# Hydraulic Characteristics of Groundwater Aquifer in Taungoo Area, Bago Region

Zin Nwe Khaing[1], Min Han Nyein[2]

**Abstract**

The study area is located in Taungoo Township, Bago Region. It lies between north latitude 18°55' N and 19°00'N between east longitude 96°15'E and 96°30'E. The main stream is Sittaung River flowing at the east of taungoo town with the general direction of the flow being north to south. Taungoo area has tropical monsoon climate. Alluvial aquifer is lying at depth (25ft to 100 ft) and water bearing horizon is (80ft to 90ft). Discharge range is about 900 gph from 2" diameter tube well. Irrawaddy aquifer is lying at (165ft to 315 ft) and water bearing horizon is (200ft to 300 ft). Discharge range is about 4000 gph from 4 " diameter tube well. The groundwater flow direction of the study area is from west to east towards the Sittaung River. The pumping out test shows that the transmissivity of the aquifer in Taungoo township is 102 m2/day. The recovery test shows that KD is found to be 74.28 m2/day. Geophysical investigated measured in the study area 3 VES points based on resistivity method (Schlumberger).

*Keywords; Taungoo, Sagaing fault, Alluvial aquifer, Irrawaddy aquifer, Discharge range, Pumping test, Recovery test.*

## Introduction

### Location, size and accessibility

Taungoo Township is located in Bago Region. It lies between north latitude 18°55' N and 19°00'N between east longitude 96°15'E and 96°30'E.The area of the town is (236 sq.km).At is bordered by Oktwin in the south and Yedarshe in the north and then Thandaung in the eastern part of the study area.This area refers to the one inch military Topographic map of 94 B/5.The study area can be reached by train or by car from Yangon and Mandalay (rail road mile post 176).It extends about 9.4 km from north to south and 25.2km from east to west.

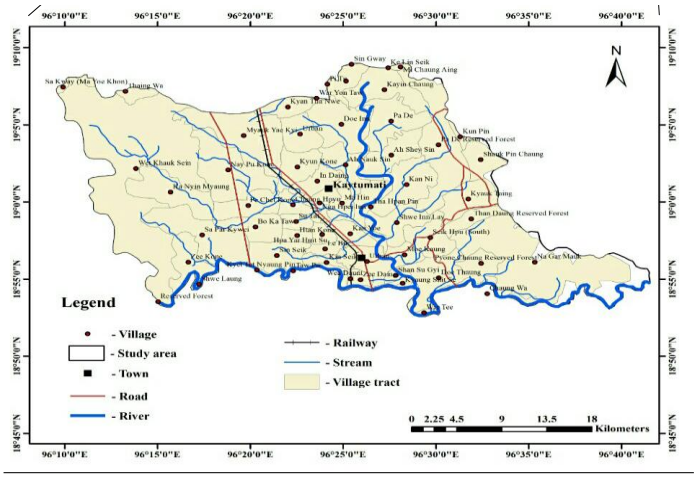


Fig. 1. location Map of the Taungoo Area

### Purpose of Study

The main objectives of the present investigation are as follows.

1. To evaluate the groundwater occurrence and movement.

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2. To know the lithological characteristics and hydraulics characteristics of aquifer.
3. To know the quality of groundwater and type of groundwater.

**Methods of Study**

The following works had been carried out during the study;Investigation of geological setting of the area using satellite images.

1. Determination of geomorphic signification of the area using satellite images.
2. Investigation of the groundwater condition, especially the underlying aquifers and groundwater flows using well log records.
3. To know hydraulic characteristic of the aquifer by using pumping out test and recovery test.

**Topography**

The study area and its vicinity occupy the low lying plain at east of Pegu Yoma. The eastern area is demarcated by the Taungoo town proper and Sittaung River.

