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REMOTE SENSING STUDIES FOR GROUNDWATER INVESTIGATIONS IN PART OF DHASAN RIVER BASIN, UTTAR PRADESH

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ABSTRACT

The study area lies in Bundelkhand Granitic complex, which is overlain by unconsolidated alluvial sediments. Here an attempt is made to employ Landsat-4 imagery (1:250,000) and Thematic Mapper Data of Landsat-5 (1:62,500) for the hydrogeological studies in the area. Based on the tonal expressions, geomorphic features, drainage patterns, lithologic characters and structural features, the hydrogeological conditions in the area were evaluated. On the basis of above studies, potential water bearing zones have been demarcated for groundwater exploration. Geophysical studies were undertaken in the zones indicated to be promising from the above studies. One site has already been drilled and proved successful and the results of other sites are expected to be encouraging.

INTRODUCTION

Agriculture in Bundelkhand region is a continuous fight against the recurrence of droughts, scarcities and famines for which the region has been well known. The major source of irrigation in this area is canals, where as other sources of irrigation are tanks and wells which are conspicuous by their negligible share in the total irrigated area. Groundwater, being a major source, plays an important role in the water resources development. Therefore, the ground water resources development is also necessary in conjunction with surface water resources in Bundelkhand region.

For this, hydrogeological investigations in drought affected areas and geophysical investigations in some parts of Hamirpur district were carried out by Central Groundwater Board in field season 1979-80 and 1980-81 (Lal A.N., Rama Krishna, A., & A. Mohammad). Presently RSAC, U.P., is carrying out investigations in part of Dhasan Basin using integrated Remote Sensing techniques followed by pin pointing of individual water well sites for ground water development.

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The area lies between latitude 25 15'43" to 25°30'N and longitude 79°15' to 79°30'E on the Survey of India toposheet Nos.54 O/7 and 54 O/11 (scale 1:50,000). Most of the study area falls in Hamirpur district of southern Uttar Pradesh. The Central Railway line (Jhansi-Manikpur Branch) passes through the area which connects the area from Delhi and Allahabad. State Highway No.44 (Jhansi-Mirzapur) passes through the area from Harpalpur to panwari which are the major towns in the area.

The area is bounded on the east and west by NE-SW trending quartz reefs, Northwards, the area extends upto village Jakha, and Southwards it closes near Harpalpur. The western boundary passes close to Dhasan River. The area forms a part of Landsat scene No.145-042 (fig.1). Detailed hydrogeological investigatios including interpretation of Thematic Mapper data of Landsat-5 on 1:62,500 scale and field investigations were undertaken (fig.2 & 3).

PHYSIOGRAPHY

The general landscape of the area is that of an undulating plain with irregular rocky hills coverging to a level plain towards north reaching upto river Yamuna. The elevation of the area, in general ranges between 180m to 200m above mean sea level, whereas the elevation isolated granite hillocks extends upto 302 mt. near village Mahobkenth.

The drainage of the area is conformed by the Dhasan river and it's tributaries (Dheri Nala, Bilwa Nala & Konara Nala) as well as by Keolari Nadi and Birma Nadi etc. All the major streams are generally perennial and flow in a north to north easterly direction following the general topographic slope of the area. A large number of gullies, nallas and rivulets traverse the area and join them at different places. There are a number of surface water storage tanks in the area. At few places the quartz reefs act as a natural dam across local streams forming shallow depression storages.

CLIMATE

The climate of the area is characterised by hot dry summer and a cold winter. May is the hottest month while January is the coldest. The average annual rainfall of the area is 900mm. Maximum rainfall occurs during south west monsoon period from mid June to September. The area is affected frequently by drou-ghts due to monsoon failure.

GEOLOGY AND HYDROGEOLOGY

Geologically, the area comprises Quaternary alluvial deposits, which were deposited on the eroded basement of the Bundelkhand gneissic complex which precludes as inliers at some places. The quartz reefs are traversing the area with a general trend in NE-SW to NNE-SSW directions.

