# Geophysical Survey in Cheheldukhtran (Maya Khil) village, Chahar Asyab District of Kabul Province

**By:**
**M. Hassan Saffi, Senior Hydrogeologist**
**Ahmad Jawid  Hydrogeologist**

**April, 2012**

Paikob-e-Naswar, Wazirabad, PO Box 208, Kabul, Afghanistan
Phone: (+93) (020) 220 17 50  Mobile (+93) (0)70 28 82 32
E-mail: dacaar@dacaar.org  Web site: www.dacaar.org

**Contents** **page**



## Figures



## Tables

## List of Abbreviation and Technical Terms

| | |
|---|---|
| Roh: | Apparent Resistivity (ohm.m) |
| Sp: | Self Potential (mV) |
| Vp: | Voltage Potential (mV) |
| In: | Current (m A) |
| VES: | Vertical Electrical Sounding |
| DACAAR: | Danish Committee for Aid to Afghan Refugee |
| WASH: | Water Sanitation and Hygiene |

## 1. Introduction

DACAAR performed geophysical survey (vertical electrical sounding) for provision of safe drinking water for Cheheldukhtran (Myakhil) village. This village is located about 5 Km to the west of Chahar Asyab district center. The people of this village have safe drinking water problems. The hydro geologic condition of this area is very complex for groundwater development. The tube wells were drilled to the depth between 43- 65 m and equipped with a hand pump. The water being pumped is saline and they are potentially a threat to the health of the people. The people are mainly collecting their drinking water from other villages which are located near of Chahar Asyab district center. Therefore, there is an urgent need to provide drinking water for the inhabitants of this village.
The area (Myakhil village) where DACAAR will construct water supply project is shown in the Figure 1.

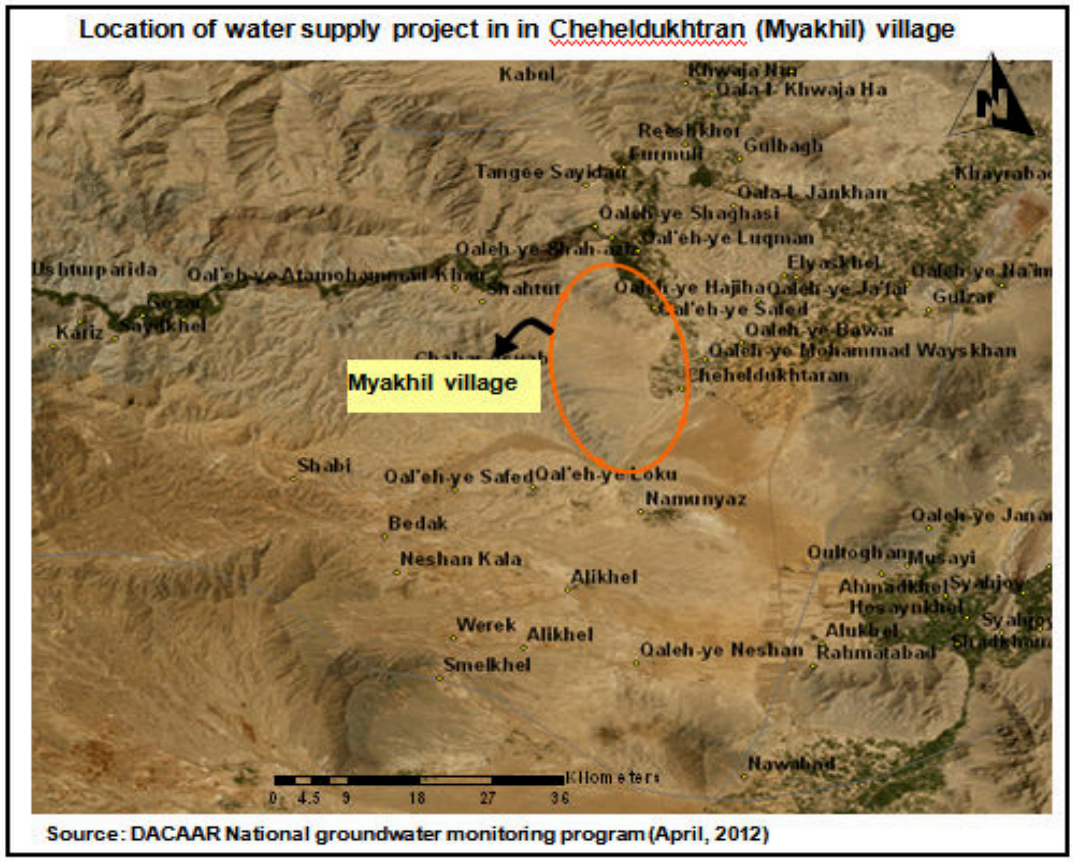



Figure 1, Location of water supply project (Myakhile village)

On March 29 to April 04 2012, DACAAR were performed Vertical Electrical Sounding (VES) survey in cheheldukhtan Myakhil (location 1), Nomunyaz (location 2) and Qalaehye Loku (location3) villages using Shlumberger electrodes arrangement (Figure 2). The field data were measured by SYSCAL Pro resistivity meter and the data interpreted by IPI2 win software.

Figure 2, Recording VES profile field data using SYSCAL Pro resistivity meter

## 2. Surface Geological setting of area

The surface geological formation of the survey area is:

- Late- Recent Quaternary shingly and detritus sediments ( gravel, sand, clay clay sand, silt sand)
- Late Quaternary shingly and detritus sediments ( gravel, sand, clay, loam, clay sand, silt and silt sand )
- Paleocene: Limestone, sandstone, siltstone, clay and conglomerate,
- Carboniferous-Early Permian: Sandstone and siltstone.
- Late Permian: Limestone, dolomite, sandstone and siltstone.
- Early-Middle Triassic: Limestone, and dolomite
- Early- Proterozoic: Mica, biotite, amphibolite, gneisses, and quartzite.

The Geological setting of the area is shown in the figure 3.

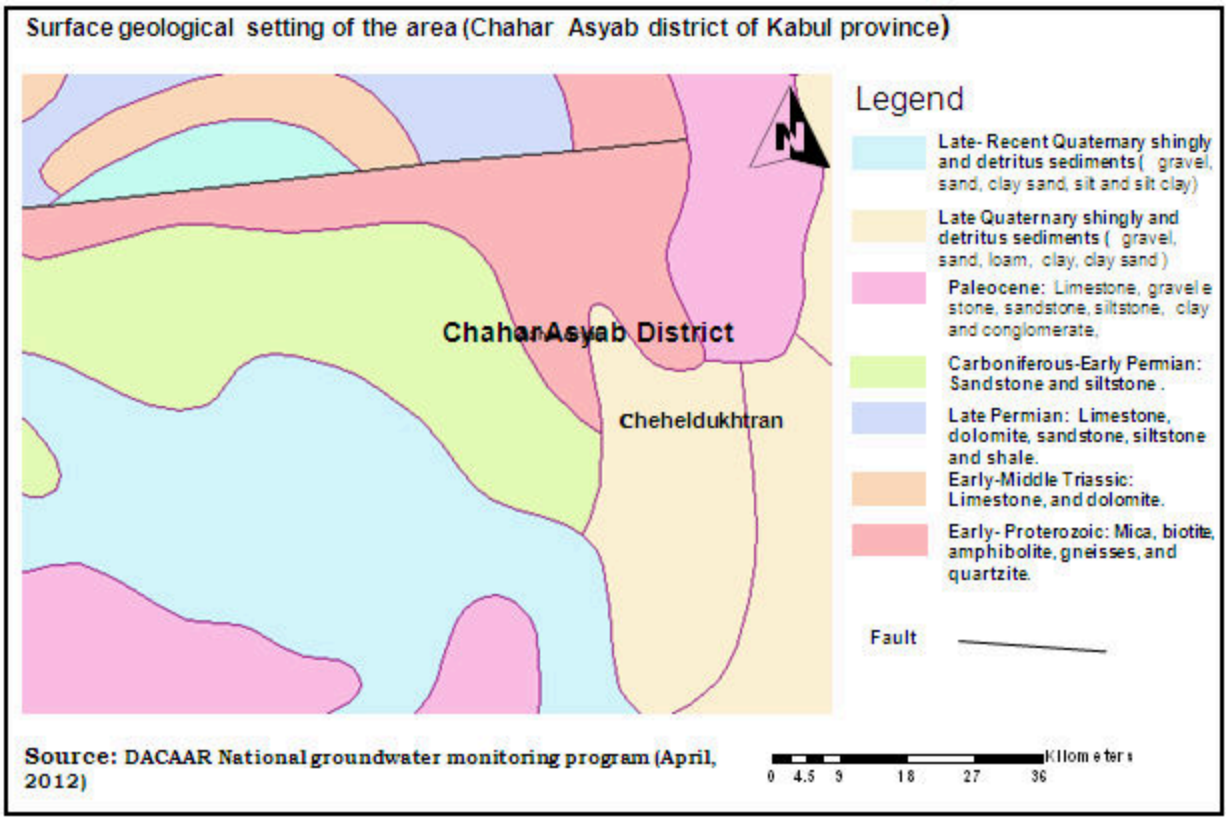



Figure 3, Surface Geological setting of the survey area (Chahar Asyab district)

