SYSTEM STUDY OF SUNKOSI-KAMALA INTER-BASIN WATER-TRANSFER SCHEME (NEPAL)

A DISSERTATION

submitted in partial fulfillment of the
requirements for the award of the degree
of
MASTER OF TECHNOLOGY
in
WATER RESOURCES DEVELOPMENT

By

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DECEMBER, 2001

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in the dissertation entitled **"SYSTEM STUDY OF SUNKOSI-KAMALA INTER BASIN WATER TRANSFER SCHEME (NEPAL)"** in partial fulfilment of the requirement for the award of the **Degree of Master of Technology in Water Resources Development (WRD)** submitted in the Water Resources Development Training Centre of the Institute is an authentic record of my own work carried out during a period from July, 2001 to December 2001 under the supervision of **Dr. U. C. Chaube**, Professor at WRDTC, Indian Institute of Technology, Roorkee, India.

The matter embodied in this Special Problem has not been submitted by me for the award of any other degree.

Place: Roorkee
Date: December , 2001

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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ACKNOWLEDGEMENT

It is my previlege to express my most sincere gratitude to **Dr. U.C. Chaube**, Professor, WRDTC, IIT - Roorkee for his expert guidance, constant encouragement, valuable suggestions, help and freely sparing time for discussions, without which it would not have been possible to complete this dissertation.

I also express my sincere gratitude to Dr. B.N. Asthan, Emeritus Professor, WRDTC, Dr. M.L. Kansal, Associate Professor and All Faculty Members of WRDTC, IIT-Roorkee for providing me valuable suggestions and discussions in proceeding with this study.

(MAHAJAN YADAV)

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SYNOPSIS

Inter -basin water transfer concept emerged in the field of water resources planning and management is to correct the natural imbalance leading to largely inequitable distribution of water-resources over the vicinity from surplus water area to water deficit area.

Nepal's Trai land between Gandhak and Kosi rivers basins, is water deficit land. The majors rivers flowing in this land area, are Kamala and Bagmati rivers which are monsoon fed with discharge in non-monsoon season becoming inadequate to meet the basin demands . Mainly because of this reason, the existing irrigation projects in these basins are water deficit. Rehabilitation and modernization of the existing projects and further extension of irrigation activities for year round irrigation in these basins have become critical to any further development above the present unsatisfactory low level. The concept of inter basin water transfer applies here to correct the natural imbalance of water distribution. This dissertation study deals with the Sunkosi Kamala inter-basin water transfer scheme. The present trend of water resources development and previous feasibility studies of Sunkosi diversion, suggest the possibility of Sunkosi Kamala inter-basin water transfer scheme.

In water balance study, multipurpose demands and water availability in Kamala basin have been computed with the purpose to find out the water status of the basin. This study shows that Kamala basin is water deficit basin (2335 MCM). The water balance study of Sunkosi river basin shows that it is a water surplus basin (26458 MCM). It is possible to transfer surplus water to meet the balance demands of the Kamala basin. Study also shows that this transfer has no adverse impacts in down stream of Sunkosi and Sapta Kosi.

In linear programming model study, a deterministic L.P model has been developed and used to study various technological options such as changes in cropping patterns, cropping intensity, conjunctive use of surface water and ground water with and without storage on Kamala river and with and without water transfer from Sunkosi to

Kamala. The outcome of the L. P. model computations have been used in finalizing the cropping pattern and cropping intensity.

The long term reservoir operation simulations have been done with 19 years data series for annual irrigation reliability and minimum height of Kamala reservoir to meet the basin demands.

The results of the simulation so that Sunkosi releases the Kamala basin demands with only one month (one year) failure with the time and volume reliability as 99.5% and 99.6% respectively. The results of Kamala reservoir show four months failure in 3-years at 83.3% of annual irrigation reliability with time and volume reliability as 98.1% and 99.7% respectively. There is only one year critical failure in July 1982 in this reservoir.

INTRODUCTION

1.1 GENERAL

Nepal's Terai land between Gandhak river and Kosi river basins has large irrigable fertile land which at present is deprived of reliable irrigation. The major rivers flowing in between these basins, are Kamala and Bagmati , which are monsoon fed with discharge in non-monsoon seasons becoming inadequate to meet the irrigation demands. Mainly because of this reason, the existing irrigation projects in these basins are water deficit. Rehabilitation and modernization existing projects and further extension of irrigation activities for year round irrigation have been envisaged in Agriculture Perspective Plan of Nepal.

The present trend of water resources development in water deficit basin, is to meet the demand of the basin through inter-basin water transfer. Inter-basin water transfer is an useful concept in the field of water resources planning and management to correct the natural imbalance leading to largely inequitable distribution of water-resources over the vicinity from surplus water area to water deficit areas.

Among the two expectedly water surplus basins (Gandhak and Kosi), the Sunkosi river, a tributary of Kosi river has large amount of surplus water to feed the Kamala basin. The present trend of water resources development and past feasibility studies of Sunkosi diversion, suggest the possibility of Sunkosi-Kamala inter-basin water transfer scheme (Nepal).

1.2 OBJECTIVE

River basin being the natural unit for water resources planning and implementation, the main objectives of the study are as follows.

(i) To assess the multipurpose water demand and conduct basins water balance study in a scientific manner.

Guidelines developed by National Water Development Agency of India have been adopted to assess the multipurpose water demands i.e., irrigation demand, domestic demand and industrial demands .

(ii) To formulate and solve a deterministic linear programming model for optimization of cropping pattern and cropping intensity:

(iii) Long term reservoir simulation study to analyze reliability of inter basin water transfer scheme.

1.3 LITERATURE REVIEW

1.3.1 Inter-Basin Water Transfer

Inter- basin water transfer is becoming a popular concept in the field of water resources planning and management to correct the natural imbalance leading to largely inequitable distribution of water-resources over the vicinity from surplus water area to water deficit areas.

Trend of water resources development for meeting human needs is by the construction of dams that create reservoir for the storage and future distribution. Currently , there are about 45000 dams higher than 15m throughout the world. About 30-40% of irrigated land worldwide now relies on dams. About 800 million people benefit from food produced by dam related irrigation.

In a related development of utmost importance in India, the recent Supreme Court Majority of Judgement for Narmada project observed that dams have positive impacts on preservation of ecology, like arresting degradation in drought prone, arid and semi-arid lands, arresting advance of deserts, arresting groundwater depletion, water quality improvement ,increasing green coverage, preservation of already degraded environment would be brought into the social mainstream to enable them the benefits of a better environment and proportion of people benefited to those affected is 100:1. (**Ref.: Water Resources and Environment Management in India-** Antagonism against large dams unjustified)

The inter-basin links and inter district (region) projects would physically make the regions inter dependent.

The national perspective plan prepared by National Water Development Agency (India) have maximum component of engineering planning. The national perspective plan brought out by N.W.D.A has two main components of

(i) Himalayan River Development

(ii) Peninsular River Development

1.3.2 Some examples of Inter Basin Water Transfer Scheme

1.3.2.1 Himalayan River Development Components

The examples of the proposed link under Himalayan rivers are as follows (Fig. 5)

1. Kosi -Mechi
2. Kosi- Ghagra
3. Gandak - Ganga
4. Karnali -Yamuna
5. Sarda -Yamuna
6. Brahmputra -Ganga (Alternative I)
7. Brahmputra -Ganga (Alternative II)
8. Brahmputra -Ganga (Alternative III)

1.3.2.2 Peninsular River Development Components

The examples of proposed links under peninsular river development components

1. Mahanadi-Godavari
2. Indravati -Wainganga
3. Krishana (Srisailam) -Peninar (Prodattur)
4. Krishna (Almatti)-Peninar
5. Godavari (Inchampalli) -Krishna (Pulichinatala)
6. Bedti-Varda
7. Netravati -Hemavati
8. Parbati-Kalisindh-Chambal
9. Par-Tapi-Narmada

1.3.2.3 Examples from Other Countries:

Many inter-basin water transfer projects have been executed in different countries and several studies have been concluded for the project executions. Some of the examples are as follows:

1.3.2.4 United States

(i) The California's state water project which diverts water from northern California to the drier central and southern parts of the State was completed in 1973.

(ii) The Texas water plan envisages redistribution of water in Texas and New Mexico to meet the needs of the year2020.

(iii) The water of the Colorado river which is the international river between USA and Mexico is being supplied outside the basin to the imperial valley in the California (USA).

(iv) In Mexico, for the Mexico city water supply, transfer of groundwater from the Lerma basin was completed in 1958.

1.3.2.5 Canada:

(i) The major existing inter-basin transfer projects are Kemano, Churchill, Diversion, Welland canal, James Bay.

(ii) Proposed enter-basin water transfer schemes in Canada are North America water and power Alliance (NAWAPA), Canadian Water Magnum plan, Central North American Water Project (CNAWP), etc. for transfer of water from Canada to U.S.A.

1.3.2.6 Srilanka:

(i) The Mahaveli project includes several inter-basin transfer links.

1.3.2.7 Kazakhistan:

(i) The notable scheme executed is the Irtysh Karganda scheme in the central Kazakhistan.

1.3.2.8 China:

(i) The Lilnua canal was completed in 214 BC.

(ii) The Grand canal was completed in 605 AD.

(iii) Recently completed projected in China is Biliuna-Dalian inter-basin water supply system.

(iv) Trans-basin transfer of Luhana river to Tiajian and Tengshan,

(v) Diversion of Quiantang river water, diversion of Yellow river surpluses and South to North transfer projects with the West route, middle route and East route are other proposed projects in China.

1.4 PREVIOUS STUDY OF THE PROJECT

1.4.1 Study by Nippon Koei

His Majesty's Government of Nepal had sponsored, the pre-feasibility study of irrigation potential in the Terai region (The Sunkosi Terai Project). Nippon Koei Co. Ltd. Tokyo Japan (1968), carried out preliminary benefit cost analysis of the project and completed the study in various alternative in 1972. The first proposed site was as at Kamphu ghat in Udayapur district to irrigate Saptri and Sirha districts through the Sunkosi-Trijuga Diversion (Plan A). The second site was at Kurule in Udayapur district to irrigate additional districts of Dhanusha, Mahottari and Sarlahi through 'Sunkosi-Kamala diversion (B Plan). The third site was at Gwaltar (Plan C) an alternative scheme to develop higher power potential than the B plan. In further upstream reaches of the Sunkosi ,fourth site at Khurkot was studied as D plan from the view-point of a general study of the effective use of water for the entire land area 526000 ha(1.3 million acres) by diverting 'Sunkosi-Marin(Bagmati)

To select the most suitable one among the above various schemes, Benefit-Cost study was carried out of all the four sites and the B plan was found to be the most one suitable among all not only based on B/C ratio but in consideration of the wide irrigable area as well as the high power potential promises.

1.4.2 Kosi Basin Master Plan Study

The Sunkosi-Kamala diversion project was studied in further detail in 1984 by JICA-sponsored Kosi basin master plan study. This report envisages that the water resources of the Kamala basin would be augmented by a diversion of 72.0cumecs from the Sunkosi river effected by a low diversion dam on Sunkosi near Kurule in Udayapur district through a 16.6km long tunnel and associated 61.4mw power station. The diversion flow would enter the Kamala watershed upstream from the proposed Kamala dam site at Chissapani in Dhanusha district. With the construction of the Kamala dam and associated 32mw power house, the combined natural and diverted flows would be re-regulated to supply a total Net Command Area (NCA) 175100 ha from the Chisapani barrage head works site.

1.4.3 Irrigation Master Plan Study

This study envisages that the total NCA of 175100 ha proposed in the JICA report is very large -67200 ha on the left bank (Sirha and Saptri districts) and 107900 ha on the right bank (Dhanusha,Mahottari and Sarlahi districts). The left bank main canal would be very long above 70.0km and would cross several significant rivers and streams. Therefore, the Master Plan Studies concluded that the maximum NCA that can be developed for year -round irrigation cropping is about 138000 ha assuming that the diversion is limited to 72.0 cumecs as recommended in the JICA report. There would be scope, however for providing additional flows by enlarging the diversion tunnel, as the reliable low flow of the Sunkosi at the diversion point is substantially higher than proposed diversion flow.

THE STUDY AREA CHARACTERISTICS

2.0 GENERAL

The availability of land decides both the potential and limitation of agricultural production. Therefore in the formulation of the basin master plan it is important to have an appraisal of available land resources in the basin and there limitations. The study of master plan for irrigation development Nepal has concluded the land of the three districts namely Dhanusha, Mahottari and Sirha as the size of the study area considering the sustainability of the irrigation systems.

2.1 BASINS STUDY

2.1.1 Kamala Basin

2.1.1.1 General

Kamala river basin is a medium scale of basin with a catchment area of 2100.0 km^2. The length of the Kamala river upto the proposed Chisapani reservoir site is about 57.0 km . The location of the river is between $27^0$17'N to $26^0$36'N latitude and between $85^0$45'E to $86^0$30'E longitude. Kamalal river originates in Sindhuli district and flows in south -east direction in the district while it flows in north to south direction in Terai belt where it is the border boundary between Dhanusha and Sirha districts.

The main tributaries of the Kamala river are as follows.

1. Chadaha Khola
2. Tawa Khola

Kamala is a monsoon type river which originates in Sindhuli district from Mahabharat mountain range and flows at an average height from 530m to 163 m in Sindhuli district and from 163 m to67 m height in Terai plain. The averge width of the river in up stream of the reservoir point is about beween 200 m to 500m while in down stream site in plain area the average width is between 500 m to 2000 m.

2.1.2 Sunkosi Basin

2.1.2.1 General

Sunkosi river is the western tributary of Saptakosi river system of eastern Nepal. Sunkosi is called Bhhotekosi in the head region and comes from Tibet. It enters into Nepal at Kodari and from there it flows to the south-west and meets Sunkosi river at the Sunkosi Bazar. Up to Dolalghaat, the distance traveled by the river is 50km and from Dolalghat to Tribeni where it joins Saptaksi is 219 km within the surface of 27 38'-0"N latitude to 26-55'-15"N latitude and 85-42'30"E longitude to 87-10;-0"E longitude. The general direction od Sunkosi in upper reaches is S30W, in middle part S30E (Tectonic), lower part S40E (Tectonic) and lowest part is S70S (Tectonic). From Dolalghat the river takes south –eastern course up to Dumja where it meets Rosikhola. At Dumja the river valley is nearly ½ to 1 kmwide. From Dumja the river course becomes more easterly and parallel to the hill ranges. The river channel starts meandering sometime cutting the northern bank and other times touching the southern bank. Wide and long flood plains occurs on the either side of the meander in alternate fashion where people grow rice and other cereals. The main tributaries of the Sunkosi from west to east are as follows.

1. Bhotekosi
2. Sunkosi
3. Balephi Khola
4. Indrawati Khola
5. Rosi Khola
6. Tamakosi
7. Likhu Khola and
8. Dudhkosi.

2.1.2.2 Hydrology

Sunkosi river makes its valley on the mid-land area. The Sunkosi valley is at height of 2000 ft from msl . The rocks on the mid-land zones are highly folded, fractured and are loose. The River follows mostly the weak zones like fault ,fold and lineation or strike of the rocks.

The catchment area of Sunkosi river is 19230 km^2.It loads the sediments of about $54.2*10^6 m^3$ and $2818m^3$ per sq.km. In an investigation of the mean flow versus drainage area of Sunkosi at Pachurwarghat, it is found that 4290 drainage area in square kilometer and ratio of mean flow in cumecs square km. of drainage area is 0.04.In a study of maximum discharge versus the drainage area at Komphughat is found that in 17600 drainage area square km. ,The ratio of maximum cumecs to drainage area is 0.53.The river practically follows an axis of anticline. On the both sides of the river valley the rocks consist dominantly of phyllite and quartzite and rarely dolomite. The river becomes narrow after "L"bend taaht is near Dudhkosi confluence, where dolomite is exposed .Near Kopmpughat a series of thrust plains and main boundary fault touch the river course and churiya formation comes close to the river bed. In central Nepal ,Sunkosi makes a short bend to the east and produces a wide valley with the flood plain terraces and meanders.

Sediment is dominant in Sunkosi. It has big boulders scattered in the river deposited by its local tributaries. The sediment consists of mostly quartz and hard heavy minerals like granite and magnesite etc.

There are three hydrological stations in Sunkosi river from Dolalghat to Tribeni and one in Saptakosi at Chattara . In Sunkosi they are located at Pachuwarghat, Khurkot, and Kompughat. These stations are established and maintained by Department of Hydrology and Meteorology. All these stations are installed with automatic stage recorder and cable way system for the discharge measurement.

Stream flow records of Sunkosi river and Saptakosi river of the above stations are available from the DoH&M .

Table 2.2

	Station No.	Name of location	period
1.0	630	Pachuwarghat	1967-1995
2.0	652	Khurkot	1968-1995
3.0	680	Kkomphughat	1967-1995
4.0	-		
5.0		Chattara	1967-1995

From the hydrograph , it is reflected that the pattern of flow in all the stations is similar,they differ only on magnitude .Like in all other major rivers of Nepal, in Sunkosi also the snowmelt and rainfall are the two major factors that contribute to the runoff. Extremely large flows occurs during the monsoon from the middle of June to the middle of September. Flow gradually decrease until the end of February. From March to the middle of June, these follow a gradual increase in flow from snowmelt. As in other rivers in Sunkosi also flood is generated essentially by rainfall and hence occur in the period of monsoon from June to September. It has been estimated that 85% of total annual precipitation falls in these months. Snows start melting in May and by late July or early August are contributing to the flood discharge. The discharge from two different sources at the same time gives rise to heavy floods and produces a distinct single peak hydrograph.

A discharge measurement data at Kampughat,the diversion point shows as the lowest and highest velocity as 0.59 m/s and 3.25m/s respectively

Records of Annual minimum Discharge	= 94.0 cumecs
Records of Annual Mean Discharge	= 839.47 cumecs
90% Dependable Flow	= 154.0 cumecs
Records of Annual maximum Discharge	= 7590.0 cumecs

2.1.2.3 Sunkosi- Reservoir Study

Reservoir in Sunkosi river is proposed of Kurule to divert the demand of Kamala basin and to produce hydro power. The reservoir area capacity table is presented in table no. 2.3 and area capacity curve (Fig. 4).

Table 2.3 : Elevation Area Capacity Table : Sunkosi Reservoir at Kurule

S.N.	Elevation in m	Water surface Area in Km^2	Capacity (10^6m^3) after o year
1.	308.0	0	0
2	309.5	0.25	1.25
3	311.0	0.50	2.50
4	312.5	0.70	5.00
5	314.0	1.00	7.50
6	315.5	1.25	10.00
7	317.0	1.50	12.50
8	318.5	1.75	15.00
9	320.0	2.00	17.50
10	321.5	2.25	20.00
11	323.0	2.50	25.00

2.2 PROJECT AREA STUDY

2.2.1 Soil

The project area is the main Terai land which comprises the lithological-deposition of Bhabar zone in northern part spreading in east-west in strip and the Indo-Gangetic plains in central and southern part. The Bhbar zone consists of coarse alluvial and alluvial sediments deposits.

The Indo- Gangetic plain is the major part of the Terai and comprise alluvial clays and silts with sand and gravel layers.

2.2.2 Land Use

The total geographical area of the Kamla basin in Mahottari, Dhanausha and Sirha district is 343288.0 ha. The total irrigation potential area is 240824.0 ha. The total area under partial surface irrigation is 41500 ha and under groundwater irrigation is 21141.0 ha.

Table 2.4 : Land Use

S.N.	Description/District	Dhanusha	Mahottari	Sirha	Total
1	Land area (ha)	121746.0	98745.0	122797.0	343288.0
2	Irrigation potential area (ha)	83182.0	69286.0	88355.0	240824.0
3	Area under surface irrigation (ha)	14800	2600	24100	41500.0
4	Area under ground water irrigation (ha)	7403.0	7274.0	6464.0	21141.0
5	Total area under irrigation	22203	9874	30564	62641

2.2.3 Land Holdings

The latest available information on land holdings in different districts, are as in Table 3.2. In the total numbers of holders are 193300, total area of holdings is 214200 ha and average land holding size is 1.13 ha.

Table 2.5 : Land Holdings

Districts	Numbers of holding	Area of holdings (ha)	Average holding size (ha)
Dhanusha	70000	73600	1.08
Mahottari	58000	63700	1.11
Sirha	65300	76900	1.21
Total	193300	214200	1.13

2.2.4 Existing Cropping Pattern

The existing cropping pattern shown in the above table shows the major crops paddy, wheat, maize, pulse, sugarcane and potatoes. The existing cropping intensity is133%. The future cropping pattern with the project is changed with high yield crops replacing the low yield crops and the cropping intensity is proposed 175%.The cropping intensity is expected to increase to 200% with change in increase of cash crops after assured irrigation and practice of conjunctive use. The tables of cropping pattern and intensity before irrigation, with irrigation and future change in cash crops and intensity with irrigation are shown in Table 2.6.

Table 2.6: Existing Cultivated area (ha)

District	paddy	Maize	Wheat	Millet	Barley	Potato	Sugarcane	Pulse	Total
Dhanusha	53288	2808	18758	585	382	518	1570	17362	95271
Mahottari	47682	3085	15902	1075	168	588	1350	15920	85770
Sirha	64600	2125	9905	1222	30	692	1200	12455	92229
Total	165570	8018	44565	2882	580	1798	4120	45737	273270
(%)	80.76	3.9	21.73	1.40	0.28	0.88	2.0	22.31	133.26

2.3 GROUND WATER

2.3.1 Stratigraphy of the Command Area

The command area is underlain by alluvial and alluvial sediments which wedge out northwards upon the consolidated folded rocks of the Siwaliks and thicken southwards towards the Indo-Gangetic plain. The command area comprises the Bhabar zone and the Indo- Gangetic plains.

2.3.2 The Bhabar Zone

The Bhabar zone consists of coarse alluvial and alluvial sediments deposited as out wash fans at the mountain front where the rivers enter the Terai plain. It is the major intake area to the aquifers of the main Terai. It is recharged directly from rainfall and from infiltration from the river beds.

2.3.3 Indo-Gangetic Plain

The Indo-Gnagetic plain underlies the major part of the Terai and comprise alluvial clays and silts with important but subordinate sand and gravel layers northwards and at depth, the sediments of Gangetic type appear to merge with Bhabar type deposits while towards the Indian border, fine grained sediments predominate.

2.3.4 The Aquifer System

The aquifer system is regarded as leaky aquifer pile with vertical exchange between shallow and deep confined aquifers. In the shallow zone, sand and gravel layers are generally common enough to support productive ,unconfined shallow aquifers which is found in most areas, typically between20%to50% of srceenable sand-gravel is encountered to 46m and exhibit high permeabilities with range 20-150m/d.

2.3.5 Present Status of Utilization

The present groundwater utilization in the project area is in 20252.0 ha by different tube wells. The details is shown in table no. 2.7

Number and area covered under different ground water systems. In the project area

Table 2.7 : Present Status of Groundwater Utilization

District	Shallow tube wells		Dug wells		Artesian wells		Medium tube wells		Deep tube wells	
	Num.	Area	Num.	Area (ha)	Num	Area (ha)	Num	Area (ha)	Num.	Area (ha)
Mahottari	1218	4683	76	286	347	672	26	793	21	840
Dhanusha	2377	3510	155	579	269	364	0	0	108	2950
Sirha	1455	5238	86	337	0	0	0	0	30	889
Total		**13431**		**1202**		**1036**		**793**		**3790**

(Source :- Ground Water Development Board 1999)

2.4 ESTIMATION OF POTENTIAL GROUNDWATER RECHARGE

2.4.1 Sunkosi Kamal Scheme

The annual groundwater recharges due to rainfall are computed suing the following relationship developed by U.P. Irrigation Research Institute in 1977.

Rr=3.47(p-38) 0.4

Where Rr = Annual groundwater recharge in cm.

P = Annual average rainfall in cm.

Total annual recharge = Rr*CCA

Rr = 3.47 (p-38) 0.4

= 3.47 (140-38) 0.4

= 0.22m

Total annual recharge = 0.221*138000ha = 304.98 MCM

(b) Recharge due to irrigation:

Annual release*Ec*(1-Ea)*0.50

= 2634*0.75(1-0.70)*0.50

= 296.325 MCM

Total groundwater recharge = 304.98 + 296.325 = 601.305 MCM

2.4.2 Existing Kamal Project:

The annual groundwater recharges due to rainfall are computed suing the following relationship developed by U.P. Irrigation Research Institute in 1977.

Rr=3.47(p-38) 0.4

Where Rr = Annual groundwater recharge in cm.

P = Annual average rainfall in cm.

Total annual recharge = Rr*CCA

Rr = 3.47 (p-38) 0.4

= 3.47 (140-38) 0.4

= 0.22m

Total annual recharge =0.22 x 25000 ha = 5500 ham

(b) Recharge due to irrigation:

Annual release*Ec*(1-Ea)*0.50

= 2634*0.75(1-0.70)*0.50

= 5256 ham

Total groundwater recharge = 5500 + 5256 = 10756 ham

WATER BALANCE STUDY

3.0 GENERAL

While planning for water resources development in any basin, a careful assessment of the reasonable water needs of the basin in the fore-seeable future for various purposes such as domestic, irrigation, industries, hydropower etc, is essential. These needs are to be met either from surface water or from ground water or from a combination of both. This chapter deals with the assessment of the reasonable basin requirements.

The water requirement for various uses, viz. irrigation, domestic, hydropower and industries are assessed as under.

Present demands and future demands of the Sunkosi Kamala Scheme have been studied and quantified as the multipurpose water demands (domestic, industrial and irrigation water demands) of the scheme. Similarly the various sources of water availability in the Kamala basin like surface water and ground water, have been studied and quantified. To find the water status in the Kamala basin, water balance sheet is tabulated (Table 3.1), which shows the net deficit quantity of water in the Kamala basin and shows that Kamala basin is water deficit basin. The net quantity of water to be transferred from other basin is found as 75.0 cumecs. The 90% dependable flow of the Sunkosi is 154 cumecs and the diversion required for Kamala basin is 75 cumecs. Thus it is seen that Sunkosi has enough water available.

3.1 DOMESTIC WATER REQUIREMENT

The human and livestock population was projected to 2025AD using 1990 census data. The per capita daily water requirement for urban, rural and live stock population was taken to be 200 litres, 70 litres and 50 litres respectively.The requirement for livestock and 50% requirement for rural population are proposed to be met from ground water resources. The requirement for urban population and 50% requirement of rural population are proposed to be met from surface water resources. 80% of the surface water utilization for the domestic purpose is considered to be available as return flow to the stream. The total surface water requirement for future population 2920444 (upto 2025 AD) is calculated as 2.3 cumecs (72.53 MCM) for details calculations refer table no. 3.1. (Source of data. NWDA guidelines and statistics of Nepal 2000)

3.2 INDUSTRIAL WATER REQUIREMENT

In the absence of information on the existing, ongoing and future industries, the total requirement of water for the industries was assumed to be of the same order as that of domestic water requirement. The total industrial requirement is assumed as less than 50% of the domestic demands i.e. 1.1 m cumecs (34.69 MCM), for details refer table no. 3.1. The entire industrial water needs are proposed to be met from surface water resources. 80% of the surface water utilized is considered to be as return flow to the streams.

3.3 IRRIGATION WATER REQUIREMENTS

The irrigation water requirements have been assessed on the basis of the net command area 138000 ha that can be brought under irrigation by 2025 AD. The irrigation water irrigation water requirements has been calculated by adopting the following procedures of irrigation water requirements.

3.3.1 Crop Water Requirements

The crop water requirements has been calculated by using modified Penman method, using the input data of the project area. The detail of the calculation is presented in table no. 3-12.

3.3.2 Selection of Crops and Cropping Pattern

The nos. and types of crops have been selected on the basis of existing use of crops in the project area. The type of crops selected for Kharif seasons are sugarcane, early paddy spring maize, summer vegetables, normal paddy and late paddy (seven in nos). While for Rabi season the selected crops are as wheat, pulses, oil seeds, vital vegetables and potato (four in nos).

3.3.3 Optimization of Crop use Areas and Cropping Intensity

The crop use areas have been finalized by using the linear programming (L-P) model study. The model study has been conducted on various conditions of cropping pattern like no crop area, constraint existing crop area constraint, designed crop area constraint and the results where analyzed with view of possible coverage by a single crop, food crop area constraint and minimum requirement of the other crops. The designed crop area has been proposed on these basic factors. Thus adopting the lower limit and upper limit of the crop areas. The optimal crop areas were suggested by the L.P. model, which is matching with the designed cropping pattern. The optimal crop areas selected by the model has been adopted. The table of L.P model analysis , results and discussions have been presented in chapter 4.

3.3.4 Irrigation Efficiency

Irrigation water requirement has been calculated considering that canal system would be semi lined and field would be maintained by the farmers. The canal conveyance efficiency as taken as 0.75 and field application efficiency as 0.70.

3.3.5 Estimation of Command Area

The maximum area that would be irrigated has been analyzed in two conditions. As first condition supply through reservoir and second condition supply without reservoir as run off river scheme.

3.3.6 Irrigation Supply Through Kamala Reservoir

The irrigation demand has been calculated for maximum net command area, considering the future demands upto 2025 AD. The maximum net command area was found as 1,38000.0 ha with G.W use and 123000 ha without G.W use.

The net irrigation demands have been calculated considering Kamala surface water, ground water, and regeneration in downstream due to surface water flow and with water transfer from Sunkosi River. The details of the calculation have been presented in Table 3·15.

3.3.7 Irrigation Supply Without Kamala Reservoir (refer Table no. 16)

3.3.7.1 Irrigation with Kamala surface water only

The maximum area that can be irrigated with Kamala surface water was found as 7000 ha.

3.3.7.2 Irrigation with Kamala surface water and ground water use

The maximum that can be irrigated in this conditions was found as 12000 ha.

3.3.7.3 Irrigation with Kamala water and water transferred from Sunkosi

The maximum area that can be irrigated in this conditions was found as 78000 ha.

3.3.7.4 Irrigation with Kamal water ground water and water transferred from Sunkosi

The maximum area that can be irrigated in this conditions was found as 114000.0 ha.

