PURPOSE DRIVEN STUDIES GROUND WATER

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GOA STATE

TITLE OF THE PROJECT

EVALUATION OF DOWNSTREAM CONSEQUENCES OF GROUND WATER DEVELOPMENT AT VERNA INDUSTRIAL ESTATE AND WATER RESOURCES MANAGEMENT.

BY

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WATER RESOURCES DEPARTMENT

GOVERNMENT OF GOA.

REPORT ON EVALUATION OF DOWNSTREAM CONSEQUENCES OF GROUND WATER DEVELOPMENT AT VERNA INDUSTRIAL ESTATE AND WATER RESOURCES MANAGEMENT

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EXECUTIVE SUMMARY

Micro level ground water studies have been taken up for the first time in Goa at Verna industrial estate and villages all around, under the Purpose Driven Studies of Hydrology Project Phase II to study the downstream consequences of bore well pumping at Verna industrial estate.

In this report aquifer geometry, ground water level trend, and chemical quality of ground water and inter relation of the aquifer systems has been described. Artificial ground water recharge studies have been carried out by constructing site specific ground water recharge structures, besides giving technical guidance to industries. Studies carried out over three years have indicated that generally drinking water open wells in village area are not affected due to bore well pumping in Verna industrial estate. Marginal variation of summer ground water level in village wells is due to variation of rainfall pattern besides local pumping if any.

However pumping of ground water over 3700 cubic meter per day in Verna Industrial Estate (with 192 bore wells and one open well), gravity springs located on the plateau and contact spring emerging out of the plateau are drying early though there is no over exploitation of ground water. Rainwater harvesting and recharging of ground water has shown positive result as rise in summer ground water levels could be observed in the vicinity of recharge structures to the tune of 1.0 m to 4.0 m and rejuvenation of springs and flow of nallah could be seen downstream of some recharge structures. Hydro-chemical relation between groundwater in bore well zone in industrial estate and open well zone in villages indicate poor hydraulic continuity between the two. For the given hydro geological setup of the area salt water intrusion in aquifer system from nearby creek is ruled out. Recommendations has been given for meeting water requirement of industries from surface water, protection of natural ground water recharge areas from filling, rainwater harvesting and recharging ground water, and equitable distribution of available ground water resources.

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31.10.2013

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1. INTRODUCTION:

1.1 BACKGROUND:

Ground water development has gained momentum in the past two decades in coastal areas of the state due to rapid urbanization, tourism and industrialization. Table lands with steep escarpment among coastal plains of Goa have become growth center for industries and preferred locations for rapid urbanization.

In Goa state, most of the industrial estates are located on narrow table lands (Plateaus and Mesas). Verna Plateau is one among them. One of the important industrial hubs with a number of industries covering an area of 6.7 sq km is located on part of Verna Plateau. With the increase in the industrial units and the population around the plateau, ground water development on this table land started increasing at an alarming rate. Water requirement of this industrial estate is met mainly from ground water by pumping bore wells within the industrial estate, and by transportation of ground water from village areas, as water supply is inadequate. About 500 to 1000 cubic meter water is being supplied against requirement of 5000 cubic meter for the existing industries. Anticipated water requirement of Verna industrial estate on future expansion is likely to go up to 10,000 cubic meters per day.

Public apprehension about impact of over exploitation of ground water in Verna industrial estate on village drinking water wells, springs, irrigation tanks and problems of salt water intrusion etc and paradigm shift from ground water development to sustainable management has necessitated ground water management at local level. Therefore micro level ground water studies have been taken up around Verna industrial estate, under Purpose Driven Studies (PDS) of Hydrology Project- II.

1.2 STUDY AREA:

Part of Table land (plateau) covering Verna industrial estate and the villages located at the foothills of the plateau have been selected for the Purpose Driven Study (Plates 1 to 4). The area under study is included in Survey of India topographic sheet No 48 E/15/5 of 1:25000 scale and is bounded by latitudes $15^0$23'13.2"N and $15^0$58'48N and longitudes $73^0$54'57.6"E and $73^0$58'48"E. It has an aerial extent of 32 sq km. It is bounded in the north and east by the river Zuari, towards west is the Konkan Railway tunnel whereas towards south the plateau merges into the coastal plain.

The study area is located between Panaji and Margaon on National High Way NH 17 (22 km from Panaji and 11 km from Margaon city). The Port town Vasco is situated 10 km west of the area which is connected by four lane high way which passes through Dabolim Airport. Villages of Cortalim, Lotoulim, Nagoa and Verna are located at foothill region.

1.3 PHYSIOGRAPHY AND DRAINAGE:

It could be seen on the plate 3 the study area comprises of following physiographic units (Geomorphic units)

A. Table land: - Narrow table land (Verna industrial estate) trends in NW-SE direction. The topography of the plateau top is almost gentle with some isolated peaks and local depressions occurring sporadically. The general elevation of the plateau is of the order of 60 m above MSL with the maximum elevation is 156 m above MSL.

B. Escarpments: - The plateau is bordered with escarpment generally covered with vegetation. There are many valleys originating on the periphery of the plateau along weak zones which are connected with storm water drains which are flowing along local depression on the plateau.

C. Foot hill region: - Early settlements (villages) are located on the gently sloping foot hill region, elevation of which ranges from 5.0 to 20 m above MSL. Width of the area ranges between 50 and 500 m.

D. Coastal plains and tidal flats: - Foothill regions are bordered either by coastal plain or tidal flats of the Zuari Creek. It is having flat topography. Coastal plains are predominantly used for paddy cultivation.

Major part of the plateau is drained towards Zuari creek in the north and part of the area is drained towards south to Sal river basin. Drainage density is very poor on the top of plateau due to occurrence of hard massive laterite cover on the surface. There are a many (minor) perennial streams flowing out of plateau. There are several water tanks (ponds) around the plateau where water is stored from October and used to irrigate second crop paddy. Generally Kharif paddy is being raised with in reservoir area.

1.4. CLIMATE AND RAINFALL:-

The climate of the area is warm and humid. The humidity during the monsoon period is high varying from 90 to 95 percent and for the rest of period of the year it ranges between 80 and 85 percent. Average minimum temperature in winter is 21.3^{o}C, and reaching only 24^{o}C in summer and the average maximum temperature reaches 32.2^{o}C in winter with a matching figure of 36.3^{o}C in summer. The area receives much of the precipitation mainly from south west monsoon between June and September (plate7).The average annual rainfall in the area is of the order of 2500 mm.

1.5 GENERAL GEOLOGY:-

Major Rock formations occurring in the State belong to Archean to Proterozoic in age. These rocks are classified under Goa Group of Dharwar Super group of rocks (Gokul et al. 1985) and consist of four Stratigraphic sequences namely the Barcem formation, Sanvordem formation, Bicholim formation and Vagheri formation with intrusive granites and basic rocks. Basalt of Deccan Trap does occur in a small area in the north eastern part of the state. Most of the rock units are covered with laterite. The rocks exposed in the study area belong to the Barcem and Sanvordem formations of Goa group.

1.6 STRATIGRAPHIC SETUP OF THE STUDY AREA:

Based on Geological mapping and soil samples collected during drilling for installation of piezometers,with correlation of maps published by Geological Survey of India, the Stratigraphic sequence of the study area has been worked out and given in table 1.

Table 1. Order of Superposition of Rock formations of study area.

Age	Geomorphic unit	Strata encountered
Recent to Sub recent	Coastal plain deposits	Silt, silty sand, Clayey sand
	Tidal flats	Clay and silt
	Laterite	Laterite sequence on plateau and foot hill region.
Sanvordem Formation	Plateau and Surrounding Villages	Meta-greywacke with lenses of tilloid
Barcem formation	Plateau and Surrounding Villages	Quartzite Quartz chlorite schist Meta-basalt

1.7 DURATION OF STUDY: - Three years starting from December 2009.

2. OBJECTIVES:

2.1.To evaluate impact of bore well pumping at Verna industrial estate located on table land, on water resources potential downstream (springs, ponds, lakes and open wells used for drinking, domestic and irrigation purposes) at the current level of ground water development (over 3700 cubic meter per day) with hydro geological approach.

2.2 To establish baseline information on water quality and hydro-chemical relations between aquifers.

2.3 To carry out pilot studies on rain water harvesting and artificial recharging of ground water.

2.4 To build up a scientific data base and conceptual model of the area to facilitate ground water modeling in future.

3. STUDY METHODOLOGY:

3.1. Studied aerial photographs to delineate different hydro-geomorphic setups of the study area. Limited field checks have been carried out in all the delineated hydro-geomorphic units.

3.2. Studied Geological exposures of rock formation in the study area.

3.3 Ground water levels in16 existing open wells (15 in the village and one on the plateau) and 8 piezometrs (one in village and 7 in Verna industrial estate) have been monitored every month since December 2009. Subsequently 4 bore wells constructed for conducting aquifer performance test and 6 Shallow piezometers constructed at topographically low areas on the plateau (industrial estate) have been included in the monitoring system since September 2011. Five piezometers are fitted with DWLR and real time data of 6 hourly intervals is being received since May 2012 through telemetric system. Details of ground water monitoring structures and and ground water levels monitored are given in annexure 1to 6.

3.4 Observation wells have been constructed at six locations at a distance of 20 m from existing bore wells and piezometers. Aquifer performance tests were conducted at 6 locations during May and first week of June 2011 with constant discharge of 9 to 12 cubic meter per hour for a duration of 1000 minutes (three log cycles) and data was analyzed with graphical methods and using Aquifer test Pro Software. Aquifer performance test data and summarized results are given in Annexure 7 and 8.

3.5 From the Lithological logs of piezometers / observation wells and geological correlation of rock exposures aquifer geometry has been worked out and presented.

3.6 Data on quantum of ground water being pumped from industries has been collected besides rainfall data from IMD. 192 bore wells and open well have been identified in Verna industrial estate by conducting participatory site inspection with villagers by works Division II (Annexure 9). Total ground water withdrawal as reported by industries is worked out to be over 3700 cubic meters per day.

3.7 Measuring devices have been installed across 05 streams and discharge has been measured since July 2010 till December 2012.

3.8 Ground water recharge studies have been carried out by constructing check dams; rainwater collection pits with infiltration shallow bore holes, and ground water recharge shafts (percolation pond). Infiltration test details are given in annexure 10. Awareness has been created among industries by conducting series of meetings about the need for ground water recharging. Technical guidance was given to some industries for construction of site specific ground water recharge structures.

3.9 Thirty five water samples from surface water, ground water and springs were collected and got analyzed to establish background information on water quality and hydro-chemical relation between aquifers (annexure 11).

3.10 Geographical position and nature of springs (geological contact) have been studied.

3.11 Elevation of springs, observation wells and piezometers have been established through differential GPS by outsourcing (annexure12).

3.12. Survey of India toposheet on 1:25000 of 1967 has been used to demarcate perennial springs and perennial streams in the study area.

4. DATA VALIDATION: -

Data collected are reliable as the same has been collected by persons holding responsible post. Data collected by technical assistants has been validated with general ground water level trend. Water quality data has been checked by ion balancing technique.

5. MAJOR OBSERVATIONS AND FINDINGS

5.1 Aquifer systems and Geometry in Plateau area (Verna industrial estate)

Aquifer system in Verna industrial area (Plateau) is unique. As usual there are two aquifers systems namely phreatic aquifer/water table aquifer/unconfined aquifer (the first aquifer) associated with mostly laterite and at places fractured rocks occurring at shallow level. Second aquifer (semi-confined aquifer) is associated with variety of fractured rocks.

First aquifer/unconfined aquifer is associated with hard laterite which covers entire plateau .The thickness of hard laterite is the order of 6 to 10 m

which is generally followed by clay. Ground water occurs under water table conditions in hard laterite at local depressions occurring at various elevations. Each local depression is independent from other. There are some open wells/filter points which are mostly used for domestic purposes besides one open well is used for industrial purpose. Near old Mardol temple and Veltolen ground water occurs under water table aquifer in fractured rock at anomalous position which is limited in area. Water table aquifers at Verna industrial estate are discontinuous therefore common water table contour map cannot be drawn. Ground water potential is also limited.

Second and most important aquifer in Vena industrial estate (plateau) is semi-confined aquifers where ground water occurrence and movement is controlled by secondary porosity (fractures and joints in hard rock). Semi-confined aquifers are heterogeneous and generally bounded by barrier boundary with relatively impervious strata at the edge of the plateau with clay or patches of massive rock. Semi-confined aquifers are discontinuous, isolated aquifer system. Semi-confined aquifers are covered by clay, silt sand with hard lateritic cap of 6 m to 10 m (overburden). Overburden thickness varies from 10 to 66 m. Two hydro geological cross sections (plate 8 and 9) depict aquifer geometry, elevation of piezometric head (pressure head) and position of semi-confined aquifers and water table of unconfined aquifer.

Salient features of semi-confined aquifers are listed in table below.

Features	Minimum	Maximum	Remark
Depth of aquifer formation below ground level	10 m	66 m	Predominantly 25 to 36 m. Area west of National Highway it is deeper.
Thickness of aquifer (fracture)	Few meters	20 m	
Elevation of top of aquifer	8.0 m below MSL	42.0 m above MSL	Predominantly above MSL
Depth of pressure head bgl (May 2013)	14.0 m	33 m	Predominantly within 18 m
Elevation of pressure head (May 2013)	33 m above MSL	110 m Above MSL	
Yield of bore wells	50 lpm	150 lpm	Average yield 100 lpm. Failure of bore well is rare.

5.1.1. Aquifer parameters: Aquifer performance test data was analyzed by using Theis Method, Theis recovery method, Cooper and Jacob method and Moenich fracture method. Charts of hydrograph and graphical method of some of the wells and Aquifer Test Pro software are presented in plates 10 A to 10Z. Summerised results are given in the annexure 8. Static water level ranges from 12.50 m to 21.50 m and pumping water level ranges between

29.09 m and 34.79 m with average discharge of 10 cubic meters per hour after 1000 minutes pumping. However near Karelab pumping water level has gone down to 54 m due to barrier boundary in the vicinity. In general the storage coefficient is the order of 0.0006 (observation well results has been taken as representative). The specific capacity of bore well ranges between 474 litre/h/m to 975 litre/h/m of drawdown. In unconfined aquifer specific capacity of the bore well in fractured rock is of the order of 2095 litre/h/m. Transmissivity of semi-confined aquifer ranges between 9.55 to 219 Sq m/day. Both the aquifers are regionally inter connected at a short distance of within 65 m as fractured rocks are occurring at very shallow level of 10 m below ground level at many locations. There are 192 bore wells and one open well that are drawing 1.26 million cubic meter of water per annum (over 3700 cubic meter water per day). Ground water pumped through bore wells gets recharged during monsoon, (up to September and occasionally up to October). Induced recharge from unconfined aquifer (laterite and sand/ silt, boulders and fractured quartzite) contributes bore well zone till end of January. Effective withdrawal of ground water in fractured rock starts from February to onset of next monsoon (10th June) for 130 days.

5.1.2 Ground Water recharge on the plateau: Ground water recharge takes place all over the plateau. Rain water gets infiltrated in cracks and joints through laterite which behaves like sponge and further reaches semi-confined aquifers. At places fractured rocks are occurring at shallow levels and are getting direct recharge from rain fall (6.0 m below ground level near Mardol temple, 10m below ground level in front of Bharti Duraline and Finolex industries could be cited as example). Rain water recharged on plateau is the main sources of water for springs and effluent seepage to streams emerging out of the plateau.

Extensive Paddy field covering about 30 Hectare (plate14) with soil cover and silt/sand formation underneath are the potential recharge area besides isolated patches. About 20 m thick sand, gravel and boulders occurring in the paddy field and adjoining areas, weathered quartzite having thickness of 50 m west of National High Way act as a storage house of ground water which are contributed to fracture system (semi-confined aquifer).

5.2 Aquifer System in village area: - Original settlements of Nagoa, Verna, Cansua, Rasaim and Cortalim are situated in foothill region of the plateau which range in elevation from 5.0 to 20 m above MSL. This region is generally separated by escarpments from the plateau and covered with detritus (secondary) laterite. Generally thickness of hard laterite is about 8.0 m which is followed by clay with depth. There are many drinking water wells in this region which tap unconfined aquifer in secondary laterite. Generally the depth of open wells and depth to ground water levels are shallow. Salient features are given in the table below.

Table 3 Details of open wells (observation wells) in village area.

Ranges			
Depth of open Wells in meters	Depth to Water Level May 2012	Depth to Water Level November 2012	Elevation of Water levels May 2012
3.50 to 9.09	1.94 m to 7.28 m	1.77 m to 6.08 m	0.01 m to 12.0 m

Depth of open wells and depth to ground water level are deeper close to foot hills and shallow towards paddy field and tidal flats.

Most of the open wells have partial penetration of aquifer and are sparingly used, as treated safe drinking water is supplied by PHE, PWD through pipe water supply scheme. Water table aquifer is limited in area from foot hill region to coastal plains or tidal flats (width varies from 50 m to 250 m). There is a zone of ground water seepage at the contact of coastal plain/Tidal flat with secondary laterite. Water table aquifer in village area is limited in area and depth (depth of clay below laterite) and it cannot support concentrated pumping. A detail of Open wells inventoried is given in the annexure 1 and a detail of wells inventoried in Nagoa village is given in annexure 13. This region receives direct recharge from rainfall.

Semi-confined aquifer associated with fractures and joints in hard rock generally occurs below the depth of 18.0 m which is mostly unutilized. There is only one bore well tapping this aquifer system and used for irrigation besides two piezometers one by WRD and another by CGWB constructed in this belt. Piezometric head of semi- confined aquifer is 9 m above MSL. Besides direct recharge from rainfall through laterite, at places it receives some recharge contribution from semi-confined aquifer from plateau area.

5.3 Ground Water Level trend:-

Ground water level trend of piezometric surface presented in plates 21A to 21G indicates that semi-confined aquifer also resonates with rainfall and gets fully recharged naturally during monsoon by 15th July with about 1000 mm rainfall. Ground water level sharply declines by November due to migration and there after decline is gentle. Marginal variation in summer water levels is due to little change in rainfall pattern. October rain (post monsoon rain) and pre-monsoon showers plays decisive role in summer ground water level. Declining trend of ground water levels in piezometers located near Karelab (plate 21F) is due to formation of ground water trough as there could be service bore well in the vicinity. Similar phenomena could be seen around Cocacola sump (Plate 22B) but the system gets fully recharged during monsoon. Building up of water levels seen in plates 21A, 21B, 21E and 22A is due to effect of artificial ground water recharge. Hydrograph of piezometer (Plate 21H) prepared from DWLR readings indicates aquifer response due to heavy rain fall and rejection of excessive

recharge in short period besides sharp decline of ground water level in February. Effect of multiple filling of ground water recharge structure, check dams could be seen in plate 21I.

Plate 23 depicts the ground water level trend in shallow piezometers tapping laterite on plateau (local depressions) which also indicates ground water gets fully recharged by June and migration of most of the recharged water by October end.

Ground water level trend in village open wells presented in plates 24A to 24M does not show any declining trend of ground water level. Marginal variations of summer water level in open wells are generally due to change in rainfall pattern. Post monsoon rain during October and pre-monsoon rain has great influence on availability of water in open wells in summer. Declining trend of ground water level seen on plate 24L and24D is due to impact of local pumping from water table aquifer. More or less constant ground water table from November to May in open well located at Amlor (plate 24L) is due to the influence of water stored in Verna Tank.

5.4 Inter relations of aquifer system: - Generally unconfined aquifer (detritus laterite) tapped by open wells is separated from plateau by escarpment. There is no hydraulic continuity between the laterite occurring at higher elevation on the plateau and detritus laterite occurring in the village area. However in the valley areas water flowing in the stream has got some influence on the water table of open well zone in the vicinity.

Semi-confined aquifer in village area may receive marginal contribution from semi-confined aquifer of the plateau area. Piezometric surface of semi-confined aquifer is much higher than village area. Effluent seepage in stream (dry weather flow in stream) is contributed by semi-confined aquifer of the plateau area.

Within plateau, unconfined aquifer (water in laterite) and semi-confined aquifer (water in fractured rock) are regionally inter connected. Ground water pumped by 192 bore wells are getting recharged during monsoon (up to September, occasionally up to October)

5.4 Springs:

There are basically two types of springs. Gravity springs within the Plateau and contact springs emerging out of plateau at the apex of the valley.

5.4.1 Gravity springs;-

Several Gravity springs are emerging out within the plateau at various elevations from hard laterite. Such springs are located at

1. Valley areas near Raheja industries(Plate),

2. Near small temple near rear gate of Cipla Industries(plate)

3. Valley area in front of Bets India Ltd and Pond upstream of Kesarwal spring (plate) and at Veltolen.

Spring water flows along the drainage line for some distance and re-enter ground and contributes to contact springs. Some of the spring water was used for cultivating second crop paddy. Reduction of ground water recharge area due to construction of industrial sheds/pavements and ground water pumping has resulted in drying of these springs immediately after monsoon.

5.4.2 Contact Springs:-

Contacts springs (see plate 11 and12) are emerging at the contact of laterite sequence and fractured hard rock. There are several springs emerging at the apex of valleys all around the plateau where topography is cutting ground water table, besides numerous small springs and seepages occurring at various places all along valley either from wall or at the bottom. Springs emerging at the apex of valley are getting contribution from semi-confined aquifer as well as from the interflow occurring in laterite clay contacts. Wide variation in the elevation of spring which could be seen from the table 4.

Table 4 Elevations of Various Springs in study area.

Sl.No	Name of spring	Elevation above MSL	Remark
1.	Kesarval spring	29.70 m	Seasonal at the contact of schistose rock
2	Palton spring	32.238 m	It was perennial spring At the contact of Schist
3	Udo spring	40.0 m	Seasonal at the contact of jointed and weathered Quartzite
4	Rasaim Spring 1	10.0 m	Seasanal
5	Rasaim Spring 2	60.0 m	Seasonal at the contact of Metagreywake
	Rasaim 3	65.0 m	At the contact of Schist.
6	Karvate Spring	60.0 m	Seasonal at the contact of Metagreywake
7	Lotlim Spring	16.0 m	Seasonal Laterite and soil
8	Veltolem	58.0 m	It was Perennial

Generally discharge of springs considerably dwindles towards summer and the flow becomes meager. Out of the above referred springs only two springs one at Veltolen and another at Palton are shown as perennial in Survey of India toposheet 1967. Flows of perennial springs at Veltolen and Palton in Nagoa village are drying by February due to ground water pumping in the

Verna industrial estate. Streams in Kelosim valley, Nagoa area, Veltolem valley, Udo valley, Rasim and Karvate valley are shown as perennial.

Initial stretch of stream at Palton (Nagoa) is drying in December due to drying of spring and transporting and selling of water from one open well at the rate of over 100 cubic meter water per day. It is also reported that there is shortage of water for areca nut cultivation in two valley areas namely Kesarval valley and Rasaim valley (two hectare each).

Discharge of stream measured at two locations are given in the table below

Table 6 Stream discharge data

(Discharge measuring device is shown at plate 27)

Average discharge in cubic meter per day in Stream contributing to Kelossim tank and one of the tributaries of Verna Tank flowing from Udo spring.

Month	Kelosim Stream			Downstream of Udo Spring		
	2010	2011	2012	2010	2011	2012
July	51840	40944	34555	23121	22388	18154
August	27735	49337	41205	14662	31320	15604
September	27440	35257	40289	9134	10987	8765
October	16374	8893	9050	7482	1710	4678
November	8676	5046	2538	2704	NA	NA
December	5478	5046	2000	N.M	N.M	NM
January	About 300	About 300	About 300	N.M	N.M	N.M

5.5 Tanks

There are many tanks where water is stored after September for second crop paddy. During monsoon Kharif paddy is being raised in reservoir area. Source of water to these traditional tanks is post-monsoon rain, spring water, natural seepage in stream and seepage of ground water directly into the tank. Details of tanks located in the vicinity of study area given in table 5 below.

Table 5 Details of Tanks in and around the study area.

Sr.No	Name of Tank/Pond	Command area	Remark
1	Kelosim tank	20Hectare	Shortage of water not felt so far
2	Verna tank and bunds downstream	81 hectare	
3	Natal tank	56 hectare	
4	Lotlium tank	25 hectare	
5.	Cansua tank	Not available	

Out of these four tanks, tank at Kelossim is fully under the influence of ground water systems of Verna Industrial Estate and Tanks at Cansua and Verna (Amlore) receives partial contribution from aquifer systems of Verna industrial estate. Verna tank and Kelosim Tanks are shown on plate 25 and 26.

Tanks are normally closed to store water during late September. So far late monsoon discharge has been sufficient for existing irrigation (shortage for irrigation water is not reported so far).

5.6 ARTIFICIAL GROUND WATER RECHARGE STUDIES:-

Artificial ground water studies has been conducted by constructing check dams at three locations across monsoon drain, stilling basin with infiltration bore holes at 3 locations (work is in progress at two more locations). Percolation tank (ground water recharge shaft) has been constructed across monsoon drain located downstream of 30 hectare paddy field. Details of ground water structures constructed are given in annexure 14. A result of infiltration study conducted is given in annexure 10 and recharge structures are shown in plates 16 A to 16 C and 17. Technical guidance was given to industries for construction of ground water recharge shaft and direct recharging of deeper aquifer through bore wells and annular space of bore wells by harvesting and filtering rooftop water. Artificial ground water structures have been funded by WRD under Hydrology Project, GIDC, Department of Science & Technology and Goa State Pollution Control Board besides private initiatives by industries.

Infiltration capacity of hard laterite is heterogeneous which is generally at the order of 1.2 cm per day and along the drainage courses joints in laterite and in local depressions, which favors more infiltration. Once water reaches next layer below hard laterite water moves faster in contact zone and silt, sand formation underneath and reaches deeper aquifer. With this background recharge studies have been carried out and the findings are as under. Infiltration Capacity of shallow infiltration bore holes tested at site (Table…) varied between 20 and 30 lpm (Considering average of 25 lpm each infiltration bore hole can infiltrate at the rate of 36 cubic meter per day) in dry condition (when tested during pre-monsoon period). It could reduce on saturation. During initial rains stilling basins with infiltration bore holes have not over flown.

Collective efforts made by all referred agencies in construction of artificial recharge structures have shown positive results. There is 4.00 m rise in ground water level near percolation pond and one meter near kare lab located at a distance of 150 m. Rejuvenation of dry nallah leading to Kesarwal spring and marginal rejuvenation of Kesarwal spring could be observed (plates 18 to 19). Despite good rainfall during October 2010 the nallah leading to Kesarwal spring was dry during December 2010. Ground

water recharge pond (shaft) was constructed before onset of the monsoon 2012. Flow in the said nallah could be seen during December 2012 though there was paucity of rain during late monsoon October 2012. Little flow in the nallah is observed on first week of March 2013. Little flow in Kesarwal spring is also observed on first week of March 2013 which was drying earlier (plate 20).

Ground water levels have built up by one meter around GIDC office due to check dams. Throughout the monsoon ground water level remains about 3 m above normal monsoon level (Plate 21I) due to ground water recharge measures. Reversal of declining trend of ground water levels could be seen in piezometer located at western side of National High way (plate21F) due to transmission of ground water from water table aquifer to deeper aquifer through annular space of two bore holes drilled for pumping test besides ground water recharge structures constructed by industries.