## 3. Hydro geological setting

In the survey areas the natural groundwater system is characterized by two main hydro geologic units:

- Late- Recent Quaternary shingly and detritus sediments ( gravel, sand, clay sand, loess)
- Late Quaternary shingly and detritus sediments ( gravel, sand, loam, clay sand and silt )

The Late- Recent Quaternary shingly and detritus sediments (gravel, sand, clay sand, loess) has fresh groundwater, however, the Late Quaternary shingly and detritus sediments (gravel, sand, loam, clay sand and loess ) has fresh and saline groundwater. The water table ranges from 11 - 31 m. The groundwater salinity ranges from 712 µS/cm (fresh water) to 4088 µS/cm (saline water)
Table 1 and figure 4 indicate water tables and salinity of groundwater.

Table 1, Groundwater tables and Salinity levels in the Cheheldukhtran village of Char Asyab district

| No | Name | Lat | Lon | Depth (m) | Water Level (m) | EC (µS/cm) | Tem (°C) | WP_Type |
|---|---|---|---|---|---|---|---|---|
| 1 | TW-1 | 34.37445 | 69.12099 | 65 | 22.4 | 3100 | 14.0 | TW |
| 2 | TW-2 | 34.37385 | 69.10912 | - | 31.0 | 4080 | - | TW |
| 3 | TW-3 | 34.37696 | 69.10950 | - | 19.0 | 3900 | 13.6 | TW |
| 4 | TW-4 | 34.36184 | 69.11259 | 60 | 25.0 | 755 | 18.8 | TW |
| 5 | DW-5 | 34.36680 | 69.09634 | 13 | 11.0 | 712 | 16.1 | DW |

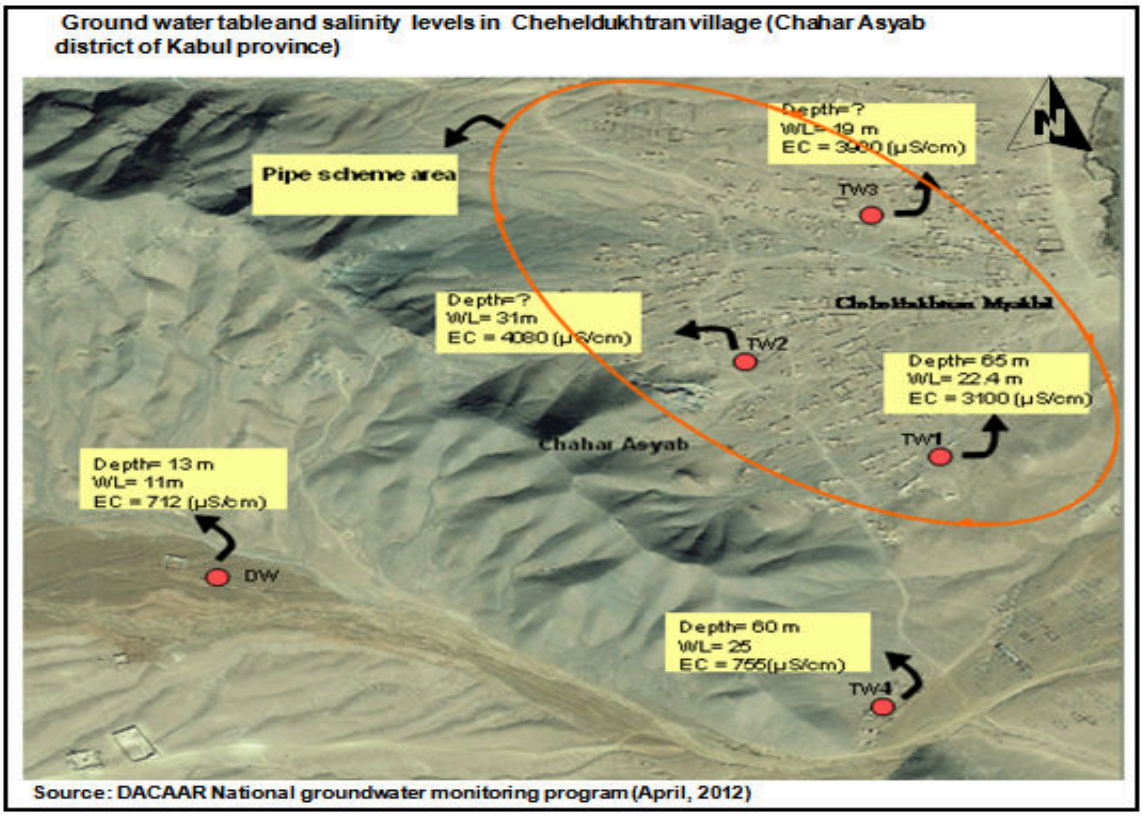



Figure 4, Groundwater level and salinity distribution level in the studied area

## 4. Vertical electrical sounding survey

### 4.1 Vertical Electrical sounding method

In this method the applied Schlumberger techniques was used. Current was transmitted into the ground from DC or low frequency sources by two electrodes (A and B) and the potential difference between a second pair of electrodes (M and N) was measured.

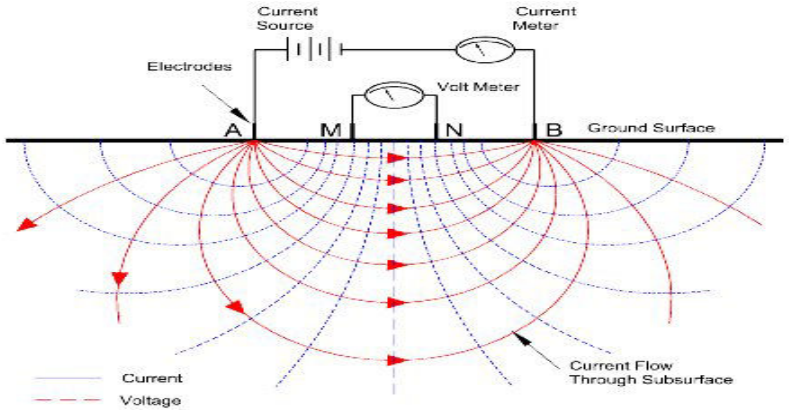



Figure 6, Vertical electrical sounding method

Apparent resistivity value is calculated:

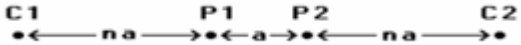
**Pa = K V / I**

Where:

**Pa** is the apparent resistivity
**K** is the geometric factor,

**V** is a voltage or potential difference between a second pair of electrodes in volts
**I** is the current from DC or low frequency sources by two electrodes in ampere.

**K = ∏n (n + 1) a**




The field data interrelated according to the following resistivity scale for water and rocks.

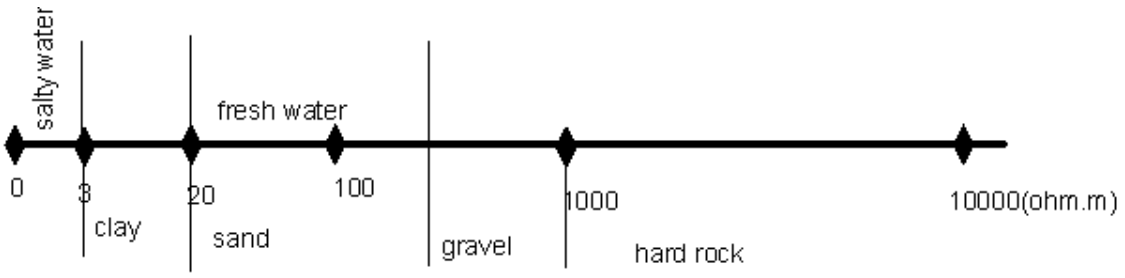



Figure 7, Resistivity scale for water and rocks

### 4.2 Field study

On March 29 – April 04 2012, 7 Vertical Electrical sounding (VES) profiles (VES-1, VES-2, VES-3, VES-4, VES-5, VES-6 and VES-7) were performed in cheheldukhtan (location -1), Nomunyaz (location- 2) and Qala-e Loku (location-3) villages of Char Asyab district using Shlumberger electrodes arrangement (Figure 8). The lengths and locations of VES profiles are indicated in Table 2 and Figure 8.

