary School

The construction of the powerhouse and its associated structures, including the tailrace, the irrigation canal junction and the outdoor switchyard will require the acquisition of approximately 2.5 hectares of land. The site selected partially covers the area presently occupied by the Thurdibuoro Secondary School. The powerhouse residential compound will require another 8 hectares located to the northeast of the powerhouse site.

Although the site for the main powerhouse does not directly affect the existing school buildings these buildings will become unusable because of their very close proximity to the powerhouse and because the school would be deprived of its playing fields. The secondary school will therefore have to be abandoned and re-built elsewhere. As a consequence of relocation, existing school staff housing will become redundant and also require replacement. It is understood that this matter has already been addressed by KPC, and is not examined further here.

This school which is variously called Thurdibuoro or Bogoa school is a secondary mixed day school for 200 - 250 pupils; It was founded by the former local Member of Parliament, Mr Odiek Miguda, who is now Chairman of the Board of Governors. The school is a government school with substantial local harambee support.

Much of the present school is of very recent construction: a government sponsored laboratory is in the final stages construction and is already in use and a new four classroom harambee block was commissioned at the beginning of 1990. The rest of the school although older is well maintained and in good repair; quantities of books and laboratory apparatus were in evidence. This is not a run-down ramshackle upcountry school but a quality school in which the local community have invested heavily and for which they feel considerable, and justifiable pride.

In addition to the main school buildings the site also contains housing for the head deputy headmaster and two or three other buildings. One of these is a self-catering dormitory block for any students who wish to board.

According to local sources, there may be resentment and possible resistance to the suggestion that the school should be relocated elsewhere, even in a better site school is provided to replace the existing buildings.

Clanism in this area is strong and since this is a Koguta clan school it should remain in the clan territory and even within the right sub-clan location: it could not easily go to Sangoro, for example, even though it is also Koguta land because this would place the school in another sub-clans territory.

It is believed that the local clan will lose considerable "face" or prestige if the school is summarily demolished and moved elsewhere and for this reason alone they may resent any efforts to relocate the school. It should also be realised that although this is actually a government school the local clan are said to regard it as their own since they have contributed so much to its recent progress, development and success.

However, in the Chiefs opinion the local support and eagerness for the Project was such that they would accept the removal of the school, should this prove necessary and unavoidable, especially if it were not moved too far. He also affirmed that because the school is a government school the Board of Governors would, in any case, abide by any government decision regarding its future.

6.2.11 AIDS

As mentioned in Section 4.5.6 the project is within a high HIV prevalence area. The impact of immigrant labour could be to spread the virus further afield rather than to bring it into the area, by unsafe sexual practices. There is no policy in Kenya of mandatory HIV testing, and since contract employees come under the jurisdiction of the contractor, and not KPC, it will not be possible to institute mandatory testing. In any case, the contractor would not have AIDS counselling facilities available.

6.3 Positive impacts

The positive impacts are expected to be:

6.3.1 The jobs created by the construction of the project

The labour cost of the project construction was estimated to be US\$ 10 million, equivalent to Shs 265 million in March 1991, which was calculated by taking a percentage of construction costs, translated into local currency @ Shs30=US\$ 1.00

The rate is now Shs80=US\$1.00. The assumption is that the number of labourers will remain unchanged. This would suggest an increase of 167% in the Kenya shilling rates, which is considered to be unrealistically high. An increase of 100% over the former (1991) rates is provided for, to apply to the four year construction period without further inflation.

883 skilled labour @ Shs 400/day, or Shs 120,000/ann, totalling Shs 106 million

402 unskilled labour @ Shs 220/day, or Shs 66,000/ann, totalling Shs 26 million

(The rates include social costs)

It is expected that the unskilled labour will come largely or wholly from the project area, and the skilled labourers will be migrants from other areas. Thus the impact on the project area in terms of employment opportunity will be 402 unskilled jobs for an average duration of four years. It is estimated that there are around 325 regular wage earners in the project area. This means that for four years, the job opportunities for local people will be doubled by the introduction of the Sondu-Miriu project.

