INVESTIGATION AND PLANNING OF MINOR IRRIGATION SYSTEM INCLUDING DEMAND TABLE

- *Costs*
- *Selection of A Dam Site*
- *Investigations*
- *Engineering Investigations*
- *Preparation of Plans to Scale*
- *Demand Computations*
- *Demand Table*
- *Irrigation Water Demands of an Irrigation Project*

Minor Irrigation works can be treated as assets as they provide water even in times of scarcity

Introduction

Irrigation should be given over riding priority. (It is these works which will provide an asset to the area; they will provide water in scarcity times). Every drop of water that falls on the ground should be conserved for future use. If major projects are deferred, the minor irrigation works should not be lost sight of. In fact, these works should be given priority as the spread effects are more and results are quicker as against the major projects whose investments will only be in selected areas. Well-being of all the people should be the objective. It is apt to quote from an American policy paper that "Well being of all the people shall be over-riding determinant in considering the best use of water and related land resources. Hardship and basic needs of particular groups within the general public shall be of concern, but care shall be taken to avoid resource use and development for the benfit of a few (or) to the disadvantage of many. In particular, policy requirements and guidelines established by the congress and aimed at assuring that the use of natural resources including water resources, safeguarding the interests of all our people shall be observed."Implicitly, emphasis must be given to cost benefit analysis of minor irrigation works.

Objective of all investigations for Minor Irrigation schemes is to locate, design and construct most economical structures to impound water. This conserved water may be used for irrigation, supplied as drinking water, recreation and reclamation of low lying areas.

Safety considerations with respect to the foundation and site characteristics govern the type of structure can be check dam / percolation tank / M.I. tank/ dam types.

COSTS

The cost of the structure is effected by the availability and price of the construction materials forming an important factor in the design. Availability of suitable material or earth for rock fill dam in close proximity will result in economic design of M.I. Tanks.

SELECTION OF A DAM SITE

Selection of a suitable site for a dam depends on many factors which are briefly discussed below:

(i) Topography and storage capacity

For economic feasiblity of a storage project, it is neccessary that the length of the barrier or dam should be as short as possible and for a given height it should store large volume of water. Hence the river valley at the dam site should open out upstream to provide a reservoir as shown in Fig

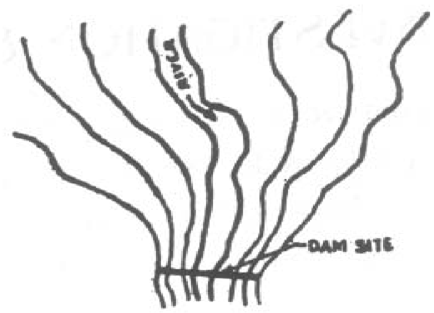

Fig 1: Suitable dam site

(ii) Foundation

The site should preferably have good, sound rock for foudation. For a concrete or masonry dam, solid rock at the surface or within a resonable depth below it is essential. For arch dams strong abutments are essential.

Though Rock fill and earth dams have more flexible foundation requirements, the cost is invariably affected by the type of foundations available.

(iii) Hydrology

A good water supply with minimum fluctuations is a desired feature. But continuous and heavy rains in most part of the year would deter the construction of an earth dam.

(jv) Sediment load

An assurance that the dam would not silt up soon is a desirable factor. The sediment load in the stream should be as little as possible.

