WATER RESOURCES-DEVELOPMENT AND PLANNING IN SANGRAMPUR BLOCK, MUNGER (BIHAR)

ASHWAJEET RATHOR

RESEARCH SCHOLAR

T.M.B. UNIVERSITY, BHAGALPUR,

Dr. U.P. SINHA

PROFESSOR & HEAD UNIVERSITY DEPT OF ECO, T.M.B. UNIVERSITY, BHAGALPUR.

IMPORTANCE

In socio-economic development of the country, the conservation and effective utilization of water resources have played a vital role. Whether it is surface water or underground water, its utilization for irrigational purposes, and power generation, industrial consumption for domestic purposes is imperative for planned development of our economy.[1] It is also essential to identify problem areas keeping both long term and short term planning perspective in view. Water resource planning and management would be desirable with special reference to National Water Plan in collaboration with hydrologists, civil engineers and planners. The historical accounts of Vedas, Smritis and and other classics, including Ramayana and Mahabharata the subsequent works also indicate a scientific approach to water resource management in the past.[2]

PURPOSE OF THE STUDY

The purpose of this chapter is to analyse water resources potential in the study. In this connection the researcher deals with in greater details pertaining to water resources survey, evaluation and planning. Keeping this in mind, the researcher analyses the following aspects :

(i) Status of canal and tubewell irrigation in the Saangrampur Block,

(ii) Ground water potential of Sangrampur Block and scope for further exploitation; and

(iii) Water demand and planning of the resources potential;

IRRIGATIONAL USE OF WATER

Irrigation has proved economically gainful for a country. In fact “Irrigation form the datum line for sustained successful agriculture.[3] Water is more valuable than land, because when water is applied to land its increases the productive capacity of the land in six fold which would produce next to nothing. Knowles writes, “The irrigation works have made security of life, they have increased the yield and the value of land and revenue derived from it. They have lessened the coat of famine, relief and have helped to civilize the whole region. In addition, they yield handsome profit to the government."[4]

Gadgil survey of the economic effects of the Godavari & Pravada Canal in Deccan has shown that the total direct and indirect effects of irrigation projects were very favourable. Due to irrigation, farmers could make additional investment in cattle, farm implements and on more valuable crops like sugarcane.[5]

As a result of studies undertaken in 1958 and 1961, it was observed that canal irrigation has helped in promoting the greater utilization of land, enlarging the average size of the farm. Increasing demand for additional productive investment in farm business, favourable input-output ratio, widening the scope for increase in land revenue and other local receipts. In addition to direct benefits there are also secondary and tertiary benefits e.g., expansion of secondary and tertiary activities. Increasing of greater work opportunities and more employment to both family and hired labour, higher value of output per industrial unit and higher turnover of business establishments in the projects area.[6]

The purpose of irrigation is to help in increase agricultural production from the land served. Irrigation helps in fulfilling moisture deficiency in soils during the crop season so as to ensure proper and sustained growth of crops grown. In additional, land use second or third crop being raised on the land having irrigation facilities which could otherwise may not be cultivated. The productive aspect of irrigation helps in establishing agriculture production against drought.

The third aspect of irrigation is changing soil sterility caused by drought, i.e., overcoming low productivity due to dryness or excessive water supply. Thus, irrigation may be defined as the process of artificially applying water to the soil for raising crops. It is a science of planning and designing efficient low cost economic irrigation system tailored to fit natural conditions.

INTENSITY OF IRRIGATION

The total culturable area of the project is 4589 hectares the canal is the major source of irrigation it is able to cover and irrigate more area than for what it has been designed. The wells and tubewells are vital sources during Rabi and Summer Seasons. The present irrigation intensity is (2016-17) 114.26%. The details are given in Table 4.1 and Fig. 4.1.

Table 4.1 : Irrigation Intensity of the Study Area (2016-17)

Season	Canal irrigation (hectare)		Ground water irrigation in % (hectare)
	Designed	Actual	
Kharif	2874	3485	364
Rabi	740	990	352
Summer	-	-	52
Total	3614	4839	768
Percentage	78.75	16.74	97.52

Source : Divisional Irrigation Management Office, Bhagalpur.

The effective use of created resources may be achieved by proper planning and distribution system. Owing to rapid growth in the Agricultural activities in the project area there is a need for creation of additional sources of irrigation in order to meet the water demand.

