GOVERNMENT OF GUJARAT

MANUAL
ON
PERCOLATION TANKS

PUBLIC WORKS DEPARTMENT
SACHIVALAYA
GANDHINAGAR

MANUAL ON PERCOLATION TANKS

I N D E X

PERCOLATION TANKS

1.0 DEFINITION :

Percolation tank is defined as a small tank whose capacity does not exceed about 2.83 lakhs cmt. (10 Mcft) and constructed by means of an earthen bund across a rivulet. The function of such a tank would be to head-up water for a period and let it gradually escape to raise the surrounding sub-soil water level and produce a small and more permanent flow in the nalla below the tank.

2.0 NECESSITY :

2.1 In the areas generally affected by scarcity conditions and where the rain fall is irregular, erratic and comparatively low, the percolation tanks are useful in conserving the moisture. They help to augment the sub soil water, thereby stabilising the irrigation practice from the wells in the area down stream of the tank within a reasonable distance. In other words such tanks help in recharging the aquifers, which are being tapped by means of wells, tubewells etc.

2.2 Regarding moisture conservation, the percolation tanks are an extention of the principle common to contour bunding and nalla plugging.

2.3 In areas where sufficient command in the vicinity of the site is not available and also where the construction of the idle reach of the canal is in difficult terrain and not economical, percolation tanks should be preferred to irrigation tanks.

3.0 DESIGN CRITERIA :

3.1 YIELD :

Depending upon the average annual rainfall within the catchment, the yield at the proposed site of the percolation tank should have the following dependability :—

Sr. No.	Averagc Annual Rainfall.	Percentage dependability
1.	Less than 380 m. m. (15")	40 %
2.	380 m. m. to 760 m. m. (15" to 30")	50 %
3.	760 m. m. to 1520 m. m. (30" to 60")	65 %

In absence of reliable data on the actual yield, the strange's table (Appendix No. I) is generally adopted for working out the yield.

However in case of percolation tanks to be taken up in D.P.A.P. area of Saurashtra region the yield should be worked out according to the formula suggested in the P.W D. Hand-Book, Volume II. (*Vide* Appendix No. II)

As direct irrigation is not envisaged from the percolation tank, no outlet is to be provided. As it will not be practicable to desilt the bed every year, provision for deposition of silt for 5 to 10 years should be made. It should however be seen that the silt deposited is periodically removed otherwise the percolation would be retarded.

3.2 F. S. L. :

Depending upon the tank basin, the capacity of the tank is fixed so as to store almost all the yield expected.

3.3 EARTHEN BUND :

3.3.1 As the intention of the percolation tank is to raise the sub—soil water level of area downstream of the site, water should be allowed to percolate below the seat of the dam.

Therefore for bunds having heights upto 4.60 mts. (15') C. O. T. is not necessary and keying and benching between the dam seat and natural ground will suffice. For bunds having more than 4.60 mts. (15') height, C. O. T. equal to $\frac{1}{2}$—$\frac{1}{3}$ height of water column may be provided.

3.3.2 The top width of the bund should be provided as under :—

Height of Bund.	Minimum Top—Width
Upto 3.00 mts. (10')	1.80 mts. (6').
3.00 to 6.00 mts. (10' to 20')	2.10 ,, (7').
6.00 to 15.00 mts. (20' to 50')	2.40 ,, (8').

A free board of 1.80 mts. (6') should be provided above the H. F. L. of the tank. Hearting and casing zone may be provided as per the standards adopted in M. I. Tanks. For protection of the U/S. slope against wave action 225 mm. (9") thick rubble pitching should be provided.

HYDRAULIC GRADIENT :

3.3.3 Down stream slope may be designed so as to have a minimum cover of 1.20 mts. (4') over the hydraulic gradient line, drawn from H.F.L. touching the U/S slope with a gradient of 4:1 in the casing zone and 2:1 in the hearting zone.

3.4 WASTE WEIR:

Where the catchment is less than one sq. mile, the following provision should be made for the flood passing over the waste weir.

(i) Up to 300 acres of C. A. rain fall of 75.0 m.m./hour (3 inches per hour) on the catchment.

(ii) Between 300 acres and one sq. mile of C. A. rainfall of 50.0 mm/hour. (2 inches per hour) on the catchment.

Where the catchment is more than one sq. mile Dicken's formula given below may be adopted in estimating the flood:—

Dickens Formula :— $Q = CM^{3/4}$ where,

Q = Discharge in cusecs.
C = Constant.
M = Catchment area in sq. miles.