6.3.2 The boost to the local economy

With around 6,500 plot/households in the project area, earning on average around Shs 60,000 per annum per family, (cash earnings and value of agricultural production combined), the gross earnings in the project area are of the order of Shs 390 million per annum, of which Shs 109 million, or 28%, is estimated to be cash earnings. The additional locally spent earnings by the immigrant labour force combined with the total earnings of the local component of the labour force will total Shs 58 million/annum, represent a 15% increase in the local economy.

Locally spent money is expected to total to Shs 48 million in a cash economy of Shs 109 million, an increase of 44%. Thus the multiplier effect for local trading and small business sector will be very high.

6.3.3 The improvement to the road network

The road improvement will have the greatest impact on the residents of the reservoir area, who presently have difficulty in marketing their produce, which is a disincentive to grow cash crops. It is estimated that there could be a marked increase in productivity of the reservoir plots as a result of road improvements; judging from their inspection of the plots and the discussions with the plot owners, the increase could be of the order of 50 to 100%. This food would be sold largely to the contract workers during the construction period, so is included in the figures above. A permanent increase in productivity would depend on the standard of maintenance of the improved road after completion of the project.

6.4 Residents' attitudes and responses

6.4.1 General

The attitude of the residents towards the project is very positive, as evidenced by the high turn-out at the public meetings convened by the Consultants, the responses given during the interviews and the degree of cooperation by local administration officials. The residents were very keen to be involved in project implementation and in discussion of mitigating measures and compensation issues. In general, the residents see the project as a long-awaited boost to the development of the area, and have high expectations of the ultimate impact particularly in providing job opportunities and irrigation, which they had been led to believe would be a key component of the project.

The Consultants had to explain that the first phase of the project, as presently designed, would not include an irrigation component. Nonetheless, the residents were still generally positive in their attitude, although disappointed that the expected benefit of irrigation would not be immediately available.

Throughout the survey, it was found that the local residents expected to be able to abstract water from the discharge channel.

6.4.2 Relocation

The residents in the reservoir area are united in a common view, that relocation is acceptable, if absolutely necessary, on two conditions:

- That compensation is adequate to actually buy alternative land;
- That the relocation will be to a site within the general locality of the project area.

95% of the respondents agreed with this viewpoint. 6% stated that relocation would be unconditionally unacceptable, and requested realignment of the project development in the event that their plot is seriously jeopardised.

However, in the discharge channel area, only 40% of the respondents agreed with this view point; 32% stated that they were not opposed to relocation in principle, but that they doubted whether land would be available. The remaining 28% were against relocation, and appealed for realignment of the channel, or exemption on the grounds that the owner was widowed, etc.

6.4.3 Land Acquisition

Residents' attitude to the question of land acquisition (ie where the majority of the plot is unaffected) is that it is quite acceptable, provided the compensation is adequate. (99% for the Reservoir area; 80% for the Discharge Channel area.)

6.4.4 Mode of Compensation

The discussion with the residents dwelt at some length on the mode of compensation preferred. The majority would prefer cash compensation for land lost, the compensation to take into account the following:

6.3.4 The bridge over the weir

This would be a permanent improvement for residents south of the reservoir as it would reduce their transport costs of taking their produce to market - ie. they would not have to pay for the ferry. This would mean that they would have a slightly higher gross margin on their produce, thereby increasing their effective income. The impact on the total project economy is, however, too small to be significant.

Positive impacts perceived by the residents but which may not necessarily be realistic were:

6.3.5 Use of dam water for irrigation (53% for Reservoir area; 64% for D.Channel area)

6.3.6 Fish farming (18% for Reservoir area; 10% for D.Channel area)

6.3.7 Introduction of a potable water scheme (17% for Reservoir area; 54% for D.Channel area)

This benefit would arise only if it is specifically provided.

6.3.8 Introduction of electricity to project area (negligible for Reservoir area; 12% for D.Channel area)

In fact there will be no provision of electricity for the local residents, within the project.

