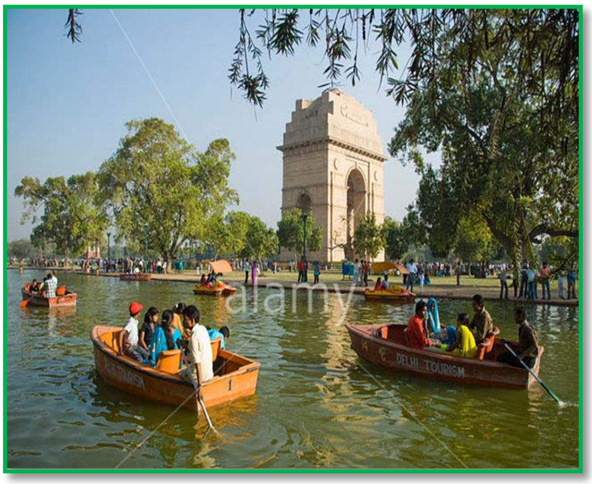
CREATION OF LAKES - NCTD



A FEASIBILITY REPORT

DELHI

AUGUST 1984

DELHI ADMINISTRATION: DELHI IRRIGATION AND FLOOD CONTROL WING

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PROPOSAL FOR CREATION OF LAKE IN NCTD.

1. BACKGROUND

During the course of a couple of meetings taken by the Chief Executive Councilor in the last fortnight regarding the Effluent Irrigation Scheme of the Flood Control Department's exchange of effluent water with Haryana for supply of raw water for drinking purposes and prevention of pollution in the River Yamuna etc. , the Chief Executive Councilor desired that some concrete proposals exploring the feasibility of creating lakes in the Union Territory of Delhi be examined and put up by the Flood Control Department at the earliest. Such lakes could be multi-purpose in use like supply of water for drinking, creating of picnic spots, recharge of ground water, moderation of floods etc. With this as the background, topo sheets of Union Territory of Delhi have been studied and in the first instance, the visit from Kakraula regulator in Dhansa bund has been carried out by the Development Commissioner-cum-Secretary (I&F) accompanied by the Chief Engineer (I&F) and his other officers.

The result of these topo sheet studies and inspections indicate that it would be possible to create a water lake from Dhansa bund up to Chhawla bridge which is a distance of 17678 Km. If necessary, this lake could be further extended within the Najafgrah Drain by another 4.48 km. up to Ambrahi bridge. Since Palam drain outfalls into Najafgarh drain just down-stream of this bridge and carries sewerage and sullage during non-monsoon months due to existing urbanization in its catchment as well as further urbanization proposed by the Delhi Development Authority, any further extension of this lake below Palam drain up to Kakraula will not be free from pollution. Hence the same is not kept in view in this proposal.

1.1 Location and area

The Union Territory of Delhi forms a part of the Indo-Gangetic plain and lies between 28 degree 24' – 17" and 28 degree-53' -00 north latitude and 76 degree-50' – 24" and 77 degree- 20' -37" east longitude. It is surrounded in the northern, western and southern sides by Sonepat, Rohtak and Gurgaon districts of Haryana respectively and on the eastern side by the Ghaziabad district of U.P. The Yamuna river flows close by the side of eastern border in the north-south directions.

Delhi occupies a land area of about 1,425 Sq. Kms. out of which, as per 1981 statistics, about 594 Sq. Km. is urban and the balance 291 Sq. Kms. Is rural.

1.2 Population

During the decade 1941-51, the population increased from 9.12 lakhs to 17.44 registering an abnormal growth of 90%. In the subsequent three decades viz. 1951-61, 1961-71 and 1971-81, the rate of increase of population has been 52.4%, 529% and 52.4% respectively. As per the 1981 census, the population of the Union Territory is 62 lakhs. According to the projections made by the Delhi Development Authority, in their perspective plan, the population of Delhi is likely to touch a staggering figure of 128 lakhs by the year 2001 A.D. This phenomenal increase in population of Delhi has resulted in accelerated pace of urbanization.

5.2.6 CATCHMENT AREAS OF PROPOSED NAJAFGARH LAKE

2.1 The Sahibi river ultimately drains into the Yamuna through Najafgarh drain in Delhi. The Najafgarh nallah/drain has also to carry the drainage water from large area in Haryana adjoining Delhi. Initially, water from large areas of Gurgaon and Rohtak districts used to drain through Delhi. After the construction of diversion drain No. 2 and diversion drain No. 8, the runoff from these areas is being drained directly into the river Yamuna. The Haryana Government is also constructing a barrage at Masani intercepting the catchment areas of river Sahibi. In view of above, the catchment area of river Sahibi downstream of Masani barrage up to Dhansa bund has been considered for our study as per details given below:-

A	**i.**	**Catchment area of Sahibi up to Masani Barrage**	**=**	**5,051 Sq. Km.**
	ii.	**Catchment area of Sahibi up to Dhansa**	**=**	**6,889 Sq. Km.**
	iii.	**Catchment area between Masani and Dhansa**	**=**	**1,838 Sq. Km.**

In addition to this, some area is directly draining into Najafgarh Jheel from south, details of which are as under:

A	i.	Gurgaon and Manesar nallah and other adjoining areas	=	464 Sq. Km.
	ii.	Area between Gurgaon nallah and Palam Drain	=	189 Sq. Km.

These two total catchments thus contribute the runoff from 2491 Sq. Km.

2.2 Dhansa Bund

This bund was constructed around 1962 along Delhi-Haryana border. The total length of bund is 3.568 Km. Its full reservoir level is 212.50 m (697 feet) and the top of the bund is 214.00 m (702 feet). It is not suitable tagging point was available in Delhi area. The high ground is available in Haryana territory. Initially, regulator with a capacity of 28 cumecs (900 cusecs) was provided in the bund so that the water of

Sahibi Nadi and other areas in Haryana could be drained into Najafgarh drain in Delhi, only when the drain was free to carry discharge. On account of 1964 floods, the Dhansa bund was strengthened as well as capacity of Dhansa regulator was increased to 85 cumecs (3000 cusecs)

2.3 Najafgarh Jheel

There is a natural bowl shaped depressions. This depression covers the area both in Haryana and Delhi. In earlier years, this jheel used to act as a natural detention basis moderating the flood water coming from Haryana area With the construction of the left bank of the Najafgarh drain through the jheel portion to protect cultivated land and about 30 villages in Delhi side, the capacity of the jheel has been reduced. There is no bank on Haryana side in a length of about 6 Km. The capacity of the jheel at various elevations is as given below:

TABLE

S. N.	Level	Capacity of Najafgarh Jheel		
1.	210.92 M (692 ft)	23300	acre feet	28.66 MCM
2.	211.84 M (695 ft)	42600	acre feet	52.40 MCM

2.4 Najafgarh drain

There is a regular drain from Dhansa Bund to Najafgarh Jheel which is known as Dhansa outfall channel. Earlier, the Najafgarh drain used to take off from down-streams of Najafgarh Jheel. Now, it is a continuous drain from Dhansa and through Najafgarh jheel right up to its outfall in the Yamuna. It drains rural areas of Delhi and Haryana up to Kakraula. At Kakraula, a regulator with a capacity of 85 Cumecs (3000 cusecs) exists. In addition, there is a road bridge at Kakraula through which the discharge of 14160 cumecs (5000 cusecs) can be passed. The length of the drain from Shansi to Kakraula is about 30 Km. From Kakraula up to its outfall in the Yamuna, the drain has a total length of about 47 Km. The present capacity of Najafgrah drain is as under:

1.	From Dhansa to Kakraula	226.56 Cumecs (8000 cusecs)
2	Kakraula to outfall	283.20 Cumecs (10000 cusecs)

2.5 Rainfall data and analysis

The rainfall series up to Dhansa established by the Central Water Commission for Sahibi Nadi-Najafgarh nallah drainage basis, has been used for this study. This data is based on a 34 rain-gauge stations in and around the catchment out of which 22 areas are self-recoding. The rainfall data is used for 87 years i.e from 1891 to

1977. The average monsoon rainfall works out to 492 mm (19.35 inch). In a period of 87 years, more than average rainfall has been recorded in a period of 42 years. Here, also, rainfall of more than 30" was recorded only in 4 years namely 1917 (43.76"), 1933 (32.49"), 1942 (34.19"). It will, thus, be seen that the rainfall of 1977 was exceeded once in 1917. Thus, the return period of 1977 works out as once in 50 years.

Month wise distribution of maximum rainfall is as under:

Month	Maximum rainfall/in inches/mm	Year of Occurrence	Total monsoon rainfall in the year
June	8.58" (218 mm)	1933	32.40´(825mm)
July	15.80" (401 mm)	1930	24.40" (620mm)
August	18.04" (458 mm)	1960	27.16" (690mm)
September	15.17" (385 mm)	1917	43.76" (1112 mm)
October	6.55" (166 mm)	1956	23.44" (595 mm)

The rainfall series for the period 1891 to 1977 are given in **Annexure I**. The series arranged in descending order to work out the rainfall at 50% and 75% dependability are given in **Annexure II**. The rainfall series for the months June to October and for the monsoon rainfall for the aforesaid period, are exhibited in **drawing No. 8.**

2.6 Ground water

Ground water occurs in all the formations of the Union Territory of Delhi. Sand and Kankar mixed with clays form the aquifers. These occur as inter-bedded or lenticular deposits.

The total ground water potential from the entire Union Territory of Delhi has been estimated to be of the order of 146x 10^6 m^3 available as the net usable ground water potential. The water table in the kanor portion of the Union Territory is generally within 4 meter below the ground level except within and close to the Delhi ridge where water levels are deeper.

The ground water has been developed on an extensive scale mostly through dug walls, bore walls, shallow cavity and deep tube wells. Large scale development has already taken place in the shallow aquifers in almost all the development blocks, more particularly in the Najafgarh block.

3. ASSESSMENT OF SURFACE WATER

3.1 Assessment of Surface Water by Actual Observations

The gauge and discharge observations are being conducted down-stream of Dhansa regulator where only the releases from Dhansa regulators are measured. Since the present proposal is to impound the runoff from June to October released through Dhansa, and store the same to be utilized for drinking facilities as first priority and there-after for any other purpose. The run-off data for the perior 1965 to 1983 has been considered for the study. The run off /releases for the months (June to October) for the period 1965 to 1983 has been arranged in the descending order. From the data so arranged, value of 50% and 75% dependability have been chosen. The sum of the value so obtained given the run off at 50% and 75% dependability as detailed below:

S. No.	%age dependability	Run off in MCM
1.	50%	3.910
2.	75%	0.347

The run off for the months June to October has also been plotted and exhibited in the **drawing No. 5**. The run off computations are given in **Annexure. No. III.**

3.2 Assessment of Surface Water Potential By Khosla's Formula

Dr. A.N. Khosla's was the Chairman of the Central Water and Power Commission from 1945 to 1953 developed a formula in 1940 based in his studies of the Sutlej, the Mahanadi and other river system.

Khosla's formula, as it is popularly known, described run-off as a function of rainfall and temperature. The run-off is the residue of rainfall after deduction of losses. The losses are assessed on account of evaporation and transpiration which, in turn, are functions of the temperature of the areas. The formula, suggested, is as under.

Rm	=	Rm-Lm	
Where PN	=	Monthly run off in mm	
Pm	=	Monthly rainfall in mm	
Lm	=	Monthly losses in mm=	481 TM where TM 74.50
Tm	=	Mean monthly temperature in C˚	

The Central Water Commission has established a rainfall series for Sahibi-Dhansa-Najafgarh drainage basin. The monthly rainfall data for June to October for the period 1891 to 1977 has been taken into consideration for the study purposes. The mean monthly temperature used for the calculation is the average of monthly maximum and minimum temperature for the period 1931 to 1980. The table below shows the maximum and minimum temperature of different months and their mean value, since as temperature data is being observed at Dhansa, the temperature data of Gurgaon observatory maintained by I.M.D. has been used for study.

Mean temperature data of Gurgaon based on 50 Years data for 1931-1980

Months	Mean of Daily Max.	Daily Min.	Mean Co
June	41.2	26.4	33.8
July	37.0	25.2	31.4
August	35.0	25.0	30.0
September	35.0	23.2	29.1
October	34.3	17.8	26.1

Based on the monthly rainfall and mean monthly temperature, monthly run-off in mm are calculated by Khosla's formula for different months i.e. from June to October. The value of 50% and 75% dependability's are chosen as per the procedure enumerated above. The value so obtained are added to get the dependable monsoon run off. The run off for the period 1891 to 1977 for the monsoon period are given in Annexure IV and exhibited in drawing No. 4. From the above series 50% and 75% dependable run off in 39.166 MCM & 0.00 MCH respectively. The utilizable flow has been taken as 50% and is 19.583 MCM. The details are given in **Annexure V.**

3.3 Surface Water Potential Assessed From Storage Tables/Curves

For assessing the surface water potential, the rainfall series established by the Central Water Commission for the period 1891 to 1977 has been used. The monthly rainfall for the month June to October for the period referred above have been given Annexure II. These figures have been arranged in descending order to arrive at 50% and 75% dependability rainfall for the respective months. These values are added to arrive at the monsoon flows.

The yield for the effective catchment area blow masani barrage and up to Dhansa i.e. 2491 Sq. Km. (962 Sq. mile) are tabulated below:

The yield series are given in Annexure No. VI.

S. No.	**%age depend-good run-off**	**Yield in Average**		**inches/sq. miles poor**	
1.	50%	2.6"	1.95"	1.41"	3084.79 87.36
2.	75%	1.25"	0.96"	0.74"	1618.97 45.86

It may be not be possible to exploit all the surface water resources available on account of various limitations viz;

i. Lack of suitable storage/diversion site.
ii. Lack of suitable topography.
iii. Environmental conditions etc.

The utilizable flow has been taken as 50% of the normal run off computed by Khosla's formula and by strenge's tables.