Generally the value of C is taken as 2400 for catchment area upto 30 sq. miles.

The procedure for locating the weir and the design there of should be as per the standards adopted in case of M. I. tanks.

4.0 AREA UNDER SUBMERGENCE :

The lands and other property affected in the tank basin upto the F. S. L. should be acquired and compensated for.

5.0 BENEFITS :

The irrigation benefits from the percolation tanks cannot be assessed directly as no direct irrigation is envisaged from such tanks. The anticipated benefit should therefore be worked out by ascertaining the number of wells which will be benefitted within a distance of one mile below the dam.

6.0 COST CRITERIA :

The compensation for the lands and structures going under submergence should not exceed 15% of the estimated cost of the scheme. The ceilling limit of the total cost of the scheme should not exceed of Rs. 4,00,000 or that may be fixed by Government from time to time. The cost per mcft. of water stored should be within Rs. 60,000 or that may be fixed by Government from time to time. However, if the Panchayat agrees to bear the expenditure beyond the ceilling limit of Rs. 4,00,000 such scheme may be considered, provided it is technically feasible,

7.0 DRAWINGS :

The following drawings should always accompany the scheme submitted for consideration :—

(i) An index plan (Scale 1" = 1 mile) showing the location of the proposed tank and its catchment.

(ii) A contour plan (Scale 1 Cm. = 20 mts. or 30 mts) showing all the details upto one meter above the top of the proposed bund and also the details indicated in para 7 (iii) below.

(iii) A village plan (Scale 1"=~~666'~~ 660' or 1"=330') showing the location of the tank, lands, roads and structures going under submergence. bund, W. W., tail channel and wells which will be benefitted after the implementation of the scheme.

(iv) Drawing showing plan, L. S. and C. S. of the alignment of the bund with details of strata available in trial pits and depth of C. O. T. proposed drawn to the following scale :—

For L. S. Horizontal scale 1 cm. = 5 mts, to 20 mts.
Vertical scale 1 cm. = 1 mt.
For C. S. Horizontal scale 1 cm. = 2 mts. to 5 mts.
Vertical scale 1 cm. = 1 mt. to 2 mts.

(v) A plan showing the details of W. W. and D/s protection works, if any, with plan C.S & L.S and strata available for foundation etc.

(vi) A plan showing the L. S. & C. S. of the approach and tail channel along with details of trial pits.

BIBLIOGRAPHY

1.0 Manual of Minor Irrigation works, Maharashtra State

2.0 P. W. D. Hand Book, Vol. II

3.0 Government of Gujarat, Resolution No. MNS-4164/52529-I, dt. 29-4-1965

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APPENDIX No. I

Strange's Table of run off due to monsoon rainfall per square mile of catchment area

Total monsoon Rainfall.		Good Catchment Yield or Run off from Catchment per Sq. mile in	Average Catchment Yield or Run off from Catchment per Sq. mile. in	Bad Catchment Yield or Run off from catchment per Sq. mile in
Inches	M.M.	Lakhs Cmt.	Lakhs Cmt.	Lakhs Cmt.
1	2	3	4	5
1.	25.4	0.000566	0.000283	0.000283
2.	50.8	0.00254	0.00169	0.00113
3.	76.2	0.00792	0.00594	0.00396
4.	101.6	0.01839	0.01358	0.00905
5.	127.0	0.03280	0.02462	0.01641
6.	152.4	0.05914	0.04414	0.02943
7.	177.8	0.09651	0.07216	0.04811
8.	203.2	0.14713	0.11037	0.07358
9.	228.6	0.20710	0.15536	0.10923
10.	254.0	0.28271	0.21196	0.14121
11.	279.4	0.37613	0.28186	0.18791
12.	304.8	0.48902	0.36676	0.24451
13.	330.2	0.61525	0.46130	0.30767
14.	355.6	0.76384	0.57283	0.38176
15.	381.0	0.92713	0.69531	0.46352
16.	406.4	1.10455	0.82835	0.55214
17.	431.8	1.29642	0.97216	0.64807
18.	457.2	1.51490	1.13590	0.75732
19.	482.6	1.73620	1.30204	0,86796
20.	508.0	1.97251	1.47921	0.98625
21.	533.4	2.22296	1.66715	1.11134
22.	558.8	2.50228	1.87655	1.25113
23.	584.2	2.78245	2.08683	1.39125
24.	609.6	3.07706	2.30754	1.53836
25.	635.0	3.38581	2.53832	1.69293
26.	660.4	3.72654	2.79490	1.86321
27.	685.8	4.06501	3.04873	2.03252
28.	711.2	4.41819	3.31366	2.20906
29.	736.6	4.78581	3.58922	2.39272
30.	762.0	5.18739	3.89046	2.59365
31.	787.4	5.58444	4.18815	2.79200
32.	812.8	5.99620	4.49713	2.99816
33.	838.2	6.42212	4.81630	3.21093
34.	863.6	6.88510	5.16362	3.44247
35.	889.0	7.34073	5.50548	3.67022
36.	914.4	7.81080	5.85816	3.90545
37.	939.8	8.29529	6.22145	4.14762
38.	965.2	8.81916	6.61429	4.40949
39.	990.6	9.33332	7.00000	4.66667
40.	1016.0	9.86197	7.39644	4.93091
41.	1041.4	10.40508	7.80373	5.20239
42.	1066.8	10.99030	8.24267	5.49500
43.	1092.2	11.56282	8.67193	5.78144
44.	1117.6	12.15004	9.11234	6.07487
45.	1143.0	12.75141	9.56345	6.37572
46.	1168.4	13.39778	10.04819	6.69893
47.	1193.8	14.02885	10.52168	7.01447
48.	1219.2	14.67468	11.00587	7.33734
49.	1244.6	15.33461	11.50086	7.66738
50.	1270.0	16.04214	12.03146	8.02107