(v) Surplus Weir Site

A convenient site for construction of a surplus weir will not be available always. This is not mandatory for a masonry dam but must essentially be considered available for an Earth dam

The best site is that in which the gorge portion is separated from the flank as shown in Fig

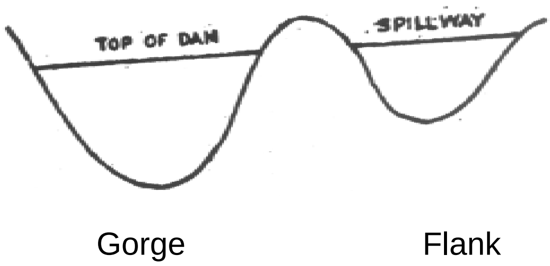

Fig 2: Suitable spill way site for an earth and rockfill dam

(vi) Availability and character of materials for construction

For economic feasibility the bulk of materials required for construction of the dam must be available in close vicinity of the site. It is desirable to use natural material or good quality rock as coarse / fine aggregate for a concrete dam if they are available nearby. If limestone is available in the surrounding area, it may be used to replace portland cement partially or wholly.

Earth dams can be designed to utilise almost any type of materials availble at site, although the economy of the work is affected accordingly.

(vii) Diversion during construction

Sometimes river diversion problems play an important role in the selection of a dam site. This factor may affect the design of the dam and also the construction schedule.

(viii) Submergence

The cost of property and the submerged land by the proposed dam should be low in comparison to the benefits expected from the dam, i.e. the benefit to cost ratio (B/c) must always be greater than one. {The height of Rihand dam could not be raised as the Singrauli coal mines were under danger of being submerged}.

(ix) Water tightness of reservoir

The rim of the dam should be water tight at the proposed site of the dam. The stored water should not esacape from under the surrounding hills through cavernous rock or any other continuous pervious strata.

(x) Flood control aspects

The dam site should be located above the area that needs to be protected from floods.

(xi) Irrigation command

The dam site should be located on upstream side of the area to be irrigated

(xii) Availabilty of suitable site for construction facilities

The dam should offer suitable area for location of rehabilitated colonies. Transportation of construction machinery & hydro mechanical equipment is economically feasible if we use the Railway. Thus availability of proper approach road to the nearest rail head must be considered.

(xiii) Climate

Cold climatic conditions and heavy rainfall will impede construction activites.

(xiv) Availability of utility services

It is economical if the site is located in the vicinity of an access road, electric line, water supply etc.

(xv) Locality

Hygienic surroundings free of mosquitoes are preferable.

INVESTIGATIONS

Investigations can be classified in to three broad categories:

(i) Engineering investigations

(ii) Geological investigations

(iii) Hydrological investigations

These investigations may further be divided in two classes:

(i) Preliminary investigations

(ii) Investigations during construction stage.

The preliminary investigations are carried out to determine technical and financial feasibility of a project and to enable the preparation of preliminary design and estimates necessary for authorization of construction.

Once construction has been authorized, detailed investigations have to be carried out to enable preparation of detiled design of the various components of the project.

Since engineering and geological investigations are carried out simultaneously, it is necessary that the services of an experienced geologist have to be requisitioned at the initial stage, when the project has been conceived. The geologist should be able to advise not only about the feasiblity of the project but also most suitable type of dam, after exploring the foundation conditions and locally available materials of construction. Once the type of dam and its height has been fixed by the engineer, the geologist should be able to draw a programme of subsurface explorations to determine the type and properties of underlying rock and devise a programme for its treatment.

While the geologist would advise on the suitability of the foundation rock and quarry materials, the engineering properties of the foundation rock and materials of construction must be determined by the engineer. It is here that he would need the help of a laboratory capable of perfoming tests on soil (both in situ and in laboratory).

ENGINEERING INVESTIGATIONS

(i) **Reconnaissance Survey:** Reconnaissance survey is the first survey done at the proposed dam site to study the topography of the site.

(ii) **D.C.B.M.(Double Check Bench Mark):** Before commencing works for any Minor irrigtion tank, levels are to be carried over from a known G.T.S. bench mark and temporary bench marks are to be established in the vicinity of the project by DCBM (Double Check Bench Mark). survey with two independent levelling instruments.

