

# **Geo Water (Pvt )Ltd**


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## **REPORT ON THE HYDROGEOLOGICAL ENVIORNMENT OF THE GROUND WATER SOURCE OF MIST BOTTLED DRINKING WATER PLANT AT MAKANDURA-GONAWILA**

  
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# **HYDROGEOLOGICAL AND GEOPHYSICAL INVESTIGATION AT THE PREMISES OF MIST BOTTLED DRINKING WATER PLANT – MAKANDURA, GONAWILA**

## **1.0 INTRODUCTION**

As requested by Mr. Gamini Wijesingha, Managing Director of MIST Mineral Waters Pvt Ltd, at the above location, detail hydro geological and geophysical investigations with regard to the availability and potential of ground water and the pumping test have been carried out on 01<sup>st</sup> December 2011. It is expected to provide sufficient amount of good quality water for the drinking water bottling plant. This supply should be permanent and steady through out the year without having any water shortage. The water source is consisting with a properly constructed deep tube well located within the premises of bottling plant. The estimated water requirement including washing and cleaning purposes of the plant is reported as 20,000 liters per day. Recently constructed deep tube well is supposed to feed safe drinking water for the bottling plant.

### **1.1 The main objectives of the study were**

- Identification of the hydrogeological background of underlined shallow and deep aquifers for long term prospecting both qualitatively and quantitatively satisfactory
- Assess the nature of the water source and productivity of aquifers
- Study of any possible contamination and pollution risk during operation
- Asses the suitability of water for bottling purposes
- Assess the extractable safe limits and possible environment impacts

## **2.0 GENERAL DESCRIPTION OF THE AREA**

The investigated land is situated about 200 meters away from 32 Km post and 800 meters towards to 31 Km post on Pannal-Negombo main road. The studied land is in Makandura area belongs to Pannala DS division of Kurunegala District in Northwestern province of Srilanka. (Please see the attached map and Sketch). The study land is falling in to Kochchikade 1:50000 topographic map having the geographical co-ordinates of 79°59'42" longitudes and 07°19'45" latitudes taken from Dandagamuwa one inch topographic map.



Tropical climatic conditions prevail in this area with clearly defined wet & dry seasons. The yearly rainfall variations are small and changing according to the rainfall pattern which follows monsoon system. The average daily temperature varies in the range of 25°C to 33° C during the year. The humidity is comparatively high and it is generally in the range of 76% to 88%. The potential evapo transpiration varies in the range of 80mm to 112 mm per month. The annual rainfall is within the range from 2000mm to 2500mm. This rainfall is total of both southwest and northeast monsoon periods with the high intensity of rainfall is expected during the months of June, July, October and November. The seasonal distribution of rainfall pattern is closely associated with the monsoon pattern. There is no specific evidence of completely dry years during the period of last 20 years.

The population density of the area is moderately developing and restricted due to existing of large extent of coconut and mix plantations. The extent of the investigated land is about 1.50 acres occupied by the factory buildings and the garden. Fertilizers, pesticides or any other soluble organic or inorganic substances are not applying at all to the garden. This land is covered by parapet walls. Boundaries of the investigated land area bound by Pradesheeya saba land in north, private land in west. Paddy fields in east and main road in south bound the other boundaries. (Please see the attached sketch) The area around the land is not highly populated and future development for industrialization and urbanization is limited. in the higher grounds occupy coconut, rubber and other mix plantations and homesteads. Lower grounds mainly occupy paddy fields and marshy lands. This land is bounded by Dolagatha road and private lands.

The study area is situated in the water shed of Mahaoya river basin and confined to the intermediate zone of Srilanka according to the classification based on rainfall.