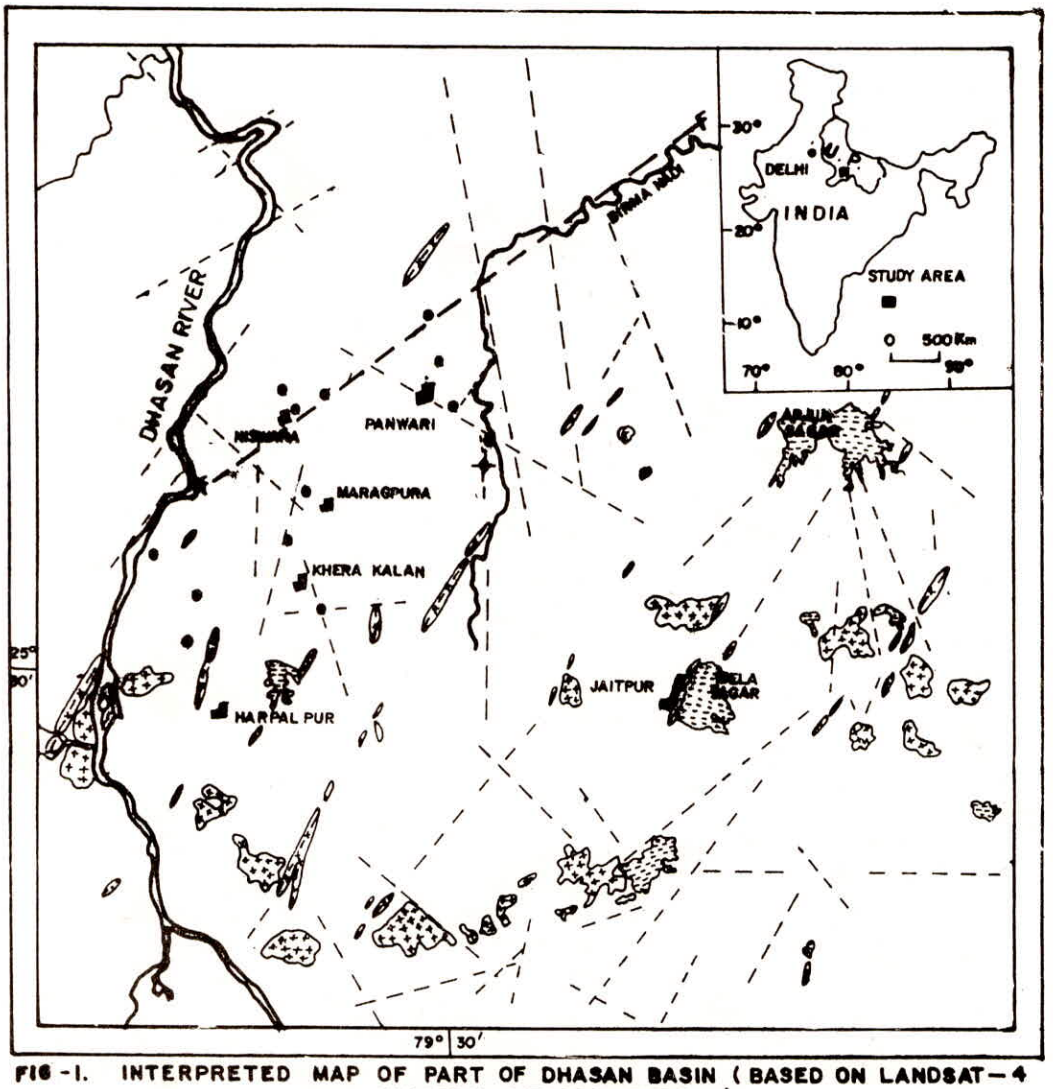

FIG - I. INTERPRETED MAP OF PART OF DHASAN BASIN (BASED ON LANDSAT — 4 IMAGERY INTERPRETATION)

LEGEND

- SETTLEMENT
- DRAINAGE
- WATER BODY
- GRANITE OUT CROP
- QUARTZ REEF
- LINEAMENT
- POINT, SUITABLE FOR DRILLING
- POINT, DRILLED SUCCESSFULL
- FAULT