The utilizable flow computed by various method is as under:

Comparison of surface water potential

S. No.	%age depend ability	Run-off in MCM as per actual observation	(Acre feet) as per Khosla's formula	As per strange's table
1.	50%	3.91 (3169	19.58	43.68 (35411.81)
2.	75%	0.347 (28128)		22.92 (18581.47)

Note 1 MCM = 210.71 Acre feet

3.4 From the perusal of the above, it is seen that the assessment, made from the actual releases, may be taken as indicative only, as the observations are for a short duration. In addition to this, the velocity, being observed, is by float method only. The run off computed by strange's table do not account for the losses due to temperature so these cannot be taken as the authentic.
From our study purposes, the runoff computed by Khosla's formula can be taken as more represented as it accounts for losses due to temperature. Moreover, the data for a longer period has been used for the present study.

4.0 WATER REQUIREMENT FOR WATER SUPPLY-PRESENT UTILISATION

4.1 The present total population of the Union Territory of Delhi, as per the latest census of 1981, is above 62 lakhs. The requirement of water for the present population, 80 gallons per head per day, is about 490 MGD. Against this, the available supply from the Yamuna is only 276 MGD (176 MGM a Wazirabad-Chandrawal, and Okhla Plants and 100 MGD at Haiderpur plant). The Government of U.P. has committed to supply 100 MGD for Shahdara Water treatment plant.

4.2 Head for augmentation of drinking water facilities

In the Ministry of Works and Housing, Govt. of India, d. o. letter No. 3153/GPHEED-80 dated 15.5.80 to Member (WR), Central Water Commission, a reference has been made to the norms laid down in the 'Manual on water supply and treatment' published by the same Ministry which are reproduced below.

Urban domestic and non-domestic needs

4.3 While a minimum 70 to 100 litres per capita per day may be considered adequate for the domestic need at the urban communities, the non-domestic needs will vary according to size and economic importance, requiring 25 to 100 litres per capita per day, in addition. As a general rule, the following rates per capita per day are considered minimum for domestic and non-domestic needs.

i.	For communities with population up to 10,000	= 70 to 100 litres
ii.	For communities with population of 10,000 to 50,000	= 100 to 125 litres
iii.	For communities with population above 50,000	= 125 to 200 litres

The requirement of each case will have to be studied with reference to the local factors governing the non-domestic needs before the optimum rate of supply for the communities is decided upon.

The water requirements for institutional and industrial needs should be provided in addition to the provision indicated above, wherever required, if they are of considerable magnitude and not covered in the provision already made.

b. Rural domestic needs for additional information

In case of rural communitie where houses service connections are not contemplated and the supply is through hand pumps or control stand post, the rate should not be less than 40 litres per day and where house service connections are contemplated to make the scheme self-paying, the rate shall be at least 70 litres per capita per day.

4.5 Yard Stick Adopted For Water Consumption

4.5.1 Human Population

In general accordance with the standard laid down by the Ministry of Works & Housing, Government of India the rate of consumption of water for urban and rural population are as under:

i. Urban population 125 litre per capita per day
ii. Rural population 70 litre per capita per day
iii. Live stock 40 litre per day
iv. Industries equal to human population consumption

4.5.2 Status of Present Water Use

The status of present water use has been calculated as per the norms indicated above and are tabulated as under:-

S. N.	Particulars	Population As per 1981 Census in lakhs	Rate per capita LPD	Water consumption LPD/MCM	Water consumption in MGD
1.	Urban	87.52	128	7190, 00000, 0.719 MCM	158.37
2.	Rural	4.44	70	3103, 0000, 0.0308 MCM	6.84
3.	Industries	-	-	-	165.21
4.	Livestock	2.087	40	8229240, 0.0082 MCM	1.81
					332.23

From the above, it is evident that there is a deficit of (332.23 – 276) 56.22 **MGD** if the consumption of water use is accounted for human population Industries and livestock based on the norms indicated above. If the assessment of water consumption is calculated @ 80 gallons per capita per day then the deficit will work out to 219.68 **MGD** since the consumption of water use @ gallons per day appears to be on very much higher side, it is felt that the norms for water consumption for various uses as per the Ministry of Works & Housing appears to be in order. In view of above, there is a deficit of 56.23 MGD.

5.0 AVAILABILITY OF SURFACE WATER

5.1 The assessment of surface water potential has been taken by Khosla's formula as it accounts for the losses due temperature effect. The surface water availability at 50% dependability has been worked out as 19.583 MCM/ 4307.67 MG/ 15876.13 acre feet. In the absence of any rational method, the runoff calculated by the Khosla's formula holds the field and is, generally, adopted by various organisations.

5.2 Storage

The present proposal is to impound the monsoon flow (June to October) in the Najafgarh drain from Dhansa to Ambrahi bridge and in the Najafgarh Jheel and utilize the same during the loan period. The computed run off calculated by Khosla's formula worked out to 19.583 MCM (15876.13 acre feet). The surface water so envisaged in proposed to be stored as per details given below:-

S.N.	Length In meter	R.L.	Particulars	Capacity in acre Feet --------------------- Dhansa to Chhawla	Chhawla to Ambrahi	Total Capacity in acre MG/feet
1	22160	208.47 684	Najafgarh drain	3115	-	3115
2.	22160	210.30 690	Najafgarh drain	-	1325	1325
3.	-	210.30	Jheel	-	-	12929
						17369 Av .Ft.
			Total			21.39 MCM 4690

Reservoir losses

5.3 There are always some losses in a reservoir from evaporation, absorption and deep percolation. Losses by absorption will depend on the type of soil forming the reservoir basis. Since the soil of the Najafgarh Jheel and of the Najafgarh drain are saturated on account of various floods encountered, hence, these have been neglected in our study.

Evaporation loss directly depends on reservoir area and is, therefore, usually, expressed in inch/mm. The other important factors influencing evaporation are temperature, wind velocity and relative humidity. The IMD has observed the mean evaporation in millimeter for each month based on the date for the year 1959-1975 for the New Delhi observatory. These are tabulated as under:-

S. No.	Months	Lake value (mm)
1.	January	72.40
2.	February	88.40
3.	March	173.70
4.	April	247.50
5.	May	331.90
6.	June	321.20
7.	July	196.80
8.	August	141.80
9.	September	141.80
10.	October	151.40
11.	November	98.80
12.	December	74.50

The losses for June to October have already been accounted for while calculating the monsoon flow. In case it is proposed to store the water throughout the year, then losses from November to May works out to 987.20 mm or 0.927 metres or 1.0 M. The next storage available is as under:-

S.N.	Length In metre	R.L.	Particulars	Capacity in acre feet --------------------- Dhansa to Chhawla	Chhawla to Ambrahi	Total Capacity in acre MG/feet
1	22160	208.47 684	Najafgarh drain	3115	-	3115
2.	22160	209.30 686.70	Najafgarh drain	-	1075	1075
3.	-	209.30 686.70	Jheel	-	-	3146
			Total			7336 ac. Ft. 9.02MCM 1985 MG

5.4 Availability of drinking water

From the perusal of the above, it is seen if the rural population of 2.5 lakhs only is proposed to be served the drinking water facilities @ 70 litres per capita per day then the drinking water facilities can be ensured throughout the year even at 50% dependability.

Thus, it is seen that the water availability and net storage at 50% dependability and pumping out the existing facilities will last for nearly 35 days. However, in case it is desired that a separate water treatment plant be set up to serve the rural population of about 2.5 lakhs people in West Delhi for the entire year, it is seen that the details of the plant will be as under:-

S.N.	Particulars	Rural Population	Rate per capita LPD/gallons	Water consumption in MGM
1.	Rural	2.50	70/15.28	3.85

A water treatment plant of 5 MGD, accounting for the inflow of some release from Masani Barrage during the monsoon period, will be adequate to serve this population.

