

No. 22

# technical bulletin



---

DEPARTMENT OF AGRICULTURE,  
GUJARAT STATE, AHMEDABAD-6

**Pumping and Surface Drainage  
Controls Ground Water and  
Salinity Problems on College  
Farm Navasari.**

= PUMPING AND SURFACE DRAINAGE CONTROLS GROUND  
WATER AND SALINITY PROBLEMS ON COLLEGE FARM =  
\*\*\*\*\*

Ground water studies in 1969-70 and 71 on Pilot 40 acre plot and adjoining Agriculture land on N.M. College Farm, Navsari indicate two shallow tube-wells controls water table on 100 acres of land and also supplement canal water. The success of Pilot Project motivated the Department of Agriculture to drill five additional shallow tube-wells in 1971 to control water table and supplement canal water on the remaining 600 acres of Agricultural land.

Installation of surface drains on the Pilot Plot and the remaining farm land in 1969 and 70 has eliminated water logging on 480 acres of land by removing impounded and stagnate water during the monsoon and irrigation season. The combined treatment measures, pumping and surface drains eliminated water logging, soil salinity problems and made possible essential and timely farming operations such as :

1. Ground preparation, Residue management, minimum and timely tillage.
2. Crop sowing and use of HYV seed.
3. Fertility and plant protection measures,
4. Improved water management,
5. Provide optimum soil conditions for plant establishment and growth,
6. Timely harvesting operations and increase food grain production.

GENERAL STATEMENT

LOCATION :-

The 1000 acres, N.M. College of Agriculture Farm is located in the southern part of the million acre Kakrapar Irrigation Project in South Gujarat State, see map figure 1. The farm is 10 miles east of the GULF OF CAMBAY, AND  $1\frac{1}{2}$  miles south of the Purna River, or about  $4\frac{1}{2}$  miles South West of Navsari.

CLIMATE AND SOIL :-

The farm elevation varies from 42 feet above sea level along the Navsari Branch Canal on the south side, to 20 feet lowest point on the north end. The climate is tropical with 4 months monsoon season from June through September. Figure 2 above the rainfall and distribution by seasons and the average water table of area not pumped for the three year period. The soils are alluvial deposits of Basalt washed in from the Decon Trap from the Western Ghats. They are deep, dark grey, clay and silty clays. The soils are high in montmorillonite clay, crack severely when dry, are sticky and plastic when wet. The soils have a very blocky structure and are very similar to the Black Lands found in Texas, U. S. A. The soils are known as "Black Cotton soils. Figure 3 and table 1 shows the soils map of the farm and physical details of the soil profiles.

CONDITIONS AND PROBLEMS

The introduction of water to soil for irrigation farming causes profound changes in the chemical, physical and biological state of the soil (5, 6). The changes take place with much more difficulty on clay soil because of their inherent characteristics especially their poor drain-ability resulting in poor soil aeration and tendency to water log and develop salinity problems. The soils are very difficult to work.

The land before it was acquired by the Government for a College Farm was owned by some 450 cultivators. After acquisition, the land surface was flattened (levelled) by bulldozer and made into 5 acre plots, 660 feet long and 330 feet wide. Each plot was surrounded by 2½ to 3 feet high dikes. There were no provisions made for removal of surplus water from the plots. Figure 4 shows a map of the farm land, the pilot Plot and areas effected by water logging, intrusion of salinity and high water table. During the monsoon, the enclosed 5 acre plots filled with water, dikes would be over topped by water and break on the lower ends flooding all fields below them. This continued through out the monsoon season, resulting in severe water logging of the soil and invasion of the area by aquatic weeds and a noxious grass, darbh, - ( *IMPERATA ARUNDINACEA* CYLL ).

The water table was steadily rising during and after monsoon reaching the highest level in October. Normally before irrigation was introduced the ground water would begin to recede in November and reach the lowest level in June. In 1968 and 1969 the area between the canal and the Gandhi Danti road figure 4, ( G BLOCK ) water was on the ground surface from June through February of the following year. The same condition existed along Machhad minor. Cropping of these areas was limited to one crop of Paddy rice in the Kharif season.

Soil water logging and stagnate water problems were aggravated by the adjoining Navsari Branch canal and the Machhad Minor. It was necessary in this section of the Navsari canal to build a high dike to maintain canal grade. Deep wide barrow areas were excavated on both sides of the canals to acquire fill material. The excavated areas were full of canal seepage water from June through February. Once the barrows and depressions were filled, the water would overflow and flood the crop land adjacent and below the Navsari canal and areas east of Machhad minor.

#### RESEARCH OBJECTIVES

The objectives of the Pilot and College Farm, Project are to serve as a centre for adoptive research, training and demonstration for Agricultural Officers and Progressive Cultivators in recognizing problems in soil and water management and application of treatment measures needed, on the problem clayly soils, for intensive irrigation farming  
in order to obtain

in order to obtain maximum yields of food grains and a sustained agriculture.

THE STUDIES TO BE UNDERTAKE ARE :

1. Use of pumping for ground water control with subsequent reduction of salinity problems.
2. Install and study use of surface drainage to reduce water logging of soil and thus permit use of soil, water and plant management practices adapted to a modern agriculture.

PROCEDURE GROUND WATER STUDIES :

1. A Pilot 40 acre plot was selected for study on the western catchment area. Figure 4 shows the location and extent of problem area.
2. A soil survey of the farm was completed by the State Soil Survey Officer in 1962. For soil classification, the comprehensive system, 7th approximation U. S. D. A. was used as a guide. Figure 3 and table 1 gives Soil details and physical profile characteristics.
3. The topographic map with one foot contour intervals was made available by P. W. D. The canals and proposed under ground concrete pipe irrigation system was outlined on the map. The map helped to correlate the planning of irrigation and drainage system. The map was used as a base for plotting ground water contours and planning of key surface drains.

.....6.

GC/28/7.

4. Water table measurements for two months, March and April of 1969 were plotted to determine direction of ground water flow,, see figure 6. This information assisted in location of proposed tube-wells to be studied for five year period 1968- to 1973.
5. Two shallow tube-wells were drilled FIGURE 6 for STUDY, with the co-operation of U. S. A. I. D. No.1 well is 1000 feet from the Navsari canal and No. 2 well in 1650 feet north of No.1 well. Each well can irrigate (command) 40, to 50 acres of crop land, figure 5 gives details of the logs of well, draw down measurements and aquifers.
6. Water table measurements were taken on the 1st and 16th of each month through out the three years. Irrigation well measurements were taken in the mornings before pumps were turned on. The shallow community wells observed are dug wells 3 to 12 feet in diameter and 19 to 38 feet deep. The existing wells being pumped for irrigation in 1969 were dug about 25 feet deep, are 8 to 12 feet in diameter and subsequently bored to a depth of 110 to 120 feet to increase water yields. Tables 2, 3 and 4 gives the highest water tables measured each month for each year. A graphic picture of this data are shown by figure 9,10, and 11.

DISCUSSION OF DATA :

To study the conditions and various factors before project initiation, the canal discharge, rainfall received and ground water levels were plotted for 1969, the first

CJG/28/7.

.....7.

year of the project study. It can be noted from the graphs in figures 9,10 and 11 heavy rains and time received have a definite effect on the water table. There appears to be a long lag of about two to three months time between highest period of rainfall and the highest water table, indicating ground water recharge from appear watershed. This is more evident in graphs, figure 9 for 1969 and figure 11 for year 1971. Preproject soil survey shows very sandy permeable soil over lying an impermeable rock in the higher watershed.

Extremely heavy rainfall in 1970, resulted in highest water table in the study. In 1971 below average rainfall was received. Timewise, it was fairly evenly distributed throughout the monsoon. The highest water table was recorded in October. Canal water was in the channel most of the time in 1971 and was continually available throughout the year on a 15 day rotation schedule. The presence of irrigation water in the canalkh throughout the year has aggravated water table problems on the project figure 12.

Tables 5, 6 and 7 were used in plotting ground water contours shown in figures 6, 7 and 8. A study of water contour 25, is figure 6 for 1969 indicates even with limited pumping, irrigation wells Nos. 15,16, and 19 had some effect of lowering the water table in this area. This can be interpreted by the depression of ground water contours, in a north easterly direction in the line with, and west of well No.15. The land surrounding well No.16 about 30 acres, was heavily irrigated by this well in 1969 as no canal water reached this point.



Water table measurements for well 25 and 28 are not indicative of ground water levels of the areas surrounding the wells, see figures 10,11 and 12. Well 28 is located in the east swale. At this point the canal is diked high with a 30 inch diameter tube below the canal to dispose of rain and canal seepage water from the catchment above (south side) of the canal. The water is intercepted by an irrigation channel which conducts the water within 20 feet of the well. In 1971, irrigation water was in the canal most of the time, the continuous presences of seepage water in the channel is resulting in extremely high water table in well 28 throughout the year. Well 25 is located 200 feet from the canal and adjoins the 15 foot deep canal barrow pit. At this location the canal dike is the highest. The canal water passes through a syphon at this point. An open channel over flow disposes of rain and seepage water off of 40 acres of catchment area south of the canal. A drain channel 5 feet deep was installed in 1971, which intercepts the barrow pit. This drain passes about 20 feet from observation well 25. Again water in the canal means a constant flow of seepage water in the drain. AND HIGH WATER TABLE MEASUREMENTS FOR WELL 25.

Figure 13 above water table isopleth. The data is plotted for years 1969-70 and 71, starting from the Navsari canal through wells No. 29 No.1, No.2, No.20 and No.17 for the 3 year period. This sectional view may help to understand and interpret the ground water contour maps. Interpolation and extrapolation of measured and projected points on the maps

and analysis of data, indicates the effectiveness of the pilot wells to be about 2000 feet wide and 3500 feet long covering an elliptical area of 100 acres. Pumping wells No. 18, 19, 15 and 16 are definitely contributing in lowering the water table along the east edge of the pilot area. The draw levels of wells 18 and 19, which are about 1100 and 1200 feet east of pilot No.1 well has been lowered about 20 feet according to college Officials due to No.1 well pumping. Table 8 above kilowatt Hour Hours of power used in 1969, 70 and 71. AID wells 1 and 2 require 8 to 10 KW'S per hour of operation. Figure 7 shows comparatively high water table at well No.1 for 1970. Well No.1 was in-operative most of the time during October, November and December. There was considerable trouble with the voltage regulator due to very wide fluctuation of power. This resulted in high water table as compared to well No.2 during these months. The power readings for well 1 and 2 are not realistic because of inoperative meters. Shortage of electric power, break downs and frequent shut downs throughout the day make it difficult to carry on adaptive irrigation trials. Note the tremendous increase of power used during the 3 year period.

#### WATER QUALITY AND AQUIFERS

Table 9 shows a partial chemical analysis of water samples made at the State Soil Saki Survey Laboratory, Navsari. The water quality is considered adequate for irrigation of semi-tolerant crops on clayey soils in this high rainfall area. Irrigation well No.10 is being abandoned for irrigation,

because of the high salt content. The laboratory tests indicate wells along with the main stream along the east side of the farm to have somewhat higher salt content and are less desirable for irrigation on clayey soils due to potential salinity hazards. These are dug wells and fed more by shallow surface ground water. Apparently the soils have a higher concentration of salts accumulated in the soil profile. The soils in this area, figure 3 have a more permeable subsoil permitting lateral and downward movement of water and thereby permits leaching of salts to the lower profile.

The water quality ratings with comments are given in table 10. The limits have been suggested by the Central Soil Salinity Research Institute, Karnal. The ratings are tentative and subject to frequent review and change as more research data becomes available.

The well logs figure 5 for two wells on the Pilot Plot indicate better water aquifers below 80 feet, where sands and some gravel are located. The aquifers improve with depth of bore. Local cultivators have experienced that yields of shallow dug wells 12 to 20 feet in diameter and 30 feet deep into the fine sand stratified with clay layers are not adequate for pump irrigation. The location of the best aquifers in the two wells indicate most of the water yield and better quality coming from lower levels. This is indicated by the last draw down being located about 100 feet deep. The normal

drawn down depression cone experienced in a uniform texture aquifer does not apply in this case, because of the great difference in hydraulic conductivity between the upper and lower aquifers. The draw down ground water contour lines in figure 6, 7 and 5 were located by interpolation and extrapolation. Similarly in figure 13, straight lines have been drawn from known points and do not necessarily indicate the actual cone of depression developed by the two pumping wells.

The Yields of well 1 and 2 vary from 280 to 325 gals per minute depending on power available and height of water table. The pumps are 5 phase submersible pumps with 5 inch inlets and outlets equipped with 15 H.P. motors. Well No.1 has 20 feet of perforated pipe placed 20 feet from bottom of the hole. No.2 well has 30 feet of perforated pipe placed 20 feet from bottom of the hole. The pumps have never pumped sand and water is clear.

