JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

FINAL REPORT

SUPPORTING REPORT [N]

DAM GEOLOGY

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THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

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CHAPTER 1 INTRODUCTION

The purpose of the dam geological study is to obtain geological information on potential damsites that were proposed in the preliminary study and to provide the basic data for the Dam development plan study.

Objective damsites for study were selected by the Study Team's Dam Planners using the following criteria:

1) High potential damsites evaluated "AA" in the preliminary study.
2) Alternative damsites selected among "A" in the preliminary study.
3) Newly proposed damsites for Hydroelectric power development plan

The geological study consisted collection of existing information, interpretation of aerial photographs and field reconnaissance.

Damsites taken up in the geological study include the following 21 sites and 7 sub-sites. The dam list are shown in Table 1-1.

1) Lusaka province	;	4 sites (AA) and 1 sub-site (A)
2) Central province	;	3 sites (AA) and 1 sub-site (A)
3) Copperbelt province	;	3 sites (AA) and 1 sub-site (A)
4) North-western province	;	4 sites (AA) and 2 sub-sites (A)
5) Luapula province	;	1 site (AA) and 1 sub-site
6) Northern province	;	1 site (AA) and 1 sub-site
7) Eastern province	;	4 sites (AA)
8) Southern province	;	2 sub-sites (A)

The geological survey was carried out from June 10th to August 2nd 1994. Location of these 28 damsites is shown in Figure 1-1 and in Figures 1-2 through 1-29.

Table 1-1 Coordinates and Reference maps of Geological Survey Points

Dam No.	Name of River	Coordinates X(1000m)	Y(1000m)	Reference maps 1:250,000	1:50,000	Aerial photographs			
1	Lufubu	729	8813	SC-35-12	1029C1				
2	West Lunga	221	8701	SC-35-13	1124C2				
3	Lukupa	278	8879	SC-36-9	1030B2				
4	Kapemba	521	8760	SD-36-15	1133A1	ZA	82/9	Chama	R7-199/201
5-1	Solwezi	434	8655	SD-35-2	1226A2	ZA	91/11G	Solwezi	R1-5/6
5-2	Kifubwa	440	8655	SD-35-2	1226A2				
6	Kafue	626	8606	SD-35-3	1228C1	ZA	93/5	Mufulira	R4-51/52
7	Mutundu	636	8598	SD-35-3	1228C2	ZA	93/5	Mufurila	R6-81/83
8	Lubi	188	8495	SD-35-5	1324C1				
9-1	Lufupa (Downstream)	375	8510	SD-35-5	1325B4				
9-2	Lufupa (Upstream)	374	8519	SD-35-5	1325B4				
10-1	Baluba	647	8560	SD-35-5	1325B4	ZA	84/2	Luanshya	R34-1944/1946
10-2	Kafubu	661	8538	SD-35-7	1328A2				
11	Lunsemfwa	746	8490	SD-35-8	1329C2	ZA	93/8	Mukushi	R9-1019/1021
12	Mwomboshi	659	8361	SD-35-11	1428C4	ZA	88/8	Central Prov.	R12-13/14
13	Kopyonga	556	8326	SD-35-15	1527B1				
14-1	Muchito (Upstream)	633	8263	SD-35-16	1528C1	ZA	19/1	Southern Prov.	R53-53/54
14-2	Muchito (Downstream)	634	8254	SD-35-16	1528C1	ZA	19/1	Southern Prov.	R51-58/60
15	Kanakantapa	672	8321	SD-35-16	1528B1	ZA	19/1	Southern Prov.	R64A-14/15
16	Chongwe	682	8306	SD-35-16	1528B3	ZA	19/1	Southern Prov.	R61A-8/9
17	Mwapula	712	8320	SD-35-16	1528B2	ZA	19/1	Southern Prov.	R64A-29/30
18	Lundazi	505	8665	SD-36-3	1233A1				
19	Lukusashi	202	8514	SD-36-5	1330A3	ZA	8/18	Serenje	R10-305/306
20	Lutembwe	432	8501	SD-36-6	1332C2				
21	Katete	399	8449	SD-36-10	1432A1	ZA	2/73	Block C	R214-485/486
24	Luongo	698	8815	SC-35-12	1028D2				
25	Lwombe	171	8883	SC-36-9	1030B2				
26	Bengwa	513	8178	SE-35-3	1627A3	ZA	80/3	Kafue/Liv.	R17-1712/1713
27	Kalomo	439	8103	SE-35-6	1726A2	ZA	91/1	Southern Prov.	R21-37/39

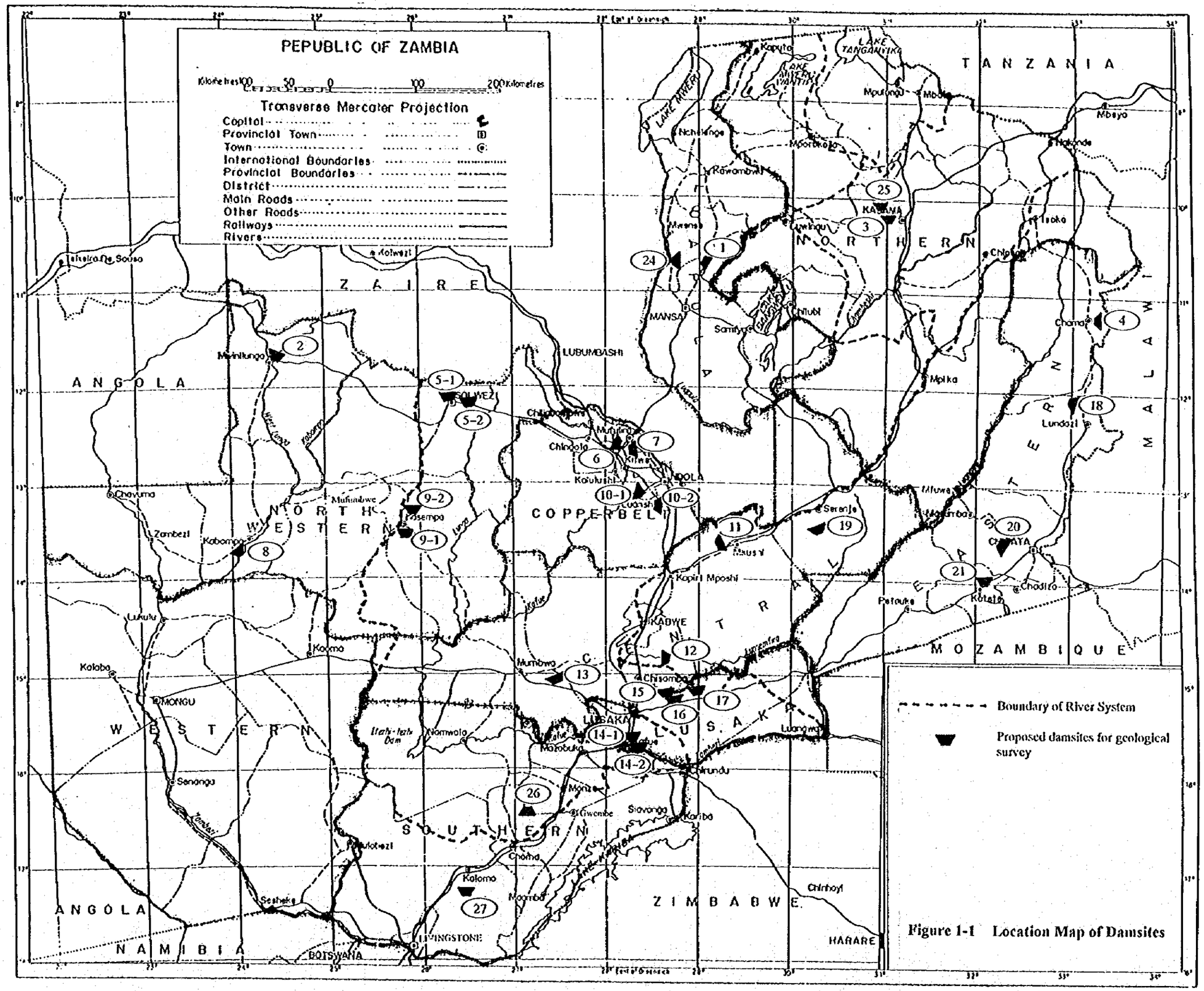


Figure 1-1 Location Map of Damsites

CHAPTER 2 GEOLOGY OF ZAMBIA

This chapter describes the general geology of Zambia and the regional geology for each of 8 provinces in which damsites are proposed. Most of the information contained herein was extracted or reproduced from existing literatures.

2.1 General Geology

In Zambia rock formations from Precambrian to early Paleozoic are extensively exposed. Basement Complex, Muva Super group, Katanga Super group lie as base rocks in Central, Northern, Eastern, North-western, and Southern part of Zambia. Several of orogenic events, Eburnian (2000-1800 million years), Kibaran (1300 million years), Katangan (900-500 million years) and Pan-African (600 million years), have been recognised in those base formations. Karroo Super group, Carboniferous to Jurassic System, is distributed along the Luangwa river and western part of Zambia. Those older base rock formations are overlain widely in western part of Zambia by Mesozoic Super group and Cenozoic Super group. The stratigraphy of Zambia is summarised in Table 2-1. Geological outline of Zambia is shown in Figure 2-1.

2.2 Regional Geology

2.2.1 Geology of Lusaka Province

Dolomites, limestones, schists and quartzites of Katanga Super group are distributed around western part of the province including Lusaka city. Gneisses and granitic gneisses of Basement Complex are widely spread in northern and eastern part surrounding Lusaka city area. In this area, hills mainly consists of quartzites are aligned E-W direction with 100-200m width and 50-200m height from plateau plane. Limestones, dolomites, schists, quartzites of Katanga Super group and gneisses of Basement Complex form Mpond dome in southern part near Kafue town. Potential damsites are selected rather narrow portions at that rivers cut down plateau planes consist of Gneisses or Granitic gneisses, or at narrow valleys where rivers cut across hill lines consist of quartzites.

2.2.2 Geology of Central Province

Mainly Granitic gneisses of Basement Complex containing pelites, quartzites, volcanic rocks are distributed in eastern part of the province. Quartzites and pelites of Muva Super group are distributed in north-eastern part. Predominantly shales, sandstones of Kundelung formation of Katanga Super group are distributed in western part. Granites of Basement Complex form Hook Granitic Massif at western end of the province. Mine Series rocks, carbonate rocks of Muva Super group are distributed central part near Kabwe town. Potential damsites are selected at gneisses and Quartzites of Basement Complex, Quartzites and pelites of Muva Super group, Sandstones of Kundelung formation. According to Topographical and Geological aspects, high potential damsites exist in deep valleys near Muchinga Escarpment. But those are far in distance from town area or high potential development area.

Table 2-1 Stratigraphical Table of Zambia

Geological Age		Super Groups	Groups or Formations	Rocks and Sediments
Cenozoic Era	Quaternary Teritaly	Cenozoic Super Group	Alluvium	Alluvium sands, Gravels, Clay near lakes
			Kalahari Group	Fine sands, Sandstones with clays
Mesozoic Era	Cretaceous	Mesozoic Super Group	Lower Cretaceous Formations	Mudstones, Siltstones
	Jurrassic Carboniferous	Karroo Super Group	Upper Karroo Group	Basalt, Interbedded Sandstone, Sandstones, Mudstones, Siltstones
			Lower Karroo Group	Mudstone with coal measures, Siltstones, Sandstones, Conglomerates
Palaeozoic Era	Silurian Ordovician	Lower Palaeozoic Super Group		Quartzites, Shales, Sandstones
Pre-cambrian Era	Early Palaeozoic - Precambrian	Katanga Super Group	Kundelung Group	Carbonate rocks with shales, Shales, Siltstones, Sandstones
			Upper Roan Group	Dolomites, Argillites
			Lower Roan Group	Quartzites, Argillites, Dolomites, Conglomerate, Mine series shales
		Muva Super Group and Basement Complex	Muva Group	Shales, Mudstones, Sandstones
			Basement Complex	Basement gneisses, Migmatites, Schists
Various age mainly older Precambrian		Intrusive and Metamorphic Rocks		Basic-igneous rocks, Meta-igneous rocks, Amphibolites, Metasediments, Metavolcanics

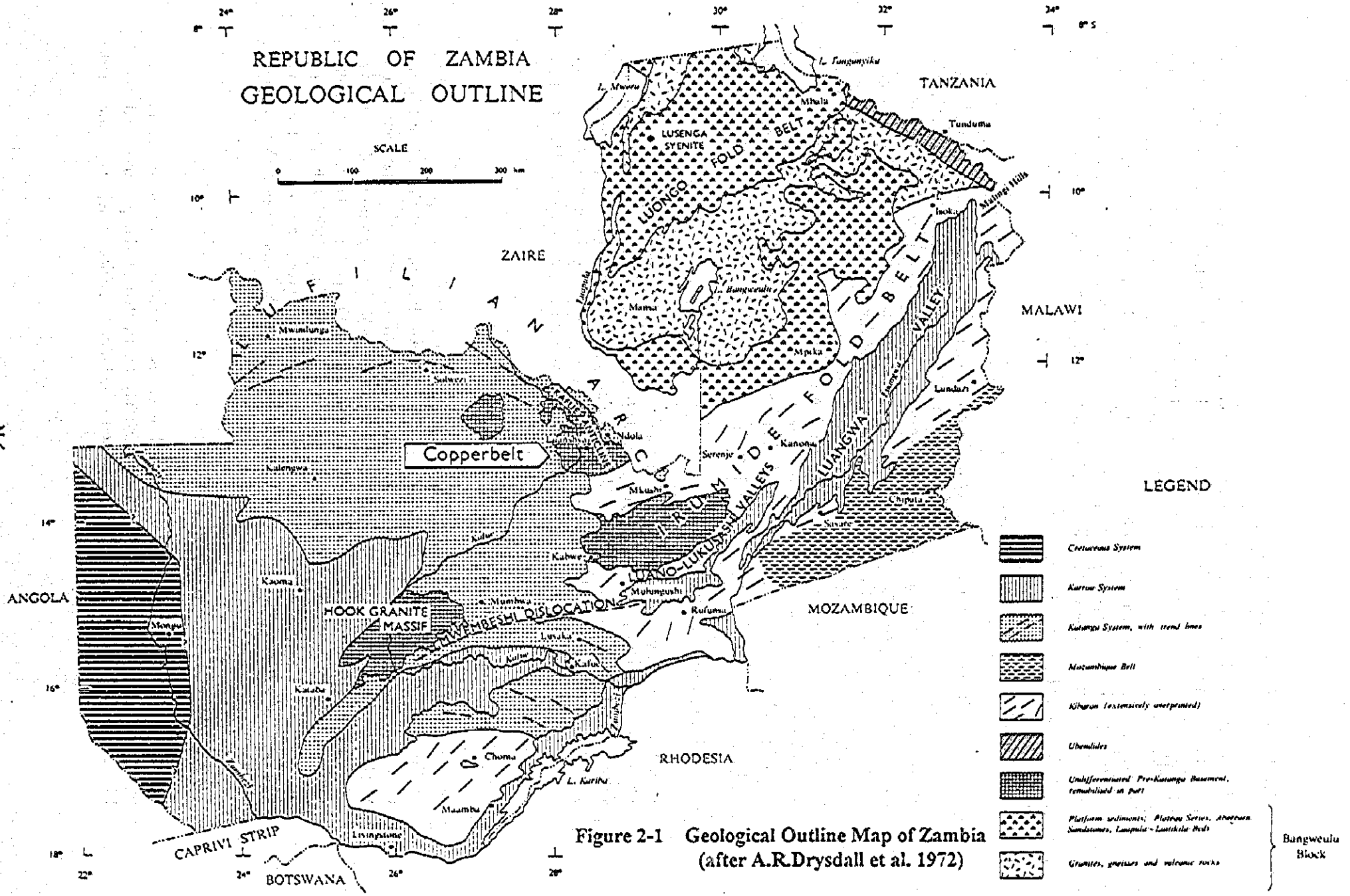


Figure 2-1 Geological Outline Map of Zambia (after A.R.Drysdall et al. 1972)

2.2.3 Geology of Copperbelt Province

The eastern end of Lufilian Arc with Kafue anticline exist at north-eastern part of the province. In Lufilian Arc, five large domes of Basement Complex were uplifted and three phases folding and metamorphism of the Katanga sequence were undergone during the Lufilian orogeny. Granitic gneisses of Basement Complex containing schists, partly quartzites are distributed at central part of Kafue anticline. Katanga Super group containing Mine Series rocks, carbonate rocks, shales, dolomites, sandstones are distributed at north-east and South-west part of Lufilian arc. Potential damsites are selected at Granitic gneisses, schists and quartzites of Basement Complex.