APPENDIX No. II

Abstract from P. 817 of P. W. D. Hand Book, Vol. II

For small tanks constructed on nallas, with catchment areas rarely above 25 square miles. discharge observations are not usually available, and the supply available (on which the height of the dam depends), is arrived at from the rainfall records in an empirical way. In Beale's Report on Investigation of Minor Irrigation Works, a replenishment of $^1/_6$th of the total average rainfall on the whole catchment is proposed. In the Northern Circle, it is usual to assume $^1/_5$th of the average annual rainfall on the whole catchment, for the Panch Mahals District, and $^1/_7$th of the average annual rainfall in the Kaira and Ahmedabad Districts. Another method adopted is to take as the figure of annual replenishment ;—

$^1/_6$th of the rainfall over catchment, for average daily falls of $\frac{1}{2}''$ to $\frac{3}{4}''$.

$\frac{1}{3}$rd of the rainfall over catchment, for average daily falls of $\frac{3}{4}''$ to $1''$.

$\frac{1}{2}$ of the rainfall over catchment, for average daily falls of 1" and above.

Mr. Inglis (Technical Paper No. 30) gives the run off from non-ghat catchments away from the hills, as roughly

$$\text{run off} = \frac{\text{Rainfall in inches (mean annual)}—7''}{100} \times \text{rainfall in inches.}$$

GOVERNMENT OF GUJARAT

Revised Manual on Percolation Tank.

WATER RESOURCES DEPARTMENT.
SACHIVALAYA
GANDHINAGAR

REVISED MANUAL ON PERCOLATION TANKS

1.0. DEFINITION :

Percolation tank is defined as a small tank whose capacity lies between 3 mcft to 15 mcft. However in the exceptional cases it can be maximum 20 mcft provided that the ceiling cost is not exceeded. This is constructed by means of an earthen bund across a rivulet. The function of such a tank would be to head up water for a period and let it gradually escape to raise the surrounding sub-soil water level and produce small and more permanent flow in the nala below the tank.

2.0. NECESSITY:

2.1. In the areas generally affected by scarcity conditions and where the rainfall is Irregular, erratic and comparatively low, the percolation tanks are useful in conserving the moisture. They help to augment the sub soil water, thereby stabilising the irrigation practice from the wells in the area down stream of the tank and also near water periphery within a reasonable distance. In other words such tanks help in recharging the aquifers, which are being tapped by means of wells, tubewells etc.

2.2. Regarding moisture conservation the percolation tanks are an extension of the principle common to contour bunding and nalla plugging.

3.0. POINT TO BE OBSERVED WHILE TAKING THE SCHEME ON HAND.

3.1. The area proposed to be benefitted by the percolation tank should have existing working wells with an intensity of not less than 5 wells per sq. mile.

3.2. The wells before the construction of the tanks should preferably have recuperation of 0.05 cusecs after the monsoon in October or November.