Aquifers below depths of 160 to 170 feet may be subject to intrusion of sea water, because of the nearness of the farm to the sea and Purna River. A local well driller has bored many wells and has found (stagnate) saline water below this depth.

PEAK PERIOD WATER TABLE CONTROLS :-

Normally water table rises rapidly starting the later part of the monsoon and reaches a peak in October, see figure 9. The canal ran at full capacity 3000 cfs, plus from June through December. Now with Ukai Reservoir completed the canal will be flowing full capacity year round. This is aggravating

the high water table conditions on the College Farm and will do so on the entire Kakrapar Project. During the peak water table period water requirement of present cropping pattern is relatively low. Kharif rice which comprises, the most extensive acreage is being drained in preparation for harvest in October and forepart of November. In November ground preparation for wheat sowing after paddy requires very limited amount of water. Kharif groundnuts, Soyabean and pulses are normally harvested during the high water period. Only cotton, sugarcane and banana can take advantage of the abundant water available. However, the acreage of these crops are limited.

To control the water table during the critical period in problem areas the following actions seem appropriate:-

1. Canal irrigation water should not be supplied to the problem areas from June through November. The water should be diverted to areas where water table is not a problem.
2. In problem areas pump to irrigate thereby lower water table and use the pumped water to supplement water requirement of crops.
3. Adjust and adopt a cropping pattern which will require more water during the critical high water period.
4. Adopt special water management practices, which will regulate and help reduce over irrigation on all cultivators land.
5. Evaluate the canal system ( Kakrapar Project) and line sections of the canal, where severe seepage is a problem.

6. Drain all canal barrow areas and reduce local water logging and intrusion of salinity conditions.
7. On College Farm - Continue pumping as required to control water table and maintain installed drainage system.

#### SURFACE DRAINAGE

On the College Farm and throughout the Kakrapar Project heavy monsoon rains, clayey soil, paddy rice grown in kharif season, and the prevalent cultural practices such as water conservation by deep water impoundment by dikas and complete obliteration of all natural drains has resulted in seasonal water logging of soil and increasing of salinity problems. The introduction in 1971 of year long irrigation water from Ukai reservoir, for intensive cropping has aggravated and speeded up the rate of soil deterioration and rapid increase of areas effected.

A paper will be presented later on the completed drainage and irrigation system installed on the Pilot Plot and the College Farm.

In conjunction with the pumping Project, surface drainage was applied and demonstrated on the Pilot Plot and the remaining cropland on the Farm. The topography of the farm land indicated the need for two main outlet drains. One for the Western catchment area, where the pilot area was located and the eastern catchment including G Block on south side of Navsari branch canal. These drains would serve.

as main outlets and provide for installation of complete lateral and individual plot drains.

To relieve and dispose of rain and seepage water along both sides of the canal, required 4 lateral drains to intercept the barrow area along the north side of the Navsari canal. These drains outleted into main drain located along the south side of the Gandhi Landi road. To provide for good root growth of crops, the drains intercepted the barrow at five depths. The drains immediately eliminated flooding of the land along the canal and provided favourable soil conditions for normal growth of crops on all the land in G Block. At ~~well 25~~ previous to installation of the drains, rainwater during the monsoons and canal seepage water flooded a 400 feet wide strip of land along the canal barrow pit. Water was standing on the surface of the ground with salt accumulating on most of the area. The soil was wet throughout the year and it was impossible to prepare the land for crop production. The barrow pit, which is being used as an intercepting drain, outlets into the new drain. The drain eliminated the flooding and water logging of the soil by removing the water before it enters into the soil profile. Normal farming operations are now possible.

Extremely heavy rains of 1970, 112 inches, resulted in some downward leaching and washing of salts off the surface of the soil. The drains were completed just before the 1970 monsoon and functioned in excellent manner. Now depth of water impoundment during kharif on paddy fields can be controlled. Laterals and individual field drains

eliminated water logging and permitted normal cultural practices during the monsoon and irrigation season. In addition to growing khariff paddy rice, the land in G block is now being farmed to wheat, pulses, cotton and sugarcane with no problems.

#### PRESENT CONDITIONS

The continued pumping and operation and maintenance of the two wells on the Pilot Project and ~~maintenance of the~~ putting into operation the 5 new wells installed in 1971 should provide complete control of ground water and eliminate salinity problems previously experienced. The annual recharge of ground water from higher watersheds and ~~shouk~~ judicious pumping should maintain a constant underground water supply. Water samples for chemical analysis should be taken continually of all pumping wells in the summer season at the time of highest salt concentration. Chemical analysis should be made for each well and remedial measures taken as needed to avoid possible build up of salts in the soil profile by use of poor quality water. Ground water research should be continued. Well density and placement should be investigated.

Surface drains on the Pilot Plot and all farm land must be maintained currently. Temporary "blocks" or filling in of channel with soil, straw or checks of any kind should not be condoned. Constant inspection and maintenance of the drainage system will make possible the necessary soil, plant and water relationships needed for use of H<sub>2</sub>Y.V. seeds and the package of practices required to obtain maximum crop yields.



INTENSIVE CROPPING & IRRIGATION OF CLAYEY SOILS

Intensive cropping of "Black Cotton" soil will require utmost technical knowledge, application of skills, timeliness of special cultural operations and special (adapted) equipment, if maximum benefits are to be experienced in use of H. Y. V. SEED and increased crop yields. At present time on irrigated land the same traditional farming practices are being used in ground preparation. These apparently have proven ample over several thousand years under rainfed Agriculture, where one crop was grown and 8 months of time was used in preparing and conditioning the soil by nature and the farmer for the next crop. However, for three crops to be grown in one year will require an entirely new set of norms of soil, water, plant management for irrigation farming on heavy clayey soils. Investigation of oxygen stress of plants in "Black Cotton" soils during the monsoon and use of basin and border strip irrigation in these problem, soils has not been given proper emphasis. On college Farm, trial ridge (Bad planting) and use of furrows for Bajra row crop under irrigation has given spectacular results. Knowledge of application of improved cultural practices and equipment needed to apply these practices, presents a challenge in future for basic and adaptive research. The Research work completed by A. R. S. in co-operation with colleges and various U. S. R. A. agencies at Temple Texas from 1952 to 1961, provide excellent guides on how to farm clayey soil under rainfed conditions and one

.....17.

crop per year. This information could be used and applied to advantage to the black soils in Gujarat State in the rainfed Agricultural Areas.

REFERENCES  
\*\*\*\*\*

1. ISRAELSON, ORSON W. AND HANSEN, VAUGH E. - Irrigation Principles and practice 3rd additions John Woley and Sons, New York.
2. SCHWAB, GLENN O., BARNES, KEWNETH K., FREVERT, H CHARD K., AND EDMINISTER, TALCOTT W. - Elementary Soil and Water Engineering.
3. TODD, DAVID K. GROUND WATER HYDROLOGY - John Wilby and Sons, New York.
4. The U. S. Department of Agriculture, 1959 Yearbook of Agriculture.
5. Irrigation of Agricultural Lands - Agronomy No. 11, 1967.  
5 b. Drainage of Agricultural Lands No. 7, 1957 Agronomy, American Society of Agronomy, U. S. A.
6. Soil Classification, a comprehensive system, 7th approximation S. C. S. - U. S. D. A. Aug. 1960.
7. Saline and Alkali Soils U. S. Salinity Lab. Hand book No. 60 U. S. D. A., 1960.
8. National Engineering Handbook Soil Conservation service, U. S. D. A.  
Drainage Section 16,  
Chapter : 1 - Principals of Drainage.  
Chapter : 2 - Drainage Surveys, Investigations and Reports.  
Chapter : 3 - Subordinate Subsurface Drainage of irrigated land in arid and semiarid areas.  
Chapter : 4 - Subsurface Drainage in Humid areas.  
Chapter : 5 - Tile Systems and appurtenances.  
Chapter : 6 - Open Ditches for Agriculture Drainage.
9. Louisiana - ENGINEERING HANDBOOK FOR WORK UNITS -1956 U. S. D. A. Alexandria Louisiana.
10. Summary of Soil and Water Conservation Research from the Blackland Conservation Field Station Temple, Texas, R. M. SMITH AND R. C. HENDERSON.
11. Chemical Mineralogical and Engineering Properties of Alabama and Mississippi Black belt Soils, Southern Co-operative Series No. 130. Alabama and Mississippi Agri. Exp. Sta. and Soil Consev. Ser. U. S. D. A. 1968.
12. Soils of the Blackland Experiment Station. Substation No. 5 Temple, Texas MP - 419- March, 1960. Texas Agricultural Exp. Sta. in Co-operation with the U. S. Dept. of Agri.

13. Waternable - ISOPLETH  
M. RAM., WATER UTILIZATION. DIVISION OF MINISTRY OF  
AGRI, TEL. AVIV. ISRAEL.
14. Land Capability : A Hydrologic Response Unit in  
Agricultural Watersheds Sept., 1970 ARS 41-172  
A. R. S. U. S. D. A.
15. The Soil Survey of Kakrapar Project Command area.  
The Soil of Ukai Command area Left Bank Canal - by  
Central Water and Power Research Station, Poona.

\*\*\*\*\*  
\*\*\*\*\*  
\*\*\*\*  
\*

: 19 :

TABLE 2 GROUND WATER MEASUREMENTS

N. M. COLLEGE FARM, NAVSAR. ( GUJARAT )

YEAR 1969 (54.1 INCHES )

COMMUNITY WELL NOT PUMPED.

WELL No.	ORD ELEV.	WELL DEPTH.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
11	33	126.0	Record-	MARCH	12.2	13.1	14.0	14.9	5.0	5.3	7.0	5.0	8.0	9.0
*13	28	28.0	ings	1,1969	12.8	14.3	15.3	16.5	4.0	4.3	6.0	3.3	8.0	8.0
17	28	23.5	Started.		14.1	15.6	16.0	17.0	9.0	7.6	7.9	2.7	9.9	11.3
20	31	26.5			15.8	16.9	18.0	19.9	13.0	10.9	8.9	5.9	13.7	17.7
21	32	34.3			20.4	21.4	22.3	23.4	21.3	18.0	13.6	11.6	15.6	17.2
22	42	30.5			13.2	15.9	18.2	20.0	11.0	6.3	5.2	3.3	6.9	8.3
29	40	37.5			19.0	21.1	23.0	25.0	10.0	5.5	4.0	4.0	8.0	13.0
*25	38	25.0			10.4	12.0	12.9	13.8	2.6	2.9	4.9	3.0	8.5	6.9
*15	36	33.8			20.0	21.2	22.5	23.8	14.0	11.0	7.0	9.6	14.3	6.3
<b>Total.</b>					138.1	151.5	162.2	191.8	89.9	71.8	64.5	48.4	90.9	85.7
<b>Average.</b>					15.3	16.6	18.0	21.3	10.0	8.0	7.2	5.4	10.1	9.5

\* THESE WELLS PUMPED VERY LITTLE IN 1969 AND INCURRED WITH THIS GROUP THIS YEAR.

: 20 :

REPORT SAME READINESS AS ABOVE.

4 WELLS PUMPED FOR IRRIGATION.....

WELL NO.	GPD EL. EV.	WELL DEPTH.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
10	34	111.4			18.4	18.8	21.9	21.9	19.7	19.2	19.2	19.2	19.2	19.3
16	36	11.0			25.0	25.6	25.6	25.6	19.0	16.0	13.0	13.0	20.4	21.4
18	38	32.0			19.4	21.0	22.8	22.8	15.0	8.2	6.7	7.9	9.4	11.9
19	38	38.2			23.0	23.4	32.8	32.8	25.6	20.6	11.9	7.9	13.9	17.2
Total.					86.7	87.8	103.1	103.1	79.3	64.0	50.8	48.0	62.9	69.8
Average.					21.7	21.9	25.8	25.8	19.6	16.0	12.7	12.0	15.7	17.5

HIGHEST WATER READING DURING THE MONTH PLOTTED.

\*\*\*\*\*

.....21

CJC/14/8.