The topography of the study area can be divided into as follows;

a. Low-lying flat plain
b. Ridge area
c. Hilly region

The elevation (569ft) is highest in this area, situated in Myaukmway Taung. Irrawaddian formations are seen between the elevation 201 to 300ft. Elevation 101 to 200 ft are situated around the Sittaung River. Alluvium formation is distributed in this area. The water from elevation 569 ft flows through Kabaung Chaung and Sittaung River.

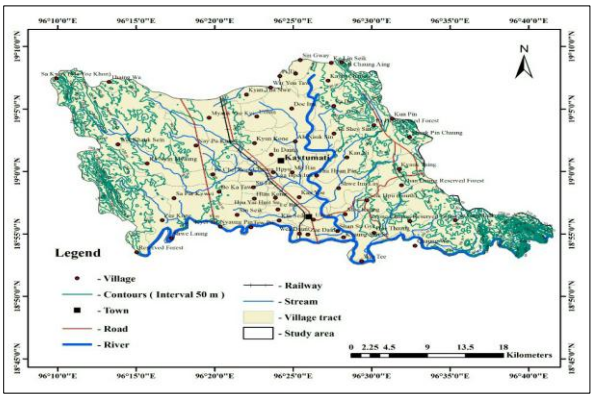


Fig. 2. Topographic Map of the Taungoo Area

**Drainage**

The drainage system is controlled by topography and structure of rocks. Dendritic drainage can be seen in this area.The main stream is Sittaung River flowing at the east of taungoo town with the general direction of the flow being north to south. And then, the minor stream are Pathi Chaung, Kabaung Chaung, Thaukyegat Chaung and Chaungmange Chaung flow into the Sittaung River from east to west.

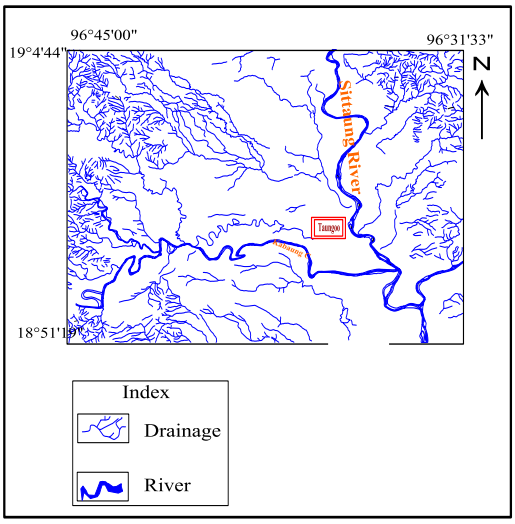


Fig. 3. Drainage map of the Taungoo Area

## Climate

Taungoo area has tropical monsoon climate. In general, the climate condition of the area can be divided into two seasons, viz ,wet and dry seasons. The average monthly maximum and minimum rainfall, relatively humidity and evaporation are presented.The monthly maximum temperature is high in April with 38.6°C and minimum temperature in April is only 22.66°C. The average monthly rainfall is 5.98 (inch) received largely during the period from May to October when the moisture-bearing south summer monsoon wind is dominant. The monthly rainfall is high in Aug with 16.03(inch). In the wet season, the relatively humidity is high in Aug with 89.4%.

| Month | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Average /Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum Temperature (°C) | 31.94 | 35.22 | 37.46 | 38.6 | 36.22 | 31.72 | 30.5 | 30.38 | 32.48 | 33.74 | 33.52 | 31.55 | 33.61 |
| Minimum Temperature (°C) | 12.76 | 14.18 | 18.44 | 22.66 | 22.3 | 21.28 | 21.42 | 21.48 | 21.72 | 21.64 | 18.76 | 14.05 | 19.22 |
| Relatively Humidity (%) | 62.4 | 54.8 | 51.8 | 57.2 | 68.6 | 85 | 87.4 | 89.4 | 83.8 | 79 | 72.2 | 66.25 | 71.49 |
| Rain Fall (inch) | 0.68 | 0 | 0.32 | 1.05 | 4.28 | 14.67 | 14.54 | 16.03 | 12.1 | 6.95 | 0.64 | 0.48 | 5.98 |
| Evaporation (mm) | 4.9 | 6.3 | 6.7 | 6.8 | 5.7 | 4 | 3.64 | 3.7 | 4.5 | 5 | 5.2 | 5.1 | 5.13 |