3.3. The maximum area benefitted would be estimated as approximately 15 to 20 acres per mcft. of gross capacity.

3.4. The maximum suitable area which could be benefitted would depend on site conditions. the reach normally not extending beyond 4 miles along the nallas.

3.5. There shonld be adequate area within easy reach of lift, which is suitable for irrigation.

3.6. The area proposed to be benefitted should have at least about 9" soil cover. Deep soil areas should be avoided as they will not have adequate permiability potential for success of the schemes.

3.7. The locarion of a percolation tank in an area where no successful wells exist at all below the same is likely to be infrusctuous.

4.0. DESIGN CRITERIA:

4.1.0. YIELD :

Depending upon the average annual rainfall within the catchment the yield at the proposed site of the percolation tank should have the following dependability.

Sr. no.	Average annual rainfall	Percentage Dependability
1.	Less than 380 mm. (15")	40%
2.	380 mm. to 760 mm. (15" to 30")	50%
3.	760 mm. to 1520 mm. (30" to 60")	65%

In absence of reliable data on the actual yield the strange's table (Appendix no. 1) is generally adopted for working out the yield.

4.1.1. As direct irrigation is not envisaged from the percolation tank, no outlet is to be provided. As it will not be practicable to desilt the bed every year provision for deposition of silt for 5 to 10 years should be made. It should however be seen that the silt deposited is periodically removed (Otherwise the percolation would be retarded) by encouraging people to borrow earth from prescribed deep submergence areas at certain intervals.

4.2. F. S. L. :–

Depending upon the basin, the capacity of the tank is fixed so as to store almost all the yield expected. Wherever feasible tanks with higher storage capacity be preferred.

4.3. EARTHEN BUND :

4.3.1. Two differnt sections may be designed (i) for the maximum height in gorge portion (ii) for the maximum height in flanks. The design of both the the earthen section may be done as per prevailing standards. The top width and the free–board may be adopted as per finally decided guideline in this draft mannual.

4.3.2. C.O.T. :–

As the intention of the percolation tank is to raise the sub soil water level of areas downstream of the site, water should be allowed to percolate below the seat of the dam. Therefore for bunds having heights upto 4.60 mt (15') C.O. T. is not nscessary and keying and benching between the dam seat and natural ground will suffice, For bunds having more than 4.60 mt. (15') height C. O. T. equal to 1/2 height of water column in case of soil and 1/3 the height of water column in case of murrum may be provided. However if the strata available in C. O. T. is murrum C. O. T. for height of dam upto 7.0 mt. may be dispensed with after considering the peremeability of soil.

4.3.3. TOP WIDTH AND SLOPES :

Bunds profile for percolation Tank should be adopted as under :–

Height of bunds.	Top Width	Slopes U/s	Slopes D/s	Remarks
Upto 8 mt.	3.50 M	2.5:1	2.1	Village not just on D/s.
Greater than 8Mt.	4.00 M	U/s and D/s slopes are to be provided as per stability analysis of slopes		

4.3.4. HYDRAULIC GRADIENT :

The phareatic line should be assumed to run horizontal in U/s casing and it will fall in level equal to "H/2" during its travel in core, where 'H' is working head (F.R.L.–G.L.)

4.3.5. HEARTING :

Core (Hearting) should be provided with a topwidth of 3.0 m & side slopes of 1/2 (H) : 1(V). Top level should be at H.F.L. + 1.0 m or H.F.L.+1/2 F.B. whichever is greater. If plasticity index of core material is less than 15%, the extent of erosion of such soil would be more with tendency of dispersion. The following precautionary measures should be taken.

The core thickness should be checked as suggested by Dr. Bharat Singh's paper on Vol. III of C.B.I.P. ADS (49th) Ooty from erosion resistance and crack length consideration.

Procedure is as follows :

Data :– MDD : (75% reliable value)
OMC, PI, ϕ, (75% reliable value)

Critical shear stress :–

$$T_{cr} = \frac{1}{1.05 + \frac{1.5}{PI} + \frac{1.25}{MDD}}$$

Limiting shear stress :

$$T_L = 4 \times T_{cr}.$$

Now $$\frac{L}{H} = \frac{V_w \times t}{2 \times T_L}$$

Where L = Core thinckness in mt.

V_w = Unit weight of water 1000 Kg/m³.

t = Thickness of horizontal crack

= 2 cm.

= 0.02 m.