3.4 WATER BALANCE CALCULATION

The water balance of Kamala basin is computed at Chisapani reservoir site. The total multipurpose project demand is calculated as per NWDA Guidelines. The project water demand in different sector is considered. The demand in different sector is as irrigation demand as major demand, hydro-power demand as the secondary demand, domestic water supply demand and industrial demand.

The irrigation demand is considered for 138000ha, hydro-power generation is as per irrigation demand. Domestic demand is considered for 2920444.0 population, considering 25 years future demand i.e. up to 2025. In absence of proper data, the industrial demand on basis of domestic demand. For details of calculation refer Table 5.7.

3.4.1 Multipurpose Demands of Kamala Basin

The total multipurpose project demand calculated are as follows.

Irrigation demand	=	3584.14 MCM
Domestic demand	=	72.53 MCM
Industrial demand	=	34.69 MCM
Total	=	3691.36 MCM (-)

3.4.2 Water Available in Kamala Basin

Main source of water in Kamala basin is ,the available discharge of Kamala river. Regeneration to the down stream main river is considered as NWDA guidelines. Groundwater is considered and the amount of water available is calculated as per the annual recharge amount in the project area.

Water available in Kamala river	= 351.42 MCM
Groundwater available in project area	= 542.00MCM
Regeneration from surface flow	= 442.82 MCM

Total	= 1336.24 MCM (+)

3.4.3 Net Deficit Quantity of Water in Kamala Basin

The quantity of water to be diverted from the Sunkosi river is the net deficit quantity of water in Kamala basin. The calculated figure is as follows.

Total demand of Kamala basin	= 3691.36 MCM (-)
Total water available in Kamal basin	= 1336.04 MCM (+)
Net deficit quantity required to divert	
From Sunkosi basin	----------------
	= 2335.12 MCM (-)
	= 74.68 cumecs

Domestic And Industrial Water Requirement

Table No. 3.1

No.	Item/Distrists	Mahottari	Dhanusha	Siraha	Total Population	litres /capita/day	Total Requirement litres/day	Total Requirement cumecs
1	Drinking Water :-							
1.1.1	Present population	526330	671582	539111	1737023			
1.1.2	Urban demands(15%population)				260553.45	200	52110690	0.60
1.1.3	Rural demands(85%population)				1476469.55	70	103352869	1.20
						Total	155463559	1.80
1.2	Future population by 2025	884915	1129126	906403	2920444			-
								-
1.2.1	Urban demands(20%population)				584088.8	200	116817760	1.35
1.2.2	Rural demands(80%population)				2336355.2	70	163544864	1.89
						Total	280362624	3.24
2	Domestic demands:-							-
2.1	Present no. of livestocks	210532	268632	210532	689696	70	48278720	0.56
2.2	Future no. of livestocks	269992	344502	276548	891042	70	62372940	0.72
3	**Total surface water demand:-**							
3.1	Drinking water							
3.2	Urban use(100% of requirement)							1.35
3.3	Rural use (50% of requirement)							0.95
							Total	2.30
4	Industrial water Requirement							
4.1	**Industrial water requirement is taken on basis of domestic water use:**							**1.10**
4.2	**Total domestic and industrial water requirement (lps)**							**3.40**
4.3	Domestic use by Ground Water							-
4.4	Industrial use(100% by SW)							1.10
							Total	7.89
5	Ground Water Demand:-							
5.1	Drinking water							
5.2	Urban use by surface water							
5.3	Rural use (50% of requirement)							0.95
5.4	Domestic use (100%)							0.72
5.5	Industrial use(100% by SW)							0
							total	1.67
6	Regeneration:-							
6.1	Surface Irrigation Water(10%of surface irrigation requirement)							Monthwise
6.2	Domestic Use (80%return flow)							1.84
6.3	Industrial Use(80% return flow)							0.88
							Total	2.72

Table No. 3.2

ETO calculation by modified Penman methods

Activities/Month	Jan	Feb	March	April	MAY	June	July	Aug	Sep	Oct	Nov	Dec
Mean Temperature	16.20	18.68	23.00	27.28	29.29	30.13	29.41	29.39	28.89	26.78	22.45	18.27
Relative Humidity(RH%)	83.10	75.33	62.37	52.47	64.27	73.63	82.60	82.97	82.60	78.63	74.64	78.30
Wind velosity(km/h)	11.00	13.00	16.00	20.00	30.00	33.00	25.00	20.00	18.00	18.00	15.00	17.00
Saturated vapour pressure(ea)	18.20	22.00	28.10	35.70	40.40	42.45	41.50	41.50	40.10	35.70	27.25	20.90
Vapour pressure(ed) =ea*RH/100	15.12	16.57	17.53	18.73	25.97	31.26	34.28	34.43	33.12	28.07	20.34	16.36
ea-ed	3.08	5.43	10.57	16.97	14.43	11.19	7.22	7.07	6.98	7.63	6.91	4.54
Actual Sunshine hours(n hrs)	6.80	7.20	8.80	9.00	11.00	10.50	8.50	8.50	9.00	8.50	8.00	8.00
Max.Sunshine hours(N hrs)	10.59	11.23	12.00	12.23	13.19	13.81	13.64	13.00	12.30	11.60	10.79	10.45
Wind function f(u)	0.30	0.31	0.31	0.32	0.35	0.36	0.34	0.32	0.32	0.32	0.31	0.32
Ratio(n/N)	0.64	0.64	0.73	0.74	0.83	0.76	0.62	0.65	0.73	0.73	0.74	0.77
Solar rad(Ra)	9.55	11.30	13.55	15.30	16.45	16.75	16.65	15.70	14.20	12.15	10.10	9.05
Shortwave radiation(Rs)=[(0.25+0.5n/N)*Ra]	5.45	6.45	8.36	9.45	10.97	10.56	9.35	9.06	8.75	7.49	6.27	5.73
f(n/N)	0.68	0.68	0.76	0.76	0.85	0.79	0.66	0.69	0.76	0.76	0.77	0.79
f(T)	13.80	14.20	15.20	16.10	16.50	16.70	16.60	16.60	16.50	16.10	15.20	14.30
f(ed)	0.17	0.16	0.16	0.15	0.12	0.09	0.08	0.08	0.09	0.11	0.14	0.16
Rnl=f(n/N)*f(T)*f(ed)	1.58	1.55	1.80	1.83	1.62	1.24	0.90	0.94	1.09	1.31	1.66	1.83
Weighting factor(W)	0.64	0.66	0.72	0.76	0.77	0.78	0.77	0.77	0.77	0.76	0.71	0.78
(1-W)	0.36	0.34	0.28	0.24	0.23	0.22	0.23	0.23	0.23	0.24	0.29	0.22
Adjust. Factor(c)	0.98	0.98	1.00	1.00	1.00	1.05	1.05	1.10	1.10	1.10	1.06	1.06
Rn=0.75*Rs-Rnl	2.51	3.28	4.47	5.26	6.60	6.68	6.11	5.86	5.47	4.31	3.05	2.46
Eto(mm/day)	1.90	2.67	4.14	5.32	6.25	6.40	5.53	5.54	5.20	4.24	2.95	2.37

Net Crop Water Requirement- Sugarcane

Table No. 3

Month	January		February		March		April		May		June		July		August		September		October		November		December		Remarks
Half month	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1 = First Half month
Eto mm/day	1.90	1.90	2.67	2.67	4.14	4.14	5.32	5.32	6.25	6.25	6.40	6.40	5.53	5.53	5.54	5.54	5.20	5.20	4.24	4.24	2.95	2.95	2.37	2.37	2 = Second half month from Panman estimae table D2
Crop cofficient KC	0.55	0.55	0.80	0.80	0.90	1.00	1.00	1.00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.80	0.80	0.60	0.60	0.00	
Etcrop mm/day	1.05	1.05	2.14	2.14	3.73	4.14	5.32	5.32	6.56	6.56	6.72	6.72	5.81	5.81	5.82	5.82	5.46	5.46	4.45	3.39	2.36	1.77	0.00	0.00	Etcrop=ETo*kc
Etcrop mm/half month	15.8	15.8	32.1	32.1	56.0	62.1	79.8	79.8	98.4	98.4	100.8	100.8	87.2	87.2	87.3	87.3	81.9	81.9	66.8	50.9	35.4	26.6	0.0	0.0	Etcrop*15
Land preparation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	momsoon rice first crop
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	40.05	40.05	55.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Eo *15 day, data from Table D1
Total crop water Req. (mm/half month)	55.9	55.9	87.3	32.1	56.0	62.1	79.8	79.8	98.4	98.4	100.8	100.8	87.2	87.2	87.3	87.3	81.9	81.9	66.8	50.9	35.4	26.6	0.00	0.00	
80% reliable rainfall, P80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.17	16.10	39.18	47.89	152.28	186.12	105.49	128.93	83.11	68.00	1.12	0.92	0.00	0.00	0.00	0.00	Homogenious series
Effective rainfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.19	13.69	33.30	40.71	106.60	130.28	73.84	90.25	58.18	47.60	0.00	0.00	0.00	0.00	0.00	0.00	if P80%<5 0*P80%rainfall if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	55.90	55.90	87.30	32.10	56.00	62.10	79.80	79.80	87.21	84.71	67.50	60.09	0.00	0.00	13.46	0.00	23.72	34.30	66.80	50.90	35.40	26.60	0.00	0.00	
Irrigation requirement (l/s/ha)	0.43	0.43	0.67	0.25	0.43	0.48	0.62	0.62	0.67	0.65	0.52	0.46	0.00	0.00	0.10	0.00	0.18	0.26	0.52	0.39	0.27	0.21	0.00	0.00	

Net Crop Water Requirement- Early Paddy

Table No. 3.4

Month	April		May		June		July		Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2	1= First Haf month 2 =Second Half
Eto mm/day	5.32	5.32	6.25	6.25	6.40	6.40	5.53	5.53	from Panman estimae table D2
Crop cofficient KC	1.10	1.10	1.10	1.00	1.00	1.00	1.00	1.00	From Table 4.10
Etcrop mm/day	5.85	5.85	6.88	6.25	6.40	6.40	5.53	5.53	Etcrop=ETo*kc
Etcrop mm/half month	87.75	87.75	103.20	93.75	96.00	96.00	82.95	82.95	Etcrop*15
Land preparation (mm/half-month)	75.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	momsoon rice first crop
Deep perculation (mm/half-month)	75.00	75.00	75.00	75.00	75.00	0.00	0.00	0.00	Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	121.35	121.35	0.00	0.00	0.00	0.00	0.00	0.00	Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	359.10	334.10	228.20	168.75	171.00	96.00	82.95	82.95	
80% reliable rainfall, P80	0.00	0.00	13.17	16.10	39.18	47.89	152.28	152.28	Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	11.19	13.69	33.30	40.71	106.60	106.60	if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	359.10	334.10	217.01	155.06	137.70	55.29	0.00	0.00	
Irrigation requirement (l/s/ha)	**2.77**	**2.58**	**1.67**	**1.20**	**1.06**	**0.43**	**0.00**	**0.00**	

Net Crop Water Requirement- Springmaize

Table No. 3.5

Month	April		May		June		July	Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1.00	1= First Haf month 2 =Second Half month
Eto mm/day	5.32	5.32	6.25	6.25	6.40	6.40	5.53	from Panman estimae table-2
Crop cofficient KC	0.60	0.80	1.10	1.50	1.10	0.80	0.80	
Etcrop mm/day	3.19	4.26	6.88	9.38	7.04	5.12	4.42	Etcrop=ETo*kc
Etcrop mm/half month	47.85	63.90	103.20	140.70	105.60	76.80	66.00	Etcrop*15
Land preparation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00		
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00		Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	121.35	121.35	0.00	0.00	0.00	0.00		
Total crop water Requirement (mm/half month)	169.20	185.25	103.20	140.70	105.60	76.80	66.00	
80% reliable rainfall, P80	0.00	0.00	13.17	16.10	39.18	47.89	152.00	Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	11.19	13.69	33.30	40.71	106.00	if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	169.20	185.25	92.01	127.01	72.30	36.09	0.00	
Irrigation requirement (l/s/ha)	**1.31**	**1.43**	**0.71**	**0.98**	**0.56**	**0.28**	**0.00**	

Net Crop Water Requirement- Summer Vege.
Table No.3.6

Month	April		May		June		Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1= First Haf month 2 =Second Half month
Eto mm/day	5.32	5.32	6.25	6.25	6.40		from Panman estimae table, D2
Crop cofficient KC	0.34	0.34	0.54	0.93	1.05		From Table 4.10
Etcrop mm/day	1.81	1.81	3.38	5.81	6.72		Etcrop=ETo*kc
Etcrop mm/half month	27.15	27.15	50.70	87.15	100.80		Etcrop*15
Land preparation (mm/half-month)	0.00	0.00	0.00	0.00	0.00		
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00		Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	121.35	121.35	131.70	0.00	0.00		Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	148.50	148.50	182.40	87.15	100.80		
80% reliable rainfall, P80	0.00	0.00	13.17	16.10	39.18		Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	11.19	13.69	33.30		if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	148.50	148.50	171.21	73.46	67.50		
Irrigation requirement (l/s/ha)	**1.15**	**1.15**	**1.32**	**0.57**	**0.52**		

Net Crop Water Requirement- Normal Paddy
Table No.3.7

Month	June		July		August		September		October		Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1= First Haf month 2 =Second Half
Eto mm/day	6.40	6.40	5.53	5.53	5.54	5.54	5.20	5.20	4.24	4.24	from Panman estimae table D2
Crop cofficient KC		1.10	1.10	1.10	1.10	1.05	0.95	0.95	0.95	0.95	From Table 4.10
Etcrop mm/day	7.04	7.04	6.08	6.08	6.09	5.82	4.94	4.94	4.03	4.03	Etcrop=ETo*kc
Etcrop mm/half month	105.60	105.60	91.20	91.20	91.35	87.30	74.10	74.10	60.45	60.45	Etcrop*15
Land preparation (mm/half-month)	55.00	55.00	55.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	momsoon rice first crop
Deep perculation (mm/half-month)	30.00	30.00	22.50	15.00	15.00	15.00	30.00	30.00	30.00	30.00	Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	114.15	114.15	93.75	93.75	0.00	0.00	0.00	0.00	0.00	0.00	Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	304.75	304.75	262.45	249.95	156.35	102.30	104.10	104.10	90.45	90.45	
80% reliable rainfall, P80	47.89	47.89	152.28	186.12	105.49	128.93	83.11	68.00	1.12	0.92	Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	40.71	40.71	106.60	130.28	73.84	90.25	58.18	47.60	0.00	0.00	if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	264.04	264.04	155.85	119.67	82.51	12.05	45.92	56.50	90.45	90.45	
Irrigation requirement (l/s/ha)	2.04	**2.04**	**1.20**	**0.92**	**0.64**	**0.09**	**0.35**	**0.36**	**0.70**	**0.70**	

Net Crop Water Requirement- Late Paddy
Table No.3.8

Month	July		August		September		October				Remarks
Half month	1	1	1.00	2.00	1.00	2.00	1.00	2.00			1= First Haf month 2 =Second Half
Eto mm/day	5.53	5.53	5.54	5.54	5.20	5.20	4.24	4.24			from Panman estimae table D2
Crop cofficient KC	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.00			From Table 4.10
Etcrop mm/day	6.08	6.08	6.09	6.09	5.72	5.72	4.66	4.24			Etcrop=ETo*kc
Etcrop mm/half month	91.20	91.20	91.35	91.35	85.80	85.80	69.90	63.60			Etcrop*15
Land preparation (mm/half-month)	55.00	55.00	55.00	55.00	55.00	50.00	50.00	0.00			momsoon rice first crop
Deep perculation (mm/half-month)	22.50	22.50	150.00	150.00	150.00	150.00	150.00	150.00			Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	108.00	108.00	90.75	90.75	79.35	0.00	0.00	0.00			Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	271.70	271.70	387.10	387.10	370.15	285.80	269.90	213.60			
80% reliable rainfall, P80	152.28	152.28	105.49	128.93	83.11	68.00	1.12	0.92			Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	106.60	106.60	73.84	90.25	58.18	47.60	0.00	0.00			if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	165.10	165.10	313.26	296.85	311.97	238.20	269.90	213.60			
Irrigation requirement (l/s/ha)	**1.27**	**1.27**	**2.42**	**2.29**	**2.41**	**1.84**	**2.08**	**1.65**			

Net Crop Water Requirement- Wheat

<u>**Table No. 3.9**</u>

Month	November		December		January		February		March				Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00			1= First Haf month 2 =Second Half month
Eto mm/day	2.95	2.95	2.37	2.37	1.90	1.90	2.67	2.67	4.14	4.14			from Panman estimae table, D2
Crop cofficient KC	0.43	0.43	0.65	1.05	1.15	1.15	1.15	0.90	0.40	0.40			From Table 4.10
Etcrop mm/day	1.27	1.27	1.54	2.49	2.19	2.19	3.07	2.40	1.66	1.66			Etcrop=ETo*kc
Etcrop mm/half month	19.05	19.05	23.10	37.35	32.85	32.85	46.05	36.00	24.90	24.90			Etcrop*15
Land preparation (mm/half-month)	60.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	0.00				0.00	0.00	0.00	0.00	0.00	0.00			Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	79.05	19.05	23.10	37.35	32.85	32.85	46.05	36.00	24.90	24.90			
80% reliable rainfall, P80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	79.05	19.05	23.10	37.35	32.85	32.85	46.05	36.00	24.90	24.90			
Irrigation requirement (l/s/ha)	0.61	0.15	0.18	0.29	0.25	0.25	0.36	0.28	0.19	0.19			

Net Crop Water Requirement-Pulses
Table No. 3.10

Month		November		December		January		February		March				Remarks
Half month		1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00			1= First Haf month 2 =Second Half month
Eto mm/day		2.95	2.95	2.37	2.37	1.90	1.90	2.67	2.67	4.14	4.14			from Panman estimae table, D2
Crop cofficient KC		0.40	0.40	0.50	0.75	0.95	1.05	1.05	0.96	0.96	0.96			From Table 4.10
Etcrop mm/day		1.18	1.18	1.19	1.78	1.81	2.00	2.80	2.56	3.97	3.97			Etcrop=ETo*kc
Etcrop mm/half month		17.70	17.70	17.85	26.70	27.15	30.00	42.00	38.40	59.55	59.55			Etcrop*15
Land preparation (mm/half-month)		60.00	60.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Deep perculation (mm/half-month)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			Constant depends on soil texture
Evaporation during Land preparation (mm/half month)		57.15	57.15	40.05	40.05	0.00	0.00	0.00	0.00	0.00	0.00			Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)		134.85	134.85	57.90	66.75	27.15	30.00	42.00	38.40	59.55	59.55			
80% reliable rainfall, P80		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)		134.85	134.85	57.90	66.75	27.15	30.00	42.00	38.40	59.55	59.55			
Irrigation requirement (l/s/ha)		**1.04**	**1.04**	**0.45**	**0.52**	**0.21**	**0.23**	**0.32**	**0.30**	**0.46**	**0.46**			

Net Crop Water Requirement- Oilseeds

Table No.3.11

Month	November		December		January		February		Remarks
Half month	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1= First Haf month 2 =Second Half
Eto mm/day	2.95	2.95	2.37	2.37	1.90	1.90	2.67	2.67	from Panman estimae table D2
Crop cofficient KC	0.40	0.40	0.50	0.80	1.00	1.00	0.70	0.70	From Table 4.10
Etcrop mm/day	1.18	1.18	1.19	1.90	1.90	1.90	1.87	1.87	Etcrop=ETo*kc
Etcrop mm/half month	17.70	17.70	17.85	28.50	28.50	28.50	28.05	28.05	Etcrop*15
Land preparation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	57.15	57.15	40.80	40.80	0.00	0.00	0.00	0.00	Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	74.85	74.85	58.65	69.30	28.50	28.50	28.05	28.05	
80% reliable rainfall, P80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	74.85	74.85	58.65	69.30	28.50	28.50	28.05	28.05	
Irrigation requirement (l/s/ha)	**0.58**	**0.58**	**0.45**	**0.53**	**0.22**	**0.22**	**0.22**	**0.22**	

Net Crop Water Requirement- Winter vegetable & Potato

Table No. 3.12

Month	November		December		January		February		Remarks
Half month	1	2.00	1.00	2.00	1.00	2.00	1.00		1= First Haf month 2 =Second Half
Eto mm/day	2.95	2.95	2.37	2.37	1.90	1.90	2.67	2.67	from Panman estimae table-2
Crop cofficient KC	0.30	0.30	0.30	0.50	0.90	1.00	0.90	0.90	From Table 4.10
Etcrop mm/day	0.89	0.89	0.71	1.19	1.71	1.90	2.40	2.40	Etcrop=ETo*kc
Etcrop mm/half month	13.35	13.35	10.65	17.85	25.65	28.50	36.00	36.00	Etcrop*15
Land preparation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Deep perculation (mm/half-month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Constant depends on soil texture
Evaporation during Land preparation (mm/half month)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Eo *15 days , data from Table D1
Total crop water Requirement (mm/half month)	13.45	13.35	10.65	17.85	25.65	28.50	36.00	36.00	
80% reliable rainfall, P80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Homogenious series if P80%<5 0*P80%rainfall
Effective rainfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	if P80%<100 .85*P80%rainfall if P80%>100 .7*P80%rainfall
Net crop (mm/half-month)	13.35	13.35	10.65	17.85	25.65	28.50	36.00	36.00	
Irrigation requirement (l/s/ha)	**0.10**	**0.10**	**0.08**	**0.14**	**0.20**	**0.22**	**0.28**	**0.28**	

Table No. 3.13

UNIT: ha

MONTHLY CROPWATER REQUIREMENT (m)

S.N.	CROPS	Coverage (%)	JAN 1	FEB 2	MAR 3	APR 4	MAY 5	JUN 6	JUL 7	AUG 8	SEP 9	OCT 10	NOV 11	DEC 12
1	Sugarcane		0.112	0.119	0.118	0.16	0.172	0.128	0	0.013	0.062	0.118	0.062	0
2	E.Paddy					0.69	0.37	0.193	0					
3	Maize					0.35	0.219	0.108						
4	S.Vegeta.					0.3	0.244	0.067						
5	N.Paddy							0.528	0.275	0.094	0.102	0.181		
6	L.Paddy								0.306	0.249	0.251	0.266		
7	Wheat		0.066	0.082	0.081								0.098	0.06
8	Pulses		0.057	0.08	0.119								0.095	0.04
9	oilseeds		0.057	0.056									0.046	0.04
10	W.Vegeta.		0.054	0.072									0.027	0.03
11	Potatoes		0.054	0.072									0.027	0.03

Cropping Pattern

Sunkosi-Kamala Scheme

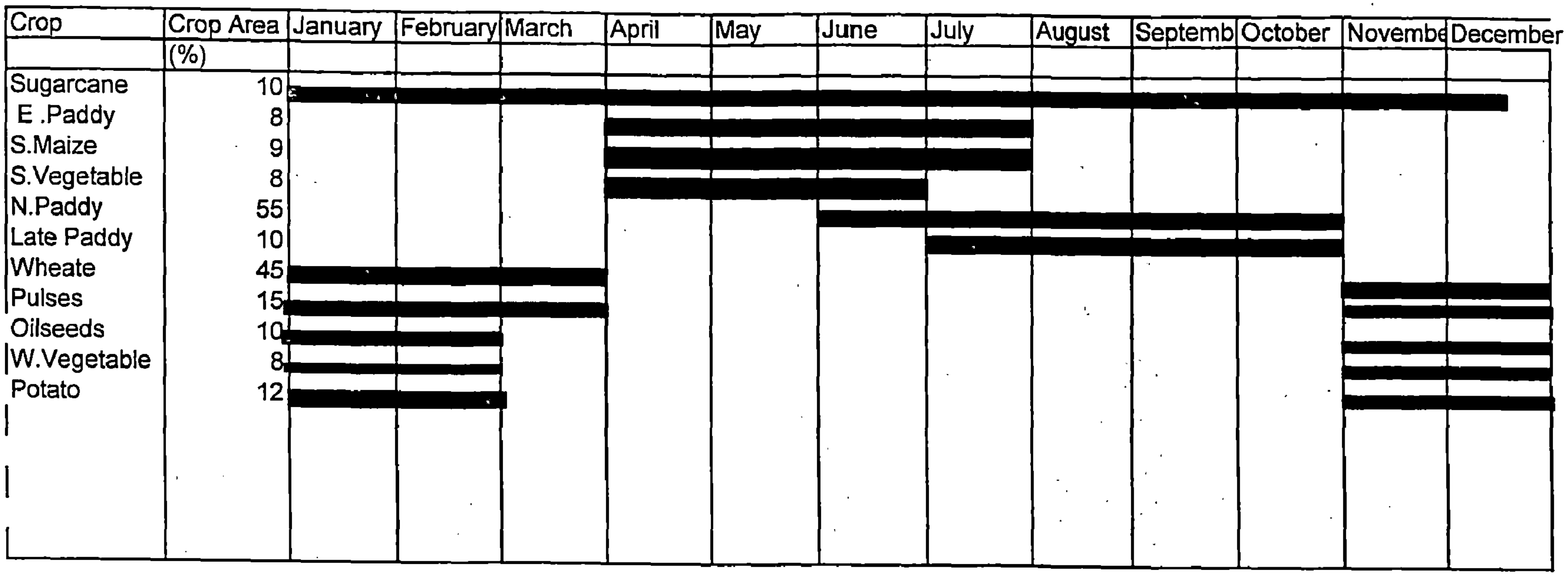


Table No. 3.14

UNIT : ha

CROPWATER REQUIREMENT (m) at 200 % CROPPING INTENSITY

S.N.	CROPS	Coverage (%)	JAN 1	%	FEB 2	%	MAR 3	%	APR 4	%	MAY 5
	Khariff Season		0								
1	Sugarcane	10	0.112	0.011	0.119	0.0119	0.118	0.0118	0.16	0.016	0.172
				0.000		0		0		0	
2	E.Paddy	8	0.022	0.002		0		0	0.69	0.0552	0.37
3	Maize	9		0.000		0		0	0.354	0.03186	0.219
4	S.Vegeta.	8		0.000		0		0	0.297	0.02376	0.244
5	N.Paddy	55		0.000		0		0		0	
6	L.Paddy	10		0.000		0		0		0	
	Rabi Season			0.000		0		0		0	
1	Sugarcane	10		0.000		0		0		0	
7	Wheat	45	0.066	0.030	0.082	0.0369	0.081	0.03645		0	
8	Pulses	15	0.057	0.009	0.08	0.012	0.119	0.01785		0	
9	oilseeds	10	0.057	0.006	0.056	0.0056		0		0	
10	W.Vegeta.	8	0.054	0.004	0.072	0.00576		0		0	
11	Potatoes	12	0.054	0.006	0.072	0.00864		0		0	
13	Total CWR(m/ha)	200%		0.06771		0.0808		0.0661		0.12682	
14	Canal conveyance efficiency (75%)			0.09028	0	0.107733	0	0.088133	0	0.169093	0
15	Field application efficiency (70%)			0.128971	0	0.153905	0	0.125905	0	0.241562	0
16	Irrigation water Reqiorement (ha-m)			0.128971	0	0.153905	0	0.125905	0	0.241562	0
	Irrigation Water Requirement (lps)			0.497575	0	0.593768	0	0.485744	0	0.931952	0
	Averag demand(lps)			0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
19	Irrigation water Required For: 138000 ha(ha-m)			17798	0	21239	0	17375	0	33336	0

%	JUN 6	%	JUL 7	%	AUG 8	%	SEP 9	%	OCT 10	%	NOV 11	%	DEC 12	%
0.0172	0.128	0.0128	0	0	0.013	0.0013	0.062	0.0062	0.118	0.0118	0.062	0.006	0	0
0		0		0		0		0		0		0		0
0.0296	0.193	0.01544	0	0		0		0		0		0		0
0.01971	0.108	0.00972		0		0		0		0		0		0
0.01952	0.067	0.00536		0		0		0		0		0		0
0	0.528	0.2904	0.275	0.15125	0.094	0.0517	0.102	0.0561	0.181	0.0996		0		0
0		0	0.306	0.0306	0.249	0.0249	0.251	0.0251	0.266	0.0266		0		0
0		0		0		0		0		0		0		0
0		0		0		0		0		0		0		0
0		0		0		0		0		0	0.098	0.044	0.06	0.027
0		0		0		0		0		0	0.095	0.014	0.044	0.0066
0		0		0		0		0		0	0.046	0.005	0.035	0.0035
0		0		0		0		0		0	0.027	0.002	0.028	0.00224
0		0		0		0		0		0	0.027	0.003	0.028	0.00336
0.08603		0.33372		0.18185		0.0779		0.0874		0.138		0.075		0.0427
0.114707	0	0.44496	0	0.242467	0	0.1039	0	0.116533	0	0.1839	0	0.099	0	0.056933
0.163867	0	0.635657	0	0.346381	0	0.1484	0	0.166476	0	0.2628	0	0.142	0	0.081333
0.163867	0	0.635657	0	0.346381	0	0.1484	0	0.166476	0	0.2628	0	0.142	0	0.081333
0.632202	0	2.452381	0	1.336346	0	0.5725	0	0.642269	0	1.0137	0	0.548	0	0.313786
0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
22614	0	87721	0	47801	0	20477	0	22974	0	36261	0	19596	0	11224

Table No.3.15

WATER BALANCE CALCULAITON OF KAMALA RIVER BASIN

Supply through Kamala Reservoir For Maximum Demand (138000.0 ha)