## Population

Taungoo township includes (23) village tracks. The total population is (85330) and household is (15019)

## Geology

### Geological Setting

The investigated area is located in Pegu region and Pegu (Bago) Yoma area is situated in the eastern part of the Central Myanmar Tertiary Basin. Pegu Yoma is a morphological and geological unit about 400miles (644km) long and 40 miles (64.4km) wide which generally strikes NNW-SSE lying nbetween the Mogok Belt (Searle and Ba than Haq, 1964) and Shan Plateau (Eastern Highlands) in the east and Central Volcanic Line in the west. The study area lies between right lateral Sagaing fault and Papun fault, (Soe Thura Tun, 2007).

East of the area comprises of a portion of granite rocks which runs along the western part of the Eastern Shan Highland and are included in the Shan Taninthayi block of geomorphic tectonic provinces of Myanmar (Maung Thein, 1983).

Central part of the area is composed of alluvial sediments and most of the area is covered by alluvium.

In the western part of the area, the Irrawaddy Formation is well exposed at both sides of Chaungmagne Chaung and along the road cutting between Sabagwe and Gyobinzeik .

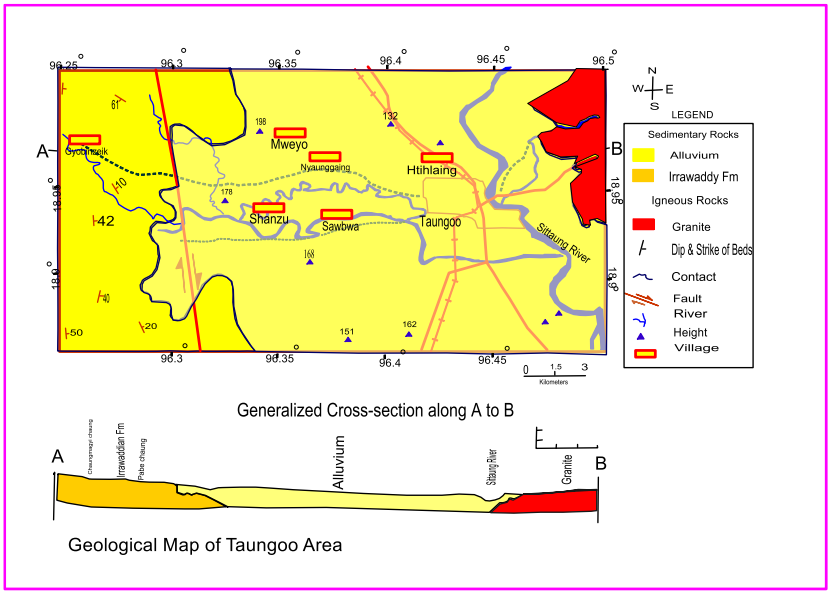


Fig. 4. Geological Map of the Taungoo Area (Source; Dr Aye Aye Myint 2009)

### Alluvium Formation

This unit occurs almost all the study area around the Sittaung River, such as Shanzu, Nyaunggaing, Shanywa, Mweyo, Yakhaingsu, etc. They are mainly composed of yellow clay, blue clay, silt sand, red sand and grit. Water from this formation gives low yield and also has been contaminated.

Location (N 18°57'19.1 " and E 96°17'29.8")

Fig. 5. Lateritic Clay of Alluvium near Shanywa

**Irrawaddy Formation**

Irrawaddian rocks can be found in the western part of the study area. These areas are mainly composed of sand and light blue grit, light blue clayey sand,sticky yellow clay, blue fine sand. They are well exposed along the Chaungmange Chaung and Thikado Chaung near the Sabagwe and Gyobinzeik villages.