Ground water recharge structures (check dams) constructed in the capture zone of Palton spring (across monsoon drain near GIDC office) has built up ground water levels above normal monsoon critical level. Additional water recharged from check dams gets drained out by January as before. However there is marginal increase in pre-monsoon ground water levels and marginal improvement in the flow of spring where water could be seen flowing on first week of March 2013. In such areas ground water recharge structures are beneficial to enhance water availability in pre-monsoon period and catching late rains (post monsoon rain in October) and unseasonal rains and pre-monsoon showers effectively. Improvement on discharge of spring is marginal. As ground water velocity is generally very low, manifestation of effect of artificial ground water recharge in the flow of springs may take some more time. There is marginal increase in summer water level of water selling well at Nagoa despite heavy pumping.

Sustainable yield of bore wells around coca-cola sump and its vicinity and fast full recovery of ground water levels with few showers during monsoon 2013 is due to ground water recharge structures constructed near Sonafa-Aventies.

5.7 Water Quality

Water samples were collected from 35 locations out of which 15 are from open wells, 10 from bore wells and 10 samples from surface water (springs and streams) and got it analyzed (annexure 11). Chemical quality of water from all the 35 samples is well within permissible range for domestic, irrigation and industrial purposes. However pH of open well water is low at the order of 5.0 to 5.8 (generally pH of open well water is low in Goa State).

Total Coli form bacteria could be observed in all open well samples which range from 45 to 225 MPN. And in surface water samples Total Coli form ranges from 150 to 225 MPN.

Hydro chemical classification of water with Hill-Pipper Diagram suggests that Ground water from open wells in the village area is Sodium bicarbonate type (NaHco3) where as 90 percent of bore well water samples are of Sodium bicarbonate type and 10 percent is Sodium chloride-Sulphate type (Na-Cl-So4).

It could be seen in the comparative statement given below that bore well water in the industrial estate is more mineralized than open well water in the village area.

Table 7.Comparative statement of Water quality parameters of Bore well water with open well water.

Water Quality Parameters	Bore Well Samples Range of concentration	Open Well samples (Village) Range of Concentration
Ph	6.6 to 8.0	5.0 to 5.80
Total Dissolved Solid ppm	92.0 to 316	36.0 to 128.0
Total Hardness as Caco3 ppm	61.0 to 195	7.0 to 43.0
EC micro mhos/Cm	136 to 490	58.0 to 115
SAR	0.30 to 0.64	0.55 to 1.55
SiO2 ppm	Predominantly 30 to 35	0.0 to 1.00

Resident time of water in Semi-confined aquifer (bore well zone) is more than that of water table aquifer in the village. Low pH and low mineralization in water table aquifer is due to heavy leaching during monsoon as village area is directly recharged during monsoon.

5.8. Problems of salt water intrusion:

It is generally believed that over exploitation of ground water may lead to salt water intrusion in coastal areas. Aquifer system in Verna industrial estate located on plateau is isolated and piezometric head (ground water level) ranges from 33.0 to 110 m above MSL during pre-monsoon 2013. Elevation of pumping water level in summer after continuous pumping of 1000 minutes in test wells ranges from 16.0 m at Karelab to 59 m at Mardol temple. Therefore possibility of salt water intrusion to the aquifer system from nearby creek is ruled out. In village area deeper Semi-confined aquifer is totally unutilized except one bore well drilled by the department for irrigation.

6. CONCLUSIONS

6.1. Drinking water wells located in the villages of Nagoa, Verna, Cansua, and Cortalim are not affected due to withdrawal of ground water in the industrial estate. Marginal variation in pre-monsoon ground water levels in different years are due to change in rainfall pattern and local use of ground water. Rainfall beyond September (non-monsoon rainfall) and pre-monsoon showers has great bearing on availability of water in open wells during summer. Water table aquifer in village area (open well zone) is limited in area and depth. Pumping and transporting of ground water beyond January from open wells located in village area may reduce availability of water in the vicinity. Deeper aquifer occurring below 18.00 to 20.0 m in village area is totally untapped.

6.2. Gravity springs on plateau (Verna industrial estate) are drying mostly due to reduction of ground water recharge area by construction of industrial sheds and pavements. Contact springs emerging out of the plateau are drying early at the current rate of pumping (over 3700 cubic meter water per day) in the industrial estate. Even perennial springs are drying up by end of December. Initial stretch of perennial nallah flowing from Palton spring is drying up in November due to early drying of the Palton spring and selling of water (exporting of water by tanker) from one open well located by the side of nallah.

6.3. Ground water recharge opportunity is very high and the ground water pumped out by bore wells in industrial estate is fully recharged during monsoon. Total ground water withdrawal in Verna industrial estate is well within ground water recharge opportunity. Therefore it cannot be termed as over exploitation of ground water. Nevertheless lowering of ground water level due to withdrawal in the industrial estate is creating environmental imbalance like early drying of springs, reducing effluent seepage of ground water to streams and paucity of moisture for the vegetation along valleys and escarpments.

6.4 As reported by Works Division II, WRD, that at present there is no shortage of water for irrigation from tanks located at Verna, Cansua and Kelossim.

6.5. Possibilities of salt water intrusion from nearby creek are ruled out.

6.6. Artificial Ground water recharge measures taken up in plateau area have shown positive results. Ground water levels have been built up by 1 to 4 m at some locations during pre-monsoon 2013 (in the vicinity of percolation pond) and reversal declining trend ground water levels could be seen in some areas, besides marginal improvement of flow in some of the nullahs and springs.

6.7. Chemical quality of ground water in bore well zone in the industrial estate (plateau area) is different from open well zone in village area. Bore well water is more mineralized than open water in village areas. Silica concentration is 1.0 ppm to Nil in open well water when compared to 30 to 35 ppm in bore well water. pH value of open well water is low which ranges from 5.0 to 5.8. Hydro-chemical relation between bore well zone in plateau area and open well zone in village area is poor.

7. KEY RECOMMENDATIONS:-

7.1. It is desirable to augment industrial water supply from surface water resources as projected future water requirement is the order of 10,000 cubic meters per day. Already water supply has been augmented from surface water (Salauli Canal).

7.2. Usage of ground water and rainwater (roof water harvesting) for industrial purpose during monsoon may lead to conservation of energy.

7.3. Ground water could be used to mitigate shortage of water during breakdowns of surface water supply by using existing bore wells.

7.4. As water supply has been augmented with untreated surface water, each industry could be permitted to have one bore well for domestic and drinking purpose.

7.5 Rain water harvesting and ground water recharging in industrial estates located on plateau area may have to be made mandatory. (Already it has been made mandatory for the industries going for expansion and new industries).

7.6 Natural potential ground water recharge area (monsoon Paddy field located covering about 30 hectare on Verna Plateau) is to be protected from filling and construction.

7.7 Two more percolation tanks one at upstream of Kesarwal spring and another in the valley area around Raheja Industries may be required to rejuvenate springs and augment water requirement of areca nut garden downstream.

7.8. Pumping and transporting of ground water from open wells located around Vena industrial estate.

7.9 Rainwater harvesting and recharging ground water in plateau areas could be used as one of the ground water management option even in high rainfall areas rainfall like Goa and Konkan belt, which are falling under Western Zone Agro Climatic region.

7.10 Micro level hydro geological studies are needed before setting up new industrial estates and monitoring of ground water levels and water quality is to be continued.

7.11. Better relationship could be established between rainfall pattern and ground water level trend in various aquifers by establishing rain gauge station at Verna industrial estate as observation wells already exist at close interval.

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Senior Hydrogeologist, WRD

Place: Alto Porvorim
Date: 31.10.2013

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ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project.

Village: Consua Well NO: OW 1

Wado: Near Maruti Temple, about 700m North East of Consua tank

Owner of well: Mr. Barbosa

Coordinate: Latitude: 15° 22'22" Longitude: 73° 55' 33"

Location: By the side of house of Gaonkar and by the side of road about 90m from Maruti temple.
Maruti temple is located about 600m from Consua-Nagoa road. Road to Maruti temple bifurcates from Consua-Nagoa road eastern-side of Consua tank.

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
1.48*1.52	0.85	5.00	2.55	Domestic	Manual

Depth of lining: Full depth Nature of lining: Laterite

Description of MP: Southern side (opposite to pulley) on the top of parapet.

Geology: Latertic soil representing valley area

RL of MP: 16.564 RL of ground level: 15.714

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project.

Village: Consua Well No: OW 2

Wado: Pipalwado

Owner of well: Mr. Agnelo Fenandes

Coordinate: Latitude: 15° 21' 83" Longitude: 73° 55' 02"

Location: By the side of Consua-Nagoa road near the house (God's Gift) of the owner.

Details of well date of inventory: 08-12-2009

Dia in m	Mp(m agl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
3.7*3.05	0.75	8.40	5.65	Domestic and gardening	manual

Depth of lining: 4.0m bmp Nature of lining: Laterite

Description of MP: Top of parapet (Road side)

Geology: Lateritic soil followed by laterite with Quartz vein (with depth).

RL of MP: 14.158 RL of ground level: 13.408

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project.

Village: Nagoa Well No: OW3

Wad: Majil Wado

Owner of well: Mr.Godwin Perreira

Coordinate: Latitude: 15° 21' 49" Longitude: 73° 55' 33"

Location: In front of cow shed and near Tomacin Silva house. It is about 70m South of Nagoa-Consua road. kuccha road bifurcates 100m west of Y Junction on Nagoa- Consua road.

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.8*2.30	0.70	8.20	5.47	domestic	Manual and pump

Depth of lining; 1.90m bmp Nature of lining: laterite

Description of MP: Southern side on top of parapet

Geology…Soil followed by hard laterite (with depth).

RL of MP:12.298 RL of ground level: 11.598

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW4

Wado: Castle wado

Owner of well: Mr. Joajinho Cabral

Coordinate: Latitude: 15º 21' 547" Longitude: 73º 55' 821"

Location: 50m behind Juhi stores, besides the house of the owner of the well. Approachable by Nagoa - Castle wado road below the bridge of NH17.

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
3.60*3.0	0.90	6.20	4.25	domestic	Manual and pump

Depth of lining: 2.5m bmp Nature of lining: laterite

Description of MP: Southern side on top of parapet.

Geology…Soil followed by hard gravelly laterite (with depth).

RL of MP: 15.277 RL of ground level: 14.377

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW5

Wado: Castle wado

Owner of well: Mr. Antony Luis Cruz

Coordinate: Latitude: 15° 21' 89" Longitude: 73° 55' 85"

Location: By the side of the house of owner. Well used for filling tanker. End of tar road on the way to Palton spring.

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
3.12*2.28	0.80	6.97	2.97	Domestic and selling water by tanker	Centrifugal pump(5HP)

Depth of lining; 2.10m bmp Nature of lining: laterite

Description of MP: Northern side on top of parapet.

Geology: Soil followed by hard laterite (with depth). At the bottom of well metabasalt.

RL of MP: 15.683 RL of ground level: 14.883

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW6

Wado: Castle wado

Owner of well: Lodovino Colaco

Coordinate: Latitude: 15º 21' 66" Longitude: 73º 65' 89"

Location: In front of the house of Lodovina Colaco, behind the house of Peter Colaco.
Approachable by path by the side of cross on Nagoa- Castle wado-Verna V.P. road, opposite T junction of the road leading to Ganpati Devasthan.

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.25*2.40	0.81	4.85	3.12	Domestic	Manual

Depth of lining: 3.60m bmp Nature of lining: laterite

Description of MP: Southern side on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP:13.595 RL of ground level:12.795

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW 7

Wado: Kumbardo

Owner of well: Public well

Coordinate: Latitude: Longitude:

Location: In front of the house of Anthony Braganza.
Approachable by old NH17 at Verna. First bifurcating road near chapel adjacent to field about 80m west of V.P. Verna.70m east on the Third bifurcation(see sketch).

Details of well Date of inventory: 01-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.32*2.40	0.80	8.35	6.30	Domestic	Manual

Depth of lining; 6.0m bmp Nature of lining: laterite

Description of MP: Southern side on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 14.661 RL of ground level: 13.861

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW8

Wado: Purye Bhat

Owner of well: Public well

Coordinate: Latitude: 15° 20' 99" Longitude: 73° 56' 20"

Location: In front of the house of Remeto F. Gama.

Approachable by Verna –Loutulim road bifurcation of old NH17 at Verna Church. About 1.0Km from old NH17.

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.50*2.80	0.70	5.27	4.05	Domestic	Manual& Pump

Depth of lining: 2.45m bmp Nature of lining: laterite

Description of MP: Northern side on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 12.561 RL of ground level: 11.861

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Verna Well No: OW9

Wado: Purye Bhat

Owner of well: Carolina Pinho

Coordinate: Latitude: 15º 21' 07" Longitude: 73º 56' 31"

Location: By the side of the house of Rosario D"mello

Approachable by Verna –Loutulim road, bifurcation of old NH17 at Verna Church. At T junction of road leading to Purye Bhat chapel

Details of well Date of inventory: 08-12-2009

Dia (in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.00	0.71	4.97	2.99	Domestic &Agriculture	Manual

Depth of lining; 4.18m bmp Nature of lining: laterite

Description of MP: Northern side (pulley) on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 13.502 RL of ground level:12.792

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Ambora Well No:OW10

Wado: Kajre Bhat(after Udo spring)

Owner of well: Panchayat

Coordinate: Latitude: 15° 20' 72" Longitude: 73° 56' 61"

Location: 50m behind the shop of Mr.Peter, by the side of Mr. Juje Vaz Xavier's house.

Approachable by Verna –Loutulim road a bifurcation of old NH17 at Verna Church.A diversion at T junction leading to Purye Bhat chapel-Verna tank Udo spring road. A bifurcation to the later leading to Kajre Bhat

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
3.75	0.80	6.50	5.05	Domestic	Manual

Depth of lining: Full depth Nature of lining: laterite

Description of MP: Southern side on the top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 17.752 RL of ground level:16.952

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Old Mardol, Verna Well No: OW11

Wado: Mhalsa temple wado

Owner of well: Temple trust

Coordinate: Latitude: Longitude:

Location: By the side of Mhalsa temple in the garden compound. Approach road starts from Verna Police Station, leding to old mardol temple.(police station located on old NH17 about 100m north of Verna Church).

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.5	0.65	7.50	4.02	Domestic& gardening	Manual & Pump

Depth of lining: 3.90m? bmp Nature of lining: laterite

Description of MP: Northern side, on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 67.994 RL of ground level: 67.344

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Karvota Racaim Well No: OW12

Wado: Karvota

Owner of well: Chapel trust

Coordinate: Latitude: 15° 21' 40" Longitude: 73° 58' 39"

Location: By the side of Our Lady of Rosario Chapel.

Approachable by Cortalim- Loutulim road.

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.48 *2.0	0.90	9.00	5.60	Domestic	Manual

Depth of lining; 2.45m bmp Nature of lining: laterite

Description of MP: Southern side, on top of parapet.

Geology…Soil followed by hard laterite (with depth).

RL of MP: 7.383 RL of ground level: 6.483

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Racaim Well No: OW13

Wado: St Joseph Chapel wado

Owner of well: Panchayat.

Coordinate: Latitude: 15º 22' 13" Longitude: 73º57' 25"

Location: By the side of the tar path from dead end of road leading to St Joseph Chapel, near the house of Mr. Vishnudas Gaonkar.
Approachable by Cortalim- Loutulim road,a bifurcation opposite Chowgule Ship Building.

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.4	0.85(from platform)	7.40	3.35	Not in use	Manual

Depth of lining: 1.75m bmp Nature of lining: laterite

Description of MP: Northern side, on top of parapet.

Geology: Soil followed by hard laterite (with depth).

RL of MP: 6.349 RL of ground level: 5.499

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Kelossim Well No: OW14

Wado: Velo wado

Owner of well: Anand Bandekar.

Coordinate: Latitude: 15º 23' 21" Longitude: 73º 55' 93"

Location: About 30m east of Mr. Cosme Lucas'es house, by the side of the road leading to Peli Hadi, a bifurcation on road leading to Kelossim from NH17 100m north of road leading to Keserval spring.(At the apex of Kelossim tank)

Approachable by Cortalim- Loutulim road and by a bifurcation on NH17 100m north of road leading to Keserval spring.

Details of well Date of inventory: 08-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
1.20*1.20	0.10	3.50	1.60	Domestic	Manual

Depth of lining: Full depth Nature of lining: laterite

Description of MP: Northern side, on top of parapet.

Geology: Lateric soil representing valley area

RL of MP: 6.07 RL of ground level: 5.97

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Loutulim Well No: OW15

Wado: Karvota

Owner of well: Xevier Pimenta.

Coordinate: Latitude: Longitude:

Location: Behind Mr Xavier Pimenta's house, about 40m south of road leading to shanti Avedana Ashram.
Approachable by Cortalim- Loutulim road and by a bifurcation on the road leading to Devhoti west of bus shelter.

Details of well Date of inventory: 17-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
2.04*2.0	0.75	6.84	5.65	Domestic	Manual

Depth of lining: 4.54m bmp Nature of lining: laterite

Description of MP: Northern side, on top of parapet.

Geology: Lateritic soil followed by laterite.

RL of MP: 8.634 RL of ground level: 7.884

ANNEXURE 1

Basic data of open wells monitored under purpose driven studies of Hydrology Project

Village: Loutulim Well No: OW16

Wado: Karmala, Devhoti

Owner of well: Mr. Lucien

Coordinate: Latitude: Longitude:

Location: Infrant of Mr. Shamba Naik's house, about 100east of Verna-Loutulim road at Devhoti.

Approachable by Verna-Loutulim road, in the eastern foot hill region after crossing plateau and it's slope.

Details of well Date of inventory: 17-12-2009

Dia(in m)	Mp(magl)	Depth bmp (in m)	DTW bmp (in m)	Use	Lift
4.0	0.25	7.20	3.24	Domestic	Manual

Depth of lining: 2.65m bmp Nature of lining: laterite

Description of MP: Southern side.

Geology: Lateric soil followed by laterite.

RL of MP: 16.252 RL of ground level: 16.002

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of Piezometer drilled for Monitoring Ground Water Levels
And aquifer geometry of the area.

Location of Bore well: south west corner of GIDC office

Observation Well No: **VP 1** Date of Drilling: 11-06-2008

Co-ordinate: Lat 15° 22' 8.951" N Long 73° 56' 4.023" E

RL of measuring point: 67.464

Depth of Bore well : 75m Depth of casing pipe: 26.5m

Drilling time Yield: 240 l/pm SWL 9.91m bmp on 29-07-2008

Aquifer: semi confined (fractured rock) M.P. 0.43m agl

Geomorphic setup: Plateau

Litho logical log

Depth in m	Strata Encountered	Water zone
00 to 09 m	Hard crust laterite dark brown color	
09 to 20m	Soft laterite followed by Clay whitish pink limonitic	
20 to 25m	Highly weathered rock Quartz Chlorite Schist	
25 to 36m	Quartz Chlorite Schist hard massive	
36 to 5om	Quartz Chlorite Schist jointed with quartz vein	Aquifer zone
50 to 75m	Chlorite Schist hard with quartz vein at places	

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of Peezometrs drilled for Monitoring Ground Water Levels
And aquifer geometry of the area.

Location; Opposite to Reynolds Show room next to Lupin

Observation well No; **VP 2** Date of Drilling; October 2009

Co-ordinate: Latitude: 15°21'59" Longitude: 73°55'23"

RL of measuring point: 57.863

Depth of Bore well : 60m Depth of casing pipe: 42m

Drilling time Yield: 60 lpm SWL: 27.42m bmp on 16-11-09

Aquifer: semi confined (fractured rock) M.P: 0.46m agl

Geomorphic setup: Plateau

Litho logical log

Depth in m	Strata Encountered	Water zone
00 to 10m	Hard crust laterite	
10 to 20m	Clay brownish pink colour	
20 to 35m	Silty clay brown	
35 to 40m	Gravel with silt and sand particles angular	
40 to 60m	moderately hard schist blackish brown colour	50 to 55

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of Piezometer drilled for monitoring ground water levels
And aquifer geometry

Location of Bore well: Opposite to Kare Lab

Observation Well No: VP3 Date of Drilling: October 2009

Co-ordinate: Latitude: 15°22'37.25" Longitude: 73°55'54"

RL of measuring point: 66.89

Depth of Bore well : 45m Depth of casing pipe: 32m

Drilling time Yield: 120 lpm SWL: 16.48 m bmp on 16-11-09

Aquifer: semi confined (fractured rock) M.P. 0.40m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10m	Laterite hard brown colour hard crust laterite	
10 to 20m	Clay whitish pink colour	
20 to 25m	Sandy clay with quartz gravel and pebble	
25 to 30m	Quartz pebbles with round faces	
30 to 35m	Quartz Chlorite Schist with vein quartz	Water zone
35 to 45m	Quartz Chlorite Schist Highly jointed	Water zone
Remark	Drilling terminated due to drilling problem.	

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of Piezometer drilled for monitoring ground water levels
And aquifer geometry of the area.

Location of Bore well; Opposite to BPCL

Observation Well No: VP4 Date of Drilling; October 2009

Co-ordinate: Latitude: 15°22'31" Longitude: 73°56'54"

RL of measuring point: 94.229

Depth of Bore well: 80 m Depth of casing pipe: 32m

Drilling time Yield: 60 lpm SWL: 11.51m bmp on 16-11-09

Aquifer: semi confined (fractured rock) M.P 0.56 m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10m	Laterite hard redish brown colour	
10 to 30m	Soft laterite, silt, clay	
30 to 35m	Quartz, chlorite schist jointed	
35 to 45m	Quartz chlorite schist with vein quartz	
45 to 70m	Schistose metabasalt	Water zone
70 to 80m	Meta- basalt	

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate

Details of Piezometer drilled for monitoring ground water levels.

Location of Bore well: Near Over Head Tank

Observation well No: VP 5 Date of Drilling: October 2009

Co-ordinate: Latitude: 15°21'22.24" Longitude: 73°51'10"

RL of measuring point:132.431

Depth of Bore well: 120m Depth of casing pipe: 48m

Drilling time Yield: lpm SWL: 16.04 m bmp on 16-11-09

Aquifer: semi confined (fractured rock) M.P 0.56 m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10m	Laterite hard brown colour	
10 to 30m	Clay whitish pink colour	
30 to 40m	Silty clay brown	
40 to 45m	Silt with sand and gravel	
45 to 50m	Highly weathered rock	
50 to 65m	moderately hard schist blackish brown colour	Water zone met at 65m
65 to 105m	Schist blackish brown colour hard rock	

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of Piezometer drilled for monitoring ground water levels
And aquifer geometry of the area.

Location : Near Eastern Boundary (after Raheja Industries)

Observation Well No: VP6 Date of Drilling: October 2009

Co-ordinate: Latitude: 15°20'525" Longitude: 73°58'7.43"

RL of measuring point: 105.396

Depth of Bore well: 60m Depth of casing pipe: 51 m

Drilling time Yield: lpm SWL: 9.82 m bmp on 16-11-09

Aquifer: semi confined (fractured rock) MP 0.60 m agl

Geomorphic setup; Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 6 m	Laterite hard brown colour Hard crust laterite	
6 to 15m	Laterite soft brown colour	
15 to 30m	clay brownish pink	
30 to 40m	Clay with sand and gravel	
40 to 45m	Gravel laterite quartz angular.	
45 to 50m	Weathered rock cement coloured	
50 to 60m	Schist hard rock black colour	Water zone

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of bore wells drilled for monitoring ground water Levels and aquifer geometry of the area.

Location: 20m East of Piezometer behind GIDC office

Observation Well No: VP7 Date of Drilling: October 2009

Co-ordinate: Latitude: 15°22'09" Longitude: 73°56'5"

RL of measuring point: 68.101

Depth of Bore well: 45 m Depth of casing pipe: 26m

Drilling time Yield: lpm SWL: 15.3 m bmp on 16-11-09

Aquifer: semi confined (fractured rock) M.P 0.45 m agl

Geomorphic setup: Plateau

Litho logical log

Depth in m	Strata Encountered	Water zone
00 to 10m	Laterite hard brown colourHard crust laterite	
10 to 20m	Clay yellow limonite	
20m to 25m	Schist Quartz Chlorite highly jointed, joints filled with limonite (Partial filling.)	
25 to 45m	Fractured Hard rock quartz chlorite schist	

ANNEXURE 2

Purpose Driven Studies Verna Industrial Estate
Details of bore wells drilled for monitoring ground water Levels
and aquifer geometry of the area.

Location: Near V.P. Office Verna

Observation Well No: VP8 Date of Drilling: ……. 2009

Coordinate: Latitude: 73°55'51" Longitude: 15°21'15.2"

RL of measuring point: 19.348

Depth of Bore well: 60 m Depth of casing pipe: 20m

Drilling time Yield: 20 lpm SWL: 10.75 m bmp on 23.01.2009

Aquifer: semi confined (fractured rock) M.P 0.45 m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10m	Laterite hard brown colour	
10 to 20m	Silt clay yellow	
20m to 22m	Weathered metabasalt	Water zone
22 to 60m	Meta-basalt	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate
Details of bore well drilled for conducting aquifer performance test
And aquifer geometry of the area

Location of Bore well; Lupin Garden West of National High way (Northern side well)

Pumping Well No: **PT1** Date of Drilling: 13-03-2011

Co-ordinate: Latitude 73°55'34" Longitude 15°21'58.18"

RL of measuring point: 51.988

Depth of Bore well : 90m Depth of casing pipe; 62m

Drilling time Yield: 240 lpm SWL: 12.50 m bmp on 20.5.2011

Aquifer: semi confined (fractured rock) M.P:0.4 m agl

Geomorphic setup; Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10 m	Hard crust laterite dark brown colour	
10 to 35m	Clay and silt highly weathered quartzite friable	
35 to 60m	Banded ferruginous Quartzite highly weathered friable	
60 to 70m	Quartz Chlorite Schist	aquifer
70. to 90m	Met basalt hard massive	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate
Details of bore well drilled for conducting aquifer performance test and aquifer geometry of the area.

Location of Bore well: Lupin Garden West of National High way (Southern side well)

Pumping Well No: **PT** 2 Date of Drilling: 06.03.2011

Coordinate: longitude: 73^0 55'33" Latitude: $15^0$21'57"

RL of measuring point: 51.502

Depth of Bore well: 70m Depth of casing pipe: 43m

PVC pipe with slots from 50 to 70m

Drilling time Yield: 240 lpm SWL: 6.49 m bmp on20.07.2011.