6.0 LAND AND ACQUISTION

As stated in para 5.2, it is proposed to store the water up to 210.30 (690.00), submerging an area of 5000 acres. The cost compensation to be paid @ Rs. 20,000 per acre works out to Rs. 10.00 crores.

7.0 WATER TREATMENT PLANT

A water treatment plant of 5 MGD has to be installed if the drinking water facilities are to the rural population of 2.5 lakhs in West Delhi throughout the year at an estimated cost of Rs.

Sd/- Sd/-

(T.S.Grover) (O.P. Kumara)
Ex. Engineer Chief Engineer

Conversion table of M.K.S. to E.P.S.

Length

1.	Metre	=	3.28084 Feet
1.	Kilometre	=	0.62137 mile

Area

1.	Hectare	=	2.47105 acres
1.	Sq. Kilometre	=	0.38610 Sq. miles

Volume

1.	Mile-cum-metre	=	810.71 acre feet
1.	Mile-cum-metre	=	.03512 T.M.C.
1.	Ha. Metre	=	8.1071 Ac. Feet
1.	Cub. Metre	=	35.3148 Cu. Feet/ 0.00081071 Ac. Feet
1.	Litre	=	0.21993 imp. gallons
1.	Litre/sec	=	0.362 Cu. Sec

Capacity

1.	Gallon	=	4.54596 Litre
1.	Litre	=	0.219975 gallons
		=	1.1 liquid seer (app.)
		=	61.025 Cubic inch.
		=	1.000029 Cubic decimeters
1.	Kilolitre	=	1.000029 Cubic metre
1.	Cubic Metre	=	1000 Litres (app.)
		=	219.97 gallons

ANNEXURE I

RAINFALL SERIES FOR SAHIBI NADI RAJAFGARH NALLAH DRAINAGE BASIN ESTABLISHED BY CENTRAL WATER COMMISSION

YEAR- 1891-1972

MONTH- JUNE

S. N0.	Year	Rain Fall	S. No.	Year	Rain Fall
1.	1891	2.08	38.	1928	1.93
2.	1892	2.91	39	1929	1.29
3.	1893	8.79	40.	1930	5.76
4.	1894	8.84	41.	1931	0.74
5.	1895	6.15	42.	1932	1.12
6.	1896	3.17	43.	1933	21.79
7.	1897	3.89	44.	1934	10.44
8.	1898	5.00	45.	1935	1.37
9.	1899	12.80	46.	1936	17.86
10.	1900	2.69	47.	1937	5.59
11.	1901	1.35	48.	1938	5.49
12.	1902	6.65	49.	1939	5.33
13.	1903	1.78	50.	1940	3.94
14.	1904	4.55	51.	1941	7.67
15.	1905	2.26	52.	1942	5.76
16.	1906	6.86	53.	1943	2.18
17.	1907	0.96	54.	1944	7.31
18.	1908	2.00	55.	1945	4.70
19.	1909	8.71	56.	1946	9.96
20.	1910	5.10	57.	1947	2.67
21.	1911	6.73	58.	1948	1.02
22.	1912	1.30	59.	1949	1.78
23.	1913	8.58	60.	1950	0.38
24.	1914	5.05	61.	1951	2.79
25.	1915	3.91	62.	1952	5.59
26.	1916	5.08	63.	1953	2.54
27.	1917	7.52	64.	1954	1.45
28.	1918	3.07	65.	1955	9.91
29.	1919	0.48	66.	1956	0.99
30.	1920	8.46	67.	1957	4.22
31.	1921	2.97	68.	1958	3.33
32.	1922	7.39	69.	1959	0.79
33.	1923	3.38	70.	1960	0.56
34.	1924	3.50	71.	1961	3.81
35.	1925	13.61	72.	1962	0.99

36.	1926	1.83	73.	1963	2.23
37.	1927	0.43	74.	1964	0.61
75.	1965	0.33			
76.	1966	5.64			
77.	1967	5.59			
78.	1968	0.71			
79.	1969	0.76			
80.	1970	6.04			
81.	1971	7.75			
82.	1972	3.33			
83.	1973	1.22			
84.	1974	1.70			
85.	1975	2.49			
86.	1976	8.74			
87.	1977	10.24			

JULY

1.	1891	8.38	34.	1924	10.11
2.	1892	12.24	35.	1925	20.52
3.	1893	27.89	36.	1926	23.03
4.	1894	12.70	37.	1927	11.71
5.	1895	14.73	38.	1928	11.33
6.	1896	19.10	39.	1929	15.21
7.	1897	19.25	40.	1930	40.13
8.	1898	15.87	41.	1931	20.90
9.	1899	9.98	42.	1932	13.77
10.	1900	7.29	43.	1933	7.72
11.	1901	11.40	44.	1934	9.98
12.	1902	18.24	45.	1935	20.24
13.	1903	12.95	46.	1936	18.47
14.	1904	15.85	47.	1937	13.36
15.	1905	5.69	48.	1938	13.16
16.	1906	17.35	49.	1939	5.33
17.	1907	8.20	50.	1940	12.12
18.	1908	25.88	51.	1941	2.13
19.	1909	29.44	52.	1942	33.88
20.	1910	10.36	53.	1943	16.59
21.	1911	2.34	54.	1944	18.26
22.	1912	21.13	55.	1945	9.50
23.	1913	8.84	56.	1946	16.26
24.	1914	23.34	57.	1947	8.28
25.	1915	5.71	58.	1948	30.58
26.	1916	19.99	59.	1949	33.91
27.	1917	25.55	60.	1950	24.71

28.	1918	2.77	61.	1951	3.99
29.	1919	21.79	62.	1952	9.73
30.	1920	23.79	63.	1953	24.43
31.	1921	10.16	64.	1954	15.70
32.	1922	14.76	65.	1955	9.22
33.	1923	22.68	66.	1956	24.41
67.	1957	23.85	77.	1967	26.06
68.	1958	20.27	78.	1968	22.78
69.	1959	8.80	79.	1969	14.35
70.	1960	18.00	80.	1970	8.58
71.	1961	13.00	81.	1971	20.32
72.	1962	16.81	82.	1972	13.34
73.	1963	6.40	83.	1973	14.15
74.	1964	33.73	84.	1974	26.82
75.	1965	12.14	85.	1975	24.28
76.	1966	9.60	86.	1976	21.18
77.	1967	26.06	87.	1977	51.23

