- Present utilization amount of groundwater in Haraz basin, and the procedure and basic data applied for its estimation.
- Groundwater runoff amount to the adjacent basin and Caspian Sea and estimation procedure, and applied basic data.
- The hydrogeological situation of estimated year, which was used as an average year of water balance calculation in report, among the longer hydrogeological period.

The hydrogeological balance in HWDP-1 Report is verified by the Groundwater Quantity Model. In the process of modeling for Haraz Basin, some items which should be deliberated more, still remain in their model structure and constitution, their items consist of;

- the treatment for aquifer constituent and their thickness in groundwater modeling, and their validity to the observation result,
- hydrogeological boundary in model, and actual input data applied to these boundary, and its correctness to the natural condition.
- the transmissibility and storage coefficient, and difference between its observation value and applied value in model,
- the modeling of recharge system of groundwater, and treatment of infiltration amount from the surface,
- actual progress and procedure of the matching of the observation groundwater hydrograph to the simulation value.

## Table A.3.1 Comparison between Groundwater Balance

Comparative Balance Sheet between Existig Studies

| Report | HWDP-1 | | | | M/P |
|---|---|---|---|---|---|
| Blancing Year | 1985-'86 | 1985-'86 | 1985-'86 | 1985-'86 | 1982 |
| Blancing Study Area | III*1 | IV*1 | III+IV*2 | (III)+IV*3 | |
| Blance Study Area(km2) | 645 | 323 | 968 | 956 | 956 |
| Subsurface inflow | 59.4 | 25.1 | 84.5 | 83.4 | - |
| Recharge from/through | | | | | |
| Precipitation | 33.2 | 15.4 | 48.6 | 48.0 | - |
| Surface Runoff | 10.2 | 4.5 | 14.7 | 14.6 | - |
| Overland Flow | 67.5 | 19.1 | 86.6 | 85.5 | - |
| Riverbed | 30.3 | 18.2 | 48.6 | 48.0 | - |
| Total | 200.6 | 82.4 | 283.0 | 279.4 | 261.6 |
| Return Flow of | | | | | |
| Agricultural Wells | 41.1 | 9.1 | 50.1 | 49.5 | - |
| Industrial Wells | 12.4 | 2.5 | 15.0 | 14.8 | - |
| Springs | 8.7 | 7.0 | 15.7 | 15.5 | - |
| Total | 62.2 | 18.5 | 80.8 | 79.7 | - |
| Total Recharge | 262.9 | 100.9 | 363.8 | 359.2 | 261.6 |
| Subsurface Outflow | 0.7 | 3.8 | 4.5 | 4.5 | 62.8 |
| Discharge from/through | | | | | |
| Agricultural wells | 164.3 | 36.2 | 200.5 | 198.0 | - |
| Industrial wells | 19.1 | 3.9 | 23.0 | 22.7 | - |
| Total | 183.4 | 40.1 | 223.5 | 220.7 | 126.2 |
| Spring | 34.7 | 27.9 | 62.6 | 61.8 | 65.7 |
| Evapotraspiration | 22.8 | 9.7 | 32.5 | 32.1 | - |
| Drainage from Aquifer | 23.0 | 9.0 | 32.0 | 31.6 | - |
| Total Discahsrge | 264.7 | 90.5 | 355.1 | 350.7 | 254.7 |
| Variation in Storage or Blance | -1.8 | 10.4 | 8.6 | 8.5 | 6.9 |

*1 : the value based on the GWDP-1 Report Zone III or Zone IV estimation
*2 : the value is the sum of Zone III and Zone IV
*3 : the value revised from the ratio of balancing areas between M/P (956km2) and GWDP-1 (968km2) report

Solving these unfavorable situation, it has been planned that hydrogeological data based upon the above three studies have been collected and a comparative study on the hydrogeological balance in Haraz Basin with reference to above materials among them also have been executed in this stage.

The collected data and the review of collected materials are summarized as below.

1) Electric Conductivity Map (1 : 20,000)

- contour map ranging Amol to Sari, drawn in Iranian calendar of 1364. 8.

2) Electric Conductivity Map (1 : 20,000)

- contour map ranging Amol to Sari, drawn in Iranian calendar of 1365. 6.

3) Equi-Depth Map of Groundwater Level (1 : 20,000)

- contour map ranging Amol to Sari, drawn in Iranian calendar of 1369. 9. 20, the map shows the distance and its contour from ground surface to groundwater level, the wells listed in figure comprise the depth of 12 m to 57 m.

4) Groundwater Contour Map (1 : 20,000)

- contour map ranging Amol to Sari, drawn in Iranian calendar of 1369. 1, the map shows the locations of 220 observation wells and the map drawn by their data.

5) Polygonal Division Map (1 : 100,000)

- division map to sub-basin ranging Amol to Sari, drawn in Iranian calendar of 1364, 65, 66.

6) Division Map of Groundwater Type (1 : 20,000)

- it refers to the classification of groundwater type, such as C1, SO4 and HCO3 types, along the coast strip ranging Amol to Sari, it was drawn 15 to 17 years ago.

7) Groundwater Cross Section along Dasht-Gorgan

- it shows the typical groundwater section crossing the downstream line from the mountainous area.

8) Groundwater Quality and Hydrogeological Map (1 : 1,000,000)

- it covers whole area of Mazandaran Province.

9) Groundwater Hydrograph and Observation Data

- monthly data observed during 1355 to 1369 covering the Project Area.

10) Location Map of Observation Wells for the Project Area

- the location map ranges Alesh Rud to Babol Rud with the coordinate grid.

11) Well Inventory for Sari to Mahmudabad Area

- it consists of 2 volumes and contains the items of well No., well location, well type, pumping rate, use period for pumping, it covers the whole wells in eastern part of Project Area which had been investigated in 1361 to 1363 and published in 1364.

12) Well Inventory for Mahmudabad to Alesh Rud Area

- it consists of 1 volume, it covers the whole wells in western part of Project Area, investigation date ranges 1364 to 1365 and published in 1366.

13) Geological Map (1 : 50,000)

- it ranges Sari to Alesh Rud dated in 1368. 10.

14) Report of Geophysical Survey

- geoelectric prospecting survey, it covers the eastern part of Project Area to Sari, it is made up of resistivity sounding curve, and its cross section and equi-resistivity map.

15) Talar-Babol-Haraz Project Report, quantitative and qualitative mathematical investigations about undergroundwater in the plains of Talar-Babol-Haraz river basin (prepared by Mahab Ghodss Consulting Engineers)

- It consists of main report and with the explanatory drawings prepared in 1990

All data and reports mentioned above are useful for a reviewing the existing studies, and so, their evaluation for the groundwater resources, which remains the feasible amount between projects. Hereby, the above data and reports had been required to MRWB.

Otherwise, the investigation data which has been collected concerning to the hydrogeology can be summarized as shown in Table A. 3. 2, and 3.

Taking advantage of the collected material and their analysis, the consideration for the safe groundwater yield in Haraz Basin had been considered. The practical procedure as well as result of it are described as following chapter.

Table A.3.2. Time Series Data List in Hydrogeology

| observation items | Year '82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 |
|---|---|---|---|---|---|---|---|---|---|---|
| **<Rain fall>** | | | | | | | | | | |
| Mahmudabad | 1964 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Sorkhrood | 1965 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Babolsar | 1950 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Babol | 1966 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Arabkyl | 1965 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Kiyacola | 1965 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Larim | 1965 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| Gaemshar | 1951 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| **<Overland flow>** | | | | | | | | | | |
| **-Haraz River-** | | | | | | | | | | |
| Caresang | 1950–1982 | | | | | | | | | |
| Sorkhrad | - - - | - - - | - - - | monthly | average | - - - | - - - | - - - | - - - | |
| **-Babol River-** | | | | | | | | | | |
| Garantalar | 1950-1982 | | | | | | | | | |
| Babol | - - - | - - - | - - - | monthly | average | - - - | - - - | - - - | - - - | |
| Miandasht | - - - | - - - | - - - | monthly | average | - - - | - - - | - - - | - - - | |
| **-Others-** | | | | | | | | | | |
| Garmrood etc*1 | - - - | - - - | - - - | monthly | average | - - - | - - - | - - - | - - - | |
| **<Evaporation>** | | | | └── | ──┘ | | | | | |
| **<G.W.L.>** | | | | | | | | | | |
| 44 localities | 1976 —— | —— | —— | —— | —— | —— | —— | —— | ——┘ | |
| **<Aquifer Test>** | | | | | | | | | | |
| 51 wells T | | | | └── | ──┘ | | | | | |
| S | | | | └── | ──┘ | | | | | |
| **Geology** | | | | | | | | | | |
| GE prospecting | 1974, | | | | | | | | | |
| Mapping | | | | | | | └── | ──┘ | | |
| **Water quality** | | | | | | | | | | |
| EC | | | | └── | ──┘ | | | | | |
| Other items | 1974-76 | | | | | | | | | |
| **GW utilization** | | | | | | | | | | |
| Well inventory | └── | —— | —— | —— | ──┘ | | | | | |
| Estimation by MB | | | | └── | ──┘ | | | | | |

Table A.3.3(1) Time series Data List of Observation Wells

| WELL NO. | OBSERVATION WELL | WELL ELEVATION (m) | | | 1351 fokitmsmaadbe | 1352 fokitmsmaadbe | 1353 fokitmsmaadbe | 1354 fokitmsmaadbe | 1355 fokitmsmaadbe | 1356 fokitmsmaadbe |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22E'1SW | -13.839 - | -14.008 | | | | ********* | ************ | ************ | ************ |
| 2 | (22G'1SW) | 3.82 | | | | | ********* | ************ | ************ | ******** |
| 3 | 24H'1SW | 15.821 - | 14.25 | 14.518 | | | ********* | *** ******** | ****** ***** | ******** |
| 4 | 15G'1SW | 5.34 | | | ****** | ************ | ************ | ************ | ****** | |
| 5 | 21C'1SW | -22.072 - | -22.181 | -22.16 | | | ********* | *********** | ************ | ******** |
| 6 | 21F'2SW | -2.205 | | | | | ********* | ************ | ********* | |
| 7 | 22F'2SW | -7.095 - | -6.835 | | | | ********* | ************ | ************ | ******** |
| 8 | 20E'1SW | -11.221 - | -10.816 | | | | ********* | ************ | **** | |
| 9 | 20G'1SW | 7.110 - | 6.158 | | | | ********* | ************ | ************ | ******** |
| 10 | 22C'1SW | -22.230 - | -21.375 | | | | ********* | ************ | ************ | ********* |
| 11 | 21H'2SW | 7.136 - | | | | | ********* | ************ | ************ | ******** |
| 12 | 21G'1SW | 0.488 - | | | | | ********* | ************ | ************ | ********* |
| 13 | 16E'1SW | -18.10 - | -19.075 | | ******** | ************ | ************ | ************ | ************ | ********** |
| 14 | 16E'2SW | -14.41 - | -14.729 | | ******** | ************ | ************ | ************ | **** | |
| 15 | 16G'1SW | 19.030 - | 19.713 | | ******** | ************ | ************ | ************ | **** | |
| 16 | 20I3SW | 65.817 | | | | | | | | |
| 17 | 18G'1SW | 28.791 - | | | | | ********* | ************ | *********** | ********* |
| 18 | 19E'1SW | -13.846 - | -13.381 | | | | ********* | ************ | ************ | ******** |
| 19 | 18E'2SW | -6.222 - | | | | | ********* | ************ | ******** | ********* |
| 20 | 18D'1SW | -20.984 - | -11.916 | | | | ********* | ************ | ************ | ********* |
| 21 | 21E'1SW | -15.121 - | -16.238 | | | | ********* | ************ | ************ | ******** |
| 22 | 19A'1SW | -20.734 - | -21.021 | | | | ********* | ************ | **** | |
| 23 | 20I'2SW | 33.463 - | 32.476 | | | | ********* | ************ | ****** ***** | ********* |
| 24 | 20D'1SW | -21.079 | | | | | ********* | ************ | ************ | ******** |
| 25 | 17H'1SW | 64.07 - | 61.112 | | ****** | ******** | ***** * | ** | *********** | ********** |
| 26 | 21J'1SW | 54.137 - | 57.386 | | | | ********* | ************ | ****** ***** | ********* |
| 27 | 21H'2SW | 19.225 - | 20.218 | | | | ********* | ************ | ****** ***** | ********* |
| 28 | 23J'1SW | 78.99 - | 77.052 | | | | ********* | ************ | ****** ***** | ********* |
| 29 | 16F'1SW | -2.52 - | -2.346 | | ******** | ************ | ************ | ************ | **** | |
| 30 | 19F'1SW | 2.234 - | 1.191 | | | | ********** | ***** ******* | ************ | ********* |
| 31 | 17F'2SW | | - 7.987 | | | | | | | |
| 32 | 20F'1SW | -6.148 - | -6.141 | | | | ********* | ************ | ************ | * |
| 33 | 19G'1SW | 27.13 - | | | | | ********* | ************ | *********** | ********** |
| 34 | 18F'1SW | 0.749 - | | | | | | | | |
| 35 | 22E1SW | 12.862 - | | | | | ********* | ************ | ****** **** | |
| 36 | 19F'2SW | 6.866 - | | | | | | | | |
| 37 | 23G'1SW | -1.234 - | | | | | ********* | *** ******** | ************ | ********* |
| 38 | 18G'2SW | 42.945 | | | | | ******** | ************ | ************ | ********** |
| 39 | 19H'2SW | 43.113 | | | | | ********* | ************ | ************ | ********* |
| 40 | 19H'2SW | 62.262 | | | | | ***** * | ******* | ********* | ****** |
| 41 | 26F2SW | 92.644 | | | | | ***** * | *** ******* | ****** ***** | |
| 42 | 23F1SW | 25.857 | | | | | ********* | ***** ******* | ****** **** | |
| 43 | 17G'2SW | 36.62 | | | ******** | *** ******** | ************ | ************ | ************ | ********** |
| 44 | 22G'3SW | -1.118 | | | | | ********* | ************ | ************ | ********* |