**Pegu Group**

These rocks are not well exposed in the study area. This rock is mainly composed of shale, sandstone and siltstone. Marine sandstone and shale of Oligocene and Miocene age belong to Pegu Group.

**Igneous Rocks**

Granite rocks are found in the eastern part of the study area. It is located near the Yahanda Chetawyar pagoda at Myogyi area. The granite rocks are late Cretaceous to Early Eocene. It is well exposed at N 18 °56 '58.6" and E 96°30'06" near Kyaunggon.

**Pegu Group**

These rocks are not well exposed in the study area. This rock are mainly composed of shale, sandstone and siltstone. Marine sandstone and shale of Oligocene and Miocene age belong to Pegu Group.

## Water Resources

**Water Resources**

There are two types of water resources in the study area.

(1) Surface water
(2) Groundwater

**Surface water**

Stream, lakes, rivers, ponds, etc; included in the surface water resources. In this area, Kan taw gyi is situated in the western part of the Taungoo township and Sittaung River is situated in the eastern part of the area.And Pathi Chaung , Kabaung Chaung, Pabe Chaung are perennial streams of the surface water body in this area.

Small lakes, “ins” and ponds are found in the villages of the area. Lakes and ponds are constructed to store the water from natural precipitation. Some of these stored surface water resources, however, cannot last up to the end of summer.

Fig. 6. Surface water body of Kan Taw Gyi near the Kaytumaddy

**Water supply**

In this area, a number household have private tube wells and hand-dug well for domestic uses. The source of water from Kan Taw Gyi, Sittaung River, Kabaung Chaung are used for irrigation and industry.

Many lakes and ponds are constructed by villagers to get drinking water and domestic uses. The main sources of water of all these lakes and ponds come from monsoon rain.

## Results and Discussions

### Aquifers and Aquifer Characteristics in the Study Area

**Types of Aquifer**

There are two types of aquifers found in this area. They are;

1. Groundwater in Alluvial Deposits
2. Groundwater in Irrawaddy Formation

**Groundwater in Alluvial Deposits**

Alluvium aquifer is mainly composed of yellow coarse sand, yellow clay and gravel. According to well log data, the water bearing horizon is at (80 ft to 90 ft depth). Discharge is about 900 gph from 2" diameter tube well (Static water level is at 10 ft depth). The direction of groundwater flow in the alluvium unit is towards the Sittaung River.

Groundwater in Irrawaddy Formation

They area are mainly composed of sand and light blue grit, light blue clayey sand, sticky yellow clay, blue fine sand. They are well exposed along the Chaungmange Chaung, Thikado Chaung near the Sabagwe village and Gyobinzeik village. According to well log data, the thickness is ranging (165ft to 315 ft) and so its thickness is (150) ft. The water bearing horizon lies at (200ft – 300ft). Discharge is about 4000 gph from 4" diameter tube well and (Static water level is at 15 ft depth). The direction of groundwater flow in the Irrawaddian formation is towards the Sittaung River.

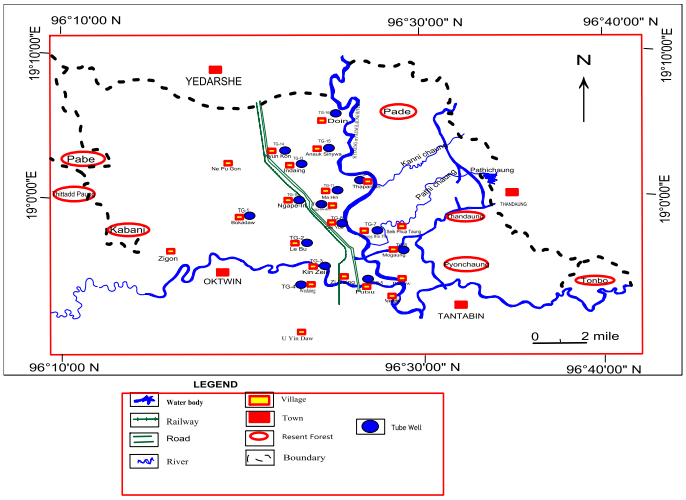


Fig. 7. Tube Well location map in the Taungoo Area (In formation)