AUGUST

1.	1891	18.62	45.	1935	12.57
2.	1892	26.49	46.	1936	18.03
3.	1893	9.50	47.	1937	4.30
4.	1894	15.29	48.	1938	6.91
5.	1895	11.96	49.	1939	4.55
6.	1896	9.52	50.	1940	21.21
7.	1897	20.55	51.	1941	10.03
8.	1898	9.47	52.	1942	29.33
9.	1899	1.75	53.	1943	14.15
10.	1900	11.91	54.	1944	13.74
11.	1901	15.85	55.	1945	12.60
12.	1902	10.62	56.	1946	21.72
13.	1903	14.71	57.	1947	11.07
14.	1904	31.19	58.	1948	24.28
15.	1905	2.46	59.	1949	3.02
16.	1906	5.33	60.	1950	11.51
17.	1907	18.72	61.	1951	13.94
18.	1908	39.32	62.	1952	29.23
19.	1909	11.33	63.	1953	18.41
20.	1910	17.32	64.	1954	2.26
21.	1911	7.62	65.	1955	17.91
22.	1912	15.03	66.	1956	14.96
23.	1913	4.75	67.	1957	10.06
24.	1914	8.26	68.	1958	17.65
25.	1915	7.72	69.	1959	12.90

26.	1916	24.69	70.	1960	45.82
27.	1917	34.29	71.	1961	29.92
28.	1918	10.90	72.	1962	13.11
29.	1919	24.71	73.	1963	36.63
30.	1920	3.28	74.	1964	29.21
31.	1921	20.98	75.	1965	16.46
32.	1922	11.51	76.	1966	25.12
33.	1923	18.21	77.	1967	32.05
34.	1924	19.73	78.	1968	5.03
35.	1925	9.98	79.	1969	17.07
36.	1926	32.00	80.	1970	21.87
37.	1927	30.35	81.	1971	N.A.
38.	1928	5.46	82.	1972	32.94
39.	1929	9.63	83.	1973	27.96
40.	1930	13.00	84.	1974	10.08
41.	1931	13.00	85.	1975	21.08
42.	1932	17.19	86.	1976	32.46
43.	1933	17.75	87.	1977	21.03
44.	1934	27.39			

September

1.	1891	11.56	54.	1944	3.10
2.	1892	11.02	55.	1945	22.30
3.	1893	12.11	56.	1946	3.45
4.	1894	16.15	57.	1947	23.72
5.	1895	0.36	58.	1948	4.39
6.	1896	0.74	59.	1949	11.68
7.	1897	3.68	60.	1950	12.45
8.	1898	3.53	61.	1951	4.83
9.	1899	0.94	62.	1952	0.23
10.	1900	27.96	63.	1953	3.02
11.	1901	0.74	64.	1954	8.94
12.	1902	8.66	65.	1955	13.51
13.	1903	6.63	66.	1956	2.54
14.	1904	10.54	67.	1948	17.83
15.	1905	7.82	68.	1949	21.61
16.	1906	19.86	69.	1950	8.48
17.	1907	0.13	70.	1951	0.68
18.	1908	2.51	71.	1952	5.46
19.	1909	8.74	72.	1953	8.79
20.	1910	14.83	74.	1955	8.89
21.	1911	30.23	75.	1956	16.76
22.	1912	13.46	76.	1957	17.83
23.	1913	2.08	77.	1958	21.61
24.	1914	11.89	78.	1959	8.48

25.	1915	3.12	79.	1961	5.46
26.	1916	14.05	80.	1962	8.79
27.	1917	38.53	81.	1963	12.29
28.	1918	2.11	82.	1964	8.89
29.	1919	7.16	83.	1965	16.76
30.	1920	0.02	84.	1966	2.59
31.	1921	8.53	85.	1967	12.14
32.	1922	15.88	86.	1968	0.00
33.	1923	1.17	87.	1969	23.60
34.	1924	28.42	88.	1970	12.67
35.	1925	0.41	89.	1971	6.35
36.	1926	7.70	90.	1972	1.42
37.	1927	2.82	91.	1973	8.07
38.	1928	1.52	92.	1974	1.55
39.	1929	2.03	93.	1975	13.08
40.	1930	2.39	94.	1976	3.95
41.	1931	10.06	95.	1977	11.25
42.	1932	11.38			
43.	1933	33.55			
44.	1934	1.57			
45.	1935	13.33			
46.	1936	9.98			
47.	1937	8.53			
48.	1938	1.45			
49.	1939	11.28			
50.	1940	0.23			
51.	1941	13.74			
52.	1942	17.86			
53.	1943	15.47			

October

1.	1891	3.09	45.	1935	0.20
2.	1892	0.00	46.	1936	0.00
3.	1893	0.05	47.	1937	0.00
4.	1894	0.00	48.	1938	0.25
5.	1895	0.00	49.	1939	0.10
6.	1896	0.33	50.	1940	0.00
7.	1897	0.05	51.	1941	0.28
8.	1898	0.00	53.	1943	0.00
9.	1899	0.00	54.	1944	4.24
10.	1900	0.35	55.	1945	0.23
11.	1901	0.00	56.	1946	1.78
12.	1902	1.42	57.	1947	1.32

13.	1903	1.17
14.	1904	0.00
15.	1905	0.00
16.	1906	0.05
17.	1907	0.00
18.	1908	0.23
19.	1909	0.03
20.	1910	14.10
21.	1911	1.83
22.	1912	0.03
23.	1913	0.00
24.	1914	2.46
25.	1915	0.86
26.	1916	2.74
27.	1917	5.26
28.	1918	0.00
29.	1919	0.00
30.	1920	0.00
31.	1921	0.25
32.	1922	0.23
33.	1923	0.63
34.	1924	5.87
35.	1925	0.48
36.	1926	0.15
37.	1927	0.38
38.	1928	2.95
39.	1929	0.18
40.	1930	0.68
41.	1931	3.10
42.	1932	0.10
43.	1933	1.70
44.	1934	0.00
58.	1948	1.24
59.	1949	0.53
60.	1950	0.00
61.	1951	0.07
62.	1952	0.07
63.	1953	0.15
64.	1954	7.14
65.	1955	7.19
66.	1956	16.64
67.	1957	2.62
68.	1958	2.97
69.	1959	2.97
70.	1960	3.91
71.	1961	2.46
72.	1962	0.00
73.	1963	0.00
74.	1964	0.00
75.	1965	1.14
76.	1966	0.53
77.	1967	0.00
78.	1968	0.71
79.	1969	0.05
80.	1970	0.00
81.	1971	3.76
82.	1972	0.79
83.	1973	0.02
84.	1974	2.51
85.	1975	2.64
86.	1976	0.00
87.	1977	0.00

Annexure 2

Rainfall series up to Dhansa for the period 1891 to 1977
arranged in descending order
Rainfall in mm.