SCALE

2500 m TO 1 Cm

Km 5 0 5

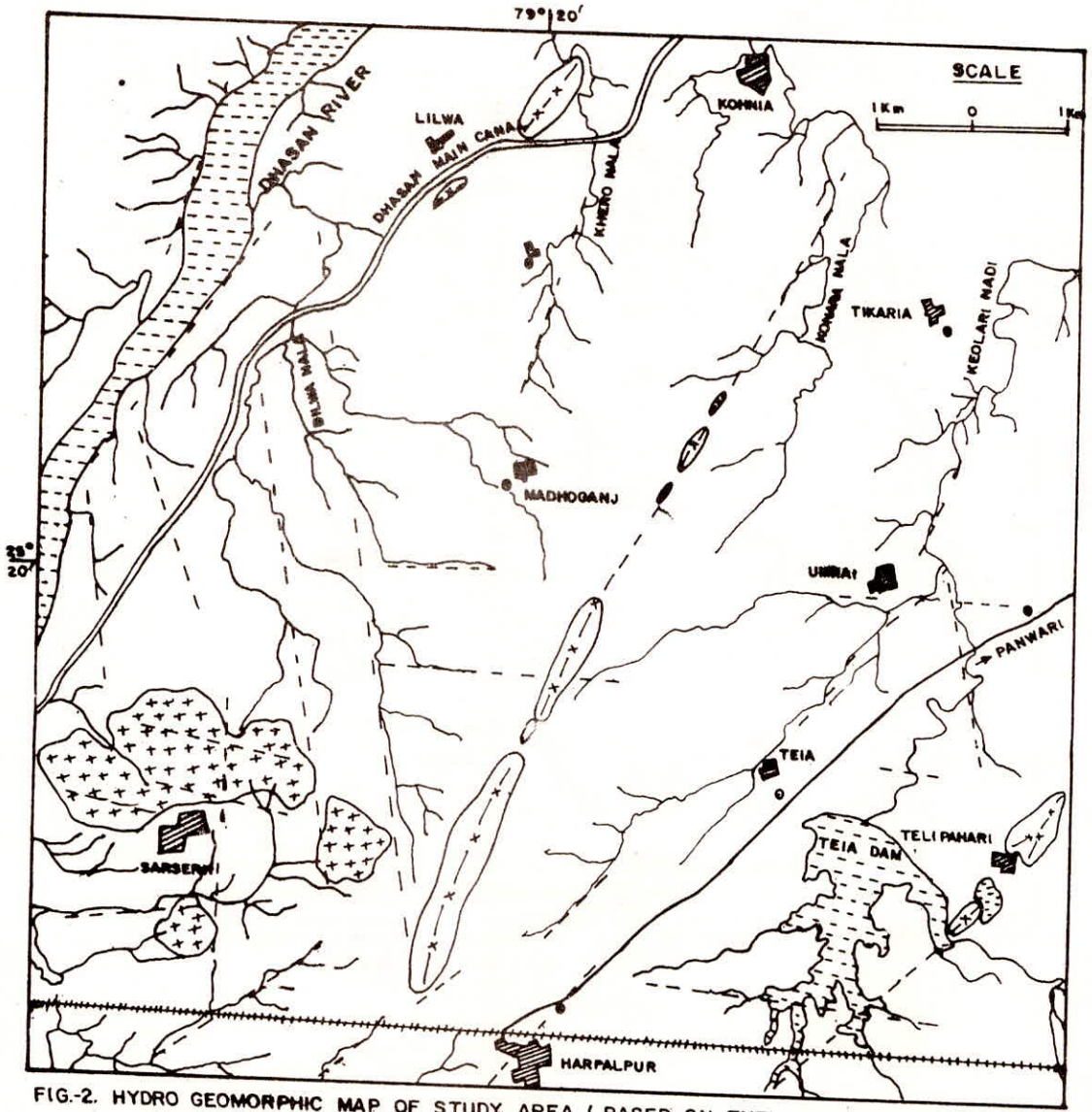

FIG.-2. HYDRO GEOMORPHIC MAP OF STUDY AREA (BASED ON THEMATIC MAPPER DATA OF LANDSAT-5 ON 1.62,500 SCALE)

LEGEND

- ROAD
- RLY. LINE
- CANAL
- DRAINAGE
- WATER BODY
- QUARTZ REEF
- GRANITE OUTCROP
- LINEAMENT
- POINT, SURVEYED
- POTENTIAL TUBEWELL SITE
- SETTLEMENT