T_L = Limiting shear resistance in Kg/m^2.
H=Head of water in m.

The minimum thickness of core should be greater than the same arrived at as per above formula and may be provided at all levels.

A transition zone should be introduced between the inclined filter and core, such that it fulfills the filter criteria laid down in clause 4.1 of IS-9429-1980. The transition zone should have width of at least 2.5m.

4.3.5. CASING ZONE:

The casing shall be of pervious or semipervious material, horizontal filter, inclined filter, rock toe, should be provided in casing zone for drainage purpose if necessary.

4.3.6. PROTECTION OF U/S & D/S SLOPE :

Pitching on U/s face is required to protect the U/s slope of earthen bund The thickness of rubble pitching should be kept 0.15 m. to 0.23 m.with 0. 15 m. thick murrum bedding. The d/s slope may be protected with rock toe and open longitudinal and Cross drains.

4.3.7. FREE BOARD:

The free board of 1.5 m. may be provided for the height of dam upto 8.0 m. For the height of dam between 8.0. to 12 M. free board may be provided as 1.5. M. To take care of wave action two feet high earthen pali (Truncated section with 0.60 mt-top width) may be provided on upstream face of earthan bund with side slopes 2:1. And for height more than 12.0 M. free board should be provided 1.75 M. and to take care of wave wash 0.60 m. high earthen pali may be provided on the U/s face of the dam.

4.3.8. Where the impervious material are not available within reasonable lead, earth dam section with semipervious material may be suitably designed with sand zone and/or rock toe if necessary.

4.4.0. Waste Weir :

4.4.1 Location :—A Waste weir should be designed to pass the design S. P. F. Generaly it is located either in the gorge portion or in the saddle region having ground level approximately equal to the crest of the weir. The location of the weir should be such that the tail water can be led into the near by natural nalla which meets the parent river away from the downstream toe of the dam.

4.4.2. Foundations :

The foundation level for the waste weir may be decided in consultation with geologist. Geological classification of the foundation strata of the weir may be got done by the geologist before deciding the type of weir and foundation level of the Waste Weir. For downstream protection works also, the geological classification of the strata in the tail channel is a must to assess the maximum permissible velocity of water

in tail channel region without scouring or retrogression. Geological investigations for the foundation, shall be carried out for Ground Bar waste Weir, Chute Spillway, Ogee shape Waste weir upto 8 mt. heights as under :

(i) Investigation by 3m deep trial pit and geophysical method,

(ii) Probing to be done upto 2 m below Ground level or upto fresh rock whichever is deeper.

(iii) Ogee shape waste weir having height more than 8 m. Core Drilling upto 5 m into fresh rock to be done.

For A/C. &T/C

(i) Investigation to be done by trial pits of 3 m depth upto rock level at every 50 to 100 m as per site condition.

ii) If rock is not available upto reasonable depth, geophysical probing to be resorted to.

4.4.3. TYPE OF WASTE WEIR.

(i) Drowned channel waste weir or Ground Bar. W.W.
(ii) Drowned waste weir (Submerged)
(iif) Clear overfall type (Ogee, Broad crested)

4.4.3-1. DROWNED CHANNEL, OR GROUND BAR WASTE WEIR.

This is one having crest of weir is at the G.L. in the saddle region The crest of weir is at F.S.L, of the tank and further the channel is excavated with the required gradient to pass design discharge. This type of waste weir is proposed where, ground selected for the site is either higher than the F.S.L. or at F.S. L. It may be founded on hard rock strata at reasonable depth.

4.4.3.2. DROWNED WEIR (SUBMERGED WEIR)

This is one of small height having its crest below the water surface of the channel when the reservoir is at H.F.L.

4.4.3.3. CLEAR OVER FALL WEIR

This type of weir is provided where the tail channel water level is below the F.S.L. level of the reservoir and there is a clear over fall when the reservoir is above the F.S.L. level.

D/S protection works may be provided either in the form of water cushion or chute fall depending on the nature of the soil strata met with in D/s Tail channel region Ogee shape with bucket and end sill wall depending on site condition may be considered.

The design of the broad crested weir with D/s water cushion or Ogee shape weir with bucket and end sill wall and chute fall type waste weir may be adopted as laid down in the relevent I.S.
The I.S. standard to be followed for different type of weirs are as under :—

1. I.S. 6934—1973 Body wall
2. I.S. 4997—1968 Stilling basin
3. I.S. 5186—1969 Chute fall
4. I.S. 7365 - 1974 Bucket Type.