Aquifer: semi confined (fractured rock) M.P: 0.46.m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10 m	Hard crust laterite dark brown colour	
10 to 35m	Clay and silt highly weathered quartzite friable	
35 to 60m	Banded ferruginous Quartzite highly weathered friable	
60 to 69m	Quartz Chlorite Schist	aquifer
69. to 70m	Meta basalt hard massive	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate

Details of bore well drilled for conducting aquifer performance test

And aquifer geometry of the area

Location of Bore well: Cipla Garden East of National High way (Northern side well)

Pumping Well No: **PT3** Date of Drilling: 04-03-2011

Co-ordinate: Latitude: 73°55'38.15" Longitude: 15°22'11"

RL of measuring point:46.283

Depth of Bore well: 70m Depth of casing pipe: 30m

Drilling time Yield: 120 lpm SWL: 12.58 m bmp on 18.5.2011

Aquifer: semi confined (fractured rock) M.P: 0.48 m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10 m	Hard crust laterite brown colour	
10 to 15m	Soft laterite ,silt, clay yellow, orange in colour	
15 to 28m	Silty clay /weathered rock greenish colour	
28 to 40.0m	Quartz Chlorite Schist fractured	Aquifer 35 to 40m
40.0 to 70m	Quartz Chlorite Schist hard	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate
Details of bore well drilled for conducting aquifer performance test
And aquifer geometry of the area

Location of Bore well: Near Coca Cola Sump

Pumping Well No: **PT4** Date of Drilling: 05.03.2011

Co-ordinate: Latitude: 73°56'43" Longitude: 15°22'340"

RL of measuring point:80.824

Depth of Bore well: 80m Depth of casing pipe: 36m

Drilling time Yield: 150 lpm SWL: 12.51 m bmp on 01.06.2011

Aquifer: semi confined (fractured rock) M.P: 1m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 5.0 m	Hard crust laterite brown colour	
5.0 to 10.0m	Soft laterite ,silt, clay yellow, orange in colour	
10to 30.0m	Silt, silty sand yellow colour	
30 to 35.0m	Coarse sand (quartz)	
35.0 to 45.0m	Quartz Chlorite Schist fractured	
45.0 to 80.0m	Quartz Chlorite Schist hard with fracture at places	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate
Details of bore well drilled for conducting aquifer performance test
And aquifer geometry of the area

Location of Bore well: Near Kare lab

Pumping Well No: **PT5** Date of Drilling; 05.03.2011

Coordinate: Latitude: 73°55'54" Longitude: 15°22'39"

RL of measuring point:66.126

Depth of Bore well: 70m Depth of casing pipe: 36m

Drilling time Yield: 50 lpm SWL: 17.88 m bmp on 24.5.2011

Aquifer: semi confined (fractured rock) M.P:0.4m agl

Geomorphic setup: Plateau

Lithological log

Depth in m	Strata Encountered	Water zone
00 to 10.0 m	laterite brown colour	
10.0 to 15.0	Pebble, clay ,weathered quartz veins	
15to 20.0m	Highly weathered rock	
20.0 to 30.0m	Quartz Chlorite Schist soft	
30.0 to 45.0m	Quartz Chlorite Schist fractured (moderate fracture)	
45.0 to 50.0m	Quartz Chlorite Schist hard	
50.0 to 70.0m	Metabasalt.	

ANNEXURE 3

Purpose Driven Studies Verna Industrial Estate
Details of bore well drilled for conducting aquifer performance test
And aquifer geometry of the area

Location of Bore well: Mahalasha Narayani temple Old Mardol Verna

Observation Well No: **PT6** Date of Drilling: 03.03.2011

Co-ordinate: Latitude 73°56'44" Longitude 15°21'37"

RL of measuring point: 67.873

Depth of Bore well: 60m Depth of casing pipe: 16.0m

Drilling time Yield: 130 lpm SWL: 5.28 m bmp on 26.5.2011

Aquifer: semi confined (fractured rock) M.P: 0.3m agl

Geomorphic setup: Plateau local ground water discharge area

Lithological log

Depth in m	Strata Encountered	Water zone
0.00 to 5.0m	Laterite hard massive brown colour	
5.00 to 10.0m	Quartz chlorite schist highly weathered green, brownish yellow colour	
10.0 to 20.0m	Quartz chlorite schist jointed	Water zone
20.0 tom 60m	Quartz chlorite schist	

ANNEXURE 4

DETAILS IF GROUND WATER LEVELS IN OPEN WELL MONITORED IN VILLAGE AREA AROUND VERNA PLATEAU

Sr.no	Location	Depth/ MP agl	Depth to water level below measuring point (bmp). From December 2009 To October 2010									
			17-12-2009	14-1-2010	17-2-2010	15-3-2010	15-4-2010	20-5-2010	18-6-2010	13-7-2010	19-8-2010	15-10-2010
1	Cansua	5.0m/0.85	2.55	2.78	3.3	3.50	3.92	4.22	2.00	2.19	1.98	2.314
2	Cansua pipal wada	8.4/0.75	5.65	5.65	5.77	5.80	5.91	5.99	4.55	4.24	3.48	4.39
3	Majil wado Nagoa	8.20/0.7	5.47	5.80	6.16	6.34	6.51	6.63	4.65	4.30	2.74	4.50
4	JUVI SHOP castle wado	6.20/0.9	4.25	4.30	4.34	4.40	4.49	4.55	3.35	3.55	2.47	3.98
5	Water selling well	6.97/0.80	2.77	3.00	3.20	3.40	3.72	4.758	1.99	2.51	2.43	2.65
6	Castle Wado Nr. Cross	4.85/0.81	3.12	3.31	3.4	3.59	3.80	4.06	2.39	2.53	2.51	2.74
7	Kumbardo	8.35/0.80	6.30	6.80	6.79	6.78	6.87	6.56	4.51	4.41	2.97	5.13
8	Puiabhat Verna	5.27/0.70	4.05	4.12	4.17	4.20	4.25	4.31	3.13	3.28	2.48	3.47
9	Puribat t junction	4.97/0.71	2.99	3.14	3.26	3.33	3.42	3.58	2.41	2.86	2.49	2.83
10	Ambora after spring	6.50/0.80	5.09	5.09	5.19	5.40	5.22	5.18	4.55	4.67	3.28	4.67
11	Devhoti Karmal	7.24/	3.24	3.86	4.44	4.65	4.89	5.54	2.01	2.00	1.91	1.99
12	Devhoti near the drain	6.84/0.75	5.34	5.46	5.62	5.70	5.81	5.79	4.22	3.95	3.36	4.27
13	Karvoto Chapel	9.09/0.9	5.60	5.82	5.79	5.75	6.32	6.10	5.16	5.02	3.75	5.17
14	Rasaim St.joseph chapel	7.40/0.85	3.95	3.97	4.02	4.25	4.43	4.56	3.67	3.96	3.53	3.92
15	Kelosim well vado	3.50/0.10	1.69	1.78	1.90	1.93	1.95	1.98	1.53	1.34	0.99	1.41

ANNEXURE 4

Details of Ground Water Levels monitored in open wells in Village area around Verna Plateau

Sr. no	Location	Depth/ MP agl	Depth to water level below measuring point (MP). From November 2010 To October 2011									
			25-11-2010	24-12-2010	28-1-2011	25-3-2011	26-4-2011	28-5-2011	29-6-2011	28-7-2011	19-9-2011	*27-10-2011*
1	Cansua	5.0m/0.85	2.49	2.62	2.96	3.56	3.83	3.34	2.08	1.93	2.09	*2.57*
2	Cansua pipal wada	8.4/0.75	5.10	5.44	5.61	5.82	5.91	5.87	3.13	3.25	3.89	*5.23*
3	Majil wado Nagoa	8.20/0.7	5.22	5.62	5.91	6.26	6.43	6.51	3.98	2.73	4.05	*5.69*
4	JUVI SHOP castle wado	6.20/0.9	4.31	4.31	4.40	4.41	4.48	4.49	3.10	2.37	3.05	*4.31*
5	Water selling well	6.97/0.80	2.87	3.18	3.31	4.09	4.05	4.03	2.54	2.54	2.48	*2.89*
6	Castle Wado Nr. Cross	4.85/0.81	3.14	3.32	3.45	3.66	3.75	3.84	2.57	2.41	2.58	*3.19*
7	Kumbardo	8.35/0.80	5.97	6.27	6.41	6.51	6.57	6.47	3.98	3.17	4.68	*6.06*
8	Puiabhat Verna	5.27/0.70	3.97	4.05	4.13	4.17	4.22	4.3	2.77	2.55	3.21	*4.33*
9	Puribat t junction	4.97/0.71	2.95	2.99	3.11	3.29	3.41	3.76	-	2.45	2.74	*2.95*
10	Ambora after spring	6.50/0.80	4.96	5.07	5.09	5.1	5.08	5.03	4.31	3.74	4.43	*5.08*
11	Devhoti Karmal	7.24/	2.09	2.72	3.71	4.55	4.71	5.08	1.95	1.62	1.85	*2.09*
12	Devhoti near the drain	6.84/0.75	5.11	5.29	5.4	5.52	5.64	5.69	3.48	3.22	3.44	*4.74*
13	Karvoto Chapel	9.09/0.9	5.72	5.89	5.95	6.08	6.15	6.15	4.98	4.26	4.2	*4.03*
14	Rasaim St.joseph chapel	7.40/0.85	4.07	4.08	4.09	4.13	4.27	4.53	3.98	3.35	3.73	*5.75*
15	Kelosim well vado	3.50/0.10	1.69	1.69	1.69	1.58	1.94	1.83	1.05	0.82	1.07	*1.69*

ANNEXURE 4

Details of Ground Water Levels in Open Well Monitored in Village Area around Verna Plateau

Sr.no	Location	Depth/ MP agl	Depth to water level below measuring point (MP). *From November 2011 To August 2012*									
			28-11-2011	*30-12-2011*	*28-1-2012*	*27-2-2012*	*26-3-2012*	*27-4-2012*	*23-5-2012*	*28-6-2012*	28-7-2012	24-8-2012
1	Cansua	5.0m/0.85	*2.86*	*3.32*	*3.58*	*3.84*	*4.05*	*4.21*	*4.52*	*1.92*	2.25	2.32
2	Cansua pipal wada	8.4/0.75	*5.54*	*5.71*	*5.80*	*6.03*	*6.02*	*5.84*	*6.00*	*3.30*	4.29	4.32
3	Majil wado Nagoa	8.20/0.7	*5.91*	*6.05*	*6.19*	*6.18*	*6.35*	*6.45*	*6.51*	*2.12*	4.60	4.81
4	JUVI SHOP castle wado	6.20/0.9	*4.37*	*4.41*	*4.44*	*4.50*	*4.56*	*4.59*	*4.71*	*1.89*	3.95	4.08
5	Water selling well	6.97/0.80	*3.49*	*3.91*	*3.85*	*3.89*	*5.69*	*5.48*	*6.52*	*2.07*	2.43	2.54
6	Castle Wado Nr. Cross	4.85/0.81	*3.39*	*3.53*	*3.70*	*3.77*	*3.91*	*4.01*	*4.13*	*2.36*	2.57	2.68
7	Kumbardo	8.35/0.80	*6.34*	*6.38*	*6.50*	*6.49*	*6.55*	*6.58*	*6.62*	*2.49*	5.23	5.44
8	Puiabhat Verna	5.27/0.70	*4.17*	*4.10*	*5.24*	*4.78*	*4.27*	*4.29*	*4.34*	*2.35*	3.44	3.58
9	Puribat t junction	4.97/0.71	*3.08*	*3.19*	*3.28*	*3.43*	*3.30*	*3.53*	*3.72*	*2.28*	2.86	2.89
10	Ambora after spring	6.50/0.80	*5.08*	*5.08*	*5.17*	*5.11*	*5.09*	*5.19*	*5.18*	*2.55*	4.90	4.85
11	Devhoti Karmal	7.24/	*3.21*	*3.95*	*4.42*	*5.6*	*4.91*	*6.39*	*6.02*	*1.87*	1.99	1.98
12	Devhoti near the drain	6.84/0.75	*5.66*	*5.13*	*6.53*	*6.92*	*5.63*	*5.22*	*5.87*	*2.76*	4.08	4.28
13	Karvoto Chapel	9.09/0.9	*5.11*	*5.62*	*5.21*	*6.45*	*5.85*	*5.4*	*7.28*	*3.84*	5.05	5.21
14	Rasaim St.joseph chapel	7.40/0.85	*4.21*	*4.29*	*4.33*	*4.43*	*4.56*	*4.63*	*4.96*	*3.45*	3.88	3.94
15	Kelosim well vado	3.50/0.10	*1.82*	*1.76*	*1.87*	*1.91*	*1.90*	*1.91*	*1.94*	*1.00*	1.28	1.40

ANNEXURE 4

Details of Ground Water Levels in Open Well Monitored in Village Area around Verna Plateau

Sr.no	Location	Depth/ MP agl	Depth to water level below measuring point (MP). From September 2012 To May 2013								
			27-9-2012	30-10-2012	30-11-2012	21-12-2012	31-1-2013	18-2-2013	26-3-2013	26-4-2013	*28-5-2013*
1	Cansua	5.0m/0.85	2.41	2.51	2.83	3.16	3.61	3.65	3.92	4.21	3.95
2	Cansua pipal wada	8.4/0.75	4.80	5.25	5.45	5.58	5.70	5.72	5.86	6.08	5.98
3	Majil wado Nagoa	8.20/0.7	5.31	5.84	6.08	6.22	6.36	6.35	6.46	6.57	6.62
4	JUVI SHOP castle wado	6.20/0.9	4.27	4.35	4.39	4.41	4.51	4.48	4.62	4.67	4.64
5	Water selling well	6.97/0.80	3.12	3.06	3.5	3.40	4.33	3.83	4.38	6.02	5.94
6	Castle Wado Nr. Cross	4.85/0.81	3.07	3.25	3.4	3.52	3.73	3.75	3.95	4.1	4.14
7	Kumbardo	8.35/0.80	5.84	6.06	6.23	6.35	6.52	6.49	6.58	6.59	6.68
8	Puiabhat Verna	5.27/0.70	3.86	4.03	4.11	4.15	4.20	4.17	4.97	5.16	4.45
9	Puribat t junction	4.97/0.71	2.99	2.97	3.05	3.15	3.25	3.26	3.5	3.8	3.96
10	Ambora after spring	6.50/0.80	4.99	5.02	5.05	5.05	5.10	5.09	5.14	5.26	5.23
11	Devhoti Karmal	7.24/	2.00	2.12	3.32	3.82	4.45	4.07	4.95	5.23	5.92
12	Devhoti near the drain	6.84/0.75	4.85	5.05	5.4	5.22	5.27	5.31	5.55	5.6	5.85
13	Karvoto Chapel	9.09/0.9	5.65	5.87	5.76	5.65	6.00	5.77	5.88	6.34	6.23
14	Rasaim St.joseph chapel	7.40/0.85	3.99	4.16	4.26	4.31	4.39	4.34	4.48	4.63	4.87
15	Kelosim well vado	3.50/0.10	1.59	1.72	1.77	1.81	1.89	1.86	1.92	1.97	1.98

ANNEXURE 5

Details of Ground Water Levels in Pumping Test Wells Monitored Under PDS, VERNA Plateau Area. Semi-Confined

Sr no	Location	Depth/ Casing	From July 2011 To June 2012										
			20-07-2011	23-9-2011	27-10-2011	28-11-2011	30-12-2011	28-1-2012	27-2-2012	26-3-2012	25-4-2012	23-5-2012	27-6-2012
1	Kare Lab	70.0 / 36.0	11.15	12.12	11.23	13.15	14.28	15.78	16.03	15.72	16.88	18.02	11.84
2	Lupin garden (panjim)	90.0/ 68.0	7.11	9.19	10.57	11.35	11.57	11.65	12.32	12.24	12.48	12.85	5.23
3	Lupin garden (Margao)	70.0/ 43.0	6.49	8.59	10.17	10.85	11.17	11.26	11.84	11.87	12.08	12.18	4.38
4 *	NH- 17 Cipala Garden	70.0/ 30.0	-----	9.4	9.91	13.41	14.96	14.20	14.55	15.07	15.94	16.2	4.78
5*	Near Mahalsa Narayani Temple	60.0/ 16.0	-----	-----	4.15	4.6	4.74	5.24	5.12	5.91	6.7	6.08	1.25
6*	Near Coco-cola water tank	80.0/ 41.0	-----	6.16	9.66	13.89	16.05	18.1	20.54	22.40	23.32	23.32	3.85

NOTE: Bore well in use is located within 20m from these observation wells

ANNEXURE 5

Details of Ground Water Levels in Pumping Test Wells Monitored Under PDS, VERNA Plateau Area.

Sr no	Location	Depth / Casing	From July 2012 To June 2013											
			28-7-2012	23-8-2012	27-9-2012	29-10-2012	29-11-2012	20-12-2012	29-1-2013	19-2-2013	26-3-2013	26-4-2013	28-5-2013	28.06.2013
1	Kare Lab	70.0 / 36.0	11.93	12.24	13.01	13.18	14.34	14.49	15.85	16.58	15.84	14.74	14.60	
2	Lupin garden (panjim)	90.0 / 68.0	9.16	9.52	10.33	10.79	11.25	11.44	11.97	12.16	12.56	12.94	12.87	
3	Lupin garden (Margao)	70.0 / 43.0	8.41	8.79	9.67	10.12	10.06	10.80	11.34	11.50	11.99	12.30	12.33	
4*	NH- 17 Cipala Garden	70.0 / 30.0	9.24	9.59	9.91	10.05	14.33	15.22	10.70	14.88	16.55	16.32	11.11	
5*	Near Mahalsa Narayani Temple	60.0 / 16.0	2.63	3.10	4.29	5.35	5.87	4.73	4.79	4.86	5.83	6.58	5.98	
6*	Near Coco-cola water tank	80.0 / 41.0	4.31	4.31	4.87	9.79	13.99	17.55	15.22	14.88	26.17	30.28	33.44	

NOTE: Bore well in use is located within 20m from these observation wells

ANNEXURE 6

Details of Ground Water Levels in Shallow Piezometers VERNA, Plateau area (Unconfined aquifer)

Sr no	Location	Depth /Casing	From May 2011 To April 2012									
			04-5-11	29-6-11	23-9-11	27-10-11	28-11-11	30-12-11	28-1-12	27-2-12	26-3-12	25-4-12
1	Cipla Garden On N.H	10.00 / 9.00	8.41	5.80	---	7.34	7.64	7.84	7.93	8.03	8.16	8.35
2	Famy care Ltd.,	10.00/ 9.00	7.94	3.27	3.39	5.72	7.34	7.96	7.95	7.64	7.85	7.27
3	Near Fire Station	12.00 / 9.00	7.06	3.56		4.39	4.99	6.04	6.61	7.32	7.75	8.57
4	Cipla (Gate No. 2) Near Tower	10.00 / 9.00	6.15	2.14	---	3.90	4.23	4.57	4.91	5.50	6.16	6.77
5	Near Compressor (Raheja)	10.00 / 9.00	6.23	4.33	4.44	5.19	5.82	5.91	5.97	6.09	6.21	6.38
6	Andrew Telecom, near Mango tree	12.00 / 9.00	8.60	5.73	7.06	7.58	8.03	8.25	8.33	8.35	8.51	Dry
7	Mahelsa Narayans Temple	10.00 / 9.00	4.42	1.15	1.26	3.42	3.94	4.05	4.13	---	4.36	4.46

ANNEXURE 6

Details of Ground Water Levels in Shallow Piezometers VERNA Plateau area (Unconfined aquifer)

Sr no	Location	Depth /Casing	From May 2012 To May 2013												
			23-5-2012	27-6-2012	28-7-2012	24-8-2012	27-9-2012	29-10-2012	29-11-2012	20-12-2012	29-1-2013	19-2-2013	26.03 13	26.04 13	28.05 2013
1	Cipla Garden On N.H	10.00 / 9.00	8.57	4.69	5.98	6.76	7.10	7.37	7.58	7.79	7.96	7.98	8.19	8.35	8.22
2	Famy care Ltd.,	10.00/ 9.00	7.48	2.65	3.44	3.48	4.24	5.42	7.07	7.76	7.56	7.78	7.81	7.45	7.80
3	Near Fire Station	12.00 / 9.00	8.83	3.3	3.43	3.82	4.08	4.42	5.14	5.36	6.09	6.38	7.24	7.93	8.23
4	Cipla (Gate No. 2) Near Tower	10.00 / 9.00	7.57	0.78	1.04	3.34	3.70	3.89	4.34	4.62	5.39	5.89	6.72	7.51	8.25
5	Near Compressor (Raheja)	10.00 / 9.00	6.6	4.75	4.40	4.72	5.35	5.74	5.87	5.92	6.03	5.78	6.18	6.40	6.46
6	Andrew Telecom, near Mango tree	12.00 / 9.00	8.66	1.77	6.38	7.41	7.77	7.92	8.15	8.25	Dry	7.91	dry	dry	dry
7	Mahelsa Narayans Temple	10.00 / 9.00	4.96	---	1.18	1.51	2.84	3.54	3.99	4.07	4.18	4.04	4.31	5.28	5.72

ANNEXURE 7

AQUIFER PERFORMANCE TEST DATA UNDER PDS, VERNA AREA GOA

	Cipla		Verna IDC		Coco Cola	
	Q=10 cum/hr		Q=10 cum/hr		Q=10 cum/hr	
Time since pump started in minutes	Pumping Well	Obs. Well	Pumping Well	Obs. Well	Pumping Well	Obs. Well
0.00	12.58	12.73	15	15.3	21.51	19.13
1.00	15.67	12.9	19.72	15.6	23.55	19.15
2.00	18.17	13.05	19.76	15.77	24.41	19.15
3.00	18.95	13.27	20.1	15.9	25.42	19.15
4.00	19.5	13.55	21.3	16	25.83	19.1
5.00	20.05	13.83	22	16.12	26.4	19.12
6.00	20.25	14.25	22.2	16.21	26.91	19.12
8.00	20.78	14.61	22.3	16.45	27.96	19.12
10.00	21.15	-------	22.5	16.73	28.4	19.15
15.00	21.9	15.45	22.56	16.81	29.45	19.18
20.00	22.5	15.9	22.7	17.15	30.31	19.2
25.00	-------	------	22.95	17.45	30.61	19.21
30.00	22.97	16.35	23.28	17.69	30.98	19.23
40.00	23.63	16.95	23.8	18.02	31.2	19.27
50.00	24.11	17.57	24.2	18.35	31.93	19.3
60.00	24.59	18	24.4	18.65	31.48	19.31
80.00	25.22	18.76	24.5	18.9	31.6	19.35
100.00	25.72	19.35	25.16	19.2	31.61	19.37
120.00	26.2	19.75	25.5	19.55	31.61	19.38
150.00	26.72	20.28	25.77	19.75	31.61	19.44
180.00	27.12	20.65	27.19	19.75	31.63	19.44
200.00	27.36	20.92	28.06	19.75	31.63	19.47
250.00	27.81	21.37	30.1	19.75	31.7	19.47
300.00	28.19	21.74	30.66	21.9	31.7	19.47
350.00	28.28	21.93	31.05	22.3	31.76	19.47
400.00	28.45	22.1	31.1	22.4	31.76	19.44
450.00	28.55	22.24	32.6	22.5	31.77	19.46
500.00	28.76	22.33	33.58	22.6	31.85	19.51
600.00	29.32	22.6	33.65	22.7	31.85	19.51
700.00	29.32	22.67	33.9	22.8	31.85	19.51
800.00	29.55	22.81	34.4	23.43	31.85	19.51
900.00	29.58	22.89	34.04	23.64	31.87	19.51
1000.00	29.69	22.9	36.1	24.01	31.87	19.51

ANNEXURE 7

AQUIFER PERFORMANCE TEST DATA UNDER PDS, VERNA AREA GOA

	Kare lab		Mardol Temple		Lupin	
	Q=9 cum/hr		Q=12 cum/hr		Q=9 cum/hr	
Time since pump started in minutes	Pumping Well	Obs. Well	Pumping Well	Obs. Well	Pumping Well	Obs. Well
0.00	17.88	16.48	5.28	4.25	12.5	12
1.00	27	16.51	6.16	4.29	23.1	12.08
2.00	28.82	16.52	7.29	4.29	25.58	12.1
3.00	31.5	16.54	7.41	4.29	27.34	12.13
4.00	33.17	16.87	7.59	4.36	28.3	12.18
5.00	34.75	16.67	7.7	4.42	29.01	12.24
6.00	35.9	16.71	7.8	4.46	29.55	12.29
8.00	37.55	16.86	7.99	4.61	30.3	12.39
10.00	38.23	16.91	8.1	4.69	30.75	12.5
15.00	39.15	17.15	8.28	4.81	31.4	12.72
20.00	39.15	17.39	8.39	4.88	31.98	12.95
25.00	39.15	17.59	8.53	4.98	32.15	13.15
30.00	39.2	17.73	8.65	5.05	32.28	13.3
40.00	39.29	17.78	8.7	5.08	32.81	13.49
50.00	39.3	18.15	8.8	5.14	33.2	13.65
60.00	39.39	18.3	8.86	5.19	33.51	13.9
80.00	39.9	18.53	9	5.25	33.62	13.99
100.00	40.3	18.7	9.05	5.29	33.74	14.11
120.00	40.79	18.81	9.1	5.32	33.9	14.22
150.00	41	19	9.17	5.33	33.9	14.3
180.00	41.05	19.08	9.19	5.33	33.9	14.35
200.00	41.1	19.08	9.21	5.34	33.9	14.38
250.00	43.4	19.08	9.21	5.28	33.9	14.39
300.00	43.5	19.1	9.25	5.28	34.12	14.4
350.00	43.6	19.15	9.29	5.28	34.21	14.45
400.00	43.75	19.15	10.35	6.05	34.2	14.4
450.00	43.8	19.36	10	6.08	34.32	14.42
500.00	43.83	19.39	9.43	5.39	34.46	14.43
600.00	43.94	19.39	9.28	5.28	34.47	14.44
700.00	44.45	19.75	9.27	5.23	34.72	14.45
800.00	50.73	20.2	9.28	5.22	34.52	14.45
900.00			9.3	5.21	34.62	14.49
1000.00			9.3	5.21	34.79	14.47

ANNEXURE 7

AQUIFER PERFORMANCE TEST RECOVERY DATA UNDER PDS, VERNA AREA

	Cipla		Verna IDC		Coco Cola	
	SWL=12.58	SWL=12.73	SWL=15	SWL=15.03	SWL=21.56	SWL=19.13
Time since pump stoped in minutes	Pumping Well	Obs. Well	Pumping Well	Obs. Well	Pumping Well	Obs. Well
1	29.69	22.9	36.1	24.01	31.87	19.51
2	22.32	21.09	32	23.95	30.18	19.49
3	21.95	21.71	30.4	23.95	29.03	19.48
4	21.68	21.49	29.34	23.95	28.52	19.44
5	21.45	21.29	27.7	23.9	26.15	19.45
6	21.29	21.14	27.1	23.85	25.86	19.42
8	21.08	20.99	26.6	23.75	25.25	19.41
10	20.75	20.75	26.2	23.6	24.9	19.41
15	20.53	20.4	26	23.43	24.48	19.4
20	19.41	19.45	25.3	23.22	24.25	19.38
25	19.1	19.09	24.9	22.91	22.4	19.3
30	18.82	18.75	24.25	22.55	21.55	19.27
40	18.33	18.56	23.45	22.07	21.1	19.25
50	18.13	18.05	22.55	21.47	21.1	19.13
60	17.78	17.69	21.55	20.8	21.1	19.13
80	17.5	17.43	20.67	20.2		
100	17.2	17.15	19.25	19.1		
120	16.97	16.9	18.2	18.2		
150	16.76	16.7	17.3	17.3		
180	16.4	16.31	16.7	16.5		
200	15.96	15.9	14.9	14.8		
240	15.7	15.75				
250	15.27	15.21				
290	14.94	14.9				
340	14.67	14.7				
390	14.45	14.48				
440	14.19	14.24				
500	14.04	14.12				
	13.99	14.04				