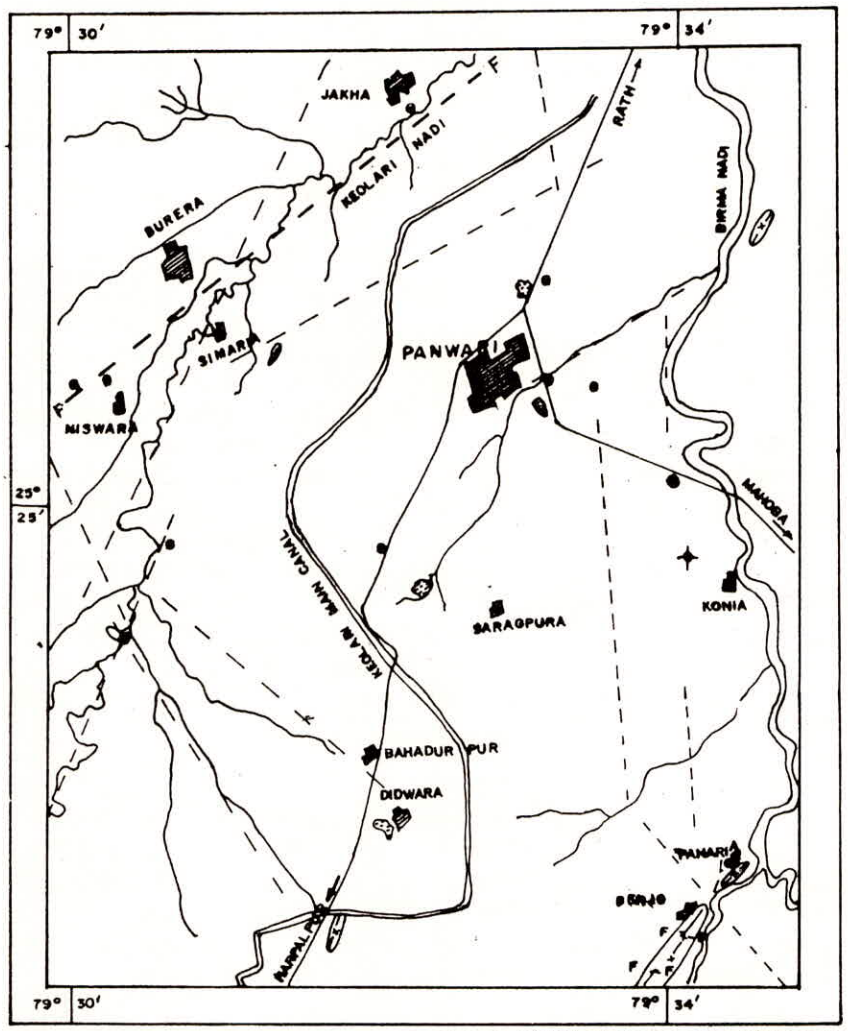

FIG.- 3. HYDRO GEOMORPHIC MAP OF STUDY AREA (BASED ON THEMATIC MAPPER DATA OF LANDSAT -5 ON 1: 62,500 SCALE)

LEGEND

- ROAD
- CANAL
- SETTLEMENT
- DRAINAGE
- WATER BODY
- QUARTZ REEF
- LINEAMENT
- FAULT
- POINT, SURVEYED
- POTENTIAL TUBEWELL SITE
- DRILLED, SUCCESSFULL

SCALE

1Km 0 1Km

The occurrence and the movement of groundwater are chiefly controlled by thickness of unconsolidated alluvial materials, the degree and depth of weathering, the extent of interconnection between joints and fractures in the compact rock and also the topography of the area. The ground water occurs under both water table and semi confined conditions. Quartz reefs act as sub surface barriers for ground water movement within the weathered mantle itself. The depth to water level in the area varies from 4m to 13m bgl. and total depth of the dug wells varies from 5m to 15m bgl. The intersection of lineaments, fractures and faults as well as the granular zones forms the targets of investigation in the area. In addition to normal rainfall, Dhasan river also acts as a source for groundwater recharge in the area.

REMOTE SENSING STUDIES

Landsat-4 imagery of bands 5 and 7 and standard FCC on 1:250,000 scale were analysed visually to understand the regional geology, geomorphology and hydrogeological conditions of the study area. Field checks have been carried out in the area to verify these interpretations. Based on these studies a map on 1:250,000 scale has been prepared, indicating geological and geomorphological features like quartz reefs, lineaments and minor faults (fig.1).

These interpretation have been studied in detail by using enlargements of the Landsat-5 Thematic Mapper data dated 9th March, 1986 on a scale of approx. 1:62,500. Based on visual interpretation, the lithology, structure, geomorphology etc. were studied and zones of ground water accumulation have been delineated (fig.2 & 3).

After gradually narrowing the target areas through satellite and aerial remote sensing, vertical electrical soundings were undertaken with a view to assessing the bedrock configuration and for pin pointing the specific sites for drilling. The selection of points for geoelectrical investigation were preferred along fractures and faults generally chosen across the area.