2.2.4 Geology of North-western Province

Granitic gneisses, partly basic igneous rocks of Basement Complex containing schists are scattered forming Luswishi Dome, Solwezi Dome, Mwonboshi Dome, Kabomp Dome at central part of northern area of the province. Mine Series rocks, Lower Roan quartzites, carbonate rocks of Katanga Super group around those domes and form the western end of Lufilian arc. Predominantly shales, sandstones of Kundelungu group are widely spread at eastern, southern and north-western part of the province. At western part, Kalahari Group overlie those base rocks. Potential damsites are selected at Quartzites and shales of Kundelungu group. It may be able to find possible damsite at south-eastern part of Kabompo Dome according to topographical and geological aspects. But, those areas are far in distance from high potential development area.

2.2.5 Geology of Luapula Province

Granites are widely extended NE-SW direction at central and north part of the province. Quartzites, shales of Muva Super group are widely spread at north-western part and form Luongo Fold Belt. Volcanics of Older Precambrian are distributed near boundary of granites. Predominantly shales, sandstones, partly carbonate rocks and psammites are distributed at south-eastern part. Potential damsites are selected at Quartzites of Muva Super group.

2.2.6 Geology of Northern Province

In Northern province, the same geological sequence as Luapula province are extended to north-eastern direction. Granites, granitic gneisses are widely spread at Central part of the province. Quartzites, shale of Muva Super group are distributed at northwestern and south-western part of granite zone, and shales ,sandstones of Kundelungu group are distributed at eastward of Lake Bangweulu. At south-western end of the province, Granites, Granitic gneisses are elongated NE-SW direction and form Irumide Fold Belt with Muva Super group rocks. Upper Karroo formation of Karroo Super group are distributed along Luangwa valley. Potential damsites are selected at granites and quartzites of Muva Super group.

2.2.7 Geology of Eastern Province

Polymetamorphased and complexly folded gneisses, granulite faces rocks cutting by granites, syenite and basic intrusions, are widely distributed at the province and form Mozambique Belt. Low grade metasediments including conglomerate, psammites and

pelites are interspersed within those rocks. Grits, sandstones, mudstones of Upper Karroo Super group are distributed along Luangwa valley. Potential damsites are selected at Granites, granitic, gneisses, quartzites of Basement Complex.

2.2.8 Geology of Southern Province

Granite, granitic gneiss, schist of Basement Complex are widely elongated NE-SW direction. At north-eastern part of the Block, partly calc-silicate rocks, meta-cubonate rocks of Basement Complex and Mine Series rocks of Katanga Super group are contained as several narrow-belts with WNW-ESE direction. Upper Karroo formation of Karroo Super group are distributed along Lake Kariba and Zambezi river, and the Batoka basalt of Karroo Super group are distributed at the southern end of the province near Livingstone town. Potential damsites are selected at granitic gneisses of Basement Complex.

CHAPTER 3 DAMSITE GEOLOGY

3.1 Maps, Aerial Photographs and References

The list of geological survey data referred to in the study is given in "Reference". Topographic maps and the aerial photographs for the geological survey are listed in Table 1-1.

3.2 Findings from Survey

The purpose of this geological survey was to obtain preliminary geological information necessary for Dam development plan study at the proposed damsites. The survey includes field reconnaissance and review of existing geological data.

The main items investigated in the survey consist of;

1) Topography at the damsite
2) Geology at the damsite and foundation condition
3) Possibility of dam construction and Maximum dam height
4) Construction materials
5) Type of dam

A summary of the survey findings for 29 damsites is shown in Table 3-1,and the details of each site are shown in Tables 3-2 through 3-30.

The results of survey are as follows.

(1) Best potential damsites according to topographical and geological aspects are:

Chongwe	(No.16)	Lukusashi	(No.19)
Mwonboshi	(No.12)	Lundazi	(No.18)
Solwezi	(No.5-1)		

Chongwe dam

Chongwe dam is expected to construct a maximum 37m height concrete dam. Damsite base rock consists of mainly gneiss, partly mica schist and meta diabase dyke of Basement Complex. Gneisses outcrops are scattered at river bed and both side slopes. Foliation of gneiss is almost N°70 E-N80° W strike,10° -30° S dip and inclined from left to right side with gentle dip. Joints of gneisses are NW-SE, NNW-SSE, NE-SW and E-W strikes with near vertical dips. Meta diabase dyke is recognised directly upstream of dam site aligning in N2° E direction. Mica shists are partly distributed at the right side of 400-500m downstream. It may be intercalated in schistic gneiss. Therefore, geological structures of damsite are stable. In reservoir area, same gneisses are distributed and geological condition of reservoir is stable without slope failure. As concrete aggregates, gneisses of the damsite is rather brittle because of rather thin schistocity by parallel arrangement of mica minerals. It is supposed to be ordinary characteristic of gneiss surrounding this area. Therefore it is necessary to find quarry site near the damsite or transport. Amphibolite, marble and dolomite outcrops may be available as concrete aggregates. As rock material for fill type dam, gneisses around the damsite are available.

Table 3-1 Summary of Preliminary Geological Assessment

Dam No.	Name of Damsite	Topo-graphy	Geo-logy	Construction material				Conceiv-able Dam type	Max Dam height (m)
				Concrete Aggregates	Rock	Filter	Core		
1	Lufubu	B	A	A	A	C	A	G/R	33
2	West Lunga	A	B	C	B	B	A	R/G	41
3	Lukupa	C	B	B	B	A	A	R	27
4	Kapemba	B	A	A	A	A	B	G/R	30
5-1	Solwezi	B	A	A	A	A	B	G/R	30
5-2	Kifubwa	B	B	A	A	A	B	R	25
6	Kafue	C	B	C	C	A	A	R	33
7	Mutundu	B	B	C	C	A	A	R	36
8	Lubi	B	C	C	C	A	C	D	-
9-1	Lufupa (Downstream)	B	B	C	B	B	B	R/G	31
9-2	Lufupa (Upstream)	C	B	C	B	B	B	R	28
10-1	Baluba	B	B	C	C	C	B	R	25
10-2	Kafubu	B	B	B	B	B	B	R	31
11	Lunsemfwa	C	B	C	C	B	B	R	27
12	Mwomboshi	B	A	A	A	A	B	G/R	35
13	Kopyonga	B	B	B	B	B	B	R	30
14-1	Muchito (Upstream)	B	B	B	B	A	A	R/G	25
14-2	Muchito (Downstream)	A	A	A	A	A	B	G/R	100
15	Kanakantapa	B	B	B	B	A	B	R/G	27
16	Chongwe	B	A	C	A	B	B	R/G	37
17	Mwapula	A	B	B	A	A	B	G/R	28
18	Lundazi	A	A	A	A	B	B	G/R	38
19	Lukusashi	A	A	B	A	A	B	G/R	56
20	Lutembwe	B	B	B	B	A	B	R/G	48
21	Katete	B	B	B	B	B	B	R/G	25
24	Luongo	B	B	B	B	A	B	R/G	43
25	Lwombe	C	B	C	C	B	A	R/E	20
26	Bengwa	B	A	A	A	A	B	G/R	40
27	Kalomo	B	A	A	A	B	C	G/R	27

Notes:

Topography	A:Good,	B:Fair,	C:Open Valley
Geology	A:Good,	B:Fair,	C:Poor
Construction Materials	A:Available,	B:Available but some constrains,	
	C:Further investigation required		
Dam type	R:Rockfill,	E:Earthfill,	G:Concrete gravity,
	D:Difficult to construct		

Mwonboshi dam

Mwonboshi dam is possible to construct a maximum 35m height concrete dam. Damsite base rock consists of gneiss of Basement Complex (Mwonboshi gneiss). Very hard gneisses outcrops extend at river bed. Same gneisses are distributed in reservoir area. Gneisses around the damsite can be used as concrete aggregates.

Solwezi dam

Solwezi dam is expected to construct a maximum 30m height concrete dam. Base rock of damsite consists of Biotite-quartzite of Kundelungu group (Solwezi biotite-quartzite formation). Hard quartzite outcrops are scattered at river bed and both side slopes. Same quartzites are distributed in reservoir area. Quartzites around the damsite can be used as concrete aggregates.

Lukusashi dam

Lukusashi dam is expected to construct a maximum 56m height concrete dam. At the high ridges of "Busendaka hills" of the dam site, it is possible to construct more than 60m height concrete dam. But dam height is limited by low watershed of reservoir area. Base rock of damsite consists of Quartzite of Basement Complex. Hard quartzite outcrops are scattered at river bed and both side slopes. In the reservoir area granitic gneiss are distributed. Quartzites around the damsite and Granitic gneisses in reservoir area can be used as concrete aggregates.

Lundazi dam

Lundazi dam is expected to construct a maximum 40m height concrete dam. Base rock of damsite consists of Granitic gneiss of Basement Complex. Very hard granitic gneisses outcrops spread at whole river bed and both side slopes. Same granitic gneisses are distributed in reservoir area. Granitic gneisses around the damsite can be used as concrete aggregates.

(2) Other good potential damsites according to topographical and geological aspects are:

Kanakamtapa	(No.15)
Mwapula	(No.17)
Kopyonga	(No.13)
Kifubwa	(No.5-2)
Lufupa upstream	(No.9-2)
Lufubu	(No.1)
Lukupa	(No.3)
Lunsemfa	(No.11)
Kapemba	(No.4)
Lutembwe	(No.20)
Katete	(No.21)
Bwengwa	(No.26)
Kalomo	(No.27)

(3) Other potential damsites, but it is necessary to consider big or rather big amount diversion of river water at the construction period.

Baluba	(No.10-1)
Kufubu	(No.10-2)
Mutundu	(No.7)
West Lunga	(No.2)
Luongo	(No.24)

(4) Other potential damsites, but it is necessary to consider countermeasure that water of reservoir submerge facilities, road, water supply pipe line, railway, town and so on.

Lufupa downstream (No.9-1)
Muchito upstream (No.14-1)
Muchito downstream (No.14-2)

About Lufupa downstream dam, it is possible to construct small dam for town's water supply without submerging facilities.

(5) Difficult damsite

Lubi (No.8)
Lwombe (No.25)

Lubi dam is difficult to construct any kind of dam in the river. Damsite base rock consists of unconsolidated sand of Kalahari group. It may be possible to construct reservoir digging dam with impermeable membrance on the surface at outside of the river. Lwombe dam is rather difficult to construct because of very flat plateau plane at damsite and reservoir area. It is possible to construct reservoir digging dam.

REFERENCES

1. GEOLOGICAL MAP OF THE REPUBLIC OF ZAMBIA 1:1,000,000 ; GEOLOGICAL SURVEY DEPARTMENT : A.R. DRYSDALL, DIRECTOR, COMPILED BY J.G. THIEME AND R.L. JOHNSON 1974-1975

2. GEOLOGICAL MAP OF THE LUSAKA AREA 1:250,000 SHEET NO.SD-35-15 ; COMPILED BY J.G. THIEME, EDITED BY A.K.RAY,1971

3. GEOLOGICAL MAP OF THE RUFUNSA AREA 1:250,000 SHEET NO.SD-35-16 ; COMPILED BY M.C. BARR, EDITED BY A.K. RAY, CARTOGRAPHY SUPERVISED BY N.S.HUNJAN,1971

4. GEOLOGICAL MAP OF THE CHIPATA AREA 1:250,000 SHEET NO.SD-36-6 ; COMPILED BY I.VAVRDA, EDITED BY A.K.RAY, CARTOGRAPHY SUPERVISED BY N.S. HUNJAN

5. GEOLOGICAL MAP OF THE PETAUKE AREA 1:250,000 SHEET NO.SD-36-9 ; COMPILED BY R.A. AGAR, EDITED BY A.K. RAY, CARTOGRAPHY SUPERVISED BY N.S. HUNJAN

6. THE GEOLOGY OF THE LUANSHYA AREA ; EXPLANATION OF DEGREE SHEET 1328,NW QUARTER : BY A.C.J. HICKMAN, 1973

7. THE GEOLOGY OF THE MONZE AREA ; EXPLANATION OF DEGREE SHEET 1627,NW.QUARTER : BY A.G. BROWN, 1966

8. THE GEOLOGY OF THE SOLWEZI AREA ; EXPLANATION OF DETREE SHEET 1226,NW QUARTER AND 1126,PART OF SW QUARTER : BY J.W. ARTHURS WITH A SECTION ON ECONOMIC GEOLOGY : BY C.A. LEGG, 1974

9. THE GEOLOGY OF THE MTETEZI RIVER AREA ; EXPLANATION OF DEGREE SHEET 1332,SW.QUARTER: BY I.Vavrda,1974

10. THE GEOLOGY OF THE MUSONDA FALLS AREA ; EXPLANATION OF DEGREE SHEET 1028,SW.QUARTER: BY J.G.THIEME,1971

11. THE GEOLOGY OF THE CHAMA AREA ; EXPLANATION OF DEGREE SHEET 1133, NW QUARTER : BY T.C.PAGE,1978

12. THE GEOLOGY OF THE CHAINAMA HILLS AREA ; EXPLANATION OF DEGREE SHEET 1528,NE.QARTER: BY P.GARRARD,1968

13. THE GEOLOGY OF THE COUNTRY AROUND MAZABUKA AND KAFUE ; EXPLANATION OF DEGEE SHEETS 1527, SE. QUARTER AND 1528, SW. QUARTER : BY A.G. SMITH, 1963

14. THE GEOLOGY OF THE MUSOFU RIVER AND MKUSHI AREAS ; EXPLANATION OF DEGREE SHEET 1329, PART OF NW. QUARTER, AND SW. QUARTER : BY C.J. STILLMAM, 1965

15. THE GEOLOGY OF THE CHISAMBA AREA ; EXPLANATION SHEET 1428,SW. QUARTER : BY T.A. MOORE, 1964

16. THE GEOLOGY OF THE MWEMBESHI RIVER AREA ; EXPLANATION OF DEGREE SHEET 1527,NE.QUARTER: BY J.G. SIMPSON,1962

17. PRECAMBRIAN GEOLOGY AND STRUCTURE IN CENTRAL NORTHERN RHODESIA ; MINISTRY OF LABOUR AND MINES : A.M.J. de SWARDT AND A.R. DRYSDALL WITH A SECTION BY P.GARRARD,1964

18. AR. DRYSDALL, RL. JOHNSON, T. A. MOORE AND J. G. THIEME, OUTLINE OF THE GEOLOGY OF ZAMBIA, GEOLOGY AR MIJNBOUW VOL.51.P.265-276,1972

19. N.J. MONLEY, AN OUTLINE OF THE GEOGRAPHY AND GEOLOGY OF ZAMBIA, GSD OCCASIONAL PAPER NO.122, 1986

TABLES

Table 3-2 Geological Assessment of Lufubu Damsite (Damsite No.1)

Item	Description
1. Topography	Damsite is 51km NNE of Mansa town. Cipili Hills align NE-SW direction with 2km width and 60-80m height from river bed. Lufubu river meanders with E-W and/or SE-NW direction across the Cipili Hills. Right side slope of dam site is 8-10 degrees and left side slope is 5-12 degrees.
2. Geology	Base rock of damsite consists of Lower Quartzite of Muva Super group and rhyolitic lava of Basement Complex. Rhyolitic lavas are underlaied by quartzites. Rhyolitic lavas are distributed around river bed. Quartzites are distributed at both side slopes. Fault is not discovered. N50 W80 S, N50 E15 S and N50 W80 E joints are distinguished.
3. Foundation condition	Very hard rhyolitic lavas outcrops spread whole river bed and forms falls at directly understream of damsite. Sound rock of river bed is expected to be only few metre under the surface. Weathering zone of upper portion of both side slope is few metre under the surface according to Observation of digging holes and outcrop condition. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	Maximum dam height is 33m, but it is necessary to consider that some height inhabitant's houses will be submerged.
6. Construction materials	
Concrete aggregates	Rhyolitic lavas and Quartzites around damsite can be used.
Rock	Rhyolitic lavas and Quartzites around damsite can be used.
Filter	No sands are available around the damsite.
Core	Alluvial deposits are available at upstream near the damsite.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-3 Geological Assessment of West Lunga Damsite (Damsite No.2)

Item	Description
1. Topography	Damsite is 2.0km NE of Mwinilunga town. West lunga river erodes plateau plane with 50-60m height from river bed, and goes through NEE-SSW or N-S direction. Right side slope of damsite is 10-12 degrees and left side is 8-10 degrees.
2. Geology	Base rock of damsite consists of psammitic schist and phyllite of Kundelungu Group of Katanga Super group. Faults are not discovered. Foliation indicates N40 W30 N and inclines toward upstream.
3. Foundation condition	Outcrops of base rocks are scattered at river bed and lower portion of both side slopes. Sound rock is expected to be few metre at these portion. At higher portion of both side slopes, weathering zone is expected to 5-10m. The foundation condition is expected to be rather good. Slightly strict foundation treatment will be required at the higher portion.
4. Possibility of construction	Possible
5. Maximum dam height	41m
6. Construction materials	
Concrete aggregates	Thick and massive portion of psammitic schist should be researched.
Rock	Psammitic schist will be suitable.
Filter	Weathering portion of psammitic schist will be suitable.
Core	Weathering zone of phyllite around the damsite or alluvial deposits near the damsite are suitable.
7. Dam type	Rockfill dam is suitable. Concrete aggregates should be found to construct concrete gravity dam.