(iii) **Chain & Compass survey:** Chain & Compass survey is done with 20m or 30m chain duly

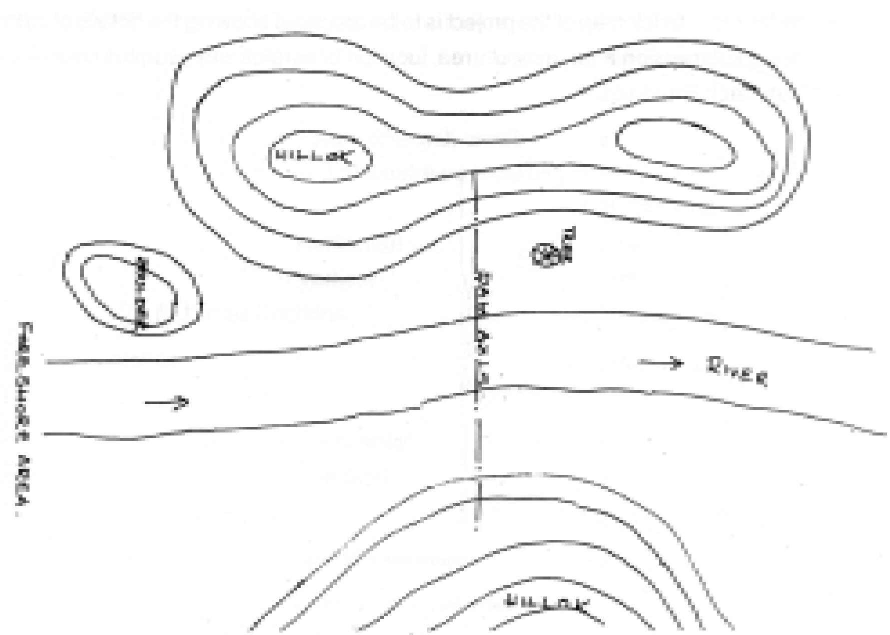

Figure 3

noting down the location of all important features like streams, trees, boulders, hillocks on either side of the dam line. Fig 3.

(iv) **L.S & CS PLAN :** On the proposed alignment of the bund (axis line) levels along the alignment at 30m intervels must be taken. Cross sections at 30m intervals must be taken duly extending the levels to a distance of 100m on either side of axis line. Levels at closer intervals shall also be taken (If necessary). Contour maps are drawn accordingly.

(v) **Block levelling**

(a) Block levels in grid, of 20m may be taken for drawing the submersion area contours, including F.T.L (Full Tank Level) and M.W.L. (Maximum Water Level). Closer grids of 5 to 10m are recommended, if the site is very undulating with steep rise and falls.

(b) Block levels of C.M. & C.D. Works (Cross Masonry and Cross Drainage works), earthen dam, head sluices, weirs, surplus courses etc. are to be taken at intervals of 10m grid.

(c) Block levels in a grid of 20m may be taken for preparation of ayacut plan. Levels at closer intervals shall be taken where ever necessary.

(d) **Canals:** Levels at 20 to 30 m intervals may be taken along the longitudinal section (L.S) of the canal. Cross sections (C.S) at 120m intervals for a length 30m on either side of canal with levels at 10m interval may be taken.

(e) **Index map:** Index map of the project has to be prepared showing the details of catchment area, submersion area, ayacut area, location of surplus weir, surplus course, canals, approach road etc.

PREPARATION OF PLANS TO SCALE

Plans should be drawn to scales as under:

a.	Index Plan	1:50,000
b.	Theissen Polygon showing rainguage stations	1:2,50,000
c.	L.S. of stream: Horizontal scale	1:5,000
	Vertical scale	1:50
d.	Anicut site surveys, head works with levels 100m upstream & 100m downstream including flood banks	1:500 or 1:1000 or 1:2000 As per site conditions
e.	Bund (i) L.S.: Horizontal	1:2000
	Vertical	1:200
	(ii) Cross Sections	1: 100, Natural
f.	Foreshore Plan	1:2000
g.	Weir	
	(i) L.S. & Plan: Horizontal	1:1000
	Vertical	1: 100
	(ii) Weir Plan	1: 200 or 1:300
	(iii) Net levels in 10m squares	1:500
	Contours to be drawn at 0.5m intervals depeding upon slope of the country	
h.	Sluice	
	(i) L.S.	
	(ii) Plan	1:100
	(iii) Cross Section	
i.	Channels	
	(i) L.S: Horizontal	1:2000
	Vertical	1:200
	(ii) Cross Section	1:100 Natural
	(iii) Net Levels for C.M & C.D works	1:500
	(iv) Plan for C.M & C.D. works	1:100 Natural

DEMAND COMPUTATIONS

A Sample minor irrigaton scheme having 100 ha of ayacut is considered for illustrating demand computations. A notional cropping pattern comprising irrigated dry crop namely groundnut and a wet crop, paddy has been considered. 30 ha has been taken for ground nut and the remaining 70 ha was assumed to be under paddy cultivation. The details are presented in tables

Monthly demand for the scheme (Khariff)

S.No.	Crop	Monthly requirement of water in cum				Total
		July	August	September	October	
1.	Paddy	3,12,900	1,07,100	1,74,300	1,53,300	7,47,600
2.	Groundnut	28,500	40,800	36,900	9,600	1,15,800
	Total	3,41,400	1,47,900	2,11,200	1,62,900	8,63,400

DEMAND TABLE

Table : Crop Water requirement as per Modified Pen-Man Method, Irrigated wet: Paddy (Khariff)

Crop period : 120 Days

S.No. & Description of Item	July	August	September	October	Total
1. E.T. Value in mm. (Hanumakonda)	136.70	134.70	123.6	131.80	
2. Kc. (Crop Co-efficient) Value.	1.10	1.10	1.10	0.95	
3. Monthly water requirement (1x2)	150.37	148.17	135.96	125.21	
4. Add fopr Nursery	40	..	..	..	
5. Add for land preparation	160	..	..	..	
6. Add for deep percolation (3mm. per day)	90	90	90	90	
7. Add for minimum depth.	50	..	50	..	
8. Gross total monthly requirement in mm.	490.37	238.17	275.96	215.21	1219.71
9. Monthly rain fall at 50% P.L.	297.52	242.71	171.30	95.93	..
10. Effective rainfall 50% of 50% P.L.	148.76	121.35	85.65	47.97	403.73
11. Net irrigation requirement [(8)-(10)]	341.61	116.82	190.31	167.24	815.98
12. Requirement at 90% field efficiency (11)x100/90	379.57	129.80	211.46	185.82	906.65
13. Monthly requirement at Canal Head at 85% conveyance efficiency (12)x100/85	446.55	152.71	248.78	218.61	1066.65
14. Total requirement in mm.	447 mm	153 mm	249 mm.	219 mm.	1068 mm
15. Total requirement per Ha.	4470 cum	1530 cum	2490 cum	2190 cum	10680 cum
16. Total requirement per 70 Ha.	312900 cum	107100 cum	174300 cum	153300 cum	747600 cum

IRRIGATION WATER DEMANDS OF AN IRRIGATION PROJECT

Water resources development planning for an Irrigation Project is done by considering the demands on water from various aspects like:

- Drinking water needs
- Irrigation water needs
- Industrial including power generation needs
- Ecological needs and other inter state obligations if any.

These demands are estimated and compared with the availability of water at the project site and as per this availability, demands have to be adjusted and prioritized. Normally in water resource planning drinking water supply is given top priority and other demands like irrigation, Industry etc follow.

Every project is planned to see that water supply needs are met with completely (100%)and irrigation needs are met 75 % of the life of the reservoir or period of sliding (ie either 25 years or 40 years period depending upon the type of need , magnitude of the Project and criticality of the flows The sliding by which the success of meeting the demands with the available water is called Simulation studies or Working tables or Regime tables.