## Ground water movement

## Fence Diagram

The tube well location map shown in figure from which fence diagram of Taungoo Area is made. In fence diagram are mainly composed of yellow sticky clay, yellow sandy clay, sand grit light blue, yellow fine sand and yellow clayey sand are dipping towards the east.

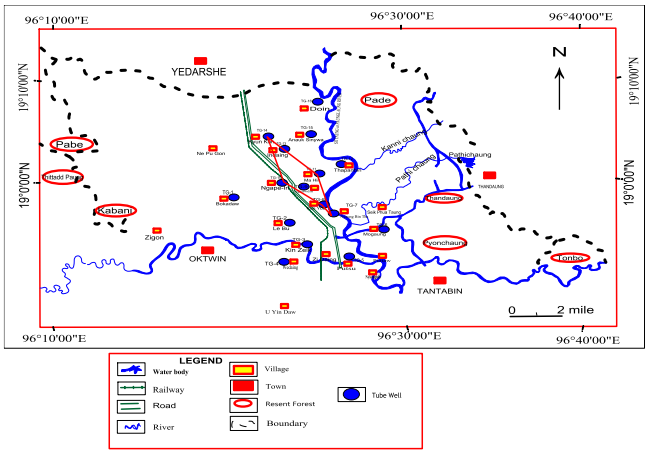


Fig. 8. Tube well location map of the Taungoo Area

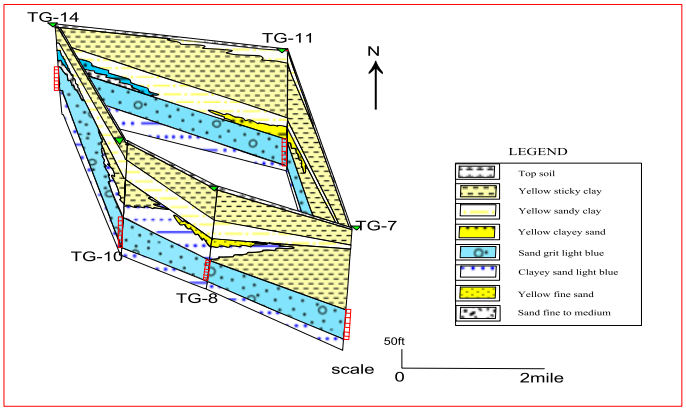


Fig. 9. Fence Diagram of the Taungoo Area

According to the observation results, the fence diagram drawn using the tube well no (TG-14, 11,10,8 and 7).All this well log data falls in the Irrawaddian aquifer so that suitable for groundwater exploration. This wells are flowing in the Sittaung River.

For the TG-14, the static water level is 10ft and screen length is between 115ft to 180 ft. The thickness of the water bearing layer is 65 ft. The groundwater exists in the fine sand to grit light blue layer and the underlying layer is enclosing the clayey sand layer. So that, this layer is suitable for groundwater exploration.

For the TG-11, the static water level is 6ft and screen length is between 240ft to 310 ft. The thickness of the water bearing layer is 70 ft. The groundwater exists in the sand grit light blue layer. So that, this layer is suitable for groundwater exploration.

For the TG-10, the static water level is 9ft and screen length is between 201ft to 275 ft. The thickness of the water bearing layer is 74 ft. The groundwater exists in the fine sand grit light blue layer. So that, this layer is suitable for groundwater exploration.

For the TG-8, the static water level is 12ft and screen length is between 195ft to 255 ft. The thickness of the water bearing layer is 60ft. The groundwater exists in the fine sand grit light blue layer. So that, this layer is suitable for groundwater exploration.