S.No.	June	July	August	September	October
1.	21.79	51.23	45.82	38.53	16.64
2.	17.36	40.13	30.32	33.55	14.10
3.	13.61	33.91	36.69	30.23	7.19
4.	12.80	33.88	31.20	28.42	7.14
5.	10.44	33.73	32.94	27.96	5.87
6.	10.24	30.58	-	23.72	5.26
7.	9.96	29.44	-	-	-
8.	9.91	27.83	32.43	28.60	4.24
9.	8.84	26.82	32.08	22.20	3.99
10.	8.79	26.82	32.00	21.61	3.91
11.	8.74	25.38	31.10	19.85	3.76
12.	8.71	23.55	30.36	17.86	3.10
13.	8.58	24.71	29.92	17.83	2.97
14.	8.46	24.43	29.23	16.76	2.87
15.	7.75	24.42	29.23	16.15	2.95
16.	6.67	24.28	29.21	15.38	2.74
17.	7.52	23.85	27.96	15.47	2.64
18.	7.39	23.34	27.33	14.83	2.62
19.	7.31	23.04	26.48	14.05	2.51
20.	6.85	23.03	25.12	13.74	2.74
21.	6.73	22.78	24.71	13.51	2.46
22.	6.65	22.68	24.69	13.46	1.83
23.	6.15	21.79	24.33	13.33	1.78
24.	6.04	21.18	21.87	13.08	1.70
25.	5.76	21.13	21.72	12.67	1.42
26.	5.76	20.90	21.81	12.45	1.32
27.	5.64	20.52	21.08	12.29	1.24
28.	5.59	20.32	21.08	12.14	1.17
29.	5.59	20.27	20.98	12.11	1.14
30.	5.59	20.24	20.55	11.89	0.85
31.	5.49	19.99	19.73	11.56	0.79
32.	5.33	19.25	18.72	11.68	0.71
33.	5.10	19.10	18.62	11.38	0.68
34.	5.08	18.47	18.41	11.28	0.63
35.	5.05	18.26	18.21	11.25	0.53
37.	4.70	18.00	17.91	10.06	0.38
38.	4.55	17.35	17.75	10.06	0.38

39.	4.22	16.81	17.64	9.98	0.35
40.	3.94	16.59	17.32	8.94	0.33
41.	3.91	16.26	17.09	8.89	0.23
42.	3.91	15.87	17.07	8.79	0.25
43.	3.89	15.85	15.85	8.74	0.25
44.	3.81	15.70	15.85	8.66	0.23
45.	3.50	15.21	15.39	8.53	0.23
46.	3.38	14.76	15.03	8.53	0.23
47.	3.33	14.73	14.96	8.46	0.20
48.	3.33	14.35	14.71	8.07	0.18
49.	3.17	14.15	14.15	7.82	0.15
50.	3.07	14.77	13.94	7.70	0.10
51.	2.97	13.36	13.11	7.16	0.10
52.	2.79	13.34	13.00	6.63	0.07
53.	2.69	13.16	13.00	6.35	0.07
54.	2.67	13.00	12.60	2.46	0.05
55.	2.54	12.95	12.60	4.83	0.05
56.	2.49	12.70	12.57	4.39	0.05
57.	2.26	12.24	11.96	3.96	0.05
58.	2.23	12.14	11.91	3.68	0.03
59.	2.18	12.12	11.51	3.53	0.03
60.	2.08	11.71	11.51	3.45	0.02
61.	2.00	11.40	11.33	3.12	0.00
62.	1.93	11.33	11.07	3.10	0.00
63.	1.83	10.36	10.90	3.02	0.00
64.	1.78	10.16	10.62	2.82	0.00
65.	1.78	10.11	10.06	2.59	0.00
66.	1.70	9.98	10.03	2.54	0.00
67.	1.45	9.98	10.03	2.52	0.00
68.	1.37	9.73	9.98	2.39	0.00
69.	1.35	9.60	9.63	2.11	0.00
70.	1.30	9.50	9.52	2.08	0.00
71.	1.29	9.22	9.50	2.03	0.00
72.	1.22	8.86	9.47	1.57	0.00
73.	1.12	8.84	8.26	1.55	0.00
74.	1.02	8.58	7.72	1.52	0.00
75.	0.99	8.38	7.62	1.45	0.00
76.	0.99	8.28	6.91	1.42	0.00
77.	0.96	8.20	5.46	1.17	0.00
78.	0.79	7.72	5.33	0.94	0.00
79.	0.76	7.29	5.03	0.74	0.00
80.	0.74	6.40	4.80	0.74	0.00
81.	0.71	5.71	4.75	0.68	0.00
82.	0.61	5.69	4.55	0.41	0.00
83.	0.56	5.33	3.28	0.36	0.00
84.	0.48	3.99	3.02	0.23	0.00
85.	0.43	2.77	2.46	0.23	0.00

86.	0.38	2.34	2.26	0.13	0.00
87.	0.33	2.13	1.75	0.02	0.00

	June	July	August	Sept.	October
50% Dependability In mm	38.10	187.00	153.9	85.3	2.3
75% Dependability	17.80	101.10	100.30	25.40	0.00

ANNEXURE III

RELEASE THROUGH DHANSA REGULATOR ACTUAL

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	in m.cft	in.m. cm	In.cft.	in m. cum	In m.cft	In m. cm	In m. cft	In m. cum.	In m. cft.	In m. cm
1964	-	-	-	-	72.49	2.053	-	-	-	-
1965	-	-	-	-	-	-	94.358	2.672	24.134	0.68
1966	-	-	-	-	166.188	4.706	45.496	1.286	-	-
1967	-	-	55.132	1.561	390.074	11.067	1156.38	32.75	96.25	2.73
1968	-	-	-	-	8.404	0.238	2.816	0.079	-	-
1969	-	-	-	-	17.688	0.51	221.376	9.10	107.426	3.04
1970	-	-	-	-	58.96	1.67	138.16	3.91	60.72	1.72
1971	-	-	-	-	150.546	4.26	185.13	5.24	-	-
1972	-	-	-	-	159.43	4.51	7.172	0.203	-	-
1973	-	-	-	-	23.348	0.67	330.35	9.35	42.26	1.196
1974	-	-	30.932	-	247.61	7.01	12.254	0.347	-	-
1975	-	-	22.308	0.63	110.682	3.134	564.586	15.99	12.606	0.357
1976	-	-	0.083	-	704.92	19.96	747.648	21.17	-	-
1977	-	-	333.564	9.446	46.002	1.303	915.64	25.93	535.612	15.168
1978	-	-	40.04	1.134	1029.91	29.167	1524.776	43.18	-	-
1979	-	-	-	-	7.545	0.212	-	-	-	-
1980	-	-	55.04	1.85	270.776	7.61	52.036	1.644	7.81	0.22
1981	-	-	271.70	7.694	261.492	7.405	-	-	-	-
1982	-	-	-	-	40.128	1.135	15.532	0.44	-	-
1983	-	-	31.378	0.838	423.89	12.003	597.94	16.93	-	-
1984	-	-	8.054	0.25	-	-	-	-	-	-

ANNEXURE III (a)

ACTUAL RELEASES THROUGH DHANSA REGULATOR ARRANGED IN DESCENDING OREDER

S. No.	June In m. cm	July In m. cum	August In m. cum	September In m. cum	October In m. cum
1.	-	9.446	29.167	43.18	15.163
2.	-	7.694	19.960	32.75	3.04
3.	-	1.561	12.003	25.93	2.73
4.	-	1.560	11.067	21.17	1.720
5.	-	1.134	7.610	16.93	1.196
6.	-	0.388	7.405	15.99	0.680
7.	-	0.876	7.010	9.35	0.257
8.	-	0.630	4.706	9.10	0.220
9.	-	0.250	4.510	5.24	-
10.	-	-	4.280	3.91	-
12.	-	-	3.134	2.672	-
13.	-	-	2.053	1.644	-
14.	-	-	1.670	1.288	-
15.	-	-	1.303	0.440	-
16.	-	-	1.136	0.347	-
17.	-	-	0.670	0.079	-
18.	-	-	1.510	-	-
19.	-	-	0.238	-	-
20.	-	-	0.236	-	-
21.	-	-	-	-	-