Since the surface water resources are being utilized fully, this leaves a scope only for the development of ground water resources.[7] The combined use of both the resources is one of the important factors which may influence the overall food production in the project area. Use of canal water during kharif to the extent possible and tapping of more ground water during rabi within the command area.

SOURCES OF IRRIGATION

Irrigation is the prime force in a developing agricultural economy like that of the Sangrampur Block under Irrigation Management. Under the vagaries of monsoonal rain, droughts and flood conditions, the peasant of this region lives to get and assured crop harvest with the help of irrigation after adopting the prevalent sources in this region under study. In the study area the chief sources of irrigation are canal, private tubewell, S.P. well and others. Among other sources ditch, pyne, ahars, rahat pump, lalha & koor, kanin etc. are important. Altogether 90% of the lands are irrigated through canal, private tubewell & S.P. well and others are the poorest sources of irrigation. Panchayatwise sources of irrigation in detail are given Table 4.2 and Fig. 4.2.

CANAL IRRIGATION

The study area has the following distributaries and canals which are the part of the Badua Command Area shown in Table 4.3.

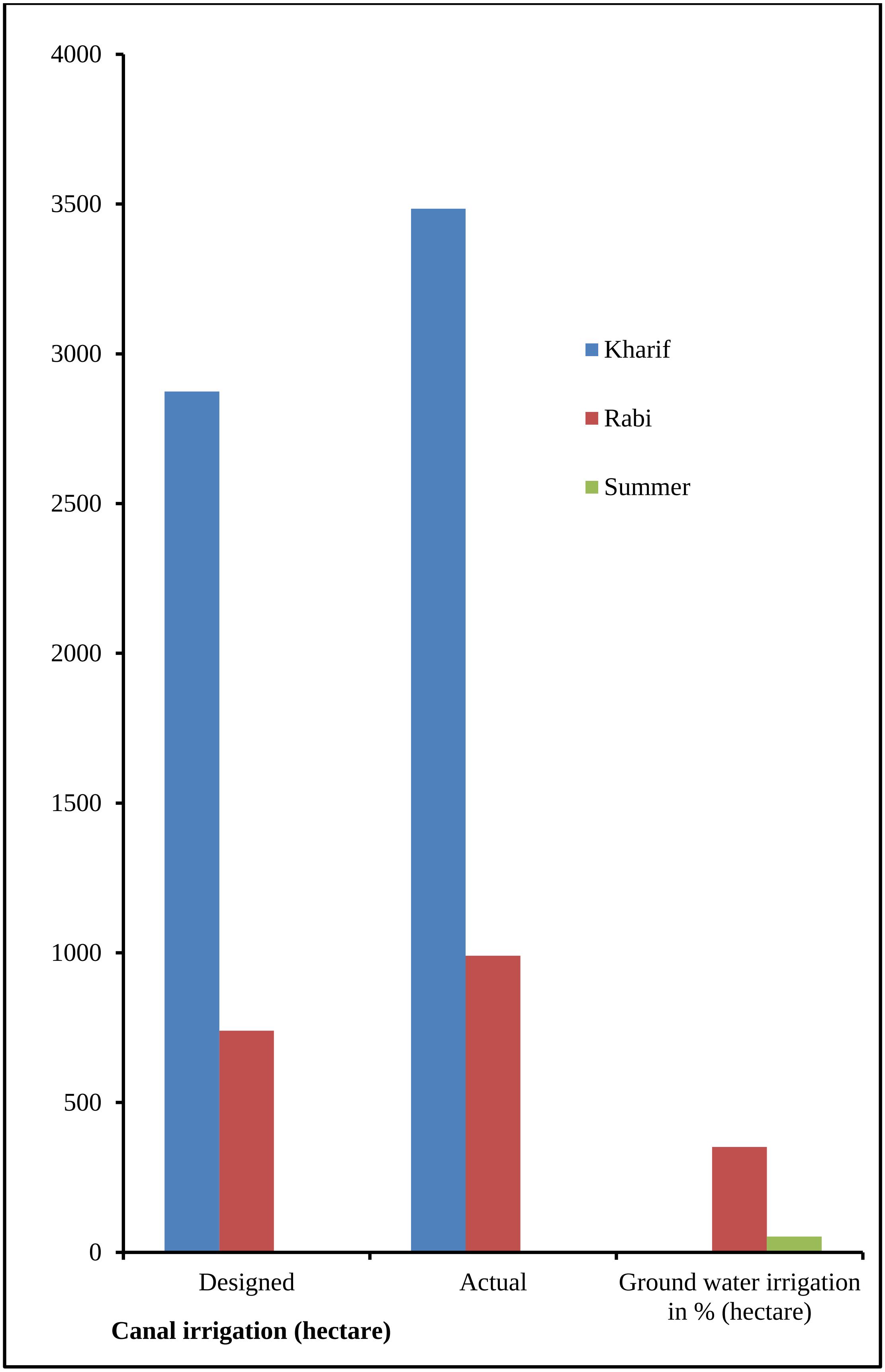

Fig. 4.1 : Irrigation Intensity of the Study Area (2016-17)