Table 2, Location of VES profiles

| NO | Location Name | VES Profiles | LAT | LON | Elevation (m) | VES Distance (m) |
|---|---|---|---|---|---|---|
| 1 | Camp Sakhi | VES-1 | 34.37402 | 69.11014 | 1913 | 300 |
| 2 | Camp Sakhi | VES-2 | 34.37914 | 69.11220 | 1906 | 300 |
| 3 | Camp Sakhi | VES-3 | 34.37015 | 69.11314 | 1913 | 300 |
| 4 | Camp Sakhi | VES-4 | 34.36169 | 69.11359 | 1929 | 300 |
| 5 | Camp Sakhi | VES-5 | 34.36539 | 69.09934 | 1959 | 300 |
| 6 | Camp Sakhi | VES-6 | 34.36513 | 69.09754 | 1965 | 300 |
| 7 | Camp Sakhi | VES-7 | | | | |
| 8 | Camp Sakhi | VES-8 | 34.36508 | 69.09671 | 1967 | 300 |

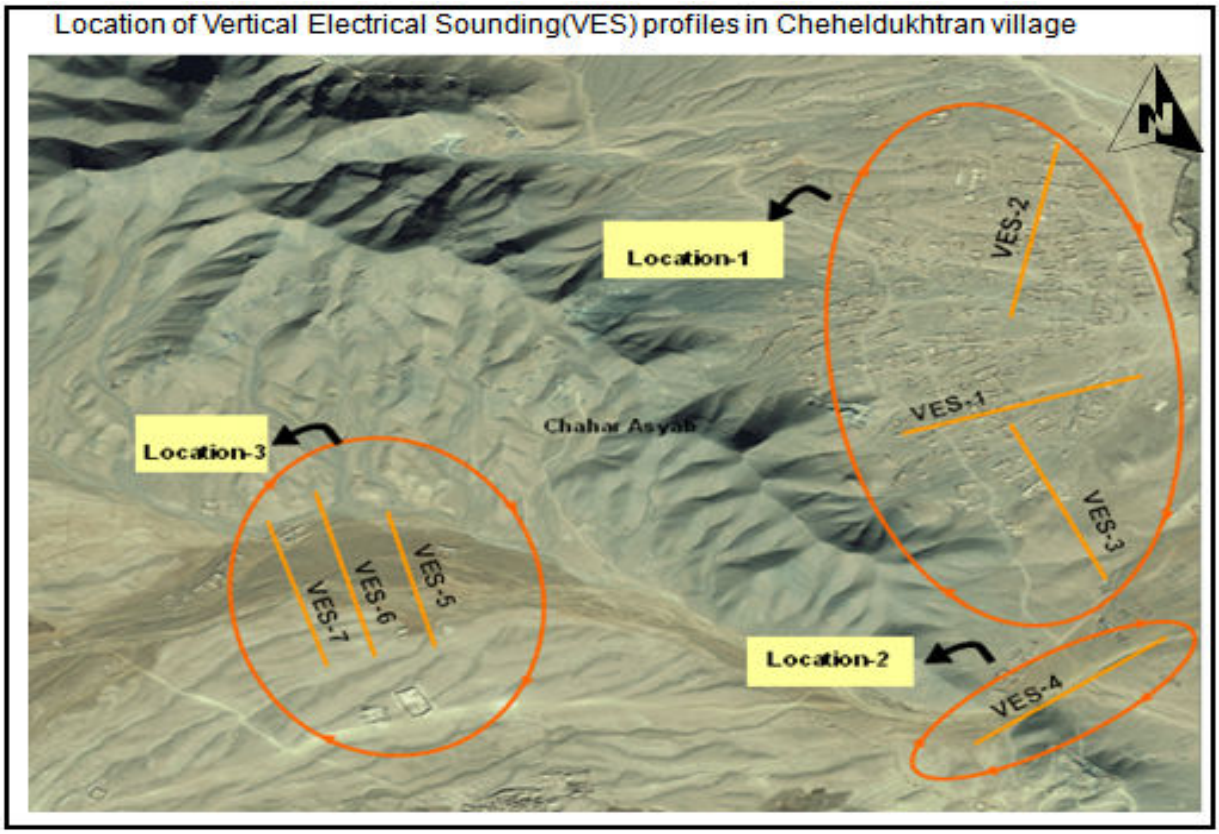



Figure 8, Location and length of VES profiles in cheheldukhtan (location -1), Nomunyaz (location- 2) and Qalaehye Loku (location-3) villages.

### 4.3 Measured VES field data

The field data were measured by SYSCAL Pro resistivity meter and the measured data are shown in Table 3, Table 4 and Table 5.

Table 3, VES-1 and VES-2 measured field data.

| VES-1 Location-1 (Cheheldukhtaran Myakhil village)<br>LAT: 34.37402<br>LON: 69.11014 | | | | | |
|---|---|---|---|---|---|
| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
| 1.5 | 0.5 | 147.37 | 821.51 | 350 | 13.7 |
| 2 | 0.5 | 173.77 | 857.07 | 581 | 24.7 |
| 3 | 0.5 | 198.53 | 517.54 | 716 | 56.2 |
| 4 | 0.5 | 205.91 | 260.89 | 626 | 100 |
| 5 | 0.5 | 212.47 | 198.52 | 726 | 157 |
| 6 | 0.5 | 209.23 | 148.76 | 798 | 226 |
| 8 | 0.5 | 184.45 | 84.98 | 922 | 402 |
| 8 | 2 | 195.45 | 382.75 | 922 | 99 |
| 10 | 2 | 153.9 | 193.63 | 948 | 156 |
| 12 | 2 | 118.42 | 127.54 | 118.4 | 225 |
| 15 | 2 | 85.52 | 76.35 | 154.9 | 352 |
| 20 | 2 | 47.34 | 16.58 | 108.9 | 627 |
| 20 | 5 | 55.6 | 51.6 | 109.3 | 247 |
| 25 | 5 | 31.19 | 15.6 | 94.3 | 389 |
| 30 | 5 | 22.38 | 7.06 | 86.7 | 562 |
| 40 | 5 | 16.42 | 2.1 | 63.2 | 1001 |
| 50 | 5 | 15.64 | 1.55 | 77.2 | 1567 |
| 50 | 10 | 15.68 | -283 | 68.1 | 778 |
| 60 | 10 | 15 | -163 | 60 | 1123 |
| 80 | 10 | 15.58 | -77 | 49.2 | 2003 |
| 100 | 10 | 15.5 | -48 | 49 | 3134 |
| 120 | 10 | 15.57 | -29 | 42.3 | 4516 |
| 120 | 25 | 16.24 | 81 | 43.3 | 1790 |
| 150 | 25 | 17.73 | 75 | 58.6 | 2808 |
| 200 | 25 | 21.7 | 43 | 49.5 | 5007 |
| 250 | 25 | 26.14 | 19 | 29.5 | 7834 |
| 300 | 25 | 35.63 | - | - | 11290 |