Description/mon	JAN.	FEB.	MARCH	APRIL	MAY	JUN	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	REMARKS
1 Irrigation water Requirement For 138000.0ha (ha-m)	17798	21239	17375	33336	22614	87721	47801	20477	22974	36261	19596	11224	358414
2 Domestic & Industrial Water Requirement(ha-m)	911	823	911	881	911	881	911	911	881	911	881	911	10724
3 Total Project Demand	18709	22062	18286	34217	23525	88602	48712	21388	23855	37172	20477	12135	369138
4 Regeneration in down-stream:													
5 Irrigation Use (10% of irrigation use)	1780	2124	1737	3334	2261	8772	4780	2048	2297	3626	1960	1122	
6 Domestic & Industrial Use 80% of use(ha-m)	729	658	729	705	729	705	729	729	705	729	705	729	
7 Total Regeneration(h	2509	2782	2466	4038	2990	9477	5509	2776	3002	4355	2664	1851	44421
8 Mean monthly flow of Kamala river(ha-m)	1709	1314	1323	1400	1710	2501	4901	6294	5651	3991	2265	1945	35004
9 Total Water Available in Kamala Basin(ha-m)	4218	4096	3789	5438	4700	11978	10410	9070	8653	8346	4929	3796	79425
10 Net Project Demand	14491	17966	14497	28778	18824	76624	38302	12317	15202	28826	15548	8339	289713
11 Groundwater available in project area	4517	4517	4517	4517	4517	4517	4517	4517	4517	4517	4517	4517	54200
Net Irrigation Demand	10773	13940	10392	24781	15107	73727	37775	13183	15455	27390	12415	4856	259793
12 Net Deficit quantity to transfer from sunkosi (ha-m)	9975	13449	9980	24262	14308	72107	33785	7800	10685	24310	11031	3822	235513
13 Net Deficit quantity to transfer from sunkosi (lps)	75	75	75	75	75	75	75	75	75	75	75	75	

Tafketo · 3.18

Irrigation supply As Run-Off River scheme(Without Kamala Reservoir)

Estimation of command area

1	Description/month	JAN.	FEB.	MARCH	APRIL	MAY	JUN	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
2	Irrigation Water Requirement (lps)	0.498	0.594	0.486	0.932	0.632	2.452	1.336	0.572	0.642	1.040	0.548	0.314
3	Average Irrigation Water Requirement (lps)	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
4	75%Dependablw flow of Kamala (lps)	5700	5700	5700	5700	5700	5700	5700	5700	5700	5700	5700	5700
5	Irrigation from Kamala water(ha)	6,786	6,786	6,786	6,786	6,786	6,786	6,786	6,786	6,786	6,786	6,786	6,786
7	Groundwater available in Kamala project area	3,410	3,410	3,410	3,410	3,410	3,410	3,410	3,410	3,410	3,410	3,410	3,410
8	Total water available (Kamala+GW)	10,196	10,196	10,196	10,196	10,196	10,196	10,196	10,196	10,196	10,196	10,196	10,196
9	Irrigation from Kamala water & GW (ha)	12,138	12,138	12,138	12,138	12,138	12,138	12,138	12,138	12,138	12,138	12,138	12,138
10	75% Dependable flow of Kamala& Sunkosi (lps)	81,475	81,475	81,475	81,475	81,475	81,475	81,475	81,475	81,475	81,475	81,475	81,475
11	Domestic& Industrial demand(lps)	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400
12	Net75% Dependable flow of Kamala& Sunkosi (lps)	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075
13	Irrigation from surface water of Kamala & Sunkosi (ha)	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075	78,075
14	Groundwater available(lps)	17186	17186	17186	17186	17186	17186	17186	17186	17186	17186	17186	17186
15	75% Dependable flow of Kamala& Sunkosi &groundwater(lps)	95,261	95,261	95,261	95,261	95,261	95,261	95,261	95,261	95,261	95,261	95,261	95,261
16	Irrigation from Kamala & Sunkosi Water with groundwater (ha)	114,222	114,222	114,222	114,222	114,222	114,222	114,222	114,222	114,222	114,222	114,222	114,222
17	Note: Groundwater would be pumped at the time of peak demand												

Table No. 3.17

Maximum,mean and minimum flow of Kamala, Sunkosi, Saptkosi

	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
Kamala minimum flow at Inarwa(m3/s)	3.86	2.51	1.72	1.14	2.41	4.25	7.55	7.55	8.47	7.04	6.8	4.83	1.14
Kamala mean flow at Inarwa(m3/s)	6.38	5.43	4.94	5.4	6.5 7	9.95	18.3	23.5	21.8	14.9	8.74	7.26	9.69
Kamala maximum flow at Inarwa(m3/s)	12	12.7	11	18.6	17.6	40.8	99.2	142	119	66.1	13.5	9.49	99.2
Sunkosi minimum flow at Kamphughatm3/s	136	114	98	94	136	154	773	1460	700	368	261	172	94
Sunkosi mean flow at Kamphughatm3/s	193	164	151	165	238	777	2,308	2,661	1,901	887	381	247	
Sunkosi maximum flow at Kamphughat (m3/s)	314	222	268	279	723	4070	7590	6870	7140	7080	806	508	7590
Saptkosi minimum flow m3/s at Chattara	248	226	235	249	27 2	513	1310	2460	1370	869	513	367	226
Saptkosi mean flow m3/s at Chattara	406	348	353	433	78 4	1890	3890	4390	3410	1630	867	555	1590
Saptkosi maximum flow m3/s at Chattara	668	686	619	943	300 0	5090	7830	9610	8980	6880	3600	863	9610

Table No. 3.18

Water balance of Sunkosi after Kamala diversion

Desription/Month	Jan	Feb	March	April	May	June	July	August	Sep.	Oct.	Nov.	Dec.
Mean monthly flow of sunkosi	193.158	163.895	151.158	165.105	238.158	776.895	2307.895	2660.526	1901.053	886.526	381.053	246.632
Demand of kamala basin m3/s	75	75	75	75	75	75	75	75	75	75	75	75
Upstream use of Sunkosi Irrigation Use	14.67	22.042	24.97	28.65	9.47	3.43	2.6	27.29	55.43	46.46	26.05	12.16
Melamchi diversion for domestic use project for Kathmandu valley	3.05	2.45	2.3	2.4	3.35	7	7	7	7	7	4.55	3.55
Total water Use	92.72	99.492	102.27	106.05	87.82	85.43	84.6	109.29	137.43	128.46	105.6	90.71
water use in relation to water available %	48.00	60.70	67.66	64.23	36.87	11.00	3.67	4.11	7.23	14.49	27.71	36.78
Water balance in Sunkosi m3/s	100.44	64.40	48.89	59.06	150.34	691.46	2,223.29	2,551.24	1,763.62	758.07	275.45	155.92

Table No. 3.19

Water balance of Saptakosi after Kamala diversion

Desription/Month	Jan	Feb	March	April	May	June	July	August	Sep.	Oct.	Nov.	Dec.
Mean monthly flow of Saptakosi at Chattara	406	348	353	433	784	1890	3890	4390	3410	1630	867	555
Upstream use of Sunkosi before joining Saptakosi at Chattara :-												
Demand of kamala basin m3/s	75	75	75	75	75	75	75	75	75	75	75	75
Irrigation Use	15	22	25	29	9	3	3	27	55	46	26	12
Melamchi diversion for water supply project for Kathmandu valley	3	2	2	2	3	7	7	7	7	7	5	4
Total water Use	93	99	102	106	88	85	85	109	137	128	106	91
Water balance in Sunkosi m3/s	313	249	251	327	696	1,805	3,805	4,281	3,273	1,502	761	464
water use in relation to water available(%)	23	29	29	24	11	5	2	2	4	8	12	16
water available in relation to water use %	77	71	71	76	89	95	98	98	96	92	88	84

Table No. 3.20

DESIGN IRRIGATION DEMAND (138000.0 ha) at DIFFERENT PERCENTAGE OF DEGREES

Description/ı	JAN.	FEB.	MARCH	APRIL	MAY	JUN	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	REMARK!
Irrigation water Requirement For 138000.0ha (ha-m)	17798.1	21238.9	17374.9	33335.5	22613.6	87720.7	47800.6	20476.6	22973.7	36261.1	19596	11224	358414
Regeneration in down-stream:	2508.6	2782.3	2466.3	4038.3	2990.2	9476.9	5508.9	2776.5	3002.2	4354.9	2664.4	1851.2	44420.7
Groundwater available in project area	4603	4158	4603	4455	4603	4455	4603	4603	4455	4603	4455	4603	54200
Net Irrigation Demand	106.86	142.99	103.05	248.42	150.20	737.89	376.88	130.97	155.17	273.03	124.77	47.70	2598
Net Irrigation Demand(5% decrease)	101.52	135.84	97.90	236.00	142.69	701.00	358.04	124.42	147.41	259.38	118.53	45.31	2468
Net Irrigation Demand(4.5% decrease)	102.05	136.55	98.42	237.25	143.44	704.68	359.92	125.07	148.18	260.74	119.15	45.55	2481
Net Irrigation Demand(4.75% decrease)	101.79	136.20	98.16	236.62	143.07	702.84	358.98	124.75	147.80	260.06	118.84	45.43	2475
Net Irrigation Demand(4.65% decrease)	101.89	136.34	98.26	236.87	143.22	703.58	359.36	124.88	147.95	260.33	118.97	45.48	2477

LP MODEL STUDY

4.1 GENERAL

The prevailing irrigation policy of Nepal states that water-resources should be used to bring largest irrigable area under irrigation.. Food crop should be given first priority. However farmers are likely to adopt that cropping pattern which yields maximum benefit. Thus the objective is to maximize the net farm benefits which reflects the farmer's choice of cropping pattern and yet certain food crop areas are irrigated. The following technological options are possible for implementing the irrigation policy.

1. Conjunctive use of available surface and ground water resources.
2. Changing the cropping pattern to satisfy the water demand of crops according to availability of irrigation water.

4.2 DEVELOPMENT OF MODEL

A deterministic Linear Programming Model has been developed on the basis of prevalent policy considerations and available data. The model can be used to evaluate physical performance of the project under different technological options.

All hydrological data are assumed to be deterministic even though they are probabilistic in nature to facilitate the formation of a deterministic model. The model is capable of analysing data on monthly basis for which monthly flow of 75% dependable year has been taken. The following notations are used in the development of the model.

The index i(=1 to 11) is used to denote crops type in the command and index t (=1 to 12) to denote time interval in months (t=1 for January).

4.3 PARAMETERS

Pi	=	Net farm benefit in NRs/ ha from i^{th} crop in the command area.
Ai	=	Area of i^{th} crop supplied with irrigation water
A_1	=	area under sugarcane crop
A_2	=	area under early paddy crop
A_3	=	area under maize crop
A_4	=	area under summer vegetable crop
A_5	=	area under normal paddy crop
A_6	=	area under late paddy crop
A_7	=	area under wheat crop
A_8	=	area under pulses crop
A_9	=	area under oilseeds crop
A_{10}	=	area under winter vegetables crop
A_{11}	=	area under potato crop
Dt	=	Diversion to project area in t^{th} month in Ha-meter.
Yt	=	Downstream release in t^{th} month in Ha-meter
St	=	Storage at the beginning of month 't' month in Ha-meter.
Ft	=	Inflow into the reservoir during t^{th} month in H-meter.
Et	=	Reservoir evaporation in t^{th} month in Ha-meter.
WRt_i	=	Net irrigation requirement of crop i^{th} in month t' in meters.
Ut	=	Project efficiency in t^{th} month for irrigation project.
Tt	=	Ground water use for project area in month 't'.
Smax	=	Maximum storage of reservoir in Ha- meter.
Smin	=	Minimum storage of reservoir in H-meter.
Amax	=	Culturable command area of the project.
AK	=	Culturable command area under Kharif season
AR	=	Culturable command area under Rabi season

4.4 OBJECTIVE FUNCTION

The objective is to maximize the net farm benefits from the irrigation project.

Maximize: $\sum_{i=1}^{11} P_i \; x \; A_i$

Where 'i ' denotes the crop type in the command area

4.4.1 Constraints

Water balance equation

The continuity equation must be satisfied at the Chissapani storage / diversion site barrage. The continuity equation for the time interval 't' can be written as

$D_t+Y_t+S_{t+1} - S_t+E_t = F_t$

t = (1, 12)

4.4.2 Water Use for Irrigation:

The net irrigation requirement of all the crops cultivated in the command area during a particular month be satisfied by the surface water and groundwater available in the command area.

4.4.2.1 Surface water use efficiency:

$$\sum_{i=1}^{11} WRi^t \; x \; Ai - Ut \; x \; Dt - Nt \; \; x \; Tt = 0$$

(t= 1,12)

The over all efficiency of surface irrigation can be expressed as

U = (Field application efficiency) $_t$* (conveyance efficiency)$_t$

$U\,t = E_{at} * E_{ct}$

Where,

U_t = Over all canal efficiency in month 't'

E_{at} = Field application efficiency in month 't'

E_{ct} = Canal conveyance efficiency in month 't'

The conveyance efficiency $E_{c.t}$ varies during different season of cultivation namely Khariff and Rabi for both lined and unlined canals.

[Conveyance efficiency]$_t$ =[canal system efficiency]$_t$ *[water course efficiency]$_t$

$$Ect = Est * Ewt$$

4.4.2.2 Ground Water Use Efficiency:

It is assumed that the groundwater is directly pumped into the water course

$$N_t = E_{at} * E_{wt}$$

4.4.3 Constraints on Use of Groundwater:

The annual withdrawals from the aquifers must be less than or equal to the annual recharge to ensure sustained yield from aquifers.

$$\sum_{t=1}^{12} T_t <= T_{max}$$

The annual groundwater recharge due to rainfall is computed using the following relationship developed by the U.P. Irrigation Research Institute in 1977.

$$R_r = 3.47\,(p-38)^{0.4}$$

Where Rr = annual groundwater recharge in cm.

P = annual average rainfall in million cubic meters.

T_{max} = Rr/100*CCA in MCM

T_{max} = Recharge due to rainfall and irrigation water utilization

4.4.4 Physical, Structural and Policy Constraints:

The optimization objective is further constrained by various policy considerations and physical and structural capacity constraints.

4.4.4.1 Storage Constraint:

The storage at any time should not exceed gross storage capacity.

$$S^t <= S_{max}$$

$$(t = 1, 12)$$

4.4.4.2 Dead Storage Constraint:

The storage at any time should not be less than dead storage:

$$S_t >= S_{min}$$

$$(t = 1, 12)$$

4.4.5 Constraint on Irrigable Land:

It is assumed that in any month of crop season the total irrigated area should not exceed the total area, proposed for irrigation in crop season

For Kharif

$$\sum_{i \le k} A_i \le A_k$$

Kharif months (April, May, June, July, Aug., Sept., Oct.,) and Rabi months (Nov., Dec., Jan., Feb, and March)

Rabi season

$$\sum_{i \le R} A_i \le A_R$$

4.4.6 Quantity of Water

The quantity of water diverted through canal should not exceed its carrying capacity. Assuming that the canal remains closed for 4 days in a month the potential capacities are estimated knowing the design discharge of the canals.

$$D_t <= D_{tmax}$$

$$(t = 1, 12)$$

D_{max} = canal capacity x no. of operating days x 24 x 60 x 60 / 10^6 MCM

4.4.7 Evaporation Losses From Reservoir:

Monthly evaporation from the reservoir depends on the reservoir area at the beginning and end of the month.

E_t = E pt*Reservoir area.

Where

E_{pt} = monthly reservoir evaporation depth in meter in t th month.

4.5 GENERALISED FORM OF LP. MODEL:

Objective function:

MAX= P1*A1+P2*A2+P3*A3+P4*A4+P5*A5+P6*A6
+P7*A7+P8*A8+P9*A9+P10*A10+P11*A11

4.5.1 Constraints: Water Balance Equation:

D1+Y1+S2-S1+E1=F1

D2+Y2+S3-S2+E2=F2

D3+Y3+S4-S3+E3=F3

D4+Y4+S5-S4+E4=F4

D5+Y5+S6-S5+E5=F5

D6+Y6+S7-S6+E6=F6

D7+Y7+S8-S7+E7=F7

D8+Y8+S9-S8+E8=F8

D9+Y9+S10-S9+E9=F9

D10+Y10+S11-S10+E10=F10

D11+Y11+S12-S11+E11=F11

D12+Y12+S1-S12+E12=F12

4.5.2 Water Use for Irrigation:

WR11*A1+WR17*A7+WR18*A8+WR19*A9+WR110*A10+WR111*A11-U1*D1-N1*T1=0

WR21*A1+WR27*A7+WR28*A8+WR29*A9+WR210*A10+WR211*A11-U2*D2-N2*T2=0

WR31*A1+ WR37*A7+WR38*A8+WR33*A3-U3*D3-N3*T3=0

WR41*A1+WR42*A2+WR43*A3+WR44*A4 -U4*D4-N4*T4=0

WR51*A1+WR52*A2+WR53*A3+WR54*A4-U5*D5-N5*T5=0

WR61*A1+WR62*A2+WR63*A3+WR64*A4+WR65*A5-U6*D6-N6*T6=0

WR71*A1+WR75*A5-U7*D7-N7*T7=0

WR81*A1+WR85*A5+WR86*-U8*D*-N8*T8=0

WR91*A1+WR95*A5+WR96*A6-U9*D9-N9*T9=0

WR101*A1+WR105*A5+WR106*A6-U10*D10-N10*T10=0

WR111*A1+ WR117*A7+WR118*A8+WR119*A9+WR1110*A10+WR1111*A11-U11*D11-N11*T11=0

WR121*A1+WR127*A7+WR128*A8+WR129*A9+WR1210*A10 +WR1211*A11-U12*D12-N12*T12 =0

4.5.3 Ground Water Constraints:

Annual withdrawal should be less than annual recharge

T1+T2+T3+T4+T5+T6+T7+T8+T9+T10+T11+T12 <=Tmax

4.5.4 Storage Constraints:

4.5.4.1 Gross storage constraints:

S1<=Smax

S2<=Smax

S3<= Smax

S4<=Smax

S5<=Smax

S6<=Smax

S7<=Smax

S8<=Smax

S9<=Smax

S10<=Smax

S11<=Smax

S12<=Smax

6.5.4.2 Dead storage:

S1>=Smin

S2>=Smin

S3>=Smin

S4>=Smin

S5>=Smin

$S6>=Smin$

$S7>=Smin$

$S8>=Smin$

$S9>=Smin$

$S10>=Smin$

$S11>=Smin$

$S12 >= Smin$

4.5.5 Constraints on Irrigation Low:

$A1+A2+A4+A5+A6<=AKmax$

$A3+A7+A8+A9+A10+A11<=ARmax$

4.5.6 Canal Capacity Constraints:

$D1<=D1max$

$D2<=D2max$

$D3<=D3max$

$D4<=D4max$

$D5<=D5max$

$D6<=D6max$

$D7<=D7max$

$D8<=D8max$

$D9<=D9max$

$D10<=D10max$

$D11<=D11max$

$D12<=D12max$

4.5.7 Area Under Irrigation:

$A1+A2+A3+A4+A5+A6 \leq AK$

$A1+A7+A8+A9+A10+A11 \leq AR$

4.6 APPLICATION OF MODEL

The generalised L.P. Model developed can now be applied to analyse various conditions related to irrigation project development . A sensitivity analysis to the optimization problem can be carried out by introducing necessary changes into the relevant constraints. Solution to different technological options with respect to base condition defined for the optimization problem would mean the sensitivity analysis to that base condition . Comparison of optimal solution under various conditions would indicate impact of various options in improving irrigation and farm benefits. The following modifications to the parameters and put data with respect to the base condition (Table 4.2) were made to study such impacts.

1. The feasibility of adopting designed cropping pattern .
2. The feasibility of adopting cropping pattern practiced(Existing pattern)
3. The effect of removing crop area constraint.
4. The effect of conjunctive use of surface and ground water resources.

4.7 ESTIMATION OF INPUT DATA AND PARAMETERS

The input data and other parameters required to run the L.P. Model have been taken from the project report. These include data on hydrology, cropping pattern, net farm benefits, irrigation efficiencies and crop water requirement. However, due to non availability of data for the estimation of several input data and parameters certain assumption had to be made. As such, there is a scope for further improvement of the model.

1. Monthly net irrigation requirement of crops for different crops (Table 3-14).
2. Monthly inflow to the reservoir (Table 4.3).
3. Net farm benefits for different crops of the command area (Table 4.5).
4. The potential capacities of the canal and the maximum and dead storage capacity of the reservoir (Table 4.4 and 2.1).
5. Bounds on irrigation land in different commands
6. Annual ground water resources
7. Other data like area capacity curve, reservoir evaporation to estimate the loss from reservoir.

4.7.2 Net Irrigation Requirement:

The crops in the project area are assumed to be grown in two seasons i.e., khariff and rabi. The khariff crops are sugarcane, early paddy, monsoon paddy, late paddy, summer vegetable and maize, wheat, oilseeds, pulses, winter vegetables and potatoes are Rabi crops.

The crop water requirement for different crops have been calculated by modified Penman method.

4.7.3 Irrigation Efficiencies

Part of water diverted at the canal head into the canal is lost during conveyance upto the fields and a part is lost while applying in the fields. The conveyance losses in unlined canals are assumed as 40% and in lined canal as 10%. Field application efficiency is assumed to vary from 60% under average field condition and 75% under improved condition. In this project canal conveyance efficiency is taken as 75% while field application efficiency as 70%.

4.7.4 Monthly Diversion Capacities

The potential diversion capacities have been calculated by multiplying the capacities by the number of operating days (Table 4.5).

4.7.5 Net Farm Benefits

Net farm benefits are referred from the other Terai irrigation project of Nepal. (Table4.7).

4.7.6 Irrigation Land Resources

The net culturable command area of the project including Dhanush, Mahottari and Sirha districts are 138000 ha.

4.7.7 Annual Groundwater Resources

Groundwater recharge due to rainfall is estimated as explained in chapter-3. The irrigation potential can be improved with conjunctive use of surface and groundwater. The recharge due to irrigation, it is assumed that 50% of the percolated water due to irrigation contributes to the recharging of aquifers.

Annual recharge due to irrigation = Average annual water release into the canal*Ec*(1-Eaf)*0.50. The total groundwater recharge are worked out in paragraph 2.4.

4.8 CONDITION OF ANALYSIS

Condition -1 (Irrigation with Surface Water of Kamla Basin with no Crop Area Constraints)

The use of surface water resources of Kamla Basin is considered without taking into account, the groundwater and Sunkosi water. The potential diversion capacity of the canal is the existing canal system of Kamla I.P. Crop area constants have not been taken into account in order to identify the ideal cropping pattern which gives the maximum returns. The net return given by the model is NRs 465 crores and covered maximum area under irrigation i.e. 100% in kharif and 100% in rabi. The model selected vegetables in kharif and potato in rabi which gives maximum benefit are requires minimum water.

Condition -1I : (Irrigation with Surface Water of Kamla Basin with Crop Area Constraints)

So far the area under different crop were not bounded by imposing upper, the lower limit of te crop area have been used as per the actual (resisting crop area constraints. The net returns in this condition is NRs 3050 crore which is less than condition I.

Condition- III : (Irrigation with Surface Water of Kamla Basin and Water Transfer from Sunkosi with no Crop area Constraints)

In the absence of minimum requirement for food crops, as constraints the model has given maximum return as NRs 2953 crores and model has selected Khariff vegetable and Rabi potato which gives maximum returns. It has not selected paddy as kharif crop and wheat as rabi crop which are food crops. This is due to the fact that these give less benefit then selected crops and require maximum water.

Condition-IV : (Irrigation with Surface Water of Kamla Basin and Sunkosi with Existing Crop Area Constraints and no Groundwater Use)

The existing cropping pattern areas have been used as crop area constraints without groundwater use. The upper limit of the crop areas have not binding by imposing upper limit. The existing cropping area under different crops are used as lower limits, in order to satisfy the minimum food crop requirements of the farmers, irrespective of the net returns. The upper limits have not been bounded to enable the model to select the optimum cropping pattern, which gives maximum net benefit. The net benefit given by the model in this case is NRs 1671 crores. The model has selected vegetable in khariff in 37% of available land and potato in rabi season in 48% of land which is practically not possible to grow due to land suitability to crops.

Condition- V : (Irrigation with Surface Water of Kamla Basin and Sunkosi with Designed Crop Area Constraints and with Groundwater Use)

The input data is same as in condition III and IV except that the lower binding limit of the crop area constraints are replaced by the areas pertaining to designed cropping pattern (Table 4.1). The net optimal benefits given by the model are NRs 1219 crores which is minimum than condition IV and V. The low net return is because of the introduction of policy constraints on cultivated areas under different crops.

Condition- VI : (Irrigation with Surface Water of Kamla Basin and Sunkosi with Lower and Upper Binding Limit of the Crop Area Constraints and with Groundwater Use)

To maximize the designed cropping pattern, the lower limits of crop areas on the basis of existing field practice and upper limit on basis of present opportunity of cash crops and suitable land use condition, the crop areas constraints have been introduced as imposing upper and lower limits. The model has selected the crop areas around designed crop areas. The areas selected by model is presented in (Table 4.1). The net benefit in this condition is NRs 1127 crores, which is less than existing are design cropping condition No. IV, V and VI. In this condition, the model has selected quite acceptable crop areas to satisfy the crop requires, irrespective of the net return. These crops areas have been selected as designed crop area for further projects requirements.

Condition- VII : (Effect of Introduction of Design Cropping Pattern.

The optimal solution highlights the suitability of the designed cropping pattern (condition V) with available resources utilization. The optimal net returns is low NRs 1127 crores than condition - V (NRs 1219 crores).

Table 4.1 : Cropping intensities and comparison of optimal and designed cropping Patterns

Benefit / crop name	**Designed crop are (ha.)**	**Optimal crop area (ha.)**	**Increase / decrease from design crop area(%)**
Benefit	NRs 1219 crores	NRs1127 crores	
Kharif crops			
Sugarcane (A_1)	11040	13835	(+2%)
Early Paddy (A_2)	16560	11012	(-4%)
Maize (A_3)	13800	12448	(-1%)
S. vegetables (A_4)	6900	11040	(+3%)
Main paddy (A_5)	69000	75900	(+5%)
Late paddy (A_6)	2700	13765	(-5%)
Total	**138000**	**138000**	
Rabi Crops			
Sugarcane (A_1)	11040	13835	(+2%)
Wheat (A_7)	48300	62110	(+10%)
Pulses (A_8)	20700	20700	No change
Oil seeds (A_9)	20700	13765	(-5%)
W. Vegetables (A_{10})	6900	11040	(+3%)
Potato (A_{11})	6900	16560	(+7%)
Total	**138000**	**138000**	

Table 4.2 : Net Returns and Optimal Irrigated Areas Under Various Conditions

Item	Condition I	Condition II	Condition III	Condition IV	Condition V	Condition VI
Net Benefit (NRs).crores	465.0	304.0	2953.0	1671.0	1219.0	1127.0
Khariff crops						
1. Sugar cane (A1)	-	1330	-	7341	11040	13835
2. E paddy (A2)	-	1195	-	11012	16560	11012
3. Maize (A3)	-	1662	-	9177	13800	12448
4. S. Vegetable (A4)	25000	9208	138000	50820	6900	11040
5.N.Paddy(A5)	-	8312	-	45885	69000	75900
6. L PADDY (A6)	-	2493	-	13765	20700	13765
Total	25000	25000	138000	138000	138000	138000
Rabi Crops:						
1. Sugarcane (A1)	-	1330	-	7341	11040	13835
2. Wheat (A7)	-	5818	-	32119	48300	62100
3. Pulses (A8)	-	2493	-	13765	20700	20700
4. Oil seeds (A9)	-	2493	-	13765	20700	13765
5. W.Vegetables (A10)	-	831	-	4588	6900	11040
6. Potato (A11)	25000	12035	138000	66422	30360	16560
Total	25000	25000	138000	138000	138000	138000

4.9 COMMENTS

The various results of the L.P model conducted to satisfy different conditions are useful in decision making for fixing crop area and for operation planning in the project. The model study justifies the proposed design cropping patterns with benefits and water consumption rate by the crops. The proposed cropping intensity and highest returns can be achieved only with conjunctive use of ground water and surface water Sunkois Kamala water transfer scheme is linked with power generation from Sunkosi and Kamala reservoirs. Further study can be carried out by incorporating proper generation constraints. These benefits have not been considered in the optimization study.