20  
**TABLE : 3**                      **GROUND WATER MEASUREMENTS**  
**N.M. COLLEGE FARM, NAVSARI, GUJARAT.**  
**YEAR 1970 ( 112.3 INCHES RAINFALL )**

**11. COMMUNITY WELLS NOT PUMPED**

Well No.	WELL Depth.	ELEV.	JAN.	FEB.	MAR.	APR.	MAY.	JUNE	JUL	AUG.	SEP.	OCT.	NOV.	DEC.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15.
11	126.5	33	09.4	09.9	13.0	13.6	13.1	10.0	05.5	02.4	03.8	05.9	07.6	09.4
13	29.0	28	09.2	10.8	11.1	14.5	15.1	09.0	03.0	02.0	02.1	05.0	05.6	09.1
17	23.5	28	12.8	13.3	13.0	15.2	15.1	15.0	08.0	03.1	04.0	06.7	08.1	10.0
20	26.5	31	18.0	18.9	19.2	17.2	17.1	18.3	10.0	02.6	02.9	05.1	07.0	10.4
21	34.3	32	18.7	19.4	19.9	21.2	21.0	23.3	17.8	11.7	12.0	13.4	12.4	15.1
22	30.5	42	09.1	09.8	10.6	14.3	17.5	18.6	06.6	02.1	03.5	05.1	08.0	06.1
29	37.5	40	16.6	19.0	21.6	22.0	23.0	22.0	09.9	04.3	04.3	05.1	04.9	04.4
25	25.0	38	08.5	08.4	03.9	06.0	06.5	03.9	02.0	02.0	02.8	04.3	04.3	02.9
26	20.5	36	-	-	05.9	07.5	09.6	09.6	03.3	03.3	05.0	05.7	06.3	06.2
27	23.0	30	-	-	11.6	13.0	14.0	04.0	03.8	01.9	03.0	05.7	07.9	09.6
28	19.0	38	-	-	-	11.0	09.6	01.9	01.6	00.8	01.9	03.0	04.1	03.2
<b>Total.</b>			102.3	109.5	129.8	155.5	161.6	135.6	72.9	36.2	45.3	65.0	76.2	86.2
<b>Average.</b>			12.8	13.7	12.9	14.1	14.7	12.3	06.6	03.3	04.1.	05.9	06.9	07.8

7. IRRIGATION WELLS:

Well No.	Well Depth	BREV.	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	111.4	34	19.3	19.3	19.3	19.4	18.1	19.0	19.0	18.0	18.1	18.0	19.2	19.5
15	33.8	36	18.6	19.9	21.6	22.0	23.4	22.6	10.8	04.0	04.6	08.8	14.0	15.4
16	110.0	36	22.0	22.0	22.0	26.0	26.6	25.9	14.0	07.1	08.2	10.5	17.5	19.8
18	32.0	38	14.3	15.5	16.4	22.2	22.2	22.6	11.2	04.9	05.0	07.6	13.1	14.4
19	38.2	38	18.6	21.6	21.2	26.8	26.1	25.0	14.1	06.9	07.6	11.9	15.8	17.4
20	152.0	41	-	-	30.0	34.4	34.0	34.6	24.5	12.6	16.0	21.3	13.3	27.2
22	161.0	35	-	-	-	-	-	25.0	19.3	15.1	17.0	18.8	19.1	21.6
<b>Total:-</b>			92.8	98.3	130.5	150.8	150.4	174.7	112.9	68.6	76.5	96.9	112.0	135.3
<b>Averages:-</b>			18.6	19.7	21.7	23.0	25.1	24.9	16.1	09.7	10.9	13.8	16.0	19.2

4. COMMUNITY WELLS LESS THAN 1000 FEET FROM CANAL.

Well No.	Well Depth.	ELEV.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
22	30.5	42	09.1	09.8	10.6	14.3	17.5	18.6	06.6	02.1	03.5	05.1	08.2	06.1
29	37.5	40	16.6	19.0	21.6	22.0	23.0	22.0	09.0	04.3	04.3	05.1	04.9	04.4
25	25.0	38	08.5	08.4	03.9	06.0	06.5	03.9	02.0	02.0	02.8	04.3	04.3	02.9
28	19.0	38	-	-		11.0	09.6	01.9	01.6	00.8	01.9	03.0	04.1	03.4
<b>Total:-</b>			34.2	37.2	36.1	53.3	56.6	46.4	19.2	09.2	12.5	17.5	21.5	16.8
<b>Average.</b>			11.4	12.4	12.4	13.4	14.1	11.6	04.8	02.3	03.1	04.4	05.4	04.2

\*\*\*\*\*

.....24.



TABLE 4 GROUND WATER MEASUREMENTS

N. M. COLLEGE FARM, NAVSARI, GUJARAT.

11. COMMUNITY WELLS NOT PUMPED. YEAR 1971. (43.4 INCHES RAINFALL)

WELL NO.	WELL DEPTH.	ELEV.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
11	126.5	33	10.1	11.4	11.8	12.9	13.7	13.6	11.0	5.1	4.2	2.0	7.2	10.8
13	29.0	28	10.4	11.0	12.7	13.8	14.8	14.9	7.0	4.9	2.4	2.4	8.6	9.9
17	23.5	28	10.6	11.6	13.2	14.7	15.9	15.2	11.6	10.4	7.6	2.6	8.8	11.0
20	26.5	31	12.1	13.3	14.5	15.6	16.9	17.3	15.3	13.0	6.4	2.6	8.7	10.3
21	34.3	32	16.8	17.8	19.0	20.1	20.3	22.2	19.6	10.4	13.0	11.6	18.3	15.6
22	30.5	42	6.8	9.2	11.3	12.8	16.4	16.9	16.9	5.3	3.0	3.0	8.6	7.4
29	37.5	40	6.3	14.0	17.8	21.6	22.8	21.0	19.0	5.0	3.3	2.6	12.8	12.6
25	25.0	38	3.1	2.8	3.0	6.1	6.3	6.5	2.6	3.0	2.3	2.8	6.8	4.1
26	20.5	36	6.3	5.8	5.9	13.9	15.8	12.4	10.8	3.8	2.6	2.6	6.9	8.7
27	23.0	30	10.8	11.0	11.6	7.4	7.2	6.8	5.7	4.6	4.6	4.6	6.3	5.8
28	19.0	38	3.4	3.9	4.8	6.2	7.4	5.6	2.3	2.3	2.0	2.0	6.7	4.6
Total. 11)			96.7	111.8	125.6	145.1	158.5	152.4	121.8	67.8	51.4	38.8	99.7	100.6
Average.			8.8	10.2	11.4	13.2	14.4	13.8	11.1	6.2	4.7	3.5	9.1	9.2

7 IRRIGATION WELLS.

WELL NO.	WELL DEPTH.	ELEV.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
10	111.4	34	19.0	19.4	20.0	21.0	19.0	19.0	19.0	19.9	19.9	19.0	19.6	19.0
15	33.8	36	17.5	18.3	19.2	21.4	22.7	20.8	20.2	13.3	6.0	5.6	13.5	15.9
16		36	21.9	22.8	23.5	24.9	25.9	24.5	23.2	18.0	10.6	9.0	17.3	19.7
18	32.0	38	15.8	16.4	19.8	20.6	22.0	21.3	21.6	11.8	5.2	4.6	12.9	13.8
19	38.2	38	18.1	20.3	22.1	23.6	24.9	24.4	20.8	16.0	7.0	7.0	18.0	17.5
1	152	41	31.1	28.6	30.9	30.0	34.0	31.6	29.0	22.5	23.0	24.0	28.8	24.5
2	161	35	31.0	30.6	31.0	32.6	31.0	28.0	24.0	24.0	23.8	18.0	23.9	24.5
Total. 7)			153.4	156.4	166.5	174.1	179.5	169.6	158.4	124.6	95.5	87.2	134.0	134.9
Average.			21.9	22.3	22.6	24.9	25.6	24.2	21.6	17.8	13.6	12.5	19.1	19.2

4 COMMUNITY WELL LESS THAN 800 FEET FROM CANAL/

WELL No.	WELL DEPTH.	ELEV.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
22	30.5	42	6.8	9.2	11.3	12.8	16.4	16.9	5.3	3.0	3.0	8.6	7.4	
29	37.5	40	6.3	14.0	17.8	21.6	22.8	21.0	19.0	5.3	3.3	2.6	12.8	12.6
*25	25.0	38	3.1	2.8	3.0	6.1	6.3	6.5	2.6	3.0	2.3	2.8	6.8	4.1
*28	19.0	38	3.4	3.9	4.8	6.2	7.4	5.6	2.3	2.3	2.0	2.0	6.7	4.6
Total. 4)			19.6	29.9	34.9	46.7	52.9	50.0	40.8	15.6	10.6	10.4	34.9	28.7
Average.			4.4	7.5	8.7	11.7	<u>13.2</u>	12.5	10.2	3.9	2.7	<u>2.6</u>	8.7	7.2

\* WELLS LOCATED ON IRRIGATION OR DRAIN CHANNEL.

GROUND WATER STUDIES

TABLE 5 N.M. COLLEGE FARM, NAVSAR, GUJARAT  
YEAR 1969.

SHALLOW COMMUNITY WELLS (NOT PUMPED)

Location Block & Plot.	Well No.	Depth of Well (FT)	Ground Elev. (FT)	DEPTH to water (FT)	HIGHEST GROUND WATER ELEV. (FT)	REMARKS
B-2	11	125.5	33	5.0	28.0	15 JULY 1 OCT.
C-13	13	29.0	28	3.3	24.7	1 OCT.
D-21	17	23.5	28	2.7	25.3	15 AUG.
E-13	20	26.5	31	5.9	25.1	1 OCT.
F-21	21	34.5	32	11.6	20.4	1 OCT.
F-1	22	30.5	42	3.3	38.7	1 OCT.
G-8	29	37.5	40	4.0	36.0	1 SEPT-31 OCT. 200' FROM NAV, BR
G-17	25	25.0	38	2.6	35.	15 JULY
NOT ORDERED IN 1969	26	-	-	-	-	-
	27	-	-	-	-	-
	28	-	-	-	-	-
<u>IRRIGATION WELLS</u>						
A-4	10	111.4	34	19.2	14.8	ADG 15 TO NOV 01
D-10	15	33.8	36	7.0	29.0	1 SEPT.
D-16	16		36	13.0	23.0	1 SEPT.
E-1	18	32.0	38	6.7	31.3	1 SEPT.
E-8	19	38.2	38	7.9	30.1	1 OCT.
USAID						

TABLE 6 GROUND WATER ELEVATION  
N.M. COLLEGE FARM  
YEAR 1970.

LOCATION BLOCK & PLOT.	WELL NO.	Depth OF WELL	GROUND ELEV.	DEPTH TO WATER	HIGHEST GROUND WATER ELEV.	Remarks.
1	2	3	4	5	6	7.
<u>SHALLOW COMMUNITY WELLS NOT PUMPED.</u>						
B-2	11	125.5	33	2.4	30.6	15 AUGUST
C-13	13	29.0	28	1.9	26.1	1 AUGUST
D-21	17	23.5	28	3.1	24.9	15 AUGUST
E-13	20	26.5	31	2.6	28.4	15 AUGUST
F-21	21	32.5	32	11.7	20.3	15 AUG. 660' FROM
F-1	22	30.5	42	2.1	39.9	1 AUG. NAV. BR.
G-8	29	37.5	40	4.3	35.7	1-15 AUG 500' FROM NAV. BR.
G-17	25	25.0	38	2.0	36.0	1 AUG. 200' FROM NAV. BR.
G(IADP)	26	20.5	36	3.3	32.7	1 JULY 400' FROM NAV. BR.
G-1	27	23.0	30	1.9	28.1	1 AUG. 10' FROM OUTLET
G-AGH. SCH. 28		19.0	36	0.8	35.2	1 AUG. 850' FROM NAVSARI BRANCH MAIN DR. No. 3
		TOTAL.		36.1		
		MEAN.		3.3		

IRRIGATION WELLS ( SAME READINGS AS ABOVE )

LOCATION BLOCK & PLOT 1	WELL NO. 2	DEPTH OF WELL. 3	GROUND ELEV. 4	DEPTH TO WATER. 5	HIGHEST GROUND WATER ELEV. 6	REMARKS 7.
A-4	10	111.4	34	18.0	16.0	15 AUG 400' FROM 15 OCT NALA
D-10	15	33.8	36	4.0	32.0	
D-16	16		36	7.1	28.9	15 AUG
E-1	18	32.0	38	4.9	33.1	15 AUG 1500' FROM NAV. BR.
E-8 USAID	18	38.2	38	6.9	31.1	15 AUG 1800' FROM NAV. BR.
E-2		152.0	4	12.6	28.4	15 AUG.
E-12	2	161.0	35	15.1	19.9	
		Total:-		68.6		
		MEAN.		9.8		

GROUND WATER STUDIES

TABLE- 7

N.M. COLLEGE FARM, NAVSARI  
YEAR 1971.