Preparation of Demand Table: This exercise is done for various needs like projected Water supply needs , Irrigation needs arrived at by Crop Water Requirements (CWR) assessed by Modified Penman method as per FAO publication No 24 .

The Crop Water Requirements are calculated at plant level generally on a 10 day 0r fortnight basis. Once these values are arrived at for a notional cropping pattern as decided for the project under consideration the same are transformed upto the canal head or at Head regulator by taking into account the various efficiency factors like ;

Application efficiency at field level (generally taken as 75%)

Thus Field level requirement = CWR at plant level/ Application efficiency

Conveyance efficiency (Distributory, Branch canal ,Main canal etc. generally taken as 65%)

Canal head requirement = CWR at Field level / Conveyance efficiency

Once these values are arrived at which are basically in "depth per unit area" they have to be converted into quantities by considering the cropped area or command and the period or duration.

A typical worked out example is given below (tables 1,2,3 and 4)

Proposed Irrigation Facilitates

	Under Lift-I		Under Lift-II		Total	
	Acres	Hect	Acres	Hect.	Acres	Hect
G.C.A	170710	69084	141490	57259	312200	126343
C.C.A.	130540	52830	108200	43790	238740	96620
Net Irrigable Area	111000	44920	92000	37231	203000	82151

CROP AREAS

Crop	Period	Under Lift-I		Under Lift-II		Total	
		Acres	Hect	Acres	Hect.	Acres	Hect
Ground nut	16th June to 23rd Oct	82500	33387	80000	32375	162500	65762
Chillies	1st August to 31st Dec	18500	7486	12000	4856	30500	12342
Paddy	4th July to 7th Nov	10000	4047	-	-	10000	4047
Total		**111000**	**44920**	**92000**	**37231**	**203000**	**82151**

MONTHLY REQUIREMENTS OF WATER FOR CROPS PER ACRE

Sl. No.	Crop (Period)	N.I.R. in m.m.	F.I.R. in m.m.	G.I.R. in m.m.	C.I.R. in inches	In M.cft per Acre
1	Ground nut (June 16th to 23rd October)					
	June 1-15	42.24	56.32	86.65	3.41	0.013
	June 10-30	4.12	5.49	8.45	0.333	0.001
	July 1-31	-	-	-	-	-
	Aug 1-31	58.35	77.8	119.69	4.712	0.017
	Sept. 1-30	67.11	89.48	132.64	5.42	0.020
	Oct 1-23	41.84	55.79	85.93	3.379	0.012
2	Chillies: (1st August to 31st December)					
	Aug. 1 to 31	-	-	-	-	-
	Sept. 1 to 30	7.86	10.48	16.12	0.635	0.002
	Oct. 1 to 31	132.96	177.26	272.74	10.74	0.039
	Nov 1 to 30	176.93	235.91	362.98	14.29	0.051
	Dec. 1 to 31	149.60	199.47	306.87	12.082	0.044
3	Paddy (4th July to 7th November)					
	July 4-23 July 24-31	301.90	402.55	619.30	24.38	0.089
	Aug. 1-31	156.10	208.15	320.25	12.61	0.046
	Sept. 1 to 30	149.25	199.00	306.15	12.05	0.044
	Oct. 1 to 8					
	Oct 9 to 31	136.90	182.55	280.85	11.06	0.040
	Nov. 1 to 7	19.75	26.35	40.55	1.60	0.006

Total Demand Of Irrigation And Drinking Water Supplies

Sl. No.		Lift-I M cum	Lift-II, M.cum	Total M.Cum
1	Irrigation water demand for crops	281.53	198.214	479.744
2	Drinking water supply to the village under the command of the project	6.458	5.098	11.556
3	Evaporation losses in the five Balancing Reservoirs proposed under the Project.	42.969	29.698	72.667
	Total Gross Utilization	**330.957**	**233.010**	**563.967**