Table No. 4.3

POTENTIAL DIVERSION TO THE CANAL

S.N.	MONTH days	canal running days	canal capacity(m3/s) potential diversion	potential canal capacity(ha-m)
1	JAN	27	97.98	22857
2	FEB	25	97.98	21164
3	MAR	27	97.98	22857
4	APR	26	97.98	22010
5	MAY	27	97.98	22857
6	JUN	26	97.98	22010
7	JUL	27	97.98	22857
8	AUG	27	97.98	22857
9	SEP	26	97.98	22010
10	OCT	27	97.98	22857
11	NOV	26	97.98	22010
12	DEC	27	97.98	22857

Note: Canal Capacity = 0.71x 138000 /1000 = 97.98 cumecs
Potential Diversion Capacity = 97.98 x 3600 x 24 x 10^{-4} x N (No. of Days)

Table No. 4.4

INFLOW TO THE KAMALA RESERVOIR

S.N.	Month	Infow from Sunkosi			Self flow of Kamala(ha-m)		ɔtal inflow in (ha-m)
		days	m3/s	ha-m	m3/s	ha-m	ha-m
1	JAN	31	75	20088	6.38	1709	21797
2	FEB	28	75	18144	5.43	1314	19458
3	MAR	31	75	20088	4.94	1323	21411
4	APR	30	75	19440	5.4	1400	20840
5	MAY	31	75	20088	6.5	1741	21829
6	JUN	30	75	19440	9.65	2501	21941
7	JUL	31	75	20088	18.3	4901	24989
8	AUG	31	75	20088	23.5	6294	26382
9	SEP	30	75	19440	21.8	5651	25091
10	OCT	31	75	20088	14.9	3991	24079
11	NOV	30	75	19440	8.74	2265	21705
12	DEC	31	75	20088	7.26	1945	22033

Table No. 4.5

DOWN -STREAM RELAESE FOR DOMESTIC AND INDUSTRIAL SUPPLY

S.N.	MONTH	DEMAND		
		DAYS	m3/s	ha-m
1	JAN	31	3.4	911
2	FEB	28	3.4	823
3	MAR	31	3.4	911
4	APR	30	3.4	881
5	MAY	31	3.4	911
6	JUN	30	3.4	881
7	JUL	31	3.4	911
8	AUG	31	3.4	911
9	SEP	30	3.4	881
10	OCT	31	3.4	911
11	NOV	30	3.4	881
12	DEC	31	3.4	911

Note: Refer Table No. 3.1 for Detail Calculation

Table No. 4.6

KAMALA RESERVOIR EVAPORATION LOSSES

S.N.	MONTH		Pan Evap. LOSS (mm/day)	MONTHLY EVAP. LOSS	MULTI- FACTOR	RESER. EVAP.LOSS (mm)	REWSER AREA(ha)	RESER LOSS (ha-m)
1	JAN	31	3.5	108.5	0.7	76	5400	410
2	FEB	28	4.35	121.8	0.7	85	5200	443
3	MAR	31	6.3	195.3	0.7	137	4800	656
4	APR	30	8.79	263.7	0.7	185	4700	868
5	MAY	31	9.04	280.24	0.7	196	4600	902
6	JUN	30	7.28	218.4	0.8	175	4900	856
7	JUL	31	6.78	210.18	0.8	168	5400	908
8	AUG	31	6.54	202.74	0.8	162	5700	924
9	SEP	30	5.56	166.8	0.8	133	5700	761
10	OCT	31	5.21	161.51	0.8	129	5700	736
11	NOV	30	3.83	114.9	0.7	80	5600	450
12	DEC	31	3.06	94.86	0.7	66	5500	365

Table No. 4.7

Agricultural benefit Per hectare

S.N.	Crops	Without project (NRs.000)	With project (NRs.000)
1	Sugarcane	25.0	48.0
2	Early paddy	16.0	28.0
3	Maize	12.0	30.0
4	Summer vegetables	28.0	56.0
5	Monsoon paddy	21.0	47.0
6	Late paddy	16.0	28.0
7	Wheat	18.0	27.0
8	Oilseeds	6.0	17.0
9	Pulses	9.0	22.0
10	Winter vegetables	23.0	76.0
11	Potatoes	60.0	130.0

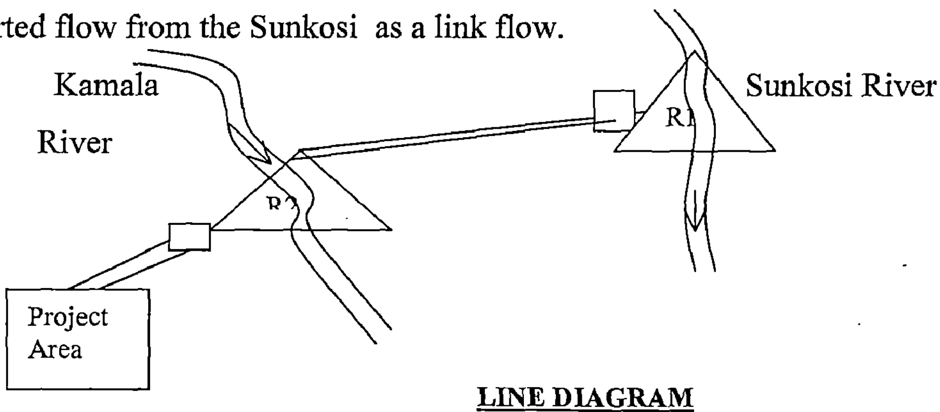
(Source:- BLGWIP,Nepal)

CHAPTER -5

LONG TERM RESERVOIR SIMULATION

5.0 GENERAL

Long term reservoir simulation is a search technique used to examine and evaluate the performance of a reservoir with different assumed capacities for meeting the specified release pattern and to satisfy the conditional operation rules. There are two reservoirs proposed in this system first one is on Sunkosi river at Kurule to divert the flow for meeting demands of Kamala basin as a link flow and to generate hydropower from this diverted flow. Second one is Kamala reservoir at Chissapani, with the view to meet the peak irrigation demand and to generate hydropower. The monthly simulation of these reservoirs operation for 19 years data series have been done using software for reservoir analysis (SRA), developed by National Institute of Hydrology, Roorkee. The model used in simulation is "multi- reservoir operation simulation" which is used to simulate the operation of a multipurpose multi-reservoirs system for conservation operation. The data required by the model are full reservoir level, dead storage level, elevation-area capacity table, various conservation demands from the reservoir like water supply for domestic and industrial use, irrigation, hydropower demands and minimum flow requirement in the downstream channel, evaporation depth, and local inflow were analyzed from these data, collected from previous studies reports and departmental data. The inflow data of the Sunkosi river is available for the period 1966 to 1985 and that of Kamala for the period from 1989 to 1994. In Sunkosi reservoir operation inflow was self flow of the Sunkosi while in Kamala reservoir the inflow is self flow of Kamala and diverted flow from the Sunkosi as a link flow.



LINE DIAGRAM

5.1 MULTI-RESERVOIR OPERATION SIMULATION

Software For Reservoir Analysis (SRA) developed by National Institute Of Hydrology, Roorkee is a menu-driven, interactive package and easy- to- use software with full -screen menu. The package includes many tabular and graphical options facilitating efficient reporting.

This model can be used to simulate the operation of a multipurpose multireservoir system for conservation operation. The various conservation purposes considered in the model are water supply for domestic and industrial purposes, irrigation, hydropower generation and minimum flow in the downstream river channel. In a multireservoir system, the model can help in finalizing the optimum rule levels for each storage location.

For each storage location, the model operates the reservoir in accordance with the given trial rule curves and carries out the reliability analysis. It calculates the time and volume reliability of each reservoir for the given set of rule curve and for the given period of operation. Detailed simulation table is also prepared. Based on the observation from the simulation tables, trial rule curves are modified till optimum results are achieved.

$$\text{Annual reliability} = \frac{\text{No. of years [illegible] one or more failure months}}{\text{Total numbers of years of operation}}$$

$$\text{Time reliability} = \frac{\text{Total number of months of operation - failure months}}{\text{Total months of operation}}$$

$$\text{Volume reliability} = \frac{\text{Total volume release during operation period}}{\text{Total demand volume during operation period}}$$

Critical failure month:

When the release from the reservoir is less than a specified percentage of the total demands. In this study release less than 75% of demand release is considered critical failure.

5.2 METHODOLOGY ADOPTED FOR RESERVOIR OPERATION:

The highest priority is given to the water supply demand for domestic and industrial purposes and the minimum flow requirements in the downstream channel. The demands for irrigation and hydropower are given second priority as compared to the water supply and minimum flow demand.

The amount of water required to produce hydropower is calculated based on the mean elevation of water during a period. In the present model, four rule curve levels have been specified, namely the upper rule level, the first middle rule level, second middle rule level and the lower rule level. The level of these rule curves have been mentioned in area capacity Table 2.1 and 2.3 of chapter 2.

(i) Upper Rule Level

The upper rule level specifies the upper most level up to which a reservoir should be filled if there is sufficient inflow to the reservoir. The upper rule level can be either FRL or a level below FRL. In Sunkosi reservoir FRL is 323.0 m and Kamala reservoir is 182m. If the reservoir reaches this level then the demands for the remaining duration of that year are likely to be satisfied in full. If the level in the reservoir overtops the upper rule level, then water is spilled from the reservoir in the downstream river. Thus, it is the most desirable level and effort is made to maintain this level.

Though it is always desirable to fill a reservoir up to the maximum available capacity (up to FRL), it is recommended that some spill should be made from the reservoir to keep up the downstream river channel and to avoid encroachment in the river bed. Keeping the upper rule level below FRL can give extra space for flood absorption in the reservoir also. However, lowering the upper rule level below FRL should not affect the performance of the reservoir for conservation demands.

(ii) First Middle Rule Level

The middle and lower rule levels are used in the situation when water is scarce and full supply for the various demands cannot be made throughout the year. Supply for some demands (with lower priority) can be curtailed to some extent so that the partial demands can be satisfied for longer duration. The underlying assumption is that it would always be better to supply less water for longer duration rather than to meet free demand for some time and then stop the supply.

Based on the priority between irrigation and hydropower, the first middle rule level can be critical for irrigation or power generation which are given low priority as compared to domestic and industrial water supply demands and minimum flow requirements. If irrigation is at higher priority, this rule level corresponds to hydropower rule level and vice versa. If the water level in the reservoir is above the first middle rule level, full supply of water is made for all the demands. However, if the water level in a reservoir falls below the first middle rule level, reduced supply (based on the curtail factor) is made for the least priority demand and full supply is made for other demands. The release is made at the reduced rate so that the partial demands can be met for longer duration. This level in Sunkosi reservoir is 312.0m in Kamala reservoir 164.o m.

(iii) Second Middle Rule Level

The second middle rule levels are derived when the purposes from a reservoir include, both, irrigation and hydropower in addition to the water supply demands. It is used in a situation when water is so scarce that even after curtailing demands for least priority demands, release for other higher priority demands can not be made in full.

The second middle rule level is critical for second higher priority demand (irrigation or hydropower). If the water level in the reservoir falls below the second middle rule level, the supply for the least priority demand is completely curtailed, reduced supply (based on the curtail factor) is made for the second least priority demand and full supply is made for the highest priority demand and full supply is made for the highest priority water supply demands. The release is made at the reduced rate so that these partial releases can be maintained throughout the water year. This level in Sunkosi reservoir is 312.0m in Kamala reservoir 164.o m.

(iv) Lower Rule Level

The lower rule level is critical for water supply demands and minimum flow requirements in the downstream river. If the reservoir level falls below the lower rule level, then supply in made to meet full demands of water supply and minimum flow only. No water is released for irrigation or hydropower generation in this situation. If this water passes through the power plants, then some incidental hydropower may also get generated. This level in Sunkosi reservoir is 312.0m in Kamala reservoir 164.o m.

5.3 DATA REQUIREMENT OF THE MODEL:

The data required for the model study are available, full reservoir level, dead storage level, elevation- area-capacity table, various conservation demands from the reservoir lime water supply for domestic and industrial purposes, irrigation, hydropower demands and minimum flow requirement in the downstream channel, evaporation depths and local inflow from the catchment area. These input data have been presented in the following Table 5.1 and other required data have been computed and presented in the following tables of this report.

(i) Elevation area capacity table in Table 2.1 and 2.3 in chapter 2.

(ii) Domestic and industrial demands in Table 4.5 in chapter 4.

(iii) Inflow of Kamala river (average) in Table 4.4 in chapter 4.

(iv) Link diversion from Sunkosi to Kamala in Table 4.4 in chapter 4.

(v) Reservoir evaporation depth in Table 4.6 in chapter 4.

(vi) Inflow of the Sunkosi river in Table 4.7 in chapter 4.

(vii) Inflow of Kamala river in Table 4.8 in chapter 4.

Table 5.1: Program Input Data

Line	Variable name	Format	Description	INPUT DATA	
1	TITL	A	Title of the problem	Reservoir-1	Reservoir-2
2	NLOC	Free	Total number of controlling locations in the system.	2.0	2.0
	IMON(1)	Free	Initial month of operation.	10.0	1.0
	IYR (1)	Free	Initial year of operation.	1966.0	1966.0
	NMON	Free	Number o months of operation.	324	324
	IFMON	Free	A factor for specifying length of a period =		
			For monthly operation,	2.0	2.0
			For early	1.0	1.0
3	-	-	Blank line		
4	NAME (I)	A	Name of location alphanumeric.	Reservoir 1	Reservoir 2
5	ICP (I)	Free	Node Number of the control point.	1.0	1.0
		Free	Number of control points immediately upstream of the present control.	0.0	0.0
		Free	A flag to specify the way of supply of water through the power plants:		
			= 0 - no power plants,		1.0
			= 1- all release pass through plants		
			= 2 - Irr. Release bypasses the plants,		
			= 3 - WS release bypasses the plants.		
			= 4 - all release bypass the plants.	4.0	
	FIR (I)	Free	A factor for reducing demands of irrigation in case of insufficient water.	1.0	1.0
	FPOW (I)	Free	A factor for reducing demands of hydropower in case of insufficient water (if icon(i0 = 0, then 0).	1.0	1.0

	FCRI (I)	Free	A factor for defining critical conditions (release less than a specified percentage of total demands).	0.75	0.75 0.0
	ICP2 (I)	Free	Node number of ICPI control points upstream of the present control point.	0.0	
If ICON (I) Greater Than 0, Then					
6	PINST (I)	Free	Installed capacity of the power plants in MW.	69.0	31.0
	ETAIL (I)	Free	Tail water elevation (m)	198.0	140.0
	PLMIN (I)	Free	Minimum level for power production in meter.	312.0	164.0
	EFF(I)	Free	Efficiency of the power plants.	0.85	0.85
7	IPRIO (I,J)	Free	Priority index for irrigation & power = 0 if irrigation has higher priority., = 1 if power has higher priority.	1.0	0.0
8	POW (I,J)	Free	Monthly/ ten-daily hydropower demand in MK wh.	0.0	0.0
Endif					
9	SMAX (I)	Free	Gross capacity up to FRL (m^3)	22.5×10^6	900×10^6
	SMIN (I)	Free	Gross capacity up to intake of WS outlet (m^3)	7.5×10^6	$190 \times ^6$
	STOR (I,1)	Free	Initial reservoir storage (m^3).	22.5×10^6	900×10^6
	NN (I)	Free	Number of points in Elevation -Area-Capacity table. NN = 0 for non-reservoir locations like weirs & barrage.	11.0	11.0
	IDP (I)	Free	A flag controlling simulation table printing: = 2 for detailed simulation table in output file; = 0 for no simulation table.	1.0 , 2.0	1.0 , 2.0
10 onward	ELEV (I, J)	Free	Elevation in the Elevation -Area -Capacity table (m).		
	AREA (I,J)	Free	Corresponding area in Million Sq. m	2.5×10^6	57×10^6
	CAP (I, J)	Free	Corresponding capacity in Million Cu.m.	22.5×10^6	900×10^6
Next line	INFL	Free	A flag for reading/ calculating local inflows: = 1, if inflow data of present location to be read: = 2, if inflow data of present location is to be computed from the inflow data of some other location.	1.0	1.0
	FAC	Free	Multiplication factor to convert inflow values in Cu. M.	1×10^6	1×10^6
		Free	Node number of the downstream location whose partial demands are to be satisfied by the present location	0	0
		Free	% age of downstream location demands to be satisfied.	0	0
		Free	Return flow expressed as fraction of the irrigation release from the present location that will join the downstream location.	0	10 %
		Free	Irrigation demand from a canal (LBC or RBC) which passes through the power house (if applicable) in M Cum (either monthly or ten-daily) starting from January. If there is no power house or all irrigation	0	monthwise attached

		Free	demand (LBC +RBC) passes through the power house, then this represents total irrigation damned (LBC+ RBC). Irrigation demand from other canal which does not pass through the power house (if applicable) in M Cum (either monthly or ten-daily) starting from January. If there is no power house or all irrigation demand (LBC + RBC) passes through the power house, then this represents zero (0) irrigation demand irrigation.	0	0
		Free	Total domestic and industrial water supply demand in Million Cu. m (either monthly or ten-daily) starting from January.	0	0
			Minimum flow demand in the downstream channel in M Can (One value only).	0	month wise attached
				0	
		Free		0	0
Next line	RULE (I,J)	Free	Upper rule levels in meter (either monthly or ten-daily straiten from January)	323.0	182.0
			First middle rule levels critical for irrigation or hydropower demands (depending on priority) in meter) either monthly or ten-daily) starting from January.	312.0	164.0
If both, Irrigation and Hydropower are to be Served, Then					
Next line	POL (I,J)	Free	Second middle rule levels critical for irrigation or hydropower demands (depending on priority) in meter (either monthly or ten daily) staring from January,	312.0	164.0
Next line	WPL (I,J)	Free	Lower rule levels critical for water supply and minimum flow demands in merrier (either monthly or ten-daily) starting from January.	312.0	164.0
Next line	EVPD (I,J)	Free	Evaporation depth in meter/ month (either monthly or ten-daily) starting from January.	monthly value attached	monthly value attached
Next line	FLOW (I, J)	Free	Inflow values at the location in Million Cu. M for all the periods of record (either monthly or ten-daily). If INFL is = 1, then mode number of the location whose inflow data is to be used for calculating the inflows at the present node must be specified here.	monthly value attached	monthly value attached

5.4 OUTPUT OF THE MODEL

The model was used to simulate the operation of the Sunkosi and Kamala reservoirs for 19 years. Based on the trial rule curve levels the monthly time and volume reliability for each reservoir have been calculated. In addition, the total number of months of irrigation failure and water supply failure have been computed. It also calculates the number of months when the release from the reservoir is less than a specified percentage of the total demands and thus calculates the Critical Failure months computer printing of line results are given in appendix 2.

For each period, the table gives the year, month and period of operation, the initial storage, flow from intermediate catchment, evaporation, irrigation demand, water supply demand, hydropower generated, spill from the structure, end level and middle and upper rule levels.

5.4.1 Results of Long Term Reservoir Simulation

The simulated results show the time and volume reliability of the Sunkosi reservoir as 0.995 and 0.996 respectively. There is only one failure year (1982). While the Kamala reservoir at 4.75% decrease of design irrigation demand shows the annual irrigation reliability as 0.833. At this demand, the number of failure years are 3·0 and the failure years are 1982 (June, July), 1983 (July), and 1984 (July). The summary of the simulated output has been presented in Table 5.2 and computer print of results are given in appendix II.

Table 5.2: Reservoir Reliability

Annual irrigation demand (Mcm)		Reservoir -1 (Reliability)			Reservoir -2 (Reliability)				
Volume	% Decrease	Time	Volume	No. of failure Year	Time reliability	Volume	Annual reliability	No. of failure Year	Years
(i) 2598	0	0.995	0.996	1 (1982)	0.971	0.953	0.056	18	
(ii) 2468	5	0.995	0.996	1	0.955	0.998	0.994	1	1982
(iii) 2481	4.5	0.995	0.996	1	0.945	0.995	0.44	11	-
(iv) 2475	4.75	0.995	0.996	1	0.981	0.997	0.833	3	1982-83-84
(v) 2477	4.65	0.995	0.996	1	0.963	0.996	0.611	8	-

5.5 COMMENTS

The irrigation demands for the condition of annual irrigation reliability more than 75%, becomes deficit by 4.75% (121 MCM). Therefore, either irrigation demands should be reduced by 4.75% or link flow diversion should be increased by 121 MCM (5% of the total diversion) or monthly peak demands of the second reservoir can be minimize by adopting alternative cropping pattern as presented in printed sheet No. VI as an alternative. The simulation was conducted also for the minimum height of the reservoir dam and it was found that the minimum capacity of 900 MCM as full resume of elevation 182.0 m (minimum height 44 m) is required.

CHAPTER 6

SUMMARY AND CONCLUSION

6.0 This report deals with basin water balance study. L.P. model study and long term reservoir simulation study.

6.1 STUDY AREA CHARACTERISTICS

The study area is the Kamala basin and the basin has catchment area 2100 sq.km at proposed reservoir site and project area 3432 sq.km. The length of the Kamala river is about 100 km. The present study of the Kamala basin covers three districts namely Dhanusha, Mahottari and Sirha. The net command area considered in this project is 138000 ha.

6.2 WATER BALANCE STUDY

6.2.1 Kamala Basin Water Balance Study

The water balance study of Kamala basin was carried out with the purpose to find out the water status of the basin. The multipurpose demands of the project such as irrigation, domestic and industrial were estimated as per NWDA guidlines. The surface water and groundwater available in the basin has been assessed. The discharge data of Kamala river at Inarawa site was obtained from the Dept. of Hydrology and Meteorology of Nepal for six years period from 1989 to 1995. This data has been considered for surface water study. The groundwater assessment has been done on basis of annual recharge due to rainfall and surface water utilization. The annual recharge has been calculated by the formula developed by U.P. Irrigation Research Institute, Roorkee. The annual recharge has been found as 601.00 MCM out of which 542 MCM has been considered for use for this project demand. Similarly the water available in Kamala basin has been worked out. The total demands of the Kamla basin sector wise are as 3584.14 MCM for irrigation, 72.53 MCM for domestic demands and 34.69 MCM for industrial demands while water available in Kamla basin are as surface water of Kamla river 351 MCM surface water, groundwater 542.0 MCM (Ground water) and regeneration due to the surface water utilization is 442.82 MCM. The net deficit of water for Kamla basin is 2355.0 MCM (75.0cumecs), which is to be transferred from the Sunkosi basin (Table 3.15).

6.2.2 Sunkosi Basin Water Balance Study

The purpose of this study was to estimate the surplus water available in the basin. The discharge data of Sunkosi river at Kamphu Ghat, immediately down stream from the, Kamala diversion point at Kurule, was obtained from the Dept. of Hydrology and Meteorology, Nepal for 18 years from 1967-1985. This data was considered for the study. In upstream of the diversion point, there are irrigation demands and Melanchi water supply demand for Kathmandu Valley. The water balance study has been computed considering these upstream demands. In down stream of the Sunkosi River there is not any major demands before joining Sapta Kosi river. So there may not be any adverse effect in downstream due to diversion from Sunkosi to Kamala (Table 17 & 18).

6.2.3 Sapta Kosi River Water Balance Study

Sunkosi river is a tributary of Saptkosi river, so water balance of Sapta Kosi has been carried out to see the effect of Kamla diversion on this river basin. The discharge of Sapta Kosi River at Chattara near Kosi barrage, was obtained for 20 years from 1977 to1997. This data was considered for this study and it was found that large amount of untapped water still remains in this basin (refer Table 19).

Thus water balance study of the Sunkosi shows that Sunkosi river basin is a water surplus basin. Hence it is possible to meet the demands of Kamala basin from Sunkosi basin and this transfer has no adverse impacts in downstream of Sunkosi

6.3 L.P. MODEL STUDY

A deterministic linear programming model has been developed and used to study the various technological options such as changes in existing and designed cropping patterns, cropping intensity, conjunctive use of surface water and ground water. As this project is in planning phase, two types of analysis were carried out in the model study. One is to find out the cropping pattern which yields maximum benefits using canal water and ground water. The second type of study was to find out the optimal crop area and intensity to check the suitability of existing and designed cropping patterns with surface water and ground water.

Estimation of input data and related prameters of the model are based on existing Kamala project data, Bhairwa -Lumbini ground water project data and feasibility study report of Sunkosi - Trai irrigation project LP Model has been solved using the above data and for various conditions

(i) Irrigation with Kamla surface water, (ii) Kamla surface water and ground water, (iii) Kamla surface water and water transferred from Sunkosi and Kamla surface water, (iv) Groundwater and water transferred from Sunkosi). These analysis have been computed using no crop area constraints, existing crop area constraints, designed crop area constraints and policy constraints as lower binding and upper binding limit for minimum required and maximum possible crop area suitable for crops. The crop area has been finalized on basis of outcome of the model computations (Table 4.2). The L.P Model study is scientific study and provides guidelines on different options of crops and crops area selections for cropping pattern and cropping intensity.

6.4 OPTIONS OF WATER SUPPLY

6.4.1 Supply through Kamla Reservoir

The maximum area that can be irrigated with water supply through reservoir supply along with groundwater use has been found as 138000 ha and power generation from this reservoir is 31 MW.

6.4.2 Supply without Kamla Reservoir (Run-off river Scheme)

The maximum area that can be irrigated with Kamla surface water has been calculated as 7000 ha, and with ground water conjuctive use it is as 12000 ha. The maximum area that can be irrigated with Kamala surface water and water transfer from Sunkosi has been found as 78000 ha while with groundwate use as 114000 ha. So the net difference in command area in supply through reservoir and without reservoir is found as 24000 ha.

6.5 LONG TERM RESERVOIR SIMULATION STUDY

It is a search technique used to examine and evaluate the performance of a reservoir with different assumed capacities for meeting the specified release pattern and to satisfy the conditional operation rules. Two reservoirs are proposed in this system; first one is on Sunkosi river at Kurule to divert the demands of Kamla basin as a link flow and to generate hydropower from this diverted flow. Second one is Kamala reservoir at Chissapani, with a view to meet the peak irrigation demand and to generate 31 hydropower. The monthly simulation of these reservoirs operation for 19 years data series have been done using software for reservoir analysis (SRA), developed by National Institute of Hydrology, Roorkee.

The model study was conducted for annual irrigation reliability and minimum height of Kamla reservoir required to meet the irrigation demand. The summary results of the simulation (Table No.5.2) show that Sunkosi releases link demands as time reliability [illegible].995% and volume reliability as [illegible].996 %. With this release from Sunkosi, the various demands of the Kamla scheme are met by the water supply through Kamla reservoir. The annual irrigation reliability has been computed for greater than 75% reliability condition. The reservoir simulation has been done to fix minimum height of the Kamla dam required for irrigation supply. It has been found that the minimum capacity of 900 MCM as full resume of elevation 182.0 m (minimum height 44 m) is required.

6.6 CONCLUSION

Kamala river basin covers the most fertile plain land which is highly valuable for the mountainous country like Nepal. The development of the basin is not possible without developing the irrigation infrastructure and fulfilling the other needs of water. Agriculture sector is the largest user of water resources and without equitable water for crops, agriculture production can not be assured. Kamla basin is water deficit basin, while Sunkosi is water surplus basin. Therefore, water transfer from Sunkosi to Kamla basin should be attempted. With this inter-basin water transfer 138,000 ha of agriculture land can be irrigated along with 69 MW power generation at Sunkosi and 31 MW power generation at Kamla reservoir. The reservoir would moderate the floods in Sunkosi and Kamala basin. Reservoirs will have positive impacts on preservation of ecology, like arresting degradation, arresting groundwater depletion and increasing green coverage which are widely required for the healthy development of the basin.

The LP model has been developed and used on various technical options. The outcome of the model study has been used in finalizing the design cropping pattern and cropping intensity. Thus the linear planning model study is scientific study and provides guidelines on different options of cropping pattern and intensity.

The monthly simulation of these reservoir operation for 19 years data series have been done using software for reservoir analysis (SRA), developed by National Institute of Hydrology, Roorkee. The model study was conducted for annual irrigation reliability and minimum height of Kamala reservoir required to meet the irrigation demand.

The result of the simulation shows in Sunkosi reservoir, there is only one year failure in 1982 in April month. Time and volume reliability of this reservoir supply are 99.5% and 99.6% respectively. Kamala reservoir at 83.3% (> 75%) irrigation reliability meets the irrigation demands at 4.75% decrease of design irrigation demands. Time and volume reliability of this reservoir are 98.1% and 99.7% respectively. For minimum height of the dam the simulation results shows that the minimum capacity of 900 MCM as full resume of elevation 182.0 m (minimum height 44 m) is required.