ANNEXURE 7

AQUIFER PERFORMANCE TEST RECOVERY DATA UNDER PDS, VERNA AREA

	Kare lab		Mardol Temple		Lupin	
	SWL=17.88	SWL=16.48	SWL=5.28	SWL=4.25	SWL=12.5	SWL=12
Time since pump stoped in minutes	Pumping Well	Obs. Well	Pumping Well	Obs. Well	Pumping Well	Obs. Well
1	50.73	20.2	9.3	5.21	34.79	14.47
2	46.5	20.15	6.38	5.2	22.6	14.47
3	39.02	20.11	6.43	4.71	20.9	14.46
4	32.08	20.09	6.4	4.7	18.9	14.4
5	29.5	19.99	6.38	4.69	17.76	14.38
6	24.7	19.9	6.31	4.68	17.25	14.34
8	23.9	19.64	6.29	4.65	16.65	14.28
10	22.64	19.62	6.23	4.62	16.36	14.22
15	22.4	19.52	6.22	4.57	16.06	14.2
20	21.59	19.38	6.15	4.52	15.38	13.85
25	21.19	19.21	6.1	4.5	15.05	13.82
30	20.9	19	6.05	4.48	14.78	13.62
40	20.35	18.8	6	4.43	14.44	13.4
50	20.01	18.41	5.9	4.36	14.26	13.25
60	19.65	18.2	5.7	4.27	13.8	12.9
80	18.85	17.9	5.6	4.25	13.75	12.75
100	18.55	17.35	5.45		13.65	12.54
120	18.31	17.12	5.34		13.39	12.4
150	18.05	16.88	5.26		13.15	12.29
180	17.89	16.7			13.09	12.25
200	17.88	16.47			12.97	12.2
240					12.9	12.17
250					12.8	12.1
290					12.7	12.06
340					12.61	12.02
390					12.52	
440						
500						

ANNEXURE 8

RESULTS OF PUMPING TEST ANALYSIS

Location	S.W.L(m)	Discharge (KL/Hr)	Duration of APT (min)	Maximum PWL (m)	Maximum Draw Down	Specific Capacity (Lit/Hr/ m)	Storage Coefficient	Dist. Of Obs. well (m)	T (sqm/ Day)
Cipla garden PW	12.58	10	1000	29.09	17.2	580	-	-	9.55
Cipla garden OW	12.73	10	1000	22.9	10.17	-	$0.95x10^{-4}$	20	11.57
Lupin garden PW	12.5	9	1000	34.79	22.2	405	-	-	18.83
Lupin garden OW	12	9	1000	14.47	2.47	-	$6.62x10^{-4}$	20	28.25
Kare lab PW	17.88	9	1000	50.73	32.85	2811	-	-	19.76
Kare lab OW	16.48	9	1000	29.09	17.2	-	$7.73x10^{-4}$	20	32.96
Mardol temple PW	5.28	12	1000	9.8	4.02	2095	-	-	52.74
Mardol temple OW	4.25	12	1000	5.21	0.91	-	$6.98x10^{-4}$	20	85.06
Cococola sump PW	21.56	10	1000	31.87	10.36	965	-	-	219.6
Cococola sump OW	19.13	10	1000	19.57	0.44	-	$64.42x10^{-4}$	20	199.77
GIDC office PW	15	10	1000	36.1	21.19	474	-	-	18.3
GIDC office OW	15.3	10	1000	24.1	8.71	-	$2.58x10^{-4}$	20	14.65

ANNEXURE 8

Summarized result of aquifer performance test on pumping wells

Bore well no		PT1	PT2	PT3	PT4	PT5	PT6
Bore well name		Lupin Garden	Old Mardol Temple	Cipla garden	Coca-cola	Kare lab	GIDC
M^2/day	Theis method	2.81×10^{1}	1.80×10^{1}	5.20×10	6.71×10^{-1}	1.81×10^{1}	2.67×10^{2}
	Cooper Jacob	1.98×10^{2}	8.64×10^{1}	2.44×10^{1}	2.47×10^{1}	1.97×10^{2}	1.96×10^{1}
	Moenich fracture	2.08×10^{1}	2.55×10^{1}	4.53×10^{-2}	3.69×10^{-1}	2.73×10^{-1}	5.45×10^{0}
	Theis recovery	1.22×10^{1}	3.60×10^{2}	1.23×10^{1}	2.94×10^{0}	7.37×10^{0}	6.36×10^{0}

Observation wells

Observation well no		OW1	OW2	OW3	OW4	OW5	OW6
Observation well name		Lupin Garden	Old Mardol Temple	Cipla garden	Coca-cola	Kare lab	GIDC
M^2/day	Theis method	1.8×10^{1}	8.06×10^{1}	5.45×10^{0}	4.48×10^{1}	2.44×10^{1}	1.40×10^{1}
	Cooper Jacob	3.43×10^{1}	8.06×10^{1}	9.92×10^{0}	6056×10^{1}	3.28×10^{1}	1.69×10^{1}
	Moenich fracture	3.28×10^{1}	8.06×10^{1}	5.45×10^{0}	5.50×10^{1}	2.42×10^{1}	1.40×10^{1}
	Theis recovery	3.45×10^{1}	1.09×10^{2}	1.20×10^{1}	1.00×10^{2}	2.48×10^{1}	1.27×10^{1}
S	Theis method	5.36×10^{-4}	5.36×10^{-4}	1.36×10^{-4}	$4.17\times10^{-}$	2.70×10^{-4}	2.79×10^{0}
	Cooper Jacob	5.48×10^{-4}	6.57×10^{-4}	1.20×10^{-4}	$3.25\times10^{-}$	4.55×10^{-4}	1.48×10^{-4}
	Moenich fracture	2.70×10^{-4}	5.36×10^{-4}	1.36×10^{-4}	4.80×10^{-8}	1.92×10^{-4}	1.68×10^{-4}

ANNEXURE 9

LIST OF BORE WELLS IN VERNA INDUSTRIAL ESTATE AS ON 14/01/2010

SR NO	NAME OF COMPANIES	PLOT NO	NO OF WELLS	DEPTH OF WELL IN MTS.	QTY OF WATER DRAWN BY THE WELL PER YEAR IN CU,M(AS PER THE STATEMENT BY OWNERS)
1	SMART LINK SYSTEM PVT.LTD	L- 30	4.00	50.00	4380.00
		L- 5		90.00	4380.00
		L- 3		150.00	4380.00
		L- 7		120.00	4380.00
2	JIM CAP ELECTRONICS PVT. LTD	L-12	1.00	45.00	438.00
3	MODEL BUCKET& ATTACHMENT PVT. LTD.	L-13	1.00	78.00	1825.00
4	INDOCO REMEDIES LTD	L-14	2.00	80.00	16425.00
				80.00	not in use
5	MHA LOGISTICS & AGRO SERVICES/ (SIDDHI VINAYAK INDUSTRIES)	L-2/3	3.00	72.00	8760.00
				100.00	292.00
				70.00	0.00
6	GROVEMARK LABORATORIES	SC-1/29,30	1.00	60.00	1250.00
7	FAMICARE LTD	L-20	1.00	20.00	73.00
8	YUNCA MACHINERY MANUFACTURING PVT.LTD	L-21	1.00	50.00	365.00
9	BLUE CROSS LAB LTD	L-17	1.00	65.00	2331.00
10	KODAK INDIA PVT.LTD	L-16	1.00	65.00	1200.00
11	KARE LABS PVT.LTD	L-40	1.00	65.00	5400.00
12	SIKA INDIA PVT. LTD	L-41	1.00	120.00	14600.00
13	LAUNDERAIDS	S-53,54,55	1.00	37.00	18250.00
14	SUPERTECH PACKAGING PVT.LTD	S-56	1.00	60.00	365.00
15	FERN ENGINEERING	S-65	1.00	60.00	810.00
16	HITECH OIL SAVERS/ SYNERGY	S-94,95	1.00		*3650*
17	SPARROW TECHNOLOGIES LTD	S-99-102	1.00		under repair
18	TULIP DIAGNOSTIC PVT.LTD	S-92,96	1.00	120.00	1120.00
19	PREMIER INDUSTRIAL PRODUCTS	S-97	2.00		*3650*
20	VINDYA PACKAGING	S-75	1.00	85.00	110.00

21	MARKSONS PHARMA LTD.	L-82,83	1.00	26.00	29200.00
22	ELIN ELECTRONICS LTD	L-84	1.00	42.00	1825.00
23	OLIVERA HOTELS	U-P-115,II-E	1.00		closed
24	LAXMI STEEL INDUSTRIES	L-86	1.00	50.00	365.00
25	NEW MIILINNIUM BAKERS (MOGINIS)	L-107,108	1.00		*3650*
26	SILICON SHIPWRIGHT PVT.LTD	L-103-106	1.00		*3650*
27	PWD WELL NEAR GROUND RESERVOIR		1.00		*10000*
28	PWD WELL NEAR CHAPEL		1.00		*10000*
29	PWD WELL NEAR OV. HEAD RESERVOIR		1.00		*10000*
30	SILICON CORTEC	L-100	1.00		*3650*
31	MUKTAR MINERALS PVT. LTD	B-2&3	1.00		*3650*
32	CACULO EARTHMOVERS PVT.LTD	B-24	1.00	60.00	7200.00
33	RATIOPHARM INDIA PVT.LTD	A-1	4.00	108.00	4562.00
				108.00	4562.00
				108.00	4563.00
				108.00	4563.00
34	WATSON PHARMA PVT. LTD.	A-3 -A6	5.00	60.00	not in use
				132.00	11040.00
				75.00	6624.00
				57.00	4416.00
				66.00	6624.00
35	SHREE PRINT& PACK	C-3	1.00	75.00	91.00
36	LUPIN LTD	B-15	4.00	80.00	25550.00
				80.00	10950.00
				80.00	18250.00
				80.00	18250.00
37	CHIKSHY LABORATORIES	C-18,20	1.00		*3650*
38	SCOOP PROJECTS PVT. LTD	U-	1.00		*3650*
39	SIEMENS LTD	L-6	2.00	70.00	13500.00
				70.00	10800.00
40	DURALINE INDIA LTD	L-24,25	2.00	65.00	2555.00
				75.00	30660.00
41	SAN MOTORS	L-31	1.00	120.00	365.00
42	GOA PAPER &BOARD CONVERTERS	L-29	1.00	60.00	90.00
43	LARK WIRE &INFOTECH LTD	L-28	1.00	40.00	1095.00
44	SCHIFFER &MENEZES PVT. LTD	L-27	1.00	45.00	3650.00

45	HIMACHAL FUTURISTIC C.L	L-35,36,37	1.00	90.00	2200.00
46	INDOCO REMEDIES LTD	L-32,33,34	2.00	70.00	16425.00
				70.00	16425.00
47	PETAL INNOVATIVE MACHINE PVT. LTD.	L-77	1.00	50.00	360.00
48	BETTS INDIA PVT. LTD	L-78	1.00	80.00	1460.00
49	PARLE EXPORT PVT. LTD	L-72	3.00	60.00	27375.00
				60.00	27375.00
				70.00	18000.00
50	TOPLINE WRITING INSTRUMENTS	L-71	1.00	90.00	not in use
51	INDART MATERIAL PVT. LTD	L-70	1.00	90.00	6405.00
52	NESTOR PHARMACEUTICAL	L-43	1.00	86.00	480.00
53	PERSISTANT SYSTEM LTD	L-44	1.00	58.00	3150.00
54	GOLDSHIELD SERVICES	44 STP II	1.00	72.00	183.00
55	INFOTECH (CONDOR POLYMERIC)	L-45/B	2.00	70.00	6200.00
				70.00	
56	F.D.C. LTD	L-56-57	2.00	110.00	4740.00
				110.00	4740.00
57	PENTAIR WATER INDIA LTD	L-52-55	2.00	60.00	not in use
				40.00	7500.00
58	OPTIC FIBER LTD	L-62-64	2.00	72.00	9490.00
				75.00	9490.00
59	UNIVERSAL CABLE LTD.	L-58,59,60	2.00	90.00	1825.00
				95.00	1825.00
60	VINKA INDUSTRIES	L-67	1.00	60.00	775.00
61	PLASTIC EXPORT ZUNDERI	L-72,69,68	1.00	35.00	1825.00
62	BARTON FIRTON ENGG. PVT. LTD	L-74	1.00	50.00	365.00
63	PANADIKAR RESEARCH & DEV. LTD	L-79	1.00		365
64	ASTRA METAL LTD	L-75	1.00	70.00	365.00
65	Q.A. TECH. SERVICES INDIA (GMP TECHNICAL SOLUTION)	L-73	1.00	50.00	438.00
66	FINOLEX CABLES LTD	L-117,118, 116,9A, 123A	2.00	60.00	3650.00
				60.00	54750.00
67	CRYSTEL COVE/ LYDIA D' SOUZA	L-123	1.00	30.00	730.00
68	FDC LTD	L-121B	3.00	110.00	5616.00
				110.00	5616.00
				110.00	3120.00
69	SRI SAI ENGINEERING CO.	L-122	1.00	80.00	183.00

70	PRAKASH CORRUGATED BOXES	L-116B	1.00	90.00	3650.00
71	CAPRICON LOGISTICS	U-XI	1.00	110.00	365.00
72	WYTH LEDERLE	L-137	3.00	100.00	21900.00
				104.00	21900.00
				75.00	9125.00
73	HERALD PUBLICATION PVT. LTD.	L-135	2.00	63.00	365.00
				60.00	not working
74	CIPLA LTD	L-139-146	9.00	60.00	45260.00
				90.00	13140.00
				120.00	8030.00
				43.00	19710.00
				125.00	19710.00
				130.00	13140.00
				100.00	13140.00
				105.00	32850.00
				105.00	26280.00
75	CIPLA LTD	S-103-105 & S-107, 112	7.00	105.00	8030.00
				51.00	13140.00
				105.00	13140.00
				125.00	405.00
				100.00	10950.00
				100.00	14600.00
				98.00	9125.00
76	CIPLA LTD	M-61-63	3.00	100.00	5840.00
				100.00	4380.00
				85.00	18980.00
77	CIPLA LTD	N-5A	1.00	103.00	46355.00
78	AVANTIS FARMA LTD	L-121	4.00	55.00	20440.00
				50.00	20440.00
				94.00	20440.00
				48.00	20440.00
79	NAVDEEP LAUNDRY	U-V	1.00	60.00	1095.00
80	CENTRAL WAREHOUSING	M-50-54	1.00	120.00	not in use
81	CMM LOGISTIC	L-129	1.00	100.00	1325.00
82	NOVACARE DRUG	L-134	1.00	150.00	360.00
83	GOA MEDICARE DEVICE	M-1	1.00	90.00	730.00
84	BRITACEL SILICONS LTD	L-124-126	1.00	61.00	1500.00
85	HINDUSTAN COCA COLA	M-2-11	2.00	170.00	73000.00
				70	not in use
86	COLORCONE ASIA PVT. LTD	M-14-18	1.00	50.00	3240.00
87	BHARAT PETROLIUM CORP.	M-19-25	2.00	80.00	365.00
				80	not in use
88	BLS POLYMERS PVT. LTD	M-36,37, 40,41	2.00	80.00	1460.00
				80.00	
89	LAXMI PACKAGING	M-44	1.00	120.00	365.00

90	ZAPHIRE BIOMEDICAL	M-46-47	2.00	130.00	1200.00
				140.00	1200.00
91	CORAL CLINICAL SYSTEM	M-46-47	1.00	120.00	1800.00
92	PHARMACEUTICAL COATING	L-48	1.00	90.00	730.00
93	FUNCREAM FOODS	L-127	1.00	90.00	365.00
94	S.M. ENGINEERING	L-128	1.00	90.00	210.00
95	VIJAY LOGISTICS PVT. LTD.	U-VII	1.00		*730*
96	ZEEKAYEEF PHARMA	M-58,59	1.00		closed
97	PAULO AUTO BODY BUILDERS	M-56	1.00	75.00	730.00
98	MAYA VALADARES D'SILVA	U-X	1.00	56.00	730.00
99	MICRO LAB LTD	S-155-158	1.00	90.00	16425.00
100	KAILAS ASSOCIATED	S-129	1.00	105.00	1095.00
101	ANANDI LOGISTIC	S-136	1.00	CAPED	
102	TOOL- X- SYSTEMS	S-134	1.00	65.00	540.00
103	SREEJA ELECTRONIC	S-122	1.00	11m depth	2m dia
104	TULIP DIAGNOSTIC PVT.LTD	S-124, 125,126	1.00	130.00	1200.00
105	PWD WELL IN THE PROPERTY OF JEROMENDIS LOVANORAS	PVT.LAND	1.00		*10000*
106	PWD WELL IN THE PROPERTY OF MARTINHO PERIERA	PVT.LAND	1.00		*10000*
107	VIJAY LOGISTICS PVT. LTD.	N-73, 74	1.00		*730*
108	CMM LOGISTICS PVT LTD	U-02-B	1.00	80.00	1325.00
109	ERICA LIFESCIENCE PVT. LTD	N-7	2.00	90.00	23360.00
				90.00	23360.00
110	PUTZMEISTER CONCRETE MACHINES PVT. LTD	N-4	2.00	45.00	400.00
				45.00	400.00
111	K. RAHEJA CORP.LTD	N77-94, N101-142, N225-237	4.00	110.00	5475.00
				126.00	5475.00
				100.00	5475.00
				90.00	5475.00
112	INOX MERCANTILE CO. PVT.LTD	N201-224	3.00	87.00	1095.00
				52.00	1095.00
				65.00	1095.00
113	ANDREW TELECOMM PVT. LTD	N-2	2.00	51.00	29200.00
				43.00	not in use
114	JOANITA D' MELLO (MOUNTAIN VIEW FOODS)	U-K 13	1.00	35.00	365.00

115	DEEPAK NAIK	U-K-14	1.00		*365*
116	GARDEN NEAR N.H. (By Cipla Ltd)		1.00		*5000*
117	GARDEN NEAR D-LINK. (By D-Link)		1.00		*5000*
118	PWD WELL IN THE PROPERTY OF CHURCH NEAR MARDOL TEMPLE	PVT.LAND	1.00		*10000*
119	PWD WELL AT BACK SIDE OF MARDOL TEMPLE	PVT.LAND	1.00		*10000*
120	ST. ANTONY HEALTH RESORT	PVT.LAND	1.00		*7300*
121	MARDOL TEMPLE	TRUST	1.00		*7300*
122	MARDOL HOTEL NEAR N.H.	PVT.LAND	1.00		*7300*
123	OPPOSITE TO PETROL PUMP NEAR COROMANDAL CEMENT GODOWN	PVT.LAND	1.00		*7300*
124	KESARWAL DRINKS	PVT.LAND	1.00	4.00m depth	*1800*
125	META COPPER AND ALLOYS LTD.	KANSUA	1.00		*7300*
126	ASTRA METAL LTD	L-75	1	70	*730*
127	BHAIRAV DISTRIBUTERS	L2/1	1	60	*730*
128	DEMPO INDUSTRIES	L-8	1		*730*
129	ELEGANT POLYPRODUCTS PVT.LTD	SC-1/35,36	1	150	*0730*

ANNEXURE 10

PDS INFILTRATION TEST VRENA INDUSTRIAL ESTSTE GOA DATE OF TEST: 02/05/2011

SL. NO	Location of site	Bore Hole location	Time started	Time completed	Total time taken	Quantity of Water	Rate of infiltration After saturation
1.	In front of Bharti Duraline	First from west	12.15	12.16	45 seconds	15 liter	20lpm
2.	do	Bore hole 2 from west	12.30	12.31.15	75seconds	15 liter	12lpm
3.	do	4th Bore hole	12.45.30	12.46.30	60seconds	15 liter	15lpm through pipe annular space poor.
4.	Infront of Wyth lab	First hole from west	13.30	13.31.20	50seconds	15 liter	18lpm
5.	do	Third hole	14.00	14.01	60seconds	15 liter	15lpm
6.	do	Close to compound well	14.30	14.31	60seconds	15 liter	15lpm
7.	Infront of sanafi aventies	Central line 3rd bore hole	15.00	15.00.20	20seconds	15 liter	60lpm
8.	do	Do 5th bore hole from west	15.10	15.10.50	50seconds	15liter	18lpm
9.	do	Eastern of side of approach road	16.00	16.00.90	90seconds	15liter	10lpm

Depth of bore hole 15m dia 203mm with 50mm dia pipe annular space filled with sand. Length of pipe 12m

0.0 to 8m late rite 8.00 to 15.00m silt, clayey silt.

ANNEXURE 11

Water Sampling Sites	Colour	Odour	pH	Turbility	Ec µmhos/cm	TH as-CaCO3	TDS	Na	K	Ca	Mg	CL	SO4	CO3	HCO3	BOD	COD	Total Coliform MPN/100ml
						mg/l												
Lotoulim Spring water	Colourless	Inoffensive	6.9	1	64	12	38	4.4	NIL	4.4	0.2	10.7	2.8	NIL	4.3	NIL	NIL	150
Veltolem Stream Water	Colourless	Inoffensive	6.7	1	52	9	28	3.0	NIL	2.8	0.5	7.1	1.3	9.0	5.2	NIL	NIL	200.0
Udo Spring water	Colourless	Inoffensive	6.6	1	190	55	128	9.7	0.1	10.0	7.3	35.5	7.4	NIL	22.0	NIL	NIL	225.0
Patton Spring Water	Colourless	Inoffensive	6.2	1	50	15	40	3.2	NIL	2.4	2.2	10.7	3.8	NIL	7.0	NIL	NIL	150.0
Recharge pit WRD	Colourless	Inoffensive	6.2	1	91	20	56	4.6	NIL	4.8	1.9	17.6	2.5	NIL	5.5	NIL	NIL	175.0
Rasaim Nallah no. 1	Colourless	Inoffensive	6.9	1	330	41	272	27.8	NIL	10.8	3.4	49.7	4.8	NIL	31.3	NIL	NIL	225.0
Rasaim Nallah no. 2	Colourless	Inoffensive	7.3	1	55	14	36	3.1	NIL	3.2	1.5	10.7	0.8	NIL	6.0	NIL	NIL	200.0
Kellosim near gauging site	Colourless	Inoffensive	7.1	1	250	35	124	17.0	0.1	2.3	2.9	42.6	3.5	NIL	10.0	NIL	NIL	150.0
Kesarval Spring Water	Colourless	Inoffensive	6.2	1	290	47	142	17.0	0.1	13.2	3.4	46.2	5.2	NIL	17.5	NIL	NIL	150.0
Upstream of Kesarval Culvert	Colourless	Inoffensive	7.7	1	480	49	258	78.0	NIL	11.6	4.9	78.0	6.2	NIL	125.0	NIL	NIL	175.0

ANNEXURE 11

CHEMICAL QUALITY OF SURFACE WATER (SPRINGS & SREAM FLOW) AROUND VERNA AREA

CHEMICAL QUALITY OF BORE WELL WATER VERNA AREA.