| VES-2 Location-1 (Cheheldukhtaran Myakhil village)<br>LAT: 34.37914<br>LON: 69.11220 | | | | | |
|---|---|---|---|---|---|
| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
| 1.5 | 0.5 | 180.25 | 968.38 | 33.7 | 13.7 |
| 2 | 0.5 | 124.67 | 737.34 | 69.6 | 24.7 |
| 3 | 0.5 | 171.7 | 762.52 | 52.3 | 56.2 |
| 4 | 0.5 | 170.99 | 277.4 | 44.5 | 100 |
| 5 | 0.5 | 173.53 | 233.61 | 66.6 | 157 |
| 6 | 0.5 | 170.84 | 109.48 | 71.9 | 226 |
| 8 | 0.5 | 159.45 | 40.66 | 51 | 402 |
| 8 | 2 | 153.26 | 168.3 | 51.7 | 99 |
| 10 | 2 | 132.71 | 105.49 | 59.9 | 156 |
| 12 | 2 | 124.42 | 65.22 | 57.6 | 225 |
| 15 | 2 | 94.43 | 25.13 | 46.1 | 352 |
| 20 | 2 | 54.87 | 5.32 | 30.2 | 627 |
| 20 | 5 | 52.66 | 13.92 | 31.1 | 247 |
| 25 | 5 | 24.8 | 11.38 | 86.4 | 389 |
| 30 | 5 | 17.86 | 4.12 | 63.4 | 562 |
| 40 | 5 | 14.52 | 1.48 | 50.7 | 1001 |
| 50 | 5 | 14.16 | 0.64 | 35.4 | 1567 |
| 50 | 10 | 15 | 1.45 | 36.5 | 778 |
| 60 | 10 | 16.53 | 1.2 | 40.1 | 1123 |
| 80 | 10 | 15.87 | 1 | 62.6 | 2003 |
| 100 | 10 | 17.15 | 0.91 | 83 | 3134 |
| 120 | 10 | 18.99 | 0.68 | 81.4 | 4516 |
| 120 | 25 | 19.48 | 1.84 | 82 | 1790 |
| 150 | 25 | 20.27 | 0.51 | 35 | 2808 |
| 200 | 25 | 23.25 | 0.59 | 63.2 | 5007 |
| 250 | 25 | 25.56 | 0.31 | 47.3 | 7834 |
| 300 | 25 | 27.6 | 0.21 | 44 | 11290 |

Table 4, VES-3 and VES-4 measured field data.

| VES-3 ,Location-1 (Cheheldukhtaran Myakhil village)<br>LAT: 34.37015<br>LON: 69.11314 | | | | | |
|---|---|---|---|---|---|
| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
| 1.5 | 0.5 | 70.75 | 864.5 | 76.7 | 13.7 |
| 2 | 0.5 | 72.96 | 599.77 | 96.8 | 24.7 |
| 3 | 0.5 | 72.18 | 186.48 | 71 | 56.2 |
| 4 | 0.5 | 66.9 | 119.35 | 88.2 | 100 |
| 5 | 0.5 | 60.34 | 66.62 | 85.8 | 157 |
| 6 | 0.5 | 54.6 | 31.58 | 64.9 | 226 |
| 8 | 0.5 | 40.82 | 11.83 | 58 | 402 |
| 8 | 2 | 47.03 | 57.86 | 57.9 | 99 |
| 10 | 2 | 35.35 | 22.78 | 48.5 | 156 |
| 12 | 2 | 23.01 | 8.75 | 41.8 | 225 |
| 15 | 2 | 16.33 | 4.48 | 47.6 | 352 |
| 20 | 2 | 12.67 | 1.83 | 44.9 | 627 |
| 20 | 5 | 14.52 | 4.51 | 36.5 | 247 |
| 25 | 5 | 14.23 | 1.99 | 26.4 | 389 |
| 30 | 5 | 14.05 | 1.42 | 27.9 | 562 |
| 40 | 5 | 14.54 | 0.82 | 28.2 | 1001 |
| 50 | 5 | 13.66 | 0.22 | 12.9 | 1567 |
| 50 | 10 | 16.53 | 0.6 | 13.7 | 778 |
| 60 | 10 | 16.66 | 0.46 | 15.1 | 1123 |
| 80 | 10 | 16.37 | 0.83 | 50.2 | 2003 |
| 100 | 10 | 16.33 | 0.53 | 50.9 | 3134 |
| 120 | 10 | 20.25 | 0.63 | 70.4 | 4516 |
| 120 | 25 | 16.06 | 0.32 | 44.8 | 1790 |
| 150 | 25 | 16.08 | 0.83 | 44.9 | 2808 |
| 200 | 25 | 17.64 | 0.57 | 44.6 | 5007 |
| 250 | 25 | 20.28 | 1.66 | 202.8 | 7834 |
| 300 | 25 | 20.346 | 0.372 | 66 | 11290 |

| VES-4 ,location-2 (Nomunyaz village).<br>LAT: 34.37914<br>LON: 69.11220 | | | | | |
|---|---|---|---|---|---|
| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
| 1.5 | 0.5 | 231.7 | 1200.91 | 32.5 | 13.7 |
| 2 | 0.5 | 37.67 | 614.9 | 29.9 | 24.7 |
| 3 | 0.5 | 66.97 | 410.57 | 43.3 | 56.2 |
| 4 | 0.5 | 81.33 | 154.56 | 27.3 | 100 |
| 5 | 0.5 | 85.52 | 106.55 | 29.6 | 157 |
| 6 | 0.5 | 88.72 | 8308.8 | 33.4 | 226 |
| 8 | 0.5 | 87.33 | 42.22 | 31.2 | 402 |
| 8 | 2 | 87.97 | 43.78 | 32.1 | 99 |
| 10 | 2 | 275.56 | 189.78 | 32.4 | 156 |
| 12 | 2 | 261.33 | 59.73 | 17.2 | 225 |
| 15 | 2 | 250.7 | 40.54 | 17.7 | 352 |
| 20 | 2 | 232.34 | 22.84 | 17 | 627 |
| 20 | 5 | 186.53 | 19.12 | 31.8 | 247 |
| 25 | 5 | 188.15 | 51.78 | 32.4 | 389 |
| 30 | 5 | 151.26 | 27.53 | 34.3 | 562 |
| 40 | 5 | 121.11 | 16.09 | 36.5 | 1001 |
| 50 | 5 | 76.62 | 6.41 | 41.4 | 1567 |
| 50 | 10 | 51.61 | 2.27 | 34.3 | 778 |
| 60 | 10 | 56.13 | 5.16 | 34.6 | 1123 |
| 80 | 10 | 44.53 | 3.08 | 38.1 | 2003 |
| 100 | 10 | 40.14 | 1.34 | 33 | 3134 |
| 120 | 10 | 41.37 | 0.63 | 24 | 4516 |
| 120 | 25 | 42.03 | 0.42 | 22.7 | 1790 |
| 150 | 25 | 46.83 | 1.31 | 24.3 | 2808 |
| 200 | 25 | 50.16 | 1.57 | 43.1 | 5007 |
| 250 | 25 | 50.76 | 0.41 | 19.9 | 7834 |
| 300 | 25 | 43.41 | 0.43 | 38.9 | 11290 |

Table5, VES-5 and VES -6 and VES-7 measured field data.

VES-5, location-3 (Qalaehye Loku village)
LAT: 34.36539
LON: 69.09934

| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
|---|---|---|---|---|---|
| 1.5 | 0.5 | 216.7 | 1228.48 | 35.6 | 13.7 |
| 2 | 0.5 | 243.7 | 718.49 | 34.7 | 24.7 |
| 3 | 0.5 | 220.27 | 190.28 | 23.7 | 56.2 |
| 4 | 0.5 | 232.86 | 160.62 | 34.1 | 100 |
| 5 | 0.5 | 226.41 | 143.88 | 49.4 | 157 |
| 6 | 0.5 | 216.15 | 55.02 | 28.5 | 226 |
| 8 | 0.5 | 191.74 | 28.54 | 29.8 | 402 |
| 8 | 2 | 198.84 | 128.22 | 30.3 | 99 |
| 10 | 2 | 183.74 | 52.72 | 21.6 | 156 |
| 12 | 2 | 174.35 | 48.81 | 30.7 | 225 |
| 15 | 2 | 162.42 | 60.31 | 64.4 | 352 |
| 20 | 2 | 143.25 | 23.33 | 50.6 | 627 |
| 20 | 5 | 145.21 | 50.67 | 41.1 | 247 |
| 25 | 5 | 114.58 | 17.95 | 29.5 | 389 |
| 30 | 5 | 93.61 | 14.03 | 41.2 | 562 |
| 40 | 5 | 52.31 | 2.56 | 24.2 | 1001 |
| 50 | 5 | 35.17 | 1.25 | 27.6 | 1567 |
| 50 | 10 | 37.1 | 2.81 | 28.6 | 778 |
| 60 | 10 | 28.04 | 0.85 | 16.7 | 1123 |
| 80 | 10 | 24.19 | 0.71 | 29.2 | 2003 |
| 100 | 10 | 24.4 | 0.24 | 15.8 | 3134 |
| 120 | 10 | 27.67 | 0.1 | 88 | 4516 |
| 120 | 25 | 26.42 | 0.18 | 15.5 | 1790 |
| 150 | 25 | 25.78 | 0.48 | 16.1 | 2808 |
| 200 | 25 | 28.45 | 0.23 | 11.1 | 5007 |
| 250 | 25 | 38.24 | 0.6 | 39.1 | 7834 |
| 300 | 25 | 43.23 | 0.28 | 2.59 | 11290 |

