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SIMULATION OF OPERATION OF VELLAR SYSTEM USING HEC - 5

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PREFACE

The efficient use of water resources is emphasized to meet the increasing conservation demands. Systems analysis has proved to be a important tool to derive operation policies for meeting the demands to the maximum possible extent. In India, it is imperative to utilize the available water resources in optimal way to overcome the vagaries of weather. Detailed guidelines are formulated to manage the reservoir in allocating the available water among multiple users to reduce the water shortages and flooding and to achieve optimum benefits. The integrated operation of a complex system is necessary for efficient management of the limited resources to meet various target demands. System analysis techniques have been used in the policy development for several reservoir operations.

The present study deals with the simulation operation of Vellar river basin, an important basin in Tamilnadu. In this study the generalized program *Simulation of Flood Control and Conservation Systems*, also known as HEC-5 has been used for simulation purposes. The data used for this study have been taken from the report of "System Studies of Vellar Basin, Tamilnadu", prepared by Central Water Commission (1991). Detailed simulation studies of the system has been carried out using different index levels in two major reservoirs of the system namely Manimukta and Gomukhi. The results of the simulation studies has been discussed in the study.

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(S. M. SETH)
DIRECTOR

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ABSTRACT

The program *Simulation of Flood Control and Conservation Systems* developed by the Hydrologic Engineering Center, USA and used in the present study, is a generalized software available for simulation of the operation of water resources systems. Also known as HEC-5, the program has been developed for simulation of operation of a system of reservoirs and diversions, being operated for flood control and conservation purposes such as water supply, irrigation, hydroelectric power generation, navigation and low flow augmentation. The program is useful in planning studies for evaluating proposed reservoirs and to assist in sizing the flood control and conservation storage requirements for each project. The program is also useful in selecting the proper reservoir releases throughout the system during the flood emergencies.

In the present study, the operation part of the Vellar river basin has been studied. The Vellar river basin is an important basin in Tamilnadu, a state of South India. The major reservoirs and regulators in the selected basin are the Manimukta reservoir, the Gomukhi reservoir and the Memathur regulator. A number of minor tanks & regulators are also available in the basin. The data used for this study have been taken from the report of "System Studies of Vellar Basin, Tamilnadu", prepared by Central Water Commission (1991). Because of lack of data, suitable assumptions regarding mandatory releases, municipal and industrial demands, irrigation return flows and capacity of equivalent tanks have been made. Detailed simulation studies of the system has been carried out using different index levels in two major reservoirs of the system, namely, Manimukta and Gomukhi.

The results of the simulation studies have been discussed in detail in the study. In general, it is found that water is not sufficiently available in the basin. Manimukta reservoir part of the basin has adequate reliability while Gomukhi reservoir part has significant deficits. Some conservation measures need to be adopted in Gomukhi reservoir part of the basin for efficient utilization of water resources.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

India is bestowed with rich water resources but more than 80% of the rainfall over this country falls in four monsoon months from June to September. Because of high time and spatial variability of rainfall, a number of dams have been constructed all over the country to tap the available water resources so that this water can be provided to the users in accordance with their requirements.

Depending upon the magnitude of natural inflows and demands at a particular time, water is either stored in the reservoir or supplied from the storage. As a result of storing water, a reservoir provides head of water which can be used for generation of hydroelectric power. In case of flood control projects, it provides empty storage space for storage of water thereby attenuating the hydrograph peaks. A reservoir also provides pool for navigation to negotiate rapids, habitat for aqua life and facilities for recreation and sports. It enhances scenic beauty, promotes afforestation and wild life.

The reservoirs are commonly built in India for conservation and flood control purposes. The conservation demands like irrigation, water supply and hydropower etc. are best served when the reservoir is as much full as possible at the end of the filling period. The flood control purposes, on the other hand, require empty storage space so that the incoming floods can be absorbed and moderated to permissible limits. The conflict between the two purposes is resolved through proper operation of reservoirs.

For the efficient use of water resource, proper management of the reservoirs is required. Reservoir operation forms a very important part of planning and management of water resources system. After a reservoir has been constructed, much of the benefits reaped, to a large extent, depend on how well it is operated. Detailed guidelines in the form of "Reservoir Operation Policy" will have to be given to the operator to enable him to take decision about storing or releasing water. A reservoir operation policy specifies the amount of water to be released from the storage at any time depending upon the state of the reservoir, level of demands and any information about the likely inflow in the reservoir.

A reservoir is operated according to a set of rules of guidelines for storing and releasing water depending upon the purposes it is required to serve. The decisions regarding releases are made in different time periods in accordance with the demands. The operation policy of reservoirs designed and operated for seasonal storage is based on yearly operation. For reservoirs which are designed for multiannual storage, the operation policy is based on long term targets. The reservoir can be operated using different policies such as, Standard linear operating policy, rule curves, concept of storage zoning, and system engineering techniques i.e. simulation and optimization.

1.1 PURPOSE AND SCOPE OF THIS REPORT

The present report describes the results of a system operation study of the operation of a part of the Vellar basin. This river basin is an important basin in Tamilnadu, a state in south India. Tamilnadu with an area of 1,30,057 sq. km. and a population of 56.60 million (1991 census) has exploited more than 95% of its surface water resources. The state has also utilized more than 60% of its ground water resources. Cauvery, Vaigai, Palar, Ponnaiyar, Vellar, Tambaraparani and Kodayar are the main rivers in Tamilnadu state.

The Vellar river basin can be divided in two distinct sub-basins. There is no exchange of surface water between the two sub-basins and hence the operation of the reservoirs and diversions of these two sub-basins can be studied separately. In the present work, the operation of reservoir system of one sub-basin has been studied.

A number of generalized software are available for simulation of the operation of a water resources system. The HEC-5 program which is a well-known simulation programs, was used in the present study. The HEC-5 program was developed at The Hydrologic Engineering Centre of US Army Corps of Engineers. The data used for this study have been taken from the "Report of System Studies of Vellar Basin, Tamilnadu", prepared by Central Water Commission (1991). The results of the simulation has been discussed in details in this report.

CHAPTER 2

DESCRIPTION OF VELLAR BASIN

2.0 BASIN DESCRIPTION

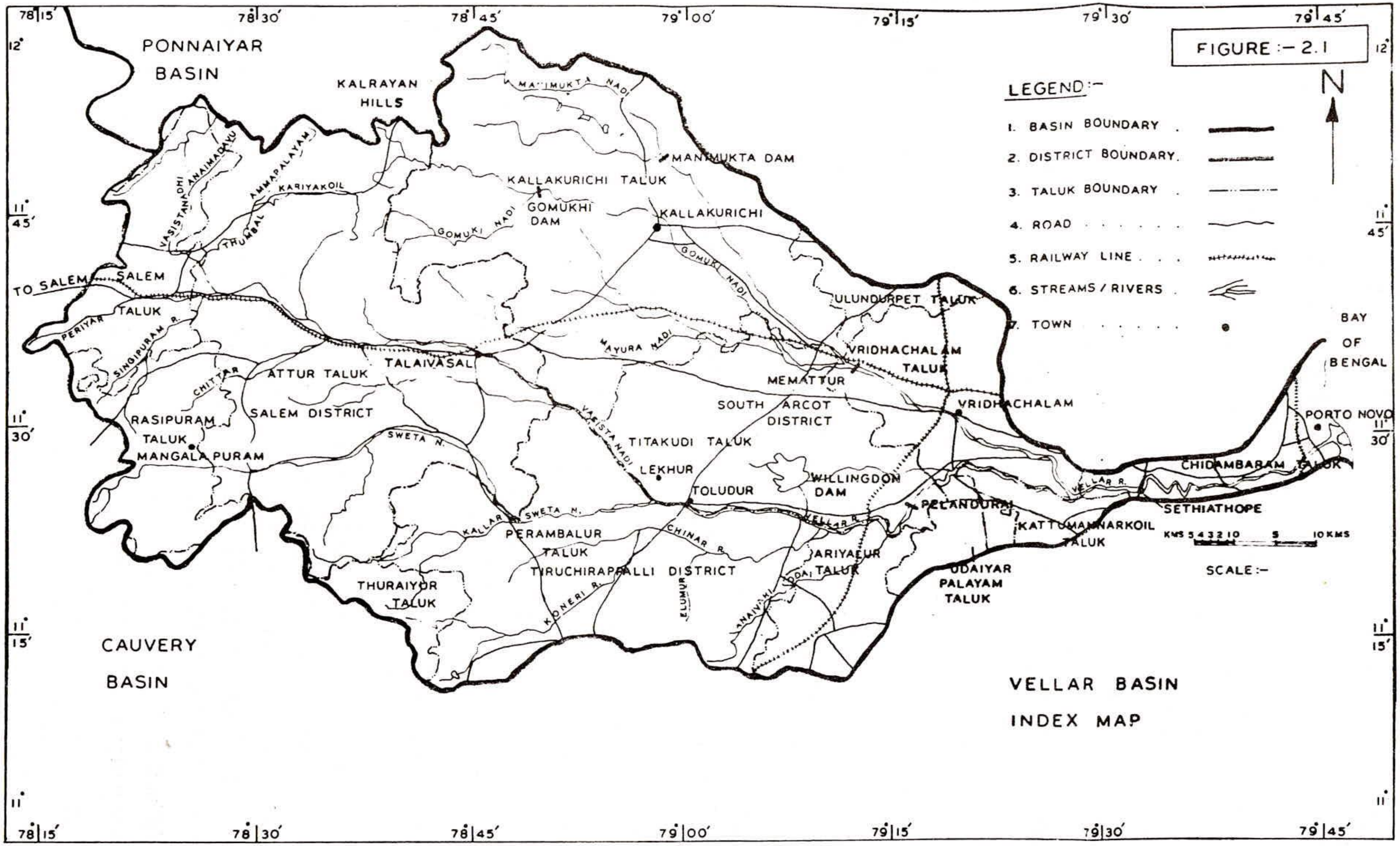
2.1 VELLAR BASIN

The Vellar river is an important river of Tamilnadu. The Vellar river basin is situated between latitude 11°13' north and 12°00' north and longitude 78°13' east and 79°47' east. The basin lies in between Ponnaiyar river in the north and Cauvery river in the south. The total catchment area of the basin is 7,659 sq. km.

The Vellar river flows through the Dharamapuri (a small portion), Salem, Trichirapalli, Villupuram Ramasamy padayachiar and South Arcot districts of Tamilnadu. The river originates from the southern slopes of Kalrayam hills, at the northern boundary of Attur Taluk of Salem district. In the initial reaches, the river is known as Ammapalayam and it flows in a south west direction for about 21 km until another tributary Kariyakoil joins it. Thereafter, the river attains its name as Thumbal and continues to flow in the south-west direction till the tributary Vasistanadi joins it on the right bank. The Vasistanadi in its headwater reaches is known as Anaimadavu. It generally flows towards south direction and meets Thumbal on its right bank. After this confluence, the river flows in a south-east direction and attains the name Vasistanadi. It crosses the Salem Kallakurchi road near Talaivasal, at about 69 km from its origin. The river continues to flow in the south easterly direction for a further distance of about 28 km and meets the Swetanadi. The river then takes an easterly direction and crosses the Trichi-Madras Trunk road over Toludur regulator located at 4 km downstream of the confluence with Swetanadi.

After the confluence of Swetanadi, the river attains its name Vellar. The river in its further course receives the tributaries Chinar and Anaivari Odai on its right bank. From the point of infall of Anaivari Odai, the river takes a north direction, flows for about 13 km, then takes south-east direction and flows for another 15 km up to the infall of the Manimukta nadi on its left bank. The river then flows in an easterly direction, crosses the Kumbakonam Villipuram road through Sethiathope regulator and finally empties into the Bay of Bengal near Portonovo in the Chidambarm Taluk of South Arcot district. The index map of the river basin is given in Figure 2.1.

FIGURE :- 2.1



VELLAR BASIN
INDEX MAP

The tributaries of Vellar river system are briefly described as follows.

2.1.1 Vasistanadi

The Vasistanadi originates from the southern slopes of the Kalrayan hills at the northern boundary of Attur Taluk of Salem district, at an elevation of 1,266 m above MSL. In the initial reach, the river is known as Anaimadavu and it flows southwards for about 23 km and then south eastwards. The Anaimadavu Reservoir was constructed in the year 1989 on this river. At a distance of 3 km below this dam, the Thumbal (also known as Kariyakoil) river joins Vasistanadi on the left bank. Another project called Kariyakoil reservoir has been completed on this river in the year 1989. After the confluence of Thumbal with Vasistanadi, it flows in south easterly direction and during its course of flow, receives many small tributaries such as Periyar, Singipuram, Kallar, Chittar etc. It then joins the river Swetanadi. The total length and catchment area of Vasistanadi up to its confluence with Swetanadi are 113 km and 1,744 sq km respectively.

2.1.2 Swetanadi

The Swetanadi originates from the Kohli hills in the Rasipuram Taluk of Salem district, at an elevation of about 1,420 m above MSL. It flows in an easterly direction for about 80 km before joining Vasistanadi at about 4 km upstream of Toludur regulator. Kallar is an important tributary of Swetanadi, which joins it on the right margin after traversing a distance of about 47 km. The total catchment area of Swetanadi up to its confluence with Vasistanadi is 1,063 sq km. After the confluence of Swetanadi and Vasistanadi, at about 4 km upstream of Toludur regulator, the river is known as Vellar.