## Table A.3.3(2) Time series Data List of Observation Wells

| WELL NO. | OBSERVATION WELL | WELL ELEVATION (m) | 1357 | | | | | | | | | | | | 1358 | | | | | | | | | | | | 1359 | | | | | | | | | | | | 1360 | | | | | | | | | | | | 1361 | | | | | | | | | | | | 1362 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e |
| 1 | 22E'1SW | -13.839 - -14.008 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 2 | (22G'1SW) | 3.82 |*|*|*|*|*|*| | | | | | | |*|*|*|*|*| |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 3 | 24H'1SW | 15.821 - 14.25 14.518 | | | | | | | | | | | | | |*|*| |*|*| |*|*|*|*| |*|*|*|*|*|*| | | | |*|*| |*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 4 | 15G'1SW | 5.34 | | | | | | | | | | | | | | | |*|*| | | |*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 21C'1SW | -22.072 - -22.181 -22.16 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|
| 6 | 21F'2SW | -2.205 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 22F'2SW | -7.095 - -6.835 |*|*|*|*|*|*|*| | | | | | |*|*|*|*|*| |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| | |*|*|*|*|*|*|*|*|*|*|
| 8 | 20E'1SW | -11.221 - -10.816 | | | | | | | | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 9 | 20G'1SW | 7.110 - 6.158 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 10 | 22C'1SW | -22.230 - -21.375 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 11 | 21H'2SW | 7.136 - |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*| |*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 12 | 21G'1SW | 0.488 - |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 16E'1SW | -18.10 - -19.075 |*|*|*|*|*|*| | | | | | | | | |*|*| | |*|*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 14 | 16E'2SW | -14.41 - -14.729 | | | | | | | | | | | | | | | |*|*| | |*|*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 15 | 16G'1SW | 19.030 - 19.713 | | | | | | | | | | | | | | | |*|*| | | |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 16 | 20I3SW | 65.817 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | 18G'1SW | 28.791 - |*|*|*|*|*|*| | | | | | | | |*|*|*| | | |*|*|*| |*|*| | | | | | | | | | | | | | | | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| | | | | | | | | | |
| 18 | 19E'1SW | -13.846 - -13.381 |*|*|*|*|*|*| | | | | | | |*|*|*|*| |*| |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 19 | 18E'2SW | -6.222 - |*|*|*|*|*|*| | | | | | | |*|*|*|*| | | |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*| | |*|*|*|*|*|*|*|*|*| | | |
| 20 | 18D'1SW | -20.984 - -11.916 |*|*|*|*|*|*| | | | | | | |*|*|*|*| |*| |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 21 | 21E'1SW | -15.121 - -16.238 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 22 | 19A'1SW | -20.734 - -21.021 | | | | | | | | | | | | | |*|*|*|*| |*| |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|
| 23 | 20I'2SW | 33.463 - 32.476 | | | | | | | | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*| | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 24 | 20D'1SW | -21.079 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 25 | 17H'1SW | 64.07 - 61.112 | | | | | | | | | | | | | | | |*|*| | |*|*|*|*| | |*|*|*|*|*| | | | | | | |*|*|*|*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|
| 26 | 21J'1SW | 54.137 - 57.386 | | | | | | | | | | | | | |*|*|*|*|*| |*|*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 27 | 21H'2SW | 19.225 - 20.218 | | | | | | | | | | | | |*|*|*|*|*| |*|*|*|*| | |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 28 | 23J'1SW | 78.99 - 77.052 | | | | | | | | | | | | | |*|*|*|*|*| |*|*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|
| 29 | 16F'1SW | -2.52 - -2.346 | | | | | | | | | | | | | | | |*|*|*| | |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 30 | 19F'1SW | 2.234 - 1.191 |*|*|*|*|*|*| | | | | | |*|*|*|*| | | |*|*|*| |*|*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 31 | 17F'2SW | - 7.987 | | | | | | | | | | | | | | | | | | | | | | | | |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 32 | 20F'1SW | -6.148 - -6.141 | | | |*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| |*|*|*|*|*|*| | | |*|*|*|*|*|*|*|*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 33 | 19G'1SW | 27.13 - |*|*|*|*|*|*| | | | | | | |*|*|*| | |*| |*|*|*| |*|*|*|*|*| | | | | |*|*|*| |*|*|*|*|*|*|*|*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 18F'1SW | 0.749 - | | | | | | | | | | | | | |*|*|*|*| | | |*|*|*| |*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 35 | 22E1SW | 12.862 - | | | | | | | | | | | | | |*|*|*|*|*| |*|*| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | 19F'2SW | 6.866 - | | | | | | | | | | | | | |*|*|*| | |*| |*|*|*| |*|*|*|*|*| | | | | |*|*|*| |*|*|*|*|*|*|*|*|*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*| |*|*|*| |
| 37 | 23G'1SW | -1.234 - |*|*|*|*|*|*| | | | | | | |*|*|*|*|*| |*|*| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | 18G'2SW | 42.945 |*|*|*|*|*|*| | | | | | | |*|*|*| | |*| |*|*|*| |*|*|*| |*| | | | | |*|*|*| |*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|*|
| 39 | 19H'2SW | 43.113 |*|*|*|*|*|*| | | | | | | |*|*|*|*| | |*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 19H'2SW | 62.262 |*|*|*|*|*|*| | | | | | | |*|*|*| | |*| |*|*|*| | |*|*|*|*| | | | | |*|*|*| |*|*|*|*|*|*|*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | |
| 41 | 26F2SW | 92.644 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | 23F1SW | 25.857 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | 17G'2SW | 36.62 | | | | | | | | | | | | | | | |*|*| | | |*|*|*| |*|*|*| |*|*| | | | |*|*|*|*|*|*|*|*|*|*|*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | |
| 44 | 22G'3SW | -1.118 |*|*|*|*|*|*| | | | | | | |*|*|*|*|*| |*|*|*|*| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table A.3.3(3) Time series Data List of Observation Wells

| WELL NO. | OBSERVATION WELL | WELL ELEVATION (m) | 1363 | 1364 | 1365 | 1366 | 1367 | 1368 |
|---|---|---|---|---|---|---|---|---|
| | | | foktmsmaadbe | foktmsmaadbe | foktmsmaadbe | foktmsmaadbe | foktmsmaadbe | foktmsmaadbe |
| 1 | 22E'1SW | -13.839 - -14.008 | ************ | ************ | ************ | ************ | ************ | ************ |
| 2 | (22G'1SW) | 3.82 | ************ | ************ | ************ | ************ | ************ | ************ |
| 3 | 24H'1SW | 15.821 - 14.25 14.518 | ************ | ****  ******* | *  ********** | **** ******* | ************ | ***   ***** |
| 4 | 15G'1SW | 5.34 | | | | | | |
| 5 | 21C'1SW | -22.072 - -22.181 -22.16 | **   ******* | ************ | ************ | ************ | | |
| 6 | 21F'2SW | -2.205 | | | | | | |
| 7 | 22F'2SW | -7.095 - -6.835 | ************ | ************ | ************ | ************ | ************ | ************ |
| 8 | 20E'1SW | -11.221 - -10.816 | ************ | ************ | ************ | ************ | ************ | ************ |
| 9 | 20G'1SW | 7.110 - 6.158 | ************ | ************ | ************ | ************ | ************ | ************ |
| 10 | 22C'1SW | -22.230 - -21.375 | ************ | ************ | ************ | **   ******* | ***  ******* | ***   ***** |
| 11 | 21H'2SW | 7.136 - | ************ | ************ | ************ | ************ | ************ | ************ |
| 12 | 21G'1SW | 0.488 - | | | | | | |
| 13 | 16E'1SW | -18.10 - -19.075 | ************ | ************ | *********** | *******  **** | ************ | ************ |
| 14 | 16E'2SW | -14.41 - -14.729 | ************ | ************ | *********** | ******* **** | ************ | ****** ***** |
| 15 | 16G'1SW | 19.030 - 19.713 | ************ | ************ | *********** | ******* **** | ************ | ***   ***** |
| 16 | 20I3SW | 65.817 | | **      **** | * | ******* **** | ************ | ****** ***** |
| 17 | 18G'1SW | 28.791 - | | ************ | ************ | ************ | ************ | ********** ** |
| 18 | 19E'1SW | -13.846 - -13.381 | ************ | ********* ** | ************ | ************ | ************ | ************ |
| 19 | 18E'2SW | -6.222 - | ************ | ************ | ************ | ************ | ************ | ***** ****** |
| 20 | 18D'1SW | -20.984 - -11.916 | ************ | ************ | ************ | ************ | ************ | ****** ***** |
| 21 | 21E'1SW | -15.121 - -16.238 | ************ | ************ | ************ | ************ | * ********** | ************ |
| 22 | 19A'1SW | -20.734 - -21.021 | ************ | ************ | ************ | ************ | ************ | ************ |
| 23 | 20I'2SW | 33.463 - 32.476 | ************ | ************ | *********** | ******* **** | ************ | ****** ***** |
| 24 | 20D'1SW | -21.079 | **** ******* | ************ | ************ | ************ | | |
| 25 | 17H'1SW | 64.07 - 61.112 | *********** | ************ | *********** | ****** **** | | |
| 26 | 21J'1SW | 54.137 - 57.386 | ************ | ************ | *********** | ******* **** | ************ | ****** ***** |
| 27 | 21H'2SW | 19.225 - 20.218 | ************ | ************ | *********** | ******* **** | ************ | ****** ***** |
| 28 | 23J'1SW | 78.99 - 77.052 | ************ | ************ | ************ | ************ | | |
| 29 | 16F'1SW | -2.52 - -2.346 | ************ | ************ | *********** | ******* **** | | |
| 30 | 19F'1SW | 2.234 - 1.191 | ************ | ************ | ************ | ************ | | |
| 31 | 17F'2SW | - 7.987 | ************ | ************ | *********** | ******* **** | | |
| 32 | 20F'1SW | -6.148 - -6.141 | ************ | ************ | ************ | ************ | | |
| 33 | 19G'1SW | 27.13 - | | | | | | |
| 34 | 18F'1SW | 0.749 - | * | | | | | |
| 35 | 22E1SW | 12.862 - | | | | | | |
| 36 | 19F'2SW | 6.866 - | | | | | | |
| 37 | 23G'1SW | -1.234 - | | | | | | |
| 38 | 18G'2SW | 42.945 | | | | | | |
| 39 | 19H'2SW | 43.113 | | | | | | |
| 40 | 19H'2SW | 62.262 | | | | | | |
| 41 | 26F2SW | 92.644 | | | | | | |
| 42 | 23F1SW | 25.857 | | | | | | |
| 43 | 17G'2SW | 36.62 | | | | | | |
| 44 | 22G'3SW | -1.118 | | | | | | |

Table A.3.3(4) Time series Data List of Observation Wells

| WELL NO. | OBSERVATION WELL | WELL ELEVATION (m) | 1369 | | | | | | | | | | | | 1370 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e |
| 1 | 22E'1SW | -13.839 - -14.008 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 2 | (22G'1SW) | 3.82 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 3 | 24H'1SW | 15.821 - 14.25 14.518 | * | | | | | | | | * | * | * | * | * | * | | | | | | | | | | |
| 4 | 15G'1SW | 5.34 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 21C'1SW | -22.072 - -22.181 -22.16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 21F'2SW | -2.205 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 22F'2SW | -7.095 - -6.835 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 8 | 20E'1SW | -11.221 - -10.816 | * | * | | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 9 | 20G'1SW | 7.110 - 6.158 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 10 | 22C'1SW | -22.230 - -21.375 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 11 | 21H'2SW | 7.136 - | * | * | * | | | | * | * | | * | * | * | * | * | * | | | | | | | | | |
| 12 | 21G'1SW | 0.488 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 16E'1SW | -18.10 - -19.075 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 14 | 16E'2SW | -14.41 - -14.729 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 15 | 16G'1SW | 19.030 - 19.713 | | | | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 16 | 20I3SW | 65.817 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 17 | 18G'1SW | 28.791 - | * | * | * | | * | | * | * | * | * | | | * | * | * | | | | | | | | | |
| 18 | 19E'1SW | -13.846 - -13.381 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 19 | 18E'2SW | -6.222 - | * | * | * | | * | | * | | * | * | * | * | * | * | * | | | | | | | | | |
| 20 | 18D'1SW | -20.984 - -11.916 | * | * | | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 21 | 21E'1SW | -15.121 - -16.238 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 22 | 19A'1SW | -20.734 - -21.021 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 23 | 20I'2SW | 33.463 - 32.476 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 24 | 20D'1SW | -21.079 | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | 17H'1SW | 64.07 - 61.112 | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | 21J'1SW | 54.137 - 57.386 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 27 | 21H'2SW | 19.225 - 20.218 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 28 | 23J'1SW | 78.99 - 77.052 | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | 16F'1SW | -2.52 - -2.346 | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 19F'1SW | 2.234 - 1.191 | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 17F'2SW | - 7.987 | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | 20F'1SW | -6.148 - -6.141 | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | 19G'1SW | 27.13 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 18F'1SW | 0.749 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 35 | 22E1SW | 12.862 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | 19F'2SW | 6.866 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | 23G'1SW | -1.234 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | 18G'2SW | 42.945 | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | 19H'3SW | 43.113 | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 19H'2SW | 62.262 | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | 26F2SW | 92.644 | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | 23F1SW | 25.857 | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | 17G'2SW | 36.62 | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | 22G'3SW | -1.118 | | | | | | | | | | | | | | | | | | | | | | | | |

Table A.3.3(4) Time series Data List of Observation Wells

| WELL NO. | OBSERVATION WELL | WELL ELEVATION (m) | 1369 | | | | | | | | | | | | 1370 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | f | o | k | t | m | s | m | a | a | d | b | e | f | o | k | t | m | s | m | a | a | d | b | e |
| 1 | 22E'1SW | -13.839 - -14.008 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 2 | (22G'1SW) | 3.82 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 3 | 24H'1SW | 15.821 - 14.25 14.518 | * | | | | | | | | * | * | * | * | * | * | | | | | | | | | | |
| 4 | 15G'1SW | 5.34 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 21C'1SW | -22.072 - -22.181 -22.16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 21F'2SW | -2.205 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 22F'2SW | -7.095 - -6.835 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 8 | 20E'1SW | -11.221 - -10.816 | * | * | | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 9 | 20G'1SW | 7.110 - 6.158 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 10 | 22C'1SW | -22.230 - -21.375 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 11 | 21H'2SW | 7.136 - | * | * | * | | | * | * | | * | * | * | * | * | * | * | | | | | | | | | |
| 12 | 21G'1SW | 0.488 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 16E'1SW | -18.10 - -19.075 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 14 | 16E'2SW | -14.41 - -14.729 | * | * | * | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 15 | 16G'1SW | 19.030 - 19.713 | | | | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 16 | 20I3SW | 65.817 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 17 | 18G'1SW | 28.791 - | * | * | * | | * | | * | * | * | * | | | * | * | * | | | | | | | | | |
| 18 | 19E'1SW | -13.846 - -13.381 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 19 | 18E'2SW | -6.222 - | * | * | * | | * | | * | | * | * | * | * | * | * | * | | | | | | | | | |
| 20 | 18D'1SW | -20.984 - -11.916 | * | * | | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 21 | 21E'1SW | -15.121 - -16.238 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 22 | 19A'1SW | -20.734 - -21.021 | * | * | * | | * | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 23 | 20I'2SW | 33.463 - 32.476 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 24 | 20D'1SW | -21.079 | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | 17H'1SW | 64.07 - 61.112 | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | 21J'1SW | 54.137 - 57.386 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 27 | 21H'2SW | 19.225 - 20.218 | * | * | * | | | | * | * | * | * | * | * | * | * | * | | | | | | | | | |
| 28 | 23J'1SW | 78.99 - 77.052 | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | 16F'1SW | -2.52 - -2.346 | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 19F'1SW | 2.234 - 1.191 | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 17F'2SW | - 7.987 | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | 20F'1SW | -6.148 - -6.141 | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | 19G'1SW | 27.13 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 18F'1SW | 0.749 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 35 | 22E1SW | 12.862 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | 19F'2SW | 6.866 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | 23G'1SW | -1.234 - | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | 18G'2SW | 42.945 | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | 19H'2SW | 43.113 | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 19H'2SW | 62.262 | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | 26F2SW | 92.644 | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | 23F1SW | 25.857 | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | 17G'2SW | 36.62 | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | 22G'3SW | -1.118 | | | | | | | | | | | | | | | | | | | | | | | | |

(2) Aquifer and Groundwater Occurrence

The classification of aquifer in this basin have not been still clear. Although the exploratory drilling or electric prospecting had been carried out for detecting the hydrogeological structure, the data is further a few for reveling whole structure and it is in definitive place in comparison with extent of objective area. However, the previous study, Alexander Gibbs or HWDP1 Report, had resulted in three discernible hydrogeological units in this area as below.

1) Shallow Aquifer

Shallow water table aquifer which have been utilized by numerous shallow agricultural and drinking wells. And the aquifer is composed of the alluvial sequence of cemented homogeneous materials, where is located as the alluvial fan of alternated permeable and impermeable layer. And the schematic sequence in whole area can be roughly described as its thickness decreases to the sea coast and is accompanied with the sea deposit.

2) Deep Aquifer

Artesian aquifer, which have the heavy discharge in place. The first semi-artesian aquifer is located beneath the shallow aquifer, and it is separated from by impervious clay, silt and sand deposits. The thickness of this aquifer is about 20 to 30 m. And this aquifer is separated from the lower aquifer by means of aquiclude. The thickness of artesian aquifer is around 50 m thick and the deeper aquifer is about 15 - 25 m which are separated from each other by means of several meters aquiclude.

3) A Rather Permeable Layer

It is located between water table and artesian aquifer. The existence of this part can be distinguished from the deep wells observed in this area.

The detail localities and respective potential of them have not been recognizable yet, to this end, the individual consideration for respective aquifer can not be made in this stage. The utilization, however, of them is mostly from shallow aquifer, it reaches to more than 80% of all, accordingly, the target for analysis in this study is applied to the shallow aquifer or unconfined shallow zone.

(3) Level and Direction of Flow in Groundwater

The fluctuation of groundwater level and its flow direction can be traced out by observation data obtaining from the well network building up in this area. As shown in Figure A. 3. 5, the arrangement of well data had been conducted for 44 wells for the long period over 20 years. On the basis of these result, the hydrogeologic condition in Haraz basin can be comprehended to a certain extent.

1) Groundwater Level and Direction in Project Area

The groundwater level in Project Area have been reappeared to the grid points by the interpolated method through the last 10 years from the 1360 in Iranian calendar. The result of calculation is shown as the contour map of groundwater table drawn in Figure A. 3. 6.

The groundwater table through long term can be pronounced in same manner that its higher area is correlative with along Haraz River while the lower is in the adjacent to the Babol River respectively. Especially in the highland portion along Babol River, the groundwater level is incessantly lower than the surroundings.

Furthermore, the direction of groundwater flow is tend to head for the Babol River from Haraz Alluvial Fan area whereas the lowland is in the ordinary align down to the Caspian Sea in the shortest distance.

2) Time Series Changes of Groundwater Level

The groundwater fluctuation in last 10 years seems to be recognized as two types which are of the up and down in conflicting tendency at different portion. This is to say, the former type is discernible only in the highland excepting for along Babol River while the later is in the lowland especially along the seacoast.

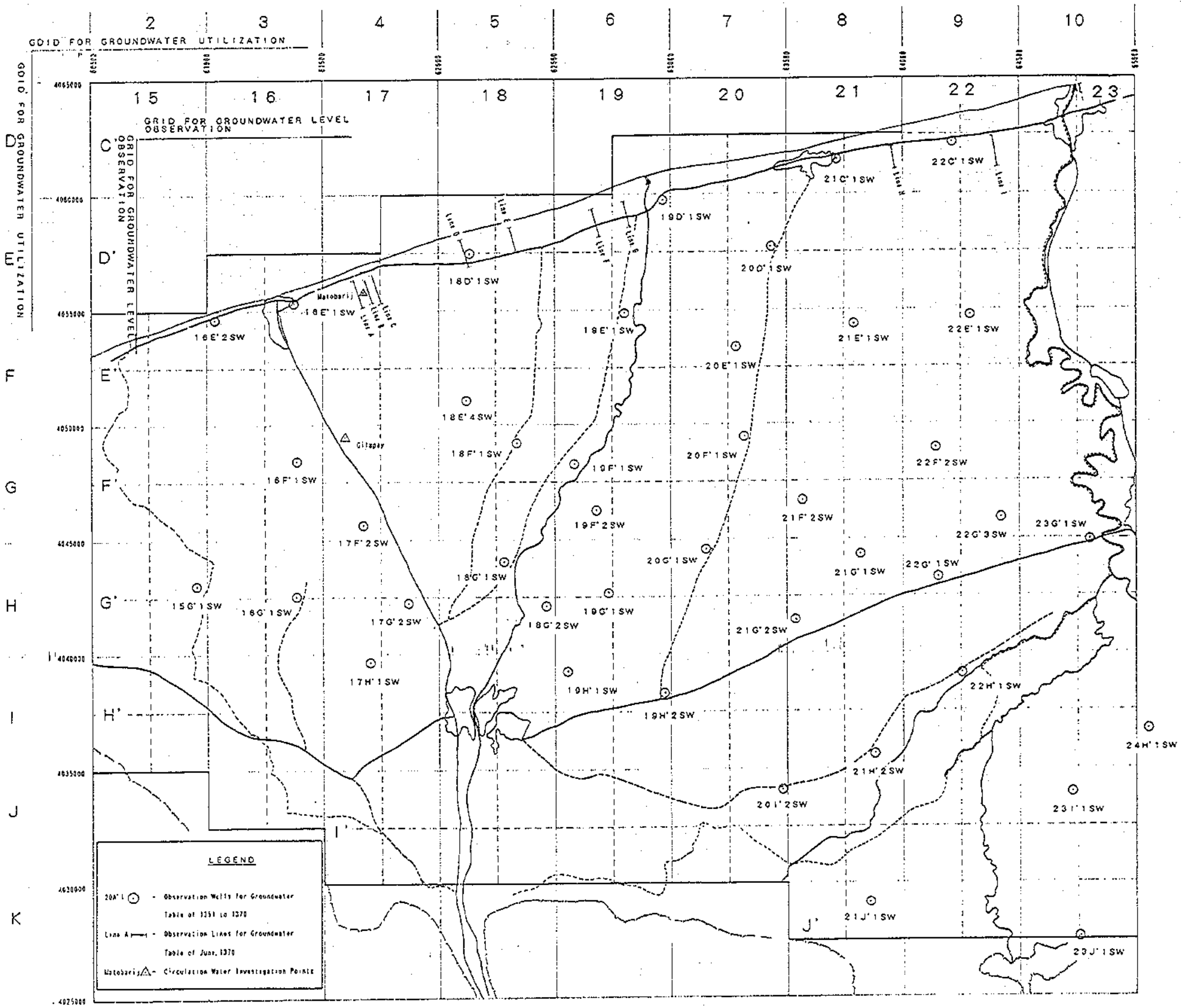
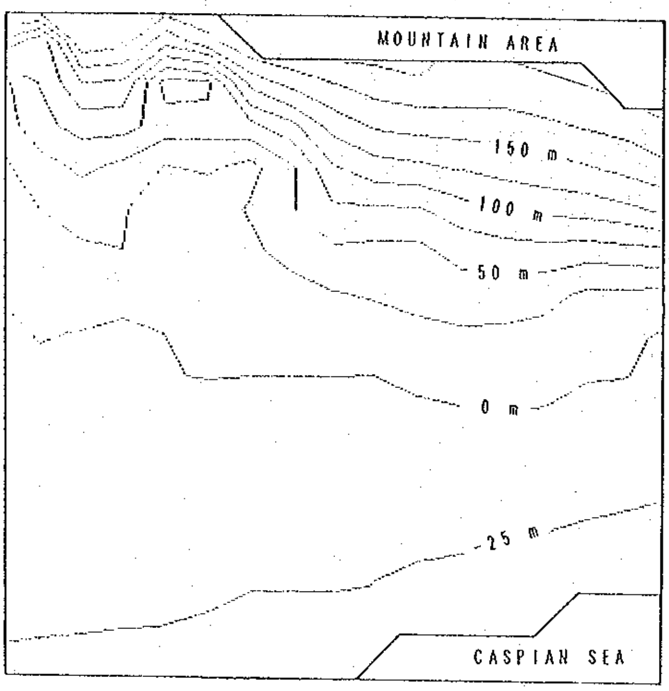
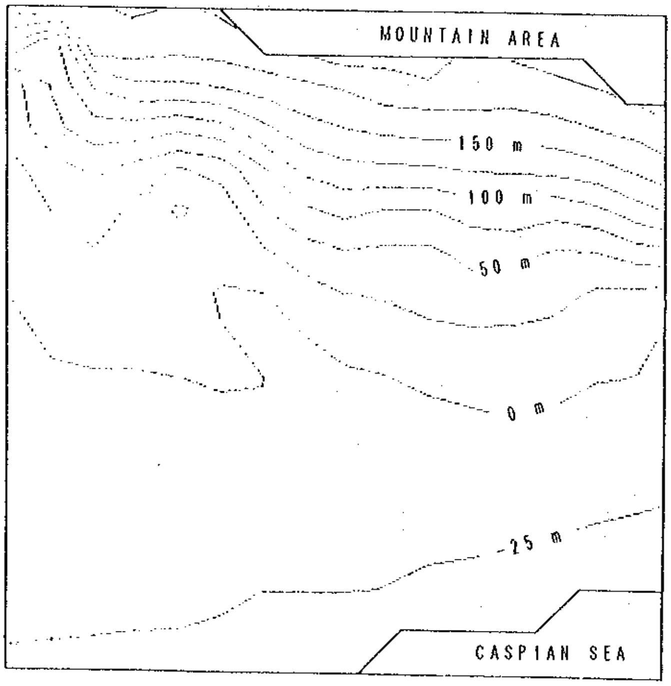



Figure A.3.5 Location Map of Hydrogeological Investigation

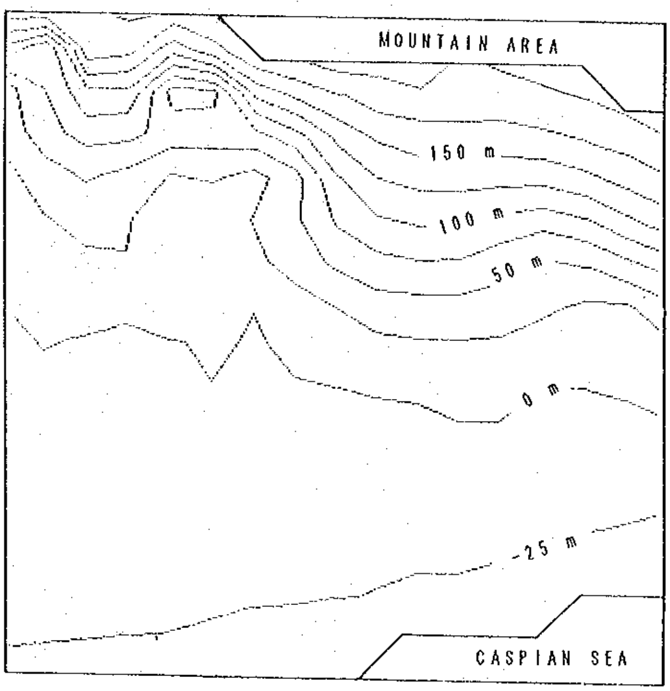



CALCULATED CONTOUR MAP OF GROUNDWATER TABLE 1360.6
(CONTOUR INTERVAL IN 25 m)

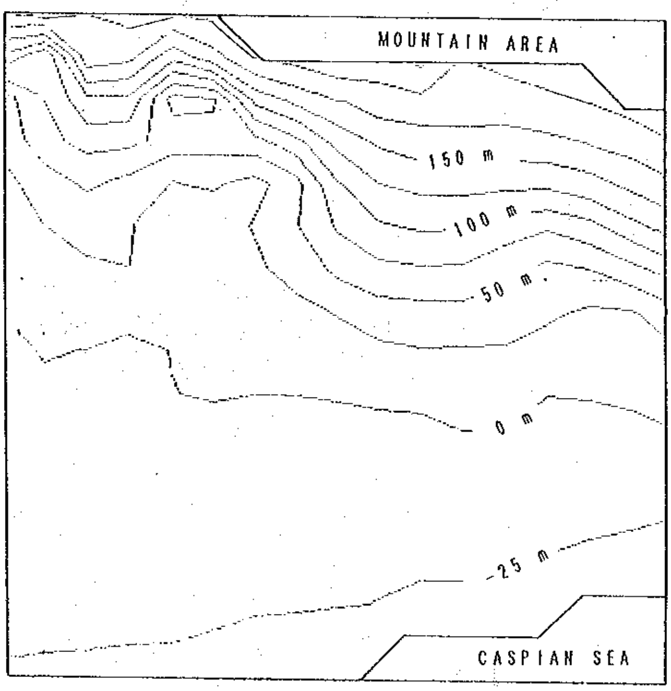



CALCULATED CONTOUR MAP OF GROUNDWATER TABLE 1360.7
(CONTOUR INTERVAL IN 25 m)

Figure A.3.6(1) Calculated Contour Map of Groundwater Table

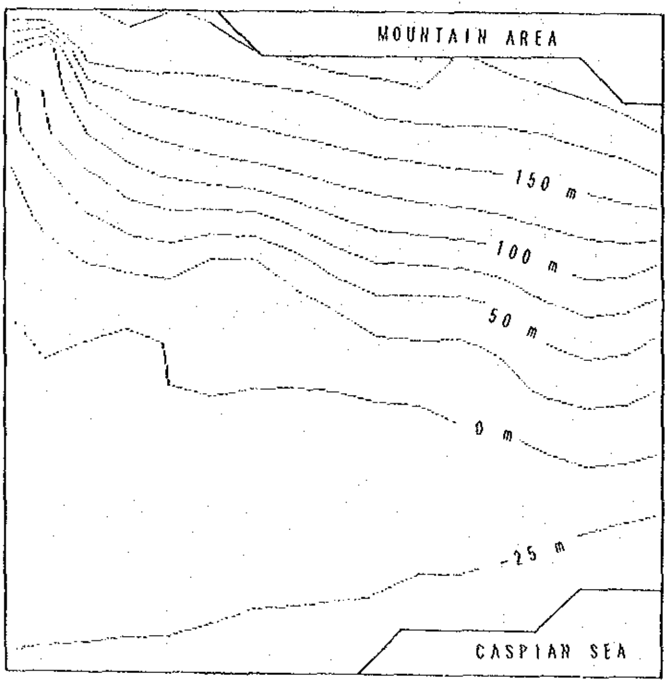



CALCULATED CONTOUR MAP OF GROUNDWATER TABLE 1364.6
(CONTOUR INTERVAL IN 25 m)

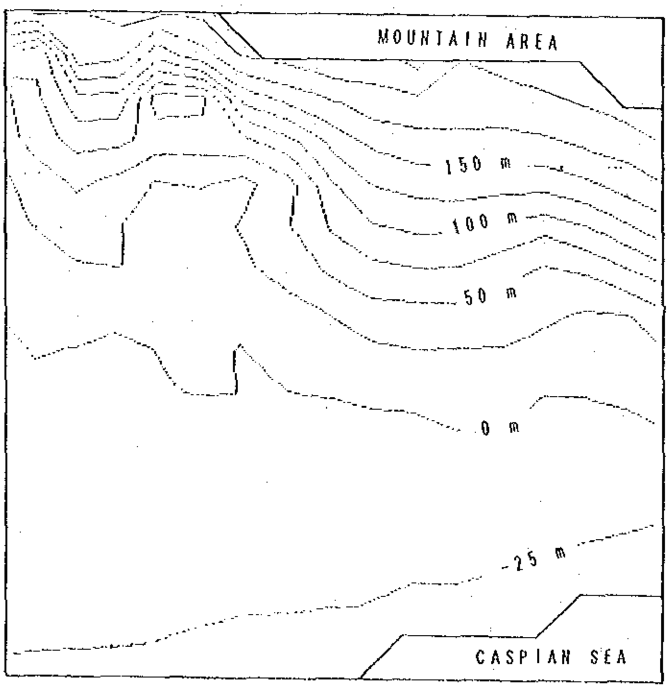



CALCULATED CONTOUR MAP OF GROUNDWATER TABLE 1364.12
(CONTOUR INTERVAL IN 25 m)

Figure A.3.6(2) Calculated Contour Map of Groundwater Table

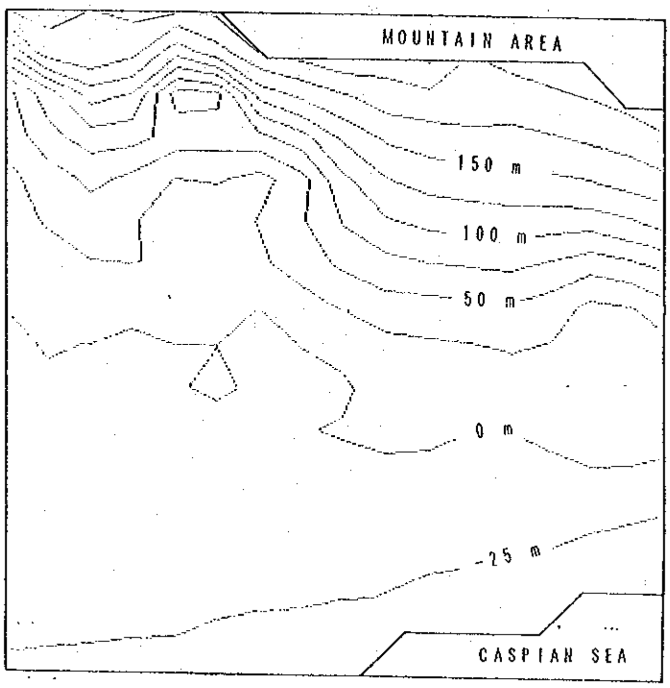



CALCULATED CONTOUR MAP OF
GROUNDWATER TABLE 1365.12
(CONTOUR INTERVAL IN 25 m)




ALCULATED CONTOUR MAP OF
GROUNDWATER TABLE 1366.5
(CONTOUR INTERVAL IN 25 m)

Figure A.3.6(3) Calculated Contour Map of Groundwater Table




ALCULATED CONTOUR MAP OF
GROUNDWATER TABLE 1369.3
(CONTOUR INTERVAL IN 25 m)

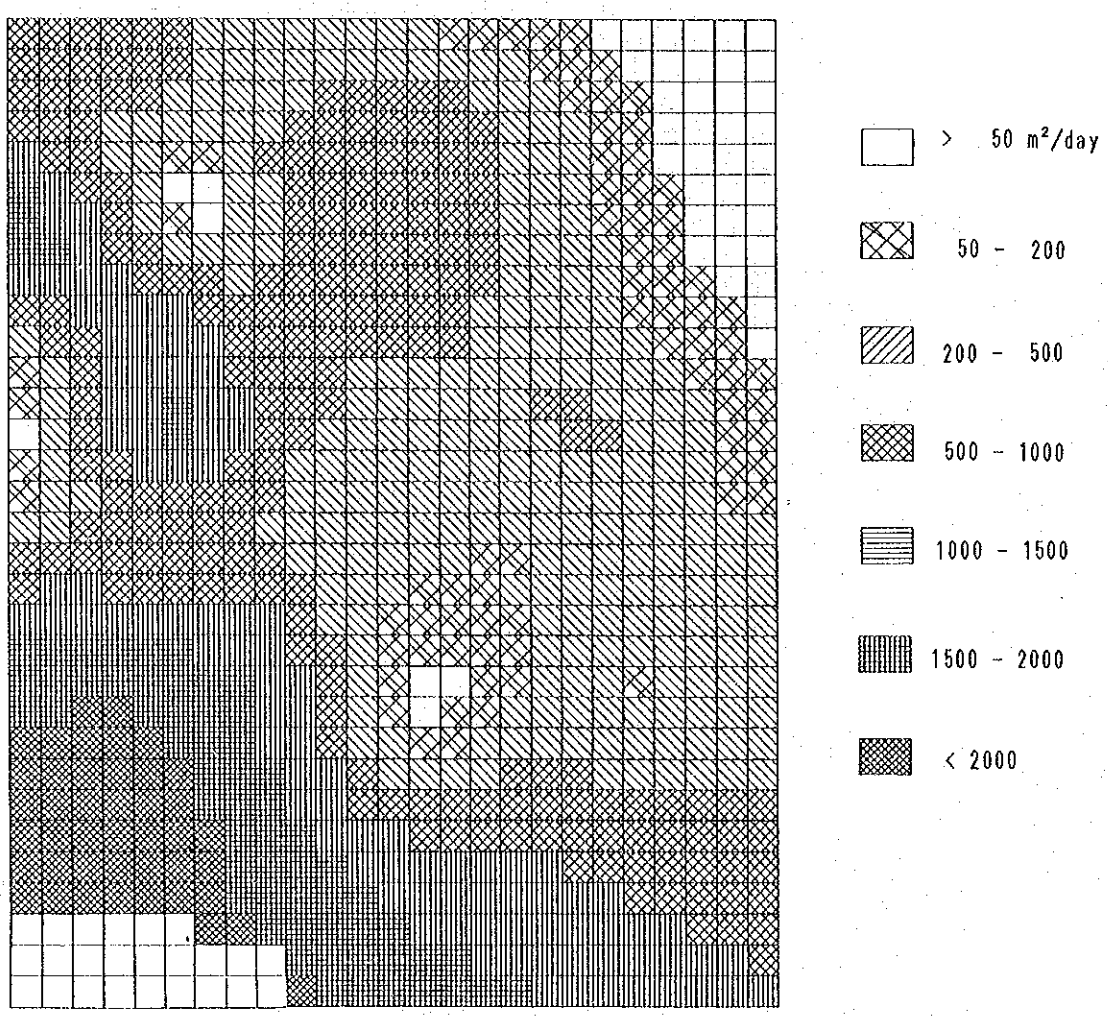
Figure A.3.6(4) Calculated Contour Map of Groundwater Table

## (4) Aquifer Coefficient

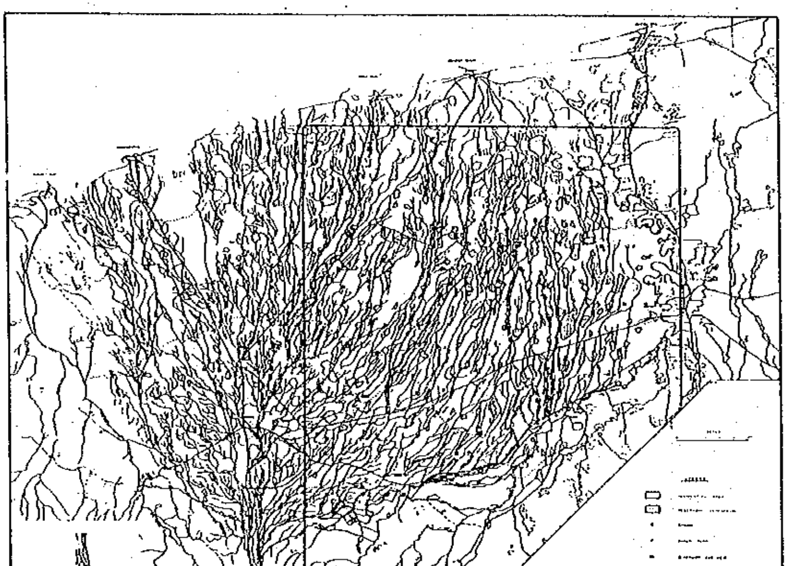
The result of aquifer test can be summarized as Table A. 3. 4 which is noted by a transmissibility of 50 $m^2$/day to 2,000 $m^2$/day. And the pattern map for transmissibility based on this observation is also drawn in Figure A. 3. 7. The highest zone, it is over 1,500 $m^2$/day, fringes the apex of alluvial fan, and to the down stream, the value decreases gradually till about 100 $m^2$/day. Further down to the coastal strip, the transmissibility is observable as a constant value of 500 to 1,000 $m^2$/day.

Table A.3.4 Transmissibility Coefficient Resulting in Well Test

| No. | Well No. | Location | Coordinate y | Coordinate x | Aquifer Type | Well Depth | Transmissibility(m3/day) Thiem | Theis | Jacob | Kozeny | Acceptable T |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4050-625-93D | Alavikalamir | 4051.4 | 626.8 | Deep | 12 | | 345 | 204 | 808 | 808 |
| 2 | 4045-625-18D | Kenesmarz | 4049.6 | 626.0 | Deep | 80 | | 366 | 319 | 1595 | 1595 |
| 3 | 4045-625-25S | Golmahaleh | 4045.0 | 625.0 | Shallow | 30 | | 125 | 144 | 2542 | 144 |
| 4 | 4040-625-15S | Yusofabad-Amol | 4045.7 | 629.0 | Shallow | 30 | | 70 | 105 | 1487 | 1487 |
| 5 | 4030-625-7D | Pashako;a | 4043.0 | 630.0 | Deep | 12 | | 1621 | 2951 | | 1621 |
| 6 | 4050-630-25S | | 4050.0 | 630.0 | Shallow | 30 | | 127 | 126 | 2008 | 127 |
| 7 | 4045-630-248AR | Ghaemieh-Divkola | 4045.5 | 634.0 | Artesian | 114 | | 226 | 210 | 604 | 604 |
| 8 | 4040-630-2D | Emadieh | 4040.0 | 630.0 | Deep | 50 | | 619 | 760 | 1637 | 619 |
| 9 | 4035-630-1AR | Amol Rice Station | 4035.0 | 631.2 | Artesian | 70 | | 1625 | | 4875 | 1625 |
| 10 | 4055-635-75S | Mahloban | 4057.0 | 636.0 | Shallow | | | 185 | 214 | 1143 | 185 |
| 11 | 4050-635-155S | Jazin | 4052.0 | 636.5 | Shallow | 48 | | 843 | 768 | 5539 | 842 |
| 12 | 4040-635-20S | Balakordkola | 4040.0 | 635.0 | Shallow | 12 | | 247 | 301 | 1714 | 247 |
| 13 | 4035-635-21S | Andikola | 4035.0 | 637.7 | Shallow | 65 | | 39 | 50 | | 50 |
| 14 | 4040-640-19S | Toghan | 4040.0 | 640.0 | Shallow | 36 | | 208 | 230 | | 208 |
| 15 | 4040-640-22S | Hadjikola | 4042.5 | 643.8 | Shallow | 12 | | 504 | 395 | | 504 |
| 16 | 4025-640-411D | Sangrudpey | 4025.0 | 640.0 | Deep | 80 | | 1570 | 1211 | 3558 | 1570 |
| 17 | 4045-645-156D | Darviskheil | 4047.9 | 647.0 | Deep | 30 | | 61 | 67 | | 65 |
| 18 | 4025-645-253D | Abolhasankola | 4025.0 | 645.0 | Deep | 30 | | 121 | 158 | 1239 | 1239 |
| 19 | 4045-650-16S | Darzikola | 4041.5 | 648.9 | Shallow | 12 | | 121 | 292 | | 121 |
| 20 | 4035-645 | | 4035.0 | 645.0 | | | 200 | | | | 200 |
| 21 | 4035-645 | | 4035.0 | 645.0 | | | 548 | 238 | | | 238 |
| 22 | 4040-650 | | 4040.0 | 650.0 | | | 407 | 259 | | | 401 |




Map of Transmissibility Distribution(unit:$m^2$/day)



Location Map

Figure A.3.7 Transmissibility Distribution on the Project Area

## 2. Return Flow

### (1) Circulation Water in Groundwater

In parallel with a investigation for the groundwater utilization, the groundwater circulation, which has been caused by highly groundwater draft, was measured in this period. The procedure was thought of with use of water balance of paddy field. It means that, if the closed system, which is scare amount of water to access in and out, is there, the pumping rate, evapotranspiration rate and the standing water amount of objective field are measured simultaneously, so that the circulation rate can be estimated.

$$Qin = Q1 + ET + Qc$$

When,

| | | |
|---|---|---|
| Qin | : | Groundwater draft and irrigation water quantity taking into the objective field |
| Q1 | : | Difference of standing water quantity |
| ET | : | Evapotranspiration |
| Qc | : | Circulation/Percolation water quantity |

The investigated areas for above measurement were selected two of Motobarij and Gilapay. The Motobarij site is 1.4 km far from the seacoast, and is covered 1.9 ha paddy field dividing into 9 plots. The area also is under high groundwater utilized condition and the groundwater level was downing till 7 m from its static condition. Moreover, the groundwater level kept a tendency to decreasing more abruptly at the time of investigation.

The Gilapay site is 8 km far from the seacoast, in the Middle land as the terminology in Project, and where is correlative with the marginal zone of Alluvial Fan. Under the position of above, the investigated field occupies about 1.2 ha separating into 9 plots. The site is also in high groundwater utilized area, accordingly, the groundwater level had down till 6 to 7 m during investigation.

In practically, the measurement of Motobarij and Gilapay were conducted during 24 hours of 17th to 18th and 24th to 25th/June/1991 respectively. And the pumping rate were measured several times during investigation to the irrigation wells which penetrate within shallow aquifer. The standing water levels were measured at two times of the start and termination of investigation for all plots. Furthermore, the evapotranspiration was estimated from the pan evaporation rate measured simultaneously at adjacent location.

The detail arrangement of investigated field are shown in Figure A. 3. 8, and 9, and the result of investigation refer to Table A. 3. 5, and 6. Depending on the results, the circulation or percolation rate was reach to about 13 to 25 mm/day and is equivalent to 75 to 85% of total groundwater amount.

The permeability in vertical direction of this area also can be simply calculated as following the Darcy's law, if it applies to the Motobarij, the value is generally.

$$Q = -k * A * (dh/d1)$$

and k is introduced as,

$$k = Q/A/(dh/d1)$$

when,

- k : permeability (m/day)
- Q : circulation/percolation water quantity (566.3 $m^3$/day)
- A : total area of field (19,038 $m^2$)
- dh : hydraulic head (7.0 m)
- d1 : thickness of impervious layer (1 m)

then, the k is,

$$k = 566.3 / 19{,}038 / 7 = 0.00425 \text{ m/day} = 4.9 \times 10^{-6} \text{ cm/sec}$$

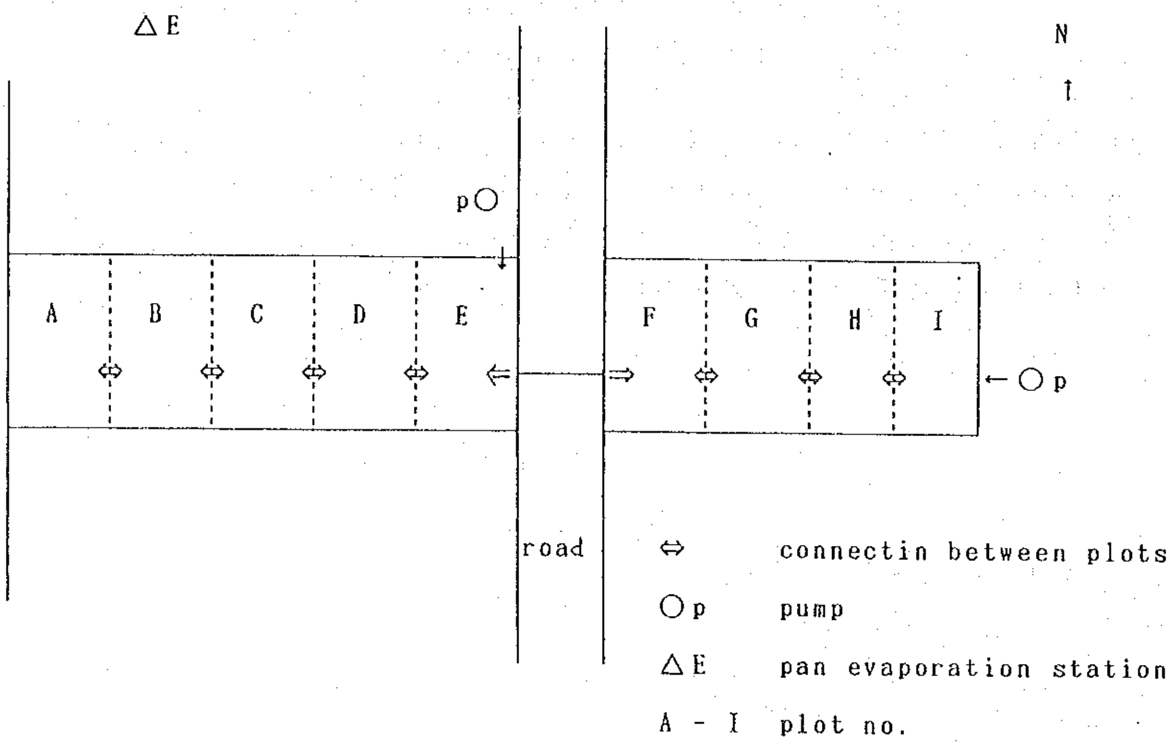
If this value is adopted to the static groundwater condition which is supposed to be commonly less than 0.7 m below the surface of field, the percolation rate in this condition calculated below.

$$Ps = k\,(0.0042) \times dh\,(0.7) / d1(1) = 2.9 \text{ mm/day}$$

where,

| | |
|---|---|
| Ps : | percolation rate in static condition |
| k : | permeability of impervious layer |
| dh : | head in impervious layer |
| dl : | length of impervious layer |

From the above simple estimation, the value in static condition can be correlative with a rate measured in M/P in the similar order, therefore, the higher percolation of this area in this season may be caused by the highly groundwater drafting nearby area.




Estimation of Area and Pumping Quantity
Motobarij(16/June/1991 - 17/June/1991)

| | Area Calculation | Pumping Quantity |
|---|---|---|
| area A | 2147 (m2) | 0.0 (m3/day) |
| area B | 2751 (m2) | 0.0 (m3/day) |
| area C | 2325 (m2) | 0.0 (m3/day) |
| area D | 2355 (m2) | 0.0 (m3/day) |
| area E | 2385 (m2) | 293.6 (m3/day) |
| area F | 1790 (m2) | 0.0 (m3/day) |
| area G | 1810 (m2) | 0.0 (m3/day) |
| area H | 1521 (m2) | 0.0 (m3/day) |
| area I | 1954 (m2) | 79.3 (m3/day) |
| TOTAL | 19038 (m2) | 372.9 (m3/day) |

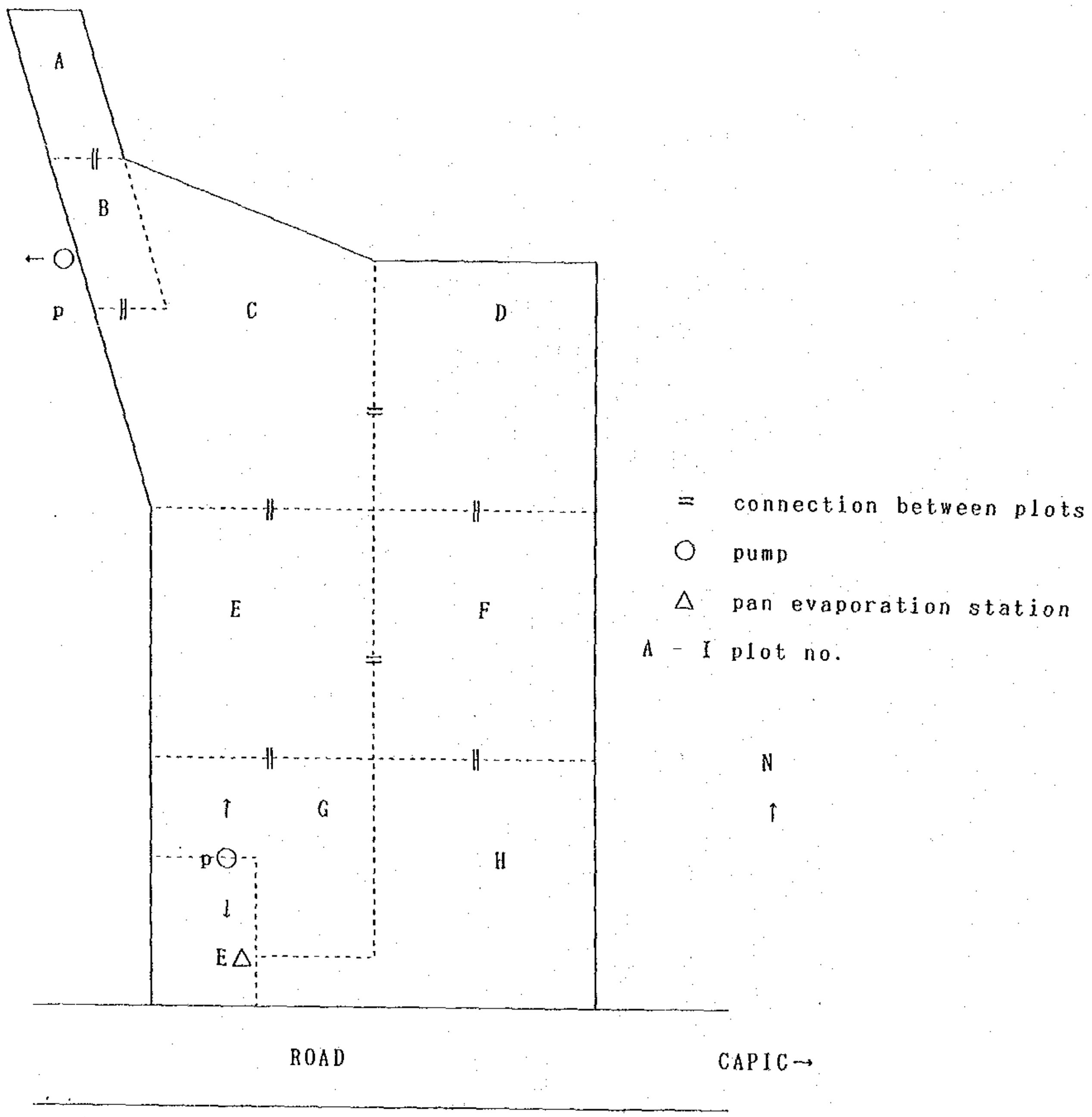
Figure A.3.8 Result of Circulation Water Investigation of Matobarij

## Table A.3.5 Estimation of Circulation Water and Percolation Rate in Matobarij

Estimation of Circulation Water and Percoration Rate
Motobarij(16/June/1991 - 17/June/1991)

| Area Division | Area for Pumping (m3) | Change WL in Plot (mm) | Change of Storage Qs(m3) | Groundwater Draft Qd(m3) | Evapo-transpiration ET(mm) | Evapo-transpiration (m3) | Net Quantity of Irrigation Qs+Qd(m3) | Estimated Percolation (m3) | Estimated Percolation (mm) | Ratio of Curculation Q3/(Q1+Q2) |
|---|---|---|---|---|---|---|---|---|---|---|
| *1/ | *2/ | *3/ | *4/ | *5/ | *6/ | *7/ | *8/ | *9/ | *10/ | *11/ |
| area A | 2147 | -5.60 | -12.02 | 0.0 | 4.4 | 9.4 | - | - | - | - |
| area B | 2751 | 4.00 | 11.00 | 0.0 | 4.4 | 12.1 | - | - | - | - |
| area C | 2325 | -26.50 | -61.61 | 0.0 | 4.4 | 10.2 | - | - | - | - |
| area D | 2355 | 3.00 | 7.07 | 0.0 | 4.4 | 10.4 | - | - | - | - |
| area E | 2385 | 1.90 | 4.53 | 293.6 | 4.4 | 10.5 | - | - | - | - |
| area F | 1790 | -48.00 | -85.91 | 0.0 | 4.4 | 7.9 | - | - | - | - |
| area G | 1810 | -27.75 | -50.23 | 0.0 | 4.4 | 8.0 | - | - | - | - |
| area H | 1521 | -7.50 | -11.41 | 0.0 | 4.4 | 6.7 | - | - | - | - |
| area I | 1954 | 2.65 | 5.18 | 79.3 | 4.4 | 8.6 | - | - | - | - |
| TOTAL | 19038 | -104 | -193.40 | 372.9 | 4.4 | 83.8 | 566.3 | 482.6 | 25.35 | 0.85 |

*1: an area is correlated to a plot respectively which is drawn in the attached map.
*2: the area is measured by the feild survey.
*3: water level change shows the difference of water levels between 2:00 of 17th and 2:00 of 18th/6/'91 in each plot.
*4: storage change is ( Area for Pumping) x (Change WL in Plot).
*5: total amount of pumping water which is taken in the objective area.
*6: 4.4 mm/day of Evapotranspilation ratio is estimated by the observed Pan Evaporation rate simultaneously.
using 0.8 coefficient of ET/PE, it can be caliculated as (5.5 mm/day of Pan Evaporation ratio)
x (0.8 coefficient of ET/PE) = 4.4 mm/day
*7: amount of Evapotranspiration is (4.4 mm/day of Evapotranspiration ratio) x (Area for Pumping)
*8: Net Quantity of Irrigation is as (Groundwater Draft) - (Change of Strage)
*9: Estimated Circuration Amount is estimated as (Groundwater Draft) - (Change of Strage) - (Evapotranspiration)
*10: Estimated Circuration rate is as (Estimated Percoration Amount) / (Area for Pumping)
*11: Ratio of Curculation or Returning water ratio for the whole irrigation water which is taken by the pumping.
it can caliculats as (Estimated Percoration Amount) / (Net Quantity for Irrigation) = 0.85




Estimation of Area and Pumping Quantity
Gilapay (24/June/1991 - 25/June/1991)

| | Area Calculation | Pumping Quantity |
|---|---|---|
| area A | 305 (m2) | 0.0 (m3/day) |
| area B | 248 (m2) | 0.0 (m3/day) |
| area C | 2806 (m2) | 0.0 (m3/day) |
| area D | 1474 (m2) | 0.0 (m3/day) |
| area E | 2269 (m2) | 0.0 (m3/day) |
| area F | 1404 (m2) | 0.0 (m3/day) |
| area G | 1841 (m2) | 0.0 (m3/day) |
| area H | 1812 (m2) | 0.0 (m3/day) |
| area I | 364 (m2) | 139.6 (m3/day) |
| TOTAL | 12521 (m2) | 139.6 (m3/day) |

Figure A.3.9 Result of Circulation Water Investigation of Gilapay

## Table A.3.6 Estimation of Circulation Water and Percolation Rate in Gilapay

Estimation of Circulation Water and Percoration Rate
Gilapay(24/June/1991 - 25/June/1991)

| Area Division *1/ | Area for Pumping (m3) *2/ | Change WL in Plot (mm) *3/ | Change of Storage Qs(m3) *4/ | Groundwater Draft Qd(m3) *5/ | Evapo-transpiration ET(mm) *6/ | (m3) *7/ | Net Quantity of Irrigation Qs+Qd(m3) *8/ | Estimated Percolation (m3) *9/ | (mm) *10/ | Ratio of Curculation Q3/(Q1+Q2) *11/ |
|---|---|---|---|---|---|---|---|---|---|---|
| area A | 305 | -7.00 | -2.14 | 0.0 | 4.5 | 1.4 | - | - | - | - |
| area B | 248 | -6.10 | -1.51 | 0.0 | 4.5 | 1.1 | - | - | - | - |
| area C | 2806 | -9.00 | -25.25 | 0.0 | 4.5 | 12.6 | - | - | - | - |
| area D | 1474 | -5.50 | -8.11 | 0.0 | 4.5 | 6.6 | - | - | - | - |
| area E | 2269 | -6.70 | -15.20 | 0.0 | 4.5 | 10.2 | - | - | - | - |
| area F | 1404 | -1.80 | -2.53 | 0.0 | 4.5 | 6.3 | - | - | - | - |
| area G | 1841 | 4.37 | 8.04 | 0.0 | 4.5 | 8.2 | - | - | - | - |
| area H | 1812 | -11.00 | -19.93 | 0.0 | 4.5 | 8.1 | - | - | - | - |
| area I | 364 | -3.10 | -1.13 | 152.9 | 4.5 | 1.6 | - | - | - | - |
| TOTAL | 12521 | -46 | -67.74 | 152.9 | 4.5 | 56.1 | 220.7 | 164.6 | 13.15 | 0.75 |

*1: an area is correlated to a plot respectively which is drawn in the attached map.
*2: the area is measured by the feild survey.
*3: water level change shows the difference of water levels between 3:00 of 24th and 3:00 of 25th/6/'91 in each plot.
*4: storage change is ( Area for Pumping) x (Change WL in Plot).
*5: total amount of pumping water which is taken in the objective area.
*6: 4.5 mm/day of Evapotranspilation ratio is estimated by the observed Pan Evaporation rate simultaneously, using 0.8 coefficient of ET/PE, it can be caliculated as (5.6 mm/day of Pan Evaporation ratio) x (0.8 coefficient of ET/PE) = 4.5 mm/day
*7: amount of Evapotranspiration is (4.5 mm/day of Evapotranspiration ratio) x (Area for Pumping)
*8: Net Quantity of Irrigation is as (Groundwater Draft) - (Change of Strage)
*9: *Estimated Circuration Amount* is estimated as (Groundwater Draft) - (Change of Strage) - (Evapotranspiration)
*10: Estimated Circuration rate is as (Estimated Percoration Amount) / (Area for Pumping)
*11: Ratio of Curculation or Returning water ratio for the whole irrigation water which is taken by the pumping, it can caliculats as (Estimated Percoration Amount) / (Net Quantity for Irrigation) = 0.

## A. 3. 3 Groundwater Use at Present

### 1. Groundwater Utilization Investigation

The present utilization from groundwater resources in this area had been estimated by both way of the field investigation and the cumulative study of the well inventory.

The field investigation mainly consists of an interview for the well management with farmer, however, due to the difficulty to meet the well keeper, these investigation have to be restricted to the low land area where the well observation had done ahead. the result shows the Table A. 3. 7 and Figure A. 3. 10.

### 2. Groundwater Use at Present

The arrangement of well inventory, aiming to the estimation of the total present utilization in Project Area, is based on the following materials.

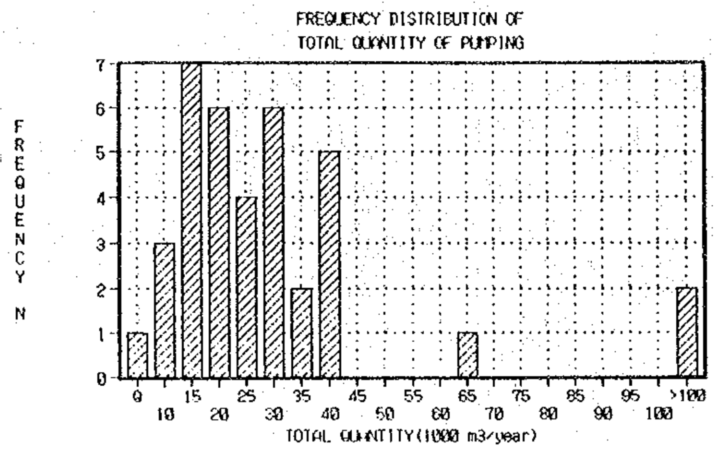
- Well inventory covering Sari to Mahmudabad published 1985, vol. 1-2, investigation dated 1982 to 1984.
- Well inventory covering Mahmudabad to Alesh Rud published 1987, vol. 1, the investigation data dated 1985 to 1986.

The estimation of the final amount of groundwater draft obtaining as a provisional accumulation indicates more than 200 MCM annually containing the 6,000 wells in the whole Project Area as shown in Table A. 3. 8. And the regional difference of groundwater drafting arranging from the above result is drawn in Figure A. 3. 11.