ANNEXURE-4

SURFACE WATER AVAILABILITY BY KHOSLA'S FORMULA FOR THE PERIOD 1891-1977 FOR THE CATCHMENT DOWNSTREAM OF DHANSA BARRAGE UPTO DHANSA REGULATOR

Year	Run off in MGM					Total run off in MGM (June to October
	June	July	August	September	October	
1891	-	-	105.16	-	-	105.16
1892	-	-	302.55	-	-	302.55
1893	-	321.14	-	-	-	321.14
1894	-	-	24.16	-	-	77.00
1895	-	-	-	-	-	-
1896	-	100.46	-	-	-	100.46
1897	-	104.29	153.64	-	-	257.93
1898	-	19.46	-	-	-	19.46
1899	-	-	-	-	-	-
1900	-	-	-	349.41	-	349.41
1901	-	-	35.64	-	-	35.64
1902	-	78.77	-	-	-	78.77
1903	-	-	6.95	-	-	6.95
1904	-	18.82	420.87	-	-	439.69
1905	-	-	-	-	-	-
1906	-	56.45	-	145.96	-	-
1907	-	-	107.72	-	-	
1908	-	270.75	624.97	-	-	
1909	-	360.04	-	-	-	
1910	-	-	72.64	19.98	1.18	
1911	-	-	-	406.18	-	
1912	-	151.48	15.24	-	-	
1913	-	-	-	-	-	
1914	-	206.97	-	-	-	
1915	-	-	-	-	-	-
1916	-	122.78	257.60	-	-	380.38
1917	-	262.46	498.63	614.74	-	1375.38
1918	-	-		-	-	-

1919	-	168.07	-	-	-	426.31
1920	-	199.32	-	-	-	199.32
1921	-	-	164.48	-	-	164.48
1922	-	-	-	45.83	-	45.83
1923	-	190.39	94.96	-	-	285.35
1924	-	-	133.28	360.29	-	494.12
1925	-	136.18	-	-	-	136.18
1926	-	199.32	441.28	-	-	640.60
1927	-	-	399.83	-	-	399.83
1928	-	-	-	-	-	-
1929	-	2.88	-	-	-	2.88
1930	-	628.55	-	-	-	628.55
1931	-	145.74	-	-	-	146.74
1932	-	-	69.45	-	-	69.45
1933	-	-	83.48	489.73	-	712.14
1934	138.93	-	321.34	-	-	321.34
1935	-	129.16	-	-	-	129.16
1936	-	84.51	90.50	-	-	215.09
1937	40.08	-	-	-	-	-
1938	-	-	-	-	-	-
1939	-	-	-	-	-	-
1940	-	-	170.22	-	-	170.22
1941	-	-	-	-	-	-
1942	-	471.66	374.31	95.57	-	951.54
1943	-	37.32	-	35.62	-	72.94
1944	-	79.41	-	-	-	79.41
1945	-	-	-	207.18	-	207.18
1946	-	29.03	182.98	-	-	212.01
1947	-	-	-	242.90	-	242.90
1948	-	388.74	247.39	-	-	636.13
1949	-	472.29	-	-	-	472.29
1950	-	242.41	-	-	-	241.41
1951	-	-	-	-	-	-
1952	-	-	362.34	-	-	362.34
1953	-	234.39	100.04	-	-	334.45
1954	-	14.99	-	-	-	14.99
1955	-	-	-	87.31	-	87.31
1956	-	233.75	13.32	-	102.62	349.69
1957	-	218.76	-	94.94	-	313.70
1958	-	129.80	80.93	189.97	-	400.70
1959	-	-	-	-	-	-
1960	-	73.03	788.24	-	-	861.27
1961	-	-	390.26	-	-	390.26

1962	-	43.06	-	-	-	43.06
1963	-	-	557.36	-	-	557.36
1964	-	467.83	371.13	-	-	838.96
1965	-	-	80.95	68.15	-	119.10s
1966	-	-	368.44	-	-	268.44
1967	-	275.22	443.19	-	-	718.41
1968	-	192.94	-	-	-	192.94
1969	-	-	66.26	239.71	-	305.97
1970	-	-	185.80	-	-	186.80
1971	-	131.07	N.A.	-	-	131.07
1972	-	-	464.88	-	-	464.88
1973	-	-	339.87	-	-	339.87
1974	-	294.35	-	-	-	294.35
1975	-	230.57	167.03	-	-	397.60
1976	-	152.76	452.76	-	-	605.52
1977	-	907.27	165.76	-	-	1073.03

ANNEXURE - V

RUN – OFF IN MGM AS PER KHOSLA'S FORMULA

Catchment area – 2511 Sq. km.
Losses due to temperature – 4.81 x Tm when Tm
10 c Tm values for June – 162.60, for July 151.0,
for Aug. 144.3 For Sept. 140.5, for Oct. 125.5

S. No.	**Percentage**	**Rain fall in MM**					**Run off In MM**					**Surface water potential Available in MGM**					**Total**	**Utilisable**
	Dependability …………………………………						…………………………					……………………………………………					**Flow in**	**Flow in**
		June	July	August	Sept.	October	June	July	August	Sept.	October	June	July	August	Sept.	Oct.	MGM	MGM
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	50%	38.1	157.0	153.9	85.3	2.3	-	6.0	9.6	-	-	-	15.066	24.10	-	-	39.166	19.583
2.	75%	17.8	101.1	100.3	25.4	0.0	-	-	-	-	-	-	-	-	-	-	-	-
3.	90%	0.96	7.72	4.80	1.45	0.0	-	-	-	-	-	-	-	-	-	-	-	-