2.1.3 Gomukhi river

The Gomukhi river originates from the eastern slopes of the Kalrayan hills in Kallkurchi Taluk at an altitude of 1,300 m above MSL. A reservoir, known as Gomukhi reservoir was completed in the year 1965, by construction of a dam across Gomukhi river, about 16 km north west of Kallakurchi town. The Mayuranadi, originating from Kalrayan hills and having a length of about 38 km up to its confluence with Gomukhi, is the main tributary of Gomukhi. It joins Gomukhi on the right flank at about 44 km downstream of Gomukhi dam. The Gomukhi joins Manimukta nadi at about 8 km below the confluence of Mayuranadi with Gomukhi. The total catchment area of Gomukhi is 1,162 sq km.

2.1.4 Manimukta Nadi

The Manimukta nadi originates in the eastern slopes of the Kalrayan hills in Kallakurchi Taluk of South Arcot district, at an elevation of about 1,000 m above MSL. the river is formed by two tributaries, namely Mani and Mukta. The Mani river flows for about 40 km and Mukta river for about 32 km before joining to form Manimukta nadi. About 5 km below the confluence of Mani and Mukta rivers and 6 km upstream of Kallakurchi town, Manimukta dam is existing. This dam was completed in the year 1970. Below the Manimukta dam, the river flows in a south easterly direction for about 52 km, till the Gomukhi river joins it on the right flank.

The Memathur regulator, constructed in the year 1873, is located across the Manimukta nadi at 5 km downstream of the confluence of Gomukhi and about 14 km north west of Vridhachalam town. Below Memathur regulator, the river flows in a south westerly direction, until the stream Periya Odai joins it on its right margin. Periya Odai originates from north-east of Toludur regulator and flows for a length of about 66 km before joining Manimukta nadi. On Periya Odai, a reservoir known as Willingdon reservoir was constructed in the year 1923. This reservoir also receives a part of the flows from Vellar, through a supply channel taking off from Toludur regulator.

The Vridhachalam regulator is existing on Manimukta nadi at about 2 km from the confluence of Periya Odai and about 8 km east of Vridhachalam town. This regulator was constructed around 1890. After Vridhachalam regulator, the river continues to flow in the south-easterly direction for a distance of about 8 km before joining river Vellar on its left margin. About 9 km below the confluence of Manimukha with Vellar, Sethiathope regulator, constructed in 1847-48 is located. The total catchment area of Manimukta nadi is 2,777 sq. km.

2.1.5 Chinar river

The Chinar river originates from the Pachaimalai hills in the Musiri Taluk of Trichinapally district. The river runs for a distance of about 46 km before joining Vellar on its right flank, about 24 km below Toludur regulator. The river is joined by two streams, namely Koneri Odai and Elumur Odai. The total catchment area of the river is 569 sq. km.

2.1.6 Anaivari Odai

The Anaivari Odai originates in Perambalur Taluk of Trichinapally district. It joins the main Vellar river on its right flank, at about 10 km below the confluence of Chinar river. It drains a total area of 301 sq. km. About 5 km downstream of its confluence with the Vellar, the Pelandurai regulator is existing, which was constructed across the Vellar around 1876.

2.2 CLIMATE OF THE BASIN

The Vellar basin experiences tropical monsoon climate, with not much variation in temperature, humidity and evaporation throughout the year. The temperature is generally high during the months of April, May and June. During summer months, the daily temperature is reported to reach a maximum of 40° C, whereas in winter months the minimum temperature goes down to about 20° C. The monsoon season in the basin is from June to December and non-monsoon season from January to May. The monsoon period is influenced by the south-west monsoon in the months from June to September and north-east monsoon during the months from October to December. The north-east monsoon is more predominant in the basin. During the monsoon period, significant rainfall and consequent stream flow occurs in the river basin, hence this period is hydrologically important.

The non-monsoon period, obviously, experiences considerably less rainfall. This period can be broadly divided into winter period from January to February and hot weather period or summer from March to May. As the non-monsoon period has considerably less rainfall, this period is hydrologically less significant.

The mean annual rainfall in the basin varies from 825 mm to 1390 mm. The rainfall in the basin increases from west to east, with higher rainfall experienced near the sea coast. Nearly 60% of the basin gets an average rainfall of less than 1000 mm.

2.3 SYSTEM DECOMPOSITION

A number of reservoir and diversion structures are located in the Vellar sub-basin. The composite modelling of the entire system will be a complex task. To reduce the problem to a reasonable size, the system can be decomposed into the following two sub-basins.

i. Sub-basin I : Catchment of Manimukta nadi up to the confluence of Periya Odai.

ii. Sub-basin II : Remaining catchment of Vellar, comprising the main arm of the river.

The above two sub-basins are independent sub-systems and the interaction between them is only in the form of flow of water at the junction point. Due to this interaction between the two sub-basins, the optimal operation of the sub-basins will be the same as the optimal operation of the whole system.

In the present study, the modelling of sub-basin I has been taken up. The catchment area map of the sub-basin I, namely Manimukta sub-basin, is given in Figure 2.2.

2.4 MAJOR IRRIGATION PROJECTS

In the Vellar basin five major irrigation reservoirs and five major regulators are existing. Out of these reservoirs and regulators Manimukta and Gomukhi Reservoirs and Memathur regulator are lying in sub-basin I and hence have been taken for the study. There is also a proposal to construct an hydroelectric project in the basin upstream of Gomukhi reservoir. However, its location and salient features are yet to be decided. As no information on this project was available, the same has not been considered for the simulation study. The details of these major reservoirs and regulator are given below.

2.4.1 Manimukta Reservoir

The Manimukta reservoir is formed across Manimukta tributary at about 5 km below the confluence of Mani and Mukta sub-tributaries and about 6 km from Kallakurichi Town. The dam was completed in the year 1970. It has a catchment area of 484 sq km. The live storage capacity of the reservoir is 19.89 M cum and irrigates an area of 1719.98 ha. The salient features of the reservoir are presented in Annexure 1.

2.4.2 Gomukhi Reservoir

The Gomukhi reservoir is located on the Gomukhi tributary of Vellar river, at about 16 km to the north-west of Kallakurichi Town. The reservoir was completed in the year 1965. It has a catchment area of 293 sq. km. The live storage capacity of the reservoir is 15.86 M cum and it irrigates an area of 2,023.43 ha. The salient features of the reservoir are presented in Annexure 2.

2.4.3 Memathur Regulator

The Memathur regulator exists across Manimukta nadi at about 5 km below the confluence of Gomukhi and about 14 km north west of Vridhachalam town. It was constructed during the year 1873. The total catchment area of the regulator is 1683.50 sq km. It irrigates an area of 2419.47 ha. The salient features of the Memathur regulator are presented in Annexure 3.

2.4.4 Minor Tanks and Regulators

In addition to the major reservoirs and regulators, about 386 minor tanks and 215 minor regulators (anicuts) are also either existing or proposed in the basin. Out of these 386 tanks and 215 anicuts, 214 tanks and 63 anicuts are lying in sub-basin I and have been considered for the study. These anicuts are located on various tributaries of the Vellar river and the tanks in the catchments of the anicuts.

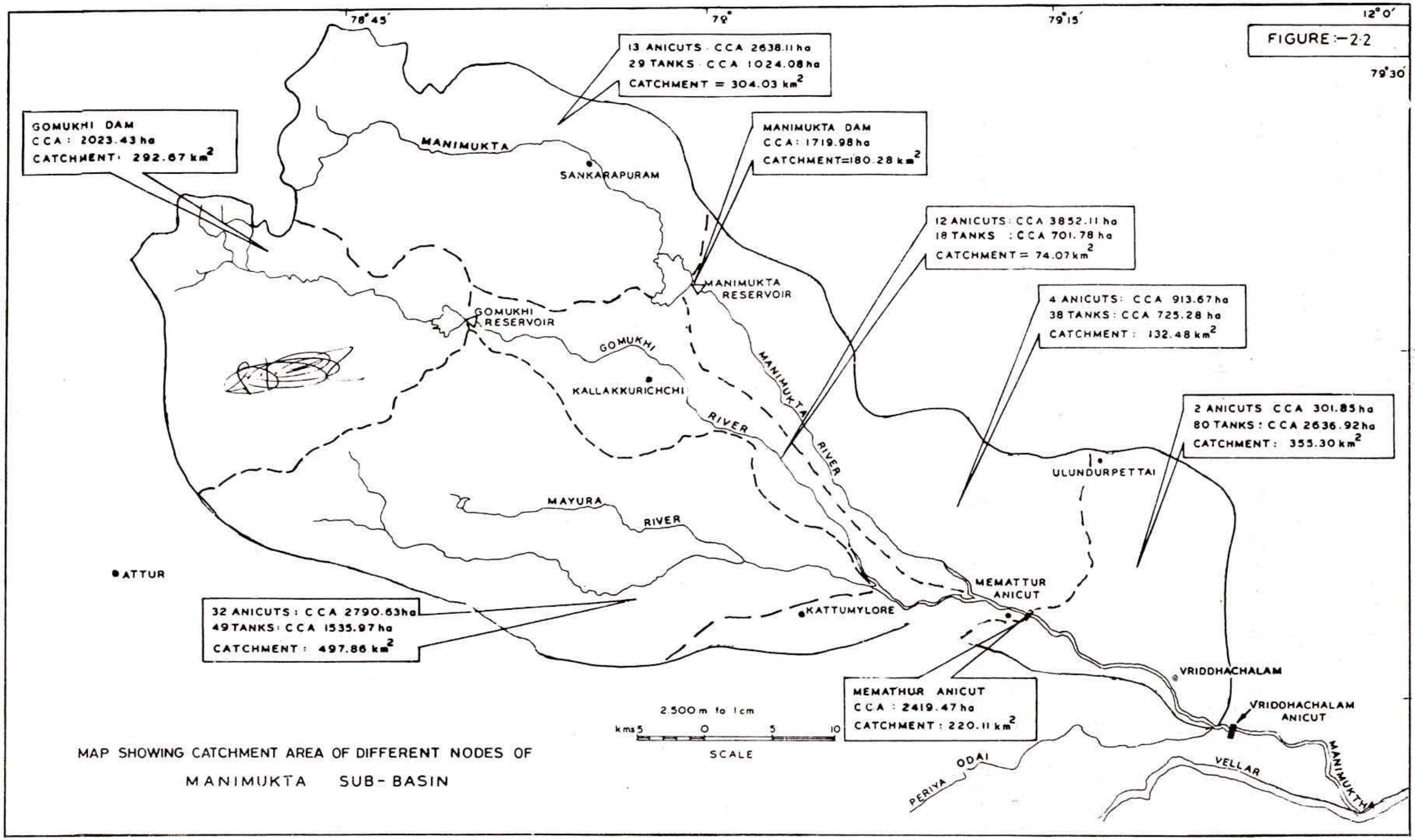


FIGURE :– 2.2

MAP SHOWING CATCHMENT AREA OF DIFFERENT NODES OF MANIMUKTA SUB-BASIN

Tanks are age old system of irrigation in the basin which evolved to suit the topographical conditions and distribution of rainfall. A tank is a very small reservoir formed behind an earthen embankment. Tanks are classified as system and non-system tanks based on the source of inflow into these tanks. Tanks which receives runoff solely from the rainfall in their catchment are called non-system tanks. Those which receive inflow from rivers, reservoirs etc., in addition to rainfall in their catchment are system tanks. Only system tanks which forms a part of the Vellar river system have been considered in the present studies.

As it is practically impossible to represent all the 277 tanks and anicuts as individual irrigation nodes in the system model, the tanks were grouped to form 10 nos. of equivalent reservoirs and anicuts to form 9 nos. of equivalent regulators, see CWC(1991). These groupings were done according to the location of tanks and anicuts on various tributaries. The further information on these projects, as well as their locations, are not available.

CHAPTER 3

DATA AND METHODOLOGY

3.0 DATA USED FOR THE STUDY

The requirement of data for simulation of a river system like Vellar, irrespective of the objective of the study, are quite extensive and diverse. In the present study, the data pertaining to the Vellar system were taken from the report by the Central Water Commission(1991). Due to limitations of available information and time, no seperate analysis of the various tanks in the catchment was carried out. The data used for the study are described below.

There is no gauge and discharge site in the basin. The discharges are, however, estimated based on the observed gauges using hydraulic formulae at various projects and control structures. The data comprise of outflows and inflows at various projects. The inflow data for a period of 20 years, from June 1969 to May 1989, have been used. The inflow data have been used for the nodes: (1) Equivalent to 29 tanks, (2) Manimukta reservoir, (3) Equivalent to 38 tanks, (4) Gomukhi reservoir, (5) Equivalent to 18 tanks, (6) Equivalent to 49 tanks, (7) Equivalent to 80 tanks, and (8) Memathur Regulator. The locations of the projects are given in Fig 2.2. The inflow data for the above nodes have been given in table 1-8 respectively. It may be mentioned that the inflow data series for a longer duration would have been better for the study.