For the TG-8, the static water level is 12ft and screen length is between 195ft to 255 ft. The thickness of the water bearing layer is 60ft. The groundwater exists in the fine sand grit light blue layer. So that, this layer is suitable for groundwater exploration.

For the TG-7, the static water level is 4ft and screen length is between 215ft to 295ft. The thickness of the water bearing layer is 80ft. The groundwater exists in the sand grit light blue layer. So that, this layer is suitable for groundwater exploration.

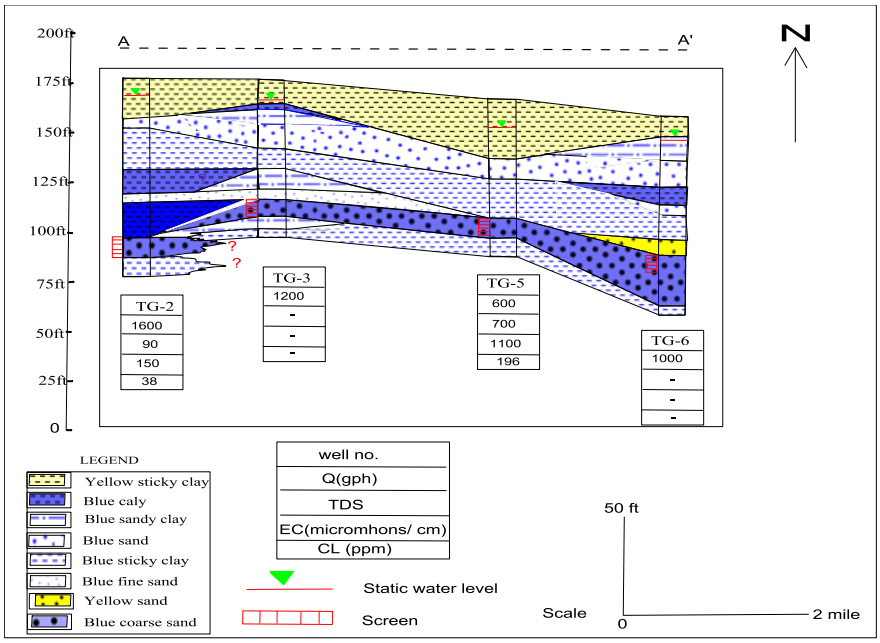


Fig. 10. Hydrogeological cross-section of the study area A-A'

## Hydraulic Characteristic of Aquifer

### Pumping Out Test in Taungoo Area

In study area, pumping out test for 3 hours and 20 minutes and recovery test of 3 hours and 40 minutes duration were performed at 8 inches diameter tube well atTaungoo

University (Nyaunggaing) village . The aquifer is located at the depth of ( 230-300 )feet and so its thickness is (70)feet. The static water level is (7.04) ft.

Pumping Out Test

The Jacob's method ( Copper and Jacob's ),1946 is based on the Theis's equation.