Table 4.2 : Sources of Irrigation (2012-16)

Sl. No.	Panchayats	Canal	Private T/wells	S.P. well + others
1.	Rampur	94.15	5.01	0.84
2	Didarganj	84.42	15.08	-
3.	Dadri Jala	81.92	17.28	0.77
4.	Durgapur	91.75	6.75	1.50
5	Kusmar	79.17	20.83	-
6.	Balia	90.64	6.44	2.92
7	Katiyari	99.53	-	0.47
8.	Jhikuli	99.61	-	0.39
9.	Barhaunian	89.94	7.57	2.49
10	Durmatta	93.17	2.48	4.35
	Average	**90.43**	**6.12**	**3.45**

Source : Waterways Division, Govt. of Bihar, Patna and Block office, Sangrampur.

Table 4.3 : Distribution of Badua Command Area

Canal	Discharge (Cumec)	No. of out wet	Commad area (hectare)
Left Bank Main	-	60	2486
Left Bank	10.41	29	1346
Khairati Khan Distributory	3.54	8	257
Total	13.95	87	4089

Source : District Irrigation Management office, Munger.

The canal is the major source of irrigation which covers 3485 hectares. The total area irrigated in the project area is 3848 hectares. The source-wise irrigated is given is Table 4.4

Table 4.4 : Source wise Irrigated Area (1916-17)

Source	Area in hectare
Canal	3485
Private Tubewell	380
Open wells	38
River Lift	10
Total	**3848**

Source : Irrigation Deptt. Govt. of Bihar, Patna.

Table 4.5 : Season-wise Irrigated & Unirrigated Holdings (2016-17)

Season	Irrigated	Unirrigated	Total
Bhadai	6	158	164
Aghani	3849	-	3849
Rabi	1342	1766	3108
Summer	41	-	41
Sugarcane	11	-	11
Total	**5243**	**1930**	**7173**

Sources of Irrigation (%)

Source : Irrigation Deptt. Govt. of Bihar, Patna.

The gross irrigated area was 5243 hectares whereas unirrigated crop for the same year was 1930 hectares. The seasonwise irrigated and unirrigated area study is given in Table 4.5

GROUND WATER SURVEY

A detailed ground water survey was conducted in the entire study area. The survey included collection of information as well data, measurement of water levels, pumping tests, geophysical investigations etc. Main objective of the survey was to assess the scope for sinking

tubwell in order to provide supplementary irrigation to crops during kharif and rabi seasons, if possible during summer season also.

GEOLOGY OF THE AREA

The study area is surrounded on the south and southwest by prominent bills of Archucan complex. The Kharagpur hills (SW of the area 25°12′6″ - 86°38′) consist of massive crantitic Gniesses. The godwans occur about 80 Kms SE of the area. The project area is a part of narrowship of alluvial embayment between the Rajmahals and grantitics on tract varies from 20 to 25 Kms.

GROUND WATER CONDITIONS

The geologic formations comprise a part of the vast stretch of gangetic alluvium deposited by fresh water action. These are sub-recent to recent deposits which overlie the eroded basement of Archacan complex of Pre-Cambrian era. Lithologically the alluvial deposits predominantly composed of finer elastics; clay and S11 with various grades of sands which are inter-stratified. They are loose and unconsolidated. The discharge of shallow wells (installed with centrifugal Pumps) is 400 1pm for an average draw down of 2.5 m. The ground water occurs chiefly under confined condition but because of characteristic lithological steeting, leaky and semi-confined conditions are also common in the area. Piezometic heads in tubwells and dug-cum-bore wells is 3-4 meters below ground level (pre-monsoon)[8] (fig. 4.5).