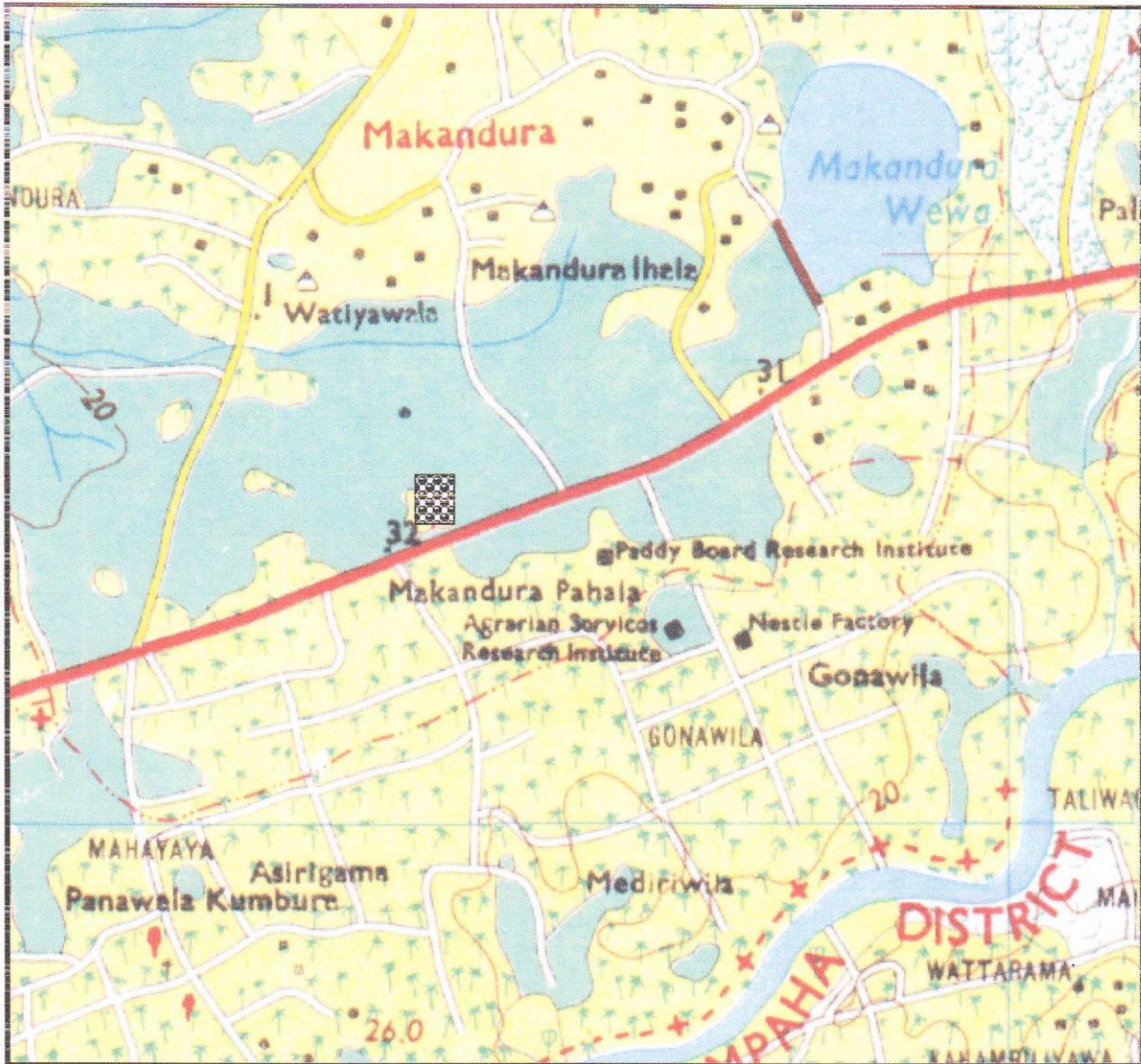
Udugampola area is a sub-urban area with moderate population density. The extent of the investigated land is about 04 acres occupied by the owner's residence, water bottling plant and mix crops.


### 3.0 METHODOLOGY

The proper investigation and assessment is an essential factor to be considered in groundwater development. Therefore prior to geophysical investigations a complete reconnaissance survey to be conducted to exclude the unfavorable zones is very important. Collect and collate of available hydrogeological, geophysical and water quality data are very important to plan out the entire groundwater investigation system. The hydro geological data were collected for the study including the analysis of topographical and geological maps, aerial photographs, yields of bore holes in respective areas, water level, total depths of existing shallow wells and bore holes, and electrical conductivities of water etc.



From Kochikade 1:50,000 topographic map



 Investigated area

### 3.1 Resistivity Method

The resistivity method is one of the most prominent methods in ground water prospecting. The Terrameter SAS 1000 which is comprised of battery powered deep penetration resistivity meter with an output sufficient for a current electrode separation of 200 meters under ground survey conditions.