\*\*\*\*\*

Location well Block & Plot.	No.	DEPTH OF WELL (FT)	GROUND ELEV(FT)	DEPTH OF WATER (FT)	HIGHEST GROUND WATER ELEV.(FT).	REMARKS.
1	2	3	4	5	6	7.
<u>SHALLOW COMMUNITY WELLS (NOT PUMPED )</u>						
B-2	11	125.5	33	2.0	31.0	1 OCT.
C-13	13	29.0	28	2.4	25.6	1 SEP. 1 OCT.
D-21	17	23.5	28	2.6	25.4	1 OCT.
E-13	20	26.5	31	2.6	28.4	1 OCT.
F-21	21	34.5	32	10.4	21.6	1 OCT. 11.6 15 AUG (Possible error in Bdg)
F-1	22	30.5	42	3.0	39.0	1 OCT.
G-8	29	37.5	40	2.6	37.4	1 OCT.
G-17	25	25.0	38	2.9	35.1	1 OCT.
G-IAP	26	20.5	36	2.6	33.4	1 OCT.
G-N. R. Sugar	27	23.0	30	4.6	25.4	ADG 1-16-SEPT-1 AND 1 OCT.
G-Agri. SCH.	28	19.0	38	2.0	36.0	1 SEPT & 1 OCT.

IRRIGATION WELLS

Location Block & Plots	WELL NO.	DEPTH OF WELL (FT)	GROUND ELEV ( FT)	DEPTH OF WATER ( FT)	HIGHEST GROUND WATER ELEV. ( FT).	REMARKS
1	2	3	4	5	6	7.
A-4	10	111-4	34	19.0	15.0	16 JUNE 16 JULY 1 OCT. 16 DEC
B-10	15	33.8	36	5.6	30.4	1 OCT
B-16	16		36	9.0	27.0	1 OCT.
E-4	18	32.0	38	4.6	33.4	1 OCT.
E-8 USAID	19	38.2	38	7.0	31.0	1 SEPT 1 OCT.
E-4	11	152.0	41	22.5	18.5	16 AUG
E-14	2	160.0	35	18.0	17.0	1 & 15 OCT.



TABLE 8    1969 POWER USED BY IRRIGATION WELLS COLLEGE FARM, (KM<sup>3</sup> S)

Well No.	Jan.	FEB.	MAR.	APR.	MAY	JUN.	JUL	AUG	SEP	OCT	NOV	DEC	Total.
1	2	3	4	5	6	7	8	9	10	11	12	13	14.
10	918	1305	950	337	429	705	335	-	-	858	201	210	6248
18	628	1072	963	837	400	565	1560	-	-	633	354	434	7446
19	-	14	243	038	037	396	-	-	028	014	004	025	0926
16	----- Electric motor installed No motor available -----												
=====													
Total:-	1546	2518	2156	1212	866	1666	1895	-	028	1505	589	669	14620
=====													

.....33.

GJC/

1970 POWER USED BY IRRIGATION WELLS

Well No.	JAN.	FEB.	MAR.	APR.	MAY	JUN	JUL	AUG	SEP	OCT.	NOV.	DEC.	Total.
16	0109	0190	0161	0018	-	0350	-	-	-	-	030	-	0858
10	1300	1430	1460	1580	1300	0500	300	850	517	350	750	400	10727
18	1110	1060	2090	1480	1550	0800	-	610	086	050	850	1000	10686
13	514	514	515	515	514	070	-	-	-	-	-	-	2642
1	-	-	-	-	-	-	-	050	010	200	-	250	510
2	-	-	-	-	-	-	-	-	-	-	040	050	0090
19	029	027	361	257	277	026	057	026	030	233	0307	321	1951
15	-	-	-	262	-	191	005	014	022	070	088	142	0794
TOTAL:-	3062	3121	4586	4112	3641	1937	0362	1550	0665	0903	2085	2163	28172

WELL NO.	JAN.	FEB.	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
<u>1971 POWER USED ON COLLEGE FARM.</u>													
16	1500	1880	1430	1500	1550	0800	-	0300	0500	-	0340	0850	10650
10	360	400	500	600	650	600	450	450	150	640	340	350	5490
18	250	200	820	1250	1400	1000	700	1000	1000	-	1020	550	9190
1	700	1200	1260	2000	2350	1000	030	050	150	100	1060	700	9790
2	450	500	500	900	2650	1000	030	050	150	100	1060	700	8090
19	381	358	336	351	250	104	053	067	026	071	257	297	2551
15	116	140	110	096	075	081	011	017	017	071	231	088	1053
=====													
TOTAL:-	3757	4678	4946	5597	9225	4585	1274	1934	1993	0982	4308	3535	46814
=====													

TABLE 9 CHEMICAL ANALYSIS OF WATER SAMPLES  
COLLEGE FARM,  
JUNE 1969, PP/100,000

ITEM	W E L L					U S A I D	U S A I D
	No.10	15	16	18	19	1	2
Total soluble salts.	106.08	71.81	130.73	96.71	98.81	70.40	
Calcium Carbonate.	N11	N11	N11	N11	N11	5.00	
Calcium bicarbonate.	6.48	19.44	12.96	11.66	18.14	4.26	
Magnesium bicarbonate.	17.52	40.88	34.95	44.13	52.55	32.57	
Sodium carbonate	46.98	-	65.88	22.20	4.72		
Sodium chloride.	35.10	8.09	16.44	18.72	23.40	19.22	
Sodium bicarbonate						7.22	
Magnesium chloride	3.40						
PH							8.2
EC	mhc/cm						1030
T S S %							0.125

\* INSTRUMENT NOT OPERATIVE.  
DECEMBER - 1971.

ITEM	WELL NO.					U SAID 1	U SAID 2
	No. 10	15	16	18	19		
Calcium carbonate						6.0	5.0
Magnesium Carbonate.						3.3	4.2
Magnesium Bi carbonate.						1.44	0.22
Sodium Bi carbonate.						53.34	63.31
Sodium Chloride.						23.40	20.43
T S S %	0.068		0.07	0.08	0.06	0.078	0.078
PH	7.7		7.9	7.5	7.5	8.7	8.8
EC mhc/cm	1450		1090	1210	960	900	780

.....37.

CJC/

TABLE 10 WATER QUALITY RATINGS

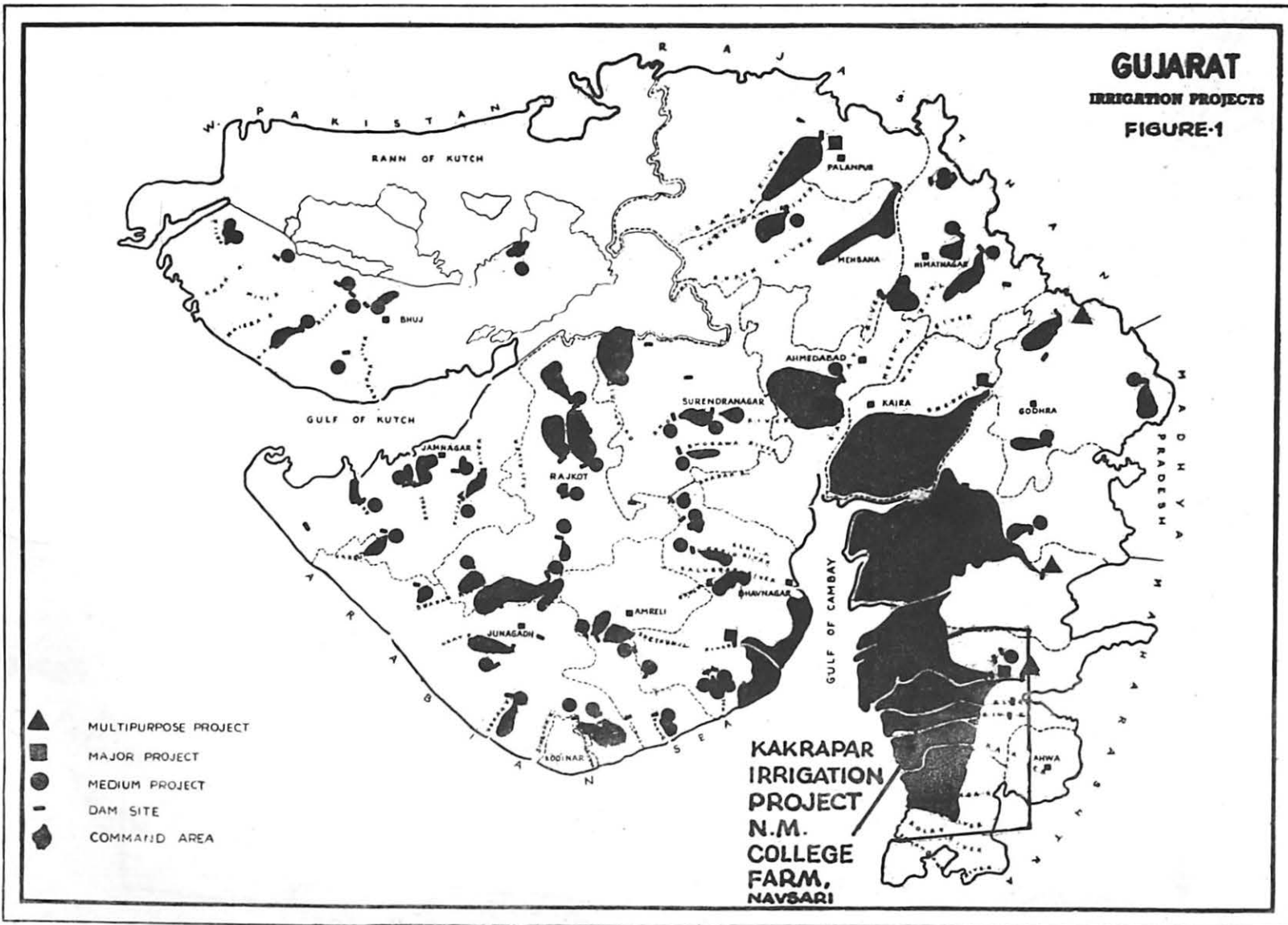
Name of Soil	Crops to be grown.	Under permissible* limit of E. C. of water for safe use xxx for irrigation.
1. Deep black soils and alluvial soils having a clay content more than 30 percent. Soils that are fairly to moderately well drained.	Semi tolerant	1,500
	Tolerant.	2,000
2. Heavy textured soils having a clay content of 20-30% Soils that are well drained internally and have a good surface drainage system.	Semi tolerant	2,000
	Tolerant.	4,000
3. Medium textured soils having a clay content of 10-20%, Soils that are well drained internally and have a good surface drainage system.	Semi tolerant.	4,000
	Tolerant.	6,000
4. Light textured soils having a clay content of less than 10% Soils that have excellent internal and surface drainage.	Semi tolerant.	6,000
	Tolerant.	8,000

1. In the above proposed limits of water quality it is presumed that the ground water table at no time of the year is within 1.5 meters from the surface, If the water table does come up within the root zone the above limit to be reduced to half the above values.
2. If the soils have impeded internal drainage either on account of presence of hard pane unusually high amounts of clay or other morphological reasons, for advisory purposes, the limit of water quality should again be reduced to half.
3. If the water contain soluble sodium percentage more than 70, gypsum should be added to soil occasionally.
4. If supplemental canal irrigation is available, waters of higher electrical conductivity could be used profitably in loan periods.