$$\mathbf{KD = (2.3\ Q)/(\ 4\pi\Delta s)}$$

Where,

KD = the transmissivity of the aquifer, $m^2$ /day

Q = the constant well discharge, $m^3$ /day

Δs = drawdown difference ,m

Jacob's Straight Line Method

Q = 446 $m^3$/day

Δs = 0.8 m

$$KD = \frac{2.3Q}{4\pi\Delta s}$$

$$= \frac{2.3\times446}{4\times3.14\times08} = 102\ m^2/day$$

Fig. 11. Measuring Water Level of well at Taungoo University

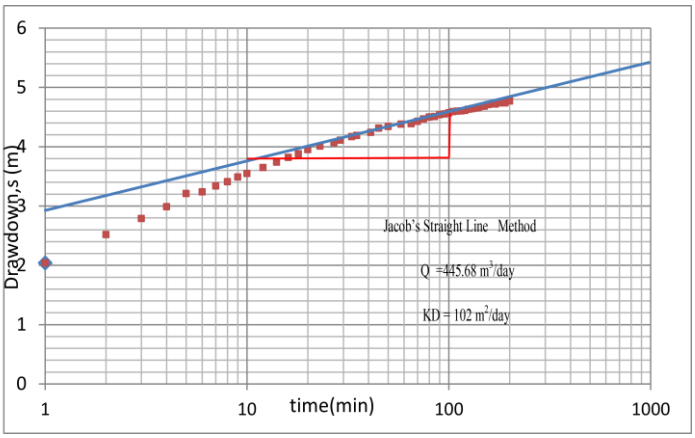


Fig. 12. Constant Discharge Pumping Test of the well at Taungoo University

**Recovery Test in Taungoo Area**

**Method of Recovery Test**

Theis's Recovery Methods is widely used for analysis of recovery test .Theis's recovery equation (1935 ) is described as follow ;

$$\Delta s' = \frac{2.30Q}{4\times\pi KD} \log t/t_0 \text{ and}$$

$$KD = \frac{2.3Q}{4\pi\Delta s'}$$

Where,

KD = the transmissivity of the aquifer, $m^2$ /day

Q = the constant well discharge , $m^3$ /day

$\Delta s'$ = the residual drawdown.

**Thesis's Recovery Method**

Q = 446 $m^3$/day

$\Delta s'$= 1.1m

$$KD = \frac{2.3Q}{4\pi\Delta s'}$$

$$= \frac{2.3\times446}{4\times3.14\times1.1}$$

$$= \frac{1025.8}{13.81}$$

= 74.28 $m^2$/day

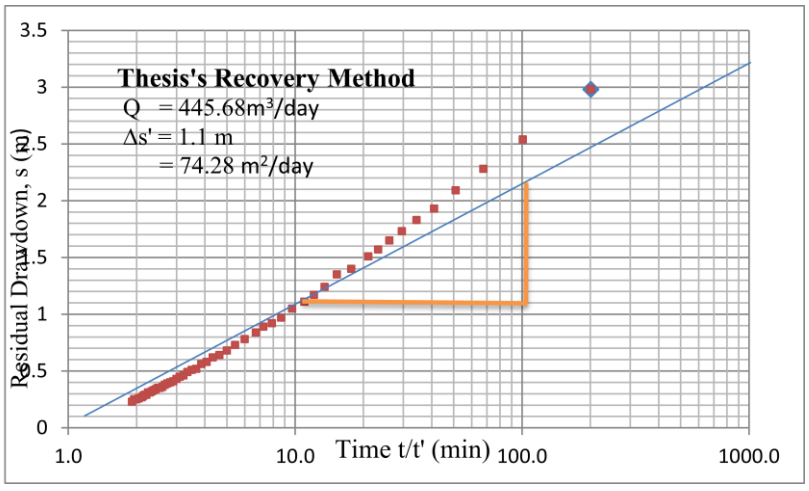


Fig. 13. Recovery Test of the well at Taungoo University

**Electric Resistivity Method**

The electric resistivity of a rock formation limits the amount of current passing through the formation when an electric potential is applied. It may be defined as the resistance in ohms between opposite faces of a unit cube of the material. If a material of resistance R has a cross-sectional area A and a length L, then its resistivity can be expressed as

$$p = \frac{RA}{t}$$

Units of resistivity are ohm-$m^2$/ m, or simply ohm-m

**Subsurface Geophysical Investigation**

The subsurface geophysical investigation by using SAS 300 Terrameter was taken by survey team of groundwater division on 1, January 2016. As the area is covered by alluvium units the apparent resistivity value of all layers is high. The 3 VES points are measured at the Taungoo Township. First VES point is located at Myinsaktwet village (Elevation-67m) and location (18°57'29.8"N and 96°20'33.7"E). The second point is located at Htangon village (Elevation-66m) and location (18°57'27.7"N and 96°22'19.9"E). The third point is located at Htihlaing village (Elevation-57m) and location (18°57'11.8"N and 96°25'21.5"). The location map of VES points.