### 3.2 Vertical Electrical Soundings

In this survey method a series of apparent resistivity measurements are made with expanding of current electrode separation. The current penetration depth is increased with the expanding of current electrode separation. Interpretation and analysis of curves plotted apparent resistivity against the current electrode separation gives the each layer resistivity and their relative thicknesses.

### 4.0 GEOMORPHOLOGY AND GEOLOGY

Geomorphologically the study area is characterized by flat topography where slightly elevated large coconut plantations and homesteads areas with broad valleys. Paddy fields and marshy areas occupy most of these low line areas and morphological depression. Investigated land is almost flat and available space for geophysical investigations is sufficient.

Rocks out crops are not visible in and around the land. The available geological maps and lithologs of drilled bore holes are revealed the nature of overburden and basement hard rocks of the study area. These rocks are identified as para gneisses with layered Hornblende Biotite Gneisses and Charnokitic Gneisses. This region falls in to Highland complex of Srilankan geological classification.

Geo structural features of the study area are not clearly visible as the lack of out crops in and around the area. The axis of Udubaddawa antiform lies in north-south direction almost east to the land. Many weak zones are delineated along these directions occupied by paddy fields and perennial streams. Surface water movement paths such as valleys, fractures and fissures are often penetrates the underground litho logic structures along which most groundwater movements are in significance. Water bearing secondary developed fractures in basement rocks can be expected in deeper levels along these geo structural features.

The overburden of investigated land is mainly consisting with grayish brown loamy and sandy soils which are developed on the deeply weathered gneisses. Litho logs of shallow bore holes and excavated pits indicated the interlayer sequence of underlined layers which have been identified. Source tube well is located on a flat terrain with thick overburden soil layer. This formation is favorable for groundwater retention due to porosity and permeability. These characteristic are mainly governing the availability of groundwater in any formation. Thickness of overburden is about 15-17 meters followed by weathered and fragmented basement rock. This fractured portion of hard rock is identified as the productive aquifer for the bottling purpose.

### 5.0 HYDROGEOLOGY

One dug well and source tube well are located within the investigated land. The deep tube well is supposed to feed water for the bottling plant. Technical data of these source tube well and dug well are given below.

### Source Tube Well

Description	Dimensions
Total Depth	50.00 meters below ground level.
Water Level	1.37 mbgl
Electrical conductivity of water	198 $\mu\text{s/cm}$
Overburden thickness	17.00 m
Blank PVC Casings	17.00 m
Screen PVC Casings	Not inserted
PVC Diameter	225 mm
Rock hole Diameter	165 mm
Rock hole depth	17.00m-50.00m
Yield (lpm)	400 litres/minute

### Dug Well

Well	Depth (mbgl)	Water Level(mbgl)	Electrical Conductivity ( $\mu\text{s/cm}$ )	Remarks
Dug well	4.60	1.52	560	concrete rings were inserted with gravel pack.

A constructional detail of the source tube well is given in attached cross section of the well.

- mbgl: meters below ground level      \*  $\mu\text{s/cm}$ : microsiemens per centimeter

This source well is excavated through the bed rock to the depth of 50 meters below ground level. Hydrogeologically the area is confined to the Mahaoya river basin.

Hydrogeological conditions of the area are favorable for groundwater development as the area consists of considerable amount of good quality ground water within the deep aquifers. The rechargeable area around the source well is highly favorable for ground water. The potential catchment area of the aquifer, which supplies adequate groundwater to the source well, is satisfactory with respect to the estimated water demand. The rechargeable conditions may be high in this aquifer as the deep fracture system is connected to the main lineaments and minor lineaments according to the regional behavior of the area.

Particularly when considering the ground water extraction from this investigated land it is recommended to extract ground water from confined fractured aquifer lies within the bed rock.

### 6.0 INVESTIGATION RESULTS AND DISCUSSION

According to the analytical results of the hydrogeological and geo-electrical soundings the formations are classified as follows at the source tube well shown in attached sketch.