HYDROGEOLOGY

To study the nature and extent of sub-surface formation inventories were carried out on 56 tubewells in the area. The depth of the wells in general falls within a range of 18-53 meters. The analysis of lithological logging of various bore wells in the project area indicate that the main subsurface formation is clay which persists to a depth of 32 meters at the southern and 38 meters at the northern side with bands of sand lenses in between. The thickness of sand lenses are not uniform. The only sand clayer which is extensive in the project area occurs between 6-25 meters. The formations show a dip towards north with an amount of 88° with the horizonal plane. The average thickness of first sand layer is around 10 meters and the 2nd one is expected to be fairly thick. The most striking feature of the formations is the presence of sand beds which is thickening and thinning frequently. A general lithologic section for the study area.

From the lithologic correlation of bore-hole logging, it is evident that there are beds of sands which are areally extent in the project area. The aquifer materials are areally extent in the project area. The aquifer materials are fine to medium in size. The clay occurs under saturated condition. There are fair chances for leaking of water from the overlaying clay zone to sand beds.

In order to ascertain the general hydraulic gradient and the degree of homogenity of aquifer porosities. water levels were recorded from 77 open wells during pre-monsoon most of the open wells are dug-cum-bore wells and hence the resultant picture would be piezometric level of combined aquifer system, from the map it is evident that the contours are evenly distributed indicating homogenity and continuity of the aquifers. The general water level gradient of the area is towards north and it may be assumed that the southern part may from a probable recharge zone. The average hydraulic gradiant of the area is 0.27°. The average fluctuation of ground water in the area is 2 meters.

THICKNESS OF AQUIFER

The thickness of shallow aquifer is about 10 meters. There is also a deeper layer which is 20 meters. Thick at certain places more than two aquifers zones and encountered. However, the average cumulative thickness of aquifer materials may not be more than 20 meters. The thickness distribution pattern is given in Table 4.7.

Table 4.7 : Thickness Distribution Pattern (2016–17)

Village	1st aquifer		2nd aquifer		Depth to bed rock (m)
	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	
Sahora	12	9	32	-	56
Douri Dusmatta	14	10	36	-	67
Kharia Majhgaon	16	11	38	-	58
Rampur	16	9	40	3.5	58
Kathor dadri	16	6	32	-	60
Kahua Mania	18	8	40	38	58
Barohaniasarai	22	10	30	-	76
Average	16	9	35	36.5	55

Source : Block Development Office, Sangrampur.

GEO-ELECTRICAL INVESTIGATIONS

A detailed geo-electrical investigation was conducted in the area to delineate effective aquifer zone for the purpose of exploitation of ground water for irrigation. The survey was conducted using an NGRI resistivity meter. The sohlumberger electrical configuration was adopted in the field (with a maximum electrode separation, A/2 = 350 m). The total area under investigation is about 40 sq. Kms. covering 47 villages. Nearly 24 m. depth sounding were taken with an one km. grid. The survey was conducted during summer season following the harvest of wheat as the area is mostly under cultivation during the other two seasons.

The field data have been plotted on a double log transparent sheet to obtain field curves. Most of them are 4 curves and in general the area presents a three layer pictures. Quantative interpretation of the curves indicate that the lower most bed in all curve is most resistive. But the characteristic feature is that no layer possesses uniform thickness throughout the study area.

During the course of survey 46 tubewells were also studied and the soundings recorded near some of these tubewells were taken as control points for the purpose of lithological interpretation of the field data. The field curves were interpreted quantitatively to ascertain the depth of the most resistive bed and the thickness and extent of the alluvium employing the partial Curves matching and interpopolation technique.[9] It has been found that the clay content in alluvium it's relatively more and in dominating proportion in the entire area. Though sands varying thickness have been inter-stratified with clay, their occurrence is not evident from the field curves which may be attributed to enormous thickness of the clay layer.[10]

GEO-ELECTRICAL SECTION AND LITHOLOGIC CORRELATION

The analysis indicates that the resistivity of surface soil cover varies from 7 ohm-mts to 200 ohm-mts. The wide variation may be attributed to various local conditions. Soil moisture, sand percentage, soil alkalinity, presence of hard clay and so on. Underlying the soil cover, a clay layer with varying thickness is encountered throughout the area. It is characteristically inter-stratified as inferred from the lithologic data of bore-holes.[11] The thickness of the layer varies from 40 meters to 100 meters and the resistivity from 5 ohm-mts to 100 ohm-mts. The last layer i.e. third layer is the basement, the erosional remants of Archaean complex comparing the bore-hole logging and the resistivity data a broad correlation between litholigic section and geoelectrical section[12] can be established.