VES-6, location-3 (Qalaehye Loku village)
LAT: 34.36513
LON: 69.09574

| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
|---|---|---|---|---|---|
| 1.5 | 0.5 | 277.96 | 122.573 | 27.7 | 13.7 |
| 2 | 0.5 | 246.22 | 173.1 | 8.2 | 24.7 |
| 3 | 0.5 | 137.28 | 47.88 | 9.5 | 56.2 |
| 4 | 0.5 | 79.41 | 10.88 | 6.7 | 100 |
| 5 | 0.5 | 69.47 | 7.99 | 8.9 | 157 |
| 6 | 0.5 | 55.76 | 4.05 | 8.1 | 226 |
| 8 | 0.5 | 45.69 | 5.08 | 22.2 | 402 |
| 8 | 2 | 50.34 | 25.13 | 23.5 | 99 |
| 10 | 2 | 46.99 | 21.58 | 34.6 | 156 |
| 12 | 2 | 43.85 | 11.45 | 28.7 | 225 |
| 15 | 2 | 37.56 | 3.27 | 15.1 | 352 |
| 20 | 2 | 29.08 | 1.97 | 21.1 | 627 |
| 20 | 5 | 32.12 | 5.96 | 21.8 | 247 |
| 25 | 5 | 27.78 | 2.54 | 17.2 | 389 |
| 30 | 5 | 24.91 | 1.92 | 21.2 | 562 |
| 40 | 5 | 28.23 | 4.11 | 72 | 1001 |
| 50 | 5 | 22.52 | 6 | 13.18 | 1567 |
| 50 | 10 | 18.74 | 0.32 | 13.4 | 778 |
| 60 | 10 | 23.51 | 0.87 | 14 | 1123 |
| 80 | 10 | 23.36 | 3.25 | 76.5 | 2003 |
| 100 | 10 | 21.5 | 1.38 | 63.9 | 3134 |
| 120 | 10 | 20.81 | 0.32 | 24.4 | 4516 |
| 120 | 25 | 21.81 | 0.53 | 21.1 | 1790 |
| 150 | 25 | 22.49 | 1.17 | 71.9 | 2808 |
| 200 | 25 | 27.99 | 0.12 | 10.9 | 5007 |
| 250 | 25 | 30.04 | 0.32 | 41.4 | 7834 |
| 300 | 25 | 34.562 | 0.732 | 57.112 | 11290 |

VES-7, location-3 (Qalaehye Loku village)
LAT: 34.36508
LON: 69.09671

| AB/2 | MN/2 | Rho (ohm.m) | Vp (mV) | In (mA) | K (m) |
|---|---|---|---|---|---|
| 1.5 | 0.5 | 50.39 | 1660.89 | 20.7 | 13.7 |
| 2 | 0.5 | 59.49 | 784.3 | 15.53 | 24.7 |
| 3 | 0.5 | 69.15 | 139.78 | 55.5 | 56.2 |
| 4 | 0.5 | 73.38 | 84.4 | 56.9 | 100 |
| 5 | 0.5 | 70.54 | 69.82 | 76.9 | 157 |
| 6 | 0.5 | 85.96 | 64.84 | 84.7 | 226 |
| 8 | 0.5 | 86.72 | 10.27 | 23.7 | 402 |
| 8 | 2 | 89.54 | 24.85 | 13 | 99 |
| 10 | 2 | 61 | 15.03 | 18.5 | 156 |
| 12 | 2 | 47.59 | 37.41 | 86.4 | 225 |
| 15 | 2 | 38.9 | 2.59 | 11.5 | 352 |
| 20 | 2 | 25.43 | 1.27 | 15.6 | 627 |
| 20 | 5 | 29.52 | 4.38 | 17.5 | 247 |
| 25 | 5 | 21.45 | 2.95 | 25.9 | 389 |
| 30 | 5 | 18.14 | 0.51 | 7.8 | 562 |
| 40 | 5 | 17.12 | 0.52 | 15.3 | 1001 |
| 50 | 5 | 15.63 | 0.37 | 18.4 | 1567 |
| 50 | 10 | 21.99 | 1.05 | 18 | 778 |
| 60 | 10 | 20.64 | 0.98 | 26.3 | 1123 |
| 80 | 10 | 20.11 | 0.17 | 8.4 | 2003 |
| 100 | 10 | 19.03 | 0.37 | 30.7 | 3134 |
| 120 | 10 | 19.09 | 0.37 | 44.2 | 4516 |
| 120 | 25 | 18.71 | 0.74 | 34.5 | 1790 |
| 150 | 25 | 18.29 | 0.42 | 32 | 2808 |
| 200 | 25 | 23.39 | 0.45 | 48 | 5007 |
| 250 | 25 | 27.47 | 0.22 | 32.6 | 7834 |
| 300 | 25 | 28.704 | 0.17 | 26.424 | 11290 |

## 4.4 Interpreted field data

The collected field data were interpreted by IPI2 wins software. The interpreted data were used to calculate apparent resistivity, thickness, depth and boundaries of layers. The interpreted data are shown in Table 6.

Table 6, VES -1, VES-2, VES-3, VES-4, VES-5, VES-6 and VES-7 interpreted data

| No | VES Profiles | Vertical Electrical Sounding data inter-pretation results | | | | Expected litho logy of layers |
|---|---|---|---|---|---|---|
| | | App-Resistivity *(Ohm-m)* | La yer | Thickness *(m)* | Depth *(m)* | |
| 1 | VES-1 LAT: 34.37402 LON: 69.11014 | 115 | 1 | 0.75 | 0.75 | Mixed sediment (Clay, sand, gravel) |
| | | 278 | 2 | 5.37 | 5.37 | Dry shingly and detritus sediments (clay sand, gravel, silt) |
| | | 14.2 | 3 | 137 | 137 | Shingly and detritus sediments (clay, sand, gravel, clay sand |
| | | 4957 | 4 | > 137 | | Bedrock |
| 2 | VES-2 LAT: 34.37914 LON: 69.11220 | 48.9 | 1 | 0.75 | 0.75 | Mixed sediment (Clay, sand, gravel) |
| | | 113 | 2 | 3.74 | 4.49 | Dry sand and gravel |
| | | 15 | 3 | 54.8 | 59.2 | shingly and detritus sediments |
| | | 37.5 | 4 | > 59.2 | > 59.2 | Bedrock |
| 3 | VES-3 LAT: 34.37015 LON: 69.11314 | 95.19 | 1 | 4.305 | 4.305 | Mixed sediment (Clay, sand, gravel) |
| | | 3.444 | 2 | 3.385 | 7.69 | clay |
| | | 37.05 | 3 | 8.22 | 15.91 | Mixed sediment (Clay, sand, gravel) |
| | | 6.054 | 4 | 23.82 | 39.73 | Sand and gravel |
| | | 26.87 | 5 | > 39.73 | | Bedrock |
| 4 | VES-4 LAT: 34.37914 LON: 69.11220 | 244 | 1 | 0.75 | 0.75 | Mixed sediment (Clay, sand, gravel) |
| | | 0.565 | 2 | 0.0232 | 0.773 | clay |
| | | 442 | 3 | 0.676 | 1.45 | Dry sand and gravel |
| | | 6.22 | 4 | 11.3 | 12.7 | Sand and gravel |
| | | 32 | 5 | 19.2 | 31.9 | sand and gravel |
| | | 0.162 | 6 | > 31.9 | | Clay? |
| 5 | VES-5 LAT: 34.36539 LON: 69.09934 | 24 | 1 | 1.29 | 1.29 | Shingly and detritus sediments ( gravel, sand) |
| | | 204 | 2 | 9.23 | 10.5 | Dry shingly and detritus sediments (clay sand, gravel, silt) |
| | | 20.6 | 3 | 88.3 | 98.8 | Shingly and detritus sediments saturated with water |
| | | 129 | 4 | > 98.8 | | Bedrock (Sandston and siltstone?) |
| 6 | VES-6 LAT: 34.36513 LON: 69.09574 | 396 | 1 | 1.08 | 1.08 | Dry shingly and detritus sediments (clay sand, gravel, silt) |
| | | 48.9 | 2 | 7.34 | 8.42 | Sand, gravel and clay sand |
| | | 21.5 | 3 | 190 | 198 | Shingly and detritus sediments (clay sand, gravel, silt) |
| | | 1407 | 4 | | > 198 | Sandston and siltstone? |
| 7 | VES-7 LAT: 34.36508 LON: 69.09671 | 67.9 | 1 | 1.14 | 1.14 | Dry sand, gravel and clay sand |
| | | 362 | 2 | 1.91 | 3.06 | Dry sand, gravel and clay sand |
| | | 21.7 | 3 | 46.9 | 52.6 | Sand, gravel |
| | | 7.5 | 4 | 41 | 93.6 | Clay |
| | | 109 | 5 | | > 93.6 | Bedrock (sandstone and siltstone?) |