CIC/

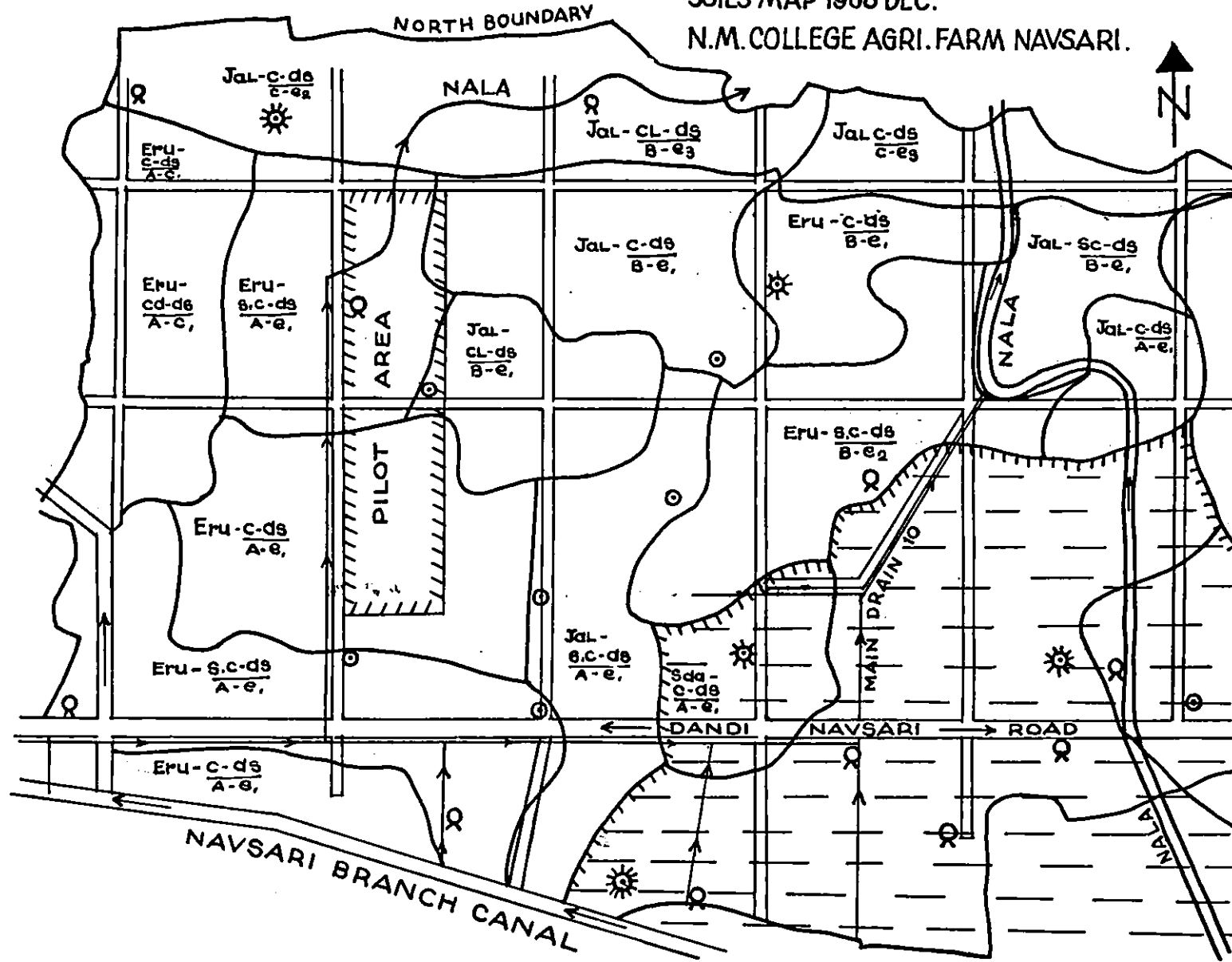
\*\*\*\*\*  
\*\*\*\*\*

**GUJARAT**  
**IRRIGATION PROJECTS**  
**FIGURE-1**



SOILS MAP 1968 DEC.

N.M. COLLEGE AGRI. FARM NAVSARI.





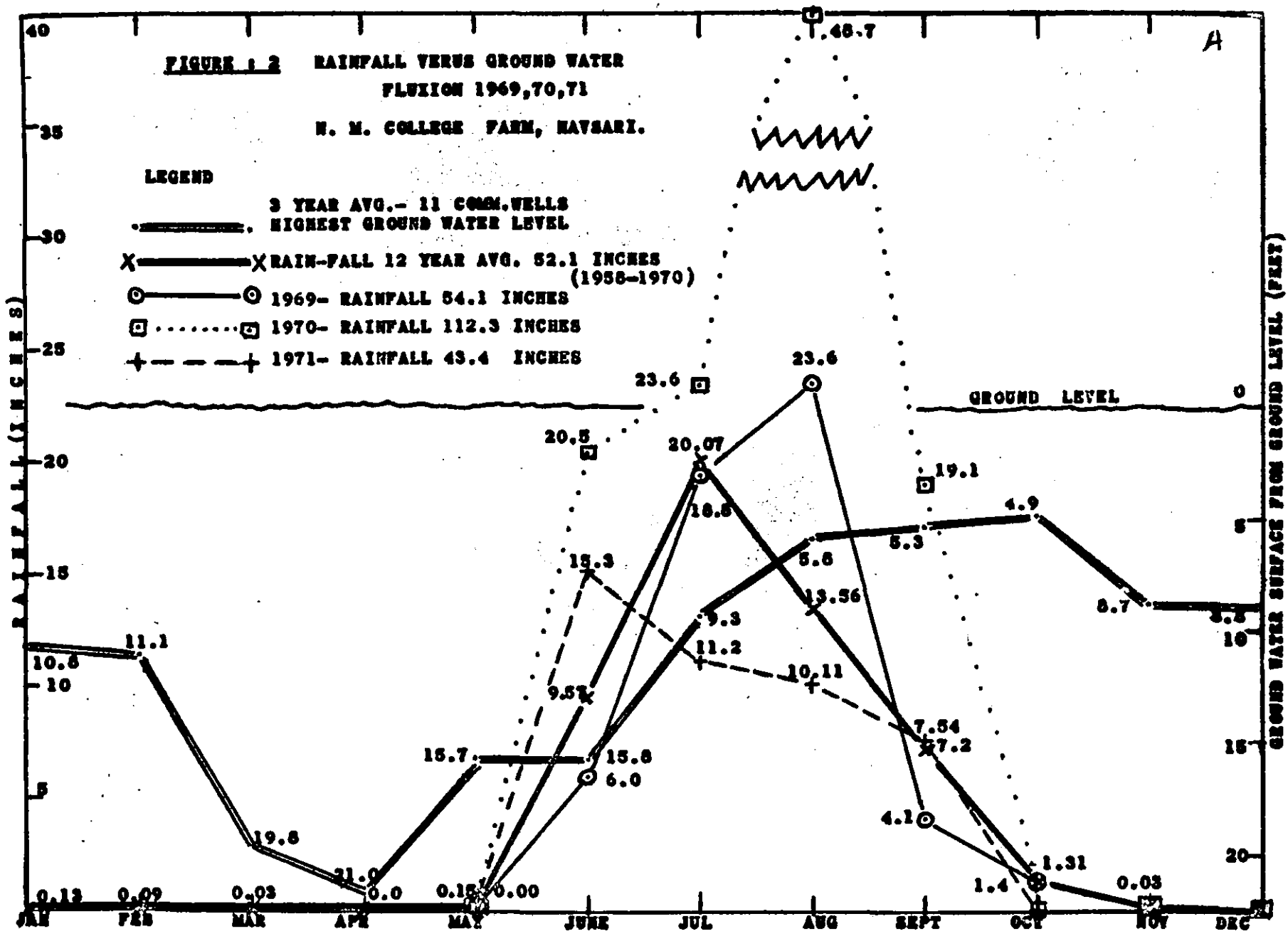
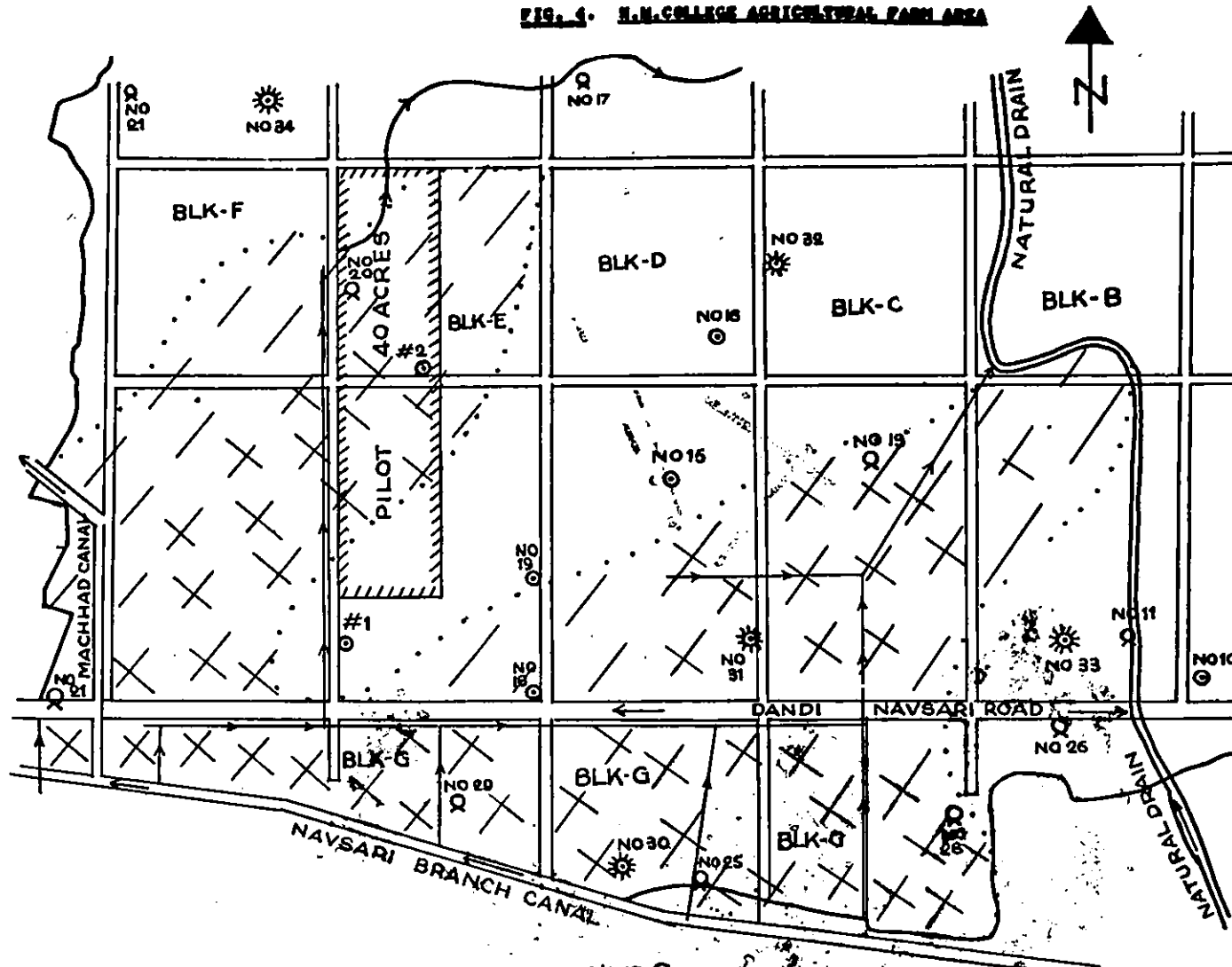