GEOPHYSICAL INVESTIGATIONS

Twentyfour sites were selected on the basis of satellite and aerial photo-interpretation for further geophysical investigation. Electrical resistivity soundings, using schlumberger configuration with maximum half current electrode seperation (AB/2) equal to 100.0 meters were conducted. The sounding curves are generally A,H,HA,QHA & KHA types representig three to five layer sub-surface set up and were interpreted by partial curve matching technique using two and three layer master curves and auxillary charts.

The top layer resistivity ranges from 5.7 ohm-m to 27 ohm-m with thickness varying from 1.2m to 11m. This indicates the variable nature of the surface soil in the area. The second layer resistivity varies from 4 ohm-m to 17.7 ohm-m with it's thickness varying from 1.7m to 27.0m. The third layer resistivity varies from 2.0 ohm-m to very high. The resistivity less than 13.0 ohm-m may be attributed to clay

Kankar and Kaolinised rock, whereas the resistivity range between 13.0 ohm-m to 100 ohm-m may be attributed to the water bearing sand, gravel, weathered, fractured and jointed rock. The thickness of this layer ranges from 6.0 m at village Tapara to 43.0 m at village Niswara. The resistivity more than 200 ohm-m indicates the presence of hard and compact granitic basement. Only at village Niswara and village Chhatesher this layer resistivity ranges between 12.4 ohm-m to 60.0 ohm-m which is attributed to the water bearing weathered, fractured and jointed rock. Thickness of this layer varies from 12.0 to 16.0 m. The infinite resistivity of the fifth layer indicates the presence of hard and compact basement. Depth to the hard and compact granitic basement ranges from 16.0 m near village Teia to 54.0 m near village Niswara (fig.3).

DISCUSSION AND RESULTS

The study of Landsat imagery indicated a major fractured zone trending N 67°E-S 67°W passing through villages Niswara, Simaria and Jakha and it is extending even upto river Yamuna (fig.1). Some part of Birma Nadi also conforms with this fractured zone. The main lithological units in the area are granite, quartz reefs and the alluvial and colluvial cover. These have been well differentiated on the Thematic Mapper data. The granites form low subdued, near circular hillocks but quartz reefs are discordent and have linear trends. Except when covered by vegetation, the quartz reefs have lighter tone while granites show variation. Quartz reefs are occupying the major fracture directions (NE-SW) and acting as a subsurface barrier for movement of groundwater within the weathered mentle itself. .Field geological studies in conjunction with drainage analysis has been taken up in villages near Berjo, Pahari and Simaria to ascertain which side of the quartz reef offers greater potential. At places the drainage seems to be controlled by the structures and it contributes to the ground water through the associated fractures and joints etc. Some sites have been selected on the fractures connecting at Teia Dam near villages Teia, Umaria and Harpalpur in view to tap water through associated fractures and joints from this reservoir. The lineaments picked up from the satellite imagery and T.M. Data of Landsat-5 have been an important guiding factor for the location of high discharge sites in the area. One site was drilled with a discharge of 13,000 gph. This site was close to a lineament, which seems to be connected with the Birma Nadi.

The geoelectrical sounding curve alongwith interpretated layer parameters lithological log of the village Konia are given in fig.4 which indicates a close correlation between geoelectrical logs. Here 12.0 ohm-m surface layer and 10.0 m second layer corresponds to black surface soil and hard clay layer respectively. The third layer having resistivity 2.0 m corresponds to kaolonised granite altered into clay and Kanker and extending down to the depth of 10.0 m. The fourth layer with resistivity 12.5 ohm-m and extending down to the depth of 36.0 m represent the composite colluvial sand followed by the fractured granite. The bottom layer indicated to have infinite resistivity corresponds to hard and compact granite basement. Furthermore, the soundings conducted near village Niswara and Jakha (fig.3) indicates that in these zones the fractured rock extends down to the depth of more than 54 m