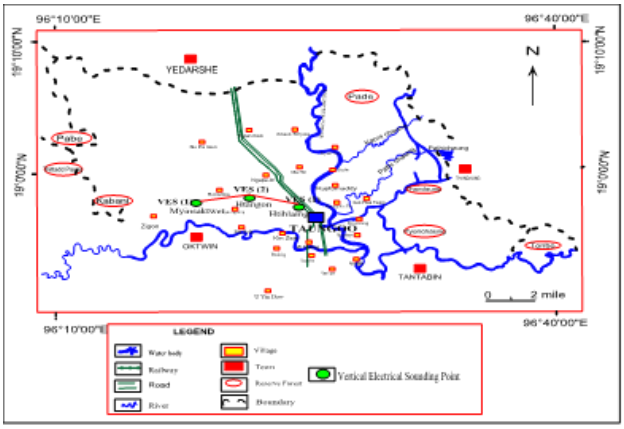


Fig. 14. The Location Map of the VES Point

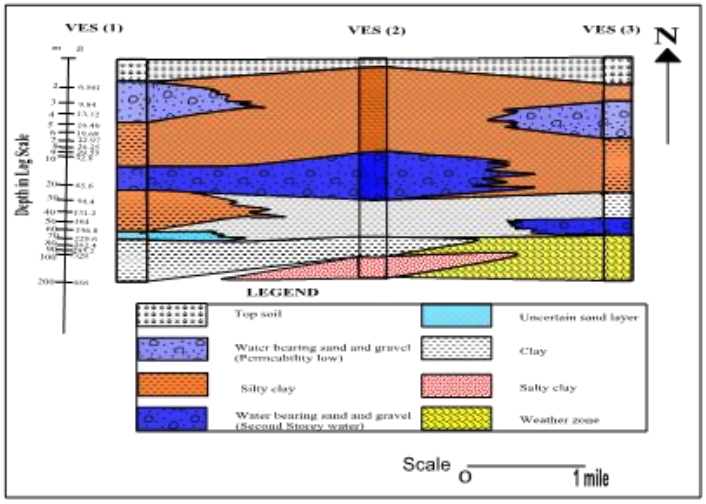


Fig. 15. Electrostratigraphic Cross-Section of the Taungoo Area

Geophysical investigation is made in the study area at 3 VES points.

Geo-electric layer of water bearing layers of 20-40 ohm/m is sand and gravels.

**Conclusions**

The study area is located in Taungoo Township, Bago Region. It lies between north latitude 18°55' N and 96°00'N between east longitude 96°15'E and 96°30'E. The stratigraphic

units exposed in the study area are Alluvial, Irrawaddy formation, and Igneous rocks. Alluvial units consists of yellow clay, blue clay, silt sand, red sand and grit. Irrawaddy formation consists of light blue grit and sand, light blue clayey sand, yellow sticky clay, blue fine sand. Granite rocks are found in the eastern part of the study area. The yield from groundwater of alluvial deposit is 900 gph from 2"diameter tube well. Static water level is found at 10 feet depth. The groundwater yield from this unit is about 4000 gph from 4"diameter tube well and static water level is 15 ft depth.In our study area pumping test for 3 hours and 20 minutes and recovery test of 3 hours and 40 minutes duration were performed at 8 inches diameter tube well at Taungoo University. The pumping out test shows that the transmissivity of the aquifer is 102 $m^2$/day. In recovery test, the transmissivity of the aquifer is found to be 74.28 $m^2$/day. In the study area, the resistivities value of water bearing horizons possesses 30 ohm/m in VES-1, 32 ohm/m in VES-2 and 30.1 ohm/m in VES-3 where groundwater drilling can be made successful.

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