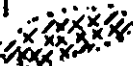






FIG. 4. H.N. COLLEGE AGRICULTURAL FARM AREA



**LEGEND**

-  PILOT AREA 40 ACRE
-  AREA WATER LOGGED AND SALINITY PROBLEMS
-  No. 21 R  
COMMUNITY WELL & NUMBER, NOT PUMPED

-  No. 10
-  No. 31
- 
- 

-  PURGATION WELL
-  NEW WELLS INSTALLED 1978
-  KEY DRAINS INSTALLED 1969-1970
-  HIGH WATER TABLE AREA

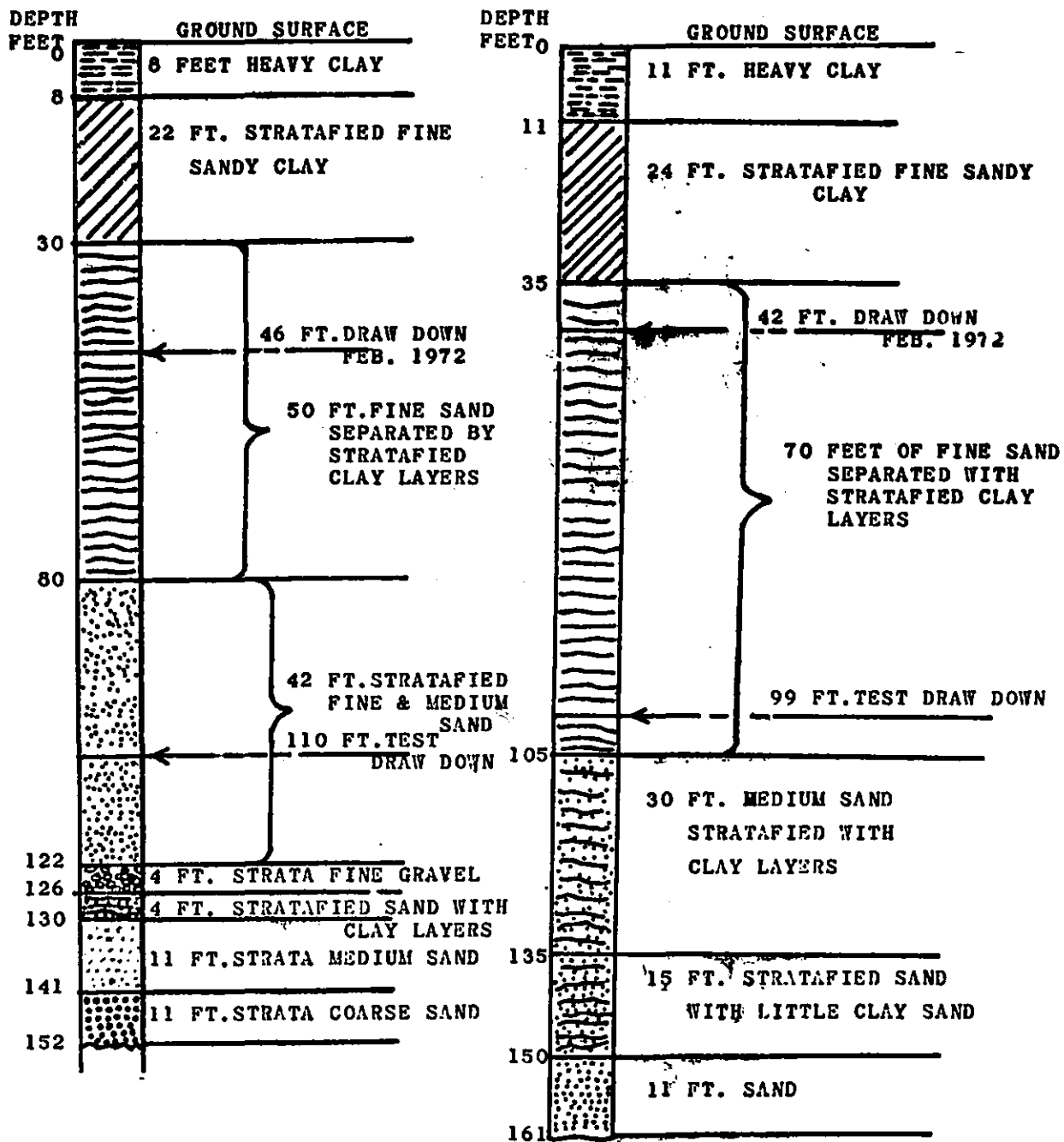
**FIGURE : 5**

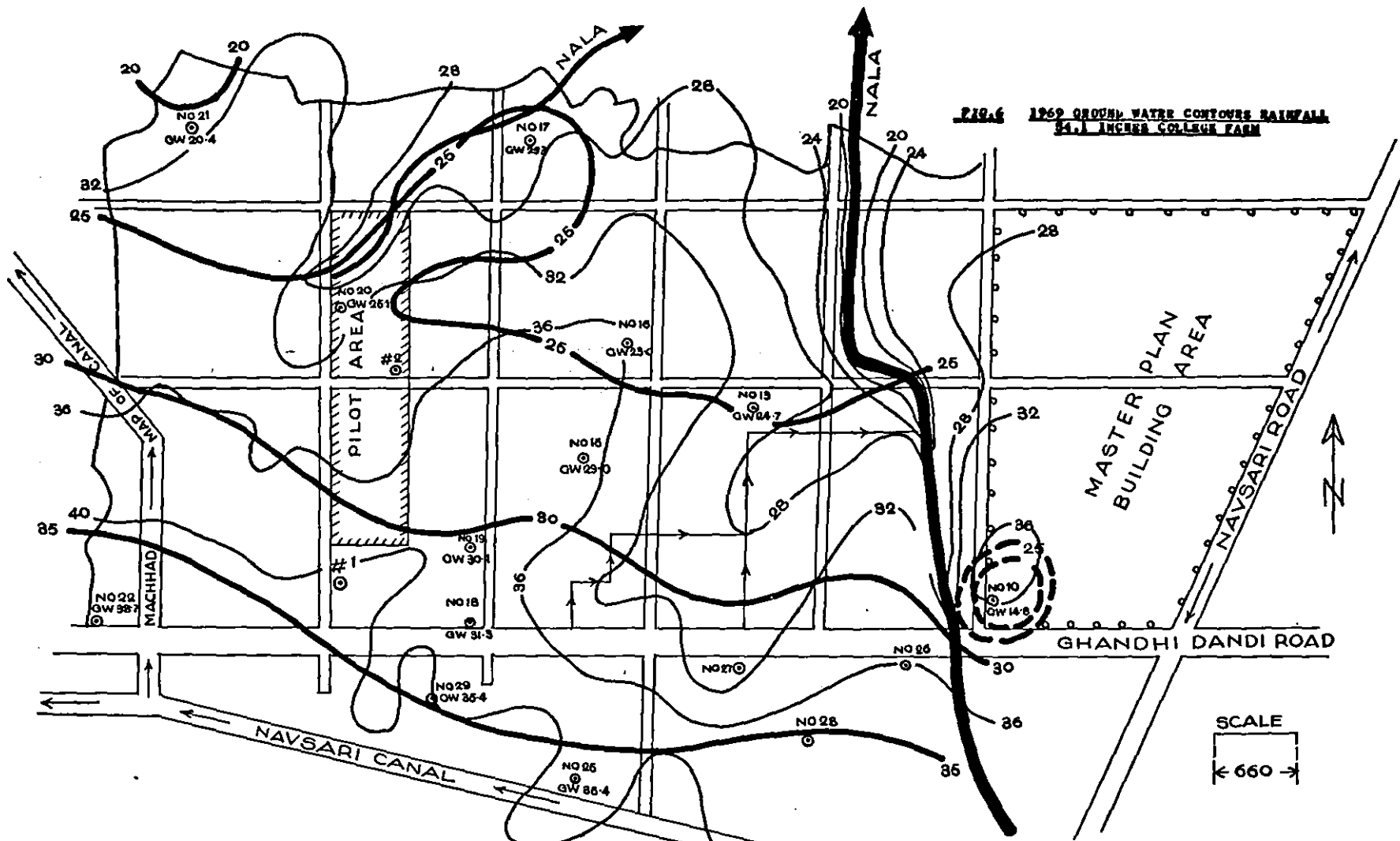
**WELL LOGS ON PILOT 40 AC. N.M.COLLEGE FARM, NAVSARI, INDIA.**

**WELLS BORED : 1970**

**BORE NO.1 - 152 FEET DEEP**

**BORE NO.2 - 161 FEET DEEP**

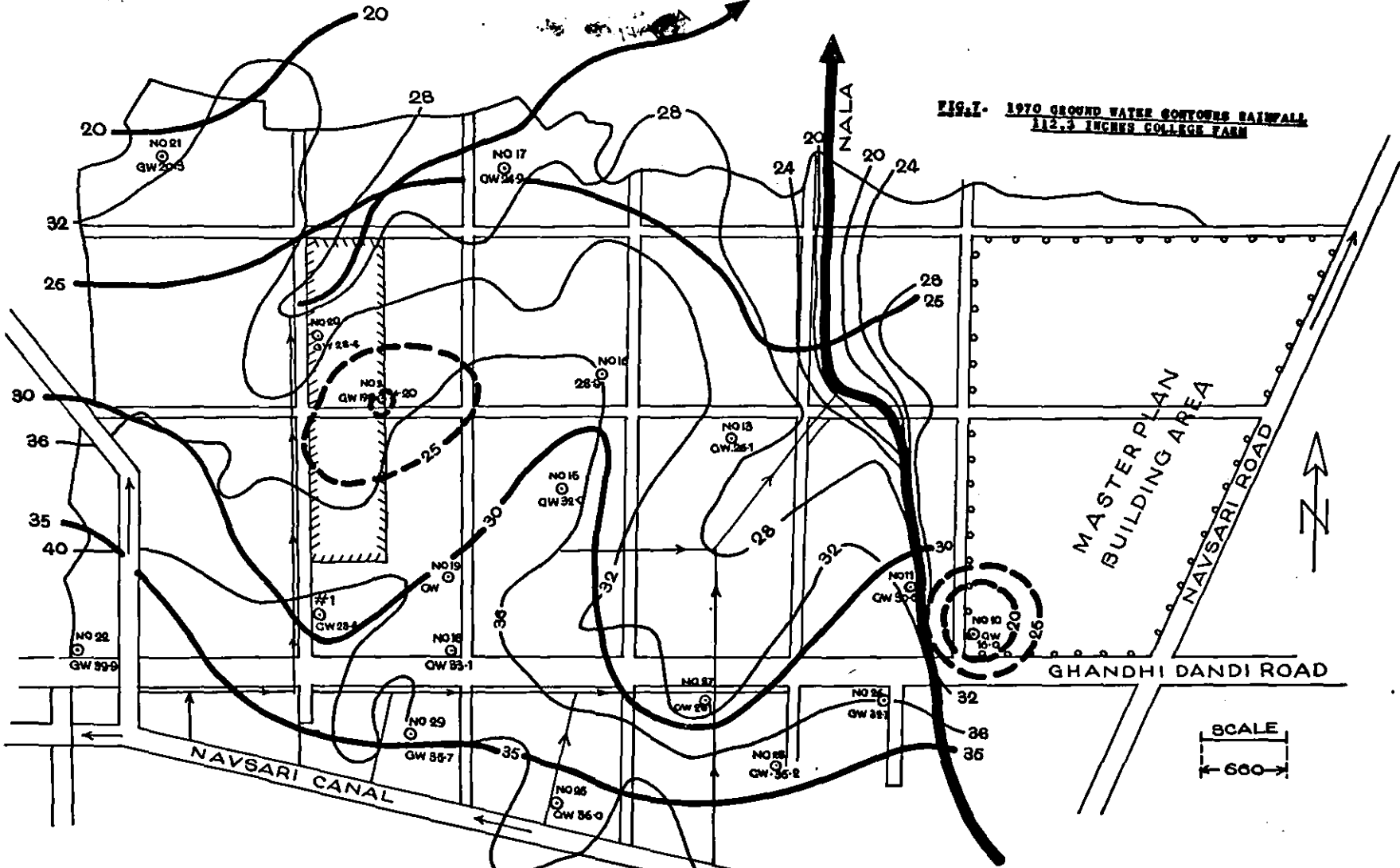




**FIG. 6 1969 GROUND WATER CONTOURS RAINFALL  
24.1 ACRE COLLEGE FARM**

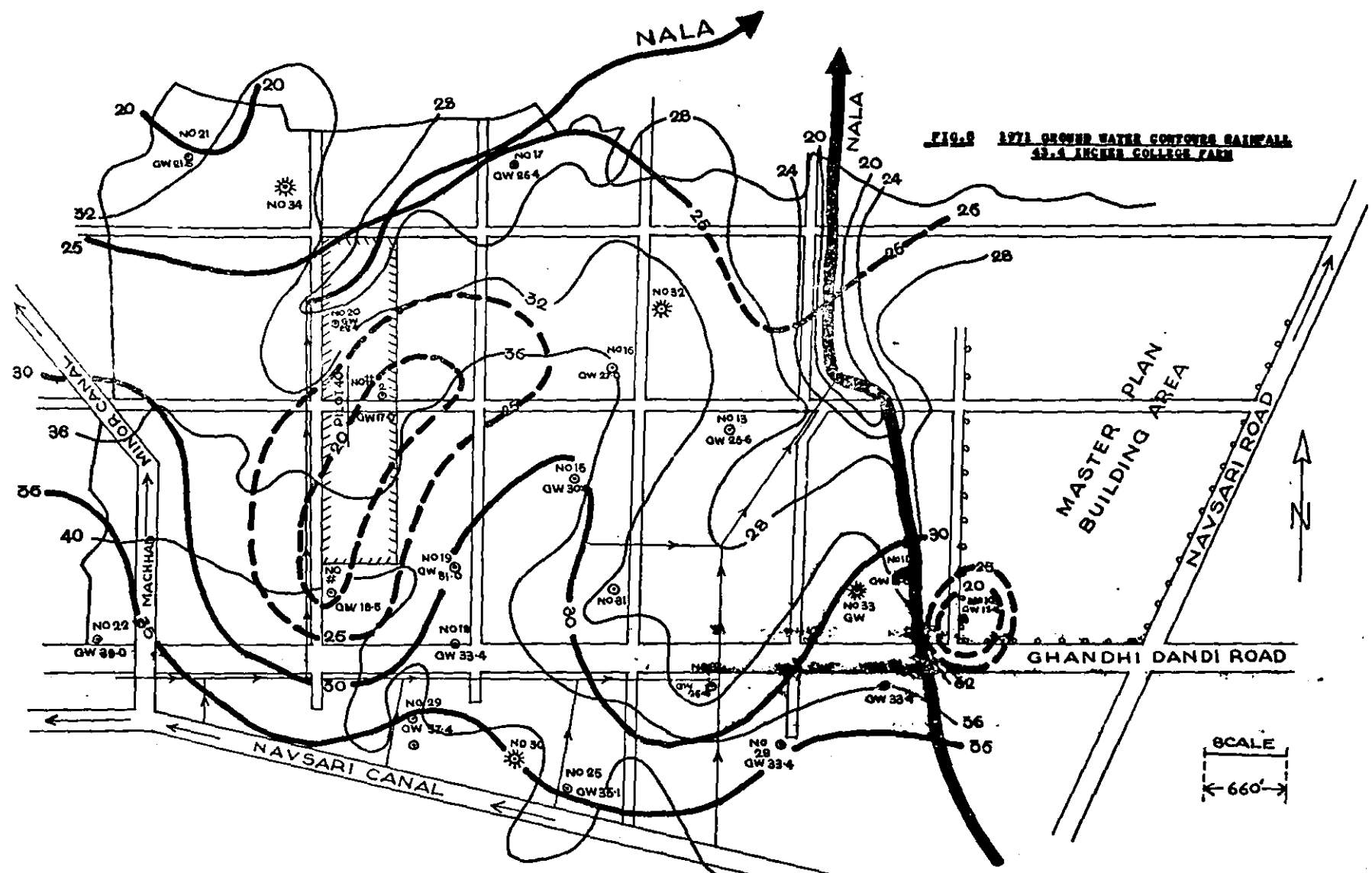
- LEGEND**
- No 21 @ GW 20.4 WELL NUMBER-GROUND WATER ELEV.
  - 22 — GROUND SURFACE CONTOUR (4 FT)
  - 30 — GROUND WATER CONTOUR (8 FT)
  - F — DRAIN CHANNEL EXISTING
  - [Hatched Box] PILOT AREA
  - [Dotted Box] FARM ROADS
  - [Dotted Box] MASTER PLAN BUILDING AREA
  - [Dashed Circle] DRAINAGE CONTOURS