Water Sampling Sites	Colour	Odour	pH	Ec µmhos/cm	Sio_2	TH as-CaCO3	TDS	Na	K	Ca	Mg	CL	SO4	CO3	HCO3	Fe	F	B	PO4	Total Coliform MPN/100ml
					mg/l															
Cipla Garden	clear	Inoffensive	6.9	136	34.2	61	92	5.3	0.2	12.0	7.5	4.0	Nil	NIL	70	0.30	NIL		NIL	
D Link	clear	Inoffensive	7.0	198	39.2	75	110	7.3	0.1	19.2	6.5	11	Nil	Nil	80	0.22	NIL		NIL	
Kare Lab	clear	Inoffensive	7.1	170	31.6	64	108	5.0	0.2	14.0	7.0	4.5	Nil	NIL	70	0.09	NIL		NIL	
Betts	clear	Inoffensive	7.4	200	39.5	75	120	7.3	0.2	13.6	9.9	19.5	NIL	NIL	70	0.09	NIL		NIL	
Cipla	clear	Inoffensive	6.6	230	20.0	76	148	8.6	0.1	15.2	9.2	24	2	NIL	55	0.45	NIL		NIL	
Watson Pharma	clear	Inoffensive	6.7	250	32.6	86	142	8.5	0.1	19.2	9.2	34	2	NIL	65	0.02	NIL		NIL	
Keserwal Irrigation	clear	Inoffensive	6.6	310	33.6	123	192	6.0	0.2	20.4	18	15	20	NIL	85	0.03	NIL		NIL	
Mardol Temple	clear	Inoffensive	7.2	180	32.6	70	108	5.4	0.2	10.6	11	10	Nil	NIL	75	0.15	NIL		NIL	
Andrew Telecom Putzmeister	clear	Inoffensive	8.0	188	22.0	63	126	6.5	0.3	8.8	3.9	4.0	Nil	NIL	60	0.04	NIL		NIL	
Zephrye Biomedical	clear	Inoffensive	7.6	490	31.6	195	316	7.0	0.2	42.0	22	64	15	NIL	110	0.08	NIL		NIL	

ANNEXURE 11

CHEMICAL QUALITY OF OPEN WELL WATER AROUND VERNA PLATEAU

Water Sampling Sites	Colour	Odour	pH	Turbility	Ec µmhos/cm	TH as-CaCO3	TDS	Na	K	Ca	Mg	CL	SO4	CO3	HCO3	Fe	F	Total Colifor m
						mg/l												
Cansua around Maruti Temple	Clear	Inoffensive	5.0		99	10	58	7.2	NIL	3.2	0.48	11	NIL	NIL	8.0	0.02	NIL	200.0
Cansua Pipalwad	Clear	Inoffensive	5.2		69	13	48	4.1	NIL	4.0	0.73	9	NIL	NIL	10.0	0.02	NIL	175.0
Nagoa Majilwada (Gods Gift)	Clear	Inoffensive	5.4		91	14	64	6.9	NIL	5.2	0.73	11	NIL	NIL	12.0	0.02	NIL	225.0
Verna castlewado (behind Juhi shop)	Clear	Inoffensive	5.5		70	9	40	5.0	NIL	2.8	0.48	7	NIL	NIL	12.0	0.03	NIL	200.0
Verna castlewado (water selling well)	Clear	Inoffensive	5.4		115	20	68	7.3	NIL	5.6	1.4	11	NIL	NIL	15.0	0.04	NIL	150.0
Verna castlewado (Lodovino Colaco) ganpati Devastan road	Clear	Inoffensive	5.2		93	9	56	7.5	NIL	2.4	0.7	14	NIL	NIL	12.0	0.01	NIL	45.0
Verna East of Village Panchayat office	Clear	Inoffensive	5.2		69	10	39	3.9	NIL	2.8	0.73	7	NIL	NIL	12.0	0.002	NIL	150.0
Verna kumbardo	Clear	Inoffensive	5.8		200	43	128	12.4	0.3	10	4.1	30	1.0	NIL	40.0	0.02	NIL	125.0
kelosim velo Vado	Clear	Inoffensive	5.5		82	17	51	5.5	NIL	4.8	1.2	10	NIL	NIL	17.0	0.01	NIL	150.0
Rasaim-st Joseph Chapel	Clear	Inoffensive	5.6		94	19	60	4.9	0.1	4.0	2.2	9	NIL	NIL	18.0	0.05	NIL	125.0
Karvate- Karvato Chapel Trust	Clear	Inoffensive	5.4		59	10	38	3.6	NIL	3.2	0.48	4	NIL	NIL	10.0	0.01	NIL	45.0
Lotullem- Devhoti near the Drain	Clear	Inoffensive	5.0		58	7	36	4.8	NIL	3.2	0.24	4	NIL	NIL	10.0	0.01	NIL	150.0
puryebhat-T- Junction	Clear	Inoffensive	5.4		65	12	40	3.0	NIL	3.2	0.73	7	NIL	NIL	10.0	0.01	NIL	175.0
Ambora Kairebhat after Udo Spring	Clear	Inoffensive	5.8		80.0	13	50	5.9	NIL	3.2	1.2	7	NIL	NIL	15.0	0.02	NIL	150.0

ANNEXURE 12

REDUCED LEVELS OF LOCATIONS

S. No	Name	Description	Long	Lat	Ortho_height	Long (Decimal Deg)	Lat (Decimal Deg)
1	CIBA	CIBA	73° 56' 7.416" E	15° 19' 44.953" N	51.097	73.935393	15.329154
2	IDC	IDC OFFICE & (BANK OF INDIA)	73° 56' 4.842" E	15° 22' 9.323" N	68.101	73.934678	15.369256
3	P001	CIPLA GARDEN & (NEAR-INFRONT OF SIEMENS GATE)	73° 55' 38.220" E	15° 22' 12.488" N	47.055	73.927283	15.370135
4	P002	CIPLA GARDEN & (NEAR-INFRONT OF SIEMENS GATE)	73° 55' 38.238" E	15° 22' 10.508" N	46.283	73.927288	15.369586
5	P003	VILLAGE PANCHAYAT	73° 55' 49.175" E	15° 21' 21.366" N	14.661	73.930326	15.355935
6	P004	VILLAGE PANCHAYAT	73° 55' 52.793" E	15° 21' 17.650" N	19.348	73.930717	15.354218
7	P005	REYNOLD WEDDINGS & (LAWARIYA MOTORS)	73° 55' 24.231" E	15° 21' 59.242" N	57.863	73.923398	15.366456
8	P006	LUPIN GARDEN MARGAO SIDE & (CACULO)	73° 55' 33.496" E	15° 21' 57.492" N	51.502	73.925971	15.36597
9	P007	LUPIN GARDEN PANJIM SIDE & (CACULO)	73° 55' 33.520" E	15° 21' 58.138" N	51.988	73.925978	15.366149
10	P008	FAMY CARE LTD & (NEAR BY ELECTRIC CITY S/S)	73° 56' 4.332" E	15° 22' 23.385" N	69.28	73.934537	15.373163
11	P009	OPP.KARE LAB	73° 55' 53.915" E	15° 22' 37.144" N	66.893	73.931643	15.376984
12	P010	OPP.KARE LAB	73° 55' 53.932" E	15° 22' 37.795" N	66.126	73.931648	15.377165
13	P011	200 mtr. NORTH KARE LAB	73° 55' 55.351" E	15° 22' 43.875" N	64.85	73.932042	15.378854

14	P012	IDC OFFICE & (BANK OF INDIA)	73° 56' 4.023" E	15° 22' 8.951" N	67.464	73.934451	15.369153
15	P013	IDC OFFICE & (BANK OF INDIA)	73° 56' 4.691" E	15° 22' 9.063" N	68.114	73.934636	15.369184
16	P014	NEAR BY FIRE STATION & (BEHIND IDC OFFICE)	73° 56' 8.117" E	15° 22' 9.505" N	67.792	73.935588	15.369307
17	P015	COCO COLA SUMP	73° 56' 42.821" E	15° 22' 3.301" N	80.824	73.945228	15.367584
18	P016	CIPLA GATE NO.2 & (NEAR BY TOWER)	73° 56' 43.462" E	15° 21' 57.816" N	78.082	73.945406	15.36606
19	P017	OPP.BHARAT PETROLEUM	73° 56' 50.036" E	15° 22' 30.468" N	94.229	73.947232	15.37513
20	P018	COMMSCOPE (NEAR BY CIPLA ELECTRICITY S/S & MANGO TREE)	73° 57' 14.703" E	15° 21' 43.996" N	88.612	73.954084	15.362221
21	P019	RAHEJA & (NEAR BY COMPRESSOR)	73° 57' 47.469" E	15° 21' 18.660" N	100.252	73.963186	15.355183
22	P020	END POINT IDC ESTATE	73° 58' 7.565" E	15° 20' 57.373" N	105.396	73.968768	15.34927
23	P021	NEAR WATER TANK	73° 57' 10.047" E	15° 21' 20.374" N	132.431	73.952791	15.355659
24	P022	BOREWELL INSIDE MAHALSA COMPLEX	-	-	67.363	-	-
25	P023	MAHALSA TEMPLE (BOREWELL)	73° 56' 43.697" E	15° 21' 36.583" N	67.873	73.945471	15.360162
26	P024	MAHALSA TEMPLE (OPENWELL)	73° 56' 41.597" E	15° 21' 33.459" N	67.994	73.944888	15.359294
27	P025	SPRING - CIPLA ELECTRICITY S/S	73° 57' 3.936" E	15° 22' 9.589" N	49.058	73.951093	15.36933
28	P026	BEHIND WYETH COMPANY	73° 56' 20.173" E	15° 22' 1.052" N	78.164	73.938937	15.366959

29	P027	Maruti Temple	73° 55' 19.954" E	15° 22' 13.209" N	16.564	73.92221	15.370336
30	P028	MARUTI TEMPLE & (CANSUA BHAT) ROAD	73° 55' 1.193" E	15° 21' 49.602" N	14.158	73.916998	15.363778
31	P029	MAJILWADO	73° 55' 19.823" E	15° 21' 29.605" N	12.298	73.922173	15.358224
32	P030	BEHIND JUHI STORES & (CASTLEWADA)	73° 55' 46.766" E	15° 21' 37.115" N	15.277	73.929657	15.36031
33	P031	CASTLEWADA & (WATER SUPPLY TANKER)	73° 55' 50.954" E	15° 21' 53.162" N	15.683	73.930821	15.364767
34	P032	CASTLEWADA & (NEAR WATER SUPPLY TANKER)	73° 55' 53.488" E	15° 22' 0.502" N	32.238	73.931524	15.366806
35	P033	CROSS NEAR GANESH TEMPLE	73° 55' 53.621" E	15° 21' 39.580" N	13.595	73.931562	15.360995
36	P034	PURYE BHAT	73° 56' 12.512" E	15° 20' 58.879" N	12.561	73.936809	15.349689
37	P035	UDO SPRING (KAJREBHAT)	73° 56' 46.548" E	15° 20' 51.795" N	30.356	73.946263	15.347721
38	P036	KAJREBHAT	73° 56' 47.237" E	15° 20' 41.320" N	17.752	73.946455	15.344811
39	P037	T Junction	73° 56' 19.053" E	15° 21' 3.157" N	13.502	73.938626	15.350877
40	P038	KARMALA & DEVHOTEE	73° 58' 16.614" E	15° 20' 27.295" N	16.252	73.971282	15.340915
41	P039	DRAIN AT DEVHOTEE	73° 58' 42.308" E	15° 20' 47.087" N	8.634	73.978419	15.346413
42	P040	KARWADDO CHAPEL	73° 58' 20.098" E	15° 21' 23.979" N	7.383	73.97225	15.356661
43	P041	RASSAIM (NR. JOSEPH CHAPEL)	73° 57' 21.348" E	15° 22' 9.834" N	6.349	73.95593	15.369398
44	P042	QUELLOSIM	73° 55' 55.747" E	15° 23' 12.702" N	6.07	73.932152	15.386862

45	P043	KESARWAL GARDEN	73° 55' 43.012" E	15° 22' 58.608" N	29.704	73.928614	15.382947
46	P044	BEHIND IFB	73° 56' 0.378" E	15° 22' 2.571" N	57.257	73.933438	15.367381
47	P045	IN FRONT OF SANOFI	73° 56' 40.019" E	15° 22' 2.090" N	78.736	73.94445	15.367247
48	P046	BANDHARA (IN FRONT OF WYETH)	73° 56' 24.412" E	15° 22' 6.694" N	78.344	73.940114	15.368526
49	P047	DURALINE	73° 56' 7.786" E	15° 22' 13.403" N	68.817	73.935496	15.37039
50	P048	S/W TO MAHALSA TEMPLE	73° 56' 46.373" E	15° 21' 19.983" N	61.302	73.946215	15.355551

ANNEXURE 13

DETAILS OF WELLS INVENTORIED IN VILLAGES AREA OF NAGOA

WELL NO.	DATE OF INVENTORY	LOCATION	OWNER OF THE WELL	MP (M) AGL	DWL (M) BMP	DEPTH OF WELL (M) BMP	ELEVATION	LINING (M)BMP	DETAILS OF STRATA OBSERVED / REPORTED
269	22/3/13	Sailawada	Public well	0.65	3.30	5.70	15	2.40	Black rock is exposed at the bottom of the well. Never dries.
270	22/3/13	Sailawada	Ncessidia Dias	0.64	6.20	8.66	16	fully lined	Clay encountered at the base.
271	22/3/13	Sailawada	Francis Valadaris	0.85	4.16	6.52	15	1.80	Hard laterite starts below 4.57 m bmp.
272	22/3/13	Sailawada	Cocacio Valis	0.70	4.11	6.07	14	2.70	Black rock is exposed in the well at a depth of 5.65 m below measuring point. No clay seen.
273	22/3/13	Sailawada	Martin Fernandes	0.60	3.17	4.45	14	1.74	3 mts of weathered rock is seen below lining.
274	29/4/13		public well	0.70	3.40	5.75	20	2.42	Black rock is exposed in the well. No clay seen. Half a meter of laterite is seen below lining. Cavities are seen in laterite.
275	29/4/13		Francis Gama	0.60	8.41	9.80	26	fully lined	black rock is exposed at the bottom
276	3/5/13		Public well	0.42	6.51	7.51	19	1.8	Fully lateritic, never dries, occasionally used

277	3/5/13		Maria Franscisco Fernandez	0.56	4.45	5.32	16	1.90	Partially lateritic. Never dries .In monsoon water reaches ground level. Used for irrigating 1000 sq mts area and for domestic purpose. 1Hp pump installed.
278	3/5/13		Antonicca Rebello	0.55	3.87	4.75	16	2.63	
279	3/5/13		Zuzessy Fernandes	0.60	9.86	10.91	23	2.10	Black rock is exposed at the bottom. Hard laterite is seen at a depth of 6.60m below MP. Water level goes down in summer but no declining trend for so many years. Well is never deepened for last 80 years.
280	3/5/13		not known	0.40	9.45	10.07	25	1.70	Fully penetrated.
281	3/5/13		St .Joseph Convent School	0.75	12.85	13.79	29	8	Hard laterite is encountered at a depth of 8 meters below measuring point. Clay is encountered at the base.
282	3/5/13		Not known	0.60	10.99	12.24	24	fully lined	
283	3/5/13	Majilwada Nagoa	John Philip Pereira	0.60	5.90	7.12	17	1.78	100 years old well. 2 hp pump is installed. Irrigates 6000sq mts area.
284	3/5/13	Majilwada Nagoa	Donald Cabreal	0.68	9.30	11.65	27	5.50	Partially lateritic water goes down in summer. In rainy season water comes upto ground level.

285	3/5/13	Majilwada Nagoa	D. S. Cabral	0.90	8.71	10.22	24	2.22	Never dries. Used for domestic purpose. monsoon water level rises up to ground level
286	3/5/13	Majilwada Nagoa	public well	0.34	3.70	4.40	19	2.65	Partially lateritic. Never dries. Half meter water remains in the well at the end of may. Water reaches ground level in monsoon.
287	21/5/13		Sucorean Fernandes	0.72	5.18	6.95	18	2.54	Partially lateritic. Never dries.
288	21/5/13		Vilma Dias	0.81	7.77	8.25		2.15	Never dries. Silty clay at the base
289	21/5/13		Joquim Mascarenhas	0.70	3.40	4.70	15	4.0	Partially lateritic. Hard laterite at the base.
290	21/5/13		Edwin Cabreal	0.72	8.48	10.42	18	5.18	No clay at the base. Never dries
291	21/5/13		Sprioza Souza	0.53	6.15	7.15	17	4.40	Never dries
292	21/5/13		Mahamaya Nageshi Temple	0.75	6.80	7.46	16	3.60	Clay at bottom.

ANNEXURE 14

Details of Artificial Ground Water recharging Structures constructed in Verna Industrial Estate

Sr. No.	Structures Constructed	Storage Capacity
1	Ground Water Recharging Pits with Infiltration bore wells on the open Area in front of D	
	1. 70.00m.x 30.00m.x 1.00m (av.ht.)	2100.00Cu.M
	2. 30.00m.x 25.00m.x1.00m. (av. Ht)	75.00Cu.M
2	Check dams with Infiltration Bore wells constructed on the open Area near Sanofi Avanti Company.	
	1. 30.00m. x 30.00m x 0.60m (Av.Ht).	540.00Cu.M
	2. 34.00m. x 80.00m x 1.00m (Av.Ht).	2720.00Cu.M
	3. 51.00m. x 55.00m x 0.90m (Av.Ht).	2524.50Cu.M
	4. 44.00m. x 15.00m x 0.60m (Av.Ht).	396.00Cu.M
3	Check dams with Infiltration Bore wells constructed on the open Area near Wyth Company	
	1. 31.50m x 55.00m x 0.75m (Av.Ht)	1299.37Cu.M
	2. 31.50m x 30.00m x 0.60m (Av.Ht)	567.00Cu.M
4	Checdk dam Constructed on the nallah behind IDC office	4300.00Cu.M
5	Check dam Constructed on the nallah U/s side of the Service Road 38.00m x 55.00m x 1.00m (Av.;Ht)	2090.00Cu.M
6	Check dam Constructed on the nallah D/s side of the service road 41.00m x 65.00m x 3.00m (Av.Ht)	7995.00Cu.M
	Grand Total	**25281.87Cu.M**

ANNEXURE 15

DEPTH TO WATER LEVEL IN THE GROUNDWATER RECHAGE SHAFT (PERCOLATION TANK) ON VERNA PLATEAU 2012-13

DATE	DEPTH TO WATER LEVEL IN M (BELOW MP) MP=0.00	DATE	DEPTH TO WATER LEVEL IN M (ABOVE MP) MP=0.00
30-5-12	9	29-6-13	0.10
28-2-13	4.46	31-7-13	0.15
30-3-13	4.92	31-8-13	0.08
30-4-13	5.48	30-9-13	0.10
31-5-13	5.32		

ANNEXURE 16

Details of Ground Water Levels in Pumping Test Wells Monitored Under PDS, VERNA Plateau Area. Semi Confined aquifer.

Sr. no	Location	Depth /Casing	From July 2011 To June 2012										
			20-07-2011	23-9-2011	27-10-2011	28-11-2011	30-12-2011	28-1-2012	27-2-2012	26-3-2012	25-4-2012	23-5-2012	27-6-2012
1	Kare Lab	70.0/ 36.0	11.15	12.12	11.23	13.15	14.28	15.78	16.03	15.72	16.88	18.02	11.84
2	Lupin garden (panjim)	90.0/ 68.0	7.11	9.19	10.57	11.35	11.57	11.65	12.32	12.24	12.48	12.85	5.23
3	Lupin garden (Margao)	70.0/ 43.0	6.49	8.59	10.17	10.85	11.17	11.26	11.84	11.87	12.08	12.18	4.38
4 *	NH- 17 Cipala Garden	70.0/ 30.0	-----	9.4	9.91	13.41	14.96	14.20	14.55	15.07	15.94	16.2	4.78
5*	Near Mahalsa Narayani Temple	60.0/ 16.0	-----	-----	4.15	4.6	4.74	5.24	5.12	5.91	6.7	6.08	1.25
6*	Near Coco-cola water tank	80.0/ 41.0	-----	6.16	9.66	13.89	16.05	18.1	20.54	22.40	23.32	23.32	3.85

NOTE: Bore well in use is located within 20m from these observation wells

ANNEXURE 16

Details of Ground Water Levels in Pumping Test Wells Monitored Under PDS, VERNA Plateau Area.

Sr no	Location	Depth /Casing	From July 2012 To June 2013											
			28-7-2012	23-8-2012	27-9-2012	29-10-2012	29-11-2012	20-12-2012	29-1-2013	19-2-2013	26-3-2013	26-4-2013	28-5-2013	28.06.2013
1	Kare Lab	70.0/ 36.0	11.93	12.24	13.01	13.18	14.34	14.49	15.85	16.58	15.84	14.74	14.60	
2	Lupin garden (panjim)	90.0/ 68.0	9.16	9.52	10.33	10.79	11.25	11.44	11.97	12.16	12.56	12.94	12.87	
3	Lupin garden (Margao)	70.0/ 43.0	8.41	8.79	9.67	10.12	10.06	10.80	11.34	11.50	11.99	12.30	12.33	
4*	NH- 17 Cipala Garden	70.0/ 30.0	9.24	9.59	9.91	10.05	14.33	15.22	10.70	14.88	16.55	16.32	11.11	
5*	Near Mahalsa Narayani Temple	60.0/ 16.0	2.63	3.10	4.29	5.35	5.87	4.73	4.79	4.86	5.83	6.58	5.98	
6*	Near Coco-cola water tank	80.0/ 41.0	4.31	4.31	4.87	9.79	13.99	17.55	15.22	14.88	26.17	30.28	33.44	

NOTE: Bore well in use is located within 20m from these observation wells

PLATE 1

INDEX MAP

PLATE 2

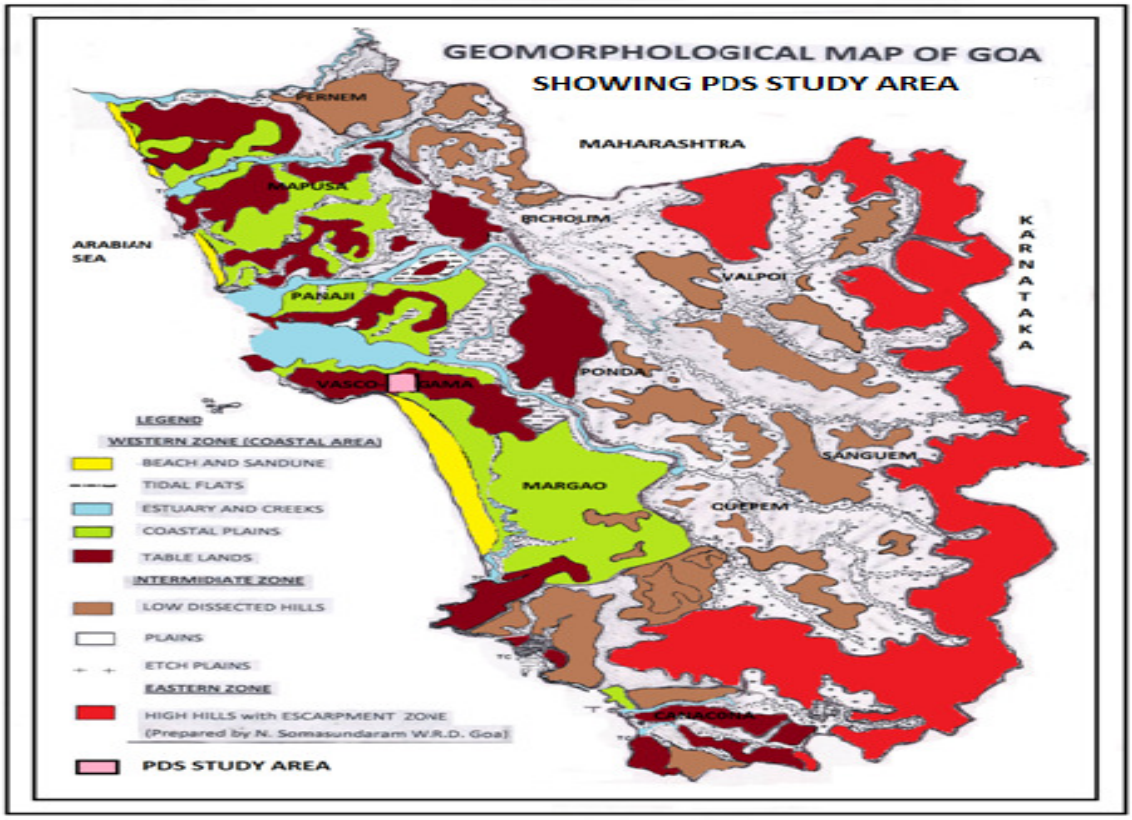


PLATE 3

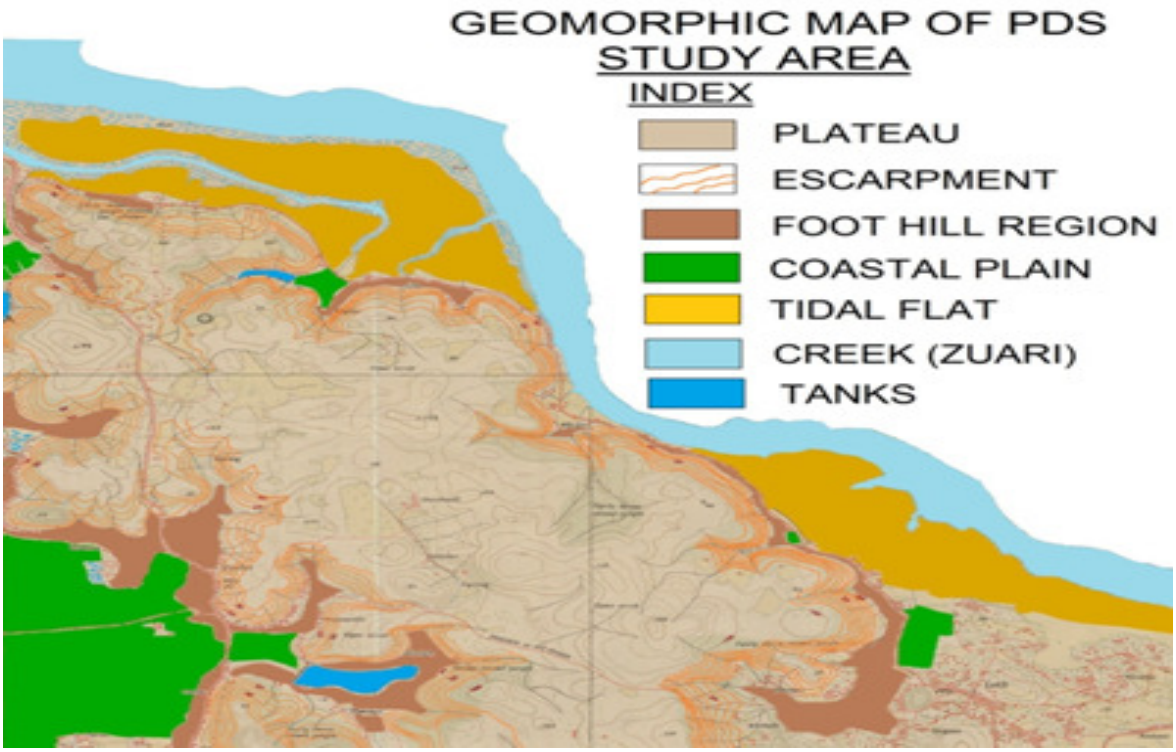
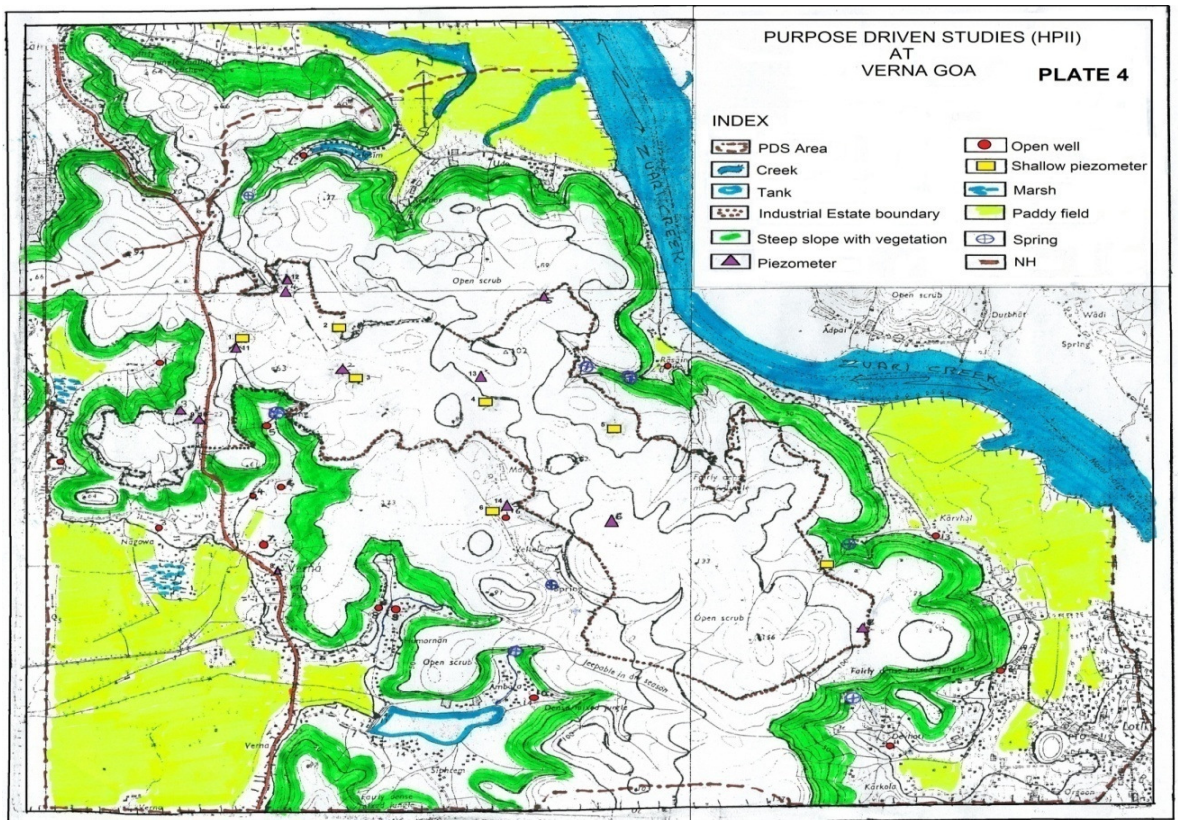