Table 3-4 Geological Assessment of Lukupa Damsite (Damsite No.3)

Item	Description
1. Topography	Damsite is 25km NNW of Kasama town. Lukupa river erodes plateau plane with 40-50m height from river bed, and goes through NE-SW direction. Right side of damsite is slip-off with 4 degrees and left side is 5-12 degrees. River bed is 170m wide.
2. Geology	Base rock of damsite consists of Granitic gneiss of Basement Complex and partly amphibolite. Geological structure is not clear because of rare outcrops. Fault is not discovered.
3. Foundation condition	Sound rock is expected to be deep more than 5-10m at higher portion of both side slopes. The foundation condition is supposed to be not so good. Strict foundation treatment will be required for the weathering zone.
4. Possibility of construction	Fairly possible
5. Maximum dam height	27m
6. Construction materials	
Concrete aggregates	Granitic gneisses outcrops should be found near the damsite.
Rock	Fresh and slightly weathered granitic gneiss will be suitable.
Filter	Weathering zone of granitic gneiss around the damsite are suitable.
Core	Alluvial deposits at directly upstream of damsite are suitable.
7. Dam type	Rockfill dam is suitable because of deep weathering zone and long dam length.

Table 3-5 Geological Assessment of West Kapemba Damsite (Damsite No.4)

Item	Description
1. Topography	Damsite is 3.7km West of Chama town. Damsite is in the hills with 40-60m height from the river bed. Flood plane spreads at the 800m downstream. Right side slope of damsite is 20-25 degrees and left side is 6 degrees. Left side is slightly gentle slope and Low ridge. The col portion with 20m height from the river bed exists at left side in reservoir area.
2. Geology	Base rock of damsite consists of biotite gneiss of Kapemba group of Basement Complex. Fault is not discovered. Foliation indicates NE-SW strike and 65-75 N dip. Foliation steeply inclines toward downstream and left side.
3. Foundation condition	Very hard biotite gneiss outcrops spread whole river bed and are scattered at both side slope. Sound rock is expected to be few metre from the surface. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	30m
6. Construction materials	
Concrete aggregates	Biotite gneisses around damsite can be used.
Rock	Biotite gneisses around damsite can be used.
Filter	Medium sands of river deposits at 800m understream of damsite are available.
Core	Alluvial deposits near river bed at 800m understream of damsite are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-6 Geological Assessment of Solwezi Damsite (Damsite No.5-1)

Item	Description
1. Topography	Damsite is 2.5km NW of Solwezi town. Solwezi river erodes plateau plane with 50-60m height from river bed, and goes through NNW-SSE direction. Right and left side slopes are 5 degrees.
2. Geology	Base rock of damsite consists of Solwezi biotite-quartzite formation of Kundelungu Group of Katanga Super group. Faults are not discovered. Foliation indicates N70E20N and gently inclines toward upstream.
3. Foundation condition	Hard biotite-quartzite outcrops are scattered at river bed and both side slopes. Sound rock is expected to be few metre from the surface at near river bed and 5-10m at higher portion of both side slope. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	30m
6. Construction materials	
Concrete aggregates	Biotite-quartzites around damsite can be used.
Rock	Biotite-quartzites around damsite can be used.
Filter	Weathering zone of biotite-quartzites around damsite are available.
Core	Alluvial deposits near the damsite are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-7 Geological Assessment of Kifubwa Damsite (Damsite No.5-2)

Item	Description
1. Topography	Damsite is 4.5km ENE of Solwezi town. Kifubwa river erodes plateau plane with 50-60m height from river bed, and goes through NE-SW direction. Right side slope is 2-3 degrees and left side slope is 3-4 degrees.
2. Geology	Base rock of damsite consists of Solwezi biotite-quartzite formation of Kundelungu Group of Katanga Super group. Faults are not discovered. Foliation indicates N70W15N and gently inclines toward upstream.
3. Foundation condition	Hard biotite-quartzite outcrops are scattered at lower portion of left side slope and rare at right side slope and river bed. Sound rock is expected to be slightly deep at near river bed and at right side slope. The foundation condition is expected to be slightly bat and strict foundation treatment will be required.
4. Possibility of construction	Fairly possible
5. Maximum dam height	25m
6. Construction materials	
Concrete aggregates	Biotite-quartzites around damsite can be used.
Rock	Biotite-quartzites around damsite can be used.
Filter	Weathering zone of biotite-quartzites around damsite are available.
Core	Alluvial deposits near the damsite are available.
7. Dam type	Rockfill dam is suitable because of slightly deep weathering zone and long dam length.

Table 3-8 Geological Assessment of Kafue Damsite (Damsite No.6)

Item	Description
1. Topography	Damsite is 12km SW of Mufulira town. Kafue river erodes plateau plane with 30-40m height from river bed, and goes through NNW-SSE direction. Right side of damsite is slip-off slope with 2 degrees and left side is 3-4 degrees slope.
2. Geology	Base rock of damsite consists of quartzite and mica schist of Muva Super group. Quartzite outcrops align almost centre of right side ridge, and mica shist distribute around quartzite. Faults are not discovered. Foliation indicates ENE-WSW strike and 70S dip and steeply inclines toward downstream.
3. Foundation condition	At the damsite, outcrops are rare, Sound rock is expected to be rather deep. The foundation condition is expected to be not so good and strict treatment will be required.
4. Possibility of construction	Fairly possible
5. Maximum dam height	33m
6. Construction materials	
Concrete aggregates	Quartzite mostly has suggary texture and very brittle. Grantic gneiss and granite near the damsite should be found.
Rock	Grantic gneiss and granite near the damsite should be found.
Filter	Weathering zone of quartzite around the damsite are suitable.
Core	Weathering zone of mica schist at directly upstream of the damsite are suitable.
7. Dam type	Rockfill dam is suitable because of rather deep weathering zone and long dam length.

Table 3-9 Geological Assessment of Mutundu Damsite (Damsite No.7)

Item	Description
1. Topography	Damsite is 14km south of Mufulira town. Mutundu river erodes plateau plane with 40-50m height from river bed, and goes through ENE-WSW direction. Right side slope is 5-6 degrees and left side slope is 5 degrees.
2. Geology	Base rock of damsite consists of muscovite schist of Muva Super group. Geological structure is not clear because of rare outcrops. Faults are not discovered.
3. Foundation condition	Base rock of damsite consists of muscovite schist of Muva Super group. Geological structure is not clear because of rare outcrops. Faults are not discovered.
4. Possibility of construction	Fairly possible
5. Maximum dam height	36m
6. Construction materials	
Concrete aggregates	Granitic gneiss at 2km north of the damsite are available.
Rock	Granitic gneiss at 2km north of the damsite are available.
Filter	Weathering zone of mica schist around the damsite are suitable.
Core	Alluvial deposits around the damsite are suitable.
7. Dam type	Rockfill dam is suitable.

Table 3-10 Geological Assessment of Lubi Damsite (Damsite No.8)

Item	Description
1. Topography	Damsite is 9.5km WSW of Kabompo town. Damsite is in plane area with low undulations. Right side slope is 4-5 degrees and left side slope is 8 degrees.
2. Geology	Base of damsite consists of fine sand of Kalahari group.
3. Foundation condition	Foundation condition is very bad because of unconsolidated fine sand.
4. Possibility of construction	Difficult to construct any kind of dam. It may be possible to construct reservoir digging dam with impermeable membrance on the surface of reservoir at outside of the river.
5. Maximum dam height	
6. Construction materials	
Concrete aggregates	
Rock	
Filter	
Core	
7. Dam type	

Table 3-11 Geological Assessment of Lufupa Damsite [Downstream] (Damsite No.9-1)

Item	Description
1. Topography	Damsite is 3.0km SSE of Kasempa town. Right side is wide and high ridge with 120m height from river bed and aligns NW-SE direction. Left side is slightly thin ridge with 60m height from river bed and aligns NE-SW direction. Right side slope is 10-30 degrees, and left side slope is 5-10 degrees.
2. Geology	Base rock of damsite consists of psammitic schist and phyllite of Kundelungu of Katanga Super group. Faults are not discovered. Foliation indicates N35 E40 N and inclines toward upstream.
3. Foundation condition	Outcrops are scattered at river bed and right side slope. Sound rock is expected to be slightly deep at river bed and right side slope, and rather shallow at left side slope. The foundation condition is expected to be rather good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	31m, but dam height is limited to 15m without submerging Kasampa town's facilities.
6. Construction materials	
Concrete aggregates	Hard and massive psammitic schists around the damsite should be found.
Rock	Psammitic schists around the damsite will be available.
Filter	Weathering zone of psammitic schists is available.
Core	Weathering zone of phylite or alluvial deposits is available.
7. Dam type	Rockfill dam is suitable.

Table 3-12 Geological Assessment of Lufupa Damsite [Upstream]
(Damsite No.9-2)

Item	Description
1. Topography	Damsite is 6.5km NNE of Kasempa town. Lufupa river erodes plateau plane with 20-30m height from river bed, and goes through N-S direction, and forms open valley. Right side is very gentle slip-off slope with 2 degrees and left side is 5-6 degrees.
2. Geology	Base rock of damsite consists of psammitic schist and phyllite of Kundelungu group of Katanga Super group. Faults are not discovered. Foliation indicates N80 E25 S and gently inclines toward upstream.
3. Foundation condition	Outcrops of base rocks are scattered at river bed and right side slope. Sound rock is expected to be slightly deep at river bed and right side, and deep at left side bed. The foundation condition is expected to be rather bad and strict foundation treatment will be required.
4. Possibility of construction	Fairly possible
5. Maximum dam height	28m
6. Construction materials	
Concrete aggregates	Hard and massive psammitic schists around the damsite should be found.
Rock	Psammitic schists around the damsite will be available.
Filter	Weathering zone of psammitic schists is available.
Core	Weathering zone of phylite or alluvial deposits is available.
7. Dam type	Rockfill dam. Dam length is expected to be long because of low right side ridge.

Table 3-13 Geological Assessment of Baluba Damsite (Damsite No.10-1)

Item	Description
1. Topography	Dam site is 3.8km NE of Baluba mine. Balba river erodes plateau plane with 50-60m height from river bed, and goes through WNW-ESE. Right side slope is 3-4 degrees, and left side slope is 2-4 degrees.
2. Geology	Base rock of damsite consists of muscovite schists of Muva Super group. Geological structure is not clear because of rare outcrops. Faults are not discovered.
3. Foundation condition	Sound rock is expected to be rather deep according to rare outcrops and thick weathering zone of muscovite schists. The foundation condition is not so good and strict treatment will be required.
4. Possibility of construction	Possible, but Location of galleries of Baluba mine should be grasped to protect leakage of reservoir water.
5. Maximum dam height	25m
6. Construction materials	
Concrete aggregates	Grantic gneiss at 3km north of the damsite will be available.
Rock	Grantic gneiss at 3km north of the damsite will be available.
Filter	Weathering zone of grantic gneiss of are available.
Core	Alluvial deposits around the damsite are available.
7. Dam type	Rockfill dam is suitable.

Table 3-14 Geological Assessment of Kafubu Damsite (Damsite No.10-2)

Item	Description
1. Topography	Damsite is 13km SE of Luanshya town. Kafubu river erodes plateau plane with 50-60m height from river bed, and meanders ENE-WSW and/or E-W direction. Right side slope of damsite is 4 degrees and left side slope is 3-4 degrees.
2. Geology	Base rock of damsite consists of Granitic gneiss. Geological structure is not clear because of rare outcrops. Faults are not discovered.
3. Foundation condition	Sound rock is expected to be rather deep at both side ridge and slightly shallow at river bed with few base rock outcrops. The foundation condition is expected to be slightly bad and strict treatment will be required for weathering zone.
4. Possibility of construction	Fairly possible
5. Maximum dam height	31m
6. Construction materials	
Concrete aggregates	Grantic gneiss around the damsite can be used.
Rock	Grantic gneiss around the damsite can be used.
Filter	Weathering zone of grantic gneiss are available.
Core	Alluvial deposits around river bed of damsite are available.
7. Dam type	Rockfill dam is suitable.

Table 3-15 Geological Assessment of Lunsemfwa Damsite (Damsite No.11)

Item	Description
1. Topography	Damsite is 13km WSW of Mukushi town. Lunsemfwa river goes through ENE-WSW direction at 3km north of Ninalesa Hills. Right side slope of damsite is 2-3 degrees, and left side slope is 4-5 degrees.
2. Geology	Base rock of damsite consists of Muscovite schists and phyllite of Kalonga formation of Basement Complex at river bed and right side slope, and quartzite, slate, phyllite of Irumi formation of Mukushi group of Muva Super group at left side slope. Inferred fault of SE-NE direction exists at boundary between Basement Complex and Muva Super group. Foliation indicates ENE-WSW strike and 70-80S dip and steeply inclines toward left side.
3. Foundation condition	Outcrops are only muscovite schists at left side slope near river bed. Sound rock is expected to be deep at both side ridge, and slightly shallow at river bed. Strict foundation treatment will be required at higher portion of both side ridge.
4. Possibility of construction	Possible
5. Maximum dam height	27m
6. Construction materials	
Concrete aggregates	Quartzites near damsite have sugary textures and are brittle. Granite 5km north of damsite should be found.
Rock	Quartzites near damsite have sugary textures and are brittle. Granite 5km north of damsite should be found.
Filter	Weathering zone of quartzites around the damsite are available.
Core	Alluvial deposits around the damsite are available.
7. Dam type	Rockfill dam is suitable.

Table 3-16 Geological Assessment of Mwonboshi Damsite (Damsite No.12)

Item	Description
1. Topography	Damsite is 20km NNE of Chisamba village. Mwonboshi river erodes plateau plane with 15-20m height from river bed, and meanders WNW-ESE and/or NE-SW direction with open valley. Right side slope of damsite is 4-5 degrees and left side slope 2-3 degrees.
2. Geology	Base rock of damsite consists of Mwonboshi gneiss of Basement Complex. Faults are not discovered. Foliation is N80W strike, 60N-80N dip and steeply inclines toward left side. Distinguished joints are N38E70N,N75E80S, and N52W30N.
3. Foundation condition	Very hard gneiss outcrops spread whole river bed. Sound rock is expected to be very shallow at river bed, and slightly deep at both side ridge. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	35m
6. Construction materials	
Concrete aggregates	Gneiss around the damsite can be used.
Rock	Gneiss around the damsite can be used.
Filter	Weathering zone of gneiss around the damsite are available.
Core	Alluvial deposits near the damsite should be found.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-17 Geological Assessment of Kopyonga Damsite (Damsite No.13)

Item	Description
1. Topography	Damsite is 78km WNW of Lusaka city. Kawena Hills align ENE-WSW direction with 0.2-1.2km width and 50-200m height from river bed. Kopyonga river goes through NE-SW direction across Kawena Hills. Right side slope is 6-25 degrees and left side slope is 3-4 degrees.
2. Geology	Base rock of damsite consists of Kawena sandstone of Kawena formation belong Kundelungu group of Katanga Super group. Inferred fault exists at downstream foot of the hill with fine sandstone/siltstone boundary and upstream foot of the hill with sandstone/grid boundary.
3. Foundation condition	Hard sandstone outcrops are scattered at lower portion of both side ridge. Sound rock is expected to be slightly shallow at lower portion and slightly deep at higher portion. Strict foundation treatment would be required at higher portion of both side ridge.
4. Possibility of construction	Possible
5. Maximum dam height	30m
6. Construction materials	
Concrete aggregates	Hard sandstone around damsite can be used.
Rock	Hard sandstone around damsite can be used.
Filter	Weathering zone of sandstone are available.
Core	Weathering zone of siltstone at downstream near the damsite are available.
7. Dam type	Rockfill dam is suitable.