ANNEXURE – 6

YIELD SERIES UPTO DHANSA

S.NO	YEAR	Monsoon Rainfall				Run off from Strangers curve			
		Rainfall in		Good	Catchment	Average	Catchment	Poor	Catchment
		Cm	inches	Cm	inches	in	inches	in	inches
1	1911	111.15	43.76	0.51	0.2	33.73	13.30	22.35	8.8
2	1977	93.75	36.91	31.75	12.50	24.13	9.50	16.51	6.5
3	1942	86.84	34.19	27.18	10.70	19.81	7.80	12.45	5.3
4	1933	35.52	32.49	23.88	9.4	17.53	6.90	11.08	4.6
5	1957	73.83	29.07	18.29	7.2	13.72	5.40	8.89	3.5
6	1964	72.44	28.52	17.27	6.8	13.46	5.30	11.05	3.35
7	1908	69.95	27.54	16.00	6.3	12.45	4.90	8.38	3.30
8	1960	68.98	27.16	15.75	6.2	11.94	4.70	8.26	3.25
9	1924	67.64	28.53	14.99	5.9	10.92	4.30	7.62	3.00
10	1916	66.55	26.20	14.48	5.7	10.66	4.20	7.49	2.95
11	1976	66.34	26.12	14.35	5.69	10.54	4.16	7.42	2.92
12	1978	65.48	25.78	13.97	6.5	10.41	4.10	7.37	2.90
13	1928	64.72	25.48	13.72	5.4	9.91	3.90	7.11	2.80
14	1926	64.34	25.33	13.46	5.3	9.65	3.80	6.73	2.65
15	1975	68.58	25.03	13.34	5.25	9.53	3.75	6.35	2.50
16	1904	62.98	24.40	12.70	5.00	9.02	3.55	6.48	2.55
17	1972	61.98	24.40	12.70	5.00	2.96	3.63	6.45	2.54
18	1930	61.98	24.40	12.45	4.9	8.96	3.53	6.45	2.54
19	1910	61.72	24.30	12.19	4.8	8.89	3.50	6.41	2.52
20	1948	61.56	24.22	12.06	4.75	8.79	3.46	6.35	2.50
21	1939	59.54	23.44	11.17	4.4	8.18	3.22	5.89	
22	1967	58.32	23.16	10.92	4.3	7.90	3.11	5.74	
23	1893	58.34	22.97	10.67	4.2	7.77	3.06	5.64	
24	1909	58.24	22.93	10.67	4.2	7.75	3.05	6.61	
25	1955	57.73	22.73	10.54	4.15	7.59	2.99	5.52	
26	1963	57.86	22.66	10.41	4.10	7.52	2.96	5.46	
27	1969	55.83	21.98	9.65	3.80	7.01	2.76	5.10	
28	1961	54.66	21.52	8.89	3.50	6.63	2.61	4.85	
29	1919	54.15	21.82	8.64	3.40	6.48	2.55	4.75	
30	1892	53.67	21.13	8.51	3.35	6.35	2.50	4.65	
31	1946	53.16	20.93	8.38	3.3	6.20	2.44	4.55	
32	1894	53.08	20.90	8.38	3.3	6.17	2.43	4.55	
33	1973	51.44	20.25	8.00	3.15	5.66	2.28	4.19	
34	1914	57.00	20.08	7.87	3.10	5.54	2.18	4.12	
35	1912	50.95	20.06	7.87	3.10	5.54	2.18	4.12	
36	1949	50.93	20.05	7.87	3.10	5.54	2.18	4.12	
37	1900	50.22	19.77	7.62	3.00	5.36	2.11	3.96	
38	1922	49.76	19.59	7.37	2.9	5.23	2.06	3.86	
39	1906	49.45	19.47	7.24	2.85	5.16	2.03	3.78	

40	1945	49.33	19.42	7.11	2.80	5.10	2.01	3.73	
41	1936	49.23	19.38	6.35	2.75	5.08	2.00	3.71	
42	1970	49.17	19.36	6.35	2.75	5.08	2.00	3.71	
43	1950	49.05	19.31	6.35	2.70	12.77	1.98	3.66	
44	1911	48.74	19.19	6.60	2.6	4.95	1.95	3.58	1.41
45	1953	48.56	19.12	6.48	2.55	4.93	1.94	3.56	1.40
46	1943	48.39	19.05	6.35	2.50	4.90	1.93	3.53	1.39
47	1931	47.80	18.82	6.22	2.45	4.75	1.87	3.45	1.36
48	1935	47.78	18.79	6.22	2.45	4.72	1.86	5.99	1.36
49	1897	47.72	18.67	5.09	2.40	4.65	1.82	3.41	1.34
50	1947	47.07	18.83	5.97	2.35	4.57	1.80	3.32	1.31
51	1965	46.84	18.44	5.84	2.30	4.50	1.77	3.28	1.29
52	1944	46.66	18.37	5.84	2.30	4.44	1.75	3.26	1.27
53	1923	46.08	18.14	5.72	2.25	4.34	1.71	3.10	1.22
54	1929	45.69	17.99	5.59	2.20	4.27	1.68	3.02	1.19
55	1902	45.89	17.95	5.59	2.20	4.27	1.67	2.99	1.18
56	1925	45.01	17.72	5.33	2.10	4.09	1.61	2.87	1.13
57	1952	44.86	17.06	5.33	2.10	4.06	1.60	2.85	1.12
58	1891	44.62	17.57	5.08	2.00	4.04	1.59	2.79	1.10
59	1932	43.56	17.15	4.83	1.90	3.76	1.43	2.54	1.00
60	1966	43.48	17.12	4.83	1.90	3.73	1.47	2.54	1.00
61	1921	42.90	16.89	4.57	1.80	3.58	1.41	2.44	0.96
62	1974	42.62	16.78	4.32	1.78	3.53	1.39	2.41	0.95
63	1962	39.70	15.63	3.81	1.50	2.79	1.10	1.96	0.77
64	1940	37.49	14.76	3.17	1.25	2.46	0.97	1.96	0.75
65	1903	37.24	14.66	3.17	1.25	2.44	0.96	1.88	0.74
66	1954	35.48	13.97	2.54	1.00	2.18	0.86	1.73	0.68
67	1920	34.80	13.70	2.41	0.95	2.06	0.81	2.33	0.65
68	1959	33.98	13.33	2.29	0.90	1.91	0.75	2.22	0.62
69	1898	33.28	13.34	2.29	0.90	1.43	0.75	2.22	0.62
70	1941	33.86	13.33	2.29	0.90	1.91	0.75	1.57	0.62
71	1895	33.20	13.07	2.16	0.85	1.80	0.71	1.80	0.59
72	1896	32.87	12.94	2.08	0.80	1.75	0.69	1.42	0.56
73	1937	32.28	12.71	1.90	0.75	1.65	0.65	1.37	0.54
74	1901	29.34	11.51	1.52	0.60	1.22	0.48	1.09	0.43
75	1968	29.24	11.51	1.52	0.60	1.22	0.48	1.09	0.43
76	1929	28.32	11.15	1.27	0.50	1.09	0.43	1.04	0.41
77	1907	28.02	11.03	1.22	0.48	1.04	0.41	1.02	0.40
78	1938	27.25	10.73	1.19	0.47	1.02	0.40	0.93	0.37
79	1939	26.59	10.47	1.14	0.45	1.36	0.38	0.86	0.34
80	1951	25.63	10.09	1.09	0.43	1.29	0.36	0.76	0.30
81	1899	25.48	10.23	1.07	0.42	1.25	0.35	0.76	0.30
82	1913	24.26	9.55	0.94	0.37	1.15	0.32	0.66	0.26
83	1928	23.19	9.13	0.76	0.30	0.86	0.24	0.56	0.28
84	1971	21.69	8.54	0.61	0.24	0.68	0.19	0.25	0.17
85	1915	21.34	8.40	0.56	0.22	0.61	0.17	0.38	0.15

86	1918	18.85	7.42	0.25	0.10	0.21	0.06	0.13	0.05
87	1905	18.24	7.18	0.23	0.09	0.11	0.03	0.08	0.03
TOTAL		4258.61	1676.62	641.35	252.50	477.57	188.02	341.55	134.47

Av. In mm $\frac{4258.61}{87}$ = 48.95 $\frac{641.35}{84}$ = 7.64 $\frac{477.57}{84}$ = 5.69 $\frac{341.55}{84}$ = 4.07

Av. In inches $\frac{1676.62}{87}$ = 19.27 $\frac{252.50}{84}$ = 3.01 $\frac{188.02}{84}$ = 2.24 $\frac{134.47}{84}$ = 1.60

% dependability 6.61 2.60 4.95 1.95 3.58 1.41

75% dependability 3.17 1.25 2.44 0.96 1.88 0.74