### 4.5 Vertical Electrical sounding data Graphic interpretation

The VES -1, VES-2, VES-3, VES-4, VES-5, VES-6 and VES-7 field data (Apparent resistivity versus Electrodes distance) were interpreted by IPI2 win software as well as manually. The boundaries, thickness and depth of rocks layers were determined according to the measured and computed apparent resistivity and geo electrical model (Table 6). The rock types were specified according to the computed apparent resistivity based on the geophysical interpretation principles. The Apparent resistivity versus Electrodes distance curve for VES -1, VES-2, VES-3, VES-4, VES-5, VES-6 and VES-7 are shown in the Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13.

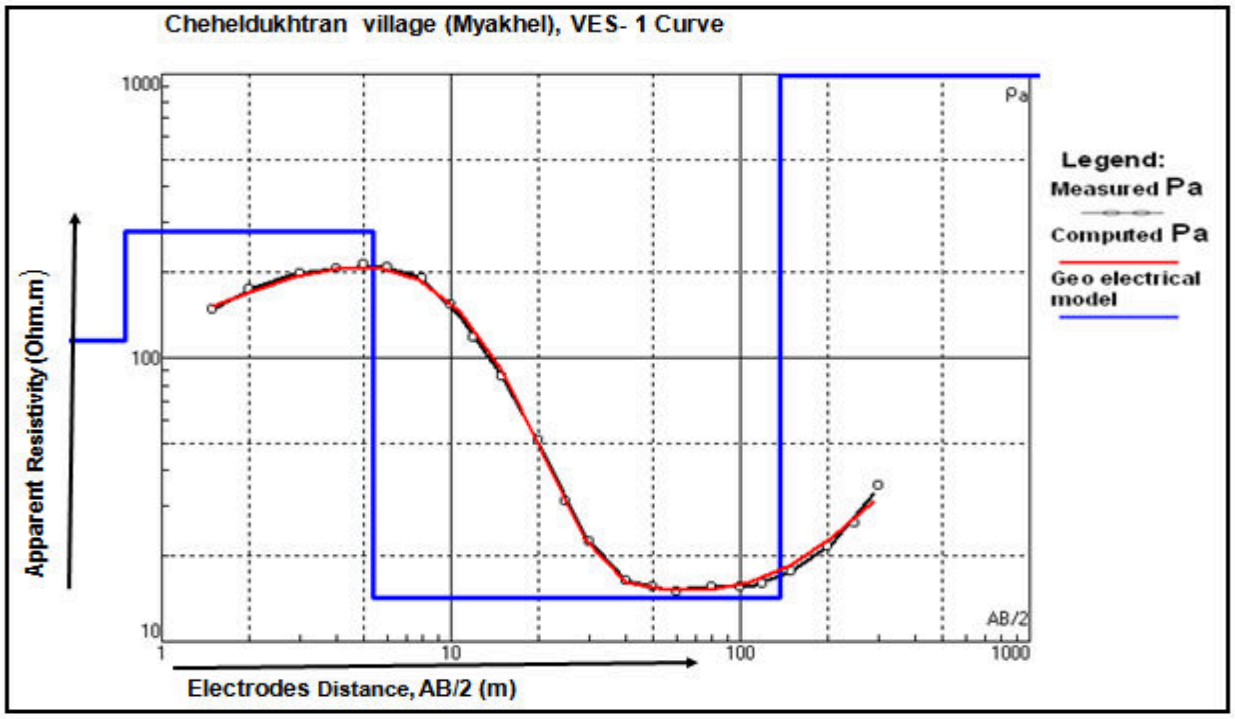



Figure 9, VES-1 Curve

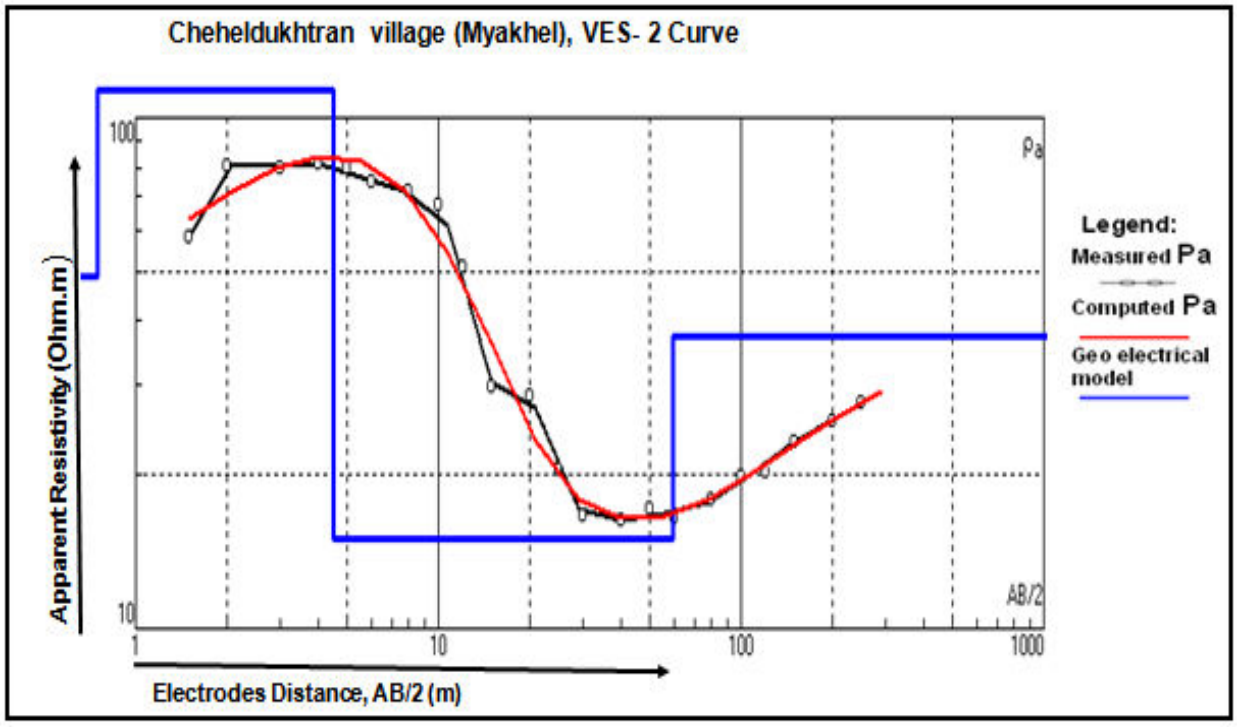



Figure 10, VES-2 Curve

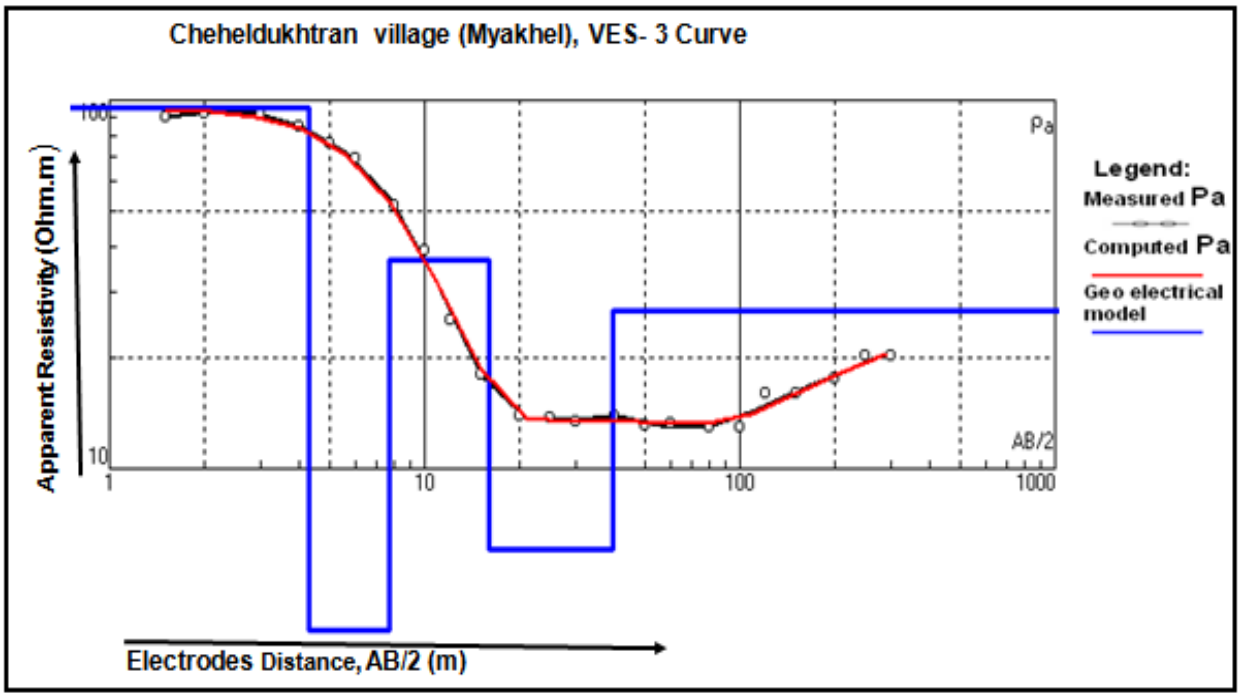



Figure 11, VES-3 Curve

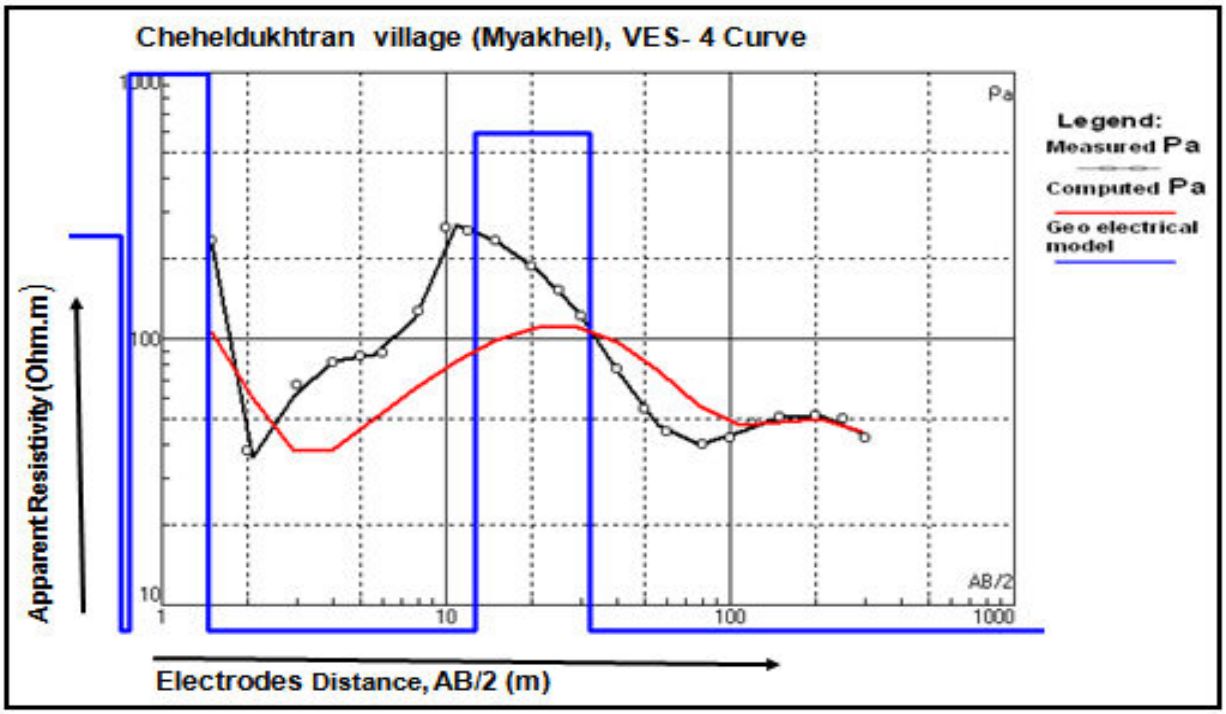



Figure 12, VES-4 Curve

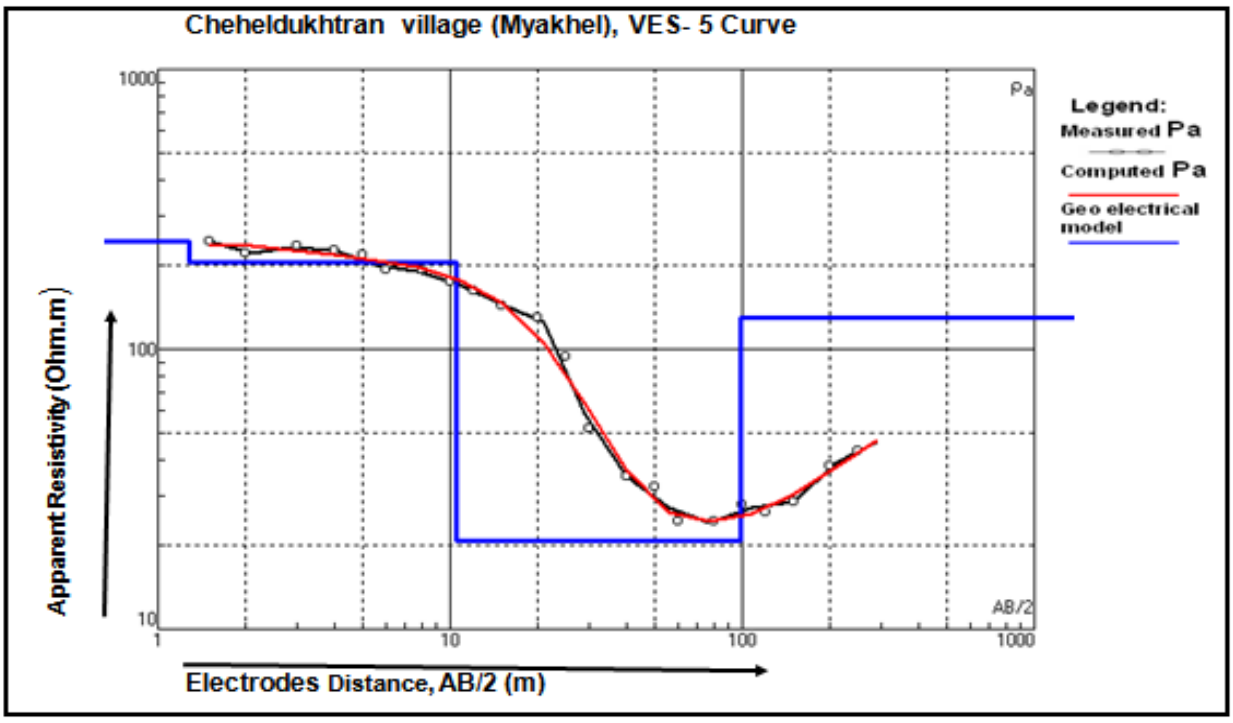



Figure 13, VES-5 Curve

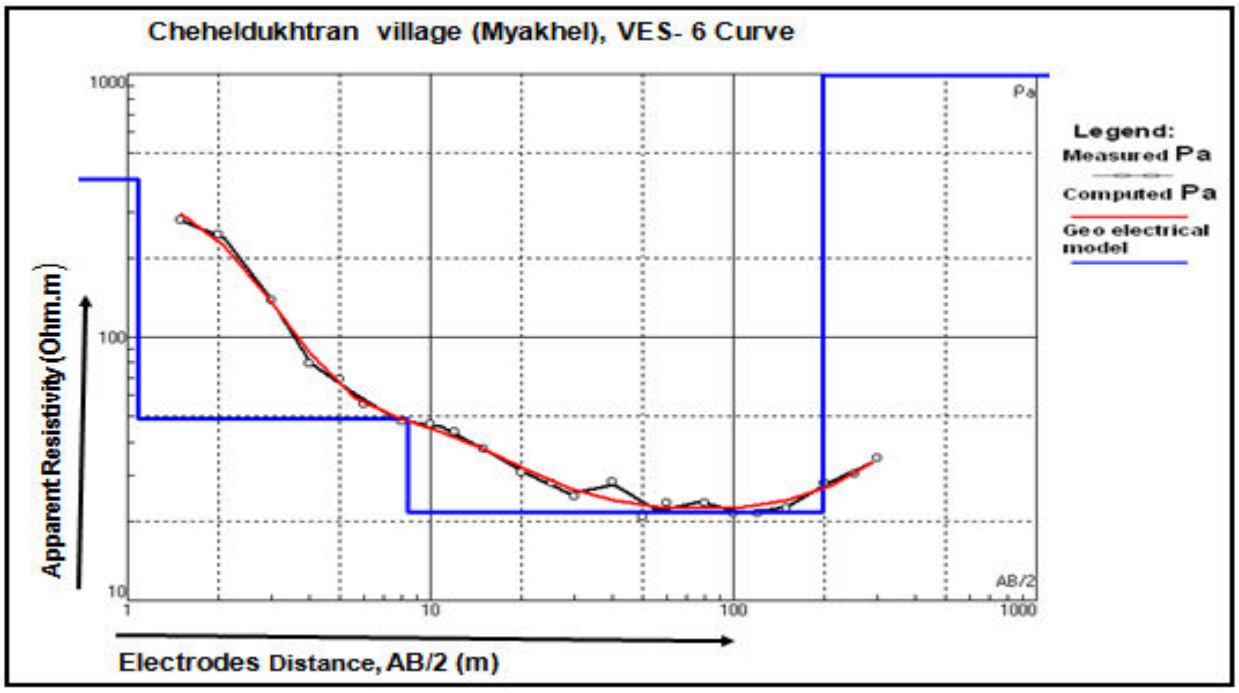



Figure 13, VES-6 Curve

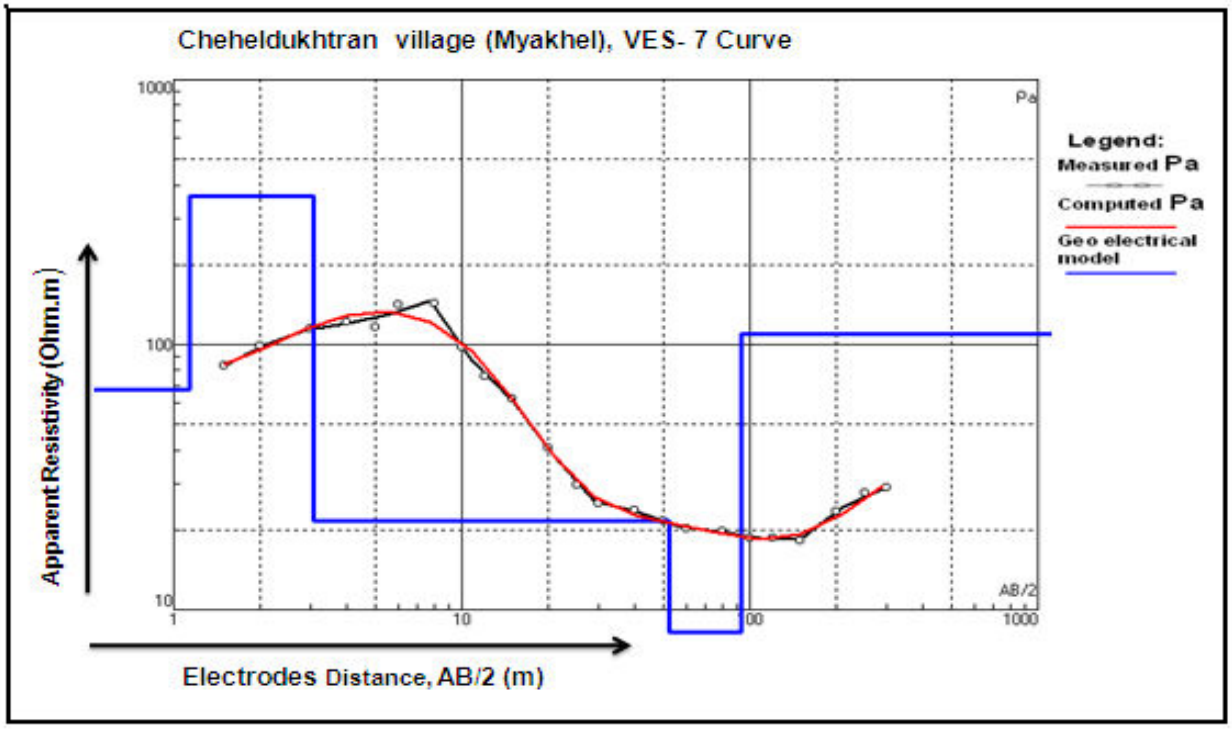



Figure 13, VES-6 Curve

### 4.6 VES profiles field data Graphic interpretation results

The measured, computed apparent resistivity and geo electrical curves show:

- VES-1, VES-2 and VES-3 profiles performed in location-1(Myakhil village). The field data interpretation from these profiles (VES-1, VES-2 and VES-3) show that the upper part of aquifer made by Mixed sediment (Clay, sand, gravel) and the aquifer consists of shingly and detritus sediments (gravel, sand, clay sand and silt sand ) which saturated with fresh and saline water. The water table range from 19 m to 32 m. The discharge of groundwater is very poor. Therefore groundwater cannot be developed for drinking purposes.