6.3.9 Improved Facilities

The introduction of the large labour camp will require new facilities such as a clinic, which is likely to remain after construction has been completed.

7

SUMMARY OF IMPACTS

(Very minimal impacts are omitted).

Negative Impacts

- High: Loss of agricultural and residential land and homesteads
- Medium: . Encroachment of Koguta Forest
- . Water and soil pollution during construction
- . Loss of earnings of ferry business
- . Social and health impact of Immigrant workers
- . Abandonment of Thurdibuoro Secondary School.
- Low: . Submerged vegetation
- . Dumping of waste material
- . Aquatic Weeds
- . Decline in water quality
- . Public safety

Positive Impacts

- High: . Job creation during construction
- . Boost to local economy during construction
- . Improved road network
- Medium: . Road access across the weir
- . Possible improved rural water supply
- . Permanent enhancement of local economy
- . Project health and other facilities
- Low: . Fisheries in the reservoir
- . Enhancement of bird habitats
- . Possible limited irrigation from reservoir

- (I) Land fertility
- (II) Scarcity of alternative land
- (III) Developments on the land
- (IV) The resultant social disruption

The percentages giving this response were as follows:

Reservoir area:	94%
Discharge channel:	72%

It will be noted that in the case of the discharge channel area, this response was not unanimous. In fact 22% of the respondents requested "land for land".

Only 6% of the reservoir area residents and only 2% of the discharge channel area residents suggested development assistance as a component of the compensation package.

Recommendation (A):

The discharge channel should be realigned to pass along the common boundary of the plots in the area, as far as possible, to minimise the number of bisected plots. There should then be a land redistribution exercise carried out jointly with the residents and the local authorities to rearrange the plots so that adjacent bisected half-plots can be recombined to provide a whole plot on one side of the channel.

Recommendation (B):

The project contains several spoil banks, which are responsible for the loss of several plots or part-plots. The possibility should be investigated of reducing this impact by dispensing with spoil banks as far as possible. This will involve ascertaining with the local residents an appropriate and economic location to deposit the material.

Recommendation (C):

Remaining parts of plots owned by relocated households can be resold to households which have lost pieces for which they have accepted cash compensation.

The loss of a house is not regarded in itself as a qualification for relocation. The loss of income-earning agricultural land is the critical issue, not the loss of a house, which can be relatively easily replaced.

8.3**Compensation**

The term "compensation" is used here to mean payment of cash to plot owners who will lose less than 50% of their plot.

Recommendation (D):

In cases where less than half the plot is lost, cash compensation should be made available, at not less than the suggested economic value of land, and not less than the market price prevailing at the time of project construction.

111 plots will lose up to 25% of their area; 36 will lose 25-49%. The majority of the first category plot owners will be happy to receive cash compensation, and stay where they are. However, those of the remaining 36 plot owners who will lose more of their plot and who are in the discharge channel area are worried about the availability of land, because plots in this particular area seldom come onto the market, and because of the lower quality of the land, the loss of even part of the plot is serious for the owner. In practice it may be possible to get the owners to accept cash as compensation, but without a viable piece of land, the money may soon be spent, and the family become destitute. Adoption of Recommendation (B) regarding spoil banks and Recommendation (C) regarding sale of remaining pieces to owners seeking replacement of small pieces of land will go some way to addressing this category, but there will be some for whom relocation will be a better option.

8. MITIGATING MEASURES

8.1 Local Attitudes

The information gathered by the Consultants was collected in meetings conducted in line with the referenced World Bank Operating Directives, in which the residents were encouraged to express their views and concerns regarding the planned projects. The overall reaction is definitely positive. They want the project, as soon as possible. There are, however, some issues to be borne in mind in planning the land acquisition programme:

- In line with the World Bank Operating Directives, and consistent with good environmental management:
 - Involuntary settlement must be minimised;
 - Displaced people must be able to at least restore their former living standard;
- The residents are, in general, determined to stay in the area, in expectation of the benefits which the project is expected to bring, and particularly the next phase, which is expected to incorporate an irrigation component.
- The amount of land in the area likely to be available on the open market will be quite limited, especially if the local people anticipate an increase in value of their plots as a result of the project.
- There are a number of anticipated negative impacts which will need to be addressed.

8.2 Relocation

191 plots will lose some land to the reservoir, access road and discharge channel.

From the discussions with the plot owners, it became clear that plots losing 50% or more of the land would be regarded as totally lost, and the owners would expect to be able to be provided with a replacement plot, or the money to acquire one. In other words, a "land for land" arrangement would be expected. It may at first appear that for the very small plots, even a small loss might render it uneconomic. However, the very small plots, which are found in the reservoir area, are in any case too small for household subsistence purposes, ie the owners usually are not living on the plot. 46 of the households will lose 50% or more of their plot, and are therefore to be regarded as potential relocation cases. Of these, 27 will be totally inundated or acquired. In addition, 18 plots will be bisected by the discharge channel. There is scope for a few plots to be bought privately in the reservoir area from households living elsewhere. However, the free market in the project area is unlikely to provide plots to meet the needs of more than 60 households all at the same time, particularly if the other project sections all create a similar number of displaced households. It is therefore recommended that the problem be reduced by the following measures:

8.6 Domestic Water Supply

Recommendation (G):

In view of the expectations of the residents in terms of an irrigation component, and in view of the problems which will inevitably arise from people entering the discharge channel to abstract water, a community water scheme for drinking water, livestock and possibly kitchen gardens should be established for the area between the forest and the main road. The Ministry of Water Development or an NGO should be approached to design a simple gravity scheme which can be managed by the community organisation mentioned above.

8.7 Ferry Operations Compensation

Recommendation (H):

If there is to be a bridge over the weir, the ferry operators should each be compensated with a sum of money equal to the NPV of their expected earnings, to enable them to set up an alternative small business.

8.8 Safety

Recommendation (I):

Special attention should be paid to the adequacy of the proposed fencing of the sides of the discharge channel, and to the issuing of warnings about fluctuating water levels.

8.9 Institutional Arrangements

Recommendation (J):

With the assistance of the NGO, the community organisation should be approached to discuss and agree with the community the following:

- *A code of conduct for residents regarding access, abstraction and fouling of the reservoir;*
- *A code of conduct regarding management of the labour camp, including fencing.*
- *The positioning of the bridges over the Discharge Channel*
- *Advice to the community on minimising the risk of exposure to malaria;*
- *Advice to the community regarding the present and future possibilities of*
- *Use of the Work Camp Clinic*

There will be some marginal cases where the loss of even 20-25% of the plot will make the household's agricultural production insufficient for subsistence purposes. A few of the discharge channel households are likely to fall into this category. Such cases may have to be categorised as relocation cases, but in most instances the attraction of the project area for the four years of construction will encourage the owners to request cash compensation, and stay where they are, possibly starting a small business or buying a piece of land outside the project area with the money received.

The loss of a building comes into this "compensation" category. In all, there are 114 houses directly affected for which compensation will be required, on 44 plots. Implementation of the recommendations on spoil banks will reduce this number significantly.

8.4 Availability of Land

It is expected that by adopting the recommendations above, the number of households for which new plots will need to be found will fall from around 50 to around 30. However, given that an additional number will be associated with other project sections such as the penstock etc, this requirement may be too great to be met by the open market. During the survey, the Consultants did not come across additional land within the project area available for acquisition as subsistence plots. The following recommendation is therefore made:

Recommendation (E):

The Ministry of Lands and the District Development Committee should be approached to study the possibility of making available new land adjacent to or near the project area to accommodate relocated families.

8.5 Institutional Arrangements

The Consultants noted that there is little track record of community development activities in the area, a high degree of clan loyalty and some degree of mistrust of local administration officials. Based on this, and on requests made during the meetings with householders, and in view of the recommendation below regarding a water scheme, the following recommendation is made:

Recommendation (F):

For purposes of arranging and negotiating compensation, land redistribution and other mitigating measures such as the positioning of bridges etc, an NGO should be approached to assist the community to set up a community organisation, and to assist the community in planning and liaising with KPC. Since there are no NGO's operating in the area, a national NGO such as Action Aid is recommended. The Consultants consider that the establishment of satisfactory institutional arrangements is the single most important factor in resolving any potential negative impacts.

8.15 Health*Recommendation (P):*

During the construction stage the greatest impact is likely to occur in the workers construction camp where large numbers of people will be crowded together. Here preventative prophylactic treatment should be provided in conjunction with spraying of hostels with persistent insecticides. Immigrant workers should also be provided with mosquito nets.

All immigrants to the area who work on the prophylactic drugs to protect them from malaria which is holoendemic (very severe) in the Sondu area. In addition, since the Anopheles mosquito which transmits malaria in the project area bites mainly at the night the provision and use of mosquito nets at night would help to significantly reduce the spread of this disease among those who have no natural immunity.

The base camp manager should also ensure that suitable breeding sites for mosquitoes in the base camp and its immediate surroundings are eliminated.

It is considered essential that these camps are provided with adequate sanitation and water supplies to prevent the outbreaks of communicable diseases among the construction workers. These facilities need to provide not only for the officials camp residents but also for the camp followers.

Post-construction impacts on health in the project area are likely to be minimal but any water retaining features such as borrow pits, quarries, blocked drains or culverts should be drained or filled in to reduce all small unnecessary water bodies to a minimum.

As mentioned in 6.2.11, contract employees come under the jurisdiction of the contractor, not KPC, and do not fall within any legal instruments for mandatory testing for HIV. Given the policies set out in the National Aids Control Programme of Kenya, and mainly discussed AIDS in the context of the Sondu/Miriu project with officials at the National Aids Control Programme, consultants consider that an AIDS education and information programme will be most appropriate.

Recommendation (Q):

It is recommended that an AIDS education and information programme for the project construction period be established by joint agreement between the National AIDS Control Programme (NACP), the District Intersectoral AIDS Committee (DIAC) for Kisumu District, the NGO assisting with community issues and the work camp management. Advice and material can be made available by the NACP under the second 5-year medium term plan for AIDS control, 1992 - 1996.

- Irrigation
- Fish farming
- Electrification

It is considered that by providing the planned bridges, the inconvenience of the discharge channel in interfering with access to the lake will be more than compensated for by the benefits of the road improvements and the multiplier effect of the introduction of 400 jobs into the area.

8.10 Koguta Forest

Recommendation (K):

The surge tank access road will allow easier access to the forest for wood cutters and collectors with possible adverse effects as well as being a direct impact in its own right. By following existing paths and tracks this impact can be minimised. The area of the forest affected by the surge tank is already in poor condition and some efforts to reforest the area would be beneficial. To reduce these effects a barrier across the road to prevent vehicular access is recommended.

8.11 Submerged Vegetation

Recommendation (L):

Vegetation which would decay underwater should be removed, and salvaged where possible for timber for resale or firewood.

8.12 Dumping of Waste Material

Recommendation (M):

Waste materials should be disposed of in an environmentally and socially acceptable manner with due regard for safety and aesthetics. Any dumping in the Koguta Forest will require Forestry Department approval.

8.13 Aquatic Weeds

Recommendation (N):

Should free-floating aquatic weeds be found in the reservoir the individual plants should be destroyed before they have time to establish the substantial populations. Mechanical or manual removal of *Pistia* would be possible while chemical means might have to be employed for *Azolla*.

8.14 Rehabilitation

Recommendation (O):

After construction, and spreading of overburden, etc those areas of forest which have been damaged should be rehabilitated and replanted.

APPENDIX I

WATER QUALITY DATA

MONITORING

The expected impacts of the Sondu-Miri project are not such as to require an extensive monitoring programme. The principal areas to be covered are:

i) Social

Monitoring of the outcome of relocation cases, for a period not exceeding five years, consisting of annual checks, leading to corrective action if necessary. The most important check will be the first in liaison with the NGO concerned, to give assistance if necessary in the purchase of alternative land if this has been a problem.

ii) Biophysical

Water quality samples at the reservoir and the outfall of the discharge channel, and liaison with the local fisheries research station on fish spawning and migration through the small discharge channels, and changes in migration pattern upstream of the weir.

APPENDIX II**GENERATION PLAN**

WATER QUALITY DATA FOR THE SONDU/MIRIU RIVER: 1984-90.

		Year		1984			1985			1987	1990	1987	1990	1987	1990
		Date	Time	15/11	27/11	27/03	24/06	30/08	26/03	09/04	26/03	12/04	24/03	11/04	
				—	1330	1051	0821	1612	1315	1135	1150	0935	1632	1145	
Parameter	Units	Sondur Bridge		Sondur Bridge			Sondur Bridge			Nyakwere Br		Chemosit Br.			
Temperature	°C	—	18.0	21.0	18.0	18.6	23.7	20.5	23.9	20.5	22.3	17.5			
Conductivity	uS/cm	46	55	65	35	64	—	—	—	—	—	—	—	—	—
pH	—	7.1	7.3	7.5	7.4	7.2	7.0	7.5	7.0	7.3	6.6	6.7			
Dissolved oxygen	mg/l	—	—	5.7	—	7.9	7.5	10.5	7.1	10.8	6.5	10.2			
Turbidity	NTU	69.0	24.0	51.0	21.0	(3.5)	51.0	160.0	65.0	460.0	37.0	440.0			
Alkalinity	mg/l CaCO ₃	22.0	25.0	28.0	18.0	72.0	48.0	34.0	70.0	67.0	14.0	92.0			
Hardness	mg/l CaCO ₃	(114.0)	3.6	—	8.8	14.7	16.4	72.0	18.4	(358.0)	7.9	(230.0)			
Chloride	mg/l	<0.8	3.6	—	1.5	—	0.1	0.7	(6.8)	0.2	0.4	2.2			
Fluoride	mg/l	—	—	—	0.83	—	0.45	—	0.42	ND	0.50	nc			
Iron	mg/l	—	—	—	—	—	0.01	0.01	0.50	0.07	0.60	0.03			
Manganese	mg/l	—	—	—	0.03	—	0.10	0.03	0.40	0.10	0.30	0.02			
Ammonia-N	mg/l	0.70	—	—	0.24	—	0.18	—	0.15	—	0.02	—			
Nitrate-N	mg/l	1.5	ND	—	0.6	—	0.7	0.3	ND	0.4	0.2	0.8			
Phosphate	mg/l	—	0.70	—	—	—	0.33	0.60	0.25	0.60	0.80	0.90			

Sampling locations: Sondur Bridge = River Sondur at the bridge in Sondur township
 Nyakwere Bridge = River Sondur at the bridge in Nyakwere township
 Chemosit Bridge = River Yurith at the bridge in Chemosit on the Kericho-Kisii road

ND = not detectables, — = not monitored, () = suspect readings.

Source: LBDA laboratory, Kisumu.