Table 3-18 Geological Assessment of Muchito [Upstream] Damsite (Damsite No.14-1)

Item	Description
1. Topography	Damsite is 9.0km east of Kafue town, Hills with 80-90m height align almost N-S direction at right side and left side. Right side slope is 28 degrees and left side slope is 26 degrees. Alluvial plane with about 270m width spread at the river bed.
2. Geology	Damsite is North part of Mpond dome. Base rock of damsite consists of quartzite and phyllite of Broken hill group of Katanga Super group. Quartzites distribute at both side slope and phyllites distribute at river bed. Faults are not discovered. Foliation indicates N45E30N and inclines toward right side and upstream.
3. Foundation condition	Outcrops are scattered at river bed and both side slope. Sound rock is expected to be slightly shallow. Thickness of alluvial deposits is 2-3m. The foundation condition is expected to be rather good and would not require complicated treatment.
4. Possibility of construction	Possible, but water supply pipe line from Kafue river to Lusaka, railway and some villages exist in the reservoir area.
5. Maximum dam height	25m
6. Construction materials	
Concrete aggregates	Hard quartzite around the damsite can be used.
Rock	Hard quartzite around the damsite can be used.
Filter	Weathering zone of quartzites around the damsite are available.
Core	Alluvial deposits around the damsite are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-19 Geological Assessment of Muchito [Downstream] Damsite (Damsite No.14-2)

Item	Description
1. Topography	Damsite is 8.0km WSW of Kafue town. Right side is high ridge extended NE-SW direction with 200m height from river bed. Left side is high ridge extended E-W direction with 140m height from river bed. Right side slope is 35 degrees and left side slope is 20 degrees.
2. Geology	Damsite is in south part of Mpond dome. Base rock of damsite consists of quartzite and phyllite of Kafue group of Muva Super group. Faults are not discovered. Foliation is N70 W40 N and inclines upstream.
3. Foundation condition	Quartzite outcrops makes a hard layer with 20-30m thickness and inclines upstream with 40 degrees slope. Phyllites distribute near river bed under quartzite layer. Sound rock is expected to be very shallow at river bed and both side slope. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible, but water supply pipe line from Kafue river to Lusaka exist in the reservoir area.
5. Maximum dam height	100m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite can be used.
Rock	Hard quartzites around the damsite can be used.
Filter	Weathering zone of quartzite near the damsite are available.
Core	Alluvial deposits of Kafue river flood area are available.
7. Dam type	Concrete gravity dam is suitable because of V shape narrow valley.

Table 3-20 Geological Assessment of Kanakantapa Damsite (Damsite No.15)

Item	Description
1. Topography	Damsite is 42km NE of Lusaka city. Chainama hills align E-W direction with 100-500m width and 60-100m height from river bed. Kanakantapa river goes through SW direction across Chainama hills. Right side and left side slope is 6-8 degrees.
2. Geology	Base rock of damsite consists of Rufunsa quartzite of Basement Complex. Biotite grantic gneisses distribute around Rufunsa quartzite. Faults are not discovered. Foliation indicates E-W strike and 20-40 degrees S dip and inclines downstream. Alluvial deposits spread at the river bed with 100m width.
3. Foundation condition	Many quartzite outcrops are scattered at left side slope and rare at right side slope. At left side, a lot of cracks are developed, make separate blocks and loosen base rock near the surface. Sound rock is expected to be rather deep at river bed and both side slopes. Weathering zone is deep in right side ridge. Foundation conditions are not so good and strict foundation treatment will be required at weathering and loosing zone.
4. Possibility of construction	Possible
5. Maximum dam height	27m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite can be used without Sugary texture quartzites. Biotite granitic gneisses directly upstream of damsite can also be used.
Rock	Hard quartzites and granitic gneisses can be used.
Filter	Weathering zone of quartzite are available.
Core	Alluvial deposits around the damsite are available.
7. Dam type	Rockfill dam is suitable because of rather thick weathering zone of base rock.

Table 3-21 Geological Assessment of Chongwe Damsite (Damsite No.16)

Item	Description
1. Topography	Damsite is 44km ENE of Lusaka city. Chongwe river erodes plateau plane with 50-60m height and goes through NW-SE direction with open valley. Right side slope is 5 degrees and left side slope is 6-7 degrees.
2. Geology	Base rock of the damsite consists of Biotite granitic gneiss of Basement Complex. Mica schist and meta dolerite dyke are partly recognised. Faults are not discovered. Foliation indicates N70 E-N80 W strike and 10-30s dip and inclines toward left side. Distinguish joints indicates NW-SE, NNW-SSE, NE-SW, E-W strike and near vitical dip.
3. Foundation condition	Many granitic gneiss outcrops are scattered at the river bed and both side slopes. Sound rock is expected to be few metre at the river bed 5-10m at the both side ridge. The foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	37m
6. Construction materials	
Concrete aggregates	Biotite granitic gneisses around the damsite are rather brittle and make easy flat pieces. They are not suitable as concrete aggregates. Concrete aggregates should be found in other area or transported from existing quarry site.
Rock	Biotite granitic gneisses around the damsite can be used.
Filter	Weathering zone of granitic gneisses are available.
Core	Alluvial deposits around the river bed are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam. Rockfill dam is rather suitable according to construction materials condition.

Table 3-22 Geological Assessment of Mwapula Damsite (Damsite No.17)

Item	Description
1. Topography	Damsite is 76km ENE of Lusaka city. Chainama hills align WNW-ESE direction with 300-500m width and 80-100m height from river bed. Mwapura river goes through NW-SE direction across Chainama hills. Right side is thin ridge with 5-18 degrees slope and left side is wide and rather big ridge with 30-40 degrees slope. The col exists at 30m height from river bed.
2. Geology	Base rock of damsite consists of Rufunsa quartzite of Basement Complex. Biotite granitic gneisses distribute around Rufunsa quartzite and meta volcanic rocks distribute at downstream. Inferred thrust that thrusts up southward exists at directly downstream of the feet of hills. Other faults are not discovered at the damsite. Foliation indicates WNW-ESE strike and 60-90S dip, and steeply inclines toward downstream.
3. Foundation condition	Many quartzite outcrops are scattered at river bed and left side slope and slightly rare at the thin right side slope. Sound rock is expected to be shallow at river bed and left side slope and slightly deep at right side slope. Foundation condition is expected to be fairly good and strict treatment will be required at right side higher portion.
4. Possibility of construction	Possible
5. Maximum dam height	28m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite and granitic gneisses at directly upstream of the damsite can be used.
Rock	Hard quartzites around the damsite and granitic gneisses at directly upstream of the damsite can be used.
Filter	Weathering zone of quartzites are available.
Core	Alluvial deposits downstream are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-23 Geological Assessment of Lundazi Damsite (Damsite No.18)

Item	Description
1. Topography	Damsite is 30km NW of Lundazi town. Lundazi river erodes low hills area with 80-120m height from the river bed and goes through SE-NW direction. Right side is slightly thin ridge with 20-30 degrees slope and left side is wide and slightly high ridge with 10-30 degrees slope. The col exists at left side of reservoir area with 40m height from the river bed.
2. Geology	Base rock of damsite consists of granitic gneiss of Basement Complex. Faults are not discovered. Foliation indicates N20W65N and inclines toward downstream and left side. Distinguished joint is NW-SE strike and near vertical dip.
3. Foundation condition	Granitic gneiss outcrops spread at almost whole river bed and are scattered at both side slope. Sound rock is expected to be very shallow. Foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	38m
6. Construction materials	
Concrete aggregates	Granitic gneisses around the damsite can be used.
Rock	Granitic gneisses around the damsite can be used.
Filter	Weathering zone of granitic gneisses around the damsite are available.
Core	Alluvial deposits at lowland area among hills near damsite are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-24 Geological Assessment of Lukusashi Damsite (Damsite No.19)

Item	Description
1. Topography	Damsite is 20km south of Serenje town. Busendaka hills align NE-SW direction with 1-2km width and 180-240m height from river bed. Lukusashi river goes through NW-SE direction across Busendaka hills with V shape valley. Right side slope is 20-30 degrees and left side slope is 20-25 degrees.
2. Geology	Base rock of damsite consists of quartzite of Basement Complex. Many quartzite outcrops are scattered at river bed and both side slope. Faults are not discovered at the damsite. Some faults may exist at feet of hills with boundaries between quartzite/phyllite zone and granitic gneiss zone. Foliation indicates NE-SW or NNE-SSW strike and 40-60N dip and inclines toward upstream.
3. Foundation condition	Quartzite outcrops are scattered at river bed and both side slope. Sound rock is expected to be shallow. Foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible, but dam height is limited because of low watershed height of construction upstream.
5. Maximum dam height	56m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite and granitic gneisses at upstream can be used.
Rock	Hard quartzites around the damsite and granitic gneisses at upstream can be used.
Filter	Weathering zone of quartzite or granitic gneisses are available.
Core	Alluvial deposits at upstream are available.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-25 Geological Assessment of Lutembwe Damsite (Damsite No.20)

Item	Description
1. Topography	Damsite is 30km WNW of Chipata town. Chisambala hills align E-W direction with 1-2km width and 100-300m height. Lutembwe river goes through SE-NW direction across Chisambala hills. Right side is large ridge with 6-10 degrees slope and left side is slip-off slope and slightly thin ridge with 4 degrees slope. Terrace plane is recognised at 10m height from river bed with 150m width.
2. Geology	Base rock of damsite consists of quartzite of Basement Complex. Gneisses distribute upstream area and granulites distribute downstream area. Faults are not discovered at the damsite. Foliation indicates ENE-WSW strike and 70-80S dip and inclines toward upstream. Many quartzite outcrops are scattered at river bed and both side slope. Faults are not discovered at the damsite. Some faults may exist at feet of hills to border between quartzite/phyllite zone and granitic gneiss zone. Foliation indicates NE-SW or NNE-SSW strike and 40-60 N dip and inclines toward upstream. Terrace deposits are expected to be 2-5m thick.
3. Foundation condition	Few quartzite outcrops are recognised at river bed and both side slope. Sound rock is expected to be rather deep. Strict treatment would be required for weathering zone.
4. Possibility of construction	Possible
5. Maximum dam height	48m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite or gneiss at upstream area can be used.
Rock	Hard quartzites around the damsite or gneiss at upstream area can be used.
Filter	Weathering zone of quartzites or gneisses are available.
Core	Terrace deposits are available.
7. Dam type	Rockfill dam is suitable.

Table 3-26 Geological Assessment of Katete Damsite (Damsite No.21)

Item	Description
1. Topography	Damsite is 7.0km NNW of Katete town. Katete river goes through NNE-SSW direction among large hills with 100-500m height from river bed. Right side slope is 6 degrees and left side slope is 4 degrees.
2. Geology	Base rock of damsite consists of gneiss and quartzite of Basement Complex. Quartzites partly distribute at right side near river bed. Faults are not discovered. Foliation indicates NNW-SSE or N-S strike and 40-60 W dip and inclines toward right side.
3. Foundation condition	Few outcrops of base rocks are scattered at river bed and both side slope. Sound rock is expected to be rather deep. Foundation condition is not so good and strict foundation treatment will be required for weathering zone.
4. Possibility of construction	Possible, but catchment area is very narrow.
5. Maximum dam height	25m
6. Construction materials	
Concrete aggregates	Gneisses around the damsite can be used.
Rock	Gneisses around the damsite can be used.
Filter	Weathering zone of quartzites and gneisses are available.
Core	Alluvial deposits near the damsite are available.
7. Dam type	Rockfill dam is suitable according to slightly thick weathering condition.

Table 3-27 Geological Assessment of Lungo Damsite (Damsite No.24)

Item	Description
1. Topography	Damsite is 51km NNW of Mansa town. Low hills align NNE-SSW direction with 1-1.5km width and 50-60m height. Lungo river goes through E-W direction. Right side is slip-off slope with 2-3 degrees. Left side is 6-20 degrees and forms 15m height river cliff near the river bed.
2. Geology	Base rock of damsite consists of Lower quartzite of Muva Super group. Faults are not discovered. Foliation indicates NE-SW or NNE-SSW strike and 5-20 SE dip and inclines toward upstream.
3. Foundation condition	Quartzite outcrops are scattered at river bed and both side slope. Sound rock is expected to be slightly shallow at river bed and lower part of left side slope and slightly deep at right side slope. Foundation condition is rather good at river bed and left side and slightly bad at right side. Strict treatment will be required at weathering zone.
4. Possibility of construction	Possible, but dam length is long because of gentle and long right-side-slip-off slope.
5. Maximum dam height	43m
6. Construction materials	
Concrete aggregates	Hard quartzites around the damsite or Rhyolitic lava/granites at downstream can be used.
Rock	Hard quartzites around the damsite or Rhyolitic lava/granites at downstream can be used.
Filter	River deposits are available.
Core	Alluvial deposits at lowland area among hills are available.
7. Dam type	Rockfill dam is suitable because of long dam length.

Table 3-28 Geological Assessment of Lwombe Damsite (Damsite No.25)

Item	Description
1. Topography	Damsite is 31km NW of Kasama town. Lwombe river goes through N-S direction on almost flat plateau plane. Right and Left side slope are very gentle with only 5-10m height from river bed and 1-2 degrees slopes.
2. Geology	Base rock of damsite consists of Lower quartzite of Muva Super group. Alluvial deposits spread widely on the base rock.
3. Foundation condition	Outcrops of base rock are rare. Sound rock is expected to be rather deep. Foundation condition is expected to be not so good and would require strict treatment for weathering zone.
4. Possibility of construction	Fairly difficult. It may be possible to construct reservoir digging dam.
5. Maximum dam height	20m
6. Construction materials	
Concrete aggregates	Granite or granitic gneiss near the damsite should be found.
Rock	Granite or granitic gneiss near the damsite should be found.
Filter	Weathering zone of granite or grantic gneiss near the damsite are available.
Core	Alluvial deposits around the damsite are available.
7. Dam type	Rockfill dam or Earth fill dam.

Table 3-29 Geological Assessment of Bengwa Damsite (Damsite No.26)

Item	Description
1. Topography	Damsite is 25km WNW of Pemba town. Bwengwa river erodes plateau plane with 30-40m height and goes through SSE-NNW direction with open valley. Right side slope is 8-30 degrees and left side slope is 6 degrees.
2. Geology	Base rock of damsite consists of gneiss of Basement Complex. Faults are not discovered. Foliation indicate N70 E strike and 5-15 N dip and gently incline toward downstream. Distinguished joint is WNW-ESE strike and near vertical dip.
3. Foundation condition	Gneiss outcrops spread at almost whole river bed and are scattered both side slope. Sound rock is expected to be Shallow. Foundation condition is expected to be good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	40m
6. Construction materials	
Concrete aggregates	Gneiss around the damsite can be used.
Rock	Gneiss around the damsite can be used.
Filter	River deposits around the damsite are available.
Core	Alluvial deposits of lowland among low hills should be found.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

Table 3-30 Geological Assessment of Kolomo Damsite (Damsite No.27)

Item	Description
1. Topography	Damsite is 15km SSW of Kolomo town. Kolomo river erodes plateau plane with 60-80m height from the river bed and goes through NNE-SSW direction with open valley. Right and left side slope of damsite are gentle with 4 degrees.
2. Geology	Base rock is granitic gneiss of Basement Complex. Faults are not discovered. Foliation is not clear. Distinguished joints are N60E80S, N75W80S and N35W85S.
3. Foundation condition	Gneiss outcrops spread at almost river bed and are scattered at both side slope. Sound rock expected to be shallow at river bed and also rather shallow at both side slope. Foundation condition is expected good and would not require complicated treatment.
4. Possibility of construction	Possible
5. Maximum dam height	27m
6. Construction materials	
Concrete aggregates	Gneiss around the damsite can be used.
Rock	Gneiss around the damsite can be used.
Filter	Weathering zone of gneisses around the damsite are available.
Core	Alluvial deposits of lowland area among hills or tributary area should be found.
7. Dam type	Foundation condition is suitable for both concrete gravity dam and rockfill dam.