**FIG. I. 1970 GROUND WATER CONTOURS RAINFALL 112.3 INCHES COLLEGE FARM**



- LEGEND**
- NO 20 GN 230 WELL NUMBER-GROUND WATER ELEV.
  - 4 FT — GROUND SURFACE CONTOUR (4 FT)
  - 5 FT — GROUND WATER CONTOUR (5 FT)
  - NEW MAIN SURFACE DRAINS
  - [Hatched Box] PILOT AREA
  - [Dotted Box] MASTER PLAN BUILDING AREA
  - [Double Line] FARM ROADS
  - [Dashed Line] DRAWDOWN CONTOURS

**FIG. 8 1971 GROUND WATER CONTOUR RAINFALL 33.4 INCHES COLLEGE FARM**

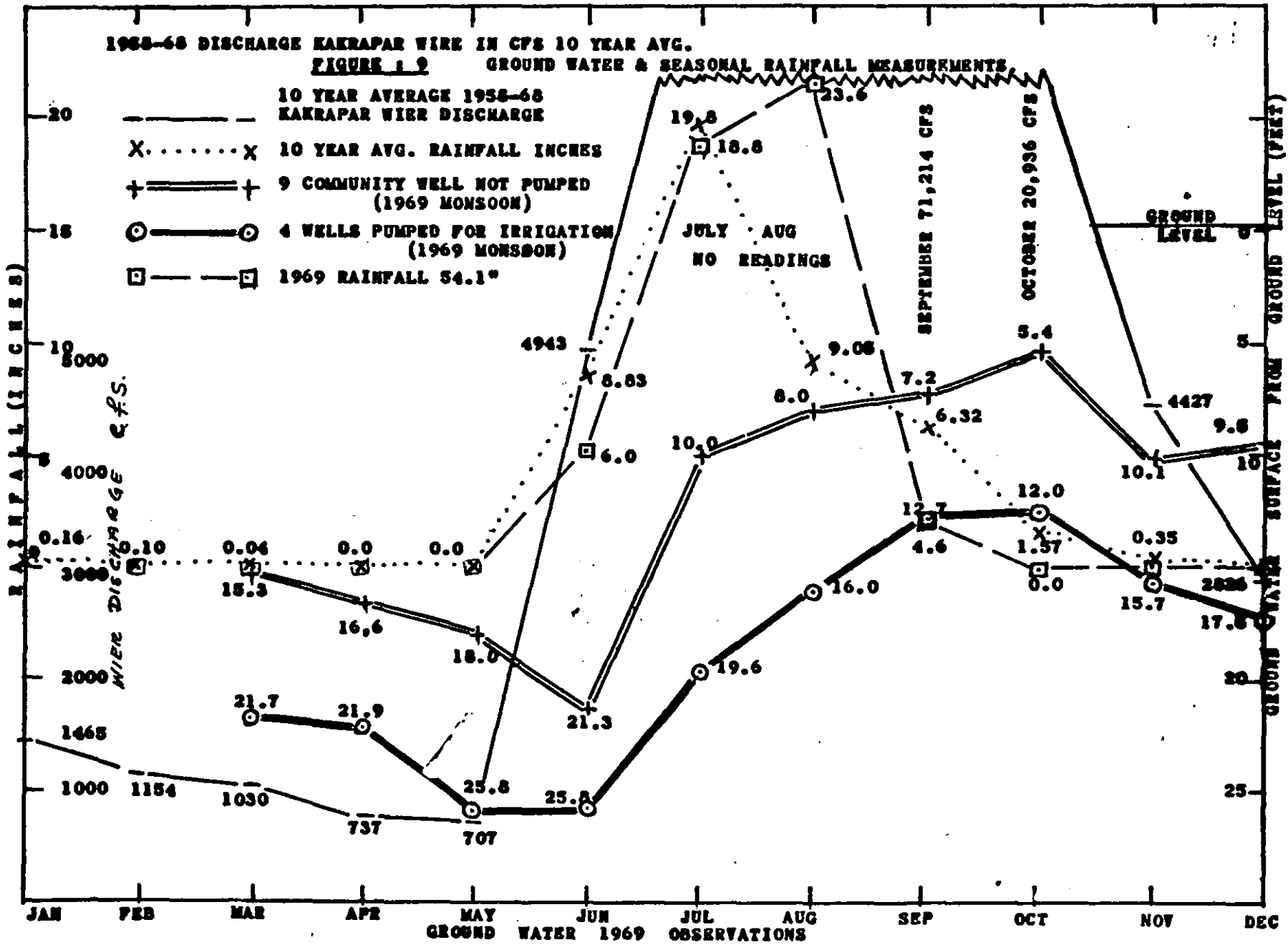


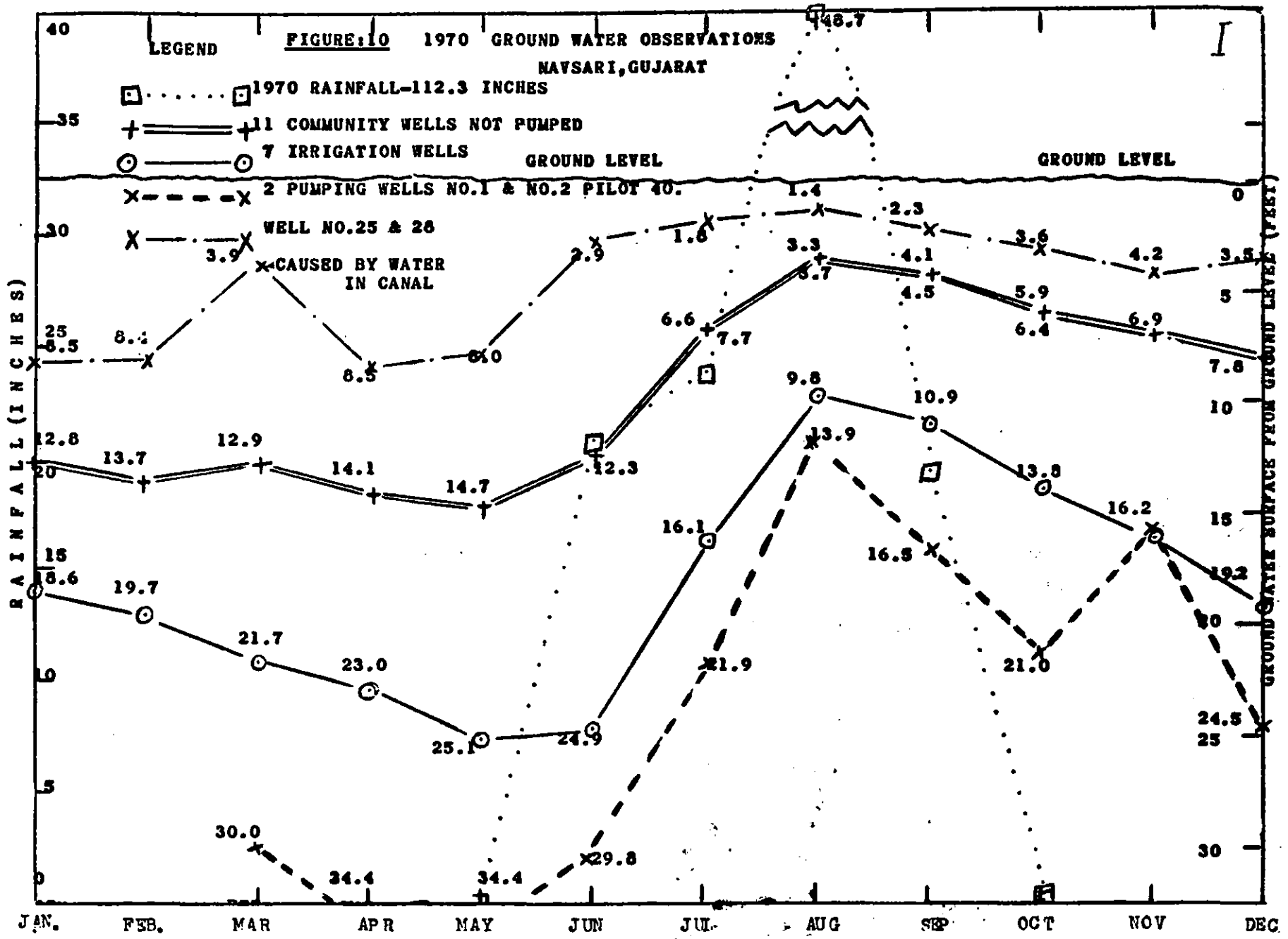
**LEGEND**

- NO 21 GWH 81.8
- WELL NUMBER-GROUND WATER ELEV.
- 4 FT — GROUND SURFACE CONTOUR (4 FT)
- - - 5 FT - GROUND WATER CONTOUR (5 FT)
- ~~~~~ 30 NEW MAIN SURFACE DRAINS

- PILOT AREA
- ▨ MASTER PLAN BUILDING AREA
- FARM ROADS
- ⊙ GROUND CONTOURS

SCALE  
1" = 660'



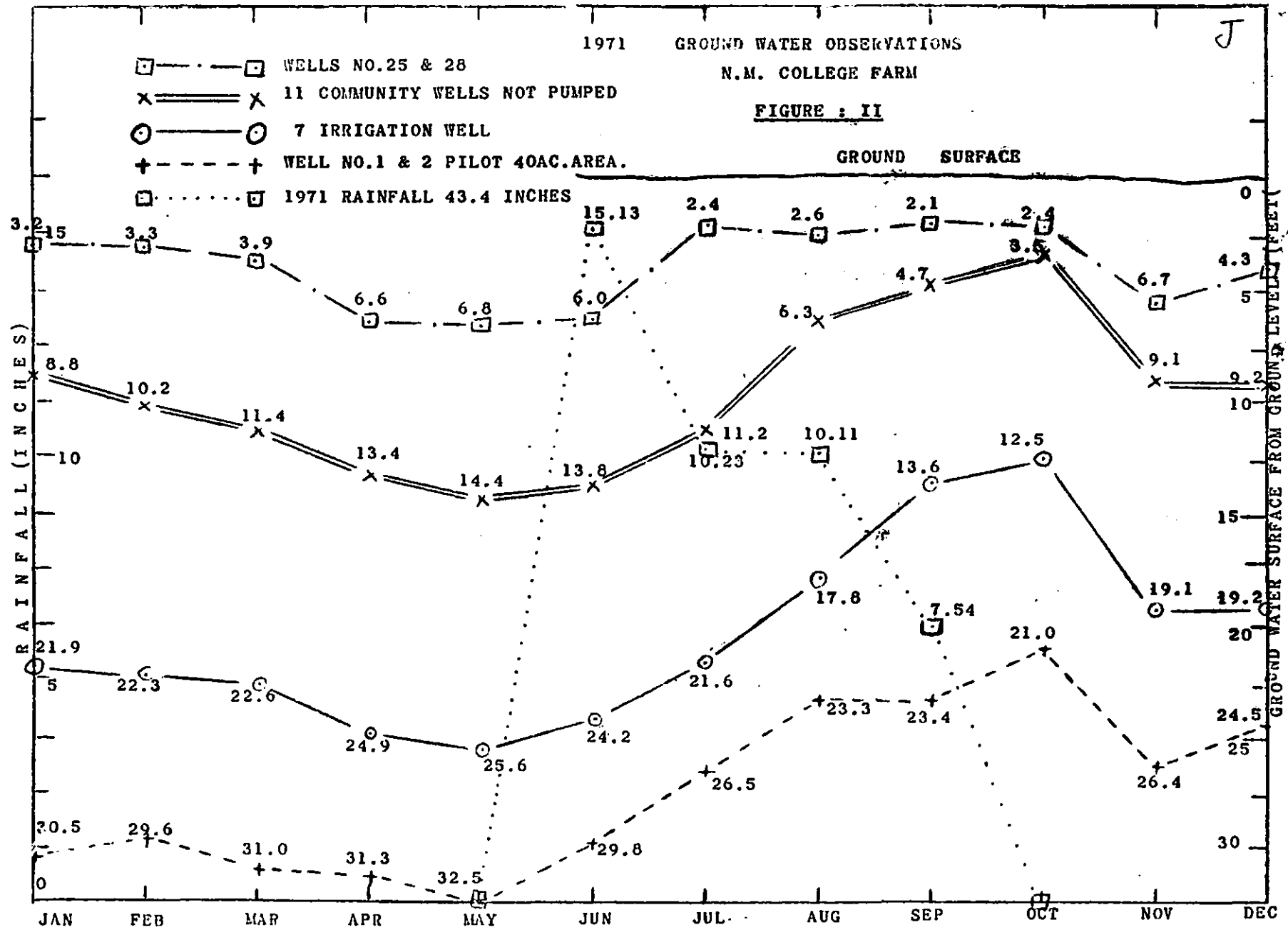


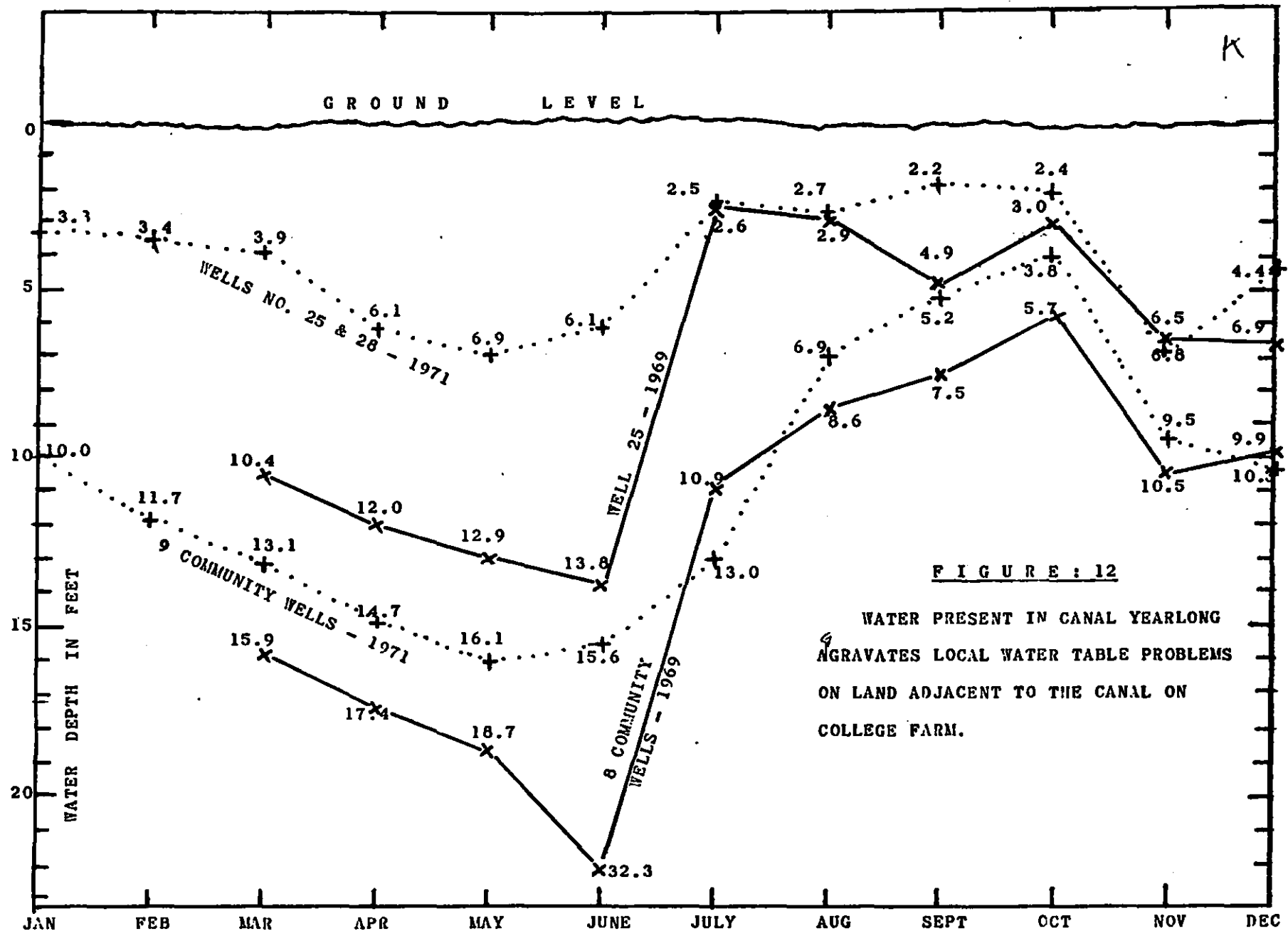


1971 GROUND WATER OBSERVATIONS

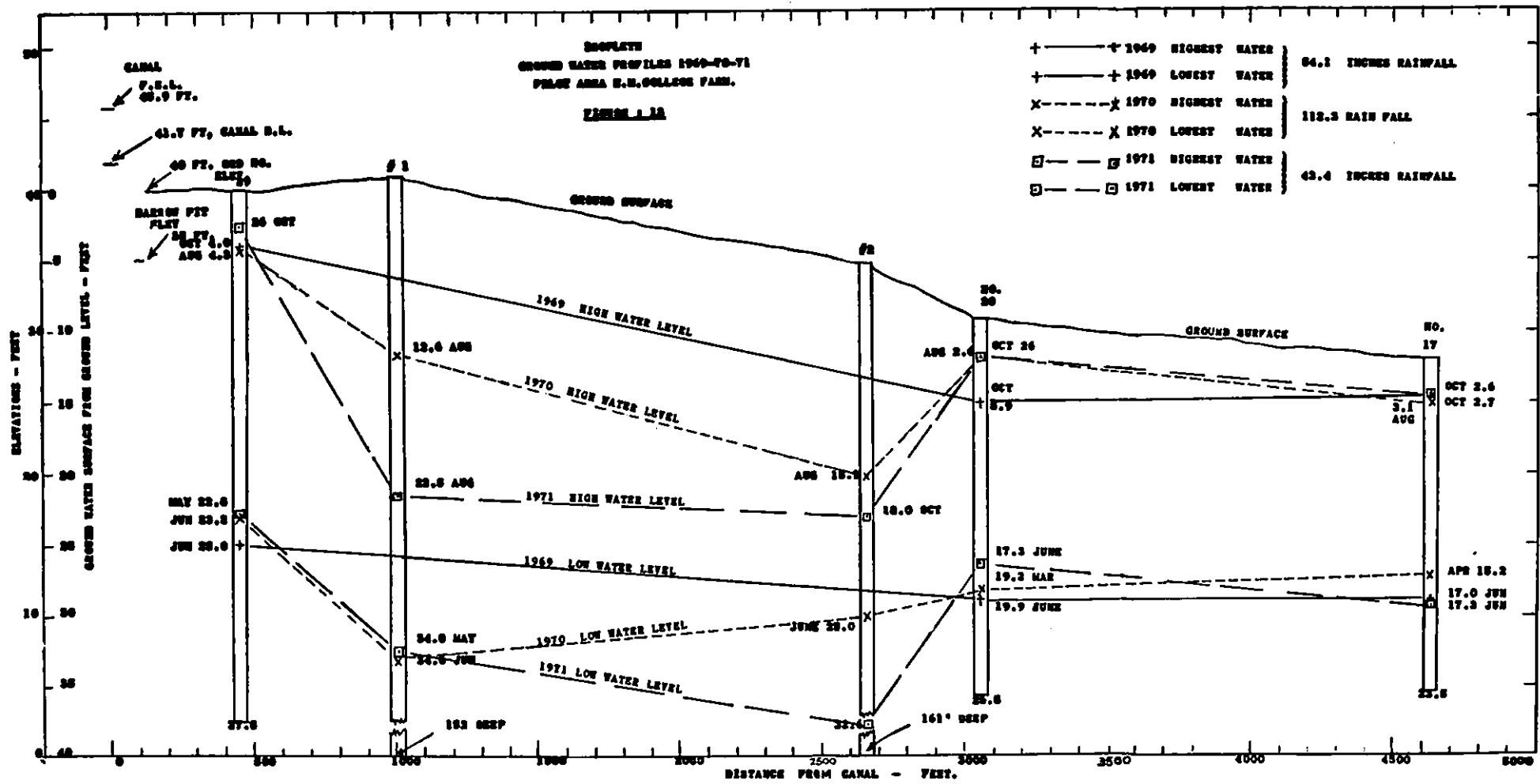
N.M. COLLEGE FARM

FIGURE : II





**FIGURE : 12**  
 WATER PRESENT IN CANAL YEARLONG  
 AGGRAVATES LOCAL WATER TABLE PROBLEMS  
 ON LAND ADJACENT TO THE CANAL ON  
 COLLEGE FARM.



**TABLE 1**

**PHYSICAL PROPERTIES OF 3 SOILS ON  
N.M. COLLEGE FARM.**

Name of soil series.	Depth		Soil desc. quat.	C/o clay	C/o silt	C/o sand	C/o water hold'g	C/o pore space	Specific gravity	App. den -city	C/o Vol expansion	pH