PLATE 4

PDS AREA VERNA GOA



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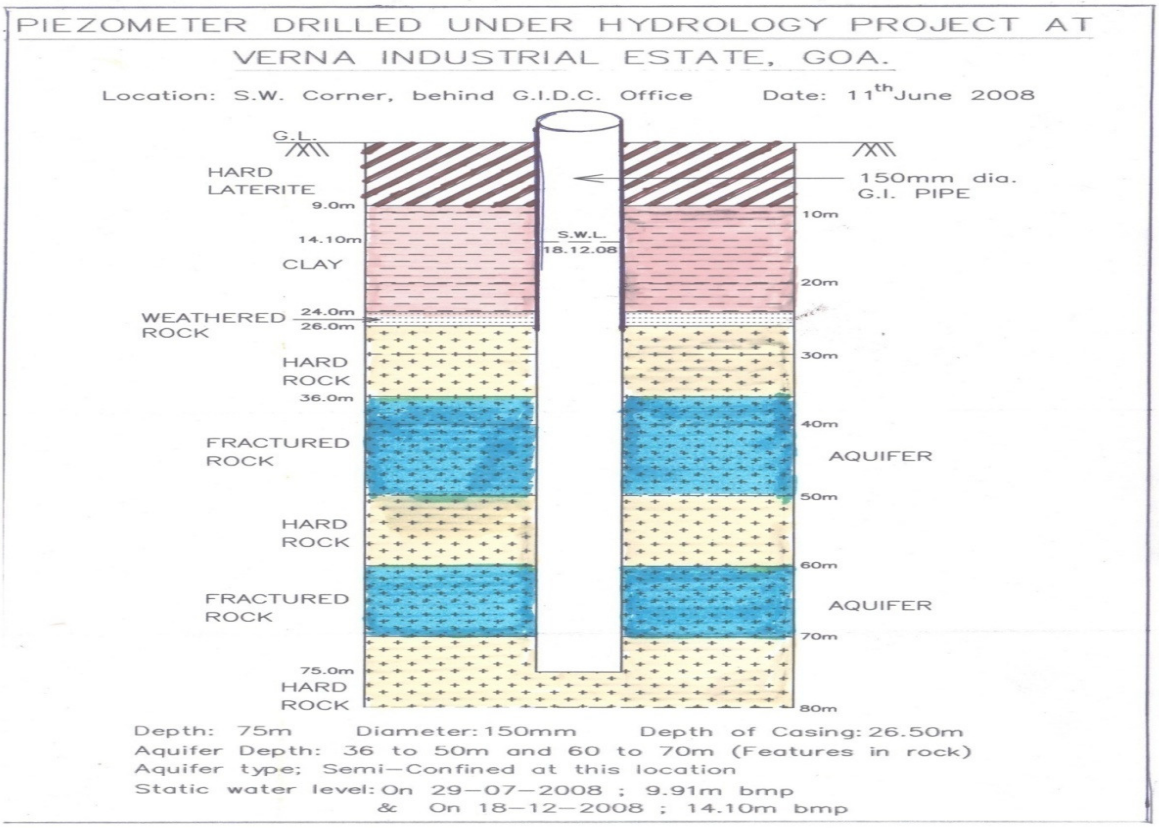

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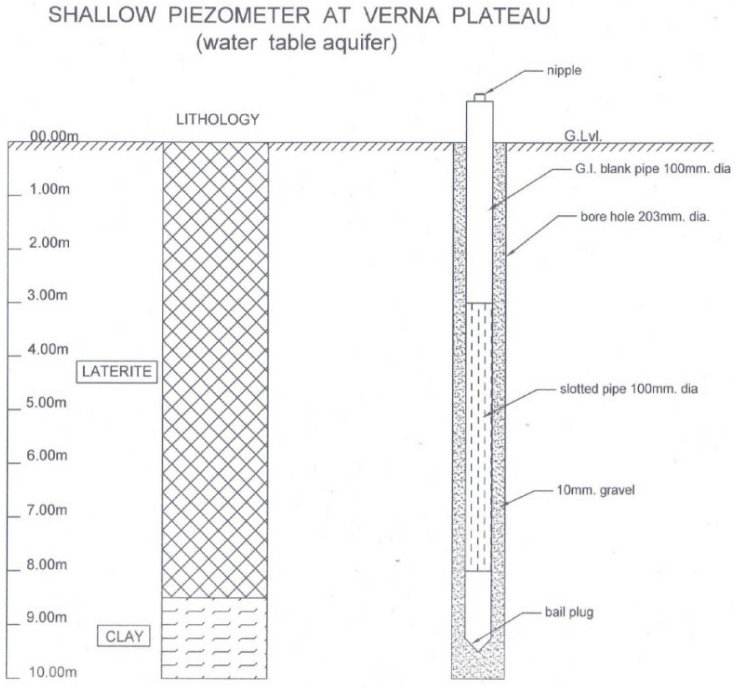

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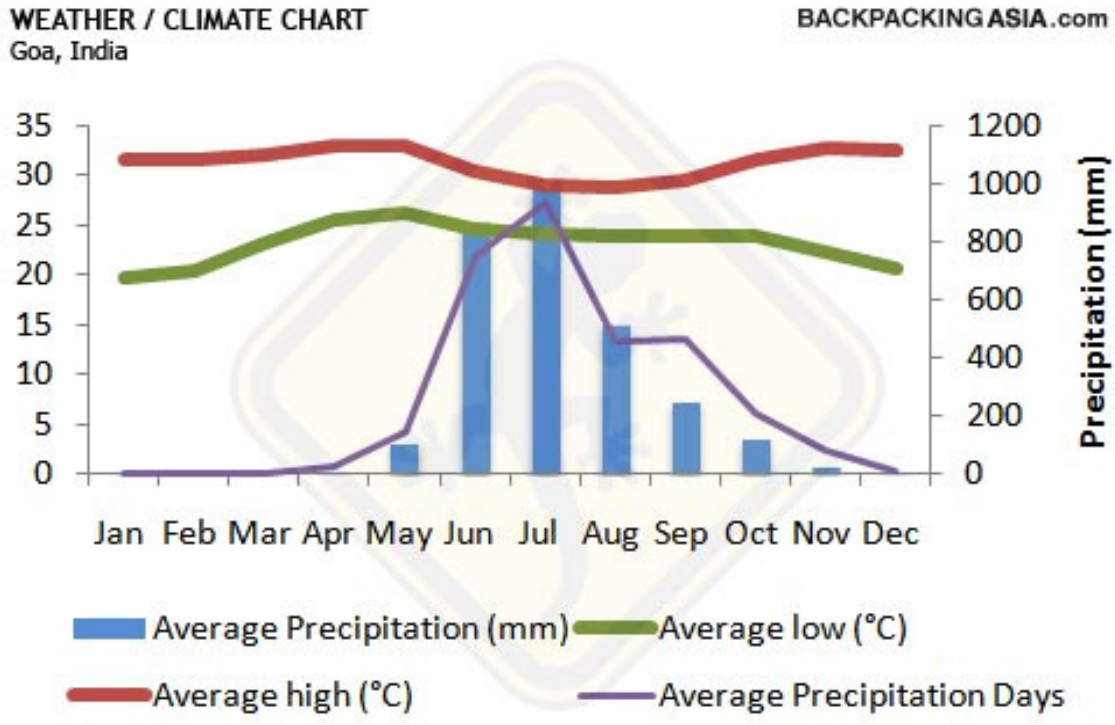

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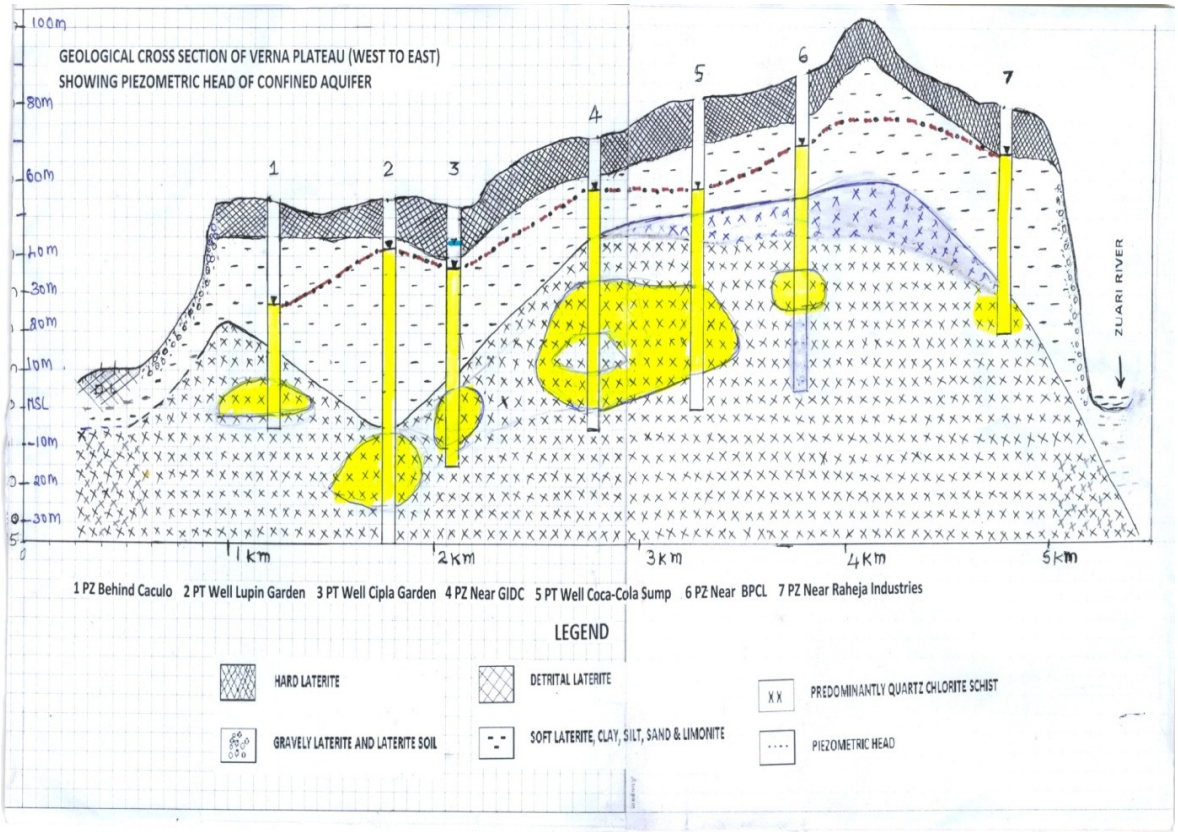

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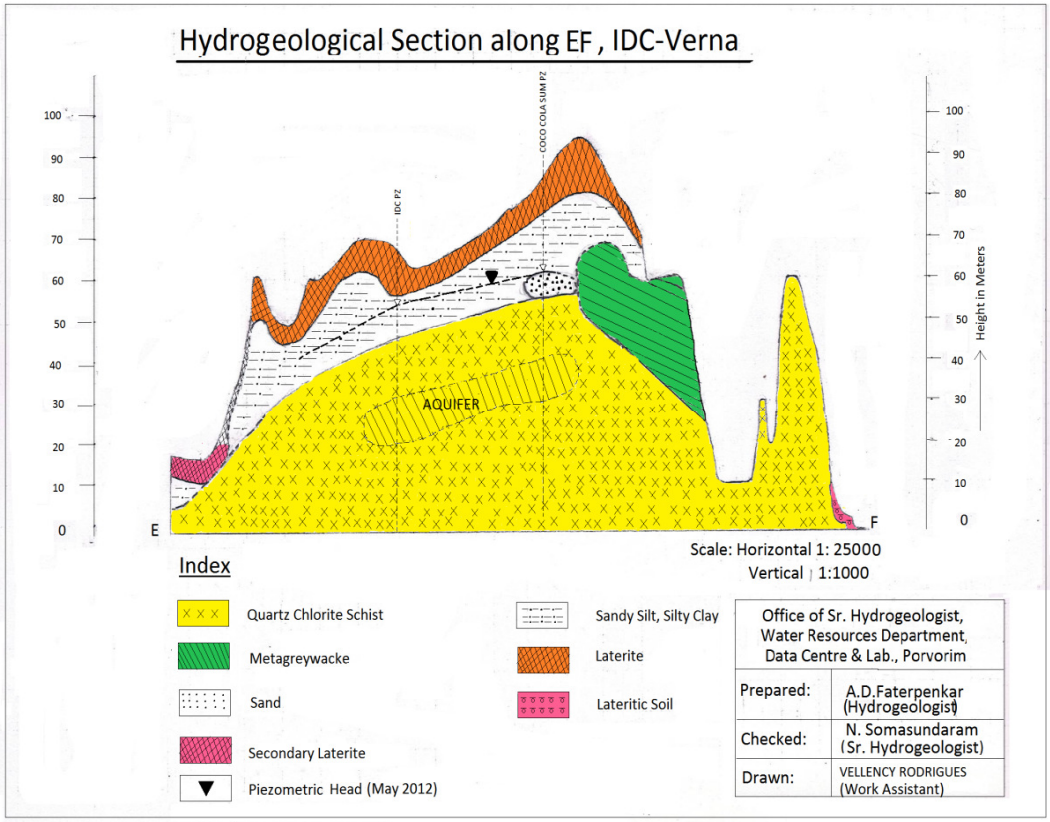


PLATE 10 A

APT AT CIPLA GARDEN VERNA

PLATE 10 B

HYDROGRAPH OF PUMPED WELL CIPLA GARDEN VERNA INDUSTRIAL ESTATE

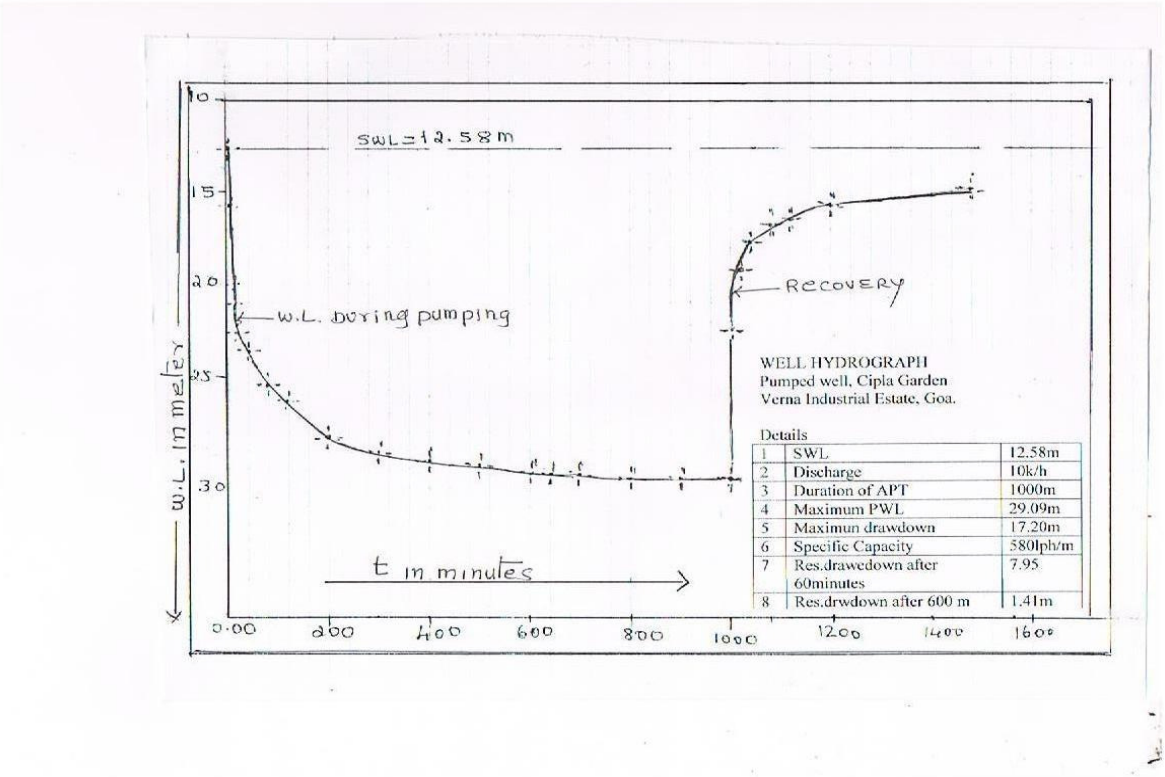


PLATE 10 C

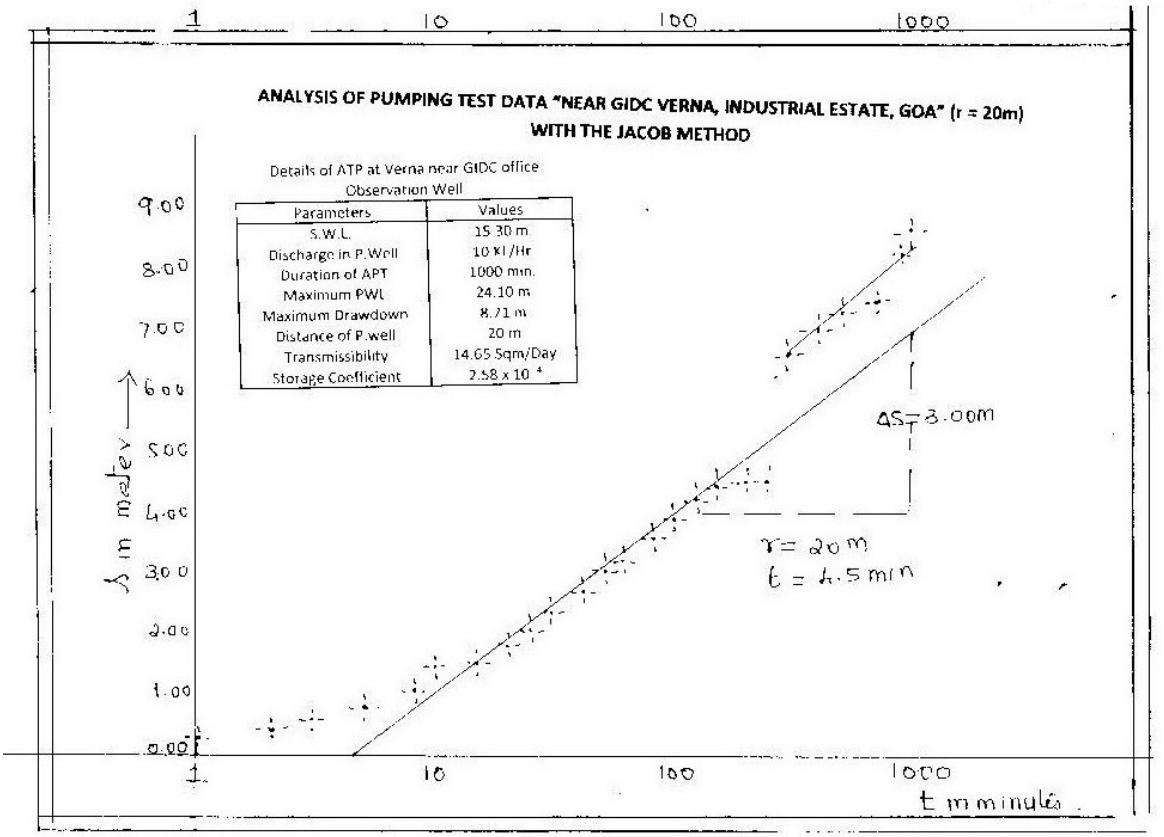


PLATE 10 D

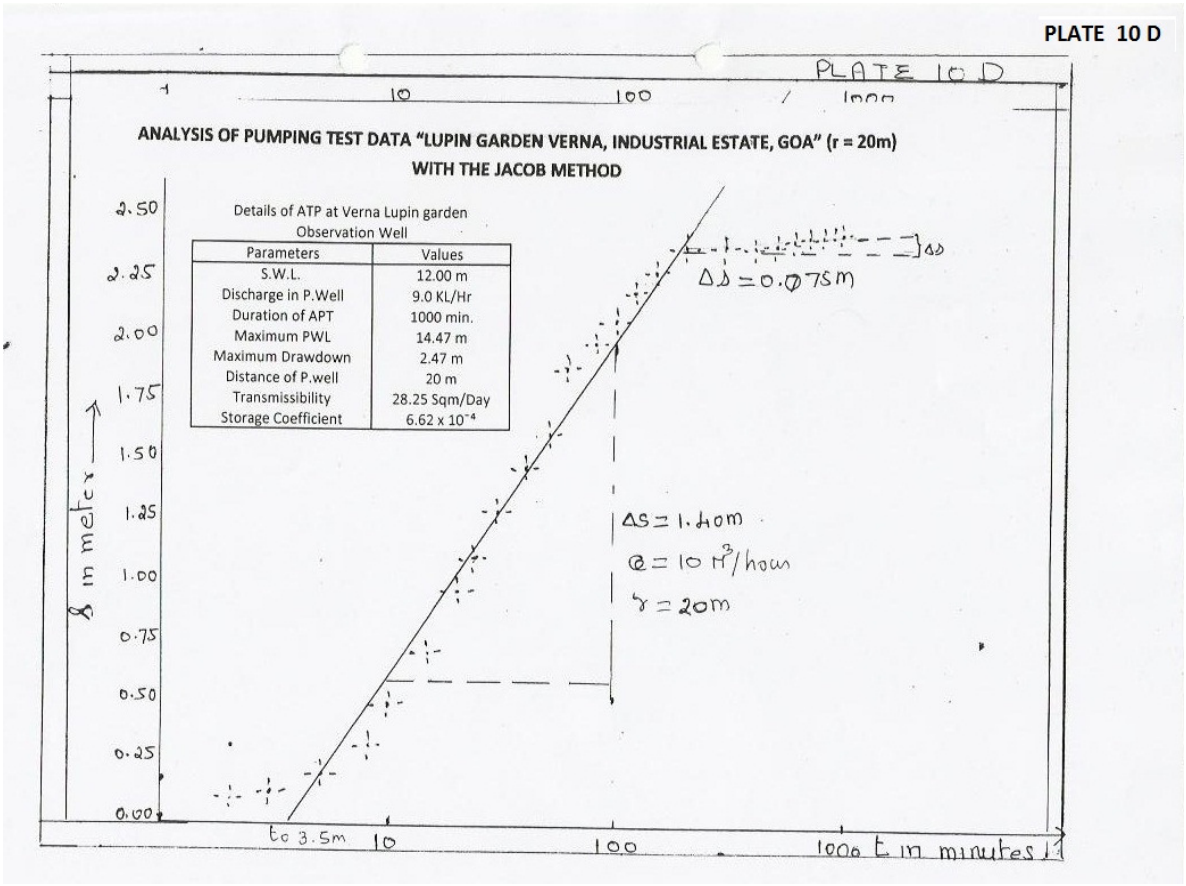
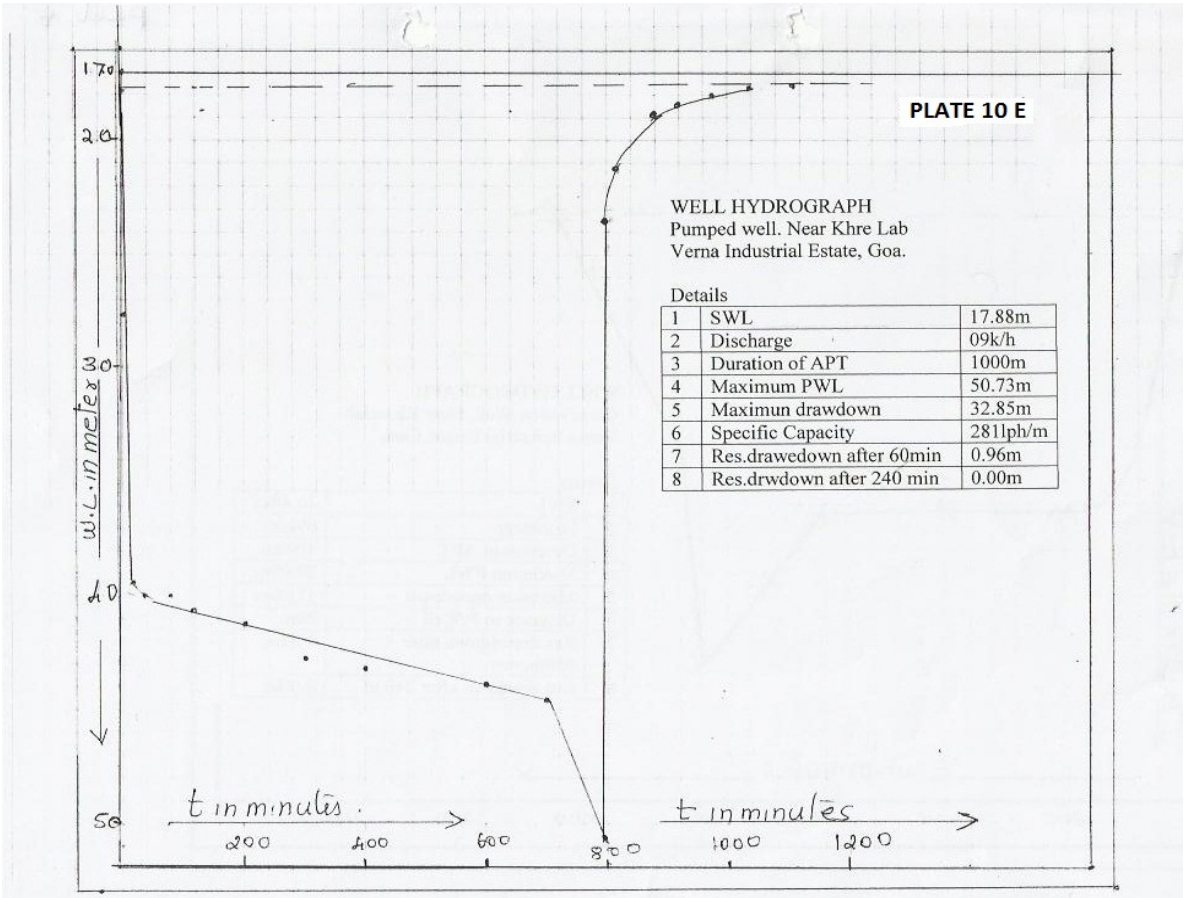