FIGURES

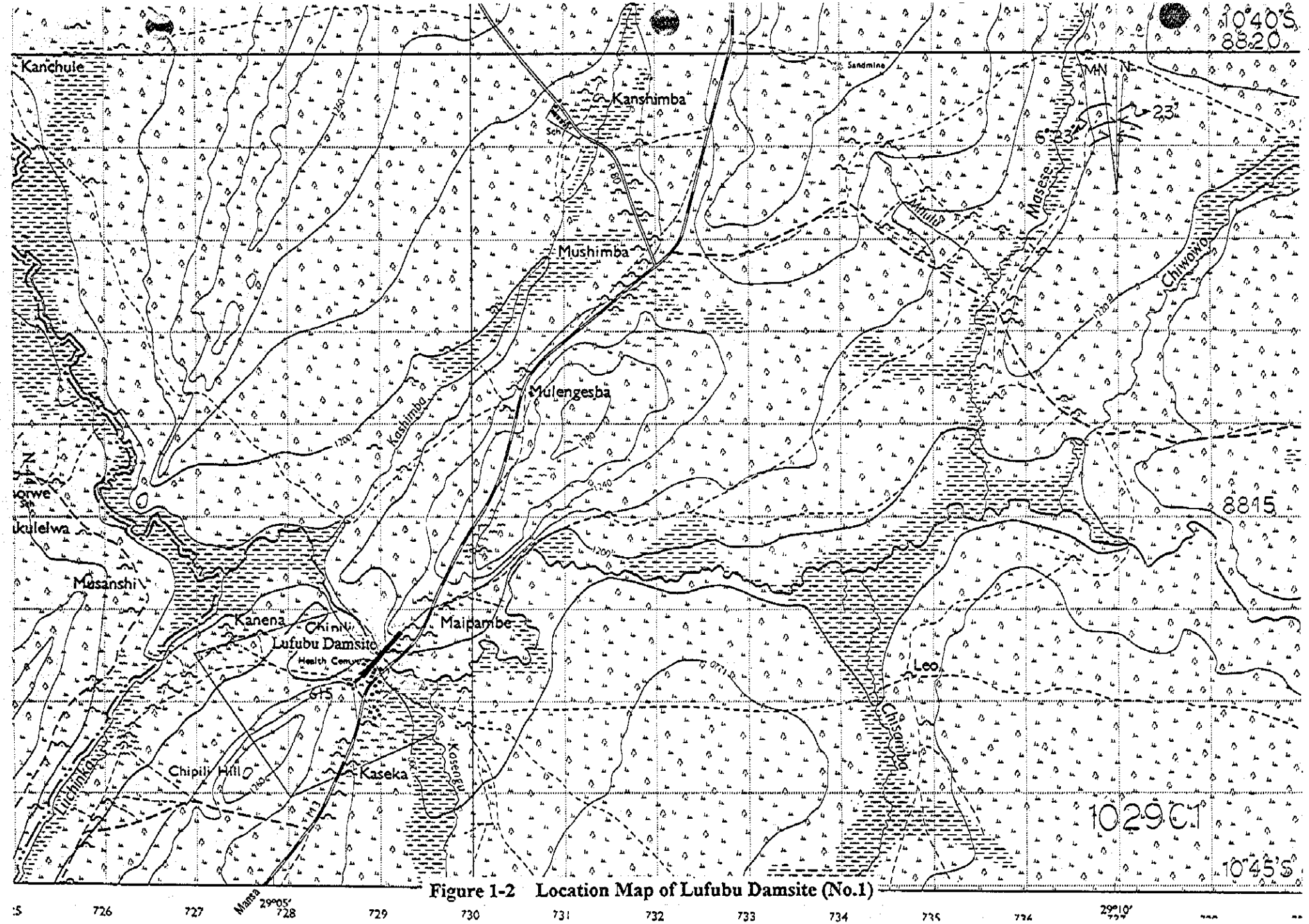


Figure 1-2 Location Map of Lufubu Damsite (No.1)

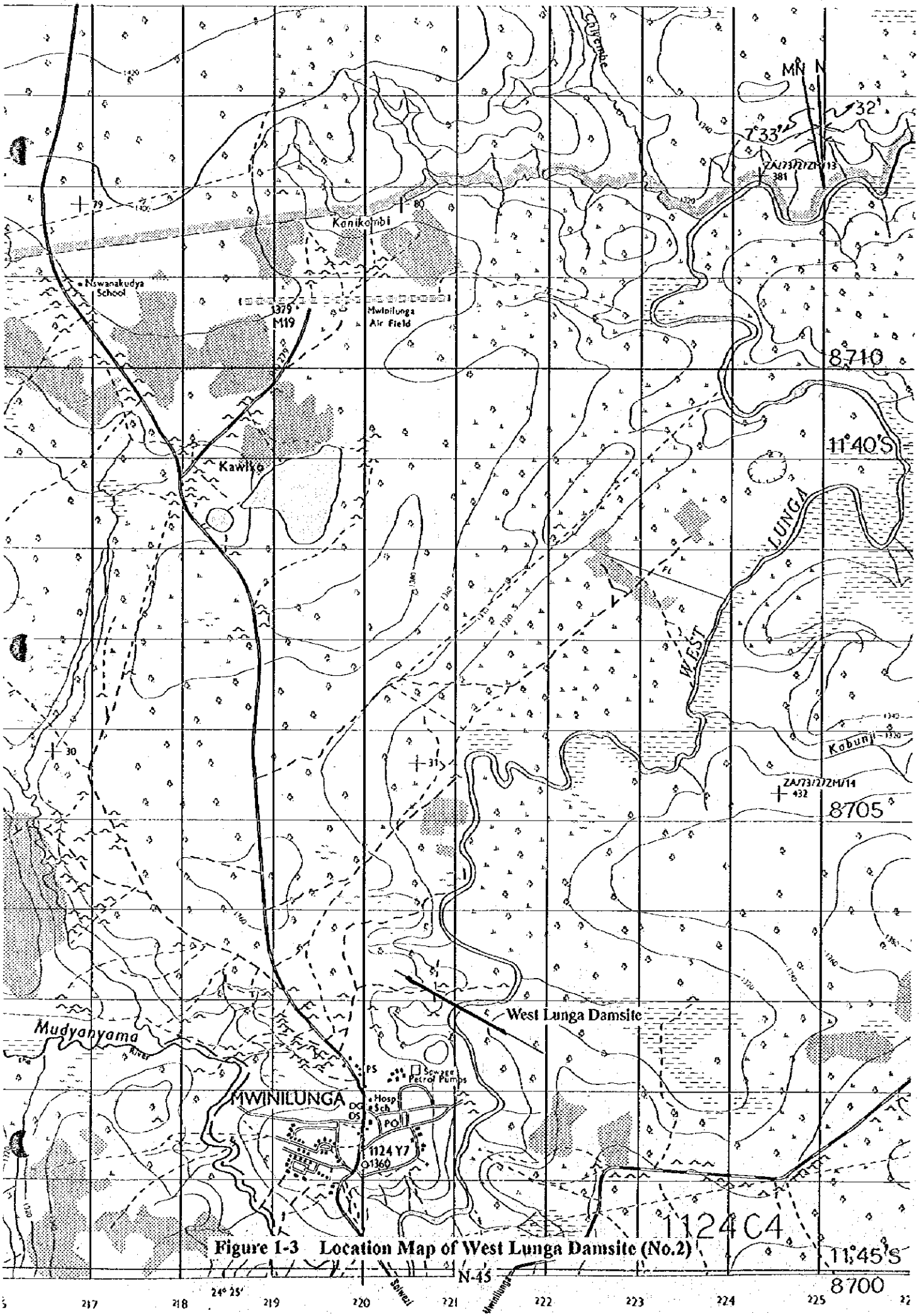


Figure 1-3 Location Map of West Lunga Damsite (No.2)

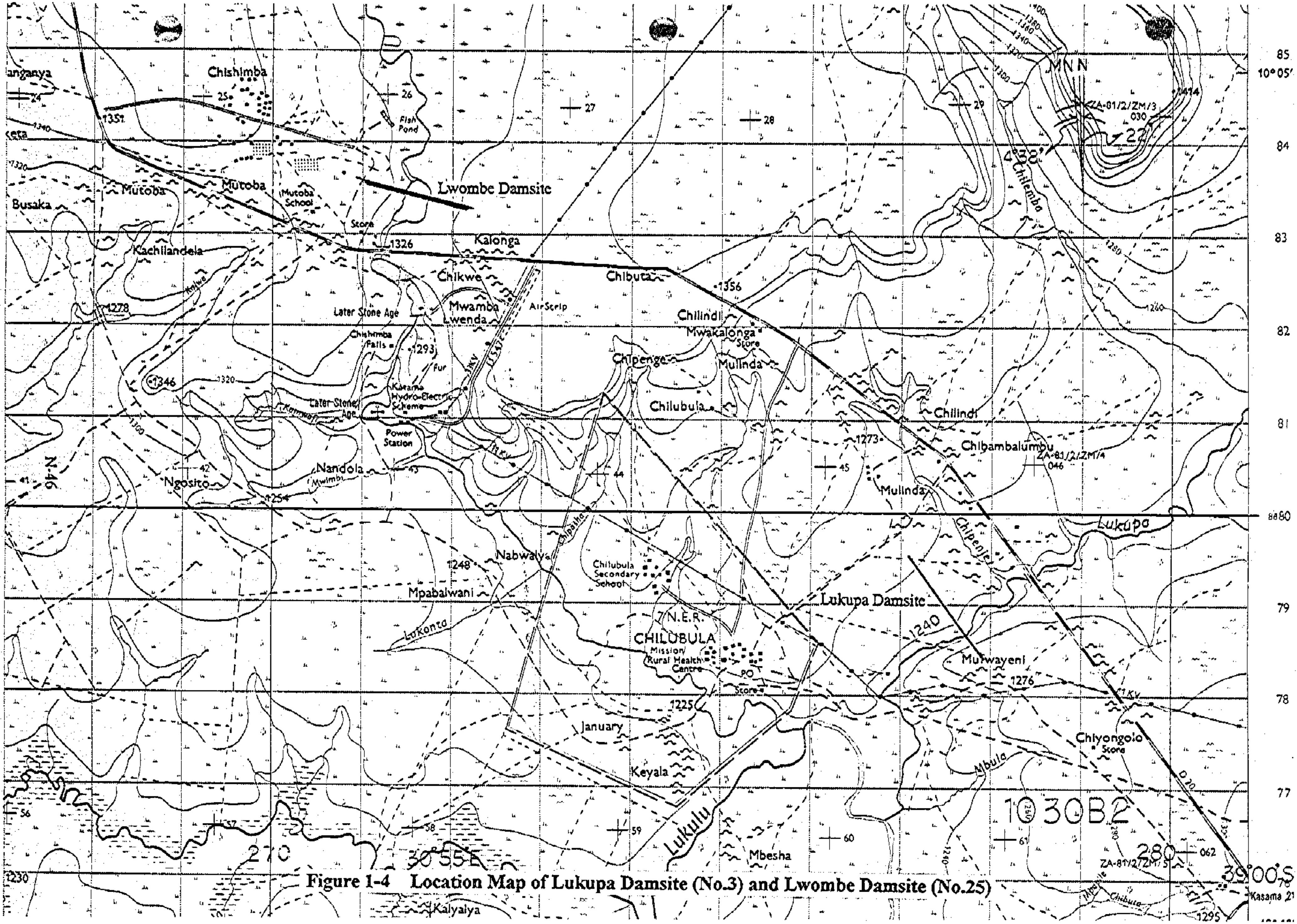


Figure 1-4 Location Map of Lukupa Damsite (No.3) and Lwombe Damsite (No.25)

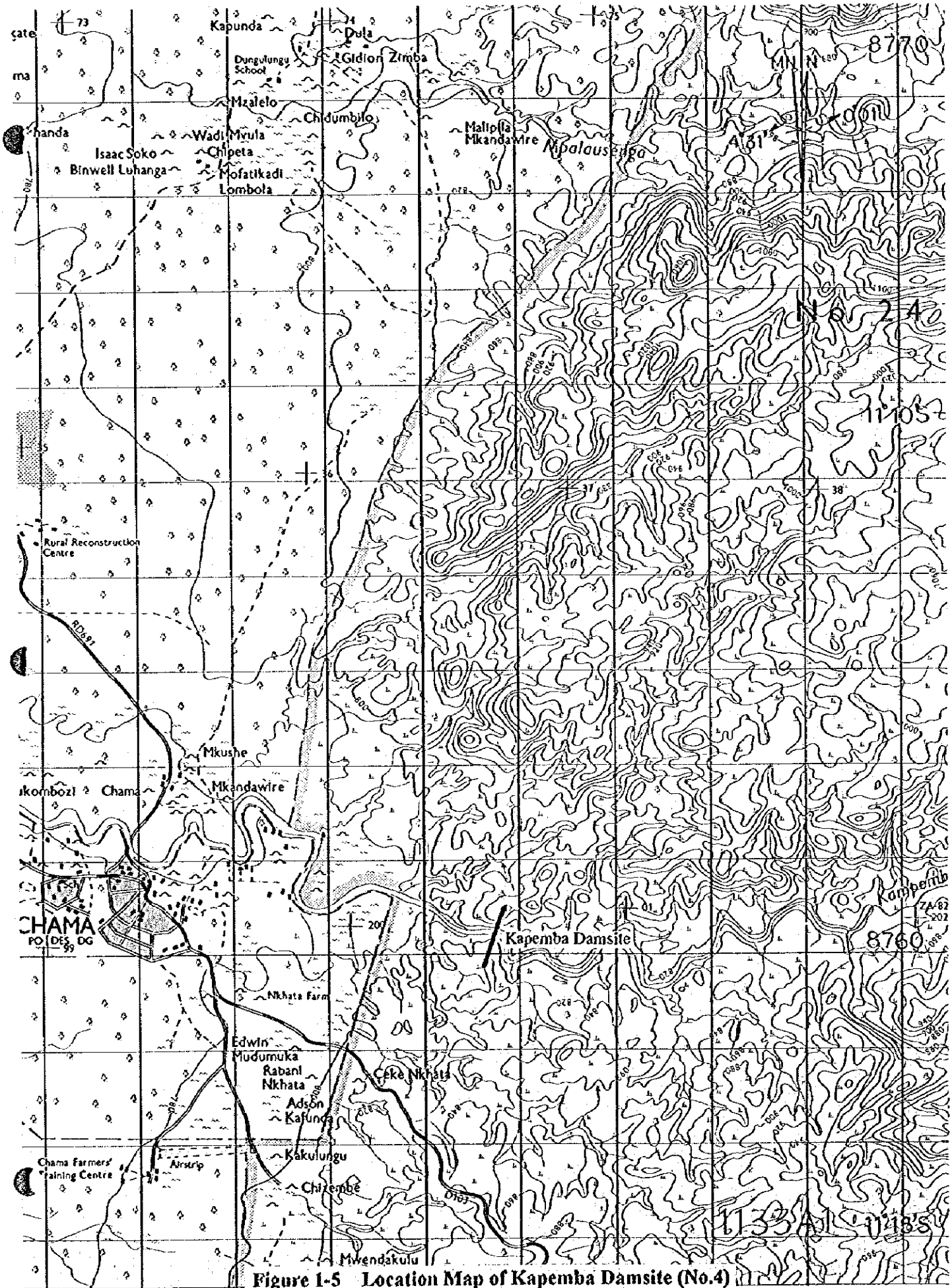


Figure 1-5 Location Map of Kapemba Damsite (No.4)