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LIST OF FIGURES

Fig. 1

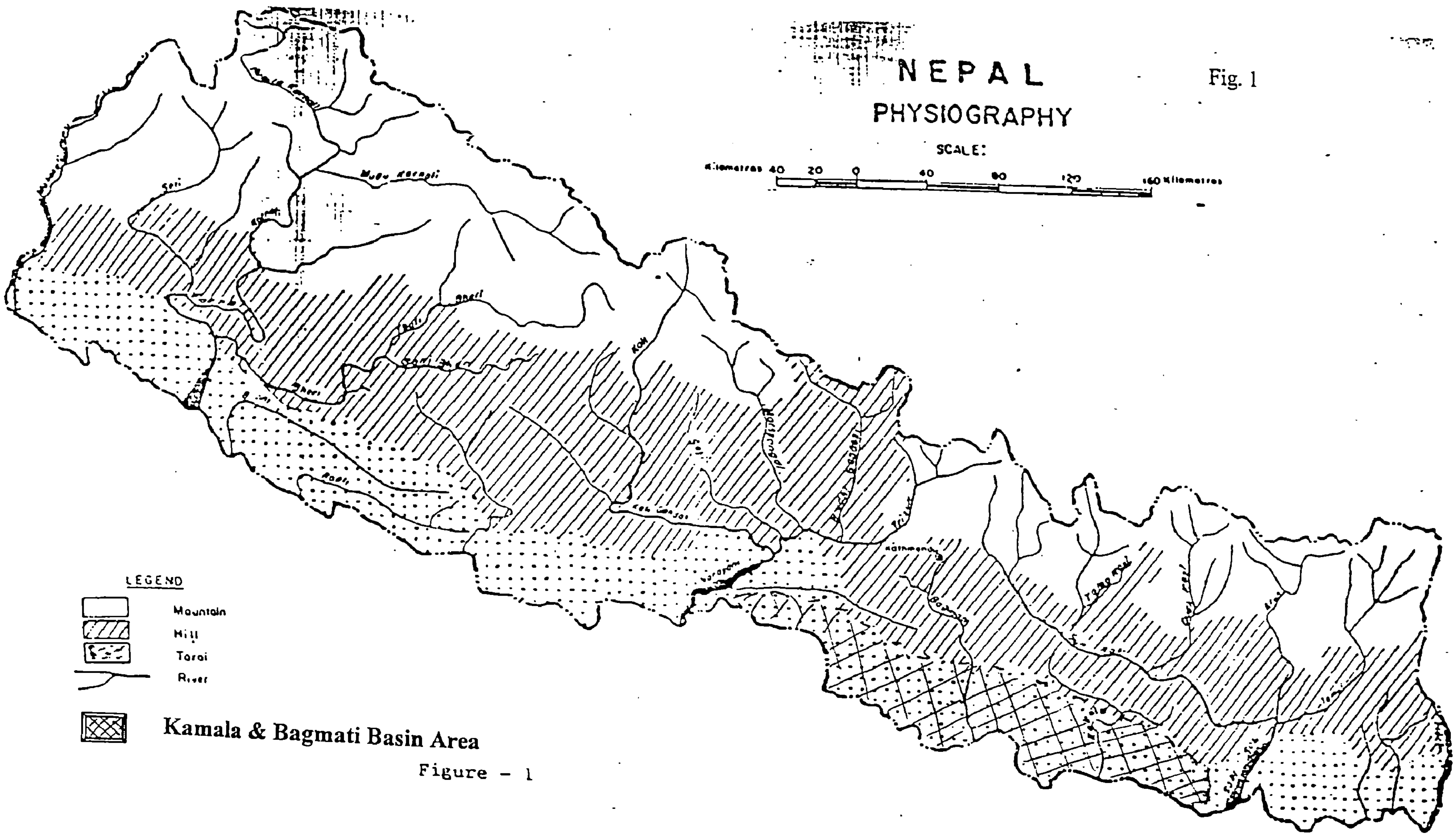


Figure - 1

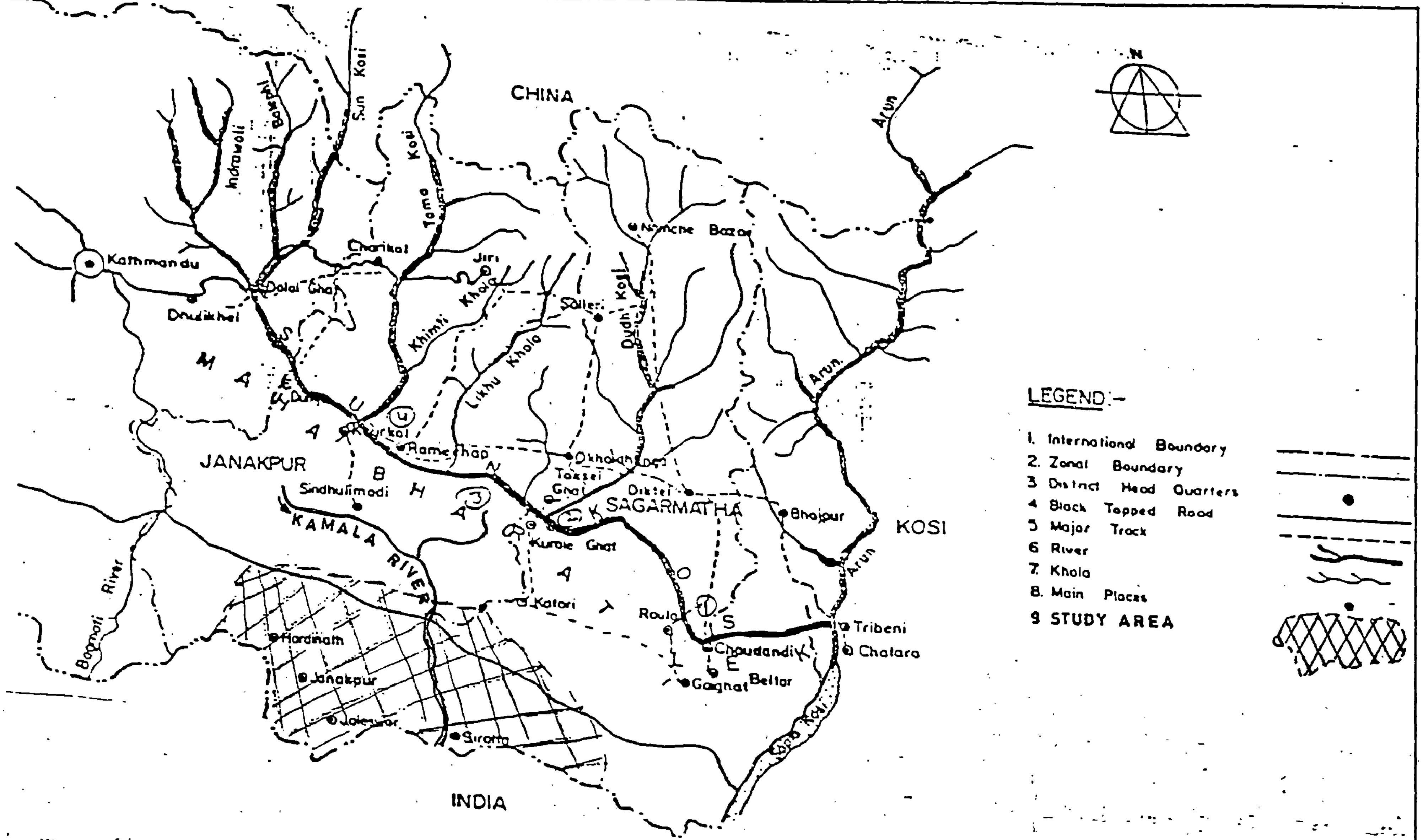


FIG. 2 - SUNKOSI KAMALA BASIN MAP

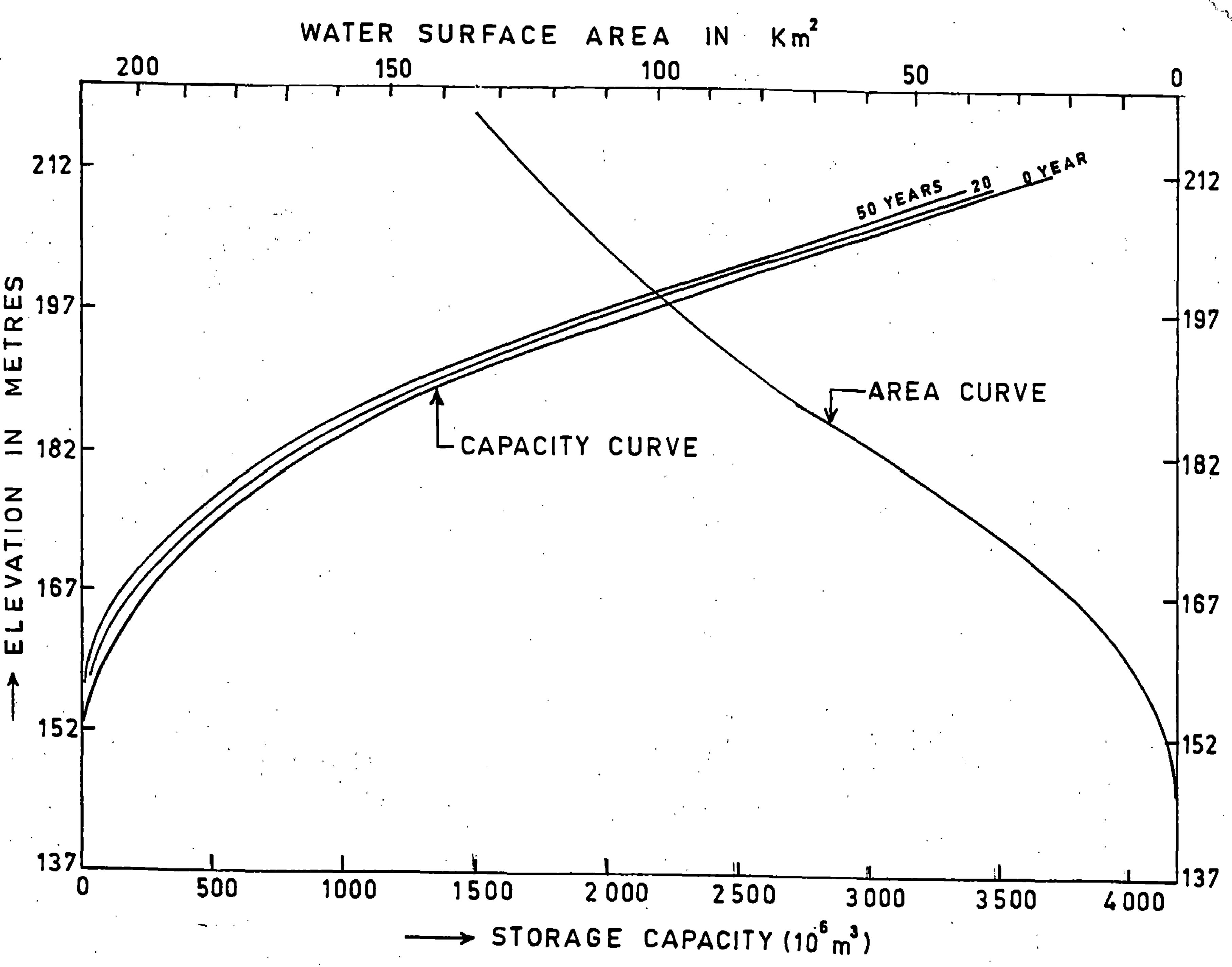


FIG. 3 - CAPACITY CURVE OF KAMALA SITE

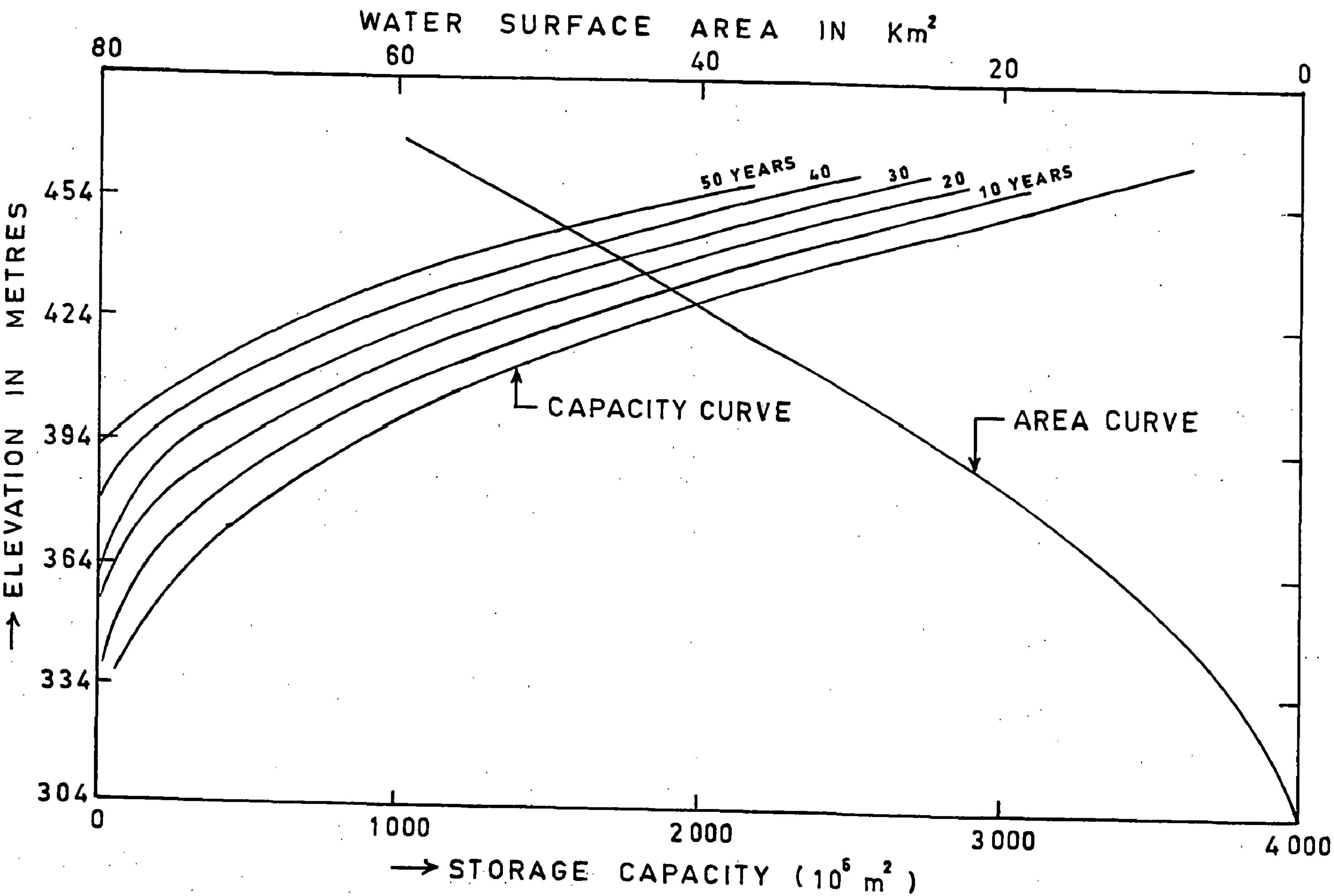
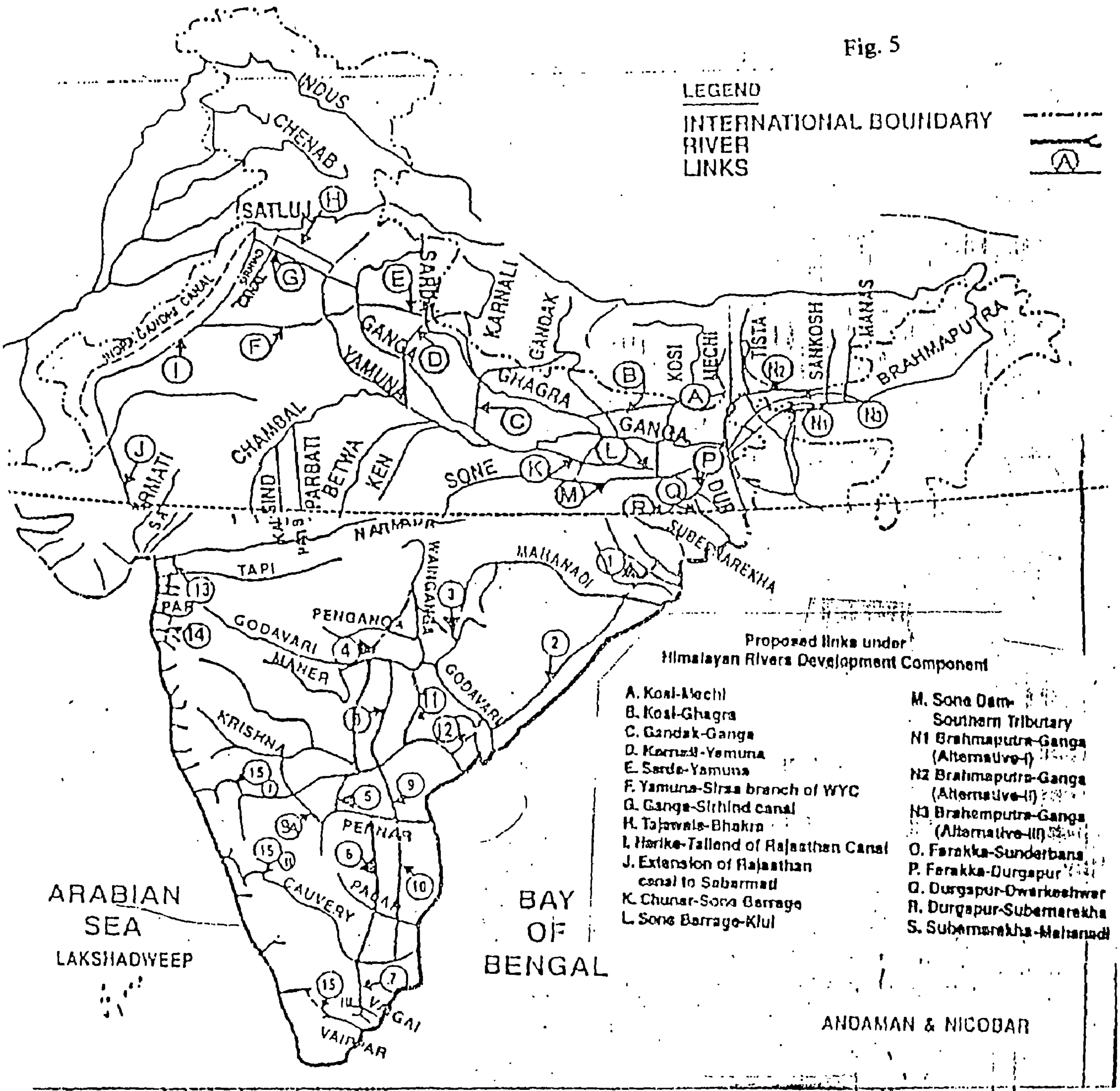


FIG. 4 - CAPACITY CURVE OF SUNKOSI SITE

Fig. 5



PENINSULAR RIVERS DEVELOPMENT COMPONENT

1 MAHANADI - BURHABALANG
2 MAHANADI - GODAVARI
3 INDRAVATI - WAINGANGA
4 WAINGANGA - KRISHNA
5 KRISHNA (SRISAILAM) - PENNAR (PRODATTUR)
6 PENNAR (GANDIKOTTA) - PALAR - CAUVERY
7 CAUVERY - VAIGAI
8 GODAVARI (INCHAMPALLI) - KRISHNA (NAGARJUNASAGAR)
9 KRISHNA (NAGARJUNASAGAR) - PENNAR (SOMASILA)
9A KRISHNA (ALMATTI) - PENNAR
10 PENNAR (SOMASILA) -PALAR - CAUVERY (COLEROON)
11 GODAVARI (INCHAMPALLI) - KRISHNA (PULICHINTALA)
12 GODAVARI (POLAVARAM) - KRISHNA (VIJAYAWADA)
13 PAR - TAPI - NARMADA
14 DAMANGANGA - TANSA / PINJAL
15 WEST FLOWING RIVERS OF KERALA AND KARNATAKA (WEST - EAST LINK)
(I) BEDTI - VARDA
(II) NETRAVATI - HEMAVATI
(III) PAMBA - ACHANKOVIL - VAIPPAR
16 KEN - BETWA
17 PARBATI - KALISINDH - CHAMBAL

APPENDIX I
(L.P. MODEL STUDY ANALYSIS COMPUTER PRINT RESULTS SHEET)

BAT
LEAVE
LP OPTIMUM FOUND AT STEP 15

T

OBJECTIVE FUNCTION VALUE

1) 4650000.

VARIABLE	VALUE	REDUCED COST
A1	0.000000	138.000000
A2	0.000000	28.000000
A3	0.000000	26.000000
A4	25000.000000	0.000000
A5	0.000000	9.000000
A6	0.000000	28.000000
A7	0.000000	103.000000
A8	0.000000	101.000000
A9	0.000000	113.000000
A10	0.000000	54.000000
A11	25000.000000	0.000000
D1	0.000000	0.000000
Y1	1709.000000	0.000000
D2	0.000000	0.000000
Y2	1314.000000	0.000000
D3	1323.000000	0.000000
Y3	0.000000	0.000000
D4	0.000000	0.000000
Y4	1400.000000	0.000000
D5	0.000000	0.000000
Y5	1741.000000	0.000000
D6	0.000000	0.000000
Y6	2501.000000	0.000000
D7	0.000000	0.000000
Y7	4901.000000	0.000000
D8	0.000000	0.000000
Y8	6294.000000	0.000000
D9	3987.000000	0.000000
Y9	1864.000000	0.000000
D10	0.000000	0.000000
Y10	3991.000000	0.000000
D11	2265.000000	0.000000
Y11	0.000000	0.000000
D12	1945.000000	0.000000
Y12	0.000000	0.000000
*A1	0.000000	0.000000
*A7	0.000000	0.000000
*A8	0.000000	0.000000
*A9	0.000000	0.000000
*A10	0.000000	0.000000
*A11	0.000000	0.000000
*D1	0.000000	0.000000
T1	0.000000	0.000000
*D2	0.000000	0.000000
T2	0.000000	0.000000
*D3	0.000000	0.000000
T3	0.000000	0.000000

LP OPTIMUM FOUND AT STEP 27

OBJECTIVE FUNCTION VALUE

II

1) 3045146.

VARIABLE	VALUE	REDUCED COST
A1	1330.000000	0.000000
A2	1995.000000	0.000000
A3	1662.000000	0.000000
A4	9208.000000	0.000000
A5	8312.000000	0.000000
A6	2493.000000	0.000000
A7	5818.000000	0.000000
A8	2493.000000	0.000000
A9	2493.000000	0.000000
A10	831.000000	0.000000
A11	12035.000000	0.000000
D1	0.000000	0.000000
Y1	1709.000000	0.000000
D2	0.000000	0.000000
Y2	1314.000000	0.000000
D3	1323.000000	0.000000
Y3	0.000000	0.000000
D4	0.000000	0.000000
Y4	1400.000000	0.000000
D5	0.000000	0.000000
Y5	1741.000000	0.000000
D6	0.000000	0.000000
Y6	2501.000000	0.000000
D7	0.000000	0.000000
Y7	4901.000000	0.000000
D8	0.000000	0.000000
Y8	6294.000000	0.000000
D9	0.000000	0.000000
Y9	5851.000000	0.000000
D10	3991.000000	0.000000
Y10	0.000000	0.000000
D11	2265.000000	0.000000
Y11	0.000000	0.000000
D12	1945.000000	0.000000
Y12	0.000000	0.000000
*A1	0.000000	0.000000
*A7	0.000000	0.000000
*A8	0.000000	0.000000
*A9	0.000000	0.000000
*A10	0.000000	0.000000
*A11	0.000000	0.000000
*D1	0.000000	0.000000
T1	0.000000	0.000000
*D2	0.000000	0.000000
T2	0.000000	0.000000
*D3	0.000000	0.000000
T3	0.000000	0.000000
*A2	0.000000	0.000000
*A3	0.000000	0.000000
*A4	0.000000	0.000000
*D4	0.000000	0.000000
T4	0.000000	0.000000
*D5	0.000000	0.000000
T5	0.000000	0.000000
*A5	0.000000	0.000000

LP OPTIMUM FOUND AT STEP 24

OBJECTIVE FUNCTION VALUE

1) 0.2953200E+08

VARIABLE	VALUE	REDUCED COST
A1	0.000000	144.000000
A2	0.000000	55.000000
A3	0.000000	53.000000
A4	138000.000000	0.000000
A5	0.000000	84.000000
A6	0.000000	0.000000
A7	0.000000	66.000000
A8	0.000000	85.000000
A9	0.000000	94.000000
A10	0.000000	34.000000
A11	138000.000000	0.000000
D1	22857.000000	0.000000
Y1	0.000000	0.000000
S2	21134.000000	0.000000
S1	42282.000000	0.000000
E1	0.000000	0.000000
D2	0.000000	0.000000
Y2	0.000000	0.000000
S3	22448.000000	0.000000
E2	0.000000	0.000000
D3	0.000000	0.000000
Y3	0.000000	0.000000
S4	22773.000000	0.000000
E3	998.000000	0.000000
D4	0.000000	0.000000
Y4	0.000000	0.000000
S5	24173.000000	0.000000
E4	0.000000	0.000000
D5	0.000000	0.000000
Y5	0.000000	0.000000
S6	25914.000000	0.000000
E5	0.000000	0.000000
D6	9415.000000	0.000000
Y6	0.000000	0.000000
S7	19000.000000	0.000000
E6	0.000000	0.000000
D7	0.000000	0.000000
Y7	0.000000	0.000000
S8	23901.000000	0.000000
E7	0.000000	0.000000
D8	0.000000	0.000000
Y8	991.000000	0.000000
S9	29204.000000	0.000000
E8	0.000000	0.000000
D9	0.000000	0.000000
Y9	0.000000	0.000000
S10	34081.000000	0.000000
E9	974.000000	0.000000
D10	0.000000	0.000000
Y10	0.000000	0.000000
S11	38072.000000	0.000000
E10	0.000000	0.000000
D11	0.000000	0.000000
Y11	0.000000	0.000000
S12	40337.000000	0.000000

IV

LP OPTIMUM FOUND AT STEP 50

OBJECTIVE FUNCTION VALUE

1) 0.1671155E+08

VARIABLE	VALUE	REDUCED COST
A1	7341.000000	0.000000
A2	11012.000000	0.000000
A3	9177.000000	0.000000
A4	50820.000000	0.000000
A5	45885.000000	0.000000
A6	13765.000000	0.000000
A7	32119.000000	0.000000
A8	13765.000000	0.000000
A9	13765.000000	0.000000
A10	4588.000000	0.000000
A11	66422.000000	0.000000
D1	0.000000	0.000000
Y1	911.000000	0.000000
S2	39476.000000	0.000000
S1	19000.000000	0.000000
E1	410.000000	0.000000
D2	0.000000	0.000000
Y2	39491.000000	0.000000
S3	19000.000000	0.000000
E2	443.000000	0.000000
D3	0.000000	0.000000
Y3	911.000000	0.000000
S4	38844.000000	0.000000
E3	656.000000	0.000000
D4	0.000000	0.000000
Y4	39817.000000	0.000000
S5	19000.000000	0.000000
E4	867.000000	0.000000
D5	0.000000	0.000000
Y5	20927.000000	0.000000
S6	19000.000000	0.000000
E5	902.000000	0.000000
D6	0.000000	0.000000
Y6	21085.000000	0.000000
S7	19000.000000	0.000000
E6	856.000000	0.000000
D7	0.000000	0.000000
Y7	24081.000000	0.000000
S8	19000.000000	0.000000
E7	908.000000	0.000000
D8	0.000000	0.000000
Y8	25458.000000	0.000000
S9	19000.000000	0.000000
E8	924.000000	0.000000
D9	0.000000	0.000000
Y9	24331.000000	0.000000
S10	19000.000000	0.000000
E9	760.000000	0.000000
D10	0.000000	0.000000
Y10	23343.000000	0.000000
S11	19000.000000	0.000000
E10	736.000000	0.000000
D11	0.000000	0.000000
Y11	21255.000000	0.000000

S12	19000.000000	0.000000
E11	450.000000	0.000000
D12	0.000000	0.000000
Y12	21657.000000	0.000000
E12	376.000000	0.000000
*A1	0.000000	0.000000
*A7	0.000000	0.000000
*A8	0.000000	0.000000
*A9	0.000000	0.000000
*A10	0.000000	0.000000
*A11	0.000000	0.000000
*D1	0.000000	0.000000
T1	0.000000	0.000000
*D2	0.000000	0.000000
T2	0.000000	0.000000
*D3	0.000000	0.000000
T3	0.000000	0.000000
*A2	0.000000	0.000000
*A3	0.000000	0.000000
*A4	0.000000	0.000000
*D4	0.000000	0.000000
T4	0.000000	0.000000
*D5	0.000000	0.000000
T5	0.000000	0.000000
*A5	0.000000	0.000000
*D6	0.000000	0.000000
T6	0.000000	0.000000
*D7	0.000000	0.000000
T7	6685.856934	0.000000
*A6	0.000000	0.000000
*D8	0.000000	0.000000
T8	0.000000	0.000000
*D9	0.000000	0.000000
T9	0.000000	0.000000
*D10	0.000000	0.000000
T10	0.000000	0.000000
*D11	0.000000	0.000000
T11	0.000000	0.000000
*D12	0.000000	0.000000
T12	0.000000	0.000000

LP OPTIMUM FOUND AT STEP 61 IV

OBJECTIVE FUNCTION VALUE

1) 0.1127476E+08

VARIABLE	VALUE	REDUCED COST
A1	13835.000000	0.000000
A2	11012.000000	0.000000
A3	12448.000000	0.000000
A4	11040.000000	0.000000
A5	75900.000000	0.000000
A6	13765.000000	0.000000
A7	62100.000000	0.000000
A8	20700.000000	0.000000
A9	13765.000000	0.000000
A10	11040.000000	0.000000
A11	16560.000000	0.000000
D1	0.000000	0.000000
Y1	911.000000	0.000000
S2	39476.000000	0.000000
S1	19000.000000	0.000000
E1	410.000000	0.000000
D2	0.000000	0.000000
Y2	39491.000000	0.000000
S3	19000.000000	0.000000
E2	443.000000	0.000000
D3	0.000000	0.000000
Y3	20755.000000	0.000000
S4	19000.000000	0.000000
E3	656.000000	0.000000
D4	0.000000	0.000000
Y4	19973.000000	0.000000
S5	19000.000000	0.000000
E4	867.000000	0.000000
D5	0.000000	0.000000
Y5	20927.000000	0.000000
S6	19000.000000	0.000000
E5	902.000000	0.000000
D6	0.000000	0.000000
Y6	881.000000	0.000000
S7	39204.000000	0.000000
E6	856.000000	0.000000
D7	0.000000	0.000000
Y7	44285.000000	0.000000
S8	19000.000000	0.000000
E7	908.000000	0.000000
D8	0.000000	0.000000
Y8	25458.000000	0.000000
S9	19000.000000	0.000000
E8	924.000000	0.000000
D9	0.000000	0.000000
Y9	881.000000	0.000000
S10	42450.000000	0.000000
E9	760.000000	0.000000
D10	0.000000	0.000000
Y10	46793.000000	0.000000
S11	19000.000000	0.000000
E10	736.000000	0.000000
D11	0.000000	0.000000
Y11	881.000000	0.000000
S12	39374.000000	0.000000
E11	450.000000	0.000000
D12	0.000000	0.000000
Y12	42031.000000	0.000000
E12	376.000000	0.000000
*A1	0.000000	0.000000
*A7	0.000000	0.000000
*A8	0.000000	0.000000
*A9	0.000000	0.000000
*A10	0.000000	0.000000
*A11	0.000000	0.000000
*D1	0.000000	0.000000
T1	0.000000	0.000000

*D2	0.000000	0.000000
T2	0.000000	0.000000
*D3	0.000000	0.000000
T3	0.000000	0.000000
*A2	0.000000	0.000000
*A3	0.000000	0.000000
*A4	0.000000	0.000000
*D4	0.000000	0.000000
T4	0.000000	0.000000
*D5	0.000000	0.000000
T5	0.000000	0.000000
*A5	0.000000	0.000000
*D6	0.000000	0.000000
T6	0.000000	0.000000
*D7	0.000000	0.000000
T7	6685.856934	0.000000
*A6	0.000000	0.000000
*D8	0.000000	0.000000
T8	0.000000	0.000000
*D9	0.000000	0.000000
T9	0.000000	0.000000
*D10	0.000000	0.000000
T10	0.000000	0.000000
*D11	0.000000	0.000000
T11	0.000000	0.000000
*D12	0.000000	0.000000
T12	0.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	0.000000
3)	0.000000	0.000000
4)	0.000000	0.000000
5)	0.000000	0.000000
6)	0.000000	0.000000
7)	0.000000	0.000000
8)	0.000000	0.000000
9)	0.000000	0.000000
10)	0.000000	0.000000
11)	0.000000	0.000000
12)	0.000000	0.000000
13)	0.000000	0.000000
14)	6494.000000	0.000000
15)	0.000000	-2.000000
16)	3271.000000	0.000000
17)	6452.000000	0.000000
18)	30015.000000	0.000000
19)	0.000000	-2.000000
20)	29981.000000	0.000000
21)	6935.000000	0.000000
22)	0.000000	-1.000000
23)	6452.000000	0.000000
24)	11972.000000	0.000000
25)	6865.000000	0.000000
26)	9688.000000	0.000000
27)	8252.000000	0.000000
28)	0.000000	26.000000
29)	0.000000	17.000000
30)	11075.000000	0.000000
31)	0.000000	9.000000
32)	0.000000	4.000000
33)	6935.000000	0.000000
34)	0.000000	58.000000
35)	0.000000	112.000000
36)	0.000000	30.000000
37)	0.000000	18.000000
38)	0.000000	0.000000
39)	0.000000	0.000000