Second layer is the only productive zone and repository of ground water which contains their sand layers of 8 to 10 meters thick. There are two such distinct aquifer zones in the area. Owing to thick clay layer the thin aquifer zones could not show any prominence in most of the VES curves. In order to evaluate the quantitative data the second layer was further categorised into three zones on the basis of the resistivity variation of the layer. The clay layer being more porous and capable of retaining more water, a low resistivity value has been recorded.

The varying proportion of clay and sand admixture may, therefore, will have a direct relationship with the resistivity of the layer. By closely correlating the lithologic sections at control points, it may quantitatively be established is given in Table 4.9.

Table 4.9 : Resistivity Zonation of Principal layer (P_2)

Layer	Zone	Resistivity ohm-mts.	Lithologic-Inference
P_2	1	5 - 10	Clay with 10% sand
	2	10 – 30	Clay with 25% sand
	3	60 -100	Clay with 25-50% sand

Source : Waterways Division, Govt. of Bihar, Patna.

The resistivity values are directly proportional to content of coarser material in alluvial tracts.

DEPTH TO BEDROCK

At all the sounding locations the bedrock was encountered. On the basis of quantative values a Depth to Bedrock map was constructed for entire area. It is observed that the basement floor is uneven and undulating with prominent depressions and mounds. The average depth to bedrock is 60 meters and the deepest point is 92 meters. The depressions are aligned in the NNE-SSW trend which is identical to the present day course of most of the river channels originationg from the Rajmahal hills. Average basement slope is 3% towards North, through depressions and valleys have 10% to 15% slope. The analysis of the basement contour map indicates that the basement valleys have comparatively better ground water potential than the basement hills. It may be explained that the valleys may contain more process and pervious materials because of the deposition conditions prevailed in the past. The second interpretation is that wherever the basement is flat the clay content is in dominating proportion, say more than 80%.

TRANSVERSE RESISTANCE MAP (T R MAP)

The Transverse Resistance map was drawn for the layer overlying the bedrock in order to ascertain zones where groundwater development may be planned. The map is based on the concept that the higher is the TR value the greater is the chances of encountering aquifers or the higher is the resistivity or the combination of the both. The higher values of transverse resistance indicate, most likely the higher transmissibility values. In the study area pockets or tracts with TR values less than 1000 Ohm-m^2 may be considered unfit for economic exploitation of ground water. Pumping tests conducted in the area also confirms this. A series of pumping tests in the area may be able to establish a quantitative relationship between the TR values and co-efficient of co-efficient of trans missibility of aquifer (T)[13]. In other words there is a possibility of developing ground water in the second layer having resistivity more than 30 ohm-mts.

GEO-HYDROLOGICAL INVESTIGATIONS

Geohydrological investigations deal with the hydraulic of ground water by which the aquifer parameters viz. transmissibility and storage coefficient can be determined. These two aquifer constants are essential to determine the optimum discharge and spacing of wells. To arrive at the constant long duration pumping tests have to be carried out in which the well is pumping at constant discharge rate (Q) and noting down the water levels at different time in the pumping well or in observation well.[14]

During present investigations two such tests have been carried out in dug-cum-bore wells in the project area. The details of the well and lithology are given below :

(A) Pumping well Owner,		(B) Observed well	
Ramanand Singh			
Village - Rampur			
Survey No. - 511			
Well details :			
Type	Cavity	Type	Open
Depth	28 m	Depth	7.25 m
Dia	7.5 m	Dia	1.89 m
Lithology		**Distance from pumping well**	
0.21 m clay		8.32 m	
		Total drawdown 0.15 m	
21-28 m sand		Recovery : 105 meters	
Yield : 193 gpm (vs)		Residual drawdown : 0.47 m	

Duration of pumping : 120 meters

Time drawdown curve has been prepared on semilog paper taking time on the log scale and drawdown on arthmatic scale. The Jacob's formula[15] was applied for calculating coefficient of transmissibility and storage coefficient from time drawdown and time recovery curves.

Jacob's formula state

$$T = \frac{264 \cdot Q}{S}$$

$$S = \frac{0.3 \text{ T to X}}{r^2}$$

Where : T = Transmissibility in gpd/ft;

Q = Discharge in gpm;

S = Storage coefficient;

O = Time since pumping started in day; and

r = Distance from the pumping well to the observation well.