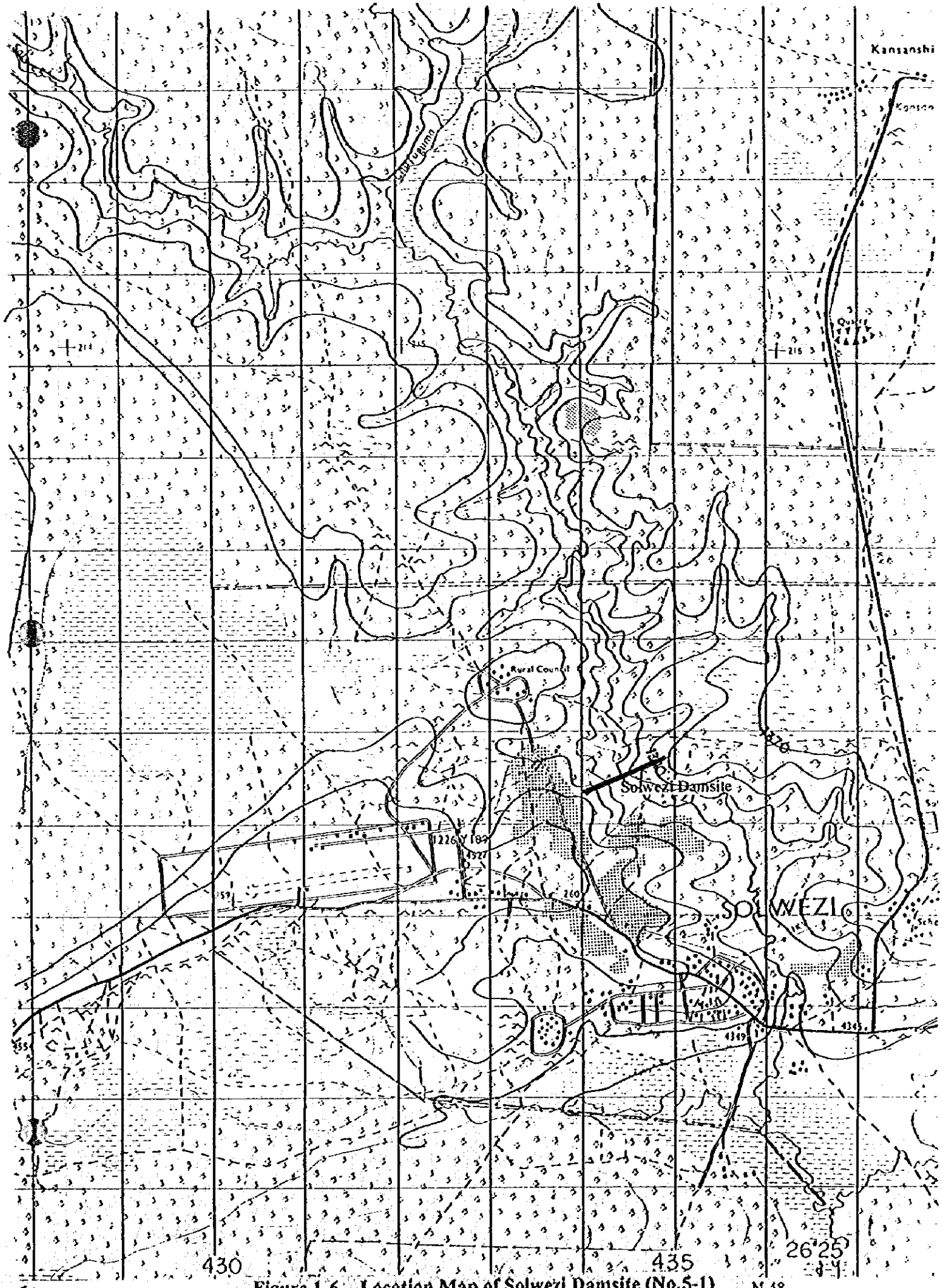


Figure 1-6 Location Map of Solwezi Damsite (No.5-1)

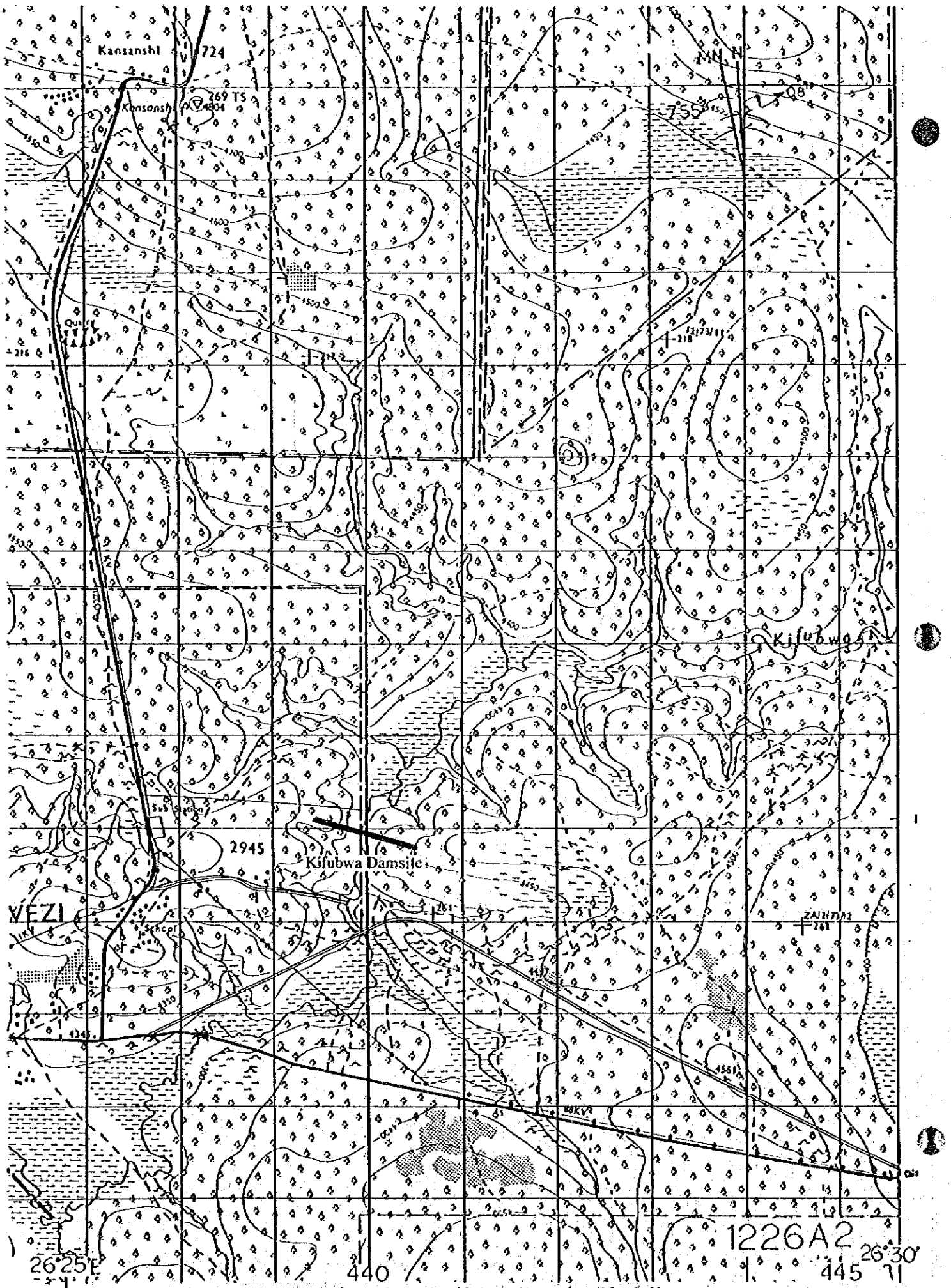


Figure 1-7 Location Map of Kifubwa Damsite (No.5-2)

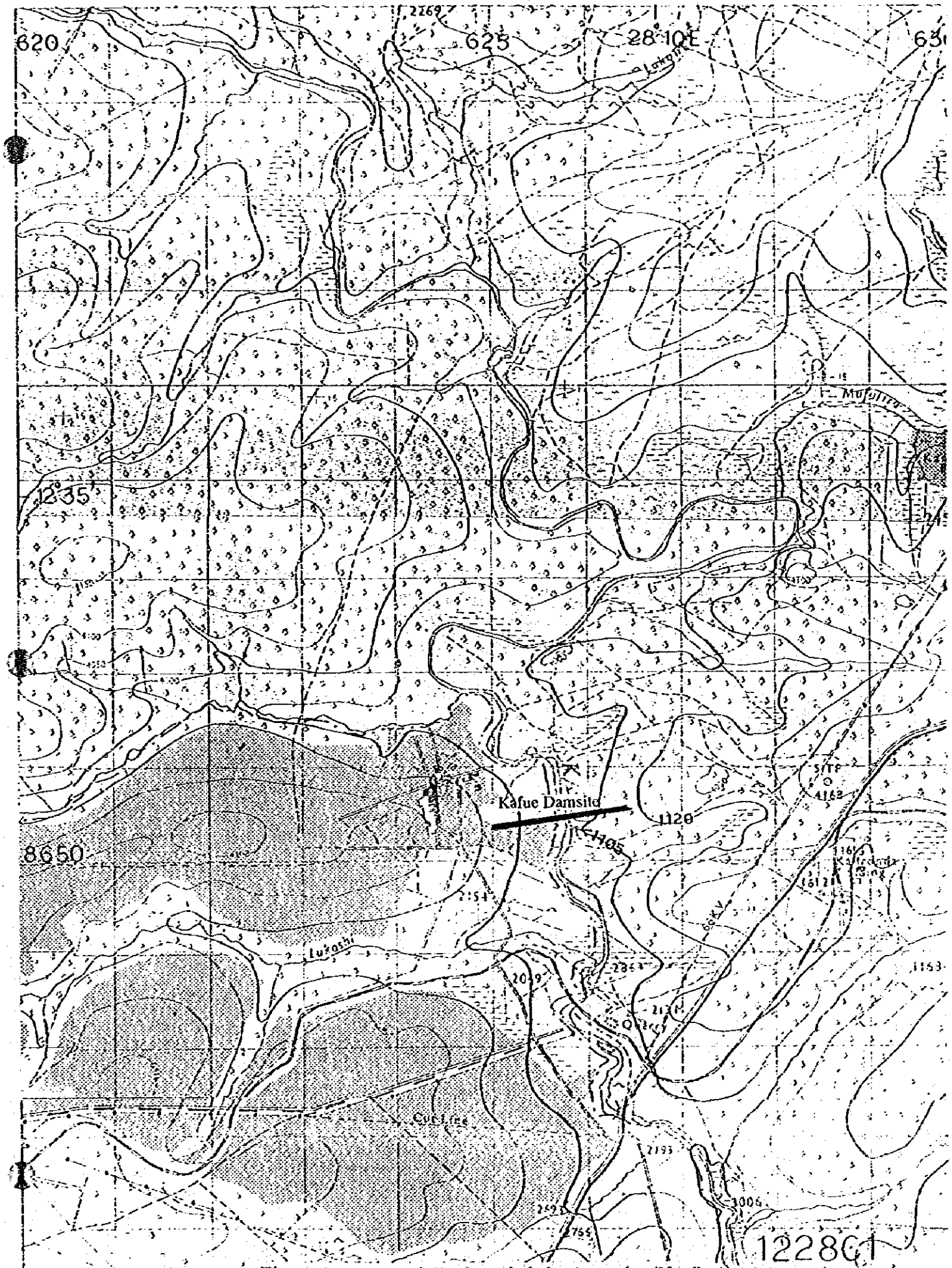


Figure 1-8 Location Map of Kafue Damsite (No.6)

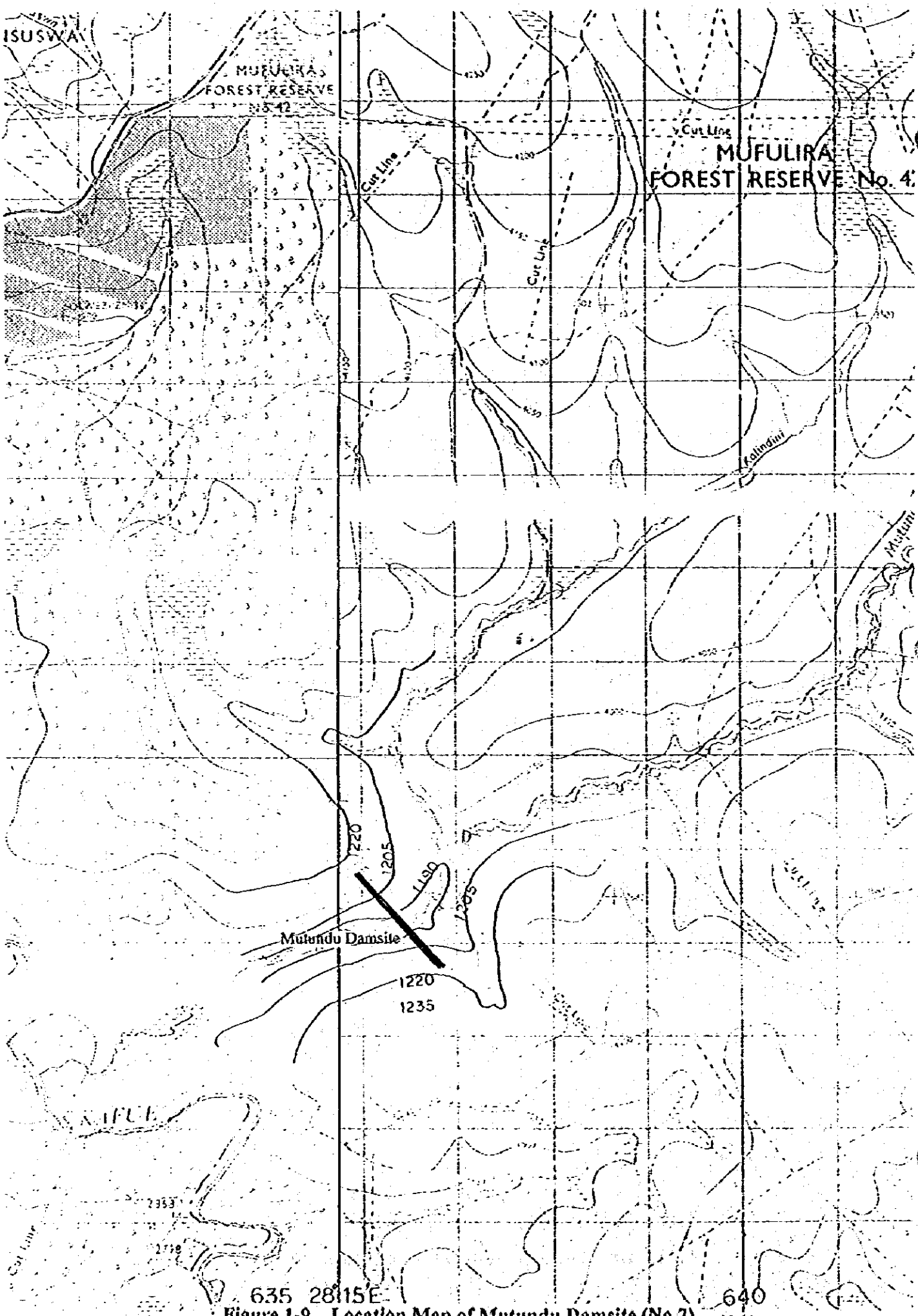


Figure 1-9 Location Map of Mutundu Damsite (No.7)