- VES-4 profile performed in location-2 (Nomunyaz village). The field data interpretation from this profile (VES-4) shows that the upper part of aquifer layers consists of dry shingly and detritus sediments (clay, sand, gravel, clay sand. clay, silt and loam) and the aquifer consists shingly and detritus sediments witch is saturated with water. The bedrock occurs in the bottom of shingly and detritus sediments. The thickens of aquifer is very low (between 7-10 m). The water table ranges from 23 -26 m. The groundwater is fresh. The field data interpretation results also indicate that the bedrock occurs to the depth of 35 m
- VES-5, VES-6 and VES-7 profiles performed in location-3 (Qalaehye Loku village). The field data interpretation from these profiles (VES-5, VES-6 and VES-7) show that the upper part of aquifer consists dry shingly and detritus sediments (clay, sand, gravel, clay sand. clay, silt and loam) and the aquifer consists of shingly and detritus sediments witch is saturated with water. The bedrock occurs in the bottom of shingly and detritus sediments. The water table range from 8 m to 13 m. The aquifer has fresh groundwater. Therefore, this area has relatively good possibility for development of groundwater than the location-1 and location-2.

## 5. Conclusion

1. In location-1 (Myakhil village), the measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:
   - The water table ranges from 19 m to 32m.
   - The aquifer consists of silt clay , shingly and detritus sediments ( gravel, sand and clay sand).
   - The aquifer has saline water. The groundwater cannot be developed for drinking purposes due to having saline groundwater and low discharge.
2. In location-2 (Nomunyaz village), the measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:
   - The water table ranges from 23 m to 26 m.
   - This area has low thickness of aquifers due to occurrence of bedrock.
   - The area has fresh groundwater
   - There is very poor possibility for groundwater development due the occurrence of bed rock to the depth of 36m.
3. In location-3 (Qalaehye Loku village), the measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:
   - The water table ranges from 8 m to 13 m.
   - This area has relatively a good possibility for groundwater development than the other studied location.
   - The groundwater is fresh

- The aquifer media  consist of shingly and detritus sediments

## 6. Recommendation

- The location-3 (Qalaehye Loku village) has relatively a good possibility for groundwater development than the other investigation locations (Figure 8)
- The water table ranges from 8 m to 13 m.
- The well should be drilled to the depth of 90 m
- The discharge of well can not guarantee according to the result of this investigation. The discharge of well will be determined during making pumping test. Therefore, there needs to drill well by percussion Rig under our supervision, then to make pumping test before installation of pipe and screen. If the well produces enough discharge, then install the pipe and screen.