4.4.4. FLOOD DISCHARGE :

(i) Estimating of peak Flood

To estimate the peak of standard project flood (SPF) for small catchment upto 1?5 Km^2 is of the form of

$Q=a.A^b$

Q (Peak) Where

Q=S. P. F. Peak incumecs

A—Catchment area in Km^2

The value of a & b depends upon the topography & Hydrometerology of respective zone of Gujarat as under :—

Zone No.	Respective Zone of Guj. (As per plat—I)	Value of 'a'	Value of 'b'
Zone–I	The lunibasin, the Banas Basin and Kutch region.	67.3697	0.6485
Zone–II	The Saurashtra region	29.0402	0.9232
Zone–III	The region from the Banas down to Narmada covering the sabarmati, the Mahi & the Dhadhar basin.	54.5883	0.7638
Zone–IV	The lower Narmada and Tapi basin.	62.2587	0.7765
Zone–V	The region South of the Tapi basin.	53.4564	0.8812

(ii) Estimating of Design Flood.

To estimate the design flood of a desired return period. the SPF peak (Q Peak) estimated by the above formula shall be adjusted suitably by applying a multiplying factor shown as under :...

Q—design —M (Q Peak)

$=M\ (a.A^b)$ Where M=Multiplying factor in percentage.

TABLE

Zone No.	Return Period				
	1 in 5 Yrs.	1 in 10 Yrs.	1 in 25 Yrs.	1 in 50 Yrs.	1 in 100 Yrs.
	MULTIPLYING FACTOR (PERCENTAGE)				
I	30	40	50	60	70
II	40	50	60	70	80
III	40	50	60	70	80
IV	35	45	55	65	75
V	30	40	45	50	60

Note:- The scheme having high potential hazard or of the scheme located in the upstream of other storage scheme are to be designed for the full SPF (Q Peak) value.

(iii) For designing the spillway capacity, the flood moderating effect could be neglected.

5.0. AREA UNDER SUBMERGENCE :

The lands and other property affected in the tank basin upto the F.S.L. should be acquired and compensated for, unless the affected owners give an undertaking in writing in the prescribed proforma that they do not mind temporary sub-mergence and will not raise claims of damages in future on this account. Generally it would be preferable to avoid land acquisition.

6.0. BENEFITS

The irrigation benefits from the percolation tanks can not be assesse directly as no direct irrigation is envisaged from such tanks. The anticipated benefit should therefore be worked out by ascertaining the number of wells which will be benefitted within a distance of one mile below the dam and some $\frac{1}{2}$ mile U/s of the dam.

7.0. COST CRITERIA:

The compensation for the lands and structures going under submergence should not exceed 15% of the estimated cost. The ceiling limit of the total cost of the scheme should not exceed Rs. 10,00,000 (Rupees ten lacs) and the cost per mcft of water stored should be within Rs. 1,00,000/— (Rupees one lacs)

If Panchayat or Voluntary Organisations agree to to bear the expenditure beyond ceiling limit of Rs.1,00,000 of stored water,such scheme shall be allowed provided it is technically feasible. Such variation should be restricted to 20% only.

80. DRAWING :

The following drawings should always accompany the scheme submitted for consideration:–

(i) An index plan (scale 1" = 1 mile or 1=50,000) showing the location of the proposed tank and its catchment.

(ii) A contour plan (scale 1cm = 20 mts. or 30 mts.) showing all the details upto one meter above the top of the proposed bund and also the detail, indicated in para 8 (iii) below:

(iii) A village Plan (scale 1"=660' or 1"=330') showing the location of the tank, lands roads and structure going under submergence, bund, W. W., tail channel and wells, which will be benefitted after the implementation of the scheme.

(iv) Drawing showing plan, L. S. and C. S. of the alignment of the bund with details of strata available in trial pits and depth of COT proposed if any, drawn to following scale.

For L S. Horizontal Scale.

1 cm=5 mts. to 20 mts.

Vertical scale 1 cm=1 mt.

For C. S. Horizontal scale 1 cm=2m to 5 mt. vertical scale 1cm=1mt to 2 mt.

(v) A Plan showing the details of W. W. and D/s protection works, if any, with plan, C. S. and L. S. and strata available for foundation etc.

(vi) A Plan showing the L. S and C. S. of the approach and tail channel along with details of trial pits.