The T and S values were worked out to be 50952 gpd/ft. and 0.014 respectively for pumping test no. - 11 and 67936 gpd/ft. and 0.0051 for pumping test no. 2

WELL SPACING

Using Jacob's non-equilibrium equation[16] the drawdown in the pumping well, penetrating throughout the aquifer can be calculated for known values of discharge: diameter of the pipe, time of pumping (t), T and S as

$$SW = \frac{2.303 \times Q}{4\,T} \log \frac{2.25\,T \cdot t}{r^2 S \cdot 1000}$$

Where: SW = Drawdown in the pumping well;

Q = Discharge in LPM;

I = Transmissibility in LPM/M;

r^2W = Radius of the well in mts;

S = Storage coefficient.

Taking T = 439 LPM, t = 960 mts, r = 0.90 m and S = 0.014 as a constant value, the drawdown can be calculated for different discharges.

However, the drawdown due to friction losses (vertical flow to the pump and turbulant flow in the viscinity of screen) has been excluded. A small percentage of it can be included to compute the total drawdown.

Table 4.10 : Type of Well and their Intensity

Type of well	No.	Unit draft (hectare mtr)	Total annual draft (hectare mtr)
1. Private Tubewell			
a. Electrical	92	1.64	150.88
b. Diesel driven	65	1.64	106.60
2. Surface wells	155	0.50	77.50
3. Drinking water	274	0.014	3.87
Total	**586**		**338.85**

TRACTS SUITABLE FOR DEVELOPMENT OF GROUNDWATER

On the basis of geoelectrical survey the project area can be divided into three zones, good, medium and poor groundwaters potential zones.

(1) The villages Dadri and Sahora have been identified as good groundwater zone. The tract is suiTable for sinking deep tubewells. The TR value range from 2017-6749 ohm-mt^2. The VES locations are 12, 20 and 24.

(2) The villages, Mahidevi, Durgapur, Kamargawan, Ralia, Sarai, Barhaunia, Batsar, Durmatta, Dhouri, Kumarsar, Mojma, Sirmatpur, Mania, Kahan, Lawrhia, etc. represent medium groundwater zone. The TR value between 1200-1860 ohm-m^2. The tract is suiTable for sinking shallow tubewell.

(3) The third zone, representing poor groundwater potential comprises the following villages: Koraji, Rampur, Kasriya, Chanpura, Laugain, Nagrakita, Chananiya and Chanduki. The TR values are upto 100 ohm-m^2. The VES sites are 1 to 8 and 18.[17]

GENERAL CONCLUSIONS

1. The depth of the bed rock varies from 55m to 76m.
2. The main sub-surface formation is clay extending to a depth of 32m to 38m interbeded with sand lenses.
3. Two prominent sand layer are extending throughout the project area. One is at depth 12 to 22m, another 30 to 40 m from the ground level.

The average thickness of both sand layers are 9 and 20 respectively.

4. The aquifer material is composed of fine to coarse sand, fine material at shallow depth and coarse one at deeper depth, in the pumping well. Considering the average depth to the top of aquifer (16 meters), thickness 9 meters and static water level 8 meters in summer. The maximum permissible drawdown is calculated as 7 meters from the graph for 2000 LPM discharge the drawdown comes about 6 meters including well losses. This can be taken as a safe discharge for this area.

Recharge

Badua River and the existing net work are the main sources of groundwater increment. The Southern part of the study area Lakshmipur, Didarganj, Kumarsar, Rangapatel, Dhankunda, Gorgawan, Chandani and Ratanpura village is the recharge zone for the tract. The average annual draft is computed in Table 4.10

5. The formation are found to be dipping towards north hence the recharge for aquifer lies in the southern part.

PLANNING

(i) The study area receives irrigation from canal during Rabi season according to the designed irrigation intensity.

(ii) It is suggested that existing low duty wells Should be fully utilized and all should be energised.

(iii) Average discharge of the low duty wells have been taken as 500 Lpm, though the discharge varies form 400 Lpm to 700 Lpm.

(iv) It is stated that all the proposed wells should be energised.

(v) Water should be distributed through proper field channels as recommended in the on-farm development planning for the area.

(vi) All wells should be pumped for a duration of 12 hours during the peak season, say March as proposed.

(vii) Wells are aligned in such a way as to enable pumping of water directly into water courses.

(ix) Heavy duty tube wells may be confined to the good ground water potential zone.

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