40)	0.000000	0.000000
41)	0.000000	0.000000
42)	0.000000	0.000000
43)	0.000000	0.000000
44)	0.000000	0.000000
45)	0.000000	0.000000
46)	0.000000	0.000000
47)	0.000000	0.000000
48)	0.000000	0.000000
49)	0.000000	0.000000
50)	22857.000000	0.000000
51)	21164.000000	0.000000
52)	22857.000000	0.000000
53)	22010.000000	0.000000
54)	22857.000000	0.000000
55)	22010.000000	0.000000
56)	22857.000000	0.000000
57)	22857.000000	0.000000
58)	22010.000000	0.000000
59)	22857.000000	0.000000
60)	22010.000000	0.000000
61)	22857.000000	0.000000
62)	0.000000	0.000000
63)	38668.000000	0.000000
64)	19844.000000	0.000000
65)	19092.000000	0.000000
66)	20016.000000	0.000000
67)	0.000000	0.000000
68)	43294.000000	0.000000
69)	24467.000000	0.000000
70)	0.000000	0.000000
71)	45802.000000	0.000000
72)	0.000000	0.000000
73)	41040.000000	0.000000
74)	47514.144531	0.000000
75)	0.000000	0.000000
76)	0.000000	0.000000
77)	0.000000	0.000000
78)	0.000000	0.000000
79)	0.000000	0.000000
80)	0.000000	0.000000
81)	0.000000	0.000000
82)	0.000000	0.000000
83)	0.000000	0.000000

84)	0.000000	0.000000
85)	0.000000	0.000000
86)	0.000000	0.000000
87)	71000.000000	0.000000
88)	50524.000000	0.000000
89)	71000.000000	0.000000
90)	71000.000000	0.000000
91)	71000.000000	0.000000
92)	71000.000000	0.000000
93)	50796.000000	0.000000
94)	71000.000000	0.000000
95)	71000.000000	0.000000
96)	47550.000000	0.000000
97)	71000.000000	0.000000
98)	50626.000000	0.000000
99)	0.000000	0.000000
100)	20476.000000	0.000000
101)	0.000000	0.000000
102)	0.000000	0.000000
103)	0.000000	0.000000
104)	0.000000	0.000000
105)	20204.000000	0.000000
106)	0.000000	0.000000
107)	0.000000	0.000000

LP OPTIMUM FOUND AT STEP 50

VI

OBJECTIVE FUNCTION VALUE

1) 0.1219920E+08

VARIABLE	VALUE	REDUCED COST
A1	11040.000000	0.000000
A2	16560.000000	0.000000
A3	13800.000000	0.000000
A4	6900.000000	0.000000
A5	69000.000000	0.000000
A6	20700.000000	0.000000
A7	48300.000000	0.000000
A8	20700.000000	0.000000
A9	20700.000000	0.000000
A10	6900.000000	0.000000
A11	30360.000000	0.000000
D1	0.000000	0.000000
Y1	911.000000	0.000000
S2	39476.000000	0.000000
S1	19000.000000	0.000000
E1	410.000000	0.000000
D2	0.000000	0.000000
Y2	39491.000000	0.000000
S3	19000.000000	0.000000
E2	443.000000	0.000000
D3	0.000000	0.000000
Y3	911.000000	0.000000
S4	38844.000000	0.000000
E3	656.000000	0.000000
D4	0.000000	0.000000
Y4	39817.000000	0.000000
S5	19000.000000	0.000000
E4	867.000000	0.000000
D5	0.000000	0.000000
Y5	20927.000000	0.000000
S6	19000.000000	0.000000
E5	902.000000	0.000000
D6	0.000000	0.000000
Y6	21085.000000	0.000000
S7	19000.000000	0.000000
E6	856.000000	0.000000
D7	0.000000	0.000000
Y7	24081.000000	0.000000
S8	19000.000000	0.000000
E7	908.000000	0.000000
D8	0.000000	0.000000
Y8	25458.000000	0.000000
S9	19000.000000	0.000000
E8	924.000000	0.000000
D9	0.000000	0.000000
Y9	24331.000000	0.000000
S10	19000.000000	0.000000
E9	760.000000	0.000000
D10	0.000000	0.000000
Y10	23343.000000	0.000000
S11	19000.000000	0.000000
E10	736.000000	0.000000
D11	0.000000	0.000000
Y11	21255.000000	0.000000
S12	19000.000000	0.000000

E11	450.000000	0.000000
D12	0.000000	0.000000
Y12	21657.000000	0.000000
E12	376.000000	0.000000
*A1	0.000000	0.000000
*A7	0.000000	0.000000
*A8	0.000000	0.000000
*A9	0.000000	0.000000
*A10	0.000000	0.000000
*A11	0.000000	0.000000
*D1	0.000000	0.000000
T1	0.000000	0.000000
*D2	0.000000	0.000000
T2	0.000000	0.000000
*D3	0.000000	0.000000
T3	0.000000	0.000000
*A2	0.000000	0.000000
*A3	0.000000	0.000000
*A4	0.000000	0.000000
*D4	0.000000	0.000000
T4	0.000000	0.000000
*D5	0.000000	0.000000
T5	0.000000	0.000000
*A5	0.000000	0.000000
*D6	0.000000	0.000000
T6	0.000000	0.000000
*D7	0.000000	0.000000
T7	10054.285156	0.000000
*A6	0.000000	0.000000
*D8	0.000000	0.000000
T8	0.000000	0.000000
*D9	0.000000	0.000000
T9	0.000000	0.000000
*D10	0.000000	0.000000
T10	0.000000	0.000000
*D11	0.000000	0.000000
T11	0.000000	0.000000
*D12	0.000000	0.000000
T12	0.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	0.000000
3)	0.000000	0.000000
4)	0.000000	0.000000
5)	0.000000	0.000000
6)	0.000000	0.000000
7)	0.000000	0.000000
8)	0.000000	0.000000
9)	0.000000	0.000000
10)	0.000000	0.000000
11)	0.000000	0.000000
12)	0.000000	0.000000
13)	0.000000	0.000000
14)	0.000000	-138.000000
15)	0.000000	-28.000000
16)	0.000000	-26.000000
17)	0.000000	0.000000
18)	0.000000	-9.000000
19)	0.000000	-28.000000
20)	0.000000	-103.000000
21)	0.000000	-108.000000

22)	0.000000	-113.000000
23)	0.000000	-54.000000
24)	23460.000000	0.000000
25)	0.000000	56.000000
26)	0.000000	130.000000
27)	0.000000	0.000000
28)	0.000000	0.000000
29)	0.000000	0.000000
30)	0.000000	0.000000
31)	0.000000	0.000000
32)	0.000000	0.000000
33)	0.000000	0.000000
34)	0.000000	0.000000
35)	0.000000	0.000000
36)	0.000000	0.000000
37)	0.000000	0.000000
38)	0.000000	0.000000
39)	22857.000000	0.000000
40)	21164.000000	0.000000
41)	22857.000000	0.000000
42)	22010.000000	0.000000
43)	22857.000000	0.000000
44)	22010.000000	0.000000
45)	22857.000000	0.000000
46)	22857.000000	0.000000
47)	22010.000000	0.000000
48)	22857.000000	0.000000
49)	22010.000000	0.000000
50)	22857.000000	0.000000
51)	0.000000	0.000000
52)	38668.000000	0.000000
53)	0.000000	0.000000
54)	38936.000000	0.000000
55)	20016.000000	0.000000
56)	20204.000000	0.000000
57)	23090.000000	0.000000
58)	24467.000000	0.000000
59)	23450.000000	0.000000
60)	22352.000000	0.000000
61)	20374.000000	0.000000
62)	20666.000000	0.000000
63)	44145.714844	0.000000
64)	0.000000	0.000000
65)	0.000000	0.000000
66)	0.000000	0.000000
67)	0.000000	0.000000
68)	0.000000	0.000000
69)	0.000000	0.000000
70)	0.000000	0.000000
71)	0.000000	0.000000
72)	0.000000	0.000000
73)	0.000000	0.000000
74)	0.000000	0.000000
75)	0.000000	0.000000
76)	71000.000000	0.000000
77)	50524.000000	0.000000
78)	71000.000000	0.000000
79)	51156.000000	0.000000
80)	71000.000000	0.000000
81)	71000.000000	0.000000
82)	71000.000000	0.000000
83)	71000.000000	0.000000
84)	71000.000000	0.000000
85)	71000.000000	0.000000
86)	71000.000000	0.000000
87)	71000.000000	0.000000
88)	0.000000	0.000000
89)	20476.000000	0.000000
90)	0.000000	0.000000
91)	19844.000000	0.000000
92)	0.000000	0.000000
93)	0.000000	0.000000
94)	0.000000	0.000000
95)	0.000000	0.000000
96)	0.000000	0.000000
97)	0.000000	0.000000
98)	0.000000	0.000000
99)	0.000000	0.000000

NO. ITERATIONS= 50

CALCULATION OF HYDROPOWER GENERATION

1. From Sunkosi- Reservoir:

Diversion Flow (Q) = 75 cumecs.

Head available (h) = 308 m - 198.0 = 110.0 m

Efficiency (η) = 0.85

Power Generation = 9.81 x 75 x 110.0 x 0.85

= 68792.0 KW

= 68.8 MW

= 69.0 MW

2. From Kamala Reservoir

Q_I = 101.77 MCM = 37.99 = 40.0 cumecs

Head Available

Bed Level = 140 m

FRL = 198 m

MDDL = 164.0 m

Head = $(164-140)+\frac{2}{3}x(198-164)=24+\frac{2}{3}\ x\ 34=46.70m$

FRL = 1182.0 m

Head = $(164-140)+\frac{2}{3}x(182-164)=24+\frac{2}{3}\ x\ 18=36.0m$

Q_I = 9.81 x 4.67 x 40 x 0.85 = 15.50 MW

$Q_{I.1}$ = 9.81 x 4.67 x 36 x 0.85 = 140.01 MW

3. It from Kamala reservoir the inflow is when as a firm discharge

Q = 75 + 5.4 = 80.4 cumecs

H = 46.7 m

h = 0.85

Power Generation = 9.81 x 80.4 x 46.7 x 0.85

= 31308.0 KW

= 31.31 MW

= 31.0 MW

Output	Kharif Paddy LV	Paddy HYV	Maize	Oilseeds	Vegetables	Pulses	Rabi Wheat	Maize	Oilseeds	Pulses	Potato	Vegetables	Hot Season Vegetables	Maize	Pulses	Sunflower
Main Produce:																
Yield(t/ha)	2.8	4.5	3.7	1.9	20	1.6	3	3.7	0.8	1.7	25	24.5	25	3.3	1.3	1.5
Price/t	13100	13100	11100	27000	4500	22500	13300	11100	27000	22500	6750	4500	4500	11100	22500	27000
Value	36680	58950	41070	51300	90000	36000	39900	41070	21600	38250	168750	110250	112500	36630	29250	40500
By-Products:																
Yield(t/ha)	3	4.9	0	1.4	0	0.23	1.8	0	0.6	0.25	0	0	0	0	0.19	0
Price/t	630	630	0	4500	0	5400	270	0	4500	5400	0	0	0	0	5400	0
Value	1890	3087	0	6300	0	1242	486	0	2700	1350	0	0	0	0	1026	0
Gross Value	38570	62037	41070	57600	90000	37242	40386	41070	24300	39600	168750	110250	112500	36630	30276	40500
Inputs:																
Seeds(kg/ha)	80	60	30	6	2	60	140	30	6	60	1500	2	2	30	60	15
Price/kg	14.4	14.4	12.2	45	450	27.0	14.6	12.2	45	27	13.5	450	450	12.2	27	54
Value	1152	864	366	270	900	1620	2044	366	270	1620	20250	900	900	366	1620	810
Urea(kg/ha)	30	75	75	60	150	0	120	75	60	0	120	150	150	75	0	60
Price/kg	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2
Value	0	1065	1065	852	2130	0	1704	1065	852	0	1704	2130	2130	1065	0	852
DAP(kg/ha)	30	90	90	30	180	45	75	90	30	45	180	180	180	90	45	90
Price/kg	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
Value	588	1764	1764	588	3528	882	1470	1764	588	882	3528	3528	3528	1764	882	1764
MOP(kg/ha)	0	0	0	0	60	0	25	0	0	0	60	60	50	0	0	30
Price/kg	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Value	0	0	0	0	918	0	383	0	0	0	918	918	918	0	0	459
Manure(t/ha)	0	1	2	2	6	0	2	2	2	0	5	6	6	2	0	2
Price/t	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
Value	0	270	540	540	1620	0	540	540	540	0	1350	1620	1620	540	0	540
Chemicals (NRs)	90	270	450	135	3150	270	90	450	135	270	900	3150	3150	450	270	450
Total Labour(md/ha)	120	140	90	60	300	60	90	90	60	60	135	300	300	90	60	100
Price/md	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5
Labour Costs	8100	9450	6075	4050	20250	4050	6075	6075	4050	4050	9113	20250	20250	6075	4050	6750
Total Animal Days(ad)	30	40	30	30	40	30	35	30	30	30	30	40	40	30	30	30
Price/ad	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
Animal Costs	948	1264	948	948	1264	948	1106	948	948	948	948	1264	1264	948	948	948
Total Costs	10878	14947	11208	7383	33760	7770	13412	11208	7383	7770	38711	33760	33760	11208	7770	12573
Net Production Value	27692	47090	29862	50217	56240	29472	26975	29862	16917	31830	130040	76490	78740	25422	22506	27927

Station nurber: 599
Location: Inarwa
River: Kamala River

Latitude: 26 36 45
Longitude: 86 09 00

AVERAGE MONTHLY AND YEAR DISCHARGE (in m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1989	4.31	3.49	2.44	2.1	4.4 3	10.0	14.7	16.6	15.9	16.2	9.51	7.07	8.9
1990	...	...	6.72	5.59	11 3	9.93	23.1	45.7	50	16	7.66	6.94	...
1991	7.07	5.39	4.8	6.4	5.8 6	14.2	12.6	10.4	11.9	11.7	8.34	7.35	8.84
1992	6.2	4.81	4.21	5.47	5.7 9	8.42	21.9	17.9	14	15.8	9.09	6.9	10
1993	5.51	4.65	5.01	6.52	5.7 7	9.05	19.5	26.8	17.1	14.8	9.08	8.05	11
1994	8.78	8.8	6.43	6.32	6.2 6	8.03	...	...	...	...	...	...	...
1995	...	...	...	...	...	...	...	...	...	...	...	...	...
1996	...	...	...	...	...	...	...	...	...	...	...	...	...
1997	...	...	...	...	...	...	...	...	...	...	...	...	...
1998	...	...	...	...	...	...	...	...	...	...	...	...	...
1999	...	...	...	...	...	...	...	...	...	...	...	...	...
Average:	6.38	5.43	4.94	5.4	6.5 7	9.95	18.3	23.5	21.8	14.9	8.74	7.26	9.69

Mean Monthly Flow Of Sunkosi River At Kamphu Ghat (Cumecs)

1966	169	138	134	159	206	487	1630	2010	1340	549	291	223
1967	169	138	134	159	206	487	1630	2010	1340	549	291	223
1968	178	148	146	146	202	697	2240	2880	1940	1500	473	298
1969	225	170	153	149	227	722	2230	2450	1950	731	342	250
1970	197	178	163	169	223	780	2750	3170	1410	755	364	262
1971	220	199	190	226	288	1870	2410	2690	1470	909	369	246
1972	188	158	155	154	260	534	1930	2160	1610	627	343	239
1973	192	160	167	179	264	1150	1750	2510	1970	1180	422	241
1974	186	149	133	158	202	538	2200	2900	1920	825	362	243
1975	196	166	139	164	224	799	2240	2420	2510	1400	520	286
1976	216	176	147	155	237	1050	2200	2710	1980	772	372	234
1977	174	148	132	167	206	508	2200	2860	1630	816	364	210
1978	156	123	123	150	408	1350	2840	3200	1810	1100	395	217
1979	165	168	138	153	203	545	2640	3100	2000	840	403	255
1981	219	189	169	185	253	759	3050	3730	2120	705	344	233
1982	189	167	156	179	188	711	2370	2940	1700	549	357	271
1983	209	175	167	172	280	419	1970	2320	2010	1020	379	257
1984	203	170	145	136	230	748	2760	2030	2630	777	367	270
1985	219	194	181	177	218	607	2810	2460	2780	1240	482	228
Mean	193	164	151	165	238	777	2308	2661	1901	887	381	247

Mean Monthly Flow Of Sunkosi River At Kamphu Ghat (MCM)

1966	452.65	345.77	358.91	412.13	551.75	1,262.30	4,224.96	5,383.58	3,589.06	1,423.01	779.41	597.28
1967	452.65	345.77	358.91	412.13	551.75	1,262.30	4,224.96	5,383.58	3,589.06	1,423.01	779.41	597.28
1968	476.76	370.83	391.05	378.43	541.04	1,806.62	5,806.08	7,713.79	5,196.10	3,888.00	1,266.88	798.16
1969	602.64	425.95	409.80	386.21	608.00	1,871.42	5,780.16	6,562.08	5,222.88	1,894.75	916.01	669.60
1970	527.64	446.00	436.58	438.05	597.28	2,021.76	7,128.00	8,490.53	3,776.54	1,956.96	974.94	701.74
1971	589.25	498.61	508.90	585.79	771.38	4,847.04	6,246.72	7,204.90	3,937.25	2,356.13	988.33	658.89
1972	503.54	395.88	415.15	399.17	696.38	1,384.13	5,002.56	5,785.34	4,312.22	1,625.18	918.69	640.14
1973	514.25	400.90	447.29	463.97	707.10	2,980.80	4,536.00	6,722.78	5,276.45	3,058.56	1,130.28	645.49
1974	498.18	373.33	356.23	409.54	541.04	1,394.50	5,702.40	7,767.36	5,142.53	2,138.40	969.58	650.85
1975	524.97	415.93	372.30	425.09	599.96	2,071.01	5,806.08	6,481.73	6,722.78	3,628.80	1,392.77	766.02
1976	578.53	440.99	393.72	401.76	634.78	2,721.60	5,702.40	7,258.46	5,303.23	2,001.02	996.36	626.75
1977	466.04	370.83	353.55	432.86	551.75	1,316.74	5,702.40	7,660.22	4,365.79	2,115.07	974.94	562.46
1978	417.83	308.19	329.44	388.80	1,092.79	3,499.20	7,361.28	8,570.88	4,847.90	2,851.20	1,057.97	581.21
1979	441.94	420.94	369.62	396.58	543.72	1,412.64	6,842.88	8,303.04	5,356.80	2,177.28	1,079.40	682.99
1980	586.57	473.56	452.65	479.52	677.64	1,967.33	7,905.60	9,990.43	5,678.21	1,827.36	921.37	624.07
1981	506.22	418.44	417.83	463.97	503.54	1,842.91	6,143.04	7,874.50	4,553.28	1,423.01	956.19	725.85
1982	559.79	438.48	447.29	445.82	749.95	1,086.05	5,106.24	6,213.89	5,383.58	2,643.84	1,015.11	688.35
1983	543.72	425.95	388.37	352.51	616.03	1,938.82	7,153.92	5,437.15	7,044.19	2,013.98	982.97	723.17
1984	586.57	486.09	484.79	458.78	583.89	1,573.34	7,283.52	6,588.86	7,445.95	3,214.08	1,290.99	610.68
1985	517.35	410.65	404.86	427.95	637.88	2,013.71	5,982.06	7,125.95	5,091.78	2,297.88	1,020.61	660.58
1986	517.35	396.49	404.86	427.95	637.88	2013.71	6181.47	7125.95	4927.53	2374.47	987.69	660.58

Station n ber: 695
Location: Chatar a-Kothu
River: Sapta Koshi

Latitu de: 26 52 00
Longitu de: 87 09 30

AVERA GE MON HLY AND YE/ DISCHA RGE (in m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1977	356	298	290	484	75 6	1300	3500	4800	2830	1730	897	543	1480
1978	387	309	327	456	109 0	2610	4310	4670	2760	1580	840	540	1660
1979	384	332	284	367	60 4	1190	...	...	2730	1380	706	516	...
1980	356	308	334	431	65 9	...	...	...	...	...	...	...	...
1981	...	...	362	559	69 8	...	...	...	...	1570	880	479	...
1982	355	335	354	489	64 1	1600	3210	3120	2300	1280	598	440	1230
1983	296	243	261	324	73 7	1350	3650	3420	3730	1500	809	497	1400
1984	370	288	287	344	62 0	1660	4370	3370	5110	1470	827	567	1610
1985	406	360	392	393	70 2	2210	4750	4230	4340	2120	1230	616	1810
1986	459	388	331	408	55 7	1850	3620	3660	3260	1820	831	565	1480
1987	379	299	307	441	62 3	1750	4230	4830	3580	1840	968	665	1660
1988	455	358	402	433	77 7	1730	4220	6090	3510	1450	856	592	1740
1989	505	428	428	462	101 0	2140	4450	4760	3930	1790	938	595	1790
1990	444	405	430	548	121 0	2500	4180	4300	3470	1960	943	579	1750
1991	452	364	371	422	79 5	2490	3830	5300	4060	1490	800	549	1740
1992	429	379	388	398	55 5	1210	2840	3810	3030	1710	864	569	1350
1993	437	394	351	467	87 2	1620	3660	5160	3190	1650	788	509	1590
1994	408	357	389	398	69 6	2010	3030	4090	3010	1340	760	535	1420
1995	422	416	409	531	129 0	2850	4380	4580	3040	1670	1080	630	1770
1996	...	...	...	...	...	...	...	...	...	...	...	...	...
1997	...	...	...	296	...	...	...	...	...	...	...	...	...
1998	...	...	...	...	...	...	...	...	...	...	...	...	...
1999	...	...	...	...	...	...	...	...	...	...	...	...	...
Average:	406	348	353	433	78 4	1890	3890	4390	3410	1630	867	555	1590

APPENDIX II
LONG TERM RESERVOIR SIMULATION COMPUTER PRINT RESULTS

II

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node

The percentage loss during transmission is .00%

Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

YYYY	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	Pw_Rel m m3	Lir_Dv m m3	Spill m m3
1967	351.	2365.	73.	2544.	0.	0.	2544.	105.	2345.	222.	2537.	0.	0.
1968	351.	2365.	67.	2544.	0.	0.	2544.	108.	2652.	178.	2177.	0.	0.
1969	351.	2365.	67.	2544.	0.	0.	2544.	108.	2652.	178.	2178.	0.	0.
1970	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2179.	0.	0.
1971	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2179.	0.	0.
1972	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2180.	0.	0.
1973	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2181.	0.	0.
1974	351.	2365.	65.	2544.	0.	0.	2544.	108.	2652.	178.	2181.	0.	0.
1975	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2182.	0.	0.
1976	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2182.	0.	0.
1977	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2183.	0.	0.
1978	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2183.	0.	0.
1979	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1980	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1981	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1982	351.	2208.	61.	2544.	0.	0.	2461.	108.	2569.	169.	2153.	0.	0.
1983	351.	2365.	60.	2544.	0.	0.	2544.	108.	2652.	171.	2219.	0.	0.
1984	351.	2365.	60.	2544.	0.	0.	2544.	108.	2652.	172.	2218.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 1, Time and Vol. Reliability = .995 .998

Number of Critical (Release < .75 * Demand) Irrigation Failures = 0

Annual Irrigation Reliability = .944

	WS	Irr.	Pow
Resi. for WS, Irr, Pow:	.000	1.000	.000
Vul. for WS, Irr, Pow:	.000	.231	.000

II

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

yyyy	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	PW_Gen Mkwh	Pw-Rel m m3	Lir_Dv m m3	Spill m m3
1967	351.	2365.	73.	2544.	0.	0.	2544.	108.	3048.	222.	2537.	0.	0.
1968	351.	2365.	67.	2544.	0.	0.	2544.	108.	2652.	178.	2177.	0.	0.
1969	351.	2365.	67.	2544.	0.	0.	2544.	108.	2652.	178.	2178.	0.	0.
1970	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2179.	0.	0.
1971	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2179.	0.	0.
1972	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2180.	0.	0.
1973	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2181.	0.	0.
1974	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2181.	0.	0.
1975	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2182.	0.	0.
1976	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	178.	2182.	0.	0.
1977	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2183.	0.	0.
1978	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2183.	0.	0.
1979	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1980	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1981	351.	2365.	66.	2544.	0.	0.	2544.	108.	2652.	177.	2184.	0.	0.
1982	351.	2208.	61.	2544.	0.	0.	2461.	108.	2569.	169.	2153.	0.	0.
1983	351.	2365.	60.	2544.	0.	0.	2544.	108.	2652.	171.	2219.	0.	0.
1984	351.	2365.	60.	2544.	0.	0.	2544.	108.	2652.	172.	2218.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 1, Time and Vol. Reliability = .995 .998

Number of Critical (Release < .75 * Demand) Irrigation Failures = 0
Annual Irrigation Reliability = .944

Resi. for WS, Irr, Pow: .000 1.000 .000
Vul. for WS, Irr, Pow: .000 .231 .000

III

Monthly simulation of Sunkosi and Kamala Reservoir Opera

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir
A Link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2208.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Resi. for WS. Irr. Pow: .000 .000 .000
Vul. for WS. Irr. Pow: .000 .000 .000

III

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

yyyy	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	Pw-Rel m m3	Lir_Dv m m3	Spill m m3
1967	351.	2365.	73.	2552.	0.	0.	2552.	108.	3054.	222.	2539.	0.	0.
1968	351.	2365.	66.	2552.	0.	0.	2552.	108.	2660.	178.	2187.	0.	0.
1969	351.	2365.	65.	2552.	0.	0.	2552.	108.	2660.	177.	2192.	0.	0.
1970	351.	2365.	65.	2552.	0.	0.	2552.	108.	2660.	177.	2196.	0.	0.
1971	351.	2365.	64.	2552.	0.	0.	2552.	108.	2660.	176.	2201.	0.	0.
1972	351.	2365.	64.	2552.	0.	0.	2552.	108.	2660.	176.	2205.	0.	0.
1973	351.	2365.	63.	2552.	0.	0.	2552.	108.	2660.	175.	2209.	0.	0.
1974	351.	2365.	63.	2552.	0.	0.	2552.	108.	2660.	175.	2212.	0.	0.
1975	351.	2365.	62.	2552.	0.	0.	2552.	108.	2660.	174.	2216.	0.	0.
1976	351.	2365.	62.	2552.	0.	0.	2552.	108.	2660.	174.	2219.	0.	0.
1977	351.	2365.	61.	2552.	0.	0.	2552.	108.	2660.	173.	2221.	0.	0.
1978	351.	2365.	61.	2552.	0.	0.	2552.	108.	2660.	173.	2222.	0.	0.
1979	351.	2365.	61.	2552.	0.	0.	2552.	108.	2660.	173.	2223.	0.	0.
1980	351.	2365.	60.	2552.	0.	0.	2552.	108.	2660.	172.	2223.	0.	0.
1981	351.	2365.	60.	2552.	0.	0.	2552.	108.	2660.	172.	2224.	0.	0.
1982	351.	2208.	56.	2552.	0.	0.	2397.	108.	2505.	162.	2130.	0.	0.
1983	351.	2365.	60.	2552.	0.	0.	2549.	108.	2657.	171.	2223.	0.	0.
1984	351.	2365.	60.	2552.	0.	0.	2549.	108.	2657.	171.	2223.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 4, Time and Vol. Reliability = .981 .997

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .833

Resi. for WS, Irr, Pow: .000 .750 .000
Vul. for WS, Irr, Pow: .000 .090 .000

IV

Monthly simulation of Sunkosi and Kamala Reservoir Operation

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .123 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir
A link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24235.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2208.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Reli. for WS. Irr. Pow: .000 .000 .000
Vul. for WS. Irr. Pow: .000 .000 .000

IV

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)
9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

yyyy	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	PW_Gen Mkwh	Pw-Rel m m3	Lin_Dv m m3	Spill m m3
1967	351.	2365.	72.	2557.	0.	0.	2557.	108.	3057.	222.	2541.	0.	0.
1968	351.	2365.	66.	2557.	0.	0.	2557.	108.	2665.	178.	2194.	0.	0.
1969	351.	2365.	64.	2557.	0.	0.	2557.	108.	2665.	177.	2201.	0.	0.
1970	351.	2365.	64.	2557.	0.	0.	2557.	108.	2665.	176.	2209.	0.	0.
1971	351.	2365.	63.	2557.	0.	0.	2557.	108.	2665.	175.	2216.	0.	0.
1972	351.	2365.	62.	2557.	0.	0.	2557.	108.	2665.	174.	2222.	0.	0.
1973	351.	2365.	61.	2557.	0.	0.	2557.	108.	2665.	173.	2226.	0.	0.
1974	351.	2365.	60.	2557.	0.	0.	2557.	108.	2665.	172.	2228.	0.	0.
1975	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1976	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1977	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1978	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1979	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1980	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1981	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1982	351.	2208.	56.	2557.	0.	0.	2396.	108.	2503.	162.	2133.	0.	0.
1983	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1984	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 11, Time and Vol. Reliability = .949 .995

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .444

Resi. for WS, Irr, Pow: .000 .909 .000
Vul. for WS, Irr, Pow: .000 .054 .000

Monthly simulation of Sunkosi and Kamala Reservoir Opera

```
Location No.  1,     Sunkosi Reservoir
Max. Storage     =  .225E+08 Cubic m,
Dead Storage     =  .750E+07 Cubic m,
Initial Storage  =  .225E+08 Cubic m
Installed Capacity of Power Plant =    69.0 MW
Multiplication factor for inflows = .100E+07
 Evaporation depths (m/month) at node          1

 .076  .088  .137  .185  .197  .174  .168  .162  .133  .129  .080  .066

Location No.  2,     Kamala Reservoir
Max. Storage     =  .900E+09 Cubic m,
Dead Storage     =  .190E+09 Cubic m,
Initial Storage  =  .900E+09 Cubic m
Installed Capacity of Power Plant =    31.0 MW
Multiplication factor for inflows = .100E+07
 Evaporation depths (m/month) at node          2

 .076  .088  .137  .185  .196  .175  .168  .162  .133  .129  .080  .066

System Operation Simulated for 216 Months, Beginning 1966 10


            RESULTS FOR LOCATION NO.  1 -   Sunkosi Reservoir
A link diverts water from this node
Water supply demands at this node (m m3)
   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40
```