Depth Range (m)	Geological Formation
0.00-2.00	Upper most brown clayey soil
2.00-17.00	Interlayered clayey soil and sand and silt mix clay soils
17.00-30.00	Weathered and fragmented rock
30.00-50.00	Fractured rock
>50.00	Hard and massive Basement rock

The groundwater in deep aquifer can be expected in good quality and within the WHO and Sri Lanka Standards and in ideal conditions for water bottling industry. Proper well design has been implemented for the completion of the well by inserting blank PVC casings to the bed rock. This will never allow free flow of subsurface groundwater in to the well. Water is only extracting from the fractures of hard rock. Any environmental impacts may not be created while pumping the well because the recharge conditions are highly favorable.

Extraction of the groundwater through the well should be done on a systemic way. Therefore prior to consumption it is very important to get recommendations from a suitable pumping test. This test is essential and recommendations should follow to get optimum usage of this well for long term groundwater prospecting. The overall studies revealed that a considerable amount of water with good quality could be extracted through out the year from the said aquifer of the existing source well.

## 7.0 PUMPING TEST

Constant Discharge Test has been carried out with constant discharge rate considering expected water demand per day for the drinking water bottling plant. The expected water demand is about 20,000 liters per day for bottling and washing. Well dimensions are given in following table.

### 7.1 WELL DIMENSIONS

ITEM	DESCRIPTION
Total Depth	50.00 mbgl
Static Water Level	1.37 mbgl
Water Quality (Electrical Conductivity)	198 $\mu$ s/cm

### 7.2 Constant Discharge Test

The flow rate adjusted using the gate valve of the installed submersible pump. This well was pumped with a constant discharge rate of 250 liters per minute and monitored changing of water levels in the source well by using electrical water level recorders. Prior to commence the test the measured initial



water level was at 1.42 meters below the ground level. During the test water level of the pumping well and nearest dug well, discharge and electrical conductivity were monitored. After three hours of pumping gradually water level was stabilized and steady state was indicated. Then the pump was shut and monitored recovery of well water level. Observed final water level at the end of pumping was 2.32 meters below ground level. The reported draw down was 0.90 meters. At the end of the pumping the measured discharge rate was 250 liters per minute. At the initial stage the measured electrical conductivity was 198us/cm and the end of test it was 198 us/cm. At the end of pumping the pump was shut off and started to take water levels while getting recovery. The water level in the well was recovered up to static water level within 120 minutes.

No considerable depletion of water level was recorded during the pumping period in nearest dug well. There is no significant ground water depletion within the area when pumping from the source well keeping the discharge rate at 250 liters per minute with reasonable time intervals. There was no considerable water level depletion observed around the source well. The required quantity of water could be obtained from this well without creating any environmental impacts. The details of recommended pumping time, installation depth of foot valve and pumping rate are tabulated in the following table in order to utilize the well with long term sustainability.

Source Well	Total Depth	Pump installation depth	Pumping Rate Liters/minute	Pumping hours Per day	Recommended Quantity per day
	50.00 m	25.00 m	250	02	30000

Although the well is capable to provide large amount of water, the recommended maximum pumping duration is 05 hours per day for this well considering the present requirement. It is advisable to keep 02 hour break for two hours pumping to allow recharge the aquifer. Therefore the well efficiency is satisfied. This recommendation should follow to avoid any future possible failures during long time pumping. It is also advisable to conduct another pumping test after using the well for three years period.

## 8.0 WELL HEAD PERIMETER PROTECTION

According to the observations and results of the survey and pumping test, it can be concluded that no adverse effects were observed during pumping test to the water level. Instructions were given to clean and clear the area around the source well to avoid contamination from disposals and garbage. As the water is extracting from the deep fractures of hard rock, the possibilities for contamination is seems to be very low. Therefore the well head perimeter is protected. Septic tanks were located about 148feet away from the source tube well. Instructions were given to maintain this favorable environment regularly to protect the aquifers which provide safe drinking water to the well.

According to the analysis of pumping test data and the hydro geological back ground of the area around the well, **the perimeter of protection area is recommended as 100 feet radius from the well.** Client must follow up necessary instructions to allow free flow of good quality groundwater in to the source well.

  
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## 9.0 RECOMMEDATIONS

The results of the investigation revealed that the ground water potential of the underlined unconfined aquifers in the area is satisfactory both qualitatively and quantitatively to obtain estimated amount of 18000 liters per day.