In the Vellar basin, paddy is the main crop and the surface water demand is mainly for irrigation purpose only. The domestic, livestock and industrial demands are indicated to be met from ground water. There is no demand for hydel power generation and thermal power generation, as no power projects exist in the basin. There is no concrete proposal for construction of any hydel project. Requirement of water for maintaining the minimum flow in the river is also not imposed. Certain mandatory releases for meeting the demands of old irrigation systems in the basin are stipulated, as per the Rules of Regulations of Manimukta and Gomukhi reservoirs. Thus the surface water requirements considered for system studies are for (a) irrigation and (b) mandatory releases. These are described in the forgoing paragraphs. The monthly irrigation demands imposed at various diversion nodes of the simulation model are given in Table 9. The monthly mandatory releases imposed at Manimukta and Gomukhi reservoirs are given in Table 10.

The monthly evaporation data was available for Manimukta reservoir. The same data has been used for the whole basin. The monthly evaporation data of Manimukta reservoir has been given in Table 11. In most of the basins in Tamilnadu, there is appreciable return flow from irriation. In the present study, a return flow of 10% was assumed.

The Area-Storage-Release capacity table used for Manimukta reservoir has been given in Table 12. Only Elevation and corresponding capacity for Gomukhi reservoir could be made available. Due to non availability of the values of corresponding areas, the same were interpolated graphically. The values of Area-Storage-Release capacity have been given in Table 13.

3.1 METHODOLOGY

The program HEC-5, which is a generalized software for simulation of operation of a conservation and flood control system, was used in this study. This software is briefly described in the following.

3.2 DESCRIPTION OF HEC-5

The generalized program *Simulation of Flood Control and Conservation Systems*, also known as HEC-5, was used in this study. This program has been developed by the Hydrologic Engineering Center, USA. The HEC-5 program has been developed for simulation of operation of a system of reservoirs and diversions, being operated for flood control and conservation purposes such as water supply, irrigation, hydroelectric power generation, navigation and low flow augmentation. The program was developed to assist in planning studies for evaluating proposed reservoirs and to assist in sizing the flood control and conservation storage requirements for each project. The program is also useful in selecting the proper reservoir releases throughout the system during the flood emergencies.

3.2.1 System Configuration

Any reservoir system configuration can be analyzed as long as the dimension limits are not exceeded for number of reservoirs, control points (all locations including reservoirs are control points) and diversions etc. Reservoirs are control points which have a finite amount of storage associated with them. The most upstream control point on each tributary must be a reservoir and the last control point must be a non-reservoir. Each control point must have an operating channel capacity which can be a constant, or vary monthly, or vary with channel flows at any location, or vary with reservoir level. Each control point can have low-flow requirements which can be constant, or vary monthly or period-by-period.

3.2.2 Input Data

The system configuration is specified by routing reaches and by the required downstream sequential order of input control points. Each reservoir must have a starting storage and storage values for each target level. The target levels can vary monthly. Additional data on reservoir areas, elevations, diversions, and costs can be given as a function of reservoir storage. Evaporation data can be read for the entire basin or for individual reservoirs by monthly periods.

The program normally uses incremental local flows (flows between adjacent control points) in the system routings. The incremental local flows can be read in or can be calculated from observed discharges and reservoir releases. Incremental local flows can also be calculated from natural flows. Further, flow data at some of the control points can be a ratio of the flow at another system point. The flows can also be shifted by several whole computation time intervals.

3.2.3 Storage-yield Optimization

Up to 6 reservoirs (none in tandem with each other) can be optimized by the program in a single run to determine different types of results (storage or yield). Up to 15 iterations are allowed in trying to draw the reservoir to the target reservoir level (usually top of inactive pool) while determining either the storage required for a given yield or the firm yield (including firm energy) from a given amount of storage. Critical period can be determined by the program from period-of-record input data and the operation of a single reservoir can be restricted to the critical period to reduce computer costs.

3.2.4 Flood Damages Analysis

Expected annual damages can be computed for any or all control points using one or more ratios for each of several historical or synthetic floods (minimum combination of six events recommended). Damages for a single flood or a series of floods can be computed if only those floods are operated in a single computer run.

The various features of this program have been described in detail in the users manual for this program, HEC (1982). This manual also describes the input and output of the program for various test problems. Recently, a PC version of this program has been brought out by HEC and this PC version was used in this study.

3.3 RESERVOIR OPERATION IN HEC-5

In HEC-5, a reservoir is operated to meet its own demands, the demands at as many downstream control points as desired, and to keep the system in balance. The operating criteria of a reservoir has to be supplied by the user. Each reservoir is operated to meet the streamflow targets at specified locations in the system. To do this, each reservoir is divided into a number of zones by imaginary horizontal planes and withdrawals are made from the highest zone first and so on. As far as possible, all reservoirs, in the system are kept in balance. The reservoirs which have flood control storage may be operated to minimize flooding at any number of downstream control points. Reservoirs without flood storage will be operated for their own requirements and can be operated to provide low flow requirements for any number of downstream control points. The reservoirs that operate for a common control point are kept in balance as much as possible for both flood and conservation operation.

The system is operated by considering the requirements at pertinent control points in the system, starting at the most upstream control point and moving in the downstream direction. The required release is determined by evaluating all operational needs and other constraints. After the requirements have been made or shortages declared, the system requirements are examined to determine additional releases which may be necessary to meet the system power demands. If these releases are required then they are proportioned among the projects which are supposed to cater for them. These additional releases are added to obtain the total releases. This process is repeated for each period. The system can also be operated for flood control in which the peak flow at a damage center is kept below a maximum limit. The hydrologic accounting is done by use of continuity equation at each control point.

The operation of the reservoirs is controlled by specifying target levels which indicate the allocation of storage for flood control and conservation purposes. These levels can vary monthly. At each control point, the user can specify the minimum desired flow and the minimum required flow. The guidelines for operation of reservoirs are as follows :

⇨ When the reservoir level is between the top of the conservation pool and the top of the flood pool, releases are made to attempt to draw the reservoir to the top of conservation pool without exceeding the designated channel capacity at the reservoir or at downstream control points for which the reservoir is being operated.

⇨ Releases are made equal to or greater than the minimum desired flows when the reservoir storage is greater than the top of buffer storage, and equal to the minimum required flow if between level one and the top of buffer pool. No releases are made when the reservoir is below level one (top of inactive pool). Releases calculated for hydropower requirements will override minimum flows if they are greater than the controlling desired or required flows.

Releases are made equal to or less than the designated channel capacity at the reservoir until the top of flood pool is exceeded, and then all excess flood water is dumped if sufficient outlet capacity is available. If insufficient capacity exists, a surcharge routing is made. Input options permit channel capacity releases (or greater) to be made prior to the time that the reservoir level reaches the top of the flood pool if forecasted inflows are excessive.

⇨ Rate of change criteria specifies that the reservoir release cannot deviate from the previous period release by more than a specified percentage of the channel capacity at the dam site, unless the reservoir is in surcharge operation.

3.3.1 Operation of gated reservoirs

The operational criteria for gated reservoirs for specified downstream control points are as follows :

⇨ Releases are not made (as long as flood storage remains) which would contribute to flooding at one or more specified downstream locations during a predetermined number of future periods. The number of future periods considered is the lesser of the number of reservoir releases routing coefficients or the number of local flow forecast periods.

⇨ Releases are made, where possible, to exactly maintain downstream flows at channel capacity (for flood operation) or for minimum desired or required flows (for conservation operation). In making a release determination, local (intervening area) flows can be multiplied by a contingency allowance (greater than 1 for flood control and less than 1 for conservation) to account for uncertainty in forecasting these flows.

The operation criteria for keeping a gated flood control reservoir system in balance are as follows :

⇨ Where two or more reservoirs are in parallel operation for a common control point, the reservoir that is at the highest index level, assuming no releases for the current time period, will be operated first to try to increase the flows in the downstream channel to the target flow. Then the remaining reservoirs will be operated in a priority established by index levels to attempt to fill any remaining space in the downstream channel without causing flooding during any of a specified number of future periods.

⇨ If one of two parallel reservoirs has one or more reservoirs upstream whose storage should be considered in determining the priority of releases from the two parallel reservoirs, then an equivalent index level is determined for the tandem reservoirs based on the combined storage in the tandem reservoirs.

⇨ If two reservoirs are in tandem, the upstream reservoir can be operated for control points between the two reservoirs. In addition, when the upstream reservoir is being operated for the downstream reservoir, an attempt is made to bring the upper reservoir to the same index level as the lower reservoir based on index levels at the end of the previous time period.

Parallel conservation operation procedures are utilized when one or more gated reservoirs are operated together to serve some common downstream flow requirement. The following steps are utilized by HEC-5 to determine the reservoir releases necessary for the downstream location M:

1. Determine all reservoirs operating for downstream location (M),

2. Determine priorities of reservoirs operating for M based on index levels (for flood control operation only),

3. Calculate table of releases to bring all other parallel reservoirs to level of each reservoir in turn,

4. Calculate release to bring all parallel reservoirs to each target storage level. Also determine sum of releases to bring system to top of conservation and top of buffer pools,

5. If no upstream parallel reservoir has been operated for flood control or water supply at M and no requirement for low flow exists and no flooding will occur at M within forecast period, skip operation for M,

6. Check for future flooding at M within forecast period. If flooding occurs, operate the reservoir for flood control,

7. If there is no flooding, determine conservation releases for each parallel reservoir to bring system reservoirs to some appropriate level.

3.3.2 Hydropower Operation

A power reservoir can operate to meet at-site firm energy requirements or allocated system firm energy. A power reservoir can also operate based on a rule curve relating plant factors to percent of conservation storage. Reservoirs can operate to meet combinations of monthly, weekly, daily and multi-hourly primary hydropower energy requirements or they can operate to satisfy rule curves relating percent conservation storage to plant factor. Operation for run-of-river projects is also provided. The system energy requirements can be specified for up to two power systems. Program will meet system requirements based on balancing reservoir levels.

A tail-water rating curve can be defined as the highest of : 1) an input block loaded tail-water, or 2) as a reservoir outflow vs. elevation table, or 3) based on a downstream reservoir elevation. For optimization of a power plant size, the tail-water is calculated from a tail-water curve using the discharge required for the installed capacity. Power peaking capability can be a constant, a function of reservoir storage, a function of reservoir releases, or a function of operating head. Power efficiency can be a constant, a function of reservoir storage, a kw/cfs coefficient vs. reservoir storage, or head vs. efficiency. Pumped storage can be modeled using a dummy reservoir site to define pump data and energy availability.

Benefits for hydropower reservoirs can be calculated based on input rates for capacity, firm energy, secondary energy and for power shortages (negative benefits). For rule curve operation (plant factor vs. percent conservation storage) benefits based on plant factors may be calculated.

3.3.3 Diversions & Routing

Diversions can be made from any reservoir or control point up to the limit of dimension. Only one diversion from each control point or reservoir is allowed. Diversions can be made to any downstream control point or reservoir, or they can also leave the system. Diversions can vary monthly or period-by-period.

The multiflood option may be used to operate the system for a continuous period of record with a mixture of computation intervals. A monthly operation could be used for a few years (assuming no routing is desired) and then the system can be operated for daily or hourly flows during a major flood (with detailed flood routing) and then back to a weekly or monthly operation interval, etc. An unlimited number of events can be simulated in this manner. Up to 9 ratios of any or all floods read can be run in a simulation operation.

The available stream routing methods are Straddle-Stagger, Tatum, Muskingum, Modified Puls, and Working R&D. Each routing reach may be subdivided into several steps. Routing criteria for natural flow conditions can also be specified.

3.4 PREPARATION OF INPUT FOR HEC-5

The input file for HEC-5 consists of different types of records. The first two characters of a record are the record identifiers. The relevant data are entered in 10 fields of 8 columns, except the first field. Variables occurring in field 1 may normally only occupy the card column 3-8 since columns 1 and 2 are reserved for the required identification characters. In the old days, the input data were fed to the computer through data cards. Although the cards are no longer used, the word 'card' is still being used to describe one record of data file.

In the input file the different types of data records are to be placed in a proper sequence. The first three (optional) records, T1, T2, and T3 are known as title cards. Both alphabetic and numeric information may be placed on these cards. The general data for the current job is entered through job control cards. These job cards are J1, J2, J3, J4, J5, J6, J7, J8. Information regarding reservoirs or non-storage nodes is entered through reservoir cards. These cards are RL, RO, RS, RQ, RA, RE, RD, R1, R2, R3 etc. The control points specification cards for identification and routing criteria etc. are CP, ID, RT, DR, QS, QD, EL, QM. The BF cards are used for specifying the beginning of flood. The IN cards are used to input inflows for the control points. The EJ and ER cards represent the end-of-job. The detailed information regarding the input data preparation may be obtained from the Users Manual for the HEC-5 program.

Using the data described in Chapter 3 and the above procedure, the input data file for HEC-5 program for the Vellar sub-basin I was prepared.

3.5 OUTPUT FROM HEC-5

There are a number of options to control the output from the HEC-5. The user can get an echo print of the input data and a diagram of the system, as perceived by the program along with the important details of the various control points. How much detailed output is desired, can be controlled through the job control cards. The user can also design the output to be printed in tabular form and the various columns of such a table can be chosen by the user.

3.6 HARDWARE REQUIREMENTS TO RUN HEC-5

The HEC-5 programme is available for mainframe computers as well as PCs. The PC version was used in this study. The PC version of the software can run on a PC-386 machine but a PC-486 is preferable. The HEC-5 package consists of HEC-5A and HEC-5B programs. Some utility programs like, CKHEC5 to check the input to HEC-5, INFIVE for interactive preparationof HEC-5 input and COED which is an editor developed by HEC, are also available to help in applying HEC-5.

CHAPTER 4

SIMULATION OF VELLAR SYSTEM USING HEC-5

4.0 VELLAR SYSTEM SETUP

The input data file for the Vellar system was prepared as described in the previous chapter with the help of the Users Manual for HEC-5. The line diagram of the Vellar system, as perceived by the program and written in the output file during the program execution is shown in Fig. 4.1.

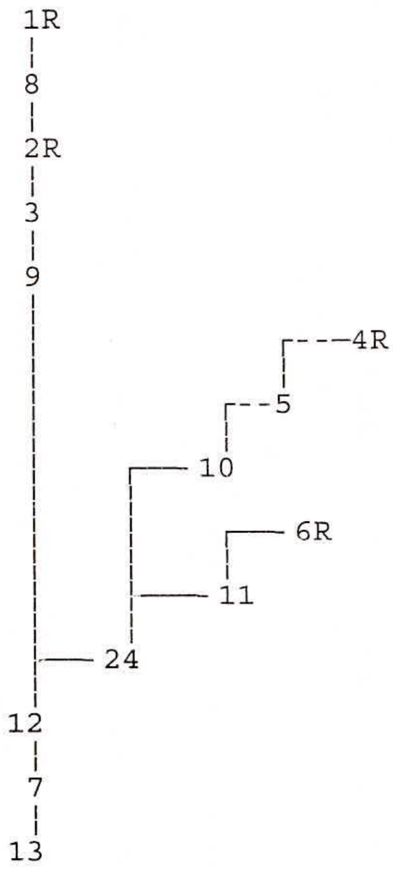
```
                            Control    Upstream Reservoirs
                            Point      Operating For This
                            Name       Location

 1R                      29-Tanks
 8                       13-Anicut          1
 2R                      Manimukta
 3                       38-Tanks           2
 9                       4-Anicuts          2
 |               .---4R  Gomukhi Res
 |          .---5        18-Tanks           4
 |     .---10            12-Anicut          4
 |     |    .---6R       49-Tanks
 |     .---11            32-Anicut          6
 .----24                 Junction
12                       Memathur           2       4
 7                       80-Tanks           2       4
13                       2-Anicuts          2       4
```

Fig. 4.1 Line Diagram of the System

In the HEC-5, the most upstream point in each tributary must be a reservoir. Accordingly, the nodes 1 and 6 have been declared as dummy reservoirs without any significant storage; the node 4 is a real reservoir (Gomukhi reservoir). In the Fig. 4.1, the reservoir locations have been identified by suffix 'R' after their node number.

The salient features of the various control points along with the network diagram have been given in Fig. 4.2. Since the flood control was not a major objective of this problem,



CHANNEL CAPACITY	FLOOD CTRL STORAGE	CONSERV. STORAGE	MIN DES. FLOW	MIN REQ. FLOW	LOCATION Id	NAME
10000.	25.	100.	0.	0.	1	29-Tanks
10000.	0.	0.	0.	0.	8	13-Anicuts
10000.	50.	19890.	0.	0.	2	Manimukta Reservoir
10000.	0.	0.	0.	0.	3	38-Tanks
10000.	0.	0.	0.	0.	9	4-Anicuts
10000.	140.	14090.	0.	0.	4	Gomukhi Reservoir
10000.	0.	0.	0.	0.	5	18-Tanks
10000.	0.	0.	0.	0.	10	12-Anicuts
10000.	25.	100.	0.	0.	6	49-Tanks
10000.	0.	0.	0.	0.	11	32-Anicuts
10000.	0.	0.	0.	0.	24	Junction node
10000.	0.	0.	0.	0.	12	Memathur Regulator
10000.	0.	0.	0.	0.	7	80-Tanks
10000.	0.	0.	0.	0.	13	2-Anicuts

Fig. 4.2 Salient Features Of The Control Points

the channel capacity at all the control points has been (arbitrarily) set at 10000 cumec. The flood control capacity at the dummy reservoirs has been set at 25000 cubic meters. Since the dummy reservoir nodes are in fact composed of a number of minor tanks with small storage capacities, their capacities have been set at 100,000 cubic meters. If their is any surplus water at any of the dummy reservoir, the same can be released to meet the demand at the control point just downstream. The Manimukta and Gomukhi reservoirs have significant conservation storage and they are assumed to meet the demands at a number of downstream control points. The Manimukta reservoir is assumed to meet the demands at the control points 3, 9, 12, 7 and 13 in addition to its own demands. Similarly, the Gomukhi reservoir is operated to meet the demands at control point number 5, 10, 12, 7 and 13 in addition to its own demands. Further, it was assumed that the minimum desired flow and the minimum required flow at each control point is nil.

4.1 VELLAR SYSTEM SIMULATION WITH HEC-5

The data file for the Vellar subbasin for HEC-5 program was prepared as discussed in the previous chapter. The HEC-5 package contains some utility programs to check the data file for possible errors. One such program is CHECK5. In the present case, the input file was first prepared for a small part of the system and the inflow data for limited period was given as input. Once the data file for this small part was corrected, the other system components were added to it and the inflow data for all periods was added. The input data file was modified many times during the course of the study and the simulation runs were taken to see the impact of the various alternate operating options. The data file for the final run is shown in Annexure 4.

The following assumptions were made in this study:

1. The mandatory releases were taken into account according to the existing regulation rules of the projects in the basin.
2. The municipal and industrial needs of the basin are met from the groundwater resources in the basin and, therefore, these were not considered.
3. The return flows from irrigation were considered as nil.
4. There was a general lack of data on minor tanks. The capacity of a group of tanks (equivalent reservoirs) is assumed to be sufficient to store the inflows from their catchment. Thus no irrigation deficit takes place due to want of storage capacity and the same is due to insufficient inflows.

The program HEC-5 was run with the data for Vellar system. The option to create the tabular output through the J8 cards was used to create two working tables in which some important variables were written in the adjacent columns. A part of one such table is shown in Annexure 5. The various decision variables were iteratively modified so as to get the best possible results from the operation of the system.

The summary data about the reliability for the various control points is given in Table

14. The number of success months (when the demand could be fully met), the number of success years, the annual reliability and the volume reliability for each control point have been given in this table. It may be pointed out that normally the annual reliability is less than the monthly reliability which is less than the volume reliability. However, in the present case, the demands at some nodes in some months were zero. Due to this, in some cases, the volume reliability turns out to be less than the monthly reliability.

It was seen from the working table that there was no shortage at the control point 1, 29-Tanks in any of the 20 year period. However, the flow at the control point 8, 13-Anicuts was insufficient to meet the demands in 35 months giving a monthly reliability of 85.42. The next column shows that the number of success years is one which implies an annual reliability of just 5%. The deficits at this control point were found to occur in the months of December, January and February. As the volume of the deficits was not very high, the volume reliability at this control point is quite high, 82%. Thus the annual reliability data may give a completely different picture compared to other data. Although the reliability is sufficient as per the prevalent norms, a little increase in irrigation efficiency may wipe out the deficits altogether.

At the Manimukta dam, there are some mandatory release requirements as well as irrigation demands. The reliability for these two has been computed separately. For the diversion demands, the monthly, annual, and volume reliability are 96%, 60% and 98% respectively while for mandatory releases, these figures are 53%, 5% and 67%. This indicates that there are a large number of months when there is a shortfall in meeting the mandatory release requirements. The shortages mostly occur in the summer months from February to June. The available water at control point 38-Tanks (Node Id. 3) was found to be sufficient to meet all the demands at this node. However, at control point 4-Anicuts, there were a few instances of water small shortages of water which led to monthly reliability of 93% and volume reliability of 92%.

Similar to Manimukta dam, there are some mandatory release requirements as well as irrigation demands at the Gomukhi dam. The reliability for these two has been computed separately. For the diversion demands, the monthly, annual, and volume reliability are 86%, 10% and 67% respectively and 53%, 0% and 66% respectively for mandatory requirements. This indicates a shortage of water at this node. An inspection of the working table shows that there is a deficit of water in many summer months and sometimes the volume of deficits is quite big. There is no single year when all the mandatory demands could be met and the reliability for the diversion demands is also quite low.

The control points 18-Tanks (Node Id. 5) and 12-Anicuts (Node Id. 10) are both served by the Gomukhi dam in addition to the local flow at 18-Tanks. The monthly reliability at these points are 87% and 77% respectively while the volume reliability are 74% and 52%. Although the shortages at 18-Tanks are small, a significant shortage of water exists particularly at 12-Anicuts. The results when viewed along with the performance indices at the Gomukhi dam indicate a general shortage of water in this part of the basin.

There appears to be significant shortage of water in the Mayura Nadi tributary also on which the node 49-Tanks and 32-Anicuts are located. The monthly reliabilities at these nodes are 87% and 79% but the volume reliability figures at 73% and 51% are cause for concern.

The demands at three downstream control points, namely, Memathur regulator (Node Id. 12), 80-Tanks (Node Id. 7), and 2-Anicuts (Node Id. 13) can be met from either Manimukta reservoir, or Gomukhi reservoir, or both. The reliability attained at these points, except the annual reliability, is quite high as seen from the table. The monthly reliabilities as well as the volume reliabilities are all above 95%.

From the above discussion it is clear that in general water is certainly not abundant in this basin. The available water is either just enough for the satisfaction of the various demands or there is a shortage of water in one part of the basin or the other. There appears to be severe shortage of water in the Gomukhi basin.

The above results should be viewed with caution since the length of the data series used in the simulation was only 20 years. While analysing the performance of a water resources system, a longer length of the data series is necessary so that one can have adequate confidence in the results.

CHAPTER 5
CONCLUSIONS

5.1 CONCLUSION

Reservoir operation forms a very important part of the planning and management of water resources. The release from a dam, at any time, depends on the prevailing demands, the available water in the reservoir, information about the likely inflow in the reservoir and likely demands of the remaining part of the water year. An operation policy is developed to guide the operators at the dam site in deciding about the release at any time.

In the present report, system operation study of a part of the Vellar basin has been carried out. The well known generalised simulation program, HEC-5 has been used for the simulation analysis of the system. Because of the lack of data, suitable assumptions regarding mandatory releases, municipal and industrial demands, irrigation return flows and capacity of equivalent tanks have been made. Detailed simulation analysis of the system has been carried out using different index levels in two major reservoirs of the system, namelv Manimukta and Gomukhi.

From the analysis, it can be concluded that at nodes adjacent to the Manimukta reservoir, the water deficits are small and few as the volume reliability is quite high. At some nodes, there may be significant number of months having deficits but the amount of deficit is not large enough and the same can be taken care of by the judicious regulation of the Manimukta reservoir. However, the results indicate shortage of water at the Gomukhi reservoir and the nodes downstream of this reservoir. In addition to the number of deficit months, the volume of deficits is also quite beg. To counter their effect, either project demands must be reduced or some water conservation methods must be adopted in this part of the basin. In the nodes on the Mayura Nadi tributary also, significant deficits have been observed. However, the three most downstream nodes have fairly good reliability as water can be met from either of the reservoirs.

In general, water is not abundant in the basin. One part of the basin has adequate reliability (Manimukta reservoir) while other part (Gomukhi reservoir) has significant deficits. Some conservation measures need to be adopted in this part of the basin for the effective utilisation of water resources.

REFERENCES

CWC, "Report on system studies of Vellar basin, Tamilnadu", Central Water Commission, New Delhi, 1991.

HEC, "Simulation of Flood Control and Conservation Systems", The Hydrologic Center, US Army Corps of Engineers, California, 1982.

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Table - 1

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 1 : Equivalent 29 tanks

Unit : Million Cubic Meter

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.99	2.01	5.99	21.99	60.00	35.01
1970	11.01	6.00	0.00	0.00	0.00	0.00	0.99	0.99	3.01	9.99	29.00	17.01
1971	11.01	6.00	0.00	0.00	0.00	0.00	0.99	0.99	3.99	15.99	44.01	24.99
1972	11.01	6.00	0.00	0.00	0.00	0.00	0.99	0.99	5.00	17.01	46.99	27.00
1973	11.01	6.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	8.01	12.00	11.01
1974	11.01	7.01	0.00	0.00	0.00	0.00	0.00	0.00	1.01	5.01	8.99	9.00
1975	11.01	6.00	0.00	0.00	0.99	0.00	0.99	2.01	2.00	12.00	14.00	11.01
1976	12.00	6.00	0.00	0.00	0.00	0.00	0.00	2.01	1.01	6.00	14.00	11.00
1977	11.01	6.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	21.99	133.00	18.99
1978	12.99	7.01	0.00	0.00	0.00	0.00	0.00	0.00	2.00	6.99	41.01	27.99
1979	15.99	7.01	0.00	0.00	0.00	0.00	0.00	0.00	5.99	6.00	102.00	17.01
1980	11.01	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.01	13.01	9.00
1981	11.01	5.00	0.00	0.00	0.00	0.00	0.00	0.99	8.99	18.00	10.99	9.00
1982	11.01	8.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.01	17.99	9.00
1983	11.01	5.00	0.00	0.00	0.00	0.00	0.00	0.99	5.00	5.01	8.01	36.99
1984	12.99	13.01	5.01	0.00	0.00	0.00	5.01	0.00	2.00	15.99	15.01	9.99
1985	15.99	9.01	0.00	0.00	0.00	0.00	0.00	2.01	3.99	8.01	15.01	14.01
1986	15.99	6.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	12.99	14.00	9.99
1987	11.01	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.99	18.00	15.99	45.00
1988	12.99	6.00	0.00	1.01	0.00	0.00	0.00	0.99	3.01	8.01	8.99	9.00
1989	11.01	5.00	0.00	0.00	0.00	-	-	-	-	-		

Table - 2

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 2 : Manimukta Reservoir

Unit : Million Cubic Meter

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.99	0.99	3.99	12.99	36.00	21.00
1970	6.99	4.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	6.00	17.00	9.99
1971	6.99	4.00	0.00	0.00	0.00	0.00	0.00	0.99	3.01	9.00	26.00	15.00
1972	6.99	4.00	0.00	0.00	0.00	0.00	0.00	0.99	3.01	9.99	27.99	15.99
1973	6.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	3.99	7.00	6.99
1974	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	5.00	5.01
1975	6.00	3.00	0.00	0.00	0.99	0.00	0.99	0.99	1.01	6.99	8.01	6.00
1976	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	3.00	8.01	6.00
1977	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.99	79.00	11.01
1978	6.99	4.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	3.99	24.00	15.99
1979	9.99	4.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	3.99	60.00	9.99
1980	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	8.01	5.01
1981	6.00	3.00	0.00	0.00	0.00	0.00	0.00	0.99	5.99	9.99	7.00	5.01
1982	6.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	10.99	5.01
1983	6.00	3.00	0.00	0.00	0.00	0.00	0.00	0.99	3.01	3.00	5.00	21.99
1984	8.01	8.01	3.00	0.00	0.00	0.00	3.00	0.00	1.01	9.00	8.99	6.00
1985	9.00	5.00	0.00	0.00	0.00	0.00	0.00	0.99	2.00	5.01	8.99	9.00
1986	9.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	8.01	8.01	6.00
1987	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	11.01	10.01	27.00
1988	6.99	3.00	0.00	1.01	0.00	0.00	0.00	0.00	2.00	5.01	5.00	5.01
1989	6.00	3.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 3

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 3 : Equivalent 38 tanks
Unit : Million Cubic Meter

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.00	0.00	3.99	6.99	14.00	9.00
1970	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	10.01	3.99
1971	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	17.99	6.99
1972	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	3.99	5.00	6.00
1973	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	3.99	3.99
1974	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	3.99
1975	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	3.00	5.00	3.99
1976	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	5.00	3.00
1977	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.01	34.01	3.00
1978	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	10.99	6.99
1979	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.99	33.00	3.00
1980	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	3.99	2.01
1981	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	3.99	3.01	3.00
1982	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	3.99	8.01
1983	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.99	5.00	9.00
1984	6.00	6.00	2.01	0.00	0.00	0.00	0.99	0.00	0.00	3.99	3.01	0.99
1985	6.99	4.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	2.01	5.00	3.00
1986	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	15.99	2.01
1987	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	5.01	2.00	9.99
1988	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	2.01	3.01	0.99
1989	5.01	2.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 4

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 4 : Gomukhi Reservoir
Unit : Million Cubic Metre

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.99	3.99	1.01	17.01	63.01	12.00
1970	6.00	3.00	2.01	2.00	0.99	1.01	0.00	0.99	3.01	12.99	8.99	0.00
1971	2.01	1.00	0.99	1.01	0.99	0.00	0.99	5.01	3.99	15.00	10.99	63.00
1972	8.01	2.00	0.99	0.00	0.99	1.01	0.00	0.99	8.01	12.00	15.01	6.99
1973	8.01	4.00	3.00	1.01	2.01	3.01	2.01	2.01	5.99	6.00	3.99	6.99
1974	2.01	1.00	0.00	0.00	0.00	1.01	0.00	0.00	5.00	11.01	2.00	0.00
1975	0.99	0.00	0.00	0.00	2.01	0.00	6.99	3.00	10.01	12.99	15.01	3.00
1976	0.00	0.00	0.00	0.00	0.99	0.00	0.99	3.99	2.00	6.00	10.01	3.99
1977	0.00	0.00	0.00	0.00	0.99	2.00	0.00	3.99	3.01	35.01	117.99	0.99
1978	2.01	1.00	0.99	1.01	0.00	0.00	0.99	0.00	8.01	11.01	34.99	32.01
1979	12.00	5.00	2.01	0.00	0.00	2.00	2.01	0.99	19.00	6.99	52.00	3.00
1980	3.00	3.00	0.99	1.01	0.99	1.01	0.00	0.00	1.01	3.00	22.99	2.01
1981	5.01	0.00	0.00	0.00	0.99	3.01	3.00	2.01	13.01	57.00	20.01	3.00
1982	0.99	0.00	0.00	1.01	0.00	1.01	0.00	0.00	3.01	8.01	31.00	0.00
1983	0.00	0.00	0.00	0.00	3.99	1.01	0.00	2.01	8.01	5.01	3.01	48.00
1984	9.99	17.99	20.01	2.00	0.99	0.00	3.00	0.99	8.01	24.00	29.99	8.01
1985	15.99	1.00	0.00	0.00	0.99	3.01	0.99	3.00	13.01	8.01	8.01	6.00
1986	9.00	1.00	0.00	1.01	0.00	0.00	0.00	0.00	5.99	15.00	10.99	6.99
1987	5.01	3.00	0.00	0.00	0.00	3.01	0.00	3.00	8.01	26.01	15.01	33.99
1988	9.99	1.00	0.00	3.01	2.01	0.00	5.01	3.99	22.01	6.00	1.01	0.99
1989	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 5

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 5 : Equivalent 18 tanks
Unit : Million Cubic Meter

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.00	0.99	0.00	3.99	13.01	3.00
1970	0.99	1.00	0.00	1.01	0.00	0.00	0.00	0.00	3.99	2.01	2.00	0.00
1971	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	3.00	3.99	15.00
1972	2.01	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	1.01	5.01
1973	2.01	1.00	0.99	0.00	0.99	1.01	0.99	0.99	2.00	2.01	1.01	2.01
1974	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.00	2.00	3.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00	2.01	0.99	2.00	3.00	3.01	0.99
1976	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	2.01	3.99	0.99
1977	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	8.01	22.99	0.00
1978	0.00	0.00	0.00	0.00	0.00	1.01	0.99	0.00	2.00	2.01	8.01	6.99
1979	3.00	1.00	0.00	0.00	0.00	1.01	0.99	0.00	5.99	0.99	20.01	0.00
1980	0.99	1.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.99	5.99	0.00
1981	0.99	0.00	0.00	0.00	0.00	1.01	0.99	0.00	3.01	11.01	7.00	0.99
1982	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	5.01	8.01	0.00
1983	0.00	0.00	0.00	0.00	0.99	1.01	0.00	0.00	2.00	0.99	2.00	11.01
1984	3.00	5.00	5.01	0.00	0.00	0.00	0.99	0.00	2.00	6.00	5.00	2.01
1985	3.99	0.00	0.00	0.00	0.00	1.01	0.00	0.99	3.99	2.01	3.01	0.99
1986	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	3.00	3.99	0.99
1987	0.99	1.00	0.00	0.00	0.00	1.01	0.00	2.01	2.00	6.00	1.01	6.00
1988	2.01	0.00	0.00	1.01	0.99	0.00	0.00	0.99	3.01	0.99	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 6

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 6 : Equivalent 49 tanks
Unit : Million Cubic Meter

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.99	3.99	2.00	23.01	86.99	12.99
1970	9.99	5.00	3.00	3.01	2.01	2.00	0.99	0.99	17.99	15.99	12.00	0.00
1971	3.99	1.00	2.01	1.01	2.01	0.00	0.99	6.00	8.01	21.99	27.01	94.01
1972	14.01	4.00	2.01	1.01	2.01	3.01	2.01	0.99	12.00	20.01	13.01	32.01
1973	12.00	6.00	5.01	2.00	3.99	5.00	3.99	5.01	8.99	14.01	5.99	12.00
1974	3.00	1.00	0.00	1.01	0.99	8.99	0.99	0.99	10.01	18.00	2.00	0.99
1975	0.99	0.00	0.00	0.00	3.00	0.00	11.01	5.01	15.99	18.00	20.01	6.00
1976	0.99	0.00	0.00	0.00	2.01	0.00	2.01	5.01	2.00	12.99	21.00	8.01
1977	0.99	1.00	0.00	1.01	2.01	2.00	0.99	6.00	8.01	51.99	172.99	2.01
1978	3.00	2.00	2.01	1.01	0.99	3.01	3.00	0.99	14.00	17.01	48.99	42.99
1979	18.99	7.01	3.00	0.00	0.00	3.99	3.00	2.01	39.99	11.01	129.00	3.00
1980	5.01	5.00	0.99	1.01	2.01	17.00	0.00	0.00	1.01	3.99	38.00	2.01
1981	8.01	0.00	0.00	0.00	2.01	5.00	5.01	3.99	20.01	82.01	34.99	3.00
1982	2.01	1.00	0.00	1.01	0.00	1.01	0.00	0.00	5.00	30.00	46.01	0.99
1983	0.00	0.00	0.00	0.00	6.00	5.00	0.00	2.01	10.01	6.99	8.01	68.00
1984	17.01	30.00	33.00	3.01	2.01	0.00	5.01	0.99	12.00	36.99	39.01	11.01
1985	26.01	2.00	0.00	0.00	2.01	3.99	0.99	3.99	21.00	11.01	14.00	8.01
1986	14.01	2.00	0.00	2.00	0.00	0.00	0.00	0.00	10.01	20.01	26.00	6.99
1987	8.01	4.00	0.00	0.00	0.00	3.99	0.00	11.01	10.99	35.01	12.00	39.99
1988	15.99	1.00	0.00	5.00	3.00	0.00	5.01	6.00	24.00	5.01	3.01	0.99
1989	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 7

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 7 : Equivalent 80 tanks

Unit : Million Cubic Meter

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.00	0.99	3.01	15.00	45.00	15.00
1970	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	3.99	41.99	135.00
1971	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	5.99	14.01	58.99	21.99
1972	8.01	4.00	0.00	0.00	0.00	0.00	0.99	0.99	2.00	12.99	36.99	30.99
1973	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	6.00	15.99	14.01
1974	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	3.01	53.01
1975	8.01	4.00	0.00	0.00	0.99	0.00	0.99	0.99	1.01	6.99	15.01	15.00
1976	9.00	4.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	5.01	10.01	17.01
1977	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	110.99	12.00
1978	9.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	6.00	29.00	24.99
1979	12.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	6.99	131.00	8.01
1980	8.01	4.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	3.99	12.00	11.01
1981	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	8.99	12.99	12.00	6.99
1982	8.01	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	13.01	109.01
1983	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	2.00	5.01	12.00	24.00
1984	9.99	9.01	3.99	0.00	0.00	0.00	3.99	0.00	1.01	9.99	8.99	6.00
1985	11.01	6.00	0.00	0.00	0.00	0.00	0.00	0.99	2.00	5.01	17.00	14.01
1986	12.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	8.01	105.00	11.01
1987	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	9.99	5.00	30.99
1988	9.00	4.00	0.00	1.01	0.00	0.00	0.00	0.00	3.01	2.01	7.00	6.99
1989	8.01	4.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 8

DAILY INFLOW DATA OF VELLAR BASIN
NODE - 12 : Memathur Regulator

Unit : Million Cubic Meter

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1969	-	-	-	-	-	0.00	0.00	0.99	7.00	24.00	86.00	36.99
1970	12.99	7.01	0.00	0.00	0.00	0.00	0.99	0.99	3.99	6.00	67.99	383.00
1971	12.99	7.01	0.00	0.00	0.00	0.00	0.00	0.99	5.00	21.99	127.99	30.00
1972	12.99	7.01	0.00	0.00	0.00	0.00	2.01	0.99	3.99	21.00	63.01	53.01
1973	12.99	7.01	0.00	0.00	0.00	0.00	0.00	0.99	1.01	11.01	26.00	21.99
1974	12.99	7.01	0.00	0.00	0.00	0.00	0 00	0.00	1.01	6.00	10.01	118.01
1975	12.99	6.00	0.00	0.00	0.99	0.00	0.99	2.01	2.00	12.00	31.00	27.99
1976	14.01	7.01	0.00	0.00	0.00	0.00	0.99	2.01	0.00	9.00	14.00	30.00
1977	12.99	7.01	0.00	0.00	0.00	0.00	0.00	0.00	1.01	24.99	208.01	14.01
1978	15.00	8.01	0.99	0.00	0.00	0.00	0.00	0.00	2.00	11.01	50.00	39.99
1979	18.99	8.01	0.00	0.00	0.00	0.00	0.00	0.00	10.99	9.00	184.99	21.99
1980	12.99	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.01	15.01	23.01
1981	12.00	6.00	0.00	0.00	0.00	0.00	0.00	2.01	13.01	18.00	19.00	17.01
1982	12.00	9.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.01	21.00	200.00
1983	12.00	6.00	0.00	0.00	0.00	0.00	0.00	2.01	3.01	8.01	17.99	42.00
1984	15.00	15.01	6.00	0.00	0.00	0.00	6.00	0.00	3.01	11.01	17.99	12.00
1985	18.00	10.01	0.00	0.00	0.00	0.00	0.00	2.01	3.01	8.01	33.00	23.01
1986	18.99	7.01	0.00	0.00	0.00	0.00	0.00	0.00	3.01	15.00	148.99	24.99
1987	12.99	6.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	18.00	10.99	57.99
1988	15.00	7.01	0.00	1.01	0.00	0.00	0.99	0.99	3.99	3.99	13.01	12.00
1989	12.00	6.00	0.00	0.00	0.00	-	-	-	-	-	-	-

Table - 9

VELLAR BASIN
Monthly Irrigation Demands for Different Nodes in Manimukta Sub Basin
Unit : Cumec

Name of Control Point	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Equivalent 29-Tanks	1.68	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.78	1.06
Equivalent 13-Anicuts	4.33	2.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	2.02	2.74
Manimukta Resevoir	2.82	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.31	1.79
Equivalent 38-Tanks	1.19	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.55	0.75
Equivalent 4-Anicuts	1.50	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.70	0.95
Gomukhi Reservoir	3.32	1.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	1.55	2.10
Equivalent 18-Tanks	1.15	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.54	0.73
Equivalent 12-Anicuts	6.32	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.62	2.94	4.00
Equivalent 49-Tanks	2.52	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.17	1.60
Equivalent 32-Anicuts	4.58	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	2.13	2.90
Memathur Regulator	3.97	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	1.85	2.51
Equivalent 80-Tanks	4.33	2.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	2.02	2.74
Equivalent 2-Anicuts	0.50	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.23	0.31

Table - 10

VELLAR BASIN
Monthly Mandatory Releases (Cumecs)

Month	Mandatory Releases	
	Gomukhi Reservoir	Manimukta Reservoir
Jan	2.407	0.425
Feb	2.265	0.283
Mar	0.566	0.283
Apr	0.566	0.283
May	0.566	0.283
Jun	0.566	0.283
Jul	0.283	0.283
Aug	0.283	0.283
Sep	0.283	0.708
Oct	2.548	0.708
Nov	3.398	0.425
Dec	2.407	0.425

Table - 11

VELLAR BASIN
Monthly Evaporation Depths For Manimukta Reservoir (mm)

Month	Evaporation Depths
Jan	146.40
Feb	169.68
Mar	235.20
Apr	276.90
May	277.89
Jun	274.10
Jul	243.71
Aug	232.47
Sep	179.51
Oct	144.60
Nov	111.05
Dec	119.37

Table - 12

MANIMUKTA RESERVOIR
Storage-Area-Release Capacity

STORAGE (1000 M^3)	AREA (1000 M^2)	RELEASE CAPACITY (CUMECS)
1	402	52
818	678	56
1097	909	59
1373	1136	60
1770	1454	62
2196	1564	65
2619	1865	69
3282	1996	70
3964	2411	73
4622	2441	75
5592	2954	78
6507	3148	80
7560	3657	81
8730	4146	83
10052	4774	85
11520	5008	88
13025	5663	90
14837	5873	91
16706	6613	94
18696	6787	98
20866	7453	100

Table - 13

GOMUKHI RESERVOIR
Storage-Area-Release Capacity

STORAGE (1000 M^3)	AREA (1000 M^2)	RELEASE CAPACITY (CUMECS)
1800	10	52
1900	15	56
2200	20	59
2900	80	60
3900	180	62
4200	200	65
5500	340	69
7500	560	70
8900	760	73
9100	800	75
9500	880	78
10000	990	80
10800	1100	81
11100	1200	83
11800	1300	85
11900	1360	88
13100	1700	90
13900	1900	91
14500	2260	94
15500	2700	98
16800	3600	100

Table 14
RELIABILITY ANALYSIS FOR VELLAR BASIN

Name of the Control Point	Success Months	Monthly Reliability in %	Success Years	Annual Reliability in %	Volume Reliability in %
29-Tanks	240	100.0	20	100	100.0
13-Anicuts	205	85.42	1	5	82.04
Manimukta Diversion	230	95.83	12	60	98.44
Manimukta Mandatory	126	52.5	1	5	66.93
38-Tanks	240	100.0	20	100	100.0
4-Anicuts	225	93.75	8	40	92.25
Gomukhi Diversion	206	85.83	2	10	66.92
Gomukhi Mandatory	126	52.50	0	0	65.62
18-Tanks	208	86.67	2	10	73.99
12-Anicuts	185	77.08	0	0	52.11
49-Tanks	208	86.67	6	30	73.41
32-Anicuts	189	78.75	0	0	51.13
Memathur Regulator	228	95.0	10	50	98.20
80-Tanks	234	97.5	14	70	99.90
2-Anicuts	239	99.58	19	95	99.30

Salient features of Manimukta Reservoir

<u>Location of the Reservoir</u>		
Latitude	:	11 48' N
Longitude	:	78 59' E
Year of completion	:	1970
<u>Reservoir data</u>		
Gross storage [mcum]	:	20.87
Dead storage [mcum]	:	0.96
Live storage [mcum]	:	19.89
Top of dam [m]	:	130.76
M.W.L [m]	:	130.10
F.R.L [m]	:	128.32
D.S.L [m]	:	121.92
Bed level [m]	:	117.35
Crest level [m]	:	121.55
Area at F.R.L. [ha]	:	7.45
<u>Hydrology</u>		
Catchment area [sq km]	:	484.31
Average rainfall [mm]	:	983.10
75% dependable flow [mcum]	:	17.20
<u>Command Area</u>		
Gross command area [ha]	:	1719.98
Culturable command area [ha]	:	1719.98
<u>Annual Irrigation</u>		
Rabi [ha]	:	nil
Kharif [ha]	:	1719.98
Perenial [ha]	:	nil

Salient features of Gomukhi Reservoir

Location of the Reservoir		
Latitude	:	11 48' N
Longitude	:	78 49' E
Year of completion	:	1965
Reservoir Data		
Gross storage [mcum]	:	15.86
Dead storage [mcum]	:	1.77
Live storage [mcum]	:	14.09
Top of dam [m]	:	185.62
M.W.L [m]	:	184.08
F.R.L [m]	:	183.18
D.S.L [m]	:	175.87
Bed level [m]	:	169.16
Crest level [m]	:	177.09
Area at F.R.L. [ha]	:	359.99
Hydrology		
Catchment area [sq.km]	:	292.67
Average rainfall [mm]	:	983.10
75% dependable flow [mcum]	:	37.77
Command Area		
Gross command area [ha]	:	2023.43
Culturable command area [ha]	:	2023.43
Annual Irrigation		
Rabi [ha]	:	nil
Kharif [ha]	:	2023.43
Perenial [ha]	:	nil

Salient features of Memathur Regulator

<u>Location of the Regulator</u>

Latitude	:	11 34' N
Longitude	:	79 13' E
Year of completion	:	1873

<u>Regulator Data</u>

Top of regulator [m]	:	49.62
M.W.L. [m]	:	48.70
Bed level [m]	:	44.74
Crest level [m]	:	46.27

<u>Hydrology</u>

Catchment area [sq km]	:	1683.50
Average rainfall [mm]	:	1683.50
75% dependable flow [mcum]	:	49.51

<u>Irrigation</u>

Gross comand area [ha]	:	2419.47
Culturable command area [ha]	:	2419.47
Annual Rabi [ha]	:	nil
Annual Kharif [ha]	:	2419.47
Annual Perenial [ha]	:	nil

Annexure 4

LISTING OF INPUT DATA FILE FOR VELLAR SYSTEM FOR HEC-5

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T1 Vellar system analysis - Manimuktha sub basin - Subbasin I
T2  4 Reservoirs, 14 Control Pts.
T3  Res. 1 & 6 dummy res.
J1      1       6       4       3       4       2       0       0
J2      0       1       0      32       0       1       0
J3      4
J6 274.1  243.71  232.47  179.51  144.60  111.05  119.37  146.40  169.68   235.2
J6 276.9  277.89
J8  1.31    8.31    2.11    2.31    2.06    3.31    4.11    4.31    4.06
J8  9.31    5.31   10.31    6.31   11.31   12.31    7.31   13.31
C
RL      1       0       0       0     100     125
RO      2       1       8
RS      2       0     150
RQ      2     100   10000
CP      1   10000
ID 29-Tanks
RT      1       8       0
DR      1      21       0       0       0     0.1       1       0       0
QD     12     0.0     0.0     0.0     0.0    0.43    0.78    1.06    1.68    0.92
QD    0.0     0.0     0.0
C
CP      8   10000
ID 13-Anicuts
RT      8      21       0
DR      8      21       0       0       0     0.1       1       0       0
QD     12     0.0     0.0     0.0     0.0    1.11    2.02    2.74    4.33    2.36
QD    0.0     0.0     0.0
C
CP     21   10000
ID Dummy Node for RetFlow
RT     21       2       0
C
RL      2    1200     960    1100   20850   20900
RO      6       2       3       9      12       7      13
RS     21       1     818    1097    1373    1770    2196    2619    3282    3964
RS   4622    5592    6507    7560    8730   10052   11520   13025   14837   16706
RS  18696   20866
RQ     21      52      56      59      60      62      65      69      70      73
RQ     75      78      80      81      83      85      88      90      91      94
RQ     98     100
RA     21     402     678     909    1136    1454    1564    1865    1996    2411
RA   2441    2954    3148    3657    4146    4774    5008    5663    5873    6613
RA   6787    7453
CP      2   10000       0
ID MANIMUKTA RESERVOIR
RT      2       3       0
DR      2      24       0       0       0     0.1       1       0       0
QD     12     0.0     0.0     0.0     0.0    0.72    1.31    1.79    2.82    1.54
QD    0.0     0.0     0.0
QM  0.283   0.283   0.283   0.708   0.708   0.425   0.425   0.425   0.283   0.283
QM  0.283   0.283
C
CP      3   10000
ID 38-Tanks
RT      3       9       0
DR      3      24       0       0       0     0.1       1       0       0
QD     12     0.0     0.0     0.0     0.0    0.31    0.55    0.75    1.19    0.65
QD    0.0     0.0     0.0
C
CP      9   10000
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ID 4-Anicuts
RT     9      12       0
DR     9       0       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    0.38    0.70    0.95    1.50    0.81
QD   0.0     0.0     0.0
C
RL     4    2000    1770    2000   15860   16000
RO     6       4       5      10      12       7      13
RS    21    1800    1900    2200    2900    3900    4200    5500    7500    8900
RS  9100    9500   10000   10800   11100   11800   11900   13100   13900   14500
RS 15500   16800
RQ    21      52      56      59      60      62      65      69      70      73
RQ    75      78      80      81      83      85      88      90      91      94
RQ    98     100
RA    21      10      15      20      80     180     200     340     560     760
RA   800     880     990    1100    1200    1300    1360    1700    1900    2260
RA  2700    3600
CP     4   10000
ID GOMUKHI RESERVOIR
RT     4       5       0
DR     4      24       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    0.85    1.55    2.10    3.32    1.81
QD   0.0     0.0     0.0
QM 0.566   0.283   0.283   0.283   2.548   3.398   2.407   2.407   2.265   0.566
QM 0.566   0.566
C
CP     5   10000
ID 18-Tanks
RT     5      10       0
DR     5      24       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    0.30    0.54    0.73    1.15    0.63
QD   0.0     0.0     0.0
C
CP    10   10000
ID 12-Anicuts
RT    10      24       0
DR    10      24       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    1.62    2.94    4.00    6.32    3.45
QD   0.0     0.0     0.0
C
RL     6       0       0       0     100     125
RO     2       6      11
RS     2       0     150
RQ     2      -1      -1
CP     6   10000
ID 49-Tanks
RT     6      11       0
DR     6      24       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    0.65    1.17    1.60    2.52    1.37
QD   0.0     0.0     0.0
C
CP    11   10000
ID 32-Anicuts
RT    11      24       0
DR    11      24       0       0       0     0.1       1       0       0
QD    12     0.0     0.0     0.0     0.0    1.17    2.13    2.90    4.58    2.50
QD   0.0     0.0     0.0
C
CP    24   10000
ID Junction node
RT    24      12       0
C
CP    12   10000
ID MEMATHUR REGULATOR
RT    12       7       0
DR    12       0       0       0       0     0.0       1       0       0
QD    12     0.0     0.0     0.0     0.0    1.02    1.85    2.51    3.97    2.16
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QD   0.0     0.0    0.0
C
CP     7   10000
ID 80-Tanks
RT     7      13      0
DR     7       0      0      0      0      0.0      1      0      0
QD    12     0.0    0.0    0.0    0.0     1.11   2.02   2.74   4.33   2.36
QD   0.0     0.0    0.0
C
CP    13   10000
ID 2-Anicuts
RT    13       0
DR    13       0      0      0      0      0.0      1      0      0
QD    12     0.0    0.0    0.0    0.0     0.13   0.23   0.31   0.50   0.27
QD   0.0     0.0    0.0
ED
BF     0     240      0  0.38669060100    240    720
NOLIST
IN     1 JUNE 69   0.00   0.99   2.01   5.99  21.99  60.00  35.01  11.01
IN  6.00    0.00   0.00   0.00   0.00   0.99   0.99   3.01   9.99  29.00
IN 17.01   11.01   6.00   0.00   0.00   0.00   0.00   0.99   0.99   3.99
IN 15.99   44.01  24.99  11.01   6.00   0.00   0.00   0.00   0.00   0.99
IN  0.99    5.00  17.01  46.99  27.00  11.01   6.00   0.00   0.00   0.00
IN  0.00    0.00   0.00   3.01   8.01  12.00  11.01  11.01   7.01   0.00
IN  0.00    0.00   0.00   0.00   0.00   1.01   5.01   8.99   9.00  11.01
IN  6.00    0.00   0.00   0.99   0.00   0.99   2.01   2.00  12.00  14.00
IN 11.01   12.00   6.00   0.00   0.00   0.00   0.00   0.00   2.01   1.01
IN  6.00   14.00  11.01  11.01   6.00   0.00   0.00   0.00   0.00   0.00
IN  0.00    1.01  21.99 133.00  18.99  12.99   7.01   0.00   0.00   0.00
IN  0.00    0.00   0.00   2.00   6.99  41.01  27.99  15.99   7.01   0.00
IN  0.00    0.00   0.00   0.00   0.00   5.99   6.00 102.00  17.01  11.01
IN  5.00    0.00   0.00   0.00   0.00   0.00   0.00   0.00   5.01  13.01
IN  9.00   11.01   5.00   0.00   0.00   0.00   0.00   0.00   0.99   8.99
IN 18.00   10.99   9.00  11.01   8.01   0.00   0.00   0.00   0.00   0.00
IN  0.00    0.00   5.01  17.99   9 00  11.01   5.00   0.00   0.00   0.00
IN  0.00    0.00   0.99   5.00   5.01   8.01  36.99  12.99  13.01   5.01
IN  0.00    0.00   0.00   5.01   0.00   2.00  15.99  15.01   9.99  15.99
IN  9.01    0.00   0.00   0.00   0.00   0.00   2.01   3.99   8.01  15.01
IN 14.01   15.99   6.00   0.00   0.00   0.00   0.00   0.00   0.00   1.01
IN 12.99   14.00   9.99  11.01   5.00   0.00   0.00   0.00   0.00   0.00
IN  0.00    5.99  18.00  15.99  45.00  12.99   6.00   0.00   1.01   0.00
IN  0.00    0.00   0.99   3.01   8.01   8.99   9.00  11.01   5.00   0.00
IN  0.00    0.00
IN     2 JUNE 69   0.00   0.99   0.99   3.99  12.99  36.00  21.00   6.99
IN  4.00    0.00   0.00   0.00   0.00   0.00   0.00   2.00   6.00  17.00
IN  9.99    6.99   4.00   0.00   0.00   0.00   0.00   0.00   0.99   3.01
IN  9.00   26.00  15.00   6.99   4.00   0.00   0.00   0.00   0.00   0.00
IN  0.99    3.01   9.99  27.99  15.99   6.00   3.00   0.00   0.00   0.00
IN  0.00    0.00   0.00   1.01   3.99   7.00   6.99   6.99   3.00   0.00
IN  0.00    0.00   0.00   0.00   0.00   0.00   3.00   5.00   5.01   6.00
IN  3.00    0.00   0.00   0.99   0.00   0.99   0.99   1.01   6.99   8.01
IN  6.00    6.99   3.00   0.00   0.00   0.00   0.00   0.00   0.99   0.00
IN  3.00    8.01   6.00   6.99   3.00   0.00   0.00   0.00   0.00   0.00
IN  0.00    0.00  12.99  79.00  11.01   6.99   4.00   0.00   0.00   0.00
IN  0.00    0.00   0.00   1.01   3.99  24.00  15.99   9.99   4.00   0.00
IN  0.00    0.00   0.00   0.00   0.00   3.99   3.99  60.00   9.99   6.99
IN  3.00    0.00   0.00   0.00   0.00   0.00   0.00   0.00   3.00   8.01
IN  5.01    6.00   3.00   0.00   0.00   0.00   0.00   0.00   0.99   5.99
IN  9.99    7.00   5.01   6.00   4.00   0.00   0.00   0.00   0.00   0.00
IN  0.00    0.00   3.00  10.99   5.01   6.00   3.00   0.00   0.00   0.00
IN  0.00    0.00   0.99   3.01   3.00   5.00  21.99   8.01   8.01   3.00
IN  0.00    0.00   0.00   3.00   0.00   1.01   9.00   8.99   6.00   9.00
IN  5.00    0.00   0.00   0.00   0.00   0.00   0.99   2.00   5.01   8.99
IN  9.00    9.00   4.00   0.00   0.00   0.00   0.00   0.00   0.00   1.01
IN  8.01    8.01   6.00   6.99   3.00   0.00   0.00   0.00   0.00   0.00
IN  0.00    3.99  11.01  10.01  27.00   6.99   3.00   0.00   1.01   0.00
IN  0.00    0.00   0.00   2.00   5.01   5.00   5.01   6.00   3.00   0.00
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IN	0.00	0.00								
IN	3	JUNE 69	0.00	0.00	0.00	3.99	6.99	14.00	9.00	5.01
IN	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	10.01
IN	3.99	5.01	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
IN	3.00	17.99	6.99	5.01	3.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	1.01	3.99	5.00	6.00	5.01	3.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	0.00	2.01	3.99	3.99	5.01	3.00	0.00
IN	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	3.99	5.01
IN	2.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	3.00	5.00
IN	3.99	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IN	2.01	5.00	3.00	5.01	2.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	0.00	5.01	34.01	3.00	5.01	3.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	0.00	2.01	10.99	6.99	6.99	3.00	0.00
IN	0.00	0.00	0.00	0.00	0.00	2.00	0.99	33.00	3.00	5.01
IN	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	3.99
IN	2.01	5.01	2.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01
IN	3.99	3.01	3.00	5.01	3.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	0.00	2.01	3.99	8.01	5.01	2.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	1.01	0.99	5.00	9.00	6.00	6.00	2.01
IN	0.00	0.00	0.00	0.99	0.00	0.00	3.99	3.01	0.99	6.99
IN	4.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01	2.01	5.00
IN	3.00	6.99	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IN	3.00	15.99	2.01	5.01	2.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	2.00	5.01	2.00	9.99	5.01	2.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	1.01	2.01	3.01	0.99	5.01	2.00	0.00
IN	0.00	0.00								
IN	4	JUNE 69	0.00	0.99	3.99	1.01	17.01	63.01	12.00	6.00
IN	3.00	2.01	2.00	0.99	1.01	0.00	0.99	3.01	12.99	8.99
IN	0.00	2.01	1.00	0.99	1.01	0.99	0.00	0.99	5.01	3.99
IN	15.00	10.99	63.00	8.01	2.00	0.99	0.00	0.99	1.01	0.00
IN	0.99	8.01	12.00	15.01	6.99	8.01	4.00	3.00	1.01	2.01
IN	3.01	2.01	2.01	5.99	6.00	3.99	6.99	2.01	1.00	0.00
IN	0.00	0.00	1.01	0.00	0.00	5.00	11.01	2.00	0.00	0.99
IN	0.00	0.00	0.00	2.01	0.00	6.99	3.00	10.01	12.99	15.01
IN	3.00	0.00	0.00	0.00	0.00	0.99	0.00	0.99	3.99	2.00
IN	6.00	10.01	3.99	0.00	0.00	0.00	0.00	0.99	2.00	0.00
IN	3.99	3.01	35.01	117.99	0.99	2.01	1.00	0.99	1.01	0.00
IN	0.00	0.99	0.00	8.01	11.01	34.99	32.01	12.00	5.00	2.01
IN	0.00	0.00	2.00	2.01	0.99	19.00	6.99	52.00	3.00	3.00
IN	3.00	0.99	1.01	0.99	1.01	0.00	0.00	1.01	3.00	22.99
IN	2.01	5.01	0.00	0.00	0.00	0.99	3.01	3.00	2.01	13.01
IN	57.00	20.01	3.00	0.99	0.00	0.00	1.01	0.00	1.01	0.00
IN	0.00	3.01	8.01	31.00	0.00	0.00	0.00	0.00	0.00	3.99
IN	1.01	0.00	2.01	8.01	5.01	3.01	48.00	9.99	17.99	20.01
IN	2.00	0.99	0.00	3.00	0.99	8.01	24.00	29.99	8.01	15.99
IN	1.00	0.00	0.00	0.99	3.01	0.99	3.00	13.01	8.01	8.01
IN	6.00	9.00	1.00	0.00	1.01	0.00	0.00	0.00	0.00	5.99
IN	15.00	10.99	6.99	5.01	3.00	0.00	0.00	0.00	3.01	0.00
IN	3.00	8.01	26.01	15.01	33.99	9.99	1.00	0.00	3.01	2.01
IN	0.00	5.01	3.99	22.01	6.00	1.01	0.99	0.00	0.00	0.00
IN	0.00	0.00								
IN	5	JUNE 69	0.00	0.00	0.99	0.00	3.99	13.01	3.00	0.99
IN	1.00	0.00	1.01	0.00	0.00	0.00	0.00	3.99	2.01	2.00
IN	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.99	1.01
IN	3.00	3.99	15.00	2.01	1.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	2.00	3.00	1.01	5.01	2.01	1.00	0.99	0.00	0.99
IN	1.01	0.99	0.99	2.00	2.01	1.01	2.01	0.00	0.00	0.00
IN	0.00	0.00	1.01	0.00	0.00	2.00	3.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	0.00	0.00	2.01	0.99	2.00	3.00	3.01
IN	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00
IN	2.01	3.99	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IN	0.99	1.01	8.01	22.99	0.00	0.00	0.00	0.00	0.00	0.00
IN	1.01	0.99	0.00	2.00	2.01	8.01	6.99	3.00	1.00	0.00
IN	0.00	0.00	1.01	0.99	0.00	5.99	0.99	20.01	0.00	0.99
IN	1.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.99	5.99
IN	0.00	0.99	0.00	0.00	0.00	0.00	1.01	0.99	0.00	3.01
IN	11.01	7.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00

IN	0.00	1.01	5.01	8.01	0.00	0.00	0.00	0.00	0.00	0.99
IN	1.01	0.00	0.00	2.00	0.99	2.00	11.01	3.00	5.00	5.01
IN	0.00	0.00	0.00	0.99	0.00	2.00	6.00	5.00	2.01	3.99
IN	0.00	0.00	0.00	0.00	1.01	0.00	0.99	3.99	2.01	3.01
IN	0.99	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01
IN	3.00	3.99	0.99	0.99	1.00	0.00	0.00	0.00	1.01	0.00
IN	2.01	2.00	6.00	1.01	6.00	2.01	0.00	0.00	1.01	0.99
IN	0.00	0.00	0.99	3.01	0.99	0.00	0.00	0.00	0.00	0.00
IN	0.00	0.00								
IN	6	JUNE 69	0.00	0.99	3.99	2.00	23.01	86.99	12.99	9.99
IN	5.00	3.00	3.01	2.01	2.00	0.99	0.99	17.99	15.99	12.00
IN	0.00	3.99	1.00	2.01	1.01	2.01	0.00	0.99	6.00	8.01
IN	21.99	27.01	94.01	14.01	4.00	2.01	1.01	2.01	3.01	2.01
IN	0.99	12.00	20.01	13.01	32.01	12.00	6.00	5.01	2.00	3.99
IN	5.00	3.99	5.01	8.99	14.01	5.99	12.00	3.00	1.00	0.00
IN	1.01	0.99	8.99	0.99	0.99	10.01	18.00	2.00	0.99	0.99
IN	0.00	0.00	0.00	3.00	0.00	11.01	5.01	15.99	18.00	20.01
IN	6.00	0.99	0.00	0.00	0.00	2.01	0.00	2.01	5.01	2.00
IN	12.99	21.00	8.01	0.99	1.00	0.00	1.01	2.01	2.00	0.99
IN	6.00	8.01	51.99	172.99	2.01	3.00	2.00	2.01	1.01	0.99
IN	3.01	3.00	0.99	14.00	17.01	48.99	42.99	18.99	7.01	3.00
IN	0.00	0.00	3.99	3.00	2.01	39.99	11.01	129.00	3.00	5.01
IN	5.00	0.99	1.01	2.01	17.00	0.00	0.00	1.01	3.99	38.00
IN	2.01	8.01	0.00	0.00	0.00	2.01	5.00	5.01	3.99	20.01
IN	82.01	34.99	3.00	2.01	1.00	0.00	1.01	0.00	1.01	0.00
IN	0.00	5.00	30.00	46.01	0.99	0.00	0.00	0.00	0.00	6.00
IN	5.00	0.00	2.01	10.01	6.99	8.01	68.00	17.01	30.00	33.00
IN	3.01	2.01	0.00	5.01	0.99	12.00	36.99	39.01	11.01	26.01
IN	2.00	0.00	0.00	2.01	3.99	0.99	3.99	21.00	11.01	14.00
IN	8.01	14.01	2.00	0.00	2.00	0.00	0.00	0.00	0.00	10.01
IN	20.01	26.00	6.99	8.01	4.00	0.00	0.00	0.00	3.99	0.00
IN	11.01	10.99	35.01	12.00	39.99	15.99	1.00	0.00	5.00	3.00
IN	0.00	5.01	6.00	24.00	5.01	3.01	0.99	0.00	0.00	0.00
IN	0.00	0.00								
IN	12	JUNE 69	0.00	0.00	0.99	3.01	15.00	45.00	15.00	8.01
IN	4.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	3.99	41.99
IN	135.0	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	5.99
IN	14.01	58.99	21.99	8.01	4.00	0.00	0.00	0.00	0.00	0.99
IN	0.99	2.00	12.99	36.99	30.99	8.01	4.00	0.00	0.00	0.00
IN	0.00	0.00	0.99	1.01	6.00	15.99	14.01	8.01	4.00	0.00
IN	0.00	0.00	0.00	0.00	0.00	0.00	3.99	3.01	53.01	8.01
IN	4.00	0.00	0.00	0.99	0.00	0.99	0.99	1.01	6.99	15.01
IN	15.00	9.00	4.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00
IN	5.01	10.01	17.01	8.01	4.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	0.00	12.00	110.99	12.00	9.00	5.00	0.00	0.00	0.00
IN	0.00	0.00	0.00	1.01	6.00	29.00	24.99	12.00	5.00	0.00
IN	0.00	0.00	0.00	0.00	0.00	7.00	6.99	131.00	8.01	8.01
IN	4.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	3.99	12.00
IN	11.01	8.01	4.00	0.00	0.00	0.00	0.00	0.00	0.99	8.99
IN	12.99	12.00	6.99	8.01	5.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	0.00	9.00	13.01	109.01	8.01	4.00	0.00	0.00	0.00
IN	0.00	0.00	0.99	2.00	5.01	12.00	24.00	9.99	9.01	3.99
IN	0.00	0.00	0.00	3.99	0.00	1.01	9.99	8.99	6.00	11.01
IN	6.00	0.00	0.00	0.00	0.00	0.00	0.99	2.00	5.01	17.00
IN	14.01	12.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01
IN	8.01	105.00	11.01	8.01	4.00	0.00	0.00	0.00	0.00	0.00
IN	0.00	3.01	9.99	5.00	30.99	9.00	4.00	0.00	1.01	0.00
IN	0.00	0.00	0.00	3.01	2.01	7.00	6.99	8.01	4.00	0.00
IN	0.00	0.00								
IN	7	JUNE 69	0.00	0.00	0.99	7.00	24.00	86.00	36.99	12.99
IN	7.01	0.00	0.00	0.00	0.00	0.99	0.99	3.99	6.00	67.99
IN	383.0	12.99	7.01	0.00	0.00	0.00	0.00	0.00	0.99	5.00
IN	21.99	127.99	30.00	12.99	7.01	0.00	0.00	0.00	0.00	2.01
IN	0.99	3.99	21.00	63.01	53.01	12.99	7.01	0.00	0.00	0.00
IN	0.00	0.00	0.99	1.01	11.01	26.00	21.99	12.99	7.01	0.00
IN	0.00	0.00	0.00	0 00	0.00	1.01	6.00	10.01	118.01	12.99
IN	6.00	0.00	0.00	0.99	0.00	0.99	2.01	2.00	12.00	31.00

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IN 27.99   14.01    7.01    0.00    0.00    0.00    0.00    0.99    2.01    0.00
IN  9.00   14.00   30.00   12.99    7.01    0.00    0.00    0.00    0.00    0.00
IN  0.00    1.01   24.99  208.01   14.01   15.00    8.01    0.99    0.00    0.00
IN  0.00    0.00    0.00    2.00   11.01   50.00   39.99   18.99    8.01    0.00
IN  0.00    0.00    0.00    0.00    0.00   10.99    9.00  184.99   21.99   12.99
IN  6.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    5.01   15.01
IN 23.01   12.00    6.00    0.00    0.00    0.00    0.00    0.00    2.01   13.01
IN 18.00   19.00   17.01   12.00    9.01    0.00    0.00    0.00    0.00    0.00
IN  0.00    0.00   14.01   21.00  200.00   12.00    6.00    0.00    0.00    0.00
IN  0.00    0.00    2.01    3.01    8.01   17.99   42.00   15.00   15.01    6.00
IN  0.00    0.00    0.00    6.00    0.00    3.01   11.01   17.99   12.00   18.00
IN 10.01    0.00    0.00    0.00    0.00    0.00    2.01    3.01    8.01   33.00
IN 23.01   18.99    7.01    0.00    0.00    0.00    0.00    0.00    0.00    3.01
IN 15.00  148.99   24.99   12.99    6.00    0.00    0.00    0.00    0.00    0.00
IN  0.00    5.00   18.00   10.99   57.99   15.00    7.01    0.00    1.01    0.00
IN  0.00    0.99    0.99    3.99    3.99   13.01   12.00   12.00    6.00    0.00
IN  0.00    0.00
LIST
EJ
ER
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Annexure 5

*USERS. 1   USER DESIGNED OUTPUT

SUMMARY BY PERIOD   FLOOD=   1

LOC NO=					8.	8.	2.	2.	2.	3.	4.	4.	4.
CODE=					8.310	8.300	2.110	2.310	2.060	3.310	4.110	4.310	4.060
					13-Anicu	13-Anicu	MANIMUKT	MANIMUKT	MANIMUKT	38-Tanks	GOMUKHI	GOMUKHI	GOMUKHI
PER	DY	MO	YR	DW	DIV SHOR	DIV REQU	EOP STOR	DIV SHOR	DEQ-SHOR	DIV SHOR	EOP STOR	DIV SHOR	DEQ-SHOR
1	1	6	69	1	0.00	0.00	955.24	0.00	0.28	0.00	1995.44	0.00	0.57
2	1	7	69	1	0.00	0.00	1860.63	0.00	0.00	0.00	2256.41	0.00	0.00
3	1	8	69	1	0.00	0.00	3761.84	0.00	0.00	0.00	5581.39	0.00	0.00
4	1	9	69	1	0.00	0.00	11259.62	0.00	0.00	0.00	5793.64	0.00	0.00
5	1	10	69	1	0.00	1.11	20850.00	0.00	0.00	0.00	14136.39	0.00	0.00
6	1	11	69	1	0.00	2.02	20850.00	0.00	0.00	0.00	15860.00	0.00	0.00
7	1	12	69	1	0.00	2.74	20850.00	0.00	0.00	0.00	12816.28	0.00	0.00
8	1	1	70	1	1.72	4.33	3285.96	0.00	0.00	0.00	1770.00	0.00	0.00
9	1	2	70	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	0.75	2.17
10	1	3	70	1	0.00	0.00	789.48	0.00	0.28	0.00	2327.98	0.00	0.00
11	1	4	70	1	0.00	0.00	612.68	0.00	0.28	0.00	2847.19	0.00	0.00
12	1	5	70	1	0.00	0.00	451.13	0.00	0.28	0.00	2339.81	0.00	0.00
13	1	6	70	1	0.00	0.00	305.98	0.00	0.28	0.00	2000.00	0.00	0.05
14	1	7	70	1	0.00	0.00	1074.78	0.00	0.28	0.00	1995.95	0.00	0.28
15	1	8	70	1	0.00	0.00	1128.15	0.00	0.00	0.00	2257.12	0.00	0.00
16	1	9	70	1	0.00	0.00	3979.14	0.00	0.00	0.00	4512.06	0.00	0.00
17	1	10	70	1	0.00	1.11	12006.16	0.00	0.00	0.00	8773.39	0.00	0.00
18	1	11	70	1	0.00	2.02	20850.00	0.00	0.00	0.00	4888.76	0.00	0.00
19	1	12	70	1	0.00	2.74	20850.00	0.00	0.00	0.00	1770.00	1.03	2.32
20	1	1	71	1	1.72	4.33	960.00	0.00	0.00	0.00	1770.00	2.63	2.32
21	1	2	71	1	0.96	2.36	960.00	0.11	0.22	0.00	1770.00	1.52	2.17
22	1	3	71	1	0.00	0.00	789.48	0.00	0.28	0.00	2000.00	0.00	0.27
23	1	4	71	1	0.00	0.00	612.68	0.00	0.28	0.00	2000.00	0.00	0.18
24	1	5	71	1	0.00	0.00	451.13	0.00	0.28	0.00	2000.00	0.00	0.19
25	1	6	71	1	0.00	0.00	305.98	0.00	0.28	0.00	1995.44	0.00	0.57
26	1	7	71	1	0.00	0.00	1074.78	0.00	0.28	0.00	2256.41	0.00	0.00
27	1	8	71	1	0.00	0.00	2063.25	0.00	0.00	0.00	6625.54	0.00	0.00
28	1	9	71	1	0.00	0.00	6795.10	0.00	0.00	0.00	9765.69	0.00	0.00
29	1	10	71	1	0.00	1.11	20850.00	0.00	0.00	0.00	15860.00	0.00	0.00
30	1	11	71	1	0.00	2.02	20850.00	0.00	0.00	0.00	13764.19	0.00	0.00
31	1	12	71	1	0.00	2.74	20850.00	0.00	0.00	0.00	15860.00	0.00	0.00
32	1	1	72	1	1.72	4.33	6793.36	0.00	0.00	0.00	1770.00	0.00	0.00
33	1	2	72	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	1.13	2.17
34	1	3	72	1	0.00	0.00	789.48	0.00	0.28	0.00	2000.00	0.00	0.27

C NO=					8.	8.	2.	2.	2.	3.	4.	4.	4.
					13-Anicu	13-Anicu	MANIMUKT	MANIMUKT	MANIMUKT	38-Tanks	GOMUKHI	GOMUKHI	GOMUKHI
PER	DY	MO	YR	DW	DIV SHOR	DIV REQU	EOP STOR	DIV SHOR	DEQ-SHOR	DIV SHOR	EOP STOR	DIV SHOR	DEQ-SHOR
35	1	4	72	1	0.00	0.00	612.68	0.00	0.28	0.00	1995.40	0.00	0.57
36	1	5	72	1	0.00	0.00	451.13	0.00	0.28	0.00	2000.00	0.00	0.19
37	1	6	72	1	0.00	0.00	305.98	0.00	0.28	0.00	2000.00	0.00	0.18
38	1	7	72	1	0.00	0.00	1074.78	0.00	0.28	0.00	1995.95	0.00	0.28
39	1	8	72	1	0.00	0.00	2063.25	0.00	0.00	0.00	2257.12	0.00	0.00
40	1	9	72	1	0.00	0.00	7775.79	0.00	0.00	0.00	9469.48	0.00	0.00
--- INTERMEDIATE LINES DELETED ---													
222	1	11	87	1	0.00	2.02	20850.00	0.00	0.00	0.00	15860.00	0.00	0.00
223	1	12	87	1	0.00	2.74	20850.00	0.00	0.00	0.00	15860.00	0.00	0.00
224	1	1	88	1	0.96	4.33	8552.00	0.00	0.00	0.00	1770.00	0.00	0.00
225	1	2	88	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	1.52	2.17
226	1	3	88	1	0.00	0.00	789.48	0.00	0.28	0.00	1768.01	0.00	0.57
227	1	4	88	1	0.00	0.00	1692.49	0.00	0.00	0.00	3299.03	0.00	0.00
228	1	5	88	1	0.00	0.00	1100.00	0.00	0.18	0.00	3820.55	0.00	0.00
229	1	6	88	1	0.00	0.00	875.62	0.00	0.28	0.00	2326.79	0.00	0.00
230	1	7	88	1	0.00	0.00	712.36	0.00	0.28	0.00	6691.60	0.00	0.00
231	1	8	88	1	0.00	0.00	1100.00	0.00	0.11	0.00	9902.08	0.00	0.00
232	1	9	88	1	0.00	0.00	3954.37	0.00	0.00	0.00	15860.00	0.00	0.00
233	1	10	88	1	0.00	1.11	9011.31	0.00	0.00	0.00	12656.16	0.00	0.00
234	1	11	88	1	0.00	2.02	10733.08	0.00	0.00	0.00	1770.00	0.00	0.38
235	1	12	88	1	0.29	2.74	960.00	0.00	0.00	0.00	1770.00	1.80	2.32
236	1	1	89	1	1.76	4.33	960.00	0.60	0.37	0.00	1620.82	3.32	2.35
237	1	2	89	1	1.35	2.36	960.00	0.50	0.22	0.00	1470.98	1.81	2.20
238	1	3	89	1	0.00	0.00	789.48	0.00	0.28	0.00	1470.98	0.00	0.57
239	1	4	89	1	0.00	0.00	612.68	0.00	0.28	0.00	1470.98	0.00	0.57
240	1	5	89	1	0.00	0.00	451.13	0.00	0.28	0.00	1470.98	0.00	0.57
			SUM =		45.11	251.20	1352570.00	6.01	33.27	0.00	1212560.00	63.52	111.62
			MAX =		1.76	4.33	20850.03	0.60	0.71	0.00	15860.00	3.32	2.35
			MIN =		0.00	0.00	8.82	0.00	0.00	0.00	0.00	0.00	0.00
			PMAX=		68.00	8.00	163.00	68.00	136.00	1.00	6.00	80.00	236.00
			AVG =		0.19	1.05	5635.71	0.03	0.14	0.00	5052.33	0.26	0.47
			PMIN=		1.00	1.00	64.00	1.00	2.00	1.00	80.00	1.00	2.00