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2365.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

```
Link time and vol. reliabilities =    .995    .996

Resl. for WS, Irr. Pow:   .000    .000    .000
Vul.  for WS, Irr. Pow:   .000    .000    .000
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V

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir
This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

yyyy	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	PW_Gen Mkwh	Pw-Rel m m3	Lin_Dv m m3	Spill m m3
1967	351.	2365.	72.	2554.	0.	0.	2554.	108.	3056.	222.	2540.	0.	0.
1968	351.	2365.	66.	2554.	0.	0.	2554.	108.	2662.	178.	2189.	0.	0.
1969	351.	2365.	65.	2554.	0.	0.	2554.	108.	2662.	177.	2195.	0.	0.
1970	351.	2365.	64.	2554.	0.	0.	2554.	108.	2662.	176.	2201.	0.	0.
1971	351.	2365.	64.	2554.	0.	0.	2554.	108.	2662.	176.	2207.	0.	0.
1972	351.	2365.	63.	2554.	0.	0.	2554.	108.	2662.	175.	2212.	0.	0.
1973	351.	2365.	62.	2554.	0.	0.	2554.	108.	2662.	174.	2216.	0.	0.
1974	351.	2365.	62.	2554.	0.	0.	2554.	108.	2662.	174.	2221.	0.	0.
1975	351.	2365.	61.	2554.	0.	0.	2554.	108.	2662.	173.	2222.	0.	0.
1976	351.	2365.	61.	2554.	0.	0.	2554.	108.	2662.	172.	2224.	0.	0.
1977	351.	2365.	60.	2554.	0.	0.	2554.	108.	2662.	172.	2225.	0.	0.
1978	351.	2365.	60.	2554.	0.	0.	2550.	108.	2657.	171.	2222.	0.	0.
1979	351.	2365.	60.	2554.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1980	351.	2365.	60.	2554.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1981	351.	2365.	60.	2554.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1982	351.	2208.	56.	2554.	0.	0.	2396.	108.	2503.	162.	2131.	0.	0.
1983	351.	2365.	60.	2554.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1984	351.	2365.	60.	2554.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 8, Time and Vol. Reliability = .963 .996

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .611

Resi. for WS, Irr, Pow: .000 .875 .000
Vul. for WS, Irr, Pow: .000 .058 .000

IV

Monthly simulation of Sunkosi and Kamala Reservoir Operation

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir

A link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	548.	1912.	2208.	14053.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Reli. for WS. Irr. Pow: .000 .000 .000
Vul. for WS. Irr. Pow: .000 .000 .000

IV

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1

The percentage loss during transmission is .00%

Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

YYYY	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mewh	Pw-Rel m m3	Lin_Dv m m3	Spill m m3
1967	351.	2365.	72.	2557.	0.	0.	2557.	108.	3057.	222.	2541.	0.	0.
1968	351.	2365.	66.	2557.	0.	0.	2557.	108.	2665.	178.	2194.	0.	0.
1969	351.	2365.	64.	2557.	0.	0.	2557.	108.	2665.	177.	2201.	0.	0.
1970	351.	2365.	64.	2557.	0.	0.	2557.	108.	2665.	176.	2209.	0.	0.
1971	351.	2365.	63.	2557.	0.	0.	2557.	108.	2665.	175.	2216.	0.	0.
1972	351.	2365.	62.	2557.	0.	0.	2557.	108.	2665.	174.	2222.	0.	0.
1973	351.	2365.	61.	2557.	0.	0.	2557.	108.	2665.	173.	2226.	0.	0.
1974	351.	2365.	60.	2557.	0.	0.	2557.	108.	2665.	172.	2228.	0.	0.
1975	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1976	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1977	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1978	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1979	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1980	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1981	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1982	351.	2208.	56.	2557.	0.	0.	2396.	108.	2503.	152.	2133.	0.	0.
1983	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.
1984	351.	2365.	60.	2557.	0.	0.	2549.	108.	2657.	171.	2222.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 11, Time and Vol. Reliability = .949 .995

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1

Annual Irrigation Reliability = .444

Resi. for WS, Irr, Pow: .000 .909 .000

Vul. for WS, Irr, Pow: .000 .054 .000

IV

Monthly simulation of Sunkosi and Kamala Reservoir Opera

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m.
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months. Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir
A link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	548.	1912.	2205.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Resi. for WS. Irr. Pow: .000 .000 .000
Vul. for WS. Irr. Pow: .000 .000 .000

IV

Monthly simulation of Sunkosi and Kamala Reservoir Opera

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir
A link diverts water from this node
water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1966-10-0	22.5	1423.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1049.	323.00	312.00	323.00
1966-11-0	22.5	779.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	405.	323.00	312.00	323.00
1966-12-0	22.5	595.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	228.	323.00	312.00	323.00
1967-01-0	22.5	452.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	78.	323.00	312.00	323.00
1967-02-0	22.5	345.8	.2	.0	.0	.0	.0	.0	151.1	43.4	151.1	194.4	0.	323.00	312.00	323.00
1967-03-0	22.5	358.9	.3	.0	.0	.0	.0	.0	157.7	45.2	157.7	200.9	0.	323.00	312.00	323.00
1967-04-0	22.5	412.1	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	38.	323.00	312.00	323.00
1967-05-0	22.5	551.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	[illegible]	197.	323.00	312.00	322.00
1967-06-0	22.5	1262.3	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	888.	323.00	312.00	323.00
1967-07-0	22.5	4225.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3857.	323.00	312.00	323.00
1967-08-0	22.5	5383.6	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	5009.	323.00	312.00	323.00
1967-09-0	22.5	3589.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3221.	323.00	312.00	323.00
1967		19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1967-10-0	22.5	1423.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1049.	323.00	312.00	323.00
1967-11-0	22.5	779.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	405.	323.00	312.00	323.00
1967-12-0	22.5	595.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	228.	323.00	312.00	323.00
1968-01-0	22.5	476.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	102.	323.00	312.00	323.00
1968-02-0	22.5	370.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3.	323.00	312.00	323.00
1968-03-0	22.5	391.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	17.	323.00	312.00	323.00
1968-04-0	22.5	378.4	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	4.	323.00	312.00	323.00
1968-05-0	22.5	541.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	[illegible]	786.	323.00	312.00	323.00
[illegible]	[illegible]	1806.6	.4	.0	[illegible]	[illegible]	.0	.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	323.00	[illegible]	[illegible]

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1968-08-0	22.5	7713.8	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	7339.	323.00	312.00	323.00
1968-09-0	22.5	5196.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4828.	323.00	312.00	323.00
1968		25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1968-10-0	22.5	1894.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1520.	323.00	312.00	323.00
1968-11-0	22.5	916.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	542.	323.00	312.00	323.00
1968-12-0	22.5	669.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	302.	323.00	312.00	323.00
1969-01-0	22.5	602.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	228.	323.00	312.00	323.00
1969-02-0	22.5	426.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	58.	323.00	312.00	323.00
1969-03-0	22.5	409.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	35.	323.00	312.00	323.00
1969-04-0	22.5	386.2	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	12.	323.00	312.00	323.00
1969-05-0	22.5	608.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	253.	323.00	312.00	323.00
1969-06-0	22.5	1871.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1497.	323.00	312.00	323.00
1969-07-0	22.5	5780.2	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5412.	323.00	312.00	323.00
1969-08-0	22.5	6562.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6188.	323.00	312.00	323.00
1969-09-0	22.5	5222.9	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4855.	323.00	312.00	323.00
1969		25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1969-10-0	22.5	1894.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1520.	323.00	312.00	323.00
1969-11-0	22.5	916.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	542.	323.00	312.00	323.00
1969-12-0	22.5	669.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	302.	323.00	312.00	323.00
1970-01-0	22.5	527.7	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	153.	323.00	312.00	323.00
1970-02-0	22.5	446.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	78.	323.00	312.00	323.00
1970-03-0	22.5	436.6	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	62.	323.00	312.00	323.00
1970-04-0	22.5	438.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	64.	323.00	312.00	323.00
1970-05-0	22.5	597.3	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	242.	323.00	312.00	323.00
1970-06-0	22.5	2021.8	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1647.	323.00	312.00	323.00
1970-07-0	22.5	7128.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	6760.	323.00	312.00	323.00
1970-08-0	22.5	8490.5	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	8116.	323.00	312.00	323.00
1970-09-0	22.5	3776.5	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3409.	323.00	312.00	323.00
1970		27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1970-10-0	22.5	1957.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1583.	323.00	312.00	323.00
1970-11-0	22.5	974.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	601.	323.00	312.00	323.00
1970-12-0	22.5	701.7	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	334.	323.00	312.00	323.00
1971-01-0	22.5	589.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	215.	323.00	312.00	323.00
1971-02-0	22.5	498.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	131.	323.00	312.00	323.00
1971-03-0	22.5	508.9	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	134.	323.00	312.00	323.00
1971-04-0	22.5	585.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	211.	323.00	312.00	323.00
1971-05-0	22.5	771.4	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	416.	323.00	312.00	323.00
1971-06-0	22.5	4847.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	4473.	323.00	312.00	323.00
1971-07-0	22.5	6246.7	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5879.	323.00	312.00	323.00
1971-08-0	22.5	7204.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6830.	323.00	312.00	323.00
1971-09-0	22.5	3937.3	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3569.	323.00	312.00	323.00
1971		28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1971-10-0	22.5	2356.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1982.	323.00	312.00	323.00
1971-11-0	22.5	988.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	614.	323.00	312.00	323.00
1971-12-0	22.5	658.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	291.	323.00	312.00	323.00

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr. m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
[illegible]	[illegible]	[illegible]	[illegible]	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	129.	323.00	312.00	323.00
1972-02-0	22.5	395.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	28.	323.00	312.00	323.00
1972-03-0	22.5	415.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	41.	323.00	312.00	323.00
1972-04-0	22.5	399.2	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	25.	323.00	312.00	323.00
1972-05-0	22.5	696.4	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	341.	323.00	312.00	323.00
1972-06-0	22.5	1384.1	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1010.	323.00	312.00	323.00
1972-07-0	22.5	5002.6	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4635.	323.00	312.00	323.00
1972-08-0	22.5	5785.3	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	5411.	323.00	312.00	323.00
1972-09-0	22.5	4312.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3944.	323.00	312.00	323.00
1972		22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1972-10-0	22.5	1625.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1251.	323.00	312.00	323.00
1972-11-0	22.5	918.7	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	544.	323.00	312.00	323.00
1972-12-0	22.5	640.1	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	272.	323.00	312.00	323.00
1973-01-0	22.5	514.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	140.	323.00	312.00	323.00
1973-02-0	22.5	400.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	33.	323.00	312.00	323.00
1973-03-0	22.5	447.3	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	73.	323.00	312.00	323.00
1973-04-0	22.5	464.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	89.	323.00	312.00	323.00
1973-05-0	22.5	707.1	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	352.	323.00	312.00	323.00
1973-06-0	22.5	2980.8	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	2606.	323.00	312.00	323.00
1973-07-0	22.5	4536.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4168.	323.00	312.00	323.00
1973-08-0	22.5	6722.8	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6348.	323.00	312.00	323.00
1973-09-0	22.5	5276.5	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4909.	323.00	312.00	323.00
1973		25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1973-10-0	22.5	3058.6	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	2684.	323.00	312.00	323.00
1973-11-0	22.5	1130.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	756.	323.00	312.00	323.00
1973-12-0	22.5	645.5	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	278.	323.00	312.00	323.00
1974-01-0	22.5	498.2	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	124.	323.00	312.00	323.00
1974-02-0	22.5	373.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	6.	323.00	312.00	323.00
1974-03-0	22.5	356.2	.3	.0	.0	.0	.0	.0	155.0	44.5	155.0	200.9	0.	323.00	312.00	323.00
1974-04-0	22.5	409.5	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	35.	323.00	312.00	323.00
1974-05-0	22.5	541.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	186.	323.00	312.00	323.00
1974-06-0	22.5	1394.5	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1020.	323.00	312.00	323.00
1974-07-0	22.5	5702.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5334.	323.00	312.00	323.00
1974-08-0	22.5	7767.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	7393.	323.00	312.00	323.00
1974-09-0	22.5	5142.5	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4775.	323.00	312.00	323.00
1974		27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1974-10-0	22.5	2138.4	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1764.	323.00	312.00	323.00
1974-11-0	22.5	969.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	595.	323.00	312.00	323.00
1974-12-0	22.5	650.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	283.	323.00	312.00	323.00
1975-01-0	22.5	525.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	151.	323.00	312.00	323.00
1975-02-0	22.5	415.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	48.	323.00	312.00	323.00
1975-03-0	22.5	372.3	.3	.0	.0	.0	.0	.0	171.1	49.1	171.1	200.9	0.	323.00	312.00	323.00
1975-04-0	22.5	425.1	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	51.	323.00	312.00	323.00
1975-05-0	22.5	600.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	245.	323.00	312.00	323.00
1975-06-0	22.5	2071.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1696.	323.00	312.00	323.00
1975-07-0	22.5	5806.1	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5438.	323.00	312.00	323.00
1975-08-0	22.5	5481.7	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6107.	323.00	312.00	323.00
1975-09-0	22.5	3722.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3395.	323.00	312.00	323.00
1975		[illegible]	4.	.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

YYYY-Mn-D	Ini_Sto	Loc_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	Pw_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	MKwh	m m3	m m3	m m3	m	m	m
1975-10-0	22.5	3628.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	3254.	323.00	312.00	323.00
1975-11-0	22.5	1392.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1018.	323.00	312.00	323.00
1975-12-0	22.5	766.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	398.	323.00	312.00	323.00
1976-01-0	22.5	578.5	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	204.	323.00	312.00	323.00
1976-02-0	22.5	441.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	73.	323.00	312.00	323.00
1976-03-0	22.5	393.7	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	19.	323.00	312.00	323.00
1976-04-0	22.5	401.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	27.	323.00	312.00	323.00
1976-05-0	22.5	634.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	280.	323.00	312.00	323.00
1976-06-0	22.5	2721.6	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	2347.	323.00	312.00	323.00
1976-07-0	22.5	5702.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5334.	323.00	312.00	323.00
1976-08-0	22.5	7258.5	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6884.	323.00	312.00	323.00
1976-09-0	22.5	5303.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4935.	323.00	312.00	323.00
1976		29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.			

YYYY-Mn-D	Ini_Sto	Loc_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	Pw_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	MKwh	m m3	m m3	m m3	m	m	m
1976-10-0	22.5	2001.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1627.	323.00	312.00	323.00
1976-11-0	22.5	996.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	622.	323.00	312.00	323.00
1976-12-0	22.5	626.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	259.	323.00	312.00	323.00
1977-01-0	22.5	466.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	92.	323.00	312.00	323.00
1977-02-0	22.5	370.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3.	323.00	312.00	323.00
1977-03-0	22.5	353.5	.3	.0	.0	.0	.0	.0	152.3	43.7	152.3	200.9	0.	323.00	312.00	323.00
1977-04-0	22.5	432.9	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	58.	323.00	312.00	323.00
1977-05-0	22.5	551.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	197.	323.00	312.00	323.00
1977-06-0	22.5	1316.7	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	942.	323.00	312.00	323.00
1977-07-0	22.5	5702.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5334.	323.00	312.00	323.00
1977-08-0	22.5	7660.2	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	7286.	323.00	312.00	323.00
1977-09-0	22.5	4365.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	3998.	323.00	312.00	323.00
1977		24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.			

YYYY-Mn-D	Ini_Sto	Loc_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	Pw_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	MKwh	m m3	m m3	m m3	m	m	m
1977-10-0	22.5	2115.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1741.	323.00	312.00	323.00
1977-11-0	22.5	974.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	601.	323.00	312.00	323.00
1977-12-0	22.5	562.5	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	195.	323.00	312.00	323.00
1978-01-0	22.5	417.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	44.	323.00	312.00	323.00
1978-02-0	22.5	308.2	.2	.0	.0	.0	.0	.0	113.6	32.6	113.6	194.4	0.	323.00	312.00	323.00
1978-03-0	22.5	329.4	.3	.0	.0	.0	.0	.0	128.2	36.8	128.2	200.9	0.	323.00	312.00	323.00
1978-04-0	22.5	388.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	14.	323.00	312.00	323.00
1978-05-0	22.5	1092.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	738.	323.00	312.00	323.00
1978-06-0	22.5	3499.2	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	3125.	323.00	312.00	323.00
1978-07-0	22.5	7361.3	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	6993.	323.00	312.00	323.00
1978-08-0	22.5	8570.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	8196.	323.00	312.00	323.00
1978-09-0	22.5	4847.9	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4480.	323.00	312.00	323.00
1978		30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	25126.			

YYYY-Mn-D	Ini_Sto	Loc_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	Pw_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	MKwh	m m3	m m3	m m3	m	m	m
1978-10-0	22.5	2551.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	2477.	323.00	312.00	323.00
1978-11-0	22.5	1058.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	684.	323.00	312.00	323.00
1978-12-0	22.5	683.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	315.	323.00	312.00	323.00
1979-01-0	22.5	[illegible]	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	[illegible]	65.	323.00	312.00	323.00
1979-02-0	22.5	420.9	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	53.	323.00	312.00	323.00
1979-03-0	22.5	339.3	.3	.0	.0	.0	.0	.0	173.2	[illegible]	[illegible]	[illegible]	[illegible]	323.00	312.00	323.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1979-07-0	22.5	6842.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	6475.	323.00	312.00	323.00
1979-08-0	22.5	8303.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	7929.	323.00	312.00	323.00
1979-09-0	22.5	5356.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4989.	323.00	312.00	323.00
1979		23680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1979-10-0	22.5	2177.3	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1803.	323.00	312.00	323.00
1979-11-0	22.5	1079.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	705.	323.00	312.00	323.00
1979-12-0	22.5	683.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	315.	323.00	312.00	323.00
1980-01-0	22.5	586.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	212.	323.00	312.00	323.00
1980-02-0	22.5	473.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	106.	323.00	312.00	323.00
1980-03-0	22.5	452.6	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	78.	323.00	312.00	323.00
1980-04-0	22.5	479.5	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	105.	323.00	312.00	323.00
1980-05-0	22.5	677.6	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	323.	323.00	312.00	323.00
1980-06-0	22.5	1967.3	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1593.	323.00	312.00	323.00
1980-07-0	22.5	7905.6	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	7538.	323.00	312.00	323.00
1980-08-0	22.5	9990.4	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	9616.	323.00	312.00	323.00
1980-09-0	22.5	5678.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5310.	323.00	312.00	323.00
1980		32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1980-10-0	22.5	1827.4	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1453.	323.00	312.00	323.00
1980-11-0	22.5	921.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	547.	323.00	312.00	323.00
1980-12-0	22.5	624.1	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	256.	323.00	312.00	323.00
1981-01-0	22.5	506.2	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	132.	323.00	312.00	323.00
1981-02-0	22.5	418.4	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	51.	323.00	312.00	323.00
1981-03-0	22.5	417.8	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	43.	323.00	312.00	323.00
1981-04-0	22.5	464.0	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	89.	323.00	312.00	323.00
1981-05-0	22.5	503.5	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	148.	323.00	312.00	323.00
1981-06-0	22.5	1842.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1468.	323.00	312.00	323.00
1981-07-0	22.5	6143.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5775.	323.00	312.00	323.00
1981-08-0	22.5	7874.5	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	7509.	323.00	312.00	323.00
1981-09-0	22.5	4553.3	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	4135.	323.00	312.00	323.00
1981		26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1981-10-0	22.5	1423.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1049.	323.00	312.00	323.00
1981-11-0	22.5	956.2	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	582.	323.00	312.00	323.00
1981-12-0	22.5	725.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	358.	323.00	312.00	323.00
1982-01-0	22.5	559.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	186.	323.00	312.00	323.00
1982-02-0	22.5	438.5	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	71.	323.00	312.00	323.00
1982-03-0	22.5	447.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	73.	323.00	312.00	323.00
1982-04-0	22.5	29.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	43.7L	0.	314.00	312.00	323.00
1982-05-0	7.5	445.8	.3	.0	.0	.0	.0	.0	179.7	49.7	179.7	181.4	69.	323.00	312.00	323.00
1982-06-0	22.5	750.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	375.	323.00	312.00	323.00
1982-07-0	22.5	1086.1	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	718.	323.00	312.00	323.00
1982-08-0	22.5	5106.2	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	4732.	323.00	312.00	323.00
1982-09-0	22.5	6213.9	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5846.	323.00	312.00	323.00
1982		18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2208.	14058.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1982-10-0	22.5	5383.6	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	5009.	323.00	312.00	323.00
1982-11-0	22.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1982-10-0	22.5	5383.6	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	5009.	323.00	312.00	323.00
1982-11-0	22.5	2643.8	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	2270.	323.00	312.00	323.00
1982-12-0	22.5	1015.1	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	647.	323.00	312.00	323.00
1983-01-0	22.5	688.3	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	314.	323.00	312.00	323.00
1983-02-0	22.5	543.7	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	176.	323.00	312.00	323.00
1983-03-0	22.5	426.0	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	52.	323.00	312.00	323.00
1983-04-0	22.5	388.4	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	14.	323.00	312.00	323.00
1983-05-0	22.5	352.5	.5	.0	.0	.0	.0	.0	170.6	48.9	170.6	181.4	0.	323.00	312.00	323.00
1983-06-0	22.5	616.0	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	242.	323.00	312.00	323.00
1983-07-0	22.5	1938.8	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	1571.	323.00	312.00	323.00
1983-08-0	22.5	7153.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6779.	323.00	312.00	323.00
1983-09-0	22.5	5437.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	5069.	323.00	312.00	323.00
1983		26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.			

YYYY-Mn-D	Ini_Sto m m3	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen MKwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3	End_Lev m	Mdl_Rul m	Upr_Rul m
1983-10-0	22.5	7044.2	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6670.	323.00	312.00	323.00
1983-11-0	22.5	2014.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	1640.	323.00	312.00	323.00
1983-12-0	22.5	983.0	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	615.	323.00	312.00	323.00
1984-01-0	22.5	723.2	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	349.	323.00	312.00	323.00
1984-02-0	22.5	586.6	.2	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	219.	323.00	312.00	323.00
1984-03-0	22.5	466.1	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	92.	323.00	312.00	323.00
1984-04-0	22.5	484.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	110.	323.00	312.00	323.00
1984-05-0	22.5	458.8	.5	.0	.0	.0	.0	.0	173.2	49.7	173.2	181.4	104.	323.00	312.00	323.00
1984-06-0	22.5	583.9	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	209.	323.00	312.00	323.00
1984-07-0	22.5	1573.3	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	1205.	323.00	312.00	323.00
1984-08-0	22.5	7283.5	.4	.0	.0	.0	.0	.0	173.2	49.7	173.2	200.9	6909.	323.00	312.00	323.00
1984-09-0	22.5	6588.9	.3	.0	.0	.0	.0	.0	173.2	49.7	173.2	194.4	6221.	323.00	312.00	323.00
1984		28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.			

Link time and vol. reliabilities = .995 .996

Resi. for WS, Irr, Pow: .000 .000 .000
Vul. for WS, Irr, Pow: .000 .000 .000

IV

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1

The percentage loss during transmission is .00%

Water supply demands at this node (m m3)

9.11	8.52	9.11	8.81	9.11	8.81	9.11	9.11	8.81	9.11	8.81	9.11

YYYY-Mn-De	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1966-10-00	900.0	39.9	200.9	7.3	260.2	.0	.0	260.2	9.1	269.3	22.	233.	.0	0.	181.54	164.00	182.0
1966-11-00	864.2	22.6	200.9	4.5	118.9	.0	.0	118.9	8.8	183.2	18.	183.	.0	0.	182.00	164.00	182.0
1966-12-00	900.0	19.5	194.4	3.8	45.4	.0	.0	45.4	9.1	210.1	20.	210.	.0	0.	182.00	164.00	182.0
1967-01-00	900.0	17.1	200.9	4.3	101.8	.0	.0	101.8	9.1	213.6	21.	214.	.0	0.	182.00	164.00	182.0
1967-02-00	900.0	13.1	194.4	5.0	136.3	.0	.0	136.3	8.5	202.5	20.	203.	.0	0.	182.00	164.00	182.0
1967-03-00	900.0	13.2	200.9	7.8	174.4	.0	.0	174.4	9.1	206.3	20.	206.	.0	0.	182.00	164.00	182.0
1967-04-00	900.0	14.0	200.9	10.4	236.7	.0	.0	236.7	8.8	245.6	22.	233.	.0	0.	181.47	164.00	182.0
1967-05-00	858.9	17.4	181.4	11.0	143.1	.0	.0	143.1	9.1	152.3	15.	152.	.0	0.	181.93	164.00	182.0
1967-06-00	894.5	25.0	200.9	7.2	703.2	.0	.0	703.2	8.8	712.0	22.	270.	.0	0.	179.04	164.00	182.0
1967-07-00	401.2	48.0	194.4	3.7	359.2	.0	.0	359.2	9.1	368.3	22.	344.	.0	0.	166.45	164.00	182.0
1967-08-00	271.6	62.9	200.9	3.5	124.8	.0	.0	124.8	9.1	133.9	9.	134.	.0	0.	169.94	164.00	182.0
1967-09-00	398.0	58.5	194.4	3.9	147.9	.0	.0	147.9	8.3	156.7	11.	157.	.0	0.	173.77	164.00	182.0
1967		351.	2365.	73.	2552.	0.	0.	2552.	108.	3054.	222.	2539.	0.	0.			

YYYY-Mn-De	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Rul
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1967-10-00	490.3	39.9	200.9	4.1	260.2	.0	.0	260.2	9.1	269.3	20.	269.	.0	0.	172.16	164.00	182.0
1967-11-00	457.6	22.6	200.9	2.9	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	176.61	164.00	182.0
1967-12-00	550.6	19.5	194.4	3.1	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	179.48	164.00	182.0