The water qualities, bacteriological and chemical contents of the source well were inspected and all of them are in permissible ranges of drinking water standards of SLS. The well water should be tested prior to consumption and monitored periodically at least twice a year in dry and wet periods. It also indicated that the possibility of contamination or pollution in the area during long term extraction is very low and can be minimized by adopting correct methodology as the topographical, geological and hydro geological nature of the formations in the investigated area where the source well located is satisfactory. It is highly advisable to follow the recommended safe pumping rate and period in order to achieve the maximum efficiency. Over pumping may affect the water table in the surrounding area.

  
07/12/2011

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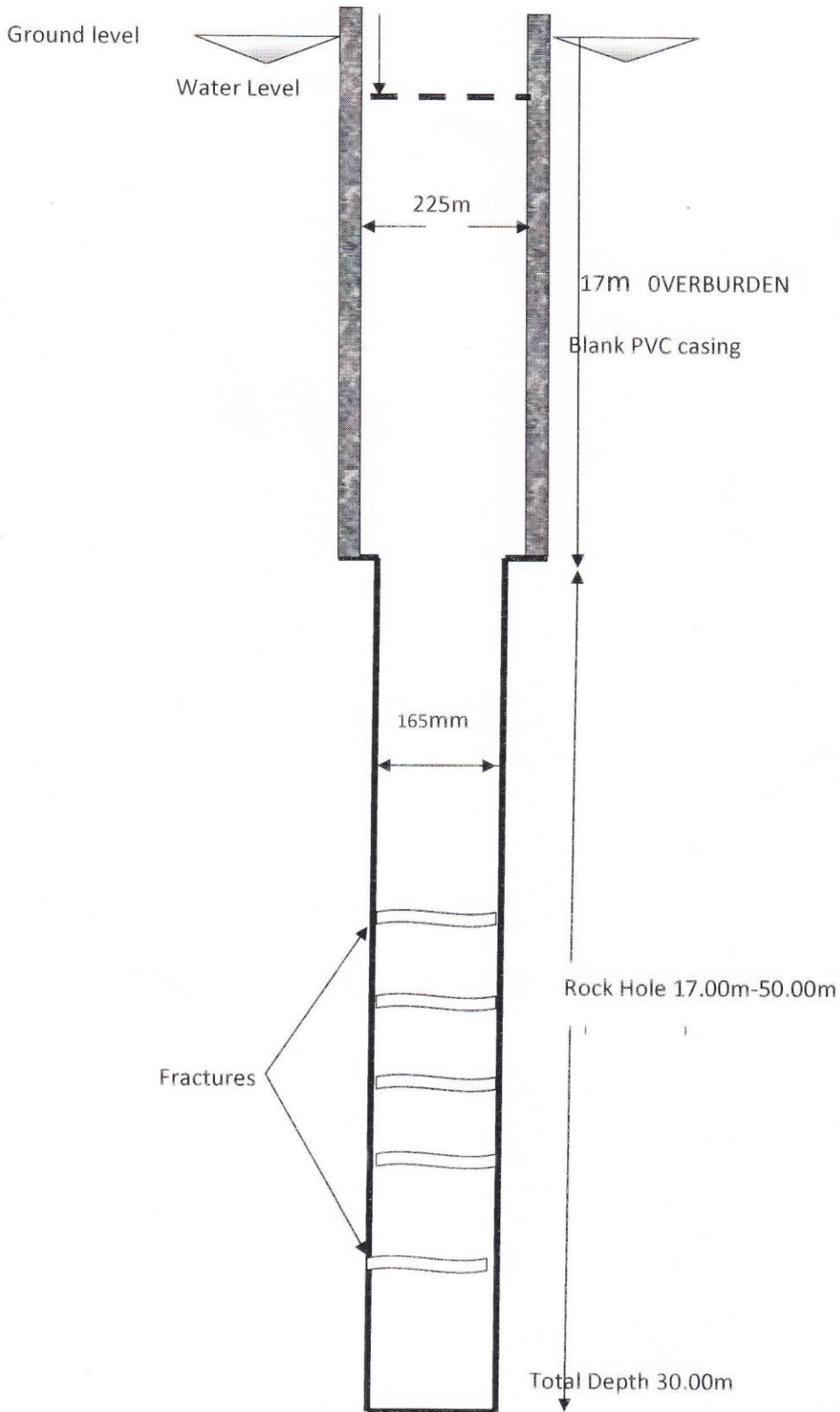
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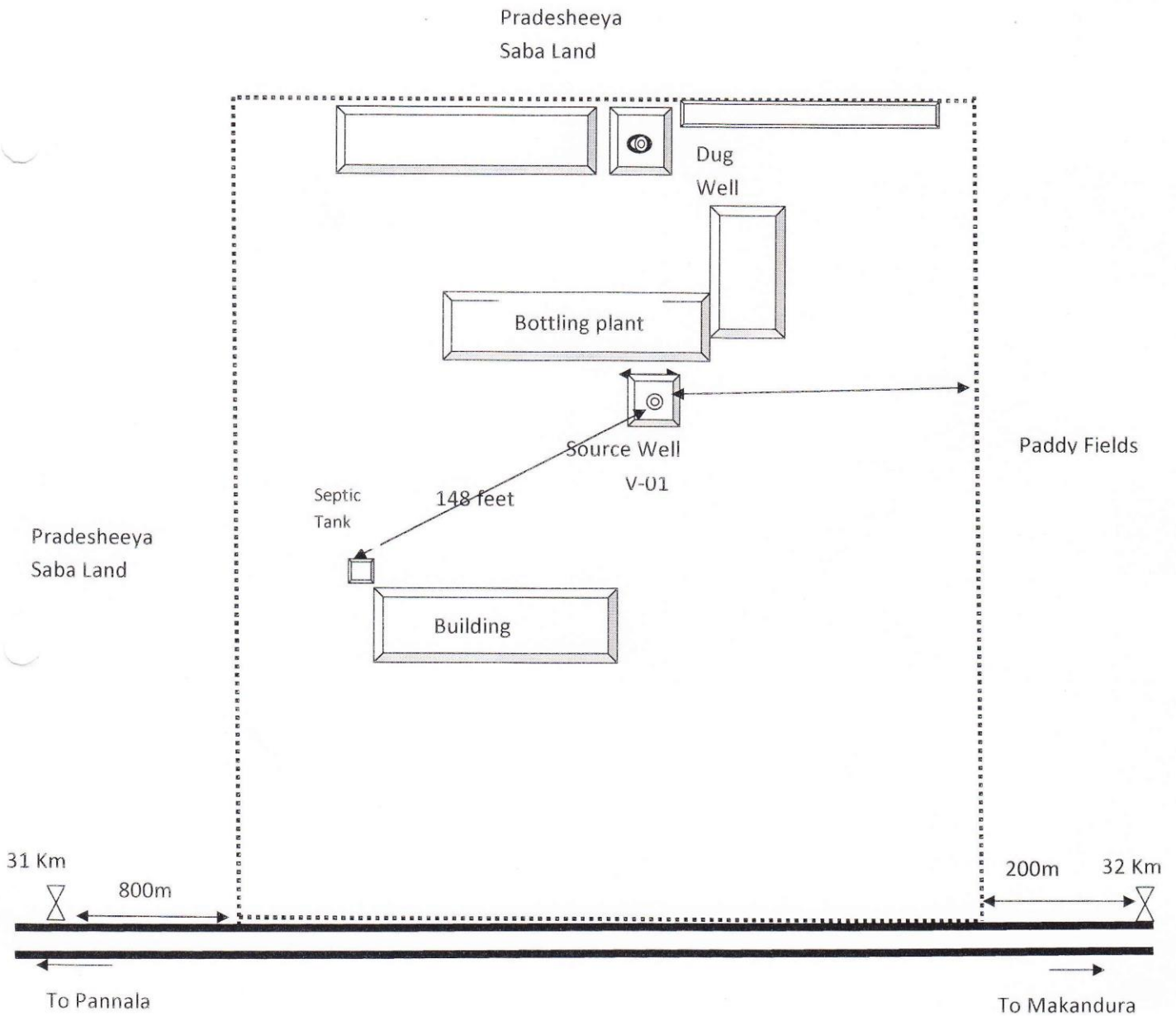


**CONSTRUCTIONAL DETAILS OF SOURCE WELL**



# SKETCH OF INVESTIGATED LAND

Not to Scale







Measuring Water Level



Measuring Discharge





Protected Source Well



Investigated site