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# Ground Water Level Fluctuations in White Bein Sub-basin-Bist Doab, Punjab (India)- Year 2002-2005

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**Abstract :** Water level data from piezometers and observation wells were utilized to depict the prevailing water levels during pre- (in the month of June) and post -monsoon (in the month of October) in the years 2002, 2003, 2004 and 2005.

The water table depth map of June 2002, reveals that in the central portion of the study area, the water level contours of 7m to 20m appear. The water level is minimum in Adampur block of Jalandhar district, in Banga block of Nawanshahar district and a part of Garhshankar. The water level is deeper in Jalandhar district and varies between 10 to 20m except in Adampur where the water level lies at 7m. In the northern and eastern parts of the study area, the water level is deeper. The water levels are increasing as moving from west to east side of the study area. The water table depth map of the October 2002 reveals that the water level in the central portion of the study area varies between 7m and 18m. In the northeastern side of the study area, water level showed an increase of 5m from June 2002 to October 2002. This rise in the water levels in October, as compared to June, is due to the monsoonal rainfall. The water table depth map of June 2003 reveals that in the central portion of the study area, the depth to water level has increased, as compared June 2002. However, in the Northeastern region, as shown in the depth to water table map of October 2003, the water level in the northeastern side is higher than in June 2003. The area adjacent to the River Sutlej has also shown rise in post-monsoon period as compared to June 2003. In the year 2004 in pre-monsoon, the water levels in the northern and eastern side of the study area has gone deep and vary between 10 m and 60 m. In the central portion of the study area, the water level is deep and varies between 10 and 20 m. In the post-monsoon, as the depth to water table map of October 2004 depicts, the water levels showed an increase as compared to June 2004. The depth to water table map of June 2005 depicts shift in water levels ranging from 13-15m, 18m and 20m more towards the central portion of the study area indicating the decline in water levels over the years from 2002 to 2005. In the northern and eastern side of the study area the water level trend is more or less the same. In Oct.2005, rise in water table is indicated in almost all parts of the study area as compared to June 2005.

On the basis of data of elevation of water level from mean sea level during pre-monsoon and post-monsoon periods of years from 2002 to 2005, the direction of ground water flow has been depicted in Maps 10 to17. The ground water flow direction in the study area is towards south and south-west going away from the hills. In the central and western part of the study area, the ground water flow is towards west.

**Key Words:** White Bein, Piezometers ,Water Table, Ground Water Flow.

## INTRODUCTION

The area under investigation covers the White Bein sub- basin of the Bist Doab tract -a part of Punjab lying between rivers Beas and Satluj. The study area forms the northeastern and southern part of the tract lying North of Satluj river. It comprises both hilly as well as plain land, the Siwalik hills demarcating the northeastern boundary. Geographically, study area lies between latitudes 31°02'50" to 31°39'20"N and longitudes 74°56'45" to 76°18'53" E and falls on the Survey of India Toposheet Numbers 44M/8, 11,12,14,15,16 and 53 A/2,3,4,7,8. It covers parts

of Jalandhar, Nawanshahar, Hoshiarpur and Kapurthala districts of Punjab. On northeastern side, the research area has a common boundary with Himachal Pradesh. The area is approachable from Chandigarh, Una, Jammu, Kapurthala, Amritsar and Ludhiana by all especially weathered metalled roads. The remote parts of the area foothill belt are approachable by mule-tracks and footpaths. Hoshiarpur,Jalandhar, Nakodar, Nawanshahar, Mahilpur are some important towns within the study area (Map.1).

## HYDROGEOLOGY

It includes the study of depth to water level and water table elevation.

**Depth to water levels:** Water level data from piezometers and observation wells obtained from Ground Water Cell, Department of Agriculture, Punjab, were utilized to depict the prevailing water levels during pre- monsoon (June) and post - monsoon (October) in the years 2002,2003, 2004 and 2005. The water level data from 2002 to 2005 (pre-monsoon and post-monsoon) is given in Table-1.

### *Year 2002*

The depth to water level in hills (Table-2) was recorded as 38.19m in the Salaran village of Hoshiarpur II block of Hoshiarpur district in the month of June and 38.01m was noticed during post-monsoon showing an increase of 18cm rise in water level. In the upper piedmont area (Table-2), the depth to water level varied from 3.87m in Bagpur village of the Hoshiarpur I block of Hoshiarpur district to 65.59m in Harjiana village of Mahilpur block of Hoshiarpur district in the month of June, whereas in the month of the October, it came up by 15cm in Bagpur and 5cm in Harjiana. In the lower piedmont area (Table-2), the depth range of the water level varied from 3.91 m (in Nasrala of Hoshiarpur I block of

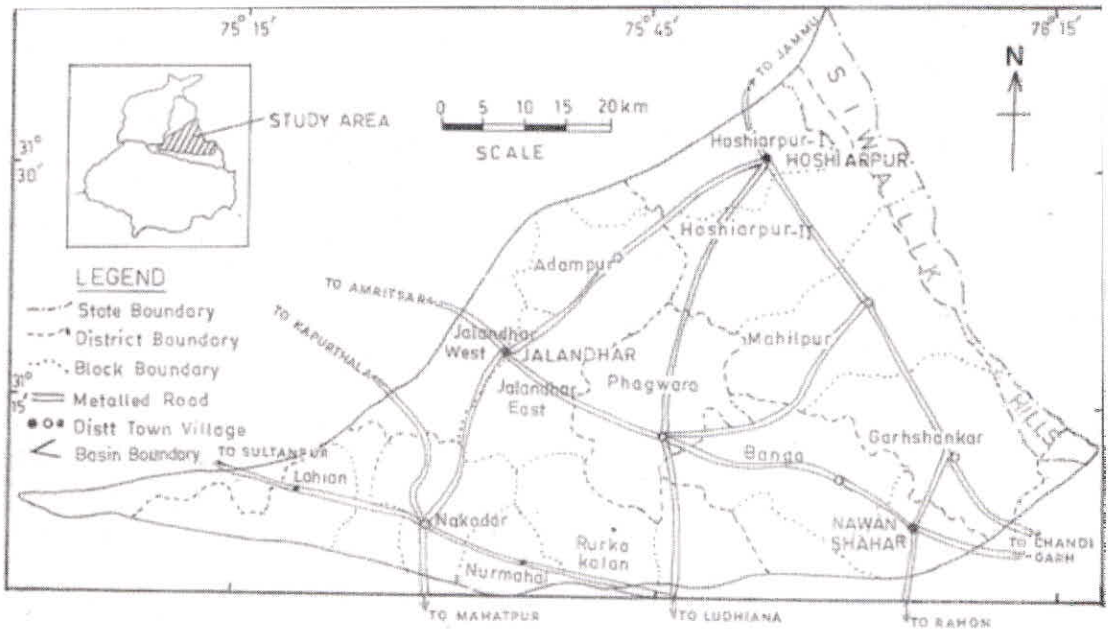


**Fig. :** 1 Location and Approach to Research Area

**Table 1 :**

| WATER LEVEL DATA FROM THE YEAR 2002 TO YEAR 2005 DURING PREMONSOON AND POST | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GEOMORPHIC UNIT -1 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | HPR | HOSHIAR PUR-II | OW | SALARAN | 44M/14 | 75 | 59 | 00 | 31 | 35 | 35 |
| | | GEOMORPHIC UNIT -2 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | HPR | HOSHIAR PUR-I | OW | BAGPUR | 44M/14 | 75 | 53 | 45 | 31 | 35 | 15 |
| 2 | HPR | HOSHIAR PUR-II | OW | BASSI MUSTFA | 44M/14 | 75 | 59 | 40 | 31 | 30 | 38 |
| 3 | HPR | HOSHIAR PUR-II | OW | JAHAN KHELAN | 44M/14 | 75 | 59 | 05 | 31 | 30 | 50 |
| 4 | HPR | MAHIL PUR | OW | MAHILPUR | 53A/3 | 76 | 01 | 52 | 31 | 21 | 50 |
| 5 | HPR | MAHIL PUR | OW | HARJIANA | 53A/3 | 76 | 07 | 25 | 31 | 21 | 08 |
| 6 | HPR | MAHIL PUR | OW | RAMPUR | 53A/3 | 76 | 04 | 55 | 31 | 23 | 05 |
| 7 | HPR | GARHSHANKAR | OW | ROR MAZARA | 53A/4 | | | | | | |
| | | GEOMORPHIC UNIT -3 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | HPR | HOSHIAR PUR-I | OW | DALAMWAL | 44M/14 | 75 | 47 | 20 | 31 | 35 | 10 |
| 2 | HPR | HOSHIAR PUR-I | OW | NASRALA | 44M/15 | 75 | 49 | 35 | 31 | 29 | 20 |
| 3 | HPR | HOSHIAR PUR-I | OW | PURHIRAN | | | | | | | |
| 4 | HPR | HOSHIAR PUR-II | OW | DHAKOWAL | 44M/15 | 75 | 53 | 00 | 31 | 27 | 55 |
| 5 | HPR | HOSHIAR PUR-II | OW | FUGLANA | 44M/15 | 75 | 50 | 20 | 31 | 23 | 20 |
| 6 | HPR | HOSHIAR PUR-II | PZ | CHHANOI KALAN | 44M/15 | 75 | 56 | 20 | 31 | 29 | 45 |
| 7 | HPR | HOSHIAR PUR-II | PZ | CHABEWAL | 44M/15 | 75 | 59 | 00 | 31 | 26 | 50 |
| 8 | HPR | MAHIL PUR | OW | KHERA | 44M/15 | 75 | 59 | 40 | 31 | 20 | 15 |
| 9 | HPR | MAHIL PUR | OW | BHAM | TOPONO | 75 | 56 | 30 | 31 | 22 | 00 |
| 10 | HPR | GARHSHANKAR | OW | RAMPUR BILRON | 53A/3 | | | | | | |
| 11 | HPR | GARHSHANKAR | PZ | PADDI SURA SINGH | 53A/3 | 76 | 04 | 10 | 31 | 16 | 45 |
| 12 | JAL | ADAMPUR | OW | BAHUDINPUR | | 75 | 45 | 45 | 31 | 28 | 15 |
| | | GEOMORPHIC UNIT-4 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | JAL | ADAMPUR | OW | ALAWALPUR | | | | | | | |
| 2 | JAL | ADAMPUR | OW | KHURDPUR | 44M/11 | 75 | 43 | 00 | 31 | 26 | 20 |
| 3 | JAL | ADAMPUR | OW | DAMUNDA | 44M/15 | 75 | 46 | 00 | 31 | 25 | 00 |
| 4 | JAL | ADAMPUR | OW | BIAS PIND | 44M/11 | 75 | 38 | 00 | 31 | 27 | 30 |
| 5 | JAL | ADAMPUR | OW | KHICHIPUR | | 75 | 42 | 25 | 31 | 22 | 40 |
| 6 | JAL | NAKODAR | PZ | SHANKAR | 44M/12 | 75 | 32 | 00 | 31 | 08 | 50 |
| 7 | JAL | NAKODAR | PZ | GOHIRAN | 44M/12 | 75 | 30 | 00 | 31 | 11 | 30 |
| 8 | JAL | NAKODAR | PZ | CHANIAN | 44M/12 | | | | | | |
| 9 | JAL | NURMAHAL | OW | MAWAI | 44M/12 | | | | | | |
| 10 | JAL | NURMAHAL | OW | BHANGALA | 44M/12 | | | | | | |
| 11 | JAL | NURMAHAL | OW | SHAMPUR | 44M/12 | 75 | 39 | 45 | 31 | 04 | 30 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | JAL | NURMAHAL | OW | UMARPUR | | | | | | | |
| 13 | JAL | JALANDHAR EAST | OW | MOHADDIPUR | 44M/11 | 75 | 44 | 20 | 31 | 20 | 15 |
| 14 | JAL | JALANDHAR EAST | OW | HAZARA | 44M/11 | 75 | 39 | 00 | 31 | 18 | 40 |
| 15 | JAL | JALANDHAR EAST | OW | TALHAN | 44M/11 | 75 | 40 | 30 | 31 | 18 | 30 |
| 16 | JAL | JALANDHAR EAST | OW | BHOJOWAL | 44M/11 | 75 | 38 | 25 | 31 | 20 | 10 |
| 17 | JAL | JALANDHAR EAST | OW | KOT KALAN | 44M/11 | 75 | 39 | 30 | 31 | 17 | 30 |
| 18 | JAL | JALANDHAR WEST | OW | RAIPUR RASULPUR | 44M/11 | 75 | 35 | 45 | 31 | 24 | 00 |
| 19 | JAL | JALANDHAR WEST | OW | HALERAN | 44M/7 | | | | | | |
| 20 | JAL | PHILLAUR | OW | PADDI JAGIR | 44M/16 | 75 | 48 | 50 | 31 | 08 | 45 |
| 21 | JAL | PHILLAUR | OW | MANSOORPUR | 44M/16 | 75 | 47 | 25 | 31 | 05 | 10 |
| 22 | JAL | RURKA KALAN | OW | RURKA KALAN | 44M/12 | | | | | | |
| 23 | JAL | RURKA KALAN | OW | CHACHRARI | 44M/16 | 75 | 46 | 35 | 31 | 09 | 50 |
| 24 | NWS | BANGA | OW | BEHRAM | 44M/16 | 75 | 53 | 40 | 31 | 12 | 10 |
| 25 | NWS | BANGA | OW | LANGERY | 44M/16 | 75 | 55 | 55 | 31 | 10 | 35 |
| 26 | NWS | BANGA | OW | LUDHANA JHIKA | 53A/4 | 76 | 01 | 45 | 31 | 12 | 58 |
| 27 | NWS | BANGA | OW | GHUMAN | 44M/16 | 75 | 51 | 47 | 31 | 15 | 25 |
| 28 | NWS | BANGA | OW | BAHAROWAL | 44M/16 | 75 | 58 | 10 | 31 | 11 | 40 |
| 29 | NWS | BANGA | OW | BHUT | 53A/4 | 76 | 02 | 10 | 31 | 10 | 07 |
| 30 | NWS | BANGA | OW | SOONDH | 44M/16 | 75 | 54 | 50 | 31 | 14 | 00 |
| 31 | NWS | BANGA | OW | MEHLI | 44M/16 | 75 | 48 | 57 | 31 | 12 | 50 |
| 32 | NWS | AUR | OW | MUKANDPUR | 44M/16 | 75 | 56 | 50 | 31 | 07 | 40 |
| 33 | NWS | AUR | OW | BALOWAL | 44M/16 | 75 | 54 | 35 | 31 | 08 | 00 |
| 34 | NWS | AUR | OW | KAMAM | 53A/4 | 76 | 01 | 32 | 31 | 07 | 14 |
| 35 | NWS | NAWAN SHAHAR | OW | MALPUR | 53A/4 | | | | | | |
| 36 | NWS | NAWAN SHAHAR | OW | USMANPUR | 53A/4 | 76 | 10 | 50 | 31 | 03 | 50 |
| 37 | NWS | NAWAN SHAHAR | OW | BARNALA KALAN | 53A/4 | 76 | 09 | 00 | 31 | 07 | 30 |
| 38 | HPR | MAHIL PUR | OW | PANJORA | | | | | | | |
| 39 | HPR | MAHIL PUR | OW | TUTOMAJRA | | | | | | | |
| 40 | HPR | GARHSHANKAR | PZ | GARHASHANKAR | 53A/4 | 76 | 08 | 15 | 31 | 13 | 00 |
| 41 | HPR | GARHSHANKAR | OW | SAMUNDRA | 53A/4 | | | | | | |
| 42 | HPR | GARHSHANKAR | PZ | KOT FATUHI | 44M/15 | 75 | 58 | 15 | 31 | 16 | 35 |
| 43 | HPR | GARHSHANKAR | OW | BASAYALA | | | | | | | |
| 44 | HPR | GARHSHANKAR | OW | MORANWALI | | | | | | | |
| 45 | HPR | GARHSHANKAR | OW | MAZARADHINGRIAN | | | | | | | |
| 46 | KPT | PHAGWARA | OW | NAROOR | 44M/15 | 75 | 31 | 32 | 31 | 19 | 55 |
| 47 | KPT | PHAGWARA | OW | KHURAMPUR | 44M/15 | 75 | 46 | 15 | 31 | 15 | 35 |
| 48 | KPT | PHAGWARA | OW | NANGAL KHERA | 44M/16 | 75 | 45 | 45 | 31 | 12 | 00 |
| 49 | KPT | PHAGWARA | OW | JAGPALPUR | | 75 | 44 | 50 | 31 | 18 | 25 |
| | | GEOMORPHIC UNIT-5 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | JAL | LOHIAN | OW | GIDDAR PINDI | | | | | | | |
| 2 | JAL | SHAHKOT | PZ | MALSIAN | 44M/6 | 75 | 21 | 00 | 31 | 07 | 50 |
| 3 | JAL | SHAHKOT | PZ | BALHUKMI | | | | | | | |
| | | GEOMORPHIC UNIT-6 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | JAL | NURMAHAL | OW | NURMAHAL | 44M/12 | 75 | 35 | 40 | 31 | 05 | 50 |
| 2 | JAL | PHILLAUR | OW | APRA | 44M/16 | 75 | 52 | 45 | 31 | 05 | 05 |
| 3 | JAL | RURKA KALAN | OW | GOROYA | 44M/16 | 75 | 46 | 10 | 31 | 07 | 40 |
| 4 | NWS | NAWAN SHAHAR | OW | GHATRAON | 53A/4 | 76 | 03 | 55 | 31 | 06 | 10 |
| 5 | NWS | AUR | OW | SHIKUPUR | | | | | | | |
| | | GEOMORPHIC UNIT-7 | | | | | | | | | |
| S_NO | DNAME | FBNAME | WELLTYPE | VILLNAME | TOPONO | LONGDEG | LONGMINT | LONGSEC | LATIDEG | LATIMINT | LATISEC |
| 1 | JAL | LOHIAN | PZ | LOHIAN | 44M/4 | 75 | 12 | 35 | 31 | 09 | 45 |
| 2 | JAL | SHAHKOT | PZ | KHIWA | 44M/8 | 75 | 23 | 20 | 31 | 12 | 40 |

## Table 2 :

Minimum and Maximum Water Level recorded in the different Geomorphic Units falling in the study area

| GEOMORPHIC UNIT | YEAR 2002 | | | | YEAR 2003 | | | | YEAI | |
|---|---|---|---|---|---|---|---|---|---|---|
| | JUNE | | OCT | | JUNE | | OCT | | JUNE | |
| | MINI | MAX | MINI | MAX | MINI | MAX | MINI | MAX | MINI | MAX |
| G-1 | 38.19 | 38.19 | 38.01 | 38.01 | 40.36 | 40.36 | 37.78 | 37.78 | 42.63 | 42.63 |
| VILLAGE BLOCK | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II | SALARAN-HOSH-II |
| G-2 | 3.87 | 65.59 | 3.72 | 65.64 | 4.78 | 67.24 | 3.31 | 65.33 | 4.99 | 66.01 |
| VILLAGE BLOCK | BAGPUR -HOSH-1 | HARJIANA MAHILPUR | BAGPUR -HOSH-1 | HARJIANA MAHILPUR | BAGPUR -HOSH-1 | HARJIANA MAHILPUR | BAGPUR -HOSH-1 | HARJIANA MAHILPUR | BAGPUR -HOSH-1 | HARJIANA MAHILPUR |
| G-3 | 3.91 | 24.7 | 3.82 | 24.25 | 4.92 | 25.2 | 3.52 | 25.25 | 6.88 | 27.27 |
| VILLAGE BLOCK | NASRALA HOSH-I | RAMPUR BILRON,GAR. | NASRALA HOSH-I | RAMPUR BILRON,GAR. | NASRALA HOSH-I | RAMPUR BILRON,GAR. | NASRALA HOSH-I | RAMPUR BILRON,GAR. | CHABEWAL HOSH-II | RAMPUR BILRON,GAR. |
| G-4 | 4.77 | 24.02 | 4.93 | 24 | 5.6 | 26.55 | 4.73 | 24.82 | 6.26 | 26.85 |
| VILLAGE BLOCK | GIDDAR PINDI LOHIAN | BALHUKMI SHAHKOT | GIDDAR PINDI LOHIAN | BALHUKMI SHAHKOT | GIDDAR PINDI LOHIAN | BALHUKMI SHAHKOT | GIDDAR PINDI LOHIAN | BALHUKMI SHAHKOT | GIDDAR PINDI LOHIAN | BALHUKMI SHAHKOT |
| G-5 | 5.52 | 24.06 | 5.58 | 21.84 | 6.8 | 24.06 | 6.03 | 24.82 | 6.26 | 26.52 |
| VILLAGE BLOCK | BASAYALA GAR. | GOHIRAN NAKODAR | BASAYALA GAR. | SHANKAR NAKODAR | BASAYALA GAR. | GOHIRAN NAKODAR | BEHRAM BANGA | BALHUKMI SHAHKOT | KHURPUR ADMPUR | GOHIRAN NAKOAR |
| G-6 | 18.4 | 22.65 | 17 | 23.9 | 18.33 | 23.9 | 16.5 | 24.77 | 21.9 | 25.25 |
| VILLAGE BLOCK | LOHIAN LOHIAN | KHIWA SHAHKOT | LOHIAN LOHIAN | KHIWA SHAHKOT | LOHIAN LOHIAN | KHIWA SHAHKOT | LOHIAN LOHIAN | KHIWA SHAHKOT | LOHIAN LOHIAN | KHIWA SHAHKOT |

Hoshiarpur district) to 24.7m (in Rampur Bilron village of Garhshankar block of Hoshiarpur district) in the month of June and an increase of 9cm was noticed in the month of October in Nasrala of Hoshairpur district and 45cm in Rampur Bilron of Garhshankar.

In the old flat plain area (Table-2), the water level varied from 5.52m in Basayala in Garhshankar block of the Hoshairpur district to 24.06m in Gohiran, Nakodar block of the Jalandhar district in pre-monsoon whereas it declined by 6cm in Basyala in the month of the October. The maximum depth to water level of 21.84m was observed in the Shankar of Nakodar block district Jalandhar in post-monsoon.

In the lower terrace area (Table-2), Giddar Pindi, of Lohian block of Jalanadhar district the minimum depth to water level was 4.77m whereas Balhukmi of Shahkot Block, Jalandhar district measured maximum depth (24.02m) to water level in the area in the month of June. However, in post-monsoon, water level showed a declined of 16cm in Giddar Pindi of Lohian block and it increased by 2 cm in Balhukmi of Shahkot block of Jalandhar district.

In the upper terrace area of the study area, the depth range of the water level varied from 9.64m (in Ghatraon of Nawanshahar block of Nawanshahar district) to 15.33m (in Apra of Phillaur block of Jalandhar district) in the month of June whereas in the month of October, the water level showed a decline of 2cm in Ghatraon. Nurmahal of Nurmahal block recorded the maximum depth to water level as 15.06m.

In the terrace with sand cover area (Table-2) of the study area, the depth of the water level varied between 18.4m and 22.65m in Lohian of Lohian block, Jalandhar district and Khiwa of Shahkot block of the Jalandhar district, respectively. In the post-monsoon, the water level came up by 1.4m in Lohian whereas it declined in Khiwa by 1.25 m. The decline occurred due to over drafting and less rainfall.

The water table depth map of June 2002 (Fig.2), reveals that in the central portion of the study area comprising old flat plain, the water level contours of 7m to 20m are present. The water level contour of 7m appears in Adampur block of Jalandhar district, in Banga block of Nawanshahar district and a part of Garhshankar representing upper terrace, indicating that the water level in this area is minimum. Though the water level in Nawanshahar, Phagwara and Aur blocks varies between 7 to 13m but the water level goes deeper in Jalandhar district and varies between 10 to 20 m except in Adampur where contour of 7m also appears. In the northern and eastern parts of the study area, comprising hills and piedmont area, the water level is deeper and varies between 5 and 60m. In the western side of the study area comprising lower terrace and terrace with sand cover, the contours of 5m to 20m are present indicating the increasing water levels as moving from west to east side of the study area.

The water table depth map of the October 2002 (Fig.3) reveals that the water level in the central portion of the study area varies within 7 m to 20 m. In the geomorphic unit 2, representing upper piedmont, water level in the month of October 2002 showed a rise of 5m compared to June 2002. This rise in the water levels in October, as compared to June, is due to the monsoonal rainfall.

***Year 2003***

In the hilly area (Table-2), the depth to the water level was measured as 40.36m in Salaran of Hoshiarpur II block of the Hoshiarpur district in pre-monsoon whereas in post-monsoon period water level came up by 2.58m. Thereby indicating the recharge in the area which may be due to rain fall.

In the month of June, the depth to water level in the upper piedmont area (Table-2), varied from 4.78m in Bagpur, Hoshiarpur I block of Hoshairpur district to 67.24m in Harjiana,

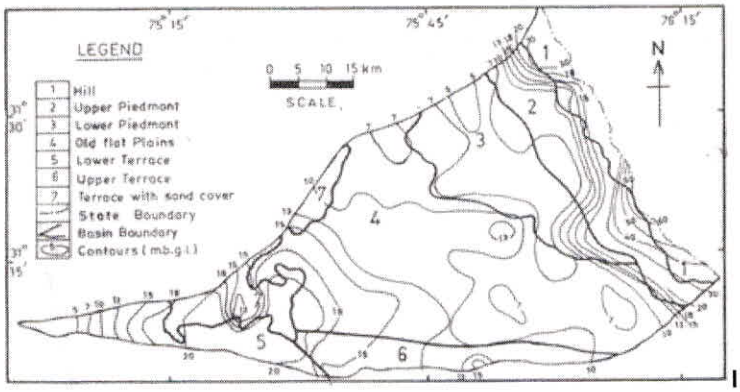


**Fig. 2.** Depth to water table and Geomorphological map June-2002.

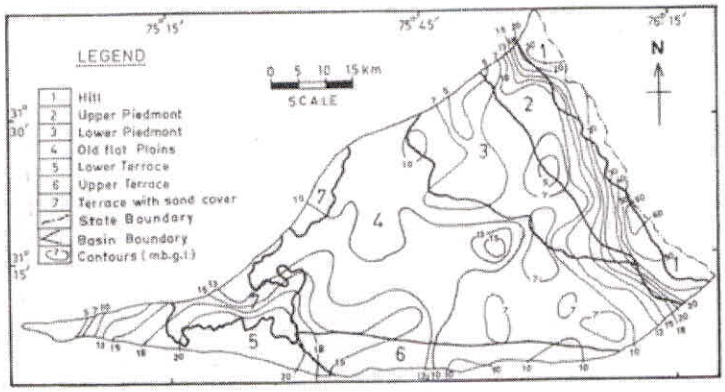


**Fig. 3.** Depth to water table and Geomorphological map October -2002.

Mahilpur block of the Hoshiarpur district. In post-monsoon period, the water level came up by 1.47m in Bagpur and by 1.91m in Harjiana of Mahilpur block, Hoshiarpur district.

In lower piedmont area (Table-2), Nasrala of Hoshiarpur I Block of Hoshiarpur district showed the minimum depth to the water level as 4.92m in pre-monsoon which showed a rise by 1.4m in post-monsoon, whereas Rampur Bilron of Gharhshankar block of Hoshiarpur district measured a maximum depth of 25.2m which goes further down in the month of October by 5 cm.

In the old flat plain area (Table-2), Basayala in Garhshankar block of Hoshiarpur district measured minimum depth to water level as 6.8m in the month of June whereas in October 2003, the observation well at Behram of Banga block district Nawanshahar measured the minimum depth of 6.03m. Gohiran of Nakodar block, district Jalandhar measured maximum depth to water level as 26.4m in the pre-monsoon whereas the water level at this site showed an improvement by 3.89m in the month of October.

Giddar Pindi of Lohian block, in the lower terrace area (Table-2), measured minimum depth to water level as 5.6m in pre-monsoon showed an increase by 87 cm in the post-monsoon whereas Balhukmi of Shahkot block of Jalandhar district measured the maximum depth to water level as 26.55m in pre-monsoon which came up by 1.73m in the area during post-monsoon.

In the upper terrace area (Table-2) of the study area, the depth to the water level varied from 10.9m (in Sheikupur of Aur block of Nawanshahar district) to 16.42m (in Apra of phillaur block of Jalandhar district) in the month of June whereas in the month of October, Ghatraon of Nawanshahar block of Nawanshahar district recorded the minimum depth to water level of 9.97m in the area whereas Nurmahal of Nurmahal block of Jalandhar district recorded the maximum depth to water level as 16.35m.

In the terrace with sand cover area (Table-2), the water level varied between 18.33m and 23.90 m in the Lohian of Lohian block of Jalandhar district and Khiwa of Shahkot block of Jalandhar district in pre-monsoon, respectively. In the post-monsoon period, the water level came up by 1.83 m in Lohian of Lohian block of Jalandhar district and declined by 87 cm in Khiwa of Shahkot block of Jalandhar district.

The water table depth map of June 2003 (Fig.4) reveals that in the central portion of the study area, the depth to water level has increased, as the contour of 7 m has been replaced by 10 m and a wider area has come under the depth range of 10-13m as compared to the area covered in June 2002 in the same depth range. The water level has gone deeper in the geomorphic unit comprising terrace with sand cover.

As the depth to water table map of October 2003 (Fig.5) reveals that the water level in the upper piedmont unit of study area marked a rise

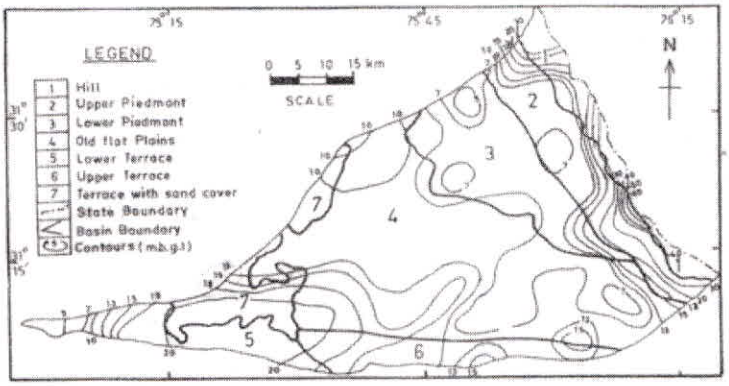


**Fig. 4.** Depth to water table and Geomorphological map June- 2003.

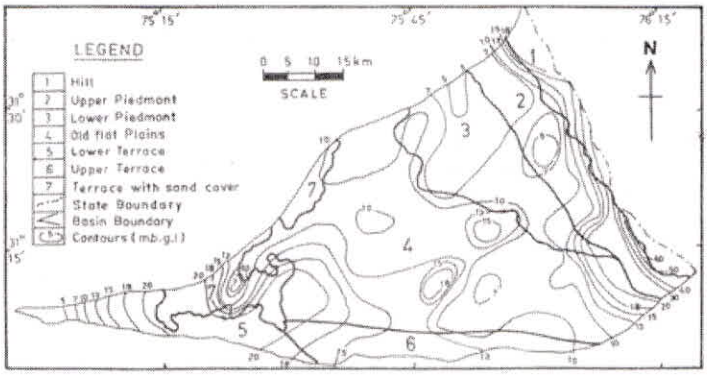


**Fig. 5.** Depth to water table and Geomorphological map October -2003.

of 5m as compared to June 2003. Terrace with sand cover unit of study area has also shown a rise in October 2003.

***Year 2004***

In the hilly area (Table-2) of Salaran village of Hoshiarpur II of Hoshiarpur district, depth to water level in pre-monsoon was recorded as 42.63m, which was reduced by 33cm during post-monsoon.

In the upper piedmont area (Table-2) of the study area, the minimum depth to water level of 4.99m was recorded in Bagpur of Hoshiarpur I block whereas maximum depth to water level of 66.01m was recorded in Harjiana of Mahilpur block of Hoshiarpur district in premonsoon.The water level came up in post-monsoon by 28cm and 78cm in Bagpur and Harjiana of Hoshiarpur district, respectively.

In the Chabewal of Hoshiarpur II block of Hoshiarpur district, the depth to water level of 6.88 m was recorded as the minimum in the area whereas Rampur Bilron, of Garhshankar block, of Hoshiarpur district recorded the maximum depth to water level as 27.27m in the month of June in lower piedmont area (Table-2). During post monsoon (that is in the month of October) both the observation wells have shown a rise in water level by 35cm and 33cm, respectively. The rise in the water level in post-monsoon is due to recharge though rainfall.

In the old flat plain area, observation well at khurdpur in Adampur block of Jalandhar district recorded a minimum depth to water level as 6.6m in pre-monsoon, the water level improved in post-monsoon period by 83cm where as a maximum depth of 26.52m was observed in Gohiran of Nakodar block in pre-monsoon. However, in the month of October water level indicated a considerable increase of 3.12 m.

In the lower terrace area (Table-2), minimum depth to water level was 6.26m in Giddar Pindi of Lohian block of Jalandhar district. In the month of October, the water level showed an increase of 12cm. The maximum depth to water level of 26.85m was recorded at Balhukmi of Shahkot block of Jalandhar district in pre-monsoon whereas during the post-monsoon period there was a decline by 15cm.

In the upper terrace area (Table-2), the depth to the water level varied from 11.95m (in Ghatraon of Nawanshahar block of Nawanshahar district) to 16.27m (in Apra of Phillaur block of Jalandhar district) in the month of June whereas in the month of October, observation well at Nurmahal of Nurmahal block of Jalandhar district showed maximum depth to water level of 16.1m. The observation well at Sheikupur of Aur block of Nawanshahar district recorded the minimum depth to water level as 11.92m.

In the terrace with sand cover area (Table-2), a minimum of 21.4m depth to water level was measured in Lohian of Lohian block and a maximum depth to water level of 25.25 m was recorded in Khiwa of Shahkot block, Jalandhar district (June) whereas, it has shown a rise of 2.82m in Lohian of Lohian block whereas Khiwa of Shahkot block has shown a decline in the water level from that of June 2004 of 1.8m.

In the year 2004 (Fig.6) in pre-monsoon, the water levels in the northeastern and southeastern side of the study area has gone deep and vary between 10 m to 60 m. In the central portion of the study area, the water level is deep and mainly varies between 10 to 20 m. In the post-monsoon (Fig.7), as the depth to water table map of October 2004 depicts, the water levels as compared to in June 2004 in the various geomorphic units have come up as the contours make a slight shift eastwards and contour of 5 m appears in the geomorphic unit 3 and 4 that is in lower piedmont and old flat plains.

***Year 2005***

In the upper piedmont area (Table-2), minimum depth to water level was 5.87m in

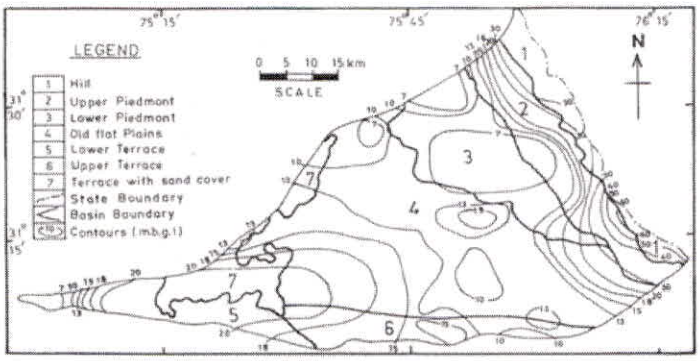


**Fig. 6.** Depth to water table and Geomorphological map June- 2004.

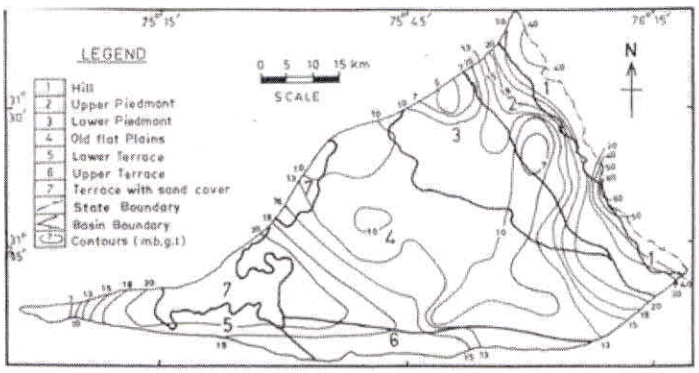


**Fig. 7** Depth to water table and Geomorphological map October -2004.

Bagpur of Hoshiarpur I block of Hoshiarpur district whereas a maximum depth to water level of 69.11m was noticed in Harjiana of Mahilpur block of Hoshirpur district in the month of June. In the month of October during post-monsoon, observation wells at both the sites have shown a rise of 42cm and 40cm, respectively.

Khera of Mahilpur block in Hoshiarpur district which lies in the lower piedmont area (Table-2) has shown a minimum depth to water level as 11.58m, where as 28.65m was recorded in Rampur Bilron of Garhshankar block of Hoshiarpur district during pre-monsoon.The water level in both the wells have come up during post-monsoon (in the month of October) by 37 cm and 68 cm, respectively. In the old flat plain area (Table-2), the minimum and maximum depth to water level of 6.61m and 28.10m was noticed in Khurdpur of Adampur block of Jalandhar district and Gohiran of Nakodar block, Jalandhar district, respectively in the pre-monsoon period. The water level in Gohiran came up during post monsoon by 4.1m. The minimum depth to water level of 6.26m was recorded at Alawalpur of Adampur block of Jalandhar district in postmonsoon period. The maximum depth to water level of 24m was recorded in Gohiran of Nakodar Block, Jalandhar district in the month of October.

In the lower terrace area (Table-2), the depth to water level was recorded as 7.41m in Giddar Pindi of Lohian block of Jalandhar district in the month of June where as it came up by 1.11m in post-monsoon.

In the upper terrace area, the depth to the water level varied from 16.0m (in Goraya of Rurkakalan block of Jalandhar district) to 17.15m (in Nurmahal of Nurmahal block of Jalandhar district) in the month of June whereas in the month of October, observation well at Sheikupur of Aur block of Nawanshahar district recorded the minimum depth to water level as 12.32m whereas Goraya of Rurkakalan block of Jalandhar district recorded the maximum depth to water level as 17.05m. In Goraya, water level declined by 1.05m from June to October.

In the terrace with sand cover area (Table-2), a minimum depth to water level of 23.12m in Lohian of Lohian block and a maximum depth of 27.0 m in khiwa of Shahkot block was recorded during the pre-monsoon .The water level in the piezometer at Lohian of Lohian block has shown a rise of the 3.67 m where as fall of 28 cm was recorded in Khiwa of Shahkot block in the month of October.

The depth to water table map of June 2005 (Fig.8) depicts shifting of contours of 13-15m, 18m and 20m more towards the central portion of the study area indicating the increase in depth to the water level than the earlier years. In the northern and eastern side of the study area the water level trend is more or less the same. In Oct.2005 (Fig.9), rise in water table is indicated in almost all the geomorphic units of the study area as compared to in June 2005.

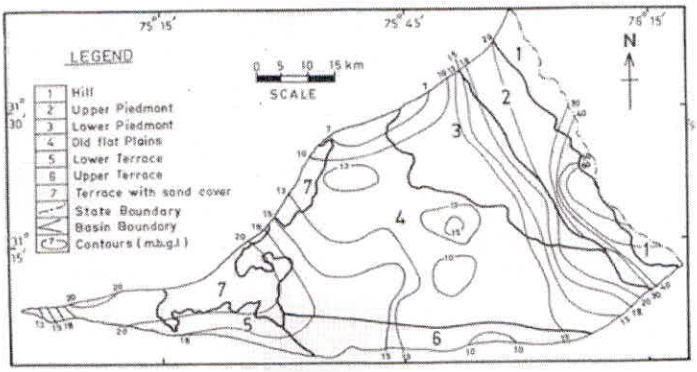


**Fig. 8.** Depth to water table and Geomorphological map June- 2005.

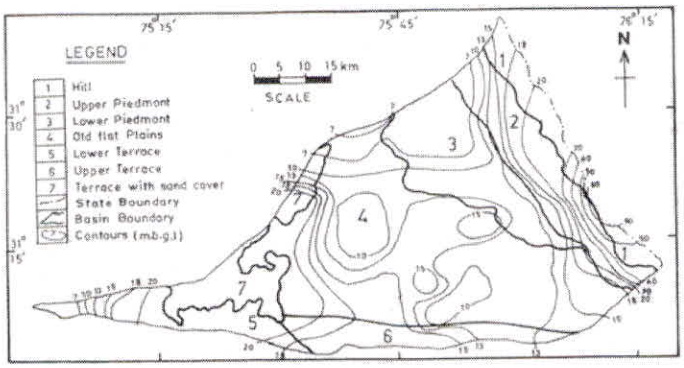


**Fig. 9.** Depth to water table and Geomorphological map October -2005.

## WATER TABLE ELEVATION MAPS

The water elevation map of pre-monsoon 2002 (Fig. 10), indicate that in the Geomorphic unit I, the water level contours showed a variation between 250m to 320m. However, in Geomorphic Unit-2 representing the upper piedmont area, indicated the maximum elevation to water level as 320m. In the Geomorphic Unit- 3, representing the lower piedmont area, the elevation contours from 240m to 310m are prevalent. In the Geomorphic Unit-5 representing the lower terrace, the elevation contours vary from 200m to 220m.

In the Geomorphic Unit-4 (old flat plains) and Geomorphic Unit-6 (upper terrace), the elevation contours varies between 220m and 250m with the maximum elevation of 250m. In the Geomorphic Unit-7, representing the terrace with sand cover, the elevation contours from 200m to 230m are present indicating the maximum elevation to water level as 230m in the terrace with sand cover areas.

During the post-monsoon of year 2002 (fig.11), elevation contours of the same height appeared in the Geomorphic Unit-1 representing the hills, Geomorphic Unit-2 representing the upper piedmont and Geomorphic Unit-3 representing the lower piedmont in the post-monsoon period, as present in the pre-monsoon period of the year 2002, indicating more or less the same water level elevation. In the Geomorphic Unit-5, representing the lower terrace, a large part of the area is under the contour elevation of 200m to 210m.The area under the elevation contours from 210m to 220m in the lower terrace remained more or less same in the post-monsoon period as compared to in the pre-monsoon period in the year 2002.

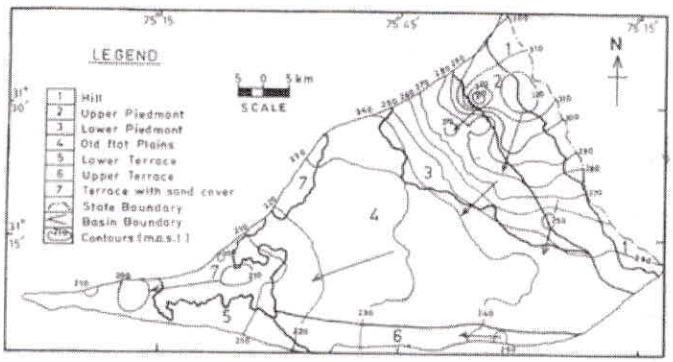


**Fig. 10.** Water Table Elevation and Geomorphological Map June – 2002

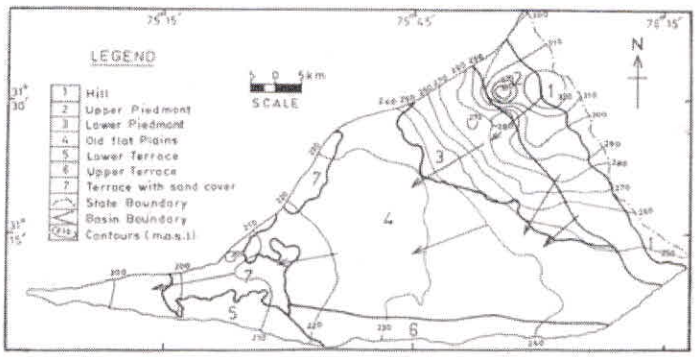


**Fig. 11.** Water Table Elevation and Geomorphological Map October – 2002.

Water level contours of pre-monsoon season of year 2003 as shown in fig. 12, Geomorphic Units-1, 2 and 3 representing hills, upper and lower piedmont area, the elevation contours have shifted slightly eastwards whereas the situation in the Geomorphic Unit-5, representing the lower terrace remained more or less the same as in June-2002. In the pre-monsoon period of 2002, the area lying between the water level elevation contours from 210m to 220m is more, in the Geomorphic Unit-4, representing old flat plains, as compared to the area covered by it in the June-2003. The water level elevation contours of 220m and 230m present in old flat plains and upper terrace area have shifted towards the eastern side as compared to June-2002 thereby indicating a rise in the water level elevation. In the Geomorphic Unit-7, representing the terrace with sand cover, more area has come under the elevation contour of 210m as compared to June- 2002.

In the post-monsoon season (fig 13), the Geomorphic Unit-5, representing the lower terrace, the rise in the water level is indicated by the appearance of contours from 230m to 280m as compared to pre-monsoon period. In the

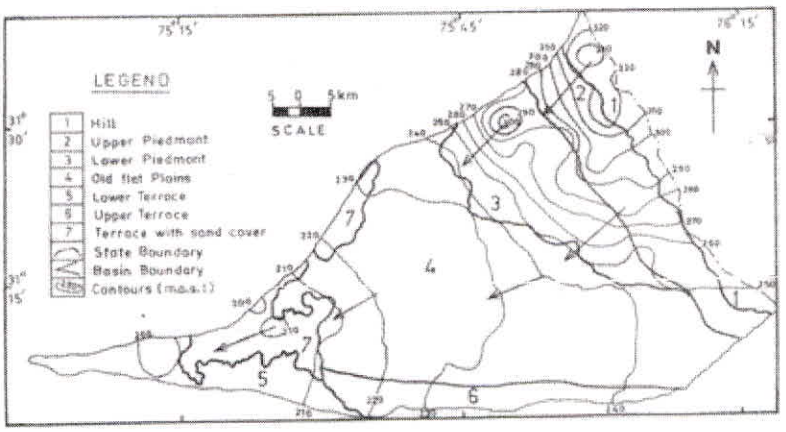


**Fig. 12.** Water Table Elevation and Geomorphological Map June – 2003.

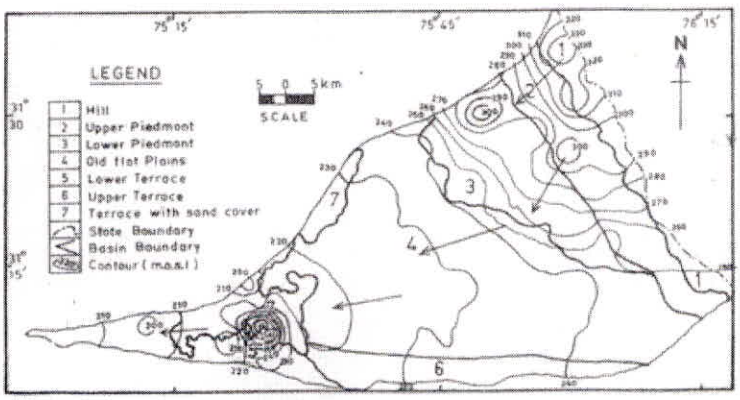


**Fig. 13.** Water Table Elevation and Geomorphological Map June – 2003.

Geomorphic Unit-4, representing the old flat plains, a shift of elevation contours of 210m, 220m, 230m and 240m towards western side is noticed in the post-monsoon as compared to the pre-monsoon period indicating rise in the water levels. In the Geomorphic Unit - 6, representing the upper terrace, the area lying between the elevation contours of 220m and 230m has increased as 220m elevation contour has shifted westward indicating a rise in the water level in October-2003 as compared to June-2003. In the Geomorphic Unit-7, representing the terrace with sand cover area, the water level elevation contours from 200m to 290m appeared in the post-monsoon period whereas in pre-monsoon, elevation contours from 200m to 210m were present indicating rise in water level during this period.

During the pre-monsoon season of 2004 it is observed that (fig.14), in the Geomorphic Unit-1 (hills), the elevation contours have shifted towards the north-eastern side as compared to pre-monsoon 2003. In the Geomorphic Unit-2 and 3 representing the upper and lower piedmont, the situation remained more or less the same as in June-2004 indicating no major change in the water level elevations as compared to June 2003. In the Geomorphic Unit-5, representing the lower terrace, the area lying between the elevation contours of 210m and 220m decreased whereas the area lying between the elevation contours of 200m to 210m has increased, thereby indicating a decline in June 2004 as compared to pre-monsoon period of June 2003. In the Geomorphic Unit-6, representing upper terrace area, the area lying between the elevation contours of 210m and 220m has decreased and area lying under the elevation contour of 200m and 210m has also appeared indicating the decline in the area. In the Geomorphic Unit-7, representing the terrace with sand cover, the area lying between the elevation contours of 200m and 210m has also increased whereas the area lying between the contours of 220m and 230m remained more or less same as compared to June 2003.

From the figure 15, it is evident that, the water level elevation contours in the post-monsoon period of the year 2004 has shown no major shift indicating more or less the same water level elevation as observed in pre-monsoon period of June 2004.

From the fig.16, it is noticed that, during the pre-monsoon of 2005, the Geomorphic Unit-2 and 3 representing the upper and lower piedmont area, the water level elevation contours of 240m and 250m has shown northwards shift. In these units,

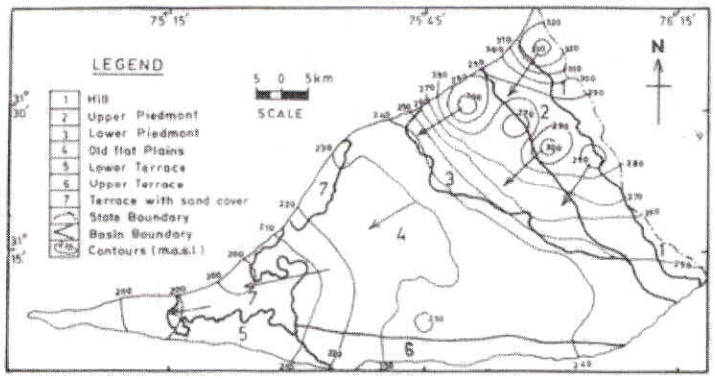


**Fig. 14.** Water Table Elevation and Geomorphological Map June – 2004.

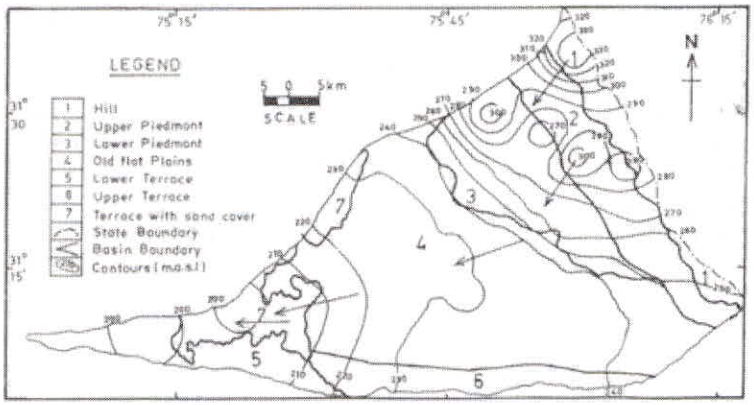


**Fig. 15.** Water Table Elevation and Geomorphological Map June – 2004.

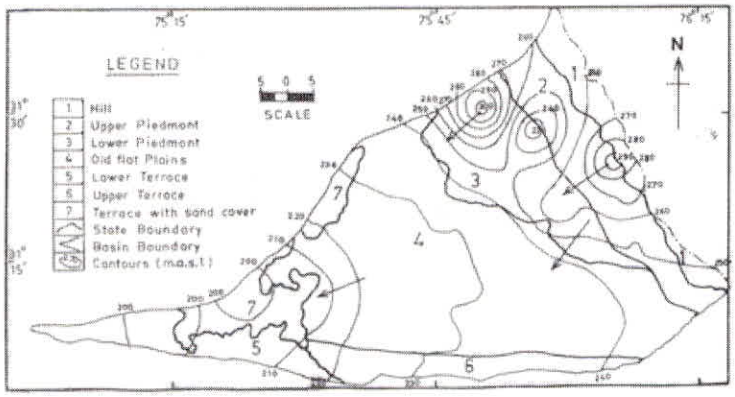


**Fig. 16.** Water Table Elevation and Geomorphological Map June – 2005.

an elevation contour of 230m appeared in the pre-monsoon period of 2005 indicating the development of a trough as compared to June 2004. The water level contours in the Geomorphic Units 5 and 7, are more or less the same and has shown hardly any shift as compared to June 2004. But in the Geomorphic Unit-4, representing the old flat plains, the water level elevation contour of 230m has shown a shift towards the eastern side. In the Geomorphic Unit-6, representing the upper terrace area, the elevation contour of 210m and 220m have shown the westward shift and the area lying between 220m and 230m elevation contours has increased indicating the rise in the water level as compared to June-2004.

The analysis of post-monsoon data of 2005 showed that in the central, western and southern parts of the study area representing the old flat plain, lower terrace, upper terrace and terrace with sand cover, the water level elevation contours of 210m, 220m and 230m have shown the shift

towards the western side indicating the rise in the water level elevations in the study area during the post-monsoon period as compared to the pre-monsoon period of the year 2005. In the northern and eastern side of the study area, representing piedmont area, the water level elevation contours of 250m and 260m has shown the shift towards the western side as compared to June 2005 whereas the area covered under the contours of 270m, 280m and 290m have shown an eastward shift indicating the rise in the water level elevation as compared to June 2005.

## GROUND WATER FLOW

On the basis of data of elevation of water level from mean sea level during pre-monsoon and post-monsoon periods of years from 2002 to 2005, the direction of ground water flow has been depicted in Maps 10 to 17. The ground water flow direction in the study area is towards south and south-west going away from the hills. In the central and western part of the study area, the ground water flow is towards west. The gradient is steep near the hills as the water elevation contours are closely spaced here. In the central and western part of the study area, the elevation contours are widely spaced indicating gentle slope in this area.

## RISE / FALL OF WATER LEVELS

In the geomorphic unit-1, in the hills (Table-1), a yearly fall of 2.22m has been noticed from the year 2002 to year 2004 in the pre-monsoon period whereas a decline of 2.14m per year is recorded in the post-monsoon.

In the geomorphic unit-2 (Table-1), i.e. the upper piedmont, a yearly fall of 1.17m in pre-monsoon and of 1.0m in post-monsoon period has been recorded in the area, from the year 2002 to 2005.

A yearly fall of 1.86m in pre-monsoon and 1.62m in post-monsoon period is recorded in the lower piedmont area (Table-1) of the study area.

In the Geomorphic Unit-4 (old flat plains), yearly fall of 94cm in pre-monsoon period and 87cm in post-monsoon period has been noticed from the year 2002 to 2005.

In the geomorphic unit-5, in the lower terrace area (Table-1), a yearly fall of 1.15cm in pre-monsoon and 98cm in post-monsoon has been noticed from the year 2002 to 2005.

In the geomorphic unit-6, representing the upper terrace area (Table-1), an yearly fall of 91

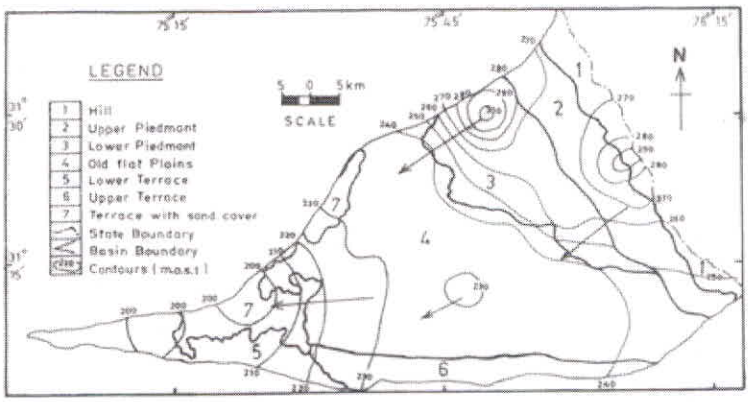


**Fig. 17.** Water Table Elevation and Geomorphological Map June – 2005.

cm in pre-monsoon and of 81cm in post-monsoon period has been recorded for the last three years i.e. from the year 2002 to 2005.

A fall of 1.51m in the water level in pre-monsoon and of 98cm in post-monsoon has been recorded in the terrace with sand cover area (Table-1) of the study area for the last three years (i.e. from the year 2002 to 2005).

Thus the study area has shown a decline in the water level in pre and post-monsoon period from the year 2002 to 2005. Though the decline recorded in the water level in post-monsoon period is less as compared to that in the pre-monsoon. This is due to the less withdrawal of ground water during monsoon period as the need of the people is met with sufficient rainfall in the monsoon.

## REFERENCES

**Uppal, H.L. (1977)** Rise of water table and development of water-logging in a non –canal irrigated tract-Bist Doab. Proc. Symp. On water-logging. Causes and measures for its prevention. 45th annual session , C.B.I.P. Vol. 1 publ. 188, 37-54.

**Agashe, R.M. Gupta, S., Srivastava, C.P. Kumar, A. and Rekha R. ( 1983)** Data of National network stations in Punjab and Chandigarh, union territory ( 1979-82). CGWB (NW region), Chandigarh. Unpublished report. pp 1-10.

**Anonymous (1979)** Data of National hydrograph stations in Northwestern region. CGWB (NW region). Unpublished report. 27p.

**Anonymous (1986)** Summary of the hydrogeological data collected at exploratory borehole sites and slim holes drilled by CGWB in Punjab State upto March, 1985 CGWB (NW region). Unpublished report. 47p (part A), 19p (part B)

**Anonymous ( 1999)** Ground water Balance Analysis – 1999, study period ( 1995-97). Appd. By Technical Sub Committee Pbl. by Water Resources and Environment Directorate, Irrigation Deptt., Pb., Chd. 290p

**Bhatnagar, N.C. ( 1977)** Hydrological conditions in state of Punjab with possibilities of groundwater development. CGWB (NW region). Unpublished report. pp. 1-40

**Central Ground Water Board (1985)** Hydrogeology of Ropar district, Punjab State, C.G.W.B. North Western region, Chandigarh. Unpublished technical report.

**Central Ground Water Board (1998)** Groundwater Resource and Development Potentials of Nawanshehar District, Punjab. C.G.W.B., Northwestern region, Chandigarh, 62p.

**Central Ground Water Board ( January 2002)** Urban Hydrologeology of Jalandhar city, Punjab, C.G.W.B., Northwestern region Chandigarh. 30p.

**Dua, K.J.S. (1975)** Geohydrological investigations in part of Ludhiana district, Punjab. GSI. Unpublished report. 19p.

**Raghunath, H.M. (1992)** Ground Water (second edition). Published by Wiley Eastern Limited, N. Delhi. 363p.

**Walton,W.C. (1970)** Groundwater resource evoluaton , McGraw Hill, Kogakusha Ltd., Japan 664p.

**Central Ground Water Board (2007a):** http://www.cgwb.gov.in/GroundWater/GW_Exploration.htm. 3p.

**Central Ground Water Board (2007b):** http://www.cgwb.gov.in/GroundWater/ArtificialRecharge.htm. 3p.

**Central Ground Water Board (2007c):** http://www.cgwb.gov.in/Hydrogeological_Surveys.htm 2p.

**Central Ground Water Board (2007d):** http://www.cgwb.gov.in/aboutus.htm. 2p.