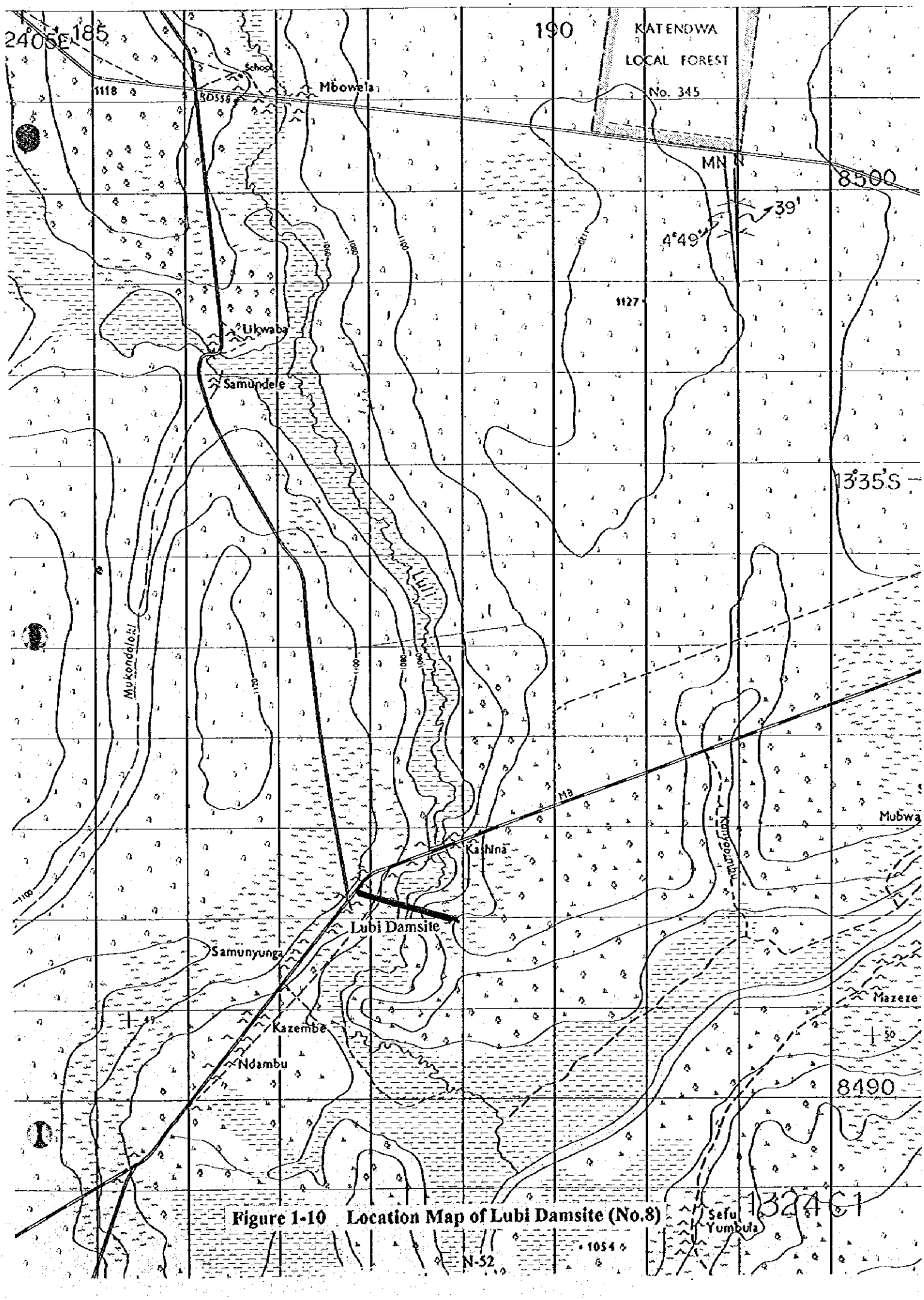
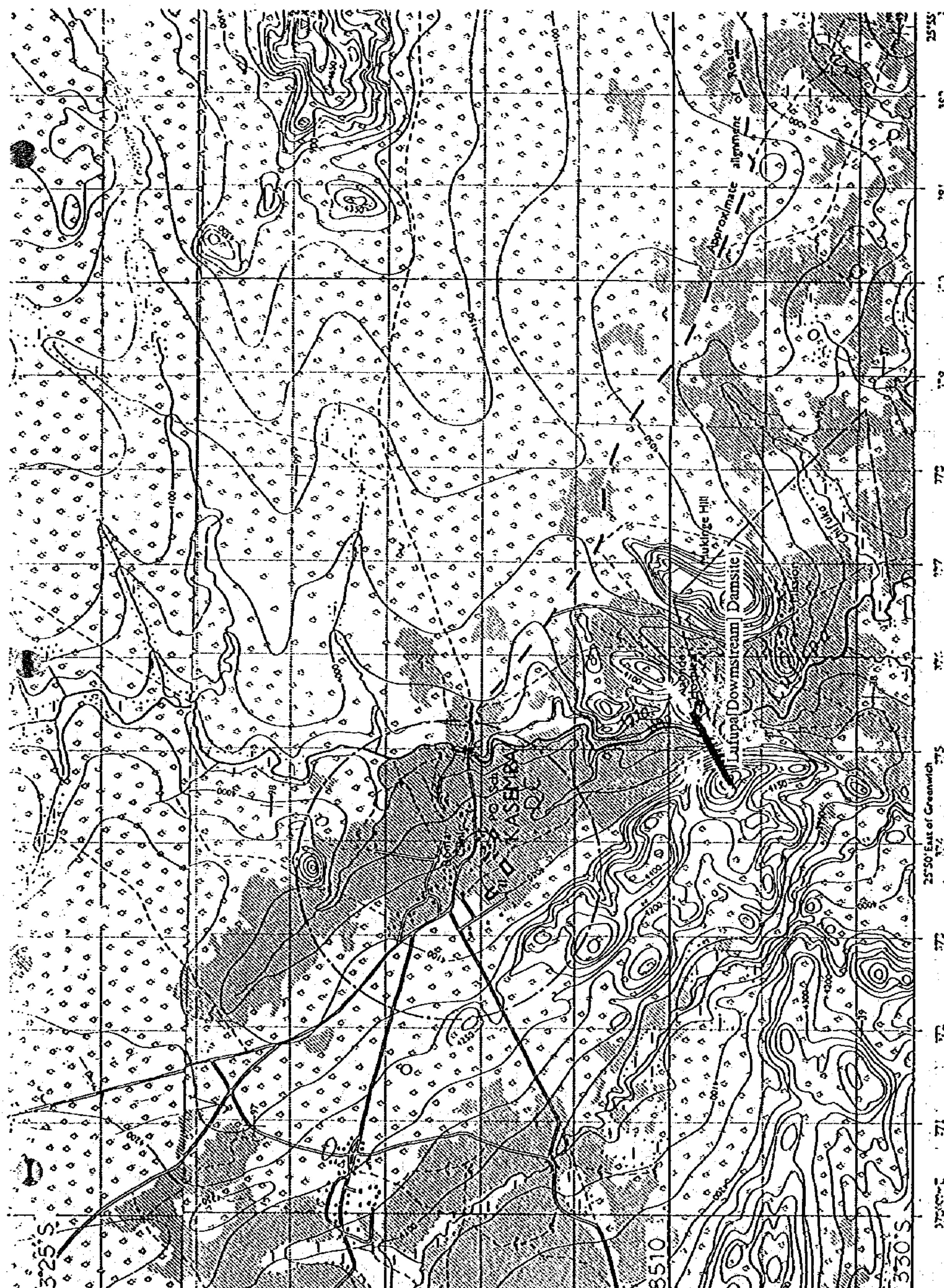


Figure 1-10 Location Map of Lubi Damsite (No.8)



Lufupa Downstream Damsite
Mukinge Hill
KASEMPA
Approximate alignment of Road
13°25'S
13°30'S
8510
25°50'East of Greenwich

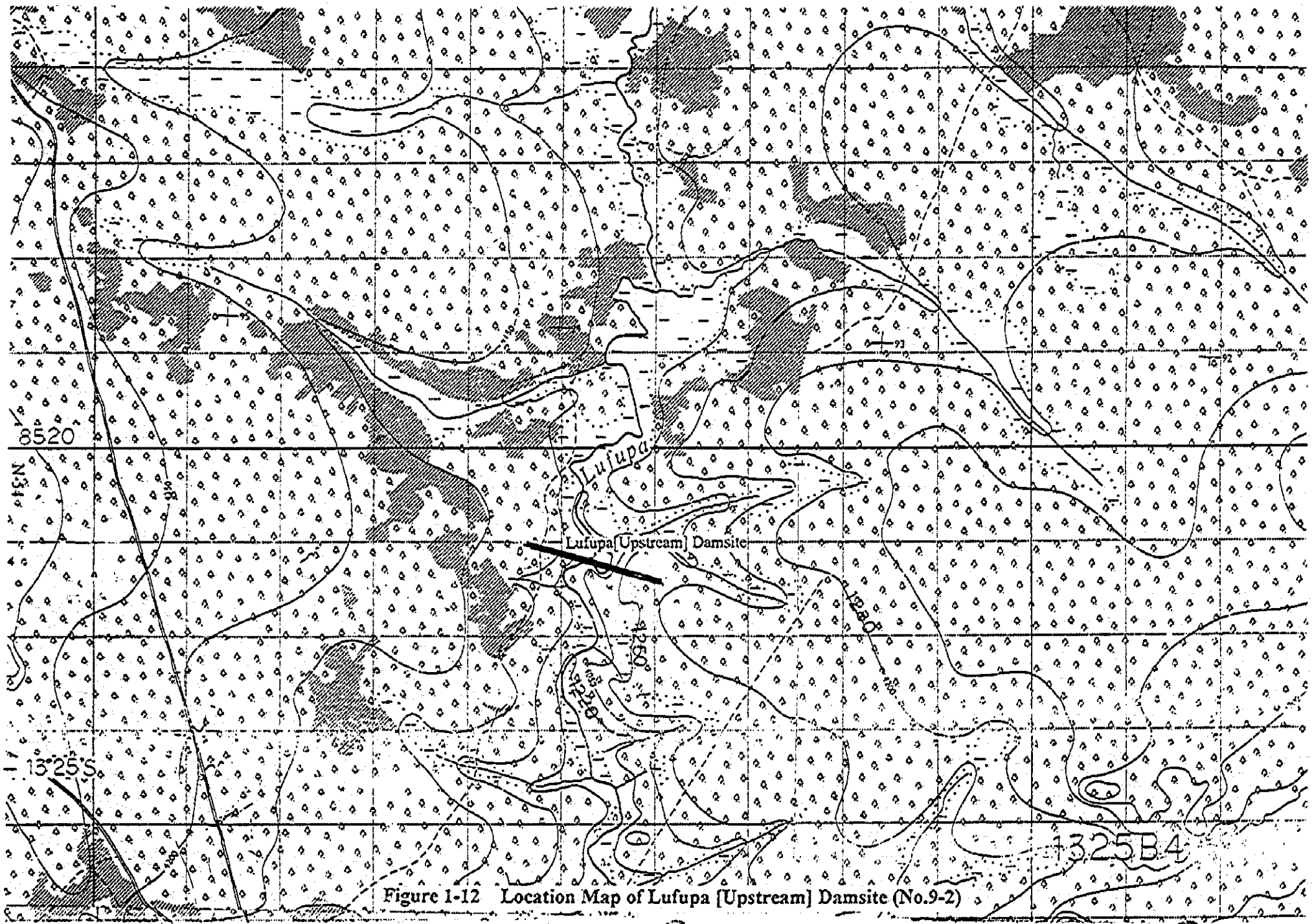


Figure 1-12 Location Map of Lufupa [Upstream] Damsite (No.9-2)

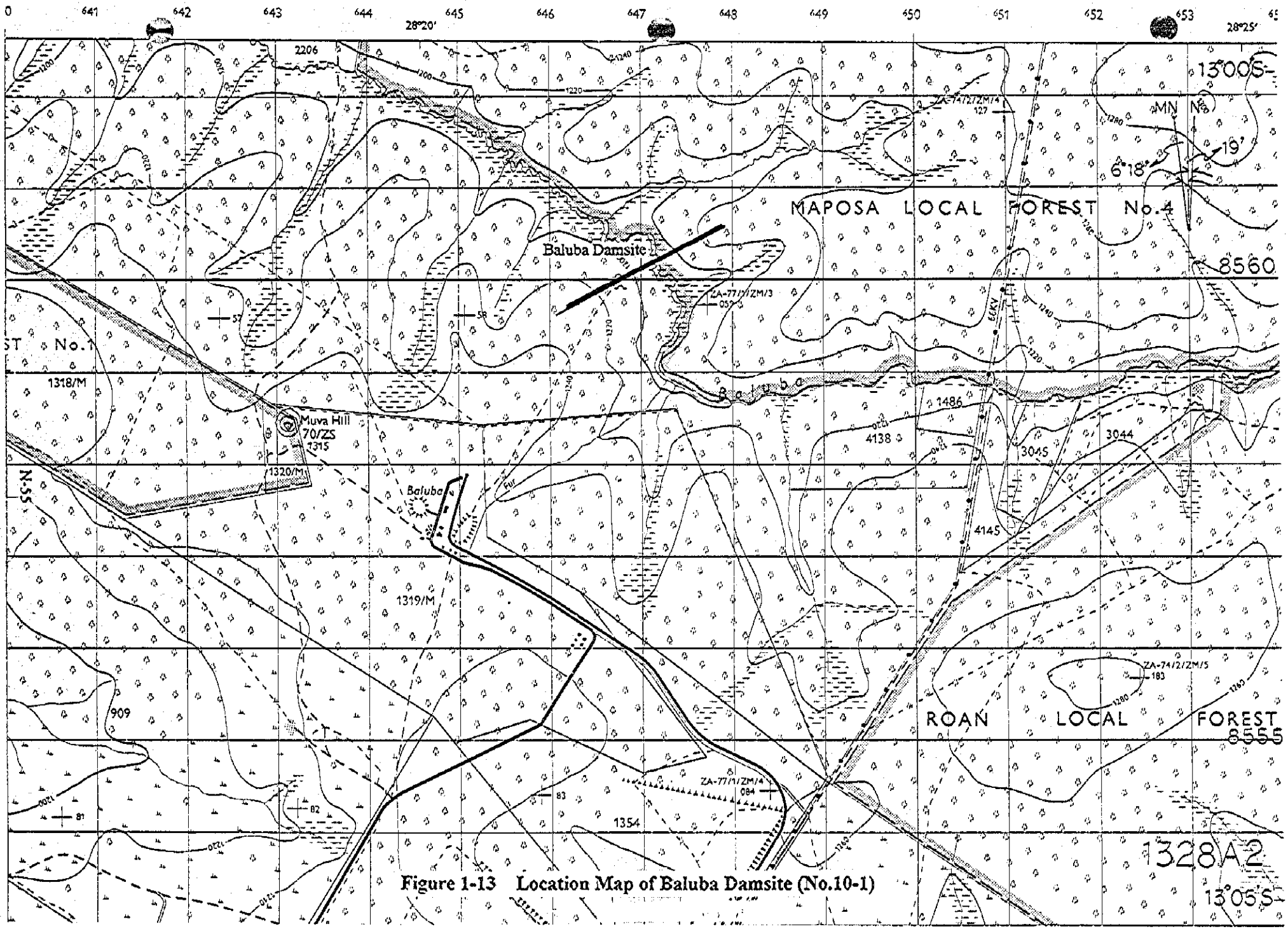


Figure 1-13 Location Map of Baluba Damsite (No.10-1)

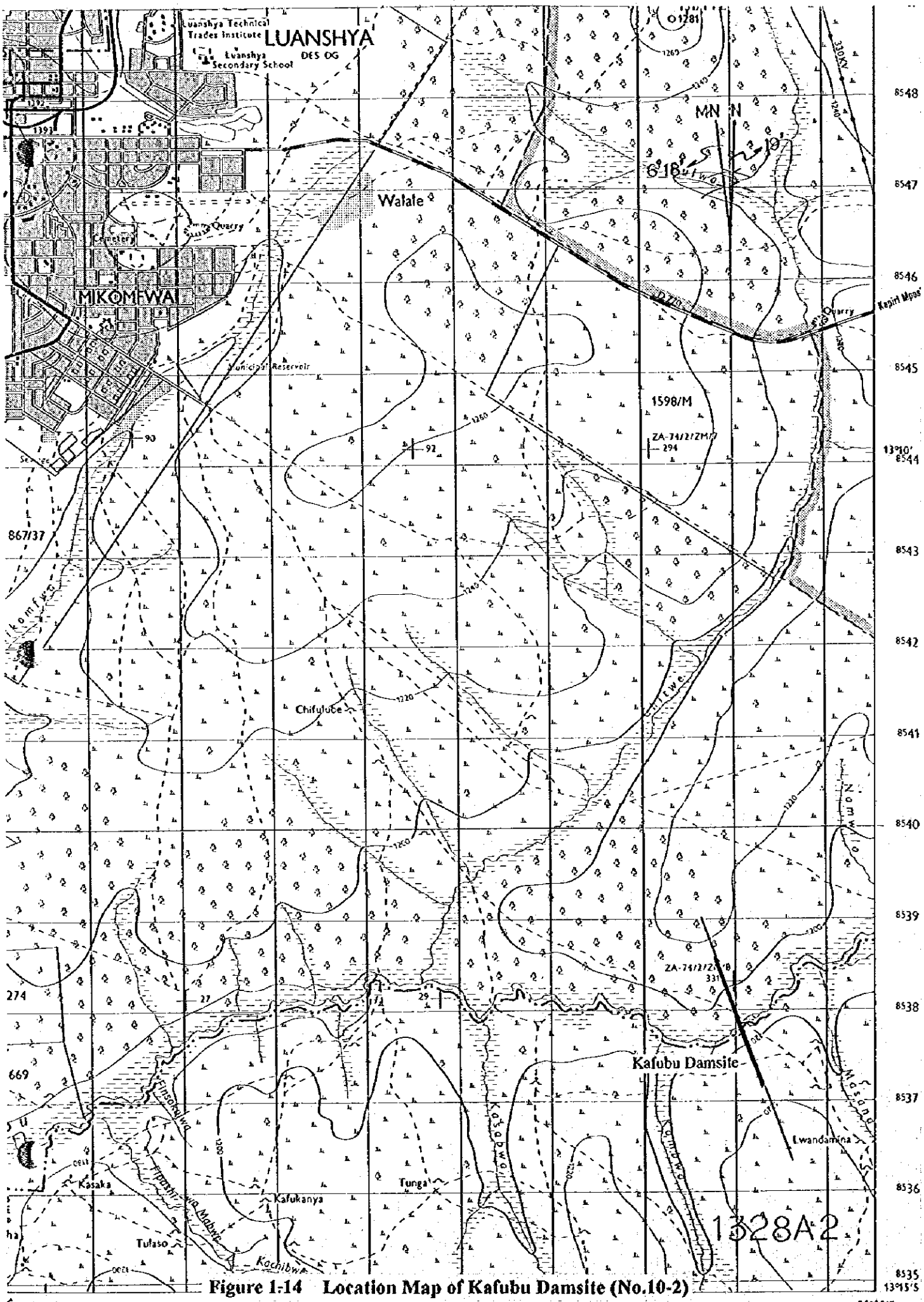


Figure 1-14 Location Map of Kafubu Damsite (No.10-2)