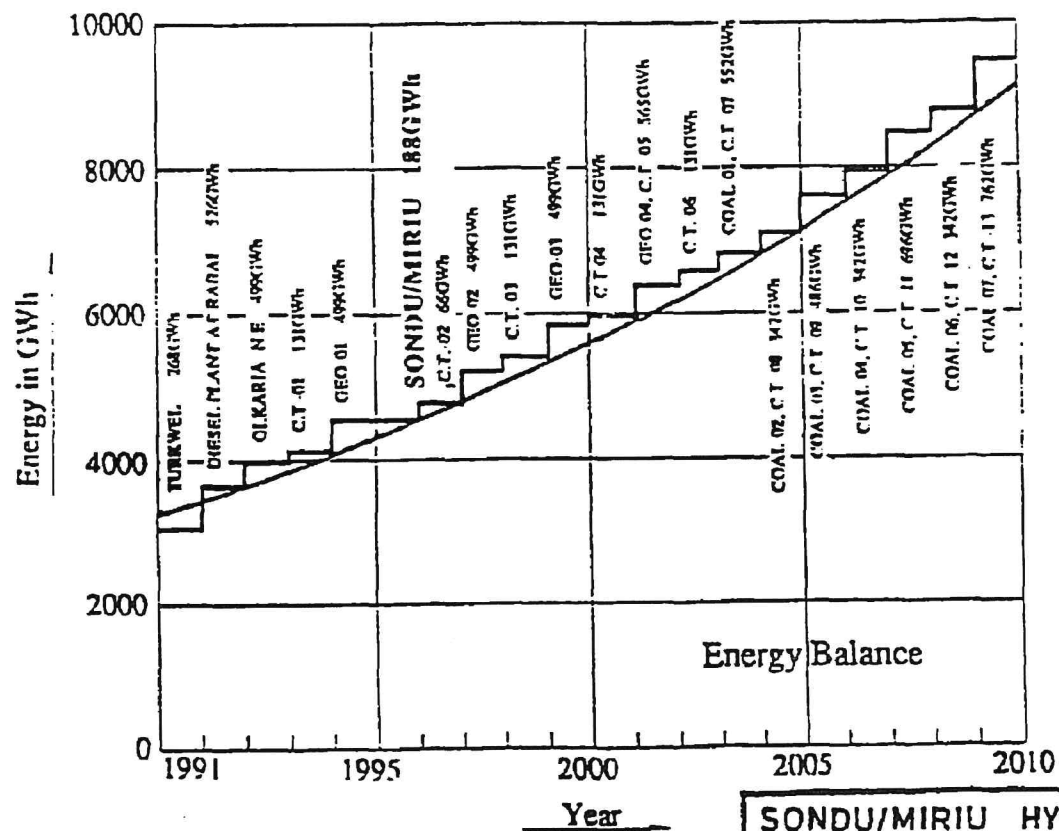
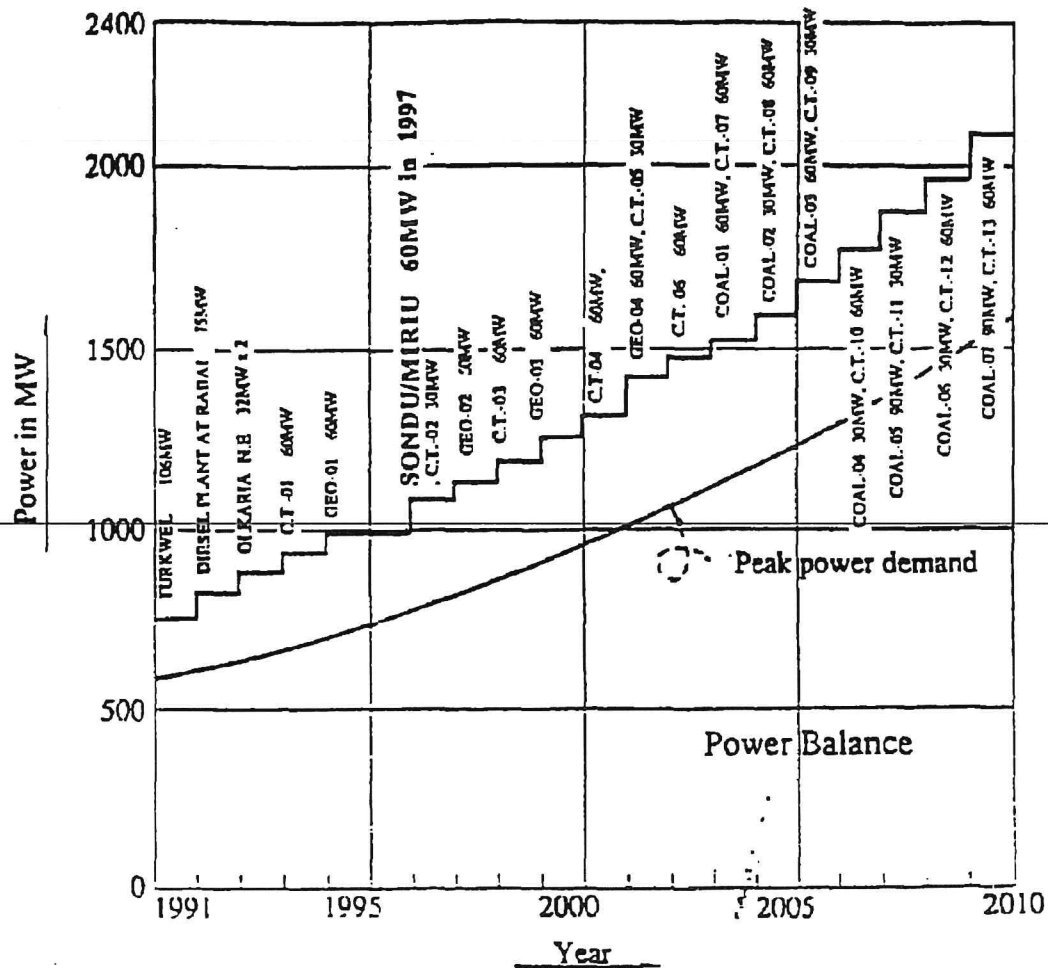
WATER QUALITY DATA FOR THE SONDU/MIRIU RIVER: 1983.