1968-01-00	706.8	17.1	200.9	4.0	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.83	164.00	182.0
1968-02-00	809.8	13.1	194.4	4.9	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.58	164.00	182.0
1968-03-00	867.7	13.2	200.9	7.7	174.4	.0	.0	174.4	9.1	183.6	18.	184.	.0	0.	181.88	164.00	182.0
1968-04-00	890.5	14.0	200.9	10.4	236.7	.0	.0	236.7	8.8	245.6	22.	234.	.0	0.	181.35	164.00	182.0

YYYY-Mn-DD	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	Pw-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
[illegible]	[illegible]	17.4	181.4	11.0	143.1	.0	.0	143.1	9.1	152.3	15.	152.	.0	0.	181.80	164.00	182.0
1968-06-00	885.1	25.0	200.9	7.1	703.2	.0	.0	703.2	8.8	712.0	22.	272.	.0	0.	169.78	164.00	182.0
1968-07-00	391.9	48.0	194.4	3.6	359.2	.0	.0	359.2	9.1	368.3	22.	348.	.0	0.	166.17	164.00	182.0
1968-08-00	262.4	62.9	200.9	3.5	124.8	.0	.0	124.8	9.1	133.9	9.	134.	.0	0.	169.70	164.00	182.0
1968-09-00	388.9	58.5	194.4	3.8	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	173.10	164.00	182.0
1968		351.	2365.	66.	2552.	0.	0.	2552.	108.	2660.	178.	2187.	0.	0.			

YYYY-Mn-DD	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	Pw-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1968-10-00	481.3	39.9	200.9	4.0	260.2	.0	.0	260.2	9.1	269.3	20.	269.	.0	0.	171.83	164.00	182.0
1968-11-00	448.8	22.6	200.9	2.8	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	176.44	164.00	182.0
1968-12-00	541.8	19.5	194.4	3.0	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	179.37	164.00	182.0
1969-01-00	698.1	17.1	200.9	4.0	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.72	164.00	182.0
1969-02-00	801.1	13.1	194.4	4.5	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.47	164.00	182.0
1969-03-00	859.0	13.2	200.9	7.7	174.4	.0	.0	174.4	9.1	183.6	18.	184.	.0	0.	181.76	164.00	182.0
1969-04-00	881.9	14.0	200.9	10.3	236.7	.0	.0	236.7	8.8	245.6	22.	234.	.0	0.	181.24	164.00	182.0
1969-05-00	840.9	17.4	181.4	10.9	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.69	164.00	182.0
1969-06-00	676.6	25.0	200.9	7.0	703.2	.0	.0	703.2	8.8	712.0	22.	273.	.0	0.	169.55	164.00	182.0
1969-07-00	383.4	48.0	194.4	3.5	359.2	.0	.0	359.2	9.1	368.3	22.	351.	.0	0.	165.92	164.00	182.0
1969-08-00	254.0	62.9	200.9	3.4	124.8	.0	.0	124.8	9.1	133.9	9.	134.	.0	0.	169.47	164.00	182.0
1969-09-00	380.5	58.5	194.4	3.7	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	172.74	164.00	182.0
1969		351.	2365.	65.	2552.	0.	0.	2552.	108.	2660.	177.	2192.	0.	0.			

YYYY-Mn-DD	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	Pw-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m

YYYY-Mn-Dl	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1969-10-00	473.1	39.9	200.9	3.9	260.2	.0	.0	260.2	9.1	269.3	20.	269.	.0	0.	171.53	164.00	182.0
1969-11-00	440.7	22.6	200.9	2.8	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	176.27	164.00	182.0
1969-12-00	533.7	19.5	194.4	3.0	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	179.26	164.00	182.0
1970-01-00	690.0	17.1	200.9	4.0	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.61	164.00	182.0
1970-02-00	793.1	13.1	194.4	4.8	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.37	164.00	182.0
1970-03-00	851.0	13.2	200.9	7.7	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.66	164.00	182.0
1970-04-00	873.9	14.0	200.9	10.3	236.7	.0	.0	236.7	8.8	245.6	22.	235.	.0	0.	181.13	164.00	182.0
1970-05-00	833.0	17.4	181.4	10.9	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.60	164.00	182.0
1970-06-00	868.7	25.0	200.9	7.0	703.2	.0	.0	703.2	8.8	712.0	22.	274.	.0	0.	169.33	164.00	182.0
1970-07-00	375.5	48.0	194.4	3.5	359.2	.0	.0	359.2	9.1	368.3	22.	354.	.0	0.	165.69	164.00	182.0
1970-08-00	246.2	62.9	200.9	3.3	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	169.26	164.00	182.0
1970-09-00	372.8	58.5	194.4	3.6	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	172.45	164.00	182.0
1970		351.	2365.	65.	2552.	0.	0.	2552.	108.	2660.	177.	2196.	0.	0.			

YYYY-Mn-Dl	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1970-10-00	465.4	39.9	200.9	3.8	260.2	.0	.0	260.2	9.1	269.3	20.	269.	.0	0.	171.24	164.00	182.0
1970-11-00	433.1	22.6	200.9	2.7	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	176.12	164.00	182.0
1970-12-00	526.2	19.5	194.4	3.0	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	179.16	164.00	182.0
1971-01-00	682.5	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.51	164.00	182.0
1971-02-00	785.6	13.1	194.4	4.8	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.27	164.00	182.0
1971-03-00	843.5	13.2	200.9	7.6	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.57	164.00	182.0
1971-04-00	866.5	14.0	200.9	10.2	236.7	.0	.0	236.7	8.8	245.6	22.	236.	.0	0.	181.03	164.00	182.0
1971-05-00	825.6	17.4	181.4	10.8	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.50	164.00	182.0
1971-06-00	861.3	25.0	200.9	6.9	703.2	.0	.0	703.2	6.8	712.0	22.	275.	.0	0.	169.13	164.00	182.0
1971-07-00	368.2	48.0	194.4	3.4	359.2	.0	.0	359.2	9.1	368.3	22.	356.	.0	0.	165.47	164.00	182.0
1971-08-00	239.0	52.9	200.9	3.3	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	169.06	164.00	182.0
1971-09-00	365.6	58.5	194.4	3.6	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	172.19	164.00	182.0
1971		351.	2365.	64.	2552.	0.	0.	2552.	108.	2660.	173.	2201.	0.	0.			

YYYY-Mn-De	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1971-10-00	458.3	39.9	200.9	3.7	260.2	.0	.0	260.2	9.1	269.3	20.	269.	.0	0.	170.98	164.00	182.0
1971-11-00	426.1	22.6	200.9	2.7	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	175.94	164.00	182.0
1971-12-00	519.2	19.5	194.4	3.0	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	179.07	164.00	182.0
1972-01-00	675.5	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.42	164.00	182.0
1972-02-00	778.6	13.1	194.4	4.8	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.18	164.00	182.0
1972-03-00	836.6	13.2	200.9	7.6	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.48	164.00	182.0
1972-04-00	859.6	14.0	200.9	10.2	236.7	.0	.0	236.7	8.8	245.6	22.	233.	.0	0.	180.94	164.00	182.0
1972-05-00	818.7	17.4	181.4	10.8	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.41	164.00	182.0
1972-06-00	854.5	25.0	200.9	6.9	703.2	.0	.0	703.2	8.8	712.0	22.	276.	.0	0.	168.95	164.00	182.0
1972-07-00	361.5	48.0	194.4	3.3	359.2	.0	.0	359.2	9.1	368.3	22.	359.	.0	0.	165.27	164.00	182.0
1972-08-00	232.3	62.9	200.9	3.2	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	166.88	164.00	182.0
1972-09-00	359.0	58.5	194.4	3.5	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	171.94	164.00	182.0
1972		351.	2365.	64.	2552.	0.	0.	2552.	108.	2660.	176.	2205.	0.	0.			

YYYY-Mn-De	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1972-10-00	451.7	39.9	200.9	3.6	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	170.73	164.00	182.0
1972-11-00	419.5	22.6	200.9	2.6	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	175.46	164.00	182.0
1972-12-00	512.8	19.5	194.4	2.9	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.98	164.00	182.0
1973-01-00	669.1	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.34	164.00	182.0
1973-02-00	772.2	13.1	194.4	4.8	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.10	164.00	182.0
1973-03-00	830.2	13.2	200.9	7.6	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.40	164.00	182.0
1973-04-00	853.2	14.0	200.9	10.2	236.7	.0	.0	236.7	8.8	245.6	22.	235.	.0	0.	180.86	164.00	182.0

1973-05-00	812.4	17.4	181.4	10.8	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.33	164.00	182.0
1973-06-00	848.2	25.0	200.9	6.9	703.2	.0	.0	703.2	8.8	712.0	22.	277.	.0	0.	168.78	164.00	182.0
1973-07-00	355.2	48.0	194.4	3.3	359.2	.0	.0	359.2	9.1	368.3	22.	361.	.0	0.	165.08	164.00	182.0
1973-08-00	226.1	62.9	200.9	3.2	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.71	164.00	182.0
1973-09-00	352.8	58.5	194.4	3.4	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	171.71	164.00	182.0
1973		351.	2365.	63.	2552.	0.	0.	2552.	108.	2660.	175.	2209.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1973-[illegible]-00	445.6	39.9	200.9	3.6	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	170.51	164.00	182.0
1973-11-00	413.5	22.6	200.9	2.5	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	175.01	164.00	182.0
1973-12-00	506.8	19.5	194.4	2.9	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.87	164.00	182.0
1974-01-00	663.3	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.26	164.00	182.0
1974-02-00	766.4	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	14.	145.	.0	0.	181.02	164.00	182.0
1974-03-00	824.4	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.32	164.00	182.0
1974-04-00	847.4	14.0	200.9	10.1	236.7	.0	.0	236.7	8.8	245.6	22.	237.	.0	0.	180.79	164.00	182.0
1974-05-00	806.6	17.4	181.4	10.7	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.26	164.00	182.0
1974-06-00	842.5	25.0	200.9	6.8	703.2	.0	.0	703.2	8.8	712.0	22.	278.	.0	0.	168.62	164.00	182.0
1974-07-00	349.5	48.0	194.4	3.2	359.2	.0	.0	359.2	9.1	368.3	22.	363.	.0	0.	164.91	164.00	182.0
1974-08-00	220.4	62.9	200.9	3.1	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.56	164.00	182.0
1974-09-00	347.2	58.5	194.4	3.4	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	171.50	164.00	182.0
1974		351.	2365.	63.	2552.	0.	0.	2552.	108.	2660.	175.	2212.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1974-10-00	440.0	39.9	200.9	3.5	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	170.30	164.00	182.0
1974-11-00	408.0	22.6	200.9	2.5	118.9	.0	.0	118.9	8.8	127.7	10.	128.	.0	0.	174.60	164.00	182.0
1974-12-00	501.4	19.5	194.4	2.8	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.76	164.00	182.0
1975-01-00	657.9	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.19	164.00	182.0
1975-02-00	761.0	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.95	164.00	182.0
1975-03-00	819.0	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.25	164.00	182.0
1975-04-00	842.1	14.0	200.9	10.1	236.7	.0	.0	236.7	8.8	245.6	22.	237.	.0	0.	180.72	164.00	182.0
1975-05-00	[illegible]	17.4	181.4	10.7	143.1	.0	.0	143.1	9.1	152.3	14.	152.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
1975-06-00	837.2	25.0	200.9	6.8	703.2	.0	.0	703.2	8.8	712.0	22.	279.	.0	0.	168.48	164.00	182.
1975-07-00	344.3	48.0	194.4	3.2	359.2	.0	.0	359.2	9.1	368.3	22.	365.	.0	0.	164.76	164.00	182.0
1975-08-00	215.2	62.9	200.9	3.1	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.42	164.00	182.0
1975-09-00	342.1	58.5	194.4	3.4	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	171.31	164.00	182.
1975		351.	2365.	62.	2552.	0.	0.	2552.	108.	2660.	174.	2216.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1975-10-00	434.9	39.9	200.9	3.4	260.2	.0	.0	260.2	9.1	269.3	19.	233.	.0	0.	170.11	164.00	182.0
1975-11-00	403.0	22.6	200.9	2.4	118.9	.0	.0	118.9	8.8	127.7	9.	123.	.0	0.	174.23	164.00	182.
1975-12-00	493.4	19.5	194.4	2.8	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.66	164.00	182.0
1976-01-00	652.9	17.1	200.9	3.9	101.8	.0	.0	101.8	9.1	110.9	10.	[illegible]	.0	0.	180.13	164.00	182.0
1976-02-00	753.1	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.88	164.00	182.
1976-03-00	814.1	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.19	164.00	182.0
1976-04-00	837.2	14.0	200.9	10.1	236.7	.0	.0	236.7	8.8	245.6	22.	233.	.0	0.	180.65	164.00	182.0
1976-05-00	795.4	17.4	181.4	10.7	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.12	164.00	182.
1976-06-00	832.4	25.0	200.9	6.8	703.2	.0	.0	703.2	8.8	712.0	22.	280.	.0	0.	168.35	164.00	182.0
1976-07-00	339.5	48.0	194.4	3.1	359.2	.0	.0	359.2	9.1	368.3	22.	357.	.0	0.	164.61	164.00	182.0
1976-08-00	210.5	62.9	200.9	3.0	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.29	164.00	182.
1976-09-00	337.3	58.5	194.4	3.3	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	171.13	164.00	182.0
1976		351.	2365.	62.	2552.	0.	0.	2552.	108.	2660.	174.	2219.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1976-10-00	430.2	39.9	200.9	3.4	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.95	164.00	182.

1976-11-00	398.3	22.6	200.9	2.4	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	173.89	164.00	182.0
1976-12-00	491.8	19.5	194.4	2.7	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.57	164.00	182.0
1977-01-00	648.4	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.07	164.00	182.0
1977-02-00	751.6	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.83	164.00	182.0
1977-03-00	809.6	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.13	164.00	182.0
1977-04-00	832.7	14.0	200.9	10.1	236.7	.0	.0	236.7	8.8	245.6	22.	238.	.0	0.	180.60	164.00	182.0
1977-05-00	791.9	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.06	164.00	182.0
1977-06-00	827.9	25.0	200.9	6.7	703.2	.0	.0	703.2	8.8	712.0	22.	281.	.0	0.	168.23	164.00	182.0
1977-07-00	335.0	48.0	194.4	3.1	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.48	164.00	182.0
1977-08-00	206.1	62.9	200.9	3.0	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.17	164.00	182.0
1977-09-00	333.0	58.5	194.4	3.3	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	170.97	164.00	182.0
1977		351.	2365.	61.	2552.	0.	0.	2552.	108.	2660.	173.	2221.	0.	0.			

VVVV-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1977-10-00	425.9	39.9	200.9	3.4	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.84	164.00	182.0
1977-11-00	394.1	22.6	200.9	2.3	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	173.57	164.00	182.0
1977-12-00	487.6	19.5	194.4	2.7	45.4	.0	.0	45.4	9.1	54.5	5.	55.	.0	0.	178.48	164.00	182.0
1978-01-00	644.2	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	180.02	164.00	182.0
1978-02-00	747.4	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.77	164.00	182.0
1978-03-00	805.4	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.07	164.00	182.0
1978-04-00	828.5	14.0	200.9	10.0	236.7	.0	.0	236.7	8.8	245.6	22.	238.	.0	0.	180.54	164.00	182.0
1978-05-00	787.8	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	181.01	164.00	182.0
1978-06-00	823.8	25.0	200.9	6.7	703.2	.0	.0	703.2	8.8	712.0	22.	281.	.0	0.	168.12	164.00	182.0
1978-07-00	331.0	48.0	194.4	3.1	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.36	164.00	182.0
1978-08-00	202.0	62.9	200.9	3.0	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	168.06	164.00	182.0
1978-09-00	329.0	58.5	194.4	3.2	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	170.82	164.00	182.0
1978		351.	2365.	61.	2552.	0.	0.	2552.	108.	2660.	173.	2222.	0.	0.			

VVVV-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_R
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1978-10-00	[illegible]	39.9	200.9	3.3	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.73	164.00	182.0

1978-12-00	483.7	19.5	194.4	2.7	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.41	164.00	182.0
1979-01-00	640.3	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.97	164.00	182.0
1979-02-00	743.5	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.72	164.00	182.0
1979-03-00	801.6	13.2	200.9	7.5	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	181.02	164.00	182.0
1979-04-00	824.7	14.0	200.9	10.0	236.7	.0	.0	236.7	8.8	245.6	22.	239.	.0	0.	180.49	164.00	182.0
1979-05-00	784.0	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.96	164.00	182.0
1979-06-00	820.0	25.0	200.9	6.7	703.2	.0	.0	703.2	8.8	712.0	22.	232.	.0	0.	168.02	164.00	182.0
1979-07-00	327.2	48.0	194.4	3.0	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.25	164.00	182.0
1979-08-00	198.3	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.96	164.00	182.0
1979-09-00	325.3	58.5	194.4	3.2	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	170.69	164.00	182.0
1979		351.	2365.	61.	2552.	0.	0.	2552.	105.	2660.	173.	2223.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1979-10-00	413.3	39.9	200.9	3.3	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.63	164.00	182.0
1979-11-00	386.5	22.6	200.9	2.3	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	173.01	164.00	182.0
1979-12-00	480.1	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.34	164.00	182.0
1980-01-00	636.8	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.92	164.00	182.0
1980-02-00	740.0	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.68	164.00	182.0
1980-03-00	798.1	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.98	164.00	182.0
1980-04-00	821.2	14.0	200.9	10.0	236.7	.0	.0	236.7	8.8	245.6	22.	239.	.0	0.	180.45	164.00	182.0
1980-05-00	780.5	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.92	164.00	182.0
1980-06-00	816.6	25.0	200.9	6.7	703.2	.0	.0	703.2	8.8	712.0	22.	233.	.0	0.	167.92	164.00	182.0
1980-07-00	323.8	48.0	194.4	3.0	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.15	164.00	182.0
1980-08-00	194.9	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.87	164.00	182.0
1980-09-00	321.9	58.5	194.4	3.2	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	170.56	164.00	182.0

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1979-10-00	418.3	39.9	200.9	3.3	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.63	164.00	182.0
1979-11-00	386.5	22.6	200.9	2.3	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	173.01	164.00	182.0
1979-12-00	480.1	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.34	164.00	182.0
1980-01-00	636.8	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.92	164.00	182.0
1980-02-00	740.0	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.68	164.00	182.0
1980-03-00	798.1	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.98	164.00	182.0
1980-04-00	821.2	14.0	200.9	10.0	236.7	.0	.0	236.7	8.8	245.6	22.	239.	.0	0.	180.45	164.00	182.0
1980-05-00	780.5	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.92	164.00	182.0
1980-06-00	816.6	25.0	200.9	6.7	703.2	.0	.0	703.2	8.8	712.0	22.	283.	.0	0.	167.92	164.00	182.0
1980-07-00	323.8	48.0	194.4	3.0	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.15	164.00	182.0
1980-08-00	194.9	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.87	164.00	182.0
1980-09-00	321.9	58.5	194.4	3.2	147.9	.0	.0	147.9	8.8	156.7	11.	157.	.0	0.	170.56	164.00	182.0
1980		351.	2365.	60.	2552.	0.	0.	2552.	108.	2660.	172.	2223.	0.	0.			

YYYY-Mn-Dd	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1980-10-00	415.0	39.9	200.9	3.3	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.54	164.00	182.0
1980-11-00	383.2	22.3	200.9	2.2	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	172.88	164.00	182.0
1980-12-00	476.8	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.27	164.00	182.0
1981-01-00	633.5	17.1	200.9	3.3	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.38	164.00	182.0
1981-02-00	736.7	13.1	194.4	4.7	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.63	164.00	182.0
1981-03-00	794.8	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.93	164.00	182.0
1981-04-00	817.9	14.0	200.9	10.0	236.7	.0	.0	236.7	8.8	245.6	22.	239.	.0	0.	180.41	164.00	182.0
1981-05-00	777.3	17.4	181.4	10.6	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.87	164.00	182.0
1981-06-00	813.3	25.0	200.9	6.6	703.2	.0	.0	703.2	8.8	712.0	22.	283.	.0	0.	167.83	164.00	182.0
1981-07-00	320.6	48.0	194.4	3.0	359.2	.0	.0	359.2	9.1	368.3	22.	368.	.0	0.	164.05	164.00	182.0
1981-08-00	191.7	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.78	164.00	182.0
1981-09-00	318.8	58.5	194.4	3.1	147.9	.0	.0	147.9	8.8	156.7	10.	157.	.0	0.	170.44	164.00	182.0
1981		351.	2365.	60.	2552.	0.	0.	2552.	108.	2660.	172.	2224.	0.	0.			

YYYY-Mn-D ℓ	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1981-10-0 0	411.8	39.9	200.9	3.2	260.2	.0	.0	260.2	9.1	269.3	19.	269.	.0	0.	169.46	164.00	182.0
1981-11-0 0	380.1	22.6	200.9	2.2	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	172.76	164.00	182.0
1981-12-0 0	473.7	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.21	164.00	182.0
1982-01-0 0	630.4	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.84	164.00	182.0
1982-02-0 0	733.6	13.1	194.4	4.6	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.59	164.00	182.0
1982-03-0 0	791.8	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.89	164.00	182.0
1982-04-0 0	814.9	14.0	43.7	9.3	236.7	.0	.0	236.7	8.8	245.6	22.	246.	.0	0.	177.95	164.00	182.0
1982-05-0 0	617.7	17.4	181.4	9.4	143.1	.0	.0	143.1	9.1	152.3	13.	152.	.0	0.	178.70	164.00	182.0
1982-06-0 0	654.9	25.0	200.9	5.5	703.2	.0	.0	676.5	8.8	685.31	22.	310.	.0	0.	164.00	164.00	182.0
1982-07-0 0	190.0	48.0	194.4	2.4	359.2	.0	.0	230.9	9.1	240.10	13.	240.	.0	0.	164.00	164.00	182.0
1982-08-0 0	190.0	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.74	164.00	182.0
1982-09-0 0	317.1	58.5	194.4	3.1	147.9	.0	.0	147.9	8.8	156.7	10.	157.	.0	0.	170.38	164.00	182.0
1982		351.	2208.	56.	2552.	0.	0.	2397.	108.	2505.	162.	2130.	0.	0.			

YYYY-Mn-D ℓ	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	PW-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1982-10-0 0	410.1	39.9	200.9	3.2	260.2	.0	.0	260.2	9.1	269.3	18.	269.	.0	0.	169.41	164.00	182.0
1982-11-0 0	378.4	22.6	200.9	2.2	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	172.70	164.00	182.0
1982-12-0 0	472.0	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.17	164.00	182.0
1983-01-0 0	628.7	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.82	164.00	182.0
1983-02-0 0	732.0	13.1	194.4	4.6	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.57	164.00	182.0
1983-03-0 0	790.1	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.87	164.00	182.0
1983-04-0 0	813.2	14.0	200.9	9.9	236.7	.0	.0	236.7	8.8	245.6	22.	240.	.0	0.	180.35	164.00	182.0

1983-05-00	772.6	17.4	181.4	10.5	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.81	164.00	182.0
1983-06-00	808.7	25.0	200.9	6.6	703.2	.0	.0	703.2	8.8	712.0	22.	284.	.0	0.	167.71	164.00	182.
1983-07-00	316.0	48.0	194.4	3.0	359.2	.0	.0	356.3	9.1	365.4I	22.	365.	.0	0.	164.00	164.00	182.0
1983-08-00	190.0	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.74	164.00	182.0
1983-09-00	317.1	58.5	194.4	3.1	147.9	.0	.0	147.9	8.8	156.7	10.	157.	.0	0.	170.38	164.00	182.
1983		351.	2365.	60.	2552.	0.	0.	2549.	108.	2657.	171.	2223.	0.	0.			

YYYY-Mn-D	Ini_Sto	Loc_Flo	Us_Flo	Evapr	Tir_Dem	Pw_Dem	Tds_Dem	Ir_Rel	Ws_Rel	Tot_Rel	PW_Gen	Pw-Rel	Lin_Dv	Spill	End_Lev	Mdl_Rul	Upr_Ru
	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	m m3	Mkwh	m m3	m m3	m m3	m	m	m
1983-10-00	410.1	39.9	200.9	3.2	260.2	.0	.0	260.2	9.1	269.3	15.	269.	.0	0.	169.41	164.00	182.0
1983-11-00	378.4	22.6	200.9	2.2	118.9	.0	.0	118.9	8.8	127.7	9.	128.	.0	0.	172.70	164.00	182.
1983-12-00	472.0	19.5	194.4	2.6	45.4	.0	.0	45.4	9.1	54.5	4.	55.	.0	0.	178.17	164.00	182.0
1984-01-00	528.7	17.1	200.9	3.8	101.8	.0	.0	101.8	9.1	110.9	10.	111.	.0	0.	179.82	164.00	182.0
1984-02-00	722.0	13.1	194.4	4.6	136.3	.0	.0	136.3	8.5	144.8	13.	145.	.0	0.	180.57	164.00	182.
1984-03-00	790.1	13.2	200.9	7.4	174.4	.0	.0	174.4	9.1	183.6	17.	184.	.0	0.	180.87	164.00	182.0
1984-04-00	813.2	14.0	200.9	9.9	236.7	.0	.0	236.7	8.8	245.6	22.	240.	.0	0.	180.35	164.00	182.0
1984-05-00	772.6	17.4	181.4	10.5	143.1	.0	.0	143.1	9.1	152.3	14.	152.	.0	0.	180.81	164.00	182.0
1984-06-00	808.7	25.0	200.9	6.6	703.2	.0	.0	703.2	8.8	712.0	22.	284.	.0	0.	167.71	164.00	182.0
1984-07-00	316.0	48.0	194.4	3.0	359.2	.0	.0	356.3	9.1	365.4I	22.	365.	.0	0.	164.00	164.00	182.0
1984-08-00	190.0	62.9	200.9	2.9	124.8	.0	.0	124.8	9.1	133.9	8.	134.	.0	0.	167.74	164.00	182.0
1984-09-00	317.1	58.5	194.4	3.1	147.9	.0	.0	147.9	8.8	156.7	10.	157.	.0	0.	170.38	164.00	182.
1984		351.	2365.	60.	2552.	0.	0.	2549.	108.	2657.	171.	2223.	0.	0,			182.0

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 4, Time and Vol. Reliability = .981 .997

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .833

Resi. for WS, Irr, Pow: .000 .750 .000
Vul. for WS, Irr, Pow: .000 .090 .000

VI alternative

Monthly simulation of Sunkosi and Kamala Reservoir Opera

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1966 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir

A link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28650.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24235.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2208.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	28790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Reli. for WS. Irr. Pow: .000 .000 .000
Vul. for WS. Irr. Pow: .000 .000 .000

VI

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir
This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)
9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

yyyy	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	Pw-Rel m m3	Lin_Dv m m3	Spill m m3
1967	351.	2365.	79.	2581.	0.	0.	2581.	108.	2973.	239.	2644.	0.	0.
1968	351.	2365.	70.	2581.	0.	0.	2581.	108.	2688.	205.	2427.	0.	0.
1969	351.	2365.	65.	2581.	0.	0.	2581.	108.	2688.	202.	2455.	0.	0.
1970	351.	2365.	60.	2581.	0.	0.	2581.	108.	2688.	199.	2504.	0.	0.
1971	351.	2365.	57.	2581.	0.	0.	2581.	108.	2688.	196.	2530.	0.	0.
1972	351.	2365.	54.	2581.	0.	0.	2581.	108.	2688.	192.	2553.	0.	0.
1973	351.	2365.	51.	2581.	0.	0.	2581.	108.	2688.	189.	2569.	0.	0.
1974	351.	2365.	48.	2581.	0.	0.	2581.	108.	2688.	185.	2576.	0.	0.
1975	351.	2365.	46.	2581.	0.	0.	2581.	108.	2688.	182.	2580.	0.	0.
1976	351.	2365.	45.	2581.	0.	0.	2581.	108.	2688.	180.	2584.	0.	0.
1977	351.	2365.	43.	2581.	0.	0.	2581.	108.	2688.	177.	2587.	0.	0.
1978	351.	2365.	42.	2581.	0.	0.	2581.	108.	2688.	175.	2591.	0.	0.
1979	351.	2365.	40.	2581.	0.	0.	2581.	108.	2688.	174.	2594.	0.	0.
1980	351.	2365.	39.	2581.	0.	0.	2581.	108.	2688.	172.	2596.	0.	0.
1981	351.	2365.	39.	2581.	0.	0.	2571.	108.	2678.	171.	2587.	0.	0.
1982	351.	2208.	35.	2581.	0.	0.	2430.	108.	2538.	156.	2467.	0.	0.
1983	351.	2365.	39.	2581.	0.	0.	2557.	108.	2665.	170.	2573.	0.	0.
1984	351.	2365.	39.	2581.	0.	0.	2570.	108.	2677.	171.	2586.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 6, Time and Vol. Reliability = .972 .996

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .778

Resi. for WS, Irr, Pow: .000 .833 .000
Vul. for WS, Irr, Pow: .000 .104 .000

VI alternative

Monthly simulation of Sunkosi and Kamala Reservoir Opera

Location No. 1, Sunkosi Reservoir
Max. Storage = .225E+08 Cubic m,
Dead Storage = .750E+07 Cubic m,
Initial Storage = .225E+08 Cubic m
Installed Capacity of Power Plant = 69.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 1

.076 .088 .137 .185 .197 .174 .168 .162 .133 .129 .080 .066

Location No. 2, Kamala Reservoir
Max. Storage = .900E+09 Cubic m,
Dead Storage = .190E+09 Cubic m,
Initial Storage = .900E+09 Cubic m
Installed Capacity of Power Plant = 31.0 MW
Multiplication factor for inflows = .100E+07
Evaporation depths (m/month) at node 2

.076 .088 .137 .185 .196 .175 .168 .162 .133 .129 .080 .066

System Operation Simulated for 216 Months, Beginning 1965 10

RESULTS FOR LOCATION NO. 1 - Sunkosi Reservoir
A Link diverts water from this node
Water supply demands at this node (m m3)
.00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
Link demands at this node (m m3)
200.88 194.40 200.88 200.88 181.44 200.88 194.40 200.88 194.40 200.88 200.88 194.40

YYYY	Loc_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	PW-Rel m m3	Lin_Dv m m3	Spill m m3
1967	19379.	4.	.0	0.	0.	.0	0.	2041.	585.	2041.	2365.	14969.
1968	25478.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21031.
1969	25349.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20902.
1970	27343.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	22895.
1971	28823.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24376.
1972	22898.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	18450.
1973	25234.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	20786.
1974	27019.	4.	.0	0.	0.	.0	0.	2060.	591.	2060.	2365.	22590.
1975	27179.	4.	.0	0.	0.	.0	0.	2076.	596.	2076.	2365.	22733.
1976	29223.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24775.
1977	24844.	4.	.0	0.	0.	.0	0.	2057.	590.	2057.	2365.	20418.
1978	30469.	4.	.0	0.	0.	.0	0.	1974.	566.	1974.	2365.	26126.
1979	28680.	4.	.0	0.	0.	.0	0.	2074.	595.	2074.	2365.	24238.
1980	32151.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	27704.
1981	26097.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	21649.
1982	18181.	4.	.0	0.	0.	.0	0.	1912.	546.	1912.	2205.	14058.
1983	26587.	4.	.0	0.	0.	.0	0.	2076.	595.	2076.	2365.	22142.
1984	25790.	4.	.0	0.	0.	.0	0.	2078.	596.	2078.	2365.	24343.

Link time and vol. reliabilities = .995 .996

Rel. for WS. Irr. Pow: .000 .000 .000
Vol. for WS. Irr. Pow: .000 .000 .000

VI

RESULTS FOR LOCATION NO. 2 - Kamala Reservoir

This node receives water through a link from node 1
The percentage loss during transmission is .00%
Water supply demands at this node (m m3)

9.11 8.52 9.11 8.81 9.11 8.81 9.11 9.11 8.81 9.11 8.81 9.11

YYYY	Loc_Flo m m3	Us_Flo m m3	Evapr m m3	Tir_Dem m m3	Pw_Dem m m3	Tds_Dem m m3	Ir_Rel m m3	Ws_Rel m m3	Tot_Rel m m3	Pw_Gen Mkwh	Pw-Rel m m3	Lin_Dv m m3	Spill m m3
1967	351.	2365.	79.	2581.	0.	0.	2581.	108.	2973.	239.	2644.	0.	0.
1968	351.	2365.	70.	2581.	0.	0.	2581.	108.	2688.	205.	2427.	0.	0.
1969	351.	2365.	65.	2581.	0.	0.	2581.	108.	2688.	202.	2455.	0.	0.
1970	351.	2365.	60.	2581.	0.	0.	2581.	108.	2688.	199.	2504.	0.	0.
1971	351.	2365.	57.	2581.	0.	0.	2581.	108.	2688.	196.	2530.	0.	0.
1972	351.	2365.	54.	2581.	0.	0.	2581.	108.	2688.	192.	2553.	0.	0.
1973	351.	2365.	51.	2581.	0.	0.	2581.	108.	2688.	189.	2569.	0.	0.
1974	351.	2365.	48.	2581.	0.	0.	2581.	108.	2688.	185.	2576.	0.	0.
1975	351.	2365.	46.	2581.	0.	0.	2581.	108.	2688.	182.	2580.	0.	0.
1976	351.	2365.	45.	2581.	0.	0.	2581.	108.	2688.	180.	2584.	0.	0.
1977	351.	2365.	43.	2581.	0.	0.	2581.	108.	2688.	177.	2587.	0.	0.
1978	351.	2365.	42.	2581.	0.	0.	2581.	108.	2688.	175.	2591.	0.	0.
1979	351.	2365.	40.	2581.	0.	0.	2581.	108.	2688.	174.	2594.	0.	0.
1980	351.	2365.	39.	2581.	0.	0.	2581.	108.	2688.	172.	2596.	0.	0.
1981	351.	2365.	39.	2581.	0.	0.	2571.	108.	2678.	171.	2587.	0.	0.
1982	351.	2208.	35.	2581.	0.	0.	2430.	108.	2538.	156.	2467.	0.	0.
1983	351.	2365.	39.	2581.	0.	0.	2557.	108.	2665.	170.	2573.	0.	0.
1984	351.	2365.	39.	2581.	0.	0.	2570.	108.	2677.	171.	2586.	0.	0.

Number of Failures for WS. = 0, Time and Vol. Reliability = 1.000 1.000

Number of Failures for Irr. = 6, Time and Vol. Reliability = .972 .996

Number of Critical (Release < .75 * Demand) Irrigation Failures = 1
Annual Irrigation Reliability = .778

Resi. for WS, Irr, Pow: .000 .833 .000
Vul. for WS, Irr, Pow: .000 .104 .000