PLATE 10 E



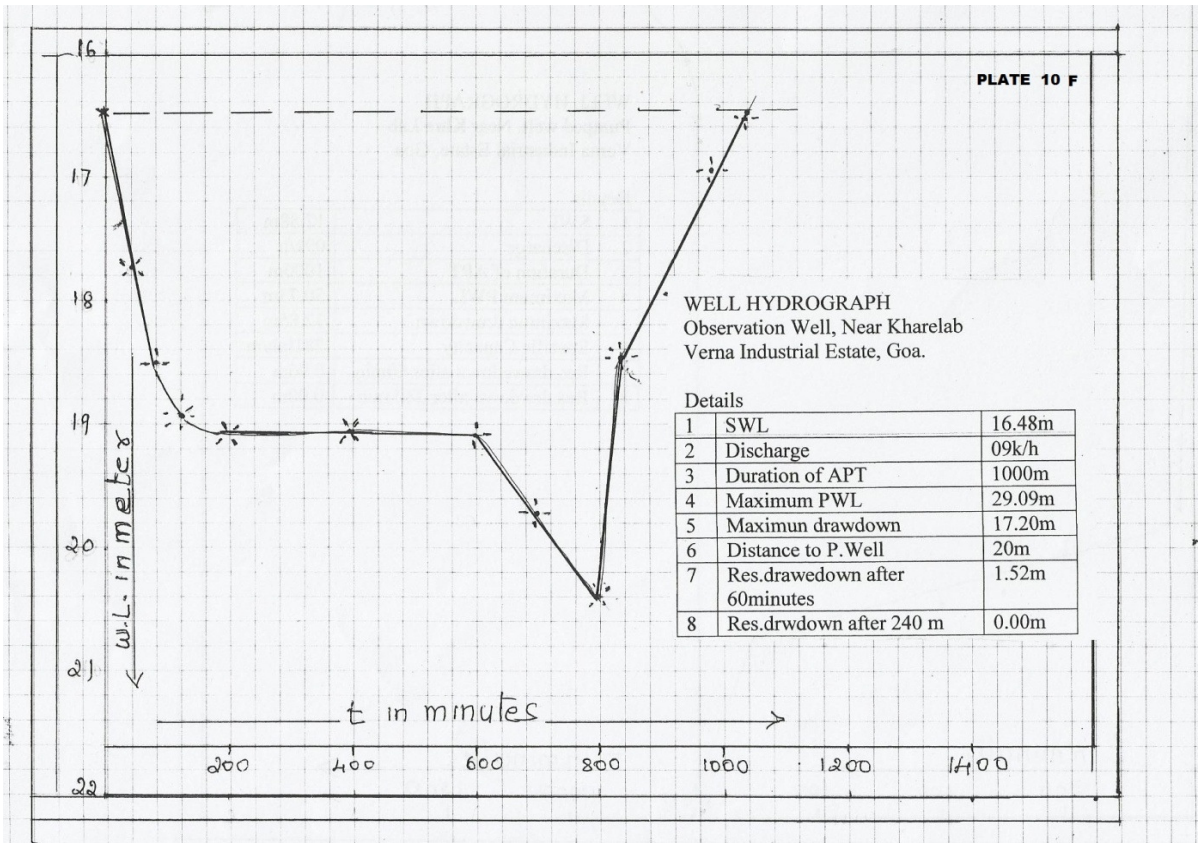
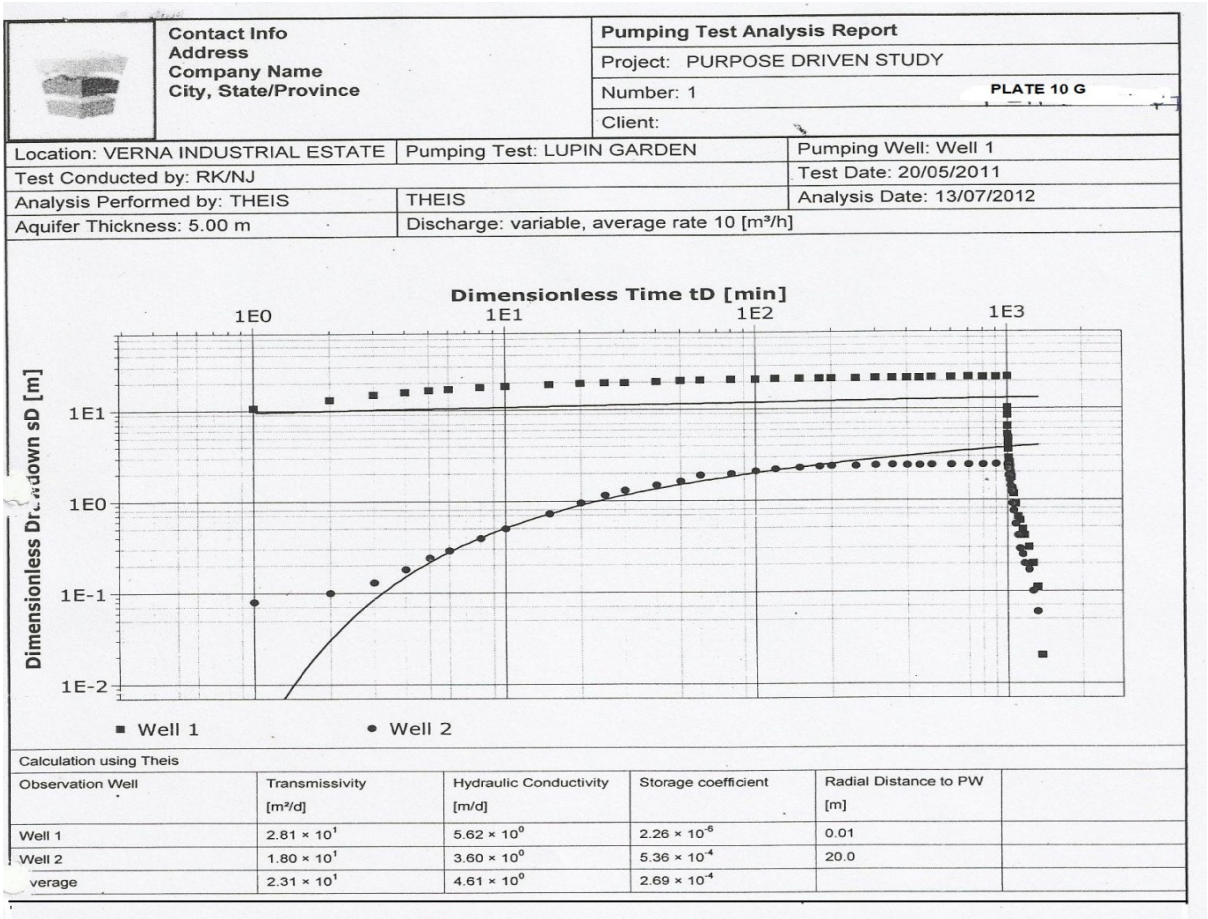
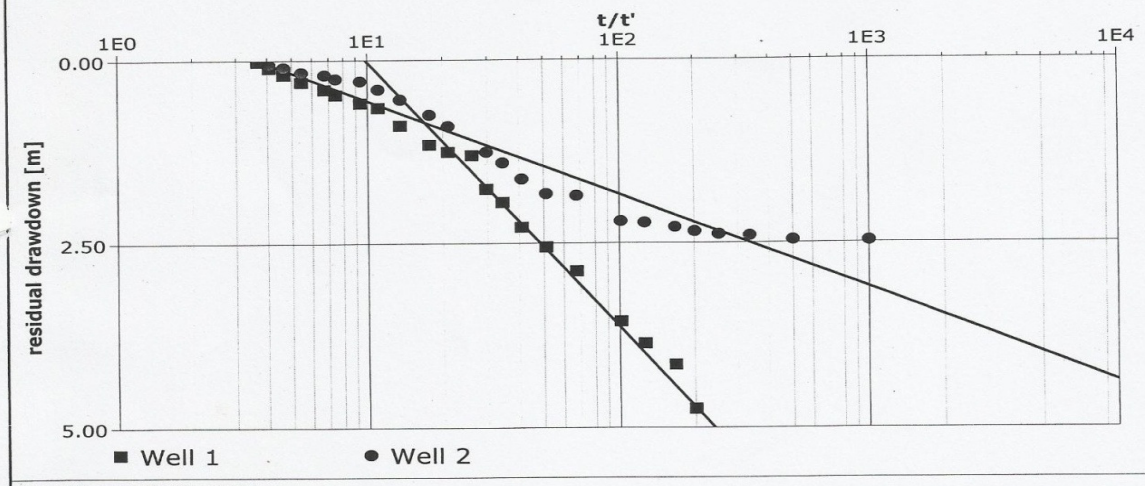


PLATE 10 F
16
17
18
19
20
21
22
w.L. in meters
t in minutes
200
400
600
800
1000
1200
1400
WELL HYDROGRAPH
Observation Well, Near Kharelab
Verna Industrial Estate, Goa.
Details
1 SWL 16.48m
2 Discharge 09k/h
3 Duration of APT 1000m
4 Maximum PWL 29.09m
5 Maximun drawdown 17.20m
6 Distance to P.Well 20m
7 Res.drawedown after 60minutes 1.52m
8 Res.drwdown after 240 m 0.00m


Contact Info
Address
Company Name
City, State/Province
Pumping Test Analysis Report
Project: PURPOSE DRIVEN STUDY
Number: 1
PLATE 10 G
Client:
Location: VERNA INDUSTRIAL ESTATE
Pumping Test: LUPIN GARDEN
Pumping Well: Well 1
Test Conducted by: RK/NJ
Test Date: 20/05/2011
Analysis Performed by: THEIS
THEIS
Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m
Discharge: variable, average rate 10 [m³/h]
Dimensionless Time tD [min]
1E0
1E1
1E2
1E3
Dimensionless Drawdown sD [m]
1E1
1E0
1E-1
1E-2
Well 1
Well 2
Calculation using Theis
Observation Well
Transmissivity [m²/d]
Hydraulic Conductivity [m/d]
Storage coefficient
Radial Distance to PW [m]
Well 1 2.81 × 10¹ 5.62 × 10⁰ 2.26 × 10⁻⁵ 0.01
Well 2 1.80 × 10¹ 3.60 × 10⁰ 5.36 × 10⁻⁴ 20.0
verage 2.31 × 10¹ 4.61 × 10⁰ 2.69 × 10⁻⁴

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report	PLATE 10 H
	Project: PURPOSE DRIVEN STUDY	
	Number: 1	
	Client:	

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: LUPIN GARDEN	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 20/05/2011
Analysis Performed by: THEIS RECOVERY	THEIS RECOVERY	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

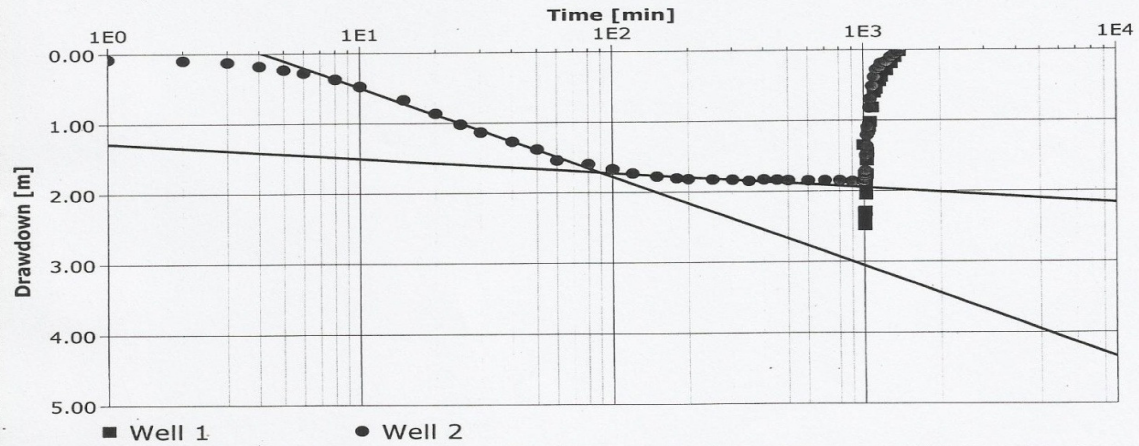


Calculation using THEIS & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial Distance to PW [m]
Well 1	1.22×10^{1}	2.43×10^{0}	0.01
Well 2	3.45×10^{1}	6.91×10^{0}	20.0
Average	2.34×10^{1}	4.67×10^{0}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report	
	Project: PURPOSE DRIVEN STUDY	
	Number: 1	PLATE 10 I
	Client:	

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: LUPIN GARDEN	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 20/05/2011
Analysis Performed by: COOPER	COOPER AND JACOB I	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

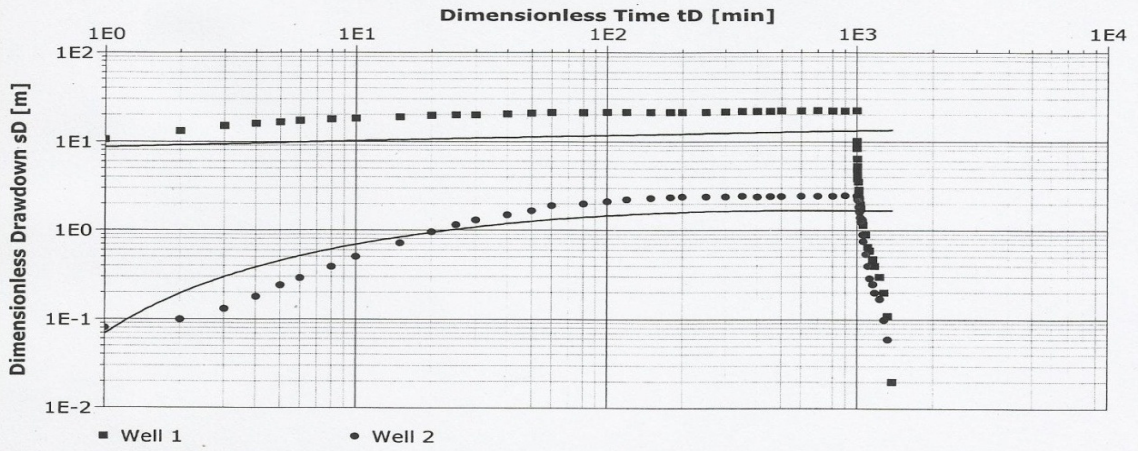


Calculation using COOPER & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]
Well 1	1.98×10^{2}	3.96×10^{1}	8.26×10^{-3}	0.01
Well 2	3.43×10^{1}	6.86×10^{0}	5.48×10^{-4}	20.0
Average	1.16×10^{2}	2.32×10^{1}	4.40×10^{-3}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 PLATE 10 J Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: LUPIN GARDEN	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 20/05/2011
Analysis Performed by: MOENCH	MOENCH FRACTURE	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

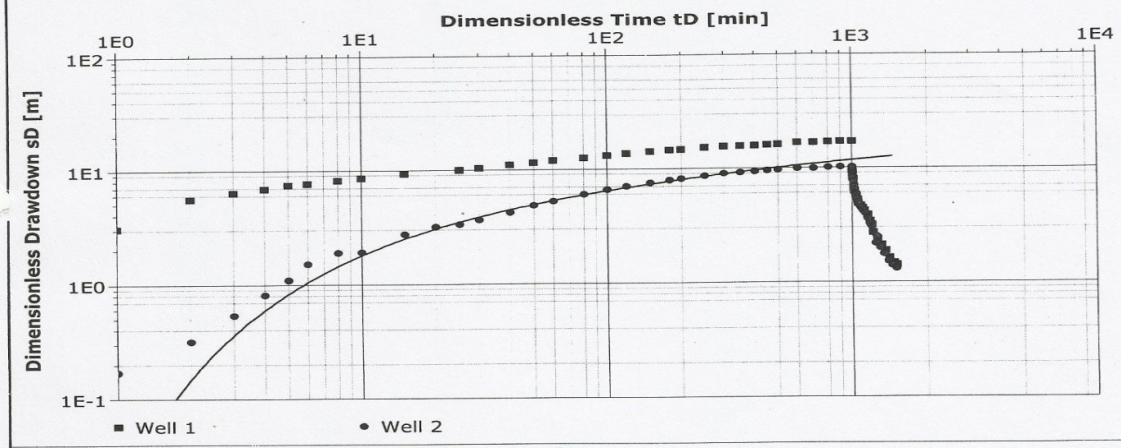


Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	2.08×10^{1}	4.17×10^{0}	1.04×10^{-6}	1.13×10^{3}	6.46×10^{0}	1.05×10^{-7}	0.01
Well 2	3.28×10^{1}	6.57×10^{0}	2.70×10^{-4}	1.00×10^{5}	1.98×10^{-3}	1.00×10^{3}	20.0
Average	2.68×10^{1}	5.37×10^{0}	1.36×10^{-4}	5.06×10^{4}	3.23×10^{0}	5.00×10^{2}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 PLATE 10 K Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: CIPLA	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 18/05/2011
Analysis Performed by: THEIS	THEIS	Analysis Date: 12/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

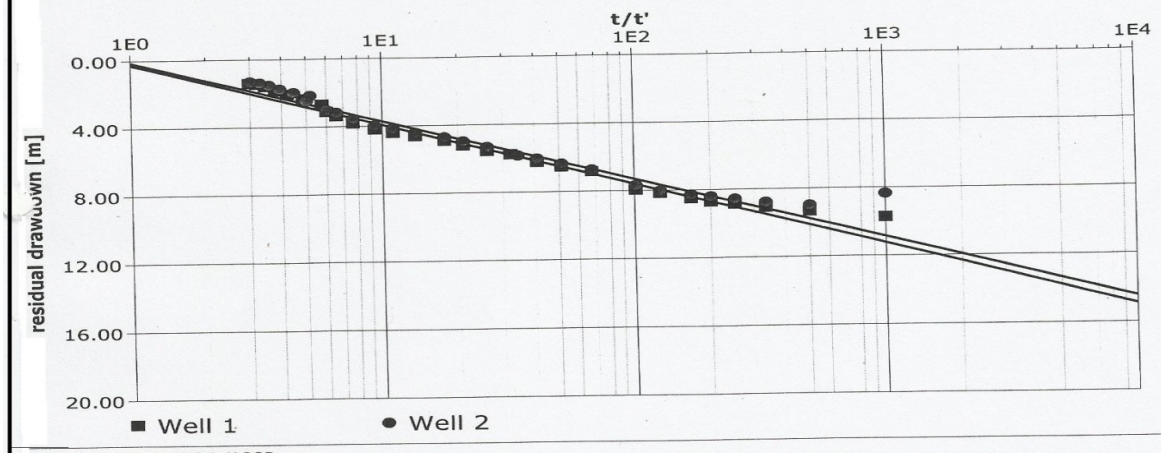


Calculation using Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]
Well 1	5.20×10^{0}	1.04×10^{0}	3.93×10^{-30}	0.01
Well 2	5.45×10^{0}	1.09×10^{0}	1.36×10^{-4}	20.0
Average	5.33×10^{0}	1.07×10^{0}	6.82×10^{-5}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 PLATE 10 L Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: CIPLA	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 18/05/2011
Analysis Performed by: THEIS RECOVERY	THEIS RECOVERY	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

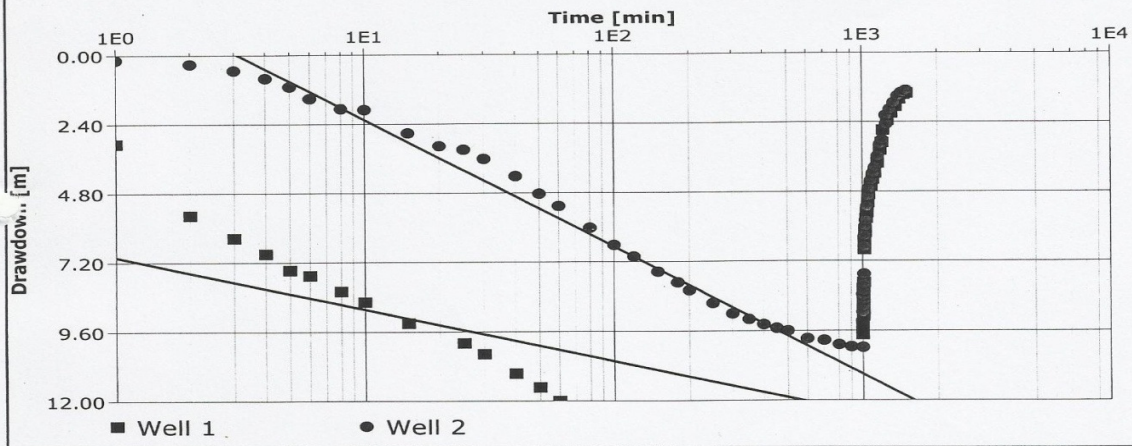


Calculation using THEIS & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial Distance to PW [m]
Well 1	1.23×10^{1}	2.45×10^{0}	0.01
Well 2	1.20×10^{1}	2.40×10^{0}	20.0
Average	1.21×10^{1}	2.43×10^{0}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 PLATE 10 M Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: CIPLA	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 18/05/2011
Analysis Performed by: COOPER	COOPER AND JACOB I	Analysis Date: 12/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

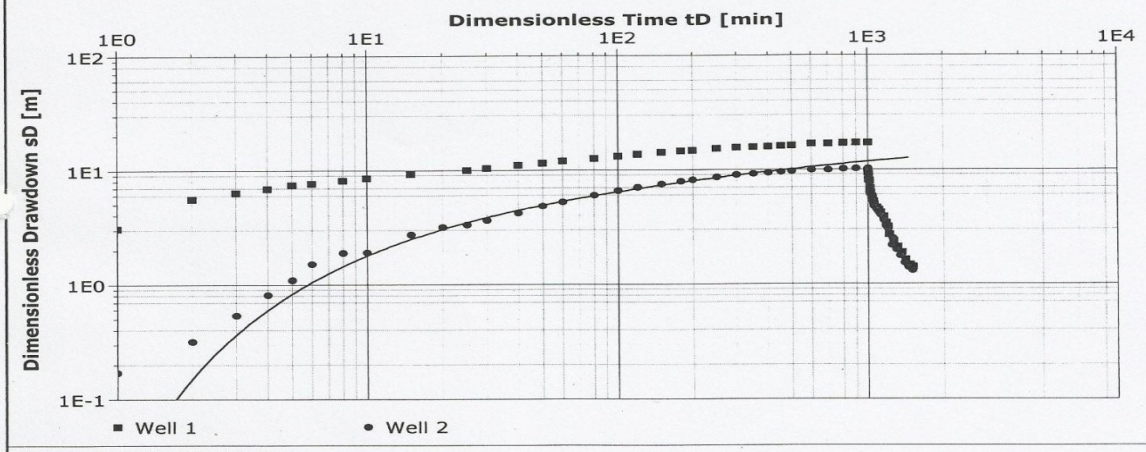


Calculation using COOPER & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]
Well 1	2.44×10^{1}	4.87×10^{0}	7.61×10^{-2}	0.01
Well 2	9.92×10^{0}	1.98×10^{0}	1.20×10^{-4}	20.0
Average	1.71×10^{1}	3.43×10^{0}	3.81×10^{-2}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 N** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: CIPLA	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 18/05/2011
Analysis Performed by: MOENCH	MOENCH FRACTURE	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

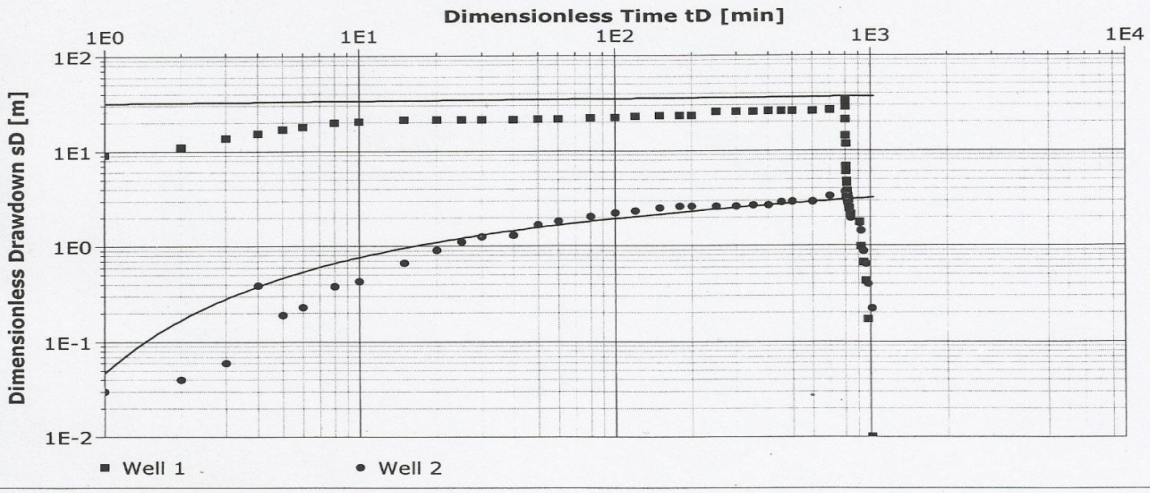


Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	4.53×10^{-2}	9.07×10^{-3}	6.89×10^{-5}	1.00×10^{0}	1.61×10^{0}	1.00×10^{-7}	0.01
Well 2	5.45×10^{0}	1.09×10^{0}	1.36×10^{-4}	1.12×10^{1}	3.98×10^{-14}	2.51×10^{2}	20.0
Average	2.75×10^{0}	5.50×10^{-1}	1.03×10^{-4}	6.11×10^{0}	8.03×10^{-1}	1.26×10^{2}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 O** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: KARE LAB	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 24/05/2011
Analysis Performed by: THEIS	THEIS	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 9 [m³/h]	

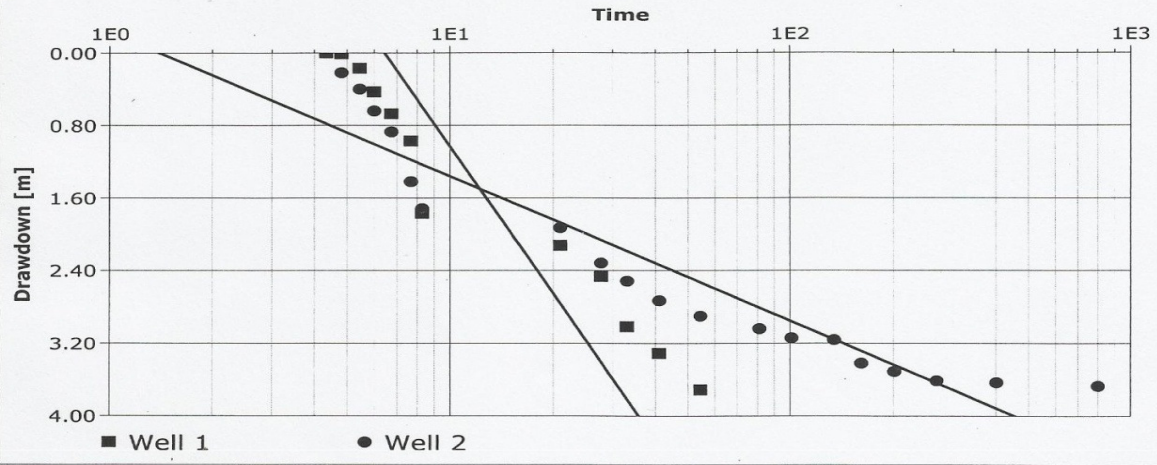


Calculation using Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 1	1.81×10^{1}	3.61×10^{0}	5.10×10^{-17}	0.01	
Well 2	2.44×10^{1}	4.87×10^{0}	2.70×10^{-4}	20.0	
Average	2.12×10^{1}	4.24×10^{0}	1.35×10^{-4}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 P** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: KARE LAB	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 24/05/2011
Analysis Performed by: THEIS RECOVERY	THEIS RECOVERY	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 9 [m³/h]	