SAMPLE STATION	pH	EC	Turb	Pt	Alk	Hard	Cl-	F-	Ca	Mg	Na	K	NO ₃	SO ₄	PO ₄	BOD
Sondur Market	7.3	77	27	26	31	12	8.2	ND	12	0.4	13.6	8.7	ND	0.3	ND	130
Molongo Road	7.4	88	42	32	26	8	6.0	ND	5.8	ND	8.2	3.8	ND	0.1	ND	50

ND = not detectable, Source: Turbo-Oeri, A. (1983).

OPTIMAL PLANTING-UP SEQUENCE FOR 1990/2010

Plant	Type	Capacity (MW)	Installation Year	Notes
TURKWEL	Hydropower	106	1991	Scheduled in January 1991
DIESEL PLANT AT RABAI	Combustion Turbine	75	1992	Committed
OLKARIA N.E	Geothermal	32	1993	
OLKARIA N.E	Geothermal	32	1993	
C.T.-01	Combustion Turbine	60	1994	
NAIROBI SOUTH		-12	1994	Retire
GEO-01	Geothermal	60	1995	
SONDU/MIRIU	Hydropower	60	1997	
C.T.-02	Combustion Turbine	30	1997	
GEO-02	Geothermal	60	1998	
C.T.-03	Combustion Turbine	60	1999	
GEO-03	Geothermal	60	2000	
C.T.-04	Combustion Turbine	60	2001	
GEO-04	Geothermal	60	2002	
C.T.-05	Combustion Turbine	30	2002	
C.T. 06	Combustion Turbine	60	2003	
COAL-01	Coal Fired	60	2004	
C.T.-07	Combustion Turbine	60	2004	
KIPEVU S.4 & 5		-20	2004	Retire
KIPEVU S. 6		-25	2004	Retire
KIPEVU S. 7		-25	2004	Retire
COAL-02	Coal Fired	30	2005	
C.T.-08	Combustion Turbine	60	2005	
COAL-03	Coal Fired	60	2006	
C.T. -09	Combustion Turbine	30	2006	
COAL-04	Coal Fired	30	2007	
C.T. -10	Combustion Turbine	60	2007	
COAL-05	Coal Fired	90	2008	
C.T. -11	Combustion Turbine	30	2008	
SMALL HYDRO		-28	2008	Retire
COAL-06	Coal Fired	30	2009	
C.T.-12	Combustion Turbine	60	2009	
COAL-07	Coal Fired	90	2010	
C.T. 13	Combustion Turbine	60	2010	
KIPEVU G.T.		-30	2010	Retire



SONDU/MIRIU HYDROPOWER PROJECT
Power and Energy Balance
in Least Cost Sequence