Note :—The scale may be varied if required

: BIBLIOGRAPHY :

1.0. Manual on percolation tanks published by Government of Gujarat Ex., P. W. D. Sachivalaya, Gandhinagar dtd. 24–11–1976.

2.0. Government of Gujarat, Irrigation Department Circular No.GIV–3281/(33) Pt. I. K. 6 Sachivalaya, Gandhinagar dtd. 16–9–1986.

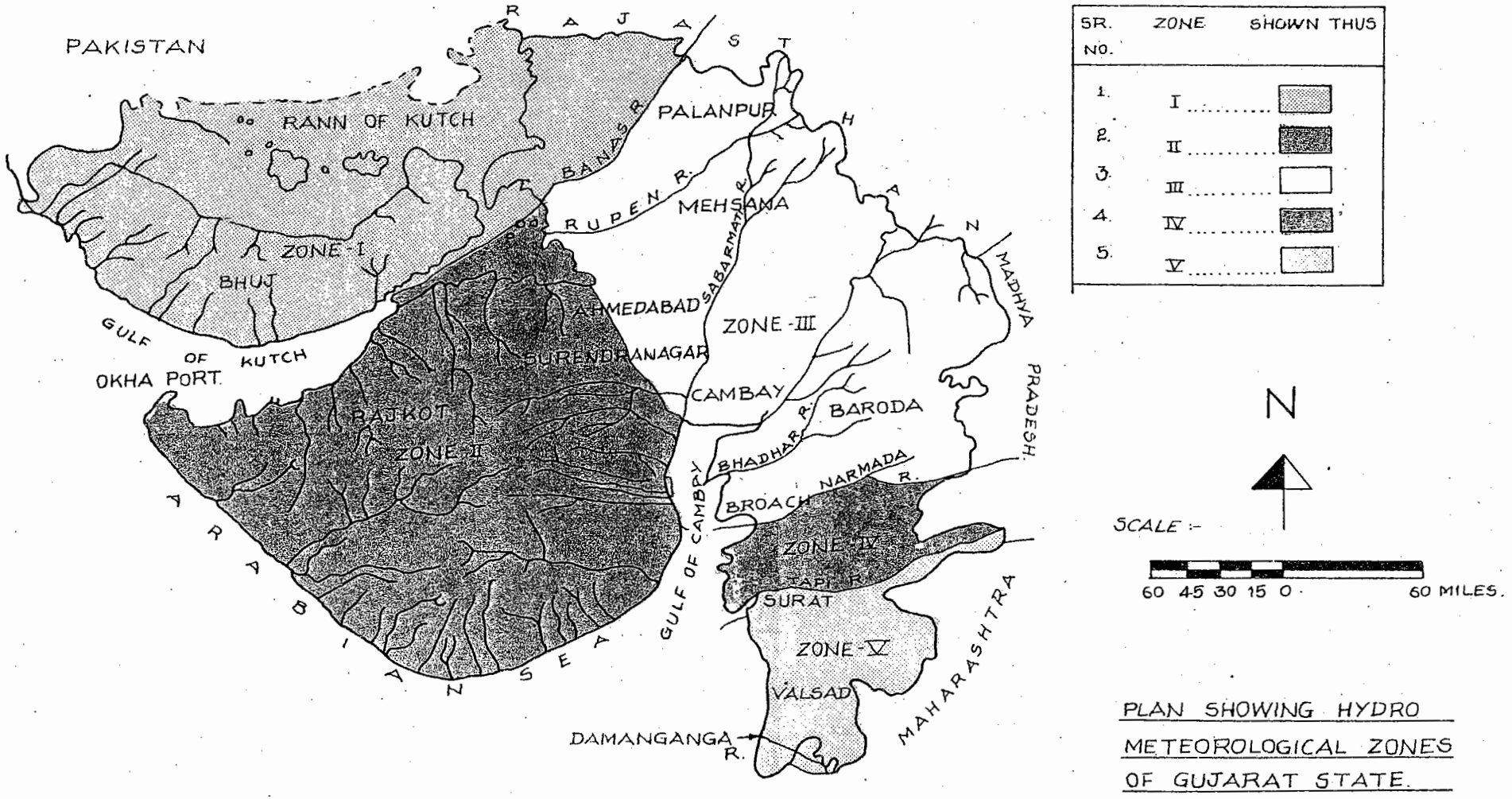
3.0 Government of Gujarat Irrigation Department Circular No. NSY–1076/7/Part–3/I, Sachivalaya, Gandhinagar dtd. 29–6–1987.