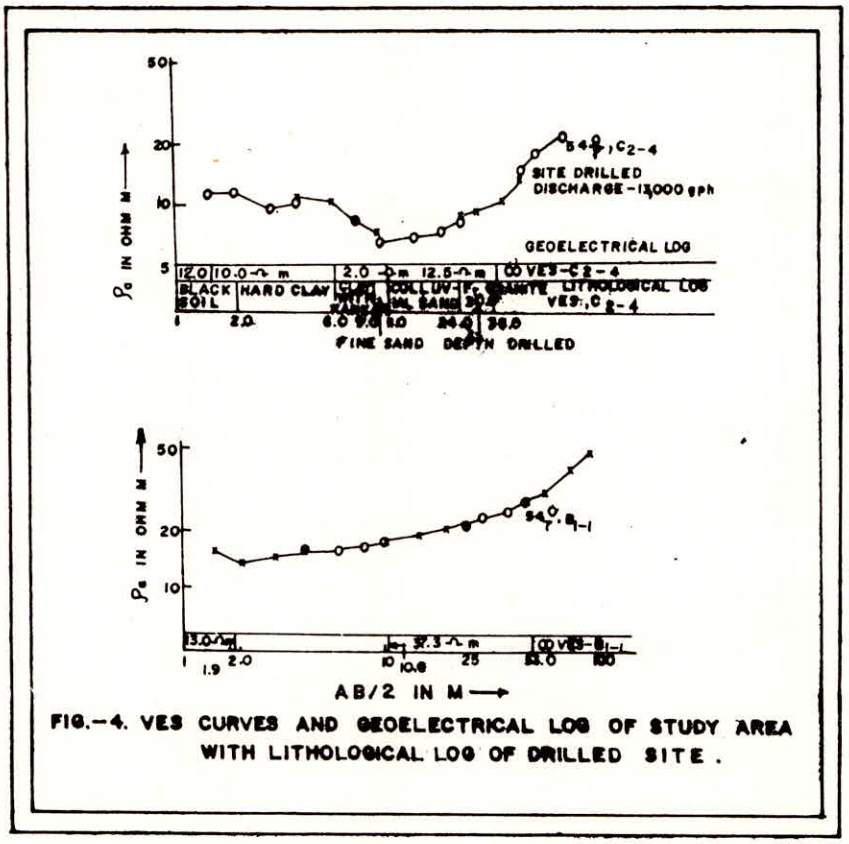

FIG.-4. VES CURVES AND GEOELECTRICAL LOG OF STUDY AREA WITH LITHOLOGICAL LOG OF DRILLED SITE.

which conforms the presence of fault zone as interpretated by satellite imagery and thematic mapper data.

CONCLUSIONS

Based on the Remote Sensing Studies, many lineaments have been delineated. These lineaments were ch cked in the field. Geophysical resistivity survey was conducted in the lineament controlled weather zones. By mean-s of detailed investigations like thematic mapper data studies and field studies, it is possible to evaluate the detailed hydrogeological conditions of the aquifers encountered and delineate even the small (micro level) potential zones etc.

Two of the potential zones picked up through the regional studies on Landsat were subjected to in-depth studies. It was found that most of the area picked up earlier bear good ground water potential. The aforementioned integrated investigations using satellite and aerial remote sensing in conjunction with geoelectrical soundings have given a number of potential well sites. Of the twentyfour sites at which geoelectrical soundings were undertaken, fourteen sites indicate good ground water potential and these will be expected to give discharges around 5000-10,000 gallons per hour. The remaining six sites, while not so encouraging from the view point of discharges are nonetheless suitable for domestic requirement of rural areas. The exact location of fourteen high potential tubewell sites in the basin is given in Annexure I.

ACKNOWLEDGEMENTS

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ANNEXURE 1

PART OF DHASAN BASIN

LOCATION OF POTENTIAL TUBEWELL SITES

Sl.No.	Point Code	Latitude	Longitude
1	54 O/7-C_1-1	25°26'30"	79°28'54"
2	54 O/7-C_1-3	25°25'41"	79°29'19"
3	54 O/7-B_1-1	25°25'49"	79°23'44"
4	54 O/7-B_1-2	25°25'38"	79°24'6"
5	54 O/7-A_2-1	25°21'52"	79°19'52"
6	54 O/7-A_2-2	25°20'34"	79°19'51"
7	54 O/7-C_2-1	25°24'12"	79°29'5"
8	54 O/7-C_2-2	25°24'48"	79°29'42"
9	54 O/7-C_2-3	25°24'28"	79°25'29"
10	54 O/7-C_2-4	25°23'58"	79°25'02"
11	54 O/7-C_1-4	25°28'45"	79°28'12"
12	54 O/7-C_1-5	25°26'09"	79°25'10"
13	54 O/7-B_3-1	25°19'56"	79°23'04"
14	54 O/7-B_3-3	25°17'34"	79°20'12"