	CMS.	INS.										
Eru	00-25	00-10	C	64.0	07.0	29.0	57.9	50.0	2.2	1.2	14.2	7.5
	25-90	10-36	C	62.5	12.5	15.0	53.2	62.4	2.2	1.2	11.2	7.8
	90-120	36-48	C	36.0	06.5	37.5	69.9	53.0	2.4	1.2	14.2	8.1
	120-150	48-60	C	39.5	11.5	49.5	73.1	54.1	2.1	1.1	14.6	8.0
Jainagar	00-25	00-10	C	76.13	17.04	11.49	65.21	58.06	2.24	1.24	30.06	7.9
	25-105	10-40	C	68.13	21.15	10.84	70.83	58.73	2.01	1.09	23.36	7.9
	105-131	40-52	C	65.41	23.97	07.98	70.22	57.30	2.00	1.17	30.80	7.9
	31 +	52 +	SICL	34.47	43.09	23.65	66.91	52.41	1.79	0.99	18.97	9.2
Sindra Alia Ala.	00-25	00-10	C	49.5	15.5	35.0	54.0	51.0	2.3	1.2	11.3	7.9
	25-52	10-20	C	51.0	07.5	41.5	58.6	59.5	2.5	1.2	10.5	7.8
	52-120	20-48	SIL	19.5	51.5	29.0	52.4	55.5	2.2	1.1	10.0	8.2
	120-135	48-53	SIL	20.0	4.0	70.0	35.3	51.8	2.4	1.2	9.6	8.4
	135-150	53-60	L	17.5	6.0	70.5	34.5	49.5	2.1	1.1	9.2	8.4

**FIG. — SOIL MAP DECEMBER, 1968  
N. M. COLLEGE FARM**

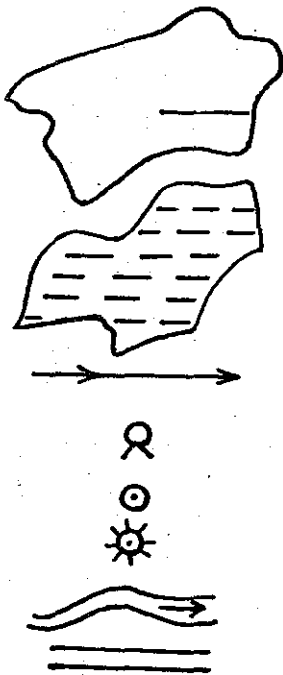
AJP/-

**LEGEND**

BOUNDARY OF SOIL SERIES (7th APPROXIMATION CLASSIFICATION)  
NOTE SOIL PROFILE ABOVE

Sda -  $\frac{C - ds}{A - G_1}$  - VERY PERAMABLE SUBSTRATA

SOIL MAP  
SCALE  
1" = 660'



DRAINS CONSTRUCTED

COMMUNITY WELL (NOT PUMPED)

IRRIGATION WELL

WELLS INSTALLED 1971

NALA ( NATURAL DRAINS)

ROADS.