4.0. Report of the study team and Recommendation thereon by the committee of the Government of Maharashtra.

APPENDIX No. I

Strange's Table of run off due to monsoon rainfall per square mile of catchment area

Total monsoon Rainfall.		Good Catchment Yield or Run off from Catchment per Sq. mile in	Average Catchment Yield or Run off from Catchment per Sq. mile in	Bad Catchment Yield or Run off from catchment per Sq. mile in
Inches	M.M.	Lakhs Cmt.	Lakhs Cmt.	Lakhs Cmt.
1	2	3	4	5
1.	25.4	0.000566	0.000283	0.000283
2.	50.8	0.00254	0.00169	0.00113
3.	76.2	0.00792	0.00594	0.00396
4.	101.6	0.01839	0.01358	0.00905
5.	127.0	0.03280	0.02462	0.01641
6.	152.4	0.05914	0.04414	0.02943
7.	177.8	0.09651	0.07216	0.04811
8.	203.2	0.14713	0.11037	0.07358
9.	228.6	0.20710	0.15536	0.10923
10.	254.0	0.28271	0.21196	0.14121
11.	279.4	0.37613	0.28186	0.18791
12.	304.8	0.48902	0.36676	0.24451
13.	330.2	0.61525	0.46130	0.30767
14.	355.6	0.76384	0.57283	0.38176
15.	381.0	0.92713	0.69531	0.46352
16.	406.4	1.10455	0.82835	0.55214
17.	431.8	1.29642	0.97216	0.64807
18.	457.2	1.51490	1.13590	0.75732
19.	482.6	1.73620	1.30204	0.86796
20.	508.0	1.97251	1.47921	0.98625
21.	533.4	2.22296	1.66715	1.11134
22.	558.8	2.50228	1.87655	1.25113
23.	584.2	2.78245	2.08683	1.39125
24.	609.6	3.07706	2.30754	1.53836
25.	635.0	3.38581	2.53832	1.69293
26.	660.4	3.72654	2.79490	1.86321
27.	685.8	4.06501	3.04873	2.03252
28.	711.2	4.41819	3.31366	2.20906
29.	736.6	4.78581	3.58922	2.39272
30.	762.0	5.18739	3.89046	2.59365
31.	787.4	5.58444	4.18815	2.79200
32.	812.8	5.99620	4.49713	2.99816
33.	838.2	6.42212	4.81630	3.21093
34.	863.6	6.88510	5.16362	3.44247
35.	889.0	7.34073	5.50548	3.67022
36.	914.4	7.81080	5.85816	3.90545
37.	939.8	8.29529	6.22145	4.14762
38.	965.2	8.81916	6.61429	4.40949
39.	990.6	9.33332	7.00000	4.66667
40.	1016.0	9.86197	7.39644	4.93091
41.	1041.4	10.40508	7.80373	5.20239
42.	1066.8	10.99030	8.24267	5.49500
43.	1092.2	11.56282	8.67193	5.78144
44.	1117.6	12.15004	9.11234	6.07487
45.	1143.0	12.75141	9.56345	6.37572
46.	1168.4	13.39778	10.04819	6.69893
47.	1193.8	14.02885	10.52168	7.01447
48.	1219.2	14.67468	11.00587	7.33734
49.	1244.6	15.33461	11.50086	7.66738
50.	1270.0	16.04214	12.03146	8.02107


PAKISTAN
RAJASTHAN
RANN OF KUTCH
BANAS R.
PALANPUR
RUPEN R.
MEHSANA
SABARMATI R.
ZONE-I
BHUJ
GULF OF KUTCH
OKHA PORT
AHMEDABAD
ZONE-III
SURENDRANAGAR
CAMBAY
BARODA
MADHYA PRADESH
RAJKOT
ZONE-II
BHADHAR R.
GULF OF CAMBAY
BROACH
NARMADA R.
ZONE-IV
ARABIAN SEA
TAPI R.
SURAT
ZONE-V
VALSAD
MAHARASHTRA
DAMANGANGA R.
REFERENCE :-
SR. NO.
ZONE
SHOWN THUS
1. I
2. II
3. III
4. IV
5. V
N
SCALE :-
60 45 30 15 0
60 MILES.
PLAN SHOWING HYDRO METEOROLOGICAL ZONES OF GUJARAT STATE.