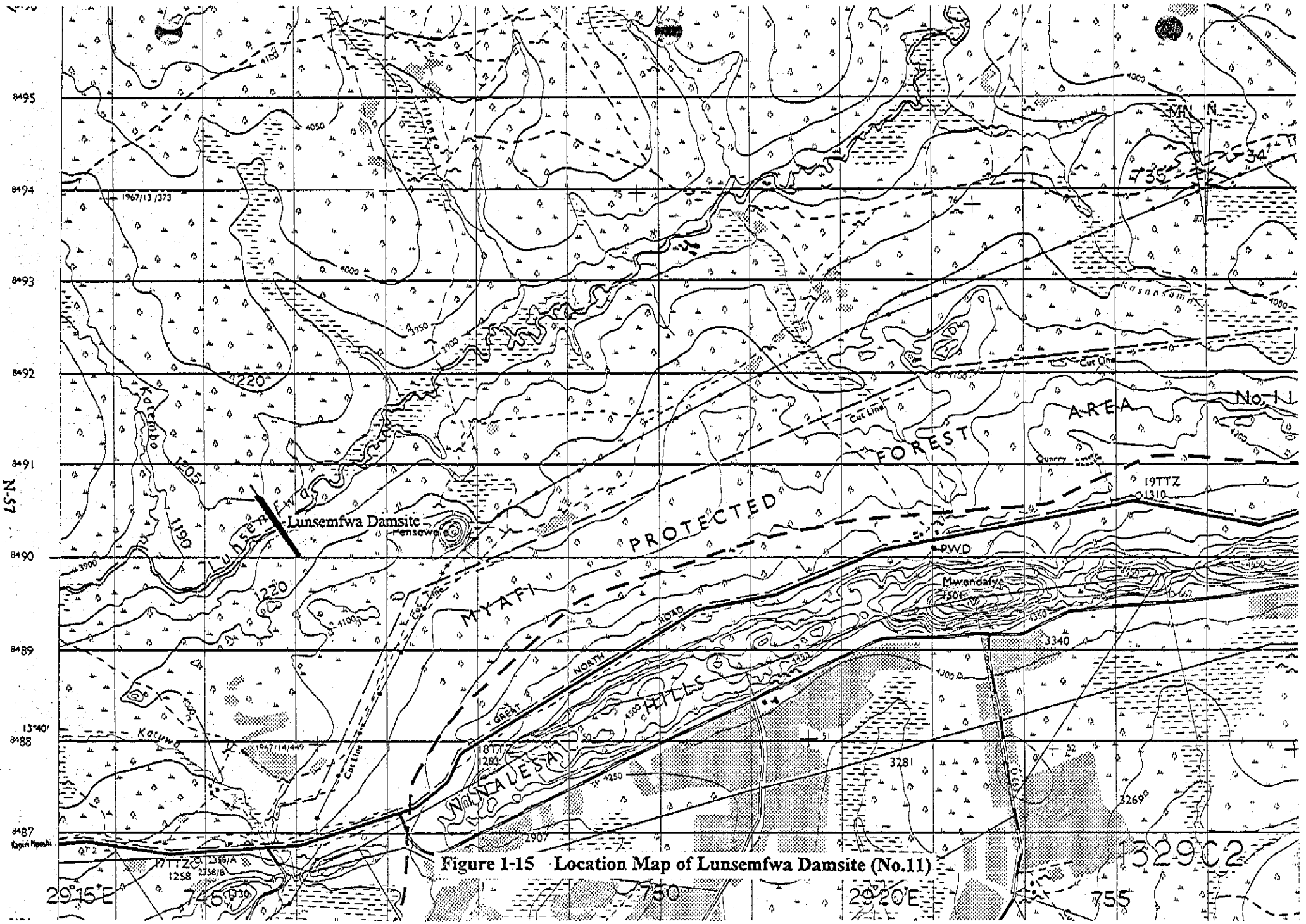


Figure 1-15 Location Map of Lunsemfwa Damsite (No.11)

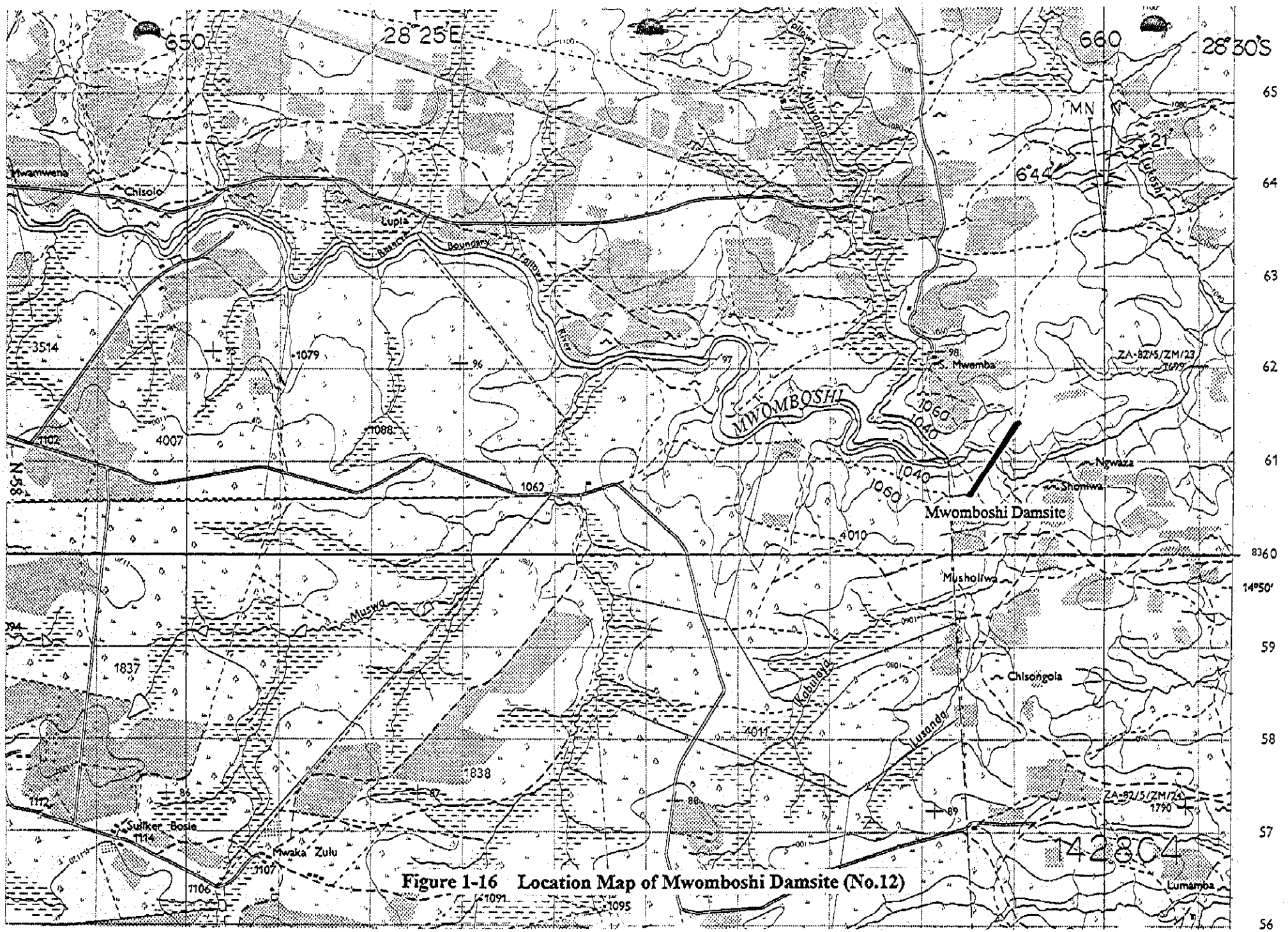


Figure 1-16 Location Map of Mwomboshi Damsite (No.12)

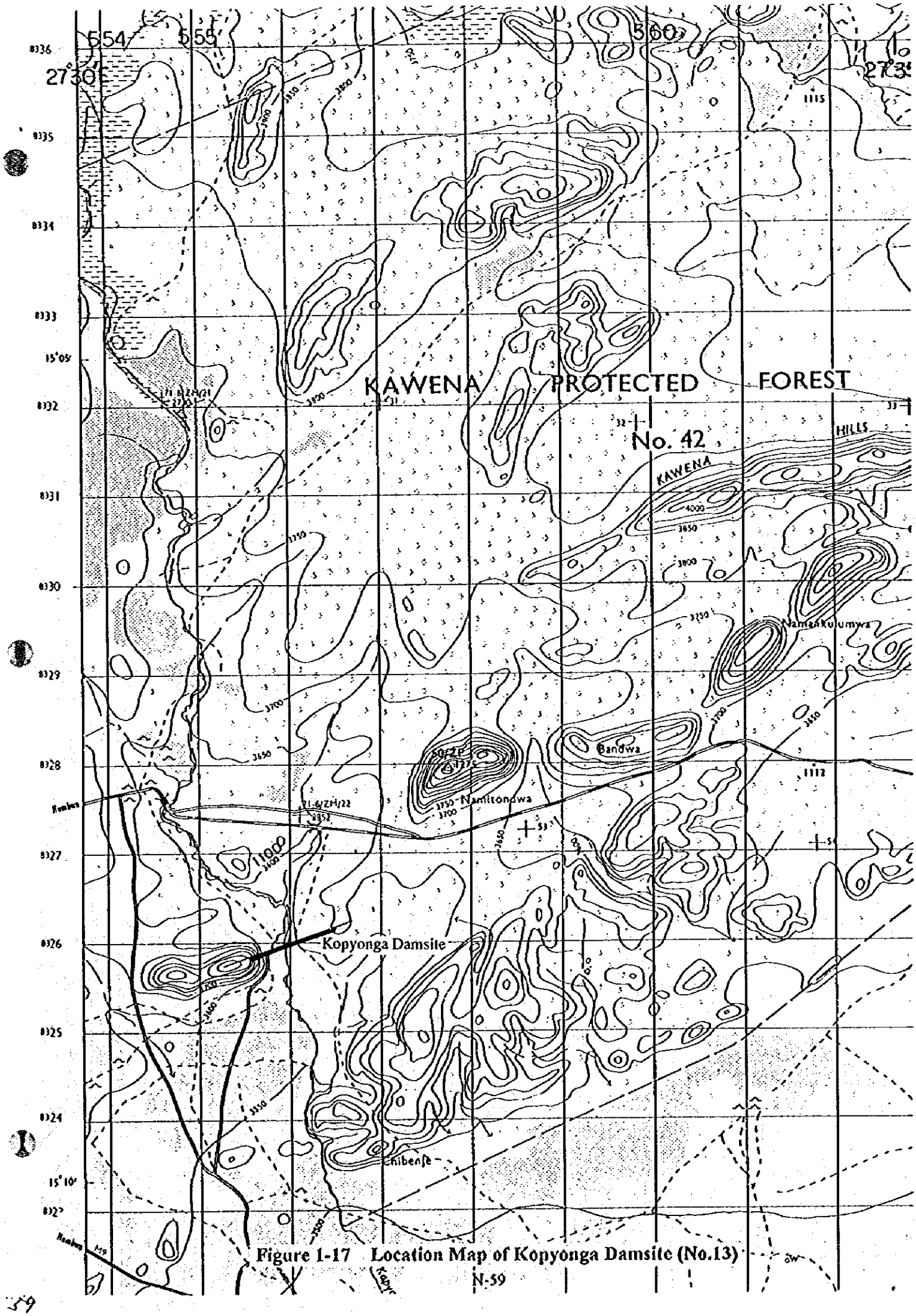


Figure 1-17 Location Map of Kopyonga Damsite (No.13)

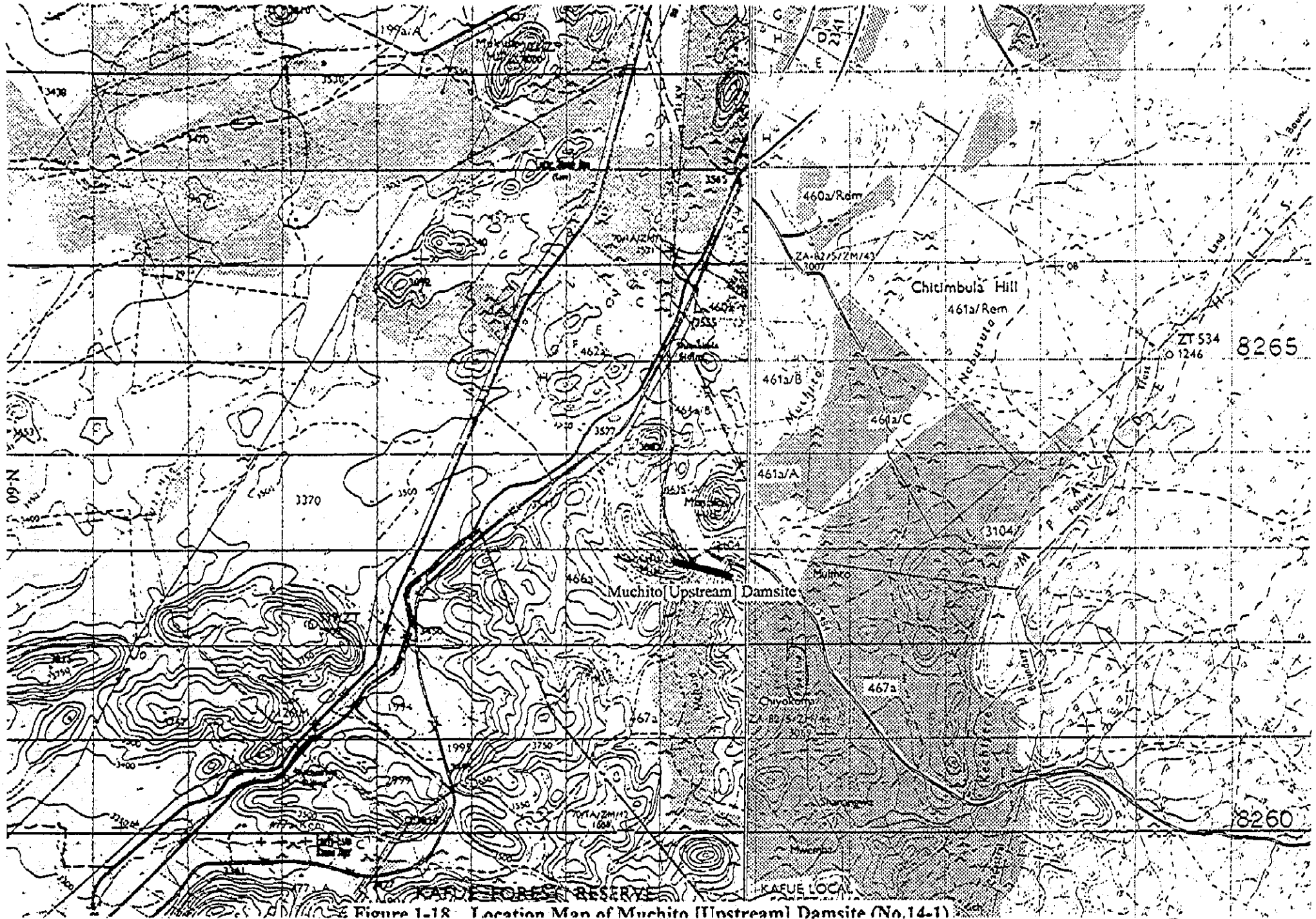


Figure 1-18 Location Map of Muchito [Upstream] Damsite (No.14-1)