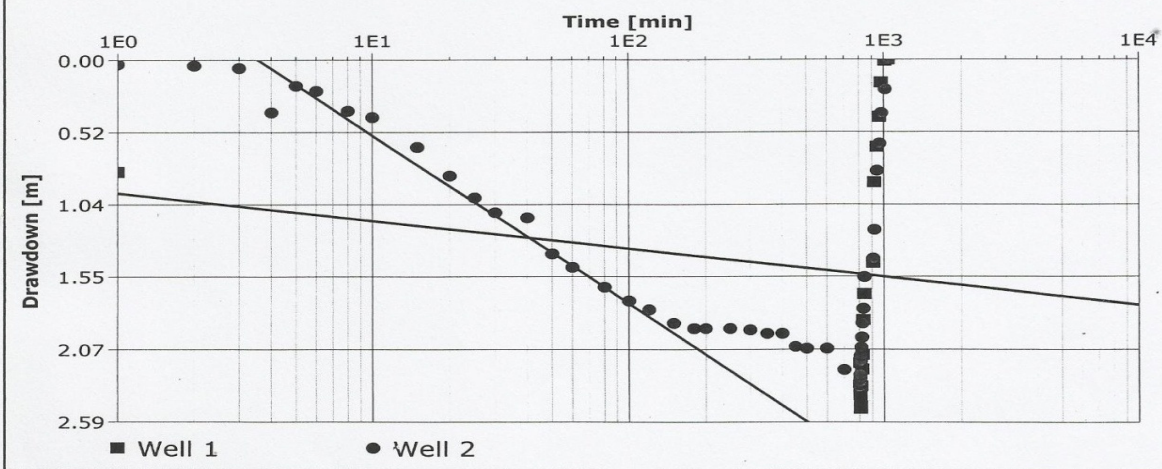


Calculation using THEIS & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Ratio K(v)/K(h)	Radial Distance to PW [m]	
Well 1	7.35×10^{0}	1.47×10^{0}	1.45×10^{-1}	0.01	
Well 2	2.48×10^{1}	4.96×10^{0}	0.00×10^{0}	20.0	
Average	1.61×10^{1}	3.21×10^{0}	7.23×10^{-2}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 Q** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: KARE LAB	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 24/05/2011
Analysis Performed by: COOPER	COOPER AND JACOB I	Analysis Date: 09/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 9 [m³/h]	

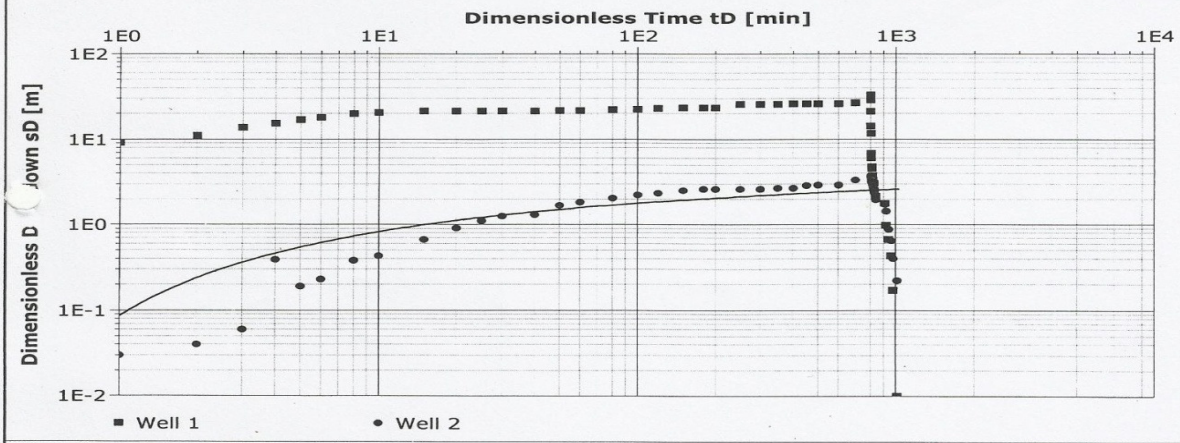


Calculation using COOPER & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 1	1.97×10^{2}	3.95×10^{1}	8.48×10^{-2}	0.01	
Well 2	3.28×10^{1}	6.57×10^{0}	4.55×10^{-4}	20.0	
Average	1.15×10^{2}	2.30×10^{1}	4.26×10^{-2}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 R** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: KARE LAB	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 24/05/2011
Analysis Performed by: MOENCH	MOENCH FRACTURE	Analysis Date: 13/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 9 [m³/h]	

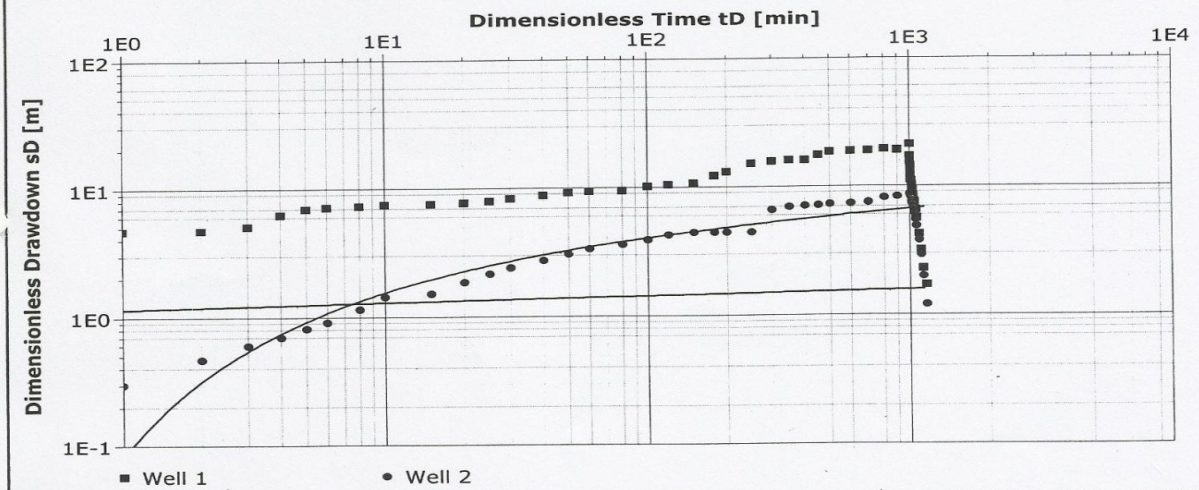


Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	2.73×10^{-1}	5.46×10^{-2}	1.36×10^{-4}	2.00×10^{4}	9.12×10^{-3}	2.00×10^{1}	0.01
Well 2	2.42×10^{1}	4.84×10^{0}	1.92×10^{-4}	6.75×10^{0}	2.67×10^{-5}	1.12×10^{-7}	20.0
Average	1.22×10^{1}	2.45×10^{0}	1.64×10^{-4}	9.98×10^{3}	4.57×10^{-3}	9.98×10^{0}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 S** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: GIDC	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 03/06/2011
Analysis Performed by: THEIS	THEIS	Analysis Date: 09/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

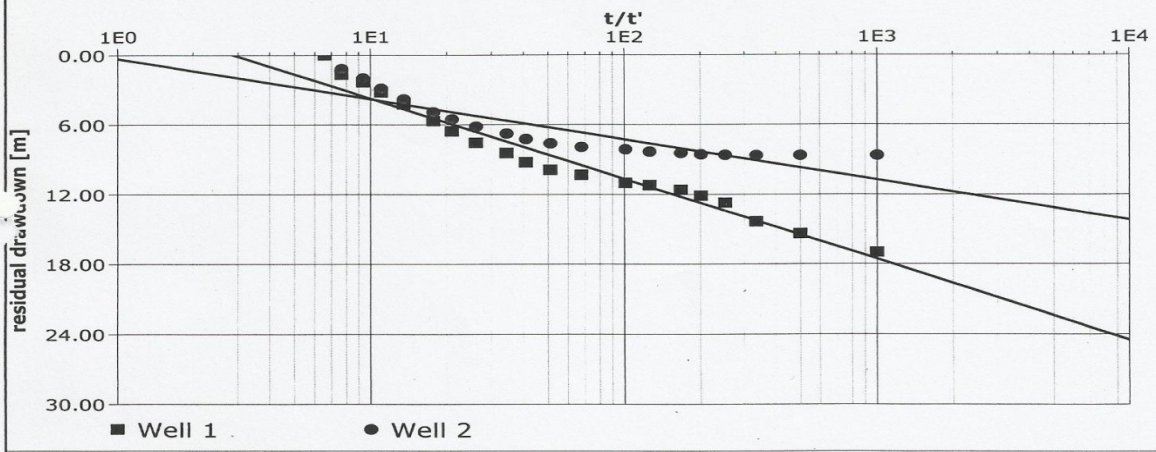


Calculation using Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 1	2.67×10^{2}	5.34×10^{1}	3.48×10^{-5}	0.01	
Well 2	1.40×10^{1}	2.79×10^{0}	1.68×10^{-4}	20.0	
Average	1.40×10^{2}	2.81×10^{1}	1.02×10^{-4}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 T** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: GIDC	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 03/06/2011
Analysis Performed by: THEIS RECOVERY	THEIS RECOVERY	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

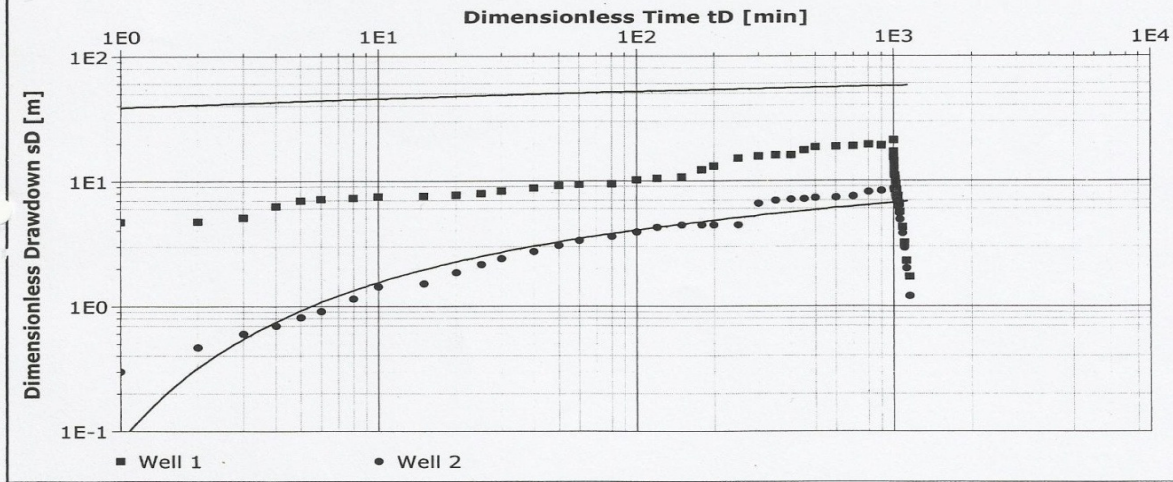


Calculation using THEIS & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial Distance to PW [m]
Well 1	6.36×10^{0}	1.27×10^{0}	0.01
Well 2	1.27×10^{1}	2.53×10^{0}	20.0
Average	9.52×10^{0}	1.90×10^{0}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 U** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: GIDC	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 03/06/2011
Analysis Performed by: MOENCH	MOENCH FRACTURE	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 10 [m³/h]	

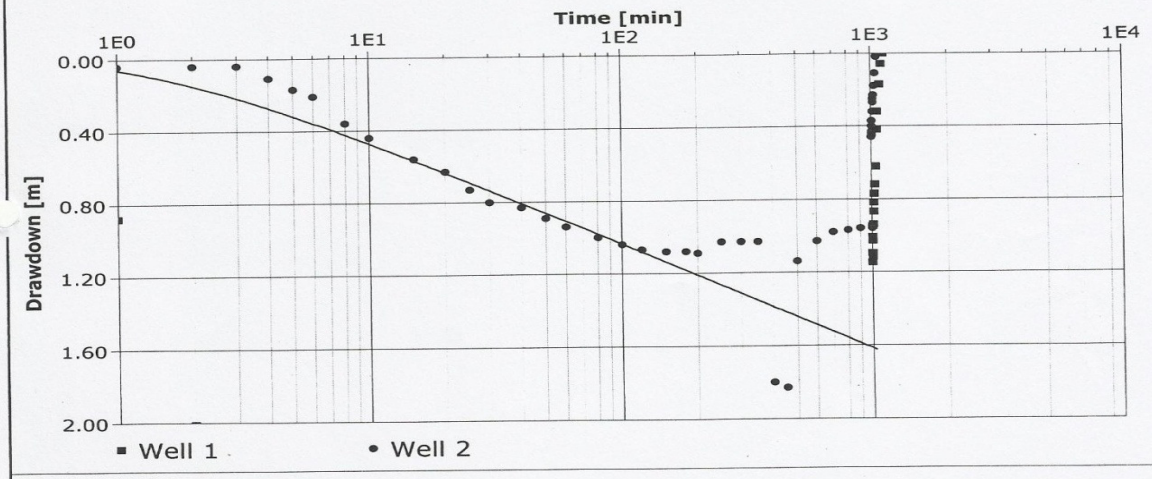


Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	5.45×10^{0}	1.09×10^{0}	2.70×10^{-4}	1.00×10^{0}	3.02×10^{-3}	1.00×10^{3}	0.01
Well 2	1.40×10^{1}	2.79×10^{0}	1.68×10^{-4}	1.00×10^{0}	1.00×10^{-15}	1.00×10^{-7}	20.0
Average	9.71×10^{0}	1.94×10^{0}	2.19×10^{-4}	1.00×10^{0}	1.51×10^{-3}	5.00×10^{2}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 V** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: MARDOL TEMPLE	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 26/05/2011
Analysis Performed by: THESIS	THEIS	Analysis Date: 09/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 12 [m³/h]	

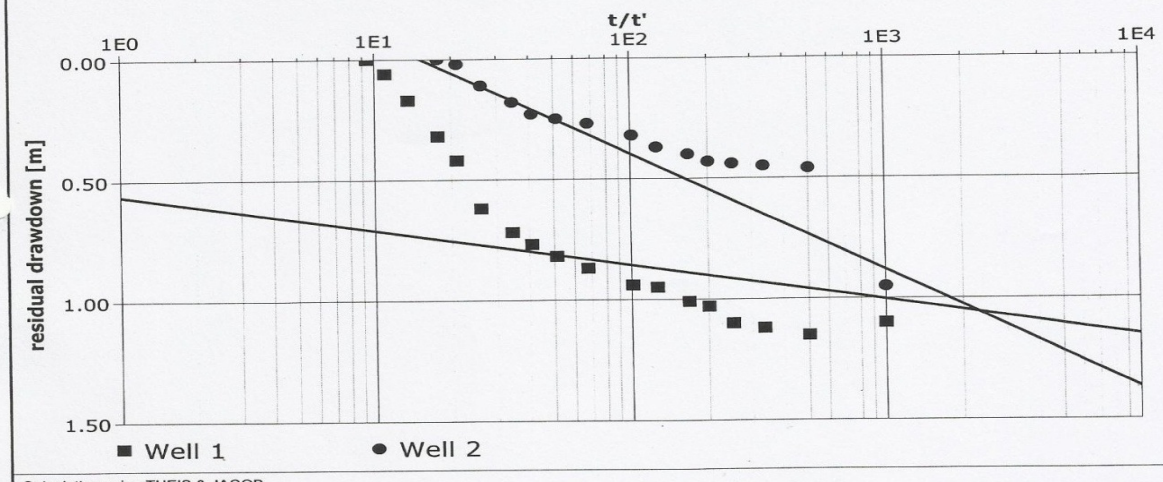


Calculation using Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 1	1.81×10^{1}	3.61×10^{0}	2.69×10^{-9}	0.01	
Well 2	8.06×10^{1}	1.61×10^{1}	5.36×10^{-4}	20.0	
Average	4.93×10^{1}	9.87×10^{0}	2.68×10^{-4}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 W** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: MARDOL TEMPLE	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 26/05/2011
Analysis Performed by: THEIS RECOVER	YTHEIS RECOVERY	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 12 [m³/h]	

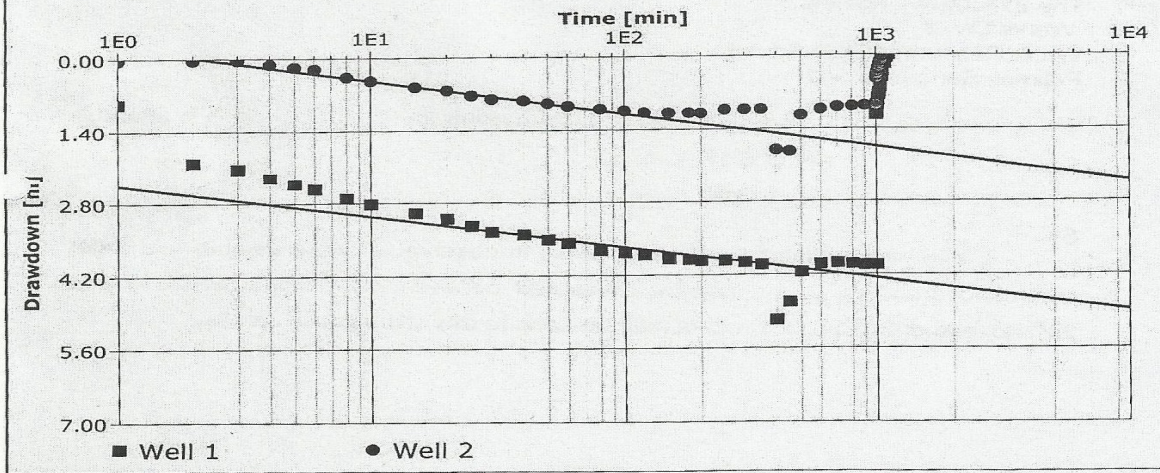


Calculation using THEIS & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial Distance to PW [m]	
Well 1	3.60×10^{2}	7.20×10^{1}	0.01	
Well 2	1.09×10^{2}	2.18×10^{1}	20.0	
Average	2.34×10^{2}	4.69×10^{1}		

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 X** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: MARDOL TEMPLE	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 26/05/2011
Analysis Performed by: COOPER	COOPER AND JACOB I	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 12 [m³/h]	

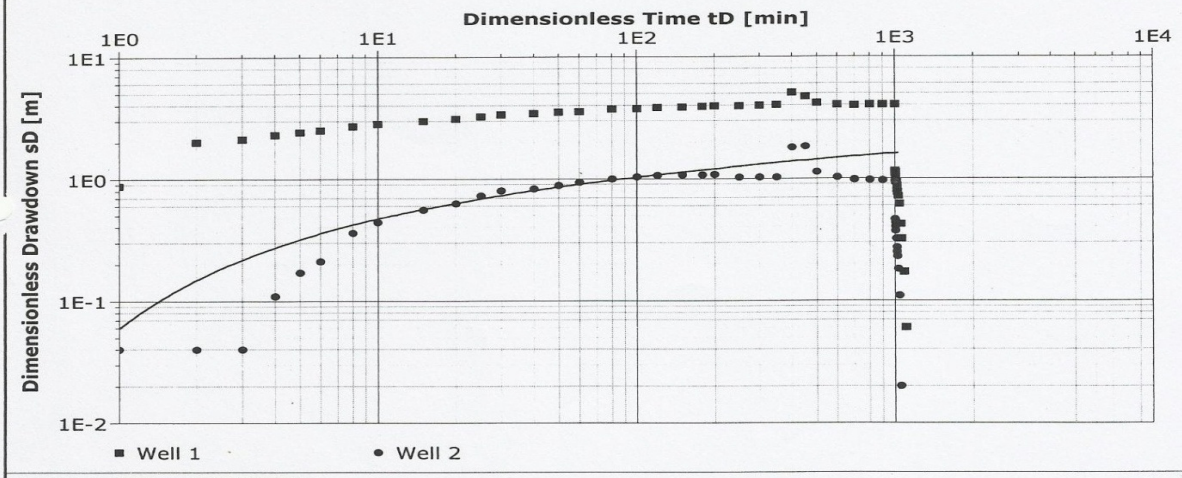


Calculation using COOPER & JACOB

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]
Well 1	8.64×10^{1}	1.73×10^{1}	2.07×10^{-1}	0.01
Well 2	8.06×10^{1}	1.61×10^{1}	6.75×10^{-4}	20.0
Average	8.35×10^{1}	1.67×10^{1}	1.04×10^{-1}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report Project: PURPOSE DRIVEN STUDY Number: 1 **PLATE 10 Y** Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: MARDOL TEMPLE	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 26/05/2011
Analysis Performed by: MOENCH	MOENCH FRACUTE	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 12 [m³/h]	

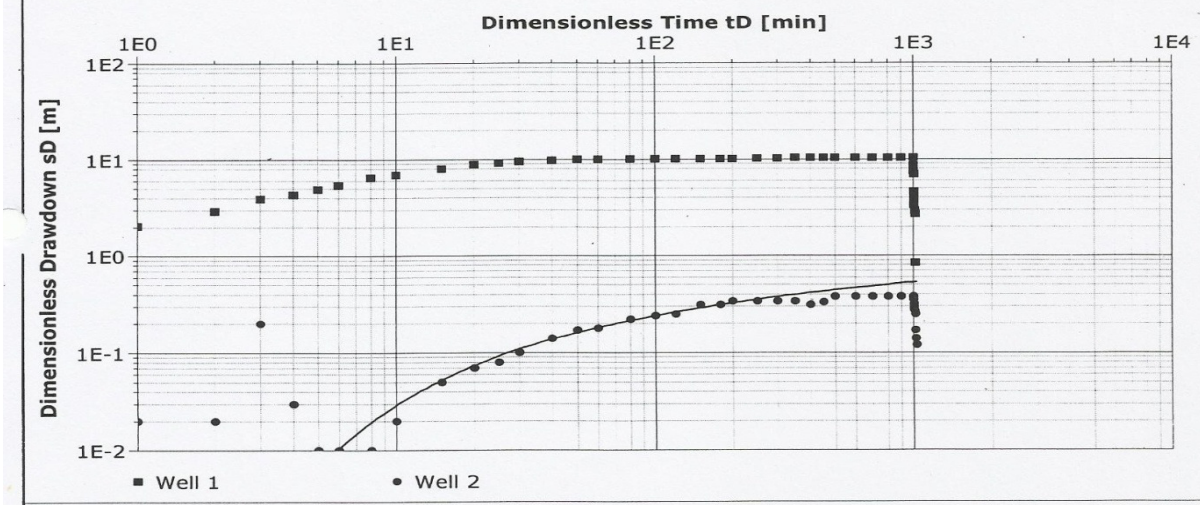


Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	2.55×10^{1}	5.11×10^{0}	2.38×10^{-28}	1.00×10^{5}	1.00×10^{-15}	1.14×10^{2}	0.01
Well 2	8.06×10^{1}	1.61×10^{1}	5.36×10^{-4}	3.55×10^{2}	2.75×10^{-6}	5.01×10^{-1}	20.0
Average	5.31×10^{1}	1.06×10^{1}	2.68×10^{-4}	5.02×10^{4}	1.38×10^{-6}	5.72×10^{1}	

Contact Info Address Company Name City, State/Province	Pumping Test Analysis Report
	Project: PURPOSE DRIVEN STUDY
	Number: 1 **PLATE 10 Z**
	Client:

Location: VERNA INDUSTRIAL ESTATE	Pumping Test: COCO COLA SUMP	Pumping Well: Well 1
Test Conducted by: RK/NJ		Test Date: 01/06/2011
Analysis Performed by: MOENCH	MOENCH FRACTURE	Analysis Date: 15/07/2012
Aquifer Thickness: 5.00 m	Discharge: variable, average rate 4 [m³/h]	



Calculation using Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Well 1	3.69×10^{-1}	7.37×10^{-2}	2.70×10^{-4}	5.01×10^{1}	1.00×10^{-1}	1.00×10^{0}	0.01
Well 2	5.50×10^{1}	1.10×10^{1}	4.80×10^{-8}	7.94×10^{4}	2.51×10^{-1}	5.01×10^{0}	20.0
Average	2.77×10^{1}	5.54×10^{0}	1.35×10^{-4}	3.97×10^{4}	1.76×10^{-1}	3.01×10^{0}	

PLATE 11

CONTACT SPRING AT KESARVAL

PLATE 12

CONTACT SPRING AT PATON VERNA GOA

PLATE 13 A

Gravity spring within Laterite Middle of Plateau Near Raheja industries

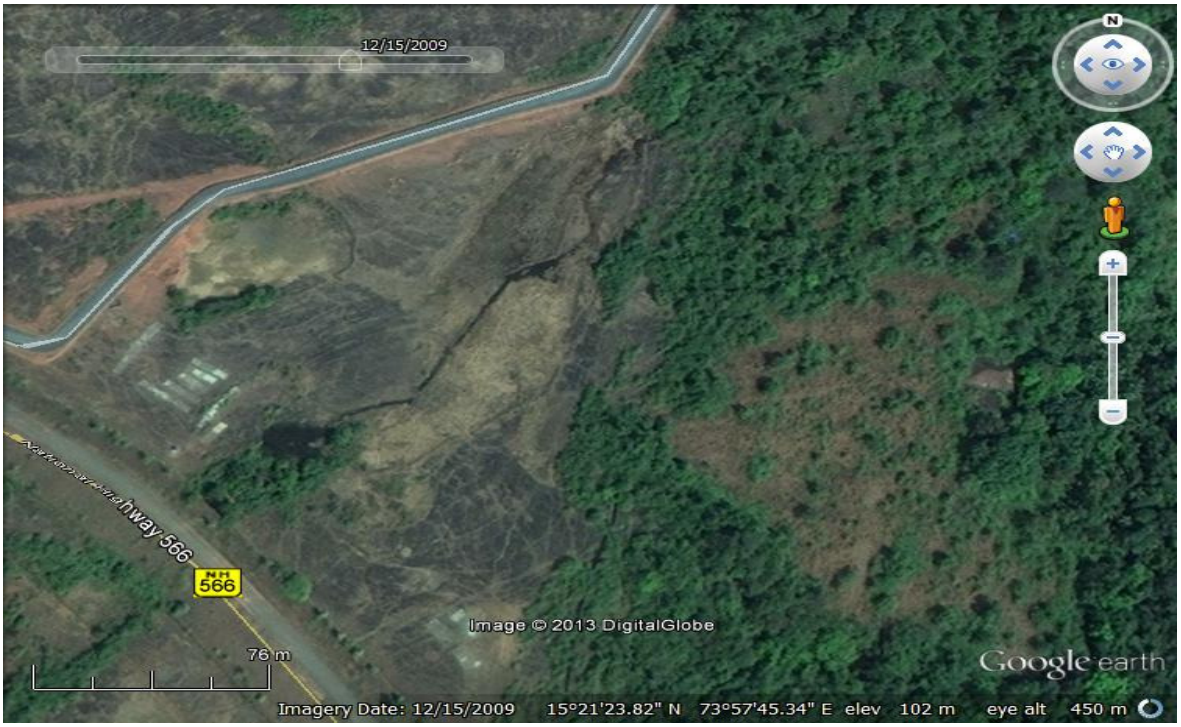


PLATE 13 B

SPRING POND ON THE PLATEAU NEAR CIPLA REAR GATE

ERROR: undefined
OFFENDING COMMAND: f‘~

STACK: