TRAINING COURSE

ON

RESERVOIR OPERATION

(UNDER WORLD BANK AIDED HYDROLOGY PROJECT)

Module 14

Simulation of Multireservoir

Systems Using

HEC-5

BY

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1.0 INTRODUCTION

The reservoirs are commonly built 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 purpose, on the other hand, requires 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.

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 program, has been described in the lecture. The HEC-5 program was developed at The Hydrologic Engineering Centre of US Army Corps of Engineers. An application study using HEC-5 for the Vellar Basin, Tamilnadu has also been described.

2.0 DESCRIPTION OF HEC-5

The generalized program *Simulation of Flood Control and Conservation Systems*, also known as HEC-5, is briefly described here. This program has been developed by the Hydrologic Engineering Center, USA. The HEC-5 program was 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.

2.1 System Configuration

Any reservoir system configuration can be analyzed as long as the dimension limits are not exceeded for number of 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.

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.

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.

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 HEC-5 users manual, HEC (1982). This manual also lists the input and output of the program for various test problems. Recently, a PC version of this program has been brought out.

3.0 RESERVOIR OPERATION IN HEC-5

The HEC-5 operates a reservoir is 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, 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.

3.1 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 in balance a system of gated flood control reservoirs 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 find 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.

3.2 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. For rule curve operation (plant factor vs. percent conservation storage) benefits based on plant factors may be calculated.

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 column 3-8 since columns 1 and 2 are reserved for the identification characters.

In the input file the different types of data cards are to be placed in a proper sequence. The first three (optional) cards, 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 indentification 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.

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. The extent of details in output can be controlled through the job control cards. The user can also design the tabular output and the various columns of such a table can be chosen by the user.

4.0 THE VELLAR BASIN

A case study of HEC-5 application to the Vellar basin is described in the following. The Vellar river is an important river of Tamilnadu. The Vellar 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 major tributaries of Vellar river system are Vasistanadi, Swetanadi, Gomukhi river, and Manimukta Nadi.

The Vellar river flows through the South Arcot, Salem and Trichinapalli districts of Tamilnadu. The river originates from the southern slopes of Kalrayam hills, at the northern boundary of Attur Taluk of Salem district. 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. The river finally empties into the Bay of Bengal near Portonovo in the Chidambarm Taluk of South Arcot district. 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.

4.1 The Manimukta Sub-basin

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 study, the modelling of sub-basin I, i.e., Catchment of Manimukta nadi up to the confluence of Periya Odai has been taken up.

The Manimukta and Gomukhi Reservoirs and Memathur regulator are the major projects in sub-basin I. The Manimukta reservoir is formed across Manimukta tributary at about 5 km below the confluence of Mani and Mukta rivers. It has a catchment area of 484 sq. km. The live storage capacity of the reservoir is 19.89 M cum and it irrigates an area of 1719.98 ha. The Gomukhi reservoir is located on the Gomukhi tributary. 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 Memathur regulator is located across Manimukta nadi at about 5 km below the confluence of Gomukhi. The total catchment area of the regulator is 1683.50 sq. km. It irrigates an area of 2419.47 ha. In addition to the major reservoirs and regulators, about 214 minor tanks and 63 minor regulators (anicuts) located in sub-basin I have been considered. These anicuts are located on various tributaries of the Vellar river and the tanks in the catchments of the anicuts.

As it is practically impossible to represent all the 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. These groupings were done according to the location of tanks and anicuts on various tributaries.

4.2 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. 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.

In the Vellar basin, 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. 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.

The monthly evaporation data were available for Manimukta reservoir. The same data has been used for the whole basin. The Area-Storage-Release capacity table for Manimukta reservoir and the Elevation-Capacity table for Gomukhi reservoir were available and used.

4.3 Vellar System Setup

The input data file for the Vellar system was prepared as described in the previous section. 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. 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. 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. 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. 2. Since the flood control was not a major objective of this problem, 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.

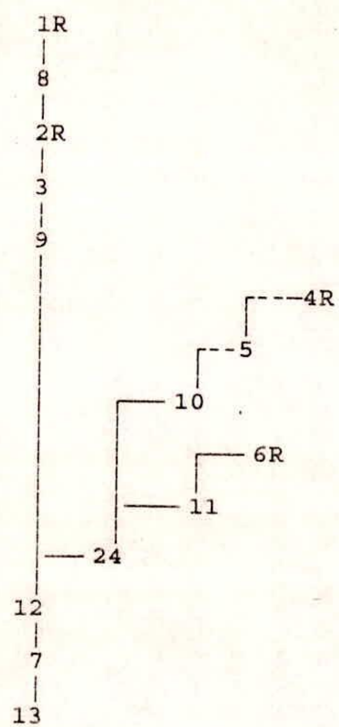
5.0 VELLAR SYSTEM SIMULATION WITH HEC-5

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 for this small part was properly setup, 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 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. The various decision variables were iteratively modified so as



CHANNEL CAPACITY	FLOOD CTRL STORAGE	CONSERV. STORAGE	MIN DES. FLOW	MIN REQ. FLOW	LOCATION Id	LOCATION 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. 2 Salient Features Of The Control Points

to get the best possible results from the operation of the system. A part of one such table is shown in Table 1.

The summary data about the reliability for the various control points is given in Table 2. 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 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.

6.0 REFERENCES

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

Jain,S.K., and M.K. Goel, "Simulation of a Vellar Sub-basin Using HEC-5", National Institute of Hydrology, Roorkee, 1996.

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Table 2

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	201	83.75	1	5	82.04
Manimukta Diversion	226	94.17	8	40	96.33
Manimukta Mandatory	120	50.0	1	5	64.44
38-Tanks	240	100.0	20	100	100.0
4-Anicuts	224	93.33	7	35	91.38
Gomukhi Diversion	206	85.83	2	10	67.02
Gomukhi Mandatory	127	52.92	0	0	65.42
18-Tanks	208	86.67	2	10	72.60
12-Anicuts	185	77.08	0	0	51.76
49-Tanks	208	86.67	6	30	73.41
32-Anicuts	190	79.17	0	0	51.13
Memathur Regulator	222	92.5	6	30	95.60
80-Tanks	234	97.5	14	70	99.90
2-Anicuts	238	99.17	18	90	99.00

Table 1

*USERS. 1 USER DESIGNED OUTPUT

SUMMARY BY PERIOD FLOOD= 1

LOC NO=					8.	8.	2.	2.	2.	3.	4.	4.
CODE=					8.310	8.300	2.110	2.310	2.060	3.310	4.110	4.310
					13-Anicu	13-Anicu	MANIMUKT	MANIMUKT	MANIMUKT	38-Tanks	GOMUKHI	GOMUKHI
PER	DY	MO	YR	DW	DIV SHOR	DIV REQU	EOP STOR	DIV SHOR	DEQ-SHOR	DIV SHOR	EOP STOR	DIV SHOR
1	1	6	69	1	0.00	0.00	955.24	0.00	0.28	0.00	1995.44	0.00
2	1	7	69	1	0.00	0.00	1860.63	0.00	0.00	0.00	2256.41	0.00
3	1	8	69	1	0.00	0.00	3761.84	0.00	0.00	0.00	5581.39	0.00
4	1	9	69	1	0.00	0.00	11259.62	0.00	0.00	0.00	5793.64	0.00
5	1	10	69	1	0.00	1.11	20850.00	0.00	0.00	0.00	14136.39	0.00
6	1	11	69	1	0.00	2.02	20850.00	0.00	0.00	0.00	15860.00	0.00
7	1	12	69	1	0.00	2.74	20850.00	0.00	0.00	0.00	12816.28	0.00
8	1	1	70	1	1.72	4.33	3285.96	0.00	0.00	0.00	1770.00	0.00
9	1	2	70	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	0.75
10	1	3	70	1	0.00	0.00	789.48	0.00	0.28	0.00	2327.98	0.00
11	1	4	70	1	0.00	0.00	612.68	0.00	0.28	0.00	2847.19	0.00
12	1	5	70	1	0.00	0.00	451.13	0.00	0.28	0.00	2339.81	0.00
13	1	6	70	1	0.00	0.00	305.98	0.00	0.28	0.00	2000.00	0.00
14	1	7	70	1	0.00	0.00	1074.78	0.00	0.28	0.00	1995.95	0.00
15	1	8	70	1	0.00	0.00	1128.15	0.00	0.00	0.00	2257.12	0.00
16	1	9	70	1	0.00	0.00	3979.14	0.00	0.00	0.00	4512.06	0.00
17	1	10	70	1	0.00	1.11	12006.16	0.00	0.00	0.00	8773.39	0.00
18	1	11	70	1	0.00	2.02	20850.00	0.00	0.00	0.00	4888.76	0.00
19	1	12	70	1	0.00	2.74	20850.00	0.00	0.00	0.00	1770.00	1.03
20	1	1	71	1	1.72	4.33	960.00	0.00	0.00	0.00	1770.00	2.63
21	1	2	71	1	0.96	2.36	960.00	0.11	0.22	0.00	1770.00	1.52
22	1	3	71	1	0.00	0.00	789.48	0.00	0.28	0.00	2000.00	0.00
23	1	4	71	1	0.00	0.00	612.68	0.00	0.28	0.00	2000.00	0.00
24	1	5	71	1	0.00	0.00	451.13	0.00	0.28	0.00	2000.00	0.00
25	1	6	71	1	0.00	0.00	305.98	0.00	0.28	0.00	1995.44	0.00
24	1	5	71	1	0.00	0.00	451.13	0.00	0.28	0.00	2000.00	0.00
25	1	6	71	1	0.00	0.00	305.98	0.00	0.28	0.00	1995.44	0.00
26	1	7	71	1	0.00	0.00	1074.78	0.00	0.28	0.00	2256.41	0.00
27	1	8	71	1	0.00	0.00	2063.25	0.00	0.00	0.00	6625.54	0.00
28	1	9	71	1	0.00	0.00	6795.10	0.00	0.00	0.00	9765.69	0.00
29	1	10	71	1	0.00	1.11	20850.00	0.00	0.00	0.00	15860.00	0.00
30	1	11	71	1	0.00	2.02	20850.00	0.00	0.00	0.00	13764.19	0.00
31	1	12	71	1	0.00	2.74	20850.00	0.00	0.00	0.00	15860.00	0.00
32	1	1	72	1	1.72	4.33	6793.36	0.00	0.00	0.00	1770.00	0.00
33	1	2	72	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	1.13
34	1	3	72	1	0.00	0.00	789.48	0.00	0.28	0.00	2000.00	0.00
35	1	4	72	1	0.00	0.00	612.68	0.00	0.28	0.00	1995.40	0.00
36	1	5	72	1	0.00	0.00	451.13	0.00	0.28	0.00	2000.00	0.00
37	1	6	72	1	0.00	0.00	305.98	0.00	0.28	0.00	2000.00	0.00
38	1	7	72	1	0.00	0.00	1074.78	0.00	0.28	0.00	1995.95	0.00
39	1	8	72	1	0.00	0.00	2063.25	0.00	0.00	0.00	2257.12	0.00
40	1	9	72	1	0.00	0.00	7775.79	0.00	0.00	0.00	9469.48	0.00
--- INTERMEDIATE LINES DELETED ---												
223	1	12	87	1	0.00	2.74	20850.00	0.00	0.00	0.00	15860.00	0.00
224	1	1	88	1	0.96	4.33	8552.00	0.00	0.00	0.00	1770.00	0.00
225	1	2	88	1	0.96	2.36	960.00	0.00	0.00	0.00	1770.00	1.52
226	1	3	88	1	0.00	0.00	789.48	0.00	0.28	0.00	1768.01	0.00
227	1	4	88	1	0.00	0.00	1692.49	0.00	0.00	0.00	3299.03	0.00
228	1	5	88	1	0.00	0.00	1100.00	0.00	0.18	0.00	3820.55	0.00
229	1	6	88	1	0.00	0.00	875.62	0.00	0.28	0.00	2326.79	0.00