## Table A.3.7 Result of Groundwater Utilization Investigation

| WELL NO. | OBSERVED DATE (1) | PUMP DIAMETRE (inch) | PUMP CAPACITY (l/min) | ENIGINE TYPE & CAPACITY (HP-RPM) | IRRIGATED AREA (ha) | PUMPING RATE (l/sec) | PUMPING HOUR (h/DAY) | PUMPING PERIOD (month) | TOTAL QUANT OF PUMPING (m3) | RATE OF PUMPING (l/ha/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| HD1 | 1/6/91 | 3 | 900 | | 1.5 | 2.00 | 24.0 | 3.5 | 18.446 | 1.33 |
| HD2 | 1/6/91 | | | 4.5-750 | | 4.00 | 24.0 | 3.5 | 36.893 | |
| HD3 | 1/6/91 | 3 | 900 | | | 2.00 | 24.0 | 3.5 | 18.446 | |
| HD4 | 1/6/91 | | | 4.5-750 | | 4.00 | 24.0 | 3.5 | 36.893 | |
| HD5 | 12/6/91 | | | | 0.1 | 2.34 | 12.0 | 3.5 | 10.800 | 11.71 |
| HD6 | 2/6/91 | 3 | | 4.5-2400 | 1.5 | 2.63 | 24.0 | 3.5 | 24.272 | 1.75 |
| HD8 | 2/6/91 | 2 | | 4.5-750 | 1.5 | 2.73 | 24.0 | 3.5 | 25.154 | 1.82 |
| HD9 | 2/6/91 | 3 | | 9.0-2400 | 3.0 | 12.00 | 24.0 | 3.5 | 110.679 | 4.00 |
| - | 1/6/91 | 4 | | 50- | | | | | | |
| MR4' | 17/6/91 | | | | 3.5 | 3.69 | 20 | 3.5 | 29.397 | 0.88 |
| MR5 | 2/6/91 | 3 | | 4.5-750 | 1.5 | 6.70 | 24.0 | 3.5 | 61.795 | 4.47 |
| MR6 | 2/6/91 | 2 | | 4.5-750 | 1.5 | 3.33 | 24.0 | 3.5 | 30.744 | 2.22 |
| MR8 | 12/6/91 | 3 | | 4.5-750 | 1.2 | 4.07 | 20.0 | 3.5 | 31.286 | 2.93 |
| MR8' | 12/6/91 | 2 | | | 0.7 | 1.82 | 12.1 | 3.5 | 8.429 | 1.31 |
| MR9 | 2/6/91 | 2 | | | 0.8 | 5.45 | 12.0 | 3.5 | 25.154 | 3.41 |
| - | 3/6/91 | 4 | | 60-1500 | | 11.11 | 20.0 | 12.0 | 292.800 | |
| BK1 | 10/6/91 | | | | 0.7 | 2.26 | 20.0 | 3.5 | 17.389 | 2.69 |
| BK2 | 3/6/91 | 2 | | | 0.5 | 6.67 | 7.0 | 3.5 | 17.934 | 3.89 |
| BK4 | 3/6/91 | 3 | 709 | 4-400 | | 2.68 | 20.0 | 3.5 | 20.588 | |
| BK5 | 3/6/91 | 3 | | | | 3.53 | 20.0 | 3.5 | 27.127 | |
| BK6 | 3/6/91 | | | 8.5-2400 | 8.0 | 4.92 | 20.0 | 3.5 | 37.800 | 0.51 |
| EZ2 | 10/6/91 | | | | | 3.62 | 11.0 | 3.5 | 15.298 | |
| EZ3 | 10/6/91 | 2 | 550 | 2.6-3600 | 0.7 | 4.86 | 20.0 | 3.5 | 37.371 | 5.79 |
| EZ3' | - | 3 | | 4.5-750 | | | | | | |
| EZ5 | 10/6/91 | 3 | | 4.5-750 | 2.0 | 4.22 | 24.0 | 3.5 | 37.091 | 2.01 |
| EZ8 | 10/6/91 | 2 | 550 | 2.6-3600 | 2.0 | 4.29 | 13.0 | 3.5 | 21.411 | 1.16 |
| DA2 | 10/6/91 | 3 | | 4.5-750 | 2.0 | 6.00 | 13.0 | 3.5 | 29.975 | 1.63 |
| HK1 | 10/6/91 | | | | 0.5 | 1.83 | 20.0 | 3.5 | 14.043 | 3.05 |
| HK2 | 10/6/91 | | 550 | 2.6-3600 | 0.5 | 2.19 | 13.0 | 3.5 | 10.948 | 2.37 |
| CH5 | 11/6/91 | 2 | | | | | | | | |
| CH6 | 11/6/91 | 3 | | | 1.5 | 10.87 | 4.5 | 3.5 | 19.797 | 1.36 |
| FK1 | 9/6/91 | 2 | | 4.5-750 | 0.2 | 2.00 | 7.5 | 3.5 | 5.761 | 3.12 |
| FK2 | 9/6/91 | 2 | 550 | 2.6-3600 | 0.1 | 2.78 | 13.0 | 3.5 | 13.865 | 12.53 |
| FK3 | 9/6/91 | | | | 1.5 | 5.96 | 13.0 | 3.5 | 29.797 | 2.15 |
| FK3" | 9/6/91 | 2 | | 4.5-750 | 0.3 | 3.16 | 6.5 | 3.5 | 7.888 | 2.85 |
| FK4 | 9/6/91 | 2 | | 4.5-750 | 0.6 | 2.93 | 20.0 | 3.5 | 22.518 | 4.07 |
| US1 | 9/6/91 | | | | 1.0 | 6.22 | 5.0 | 3.5 | 11.960 | 1.30 |
| US2 | 9/6/91 | 3 | | 4.5-750 | 0.9 | 4.55 | 8.0 | 3.5 | 13.975 | 1.68 |
| US3 | 9/6/91 | | | | 2.0 | 5.31 | 6.0 | 3.5 | 12.238 | 0.66 |
| US4 | 9/6/91 | 2 | | | 0.3 | 1.30 | 6.0 | 3.5 | 3.008 | 1.09 |

Note :The location of well refers to Figure A.3.5.



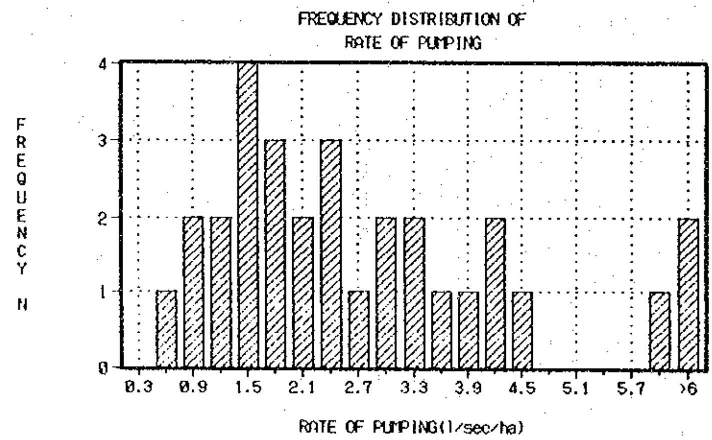
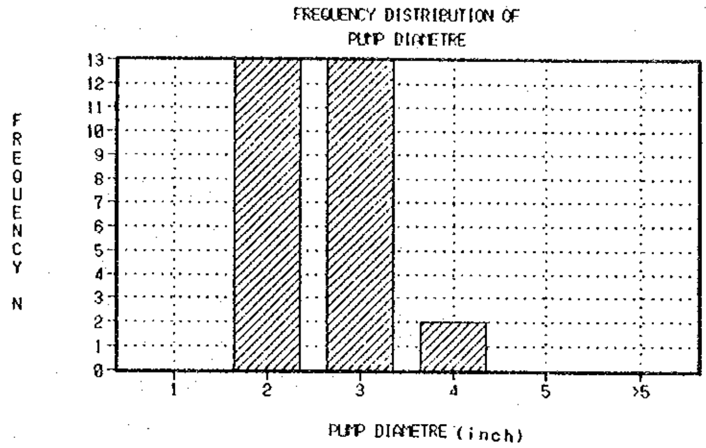
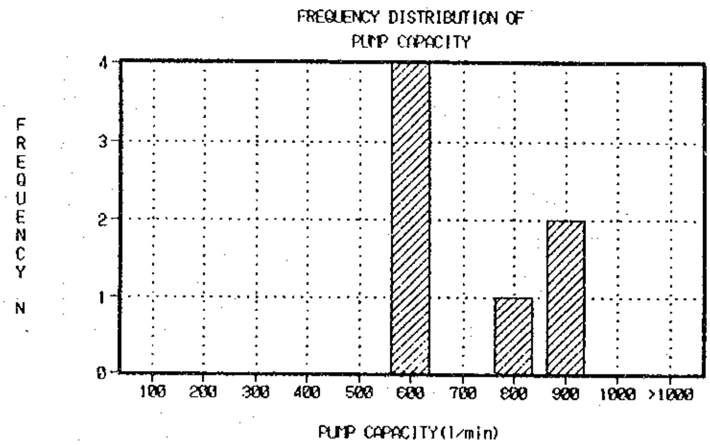




Figure A.3.10(1) Frequency Distribution for the Respective Item of Groundwater Utilization



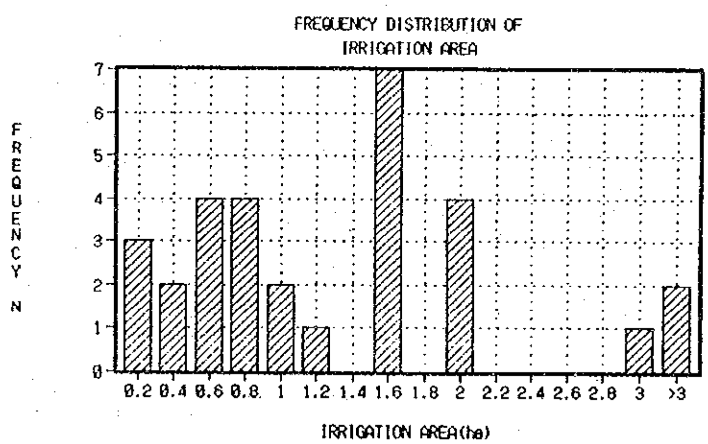




Figure A.3.10(2) Frequency Distribution for the Respective Item of Groundwater Utilization

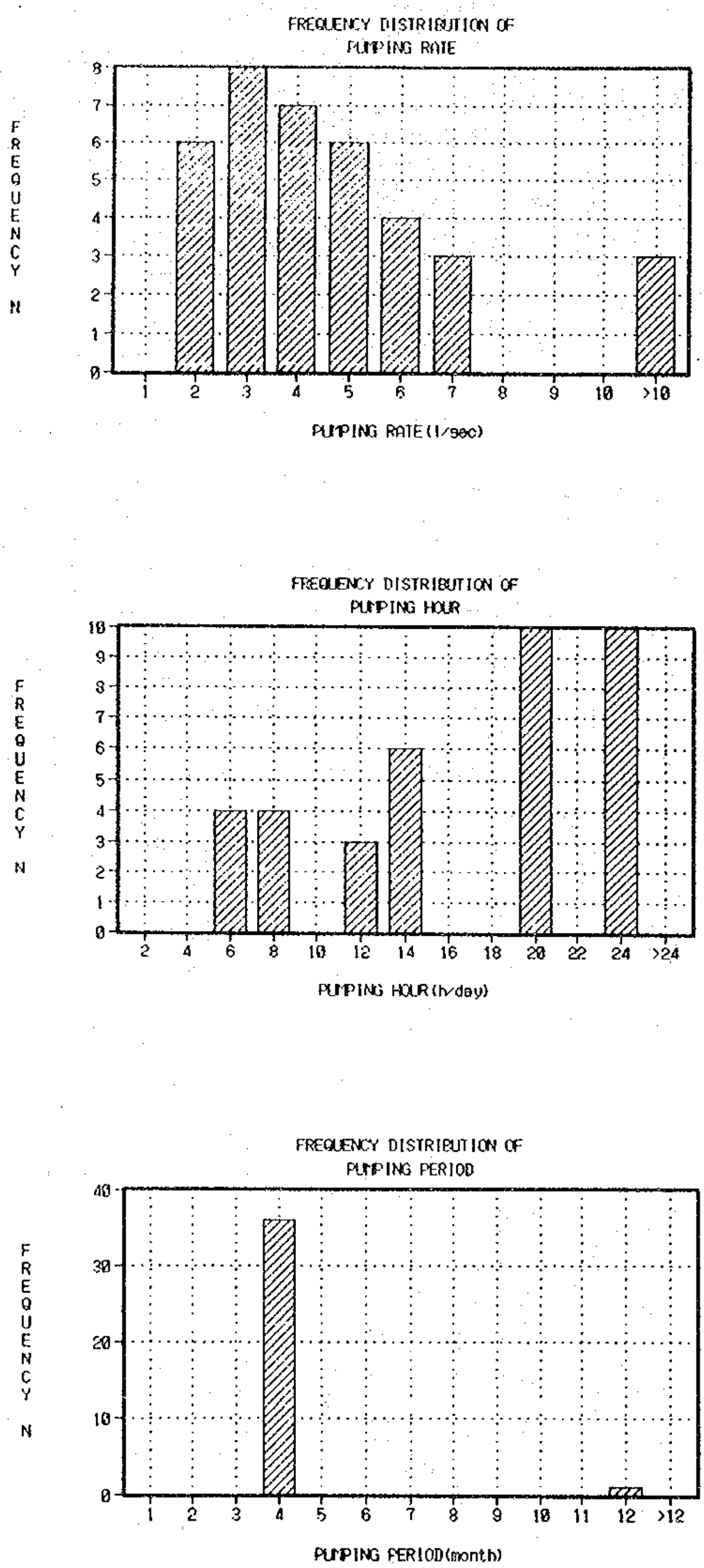



Figure A.3.10(3) Frequency Distribution for the Respective Item of Groundwater Utilization

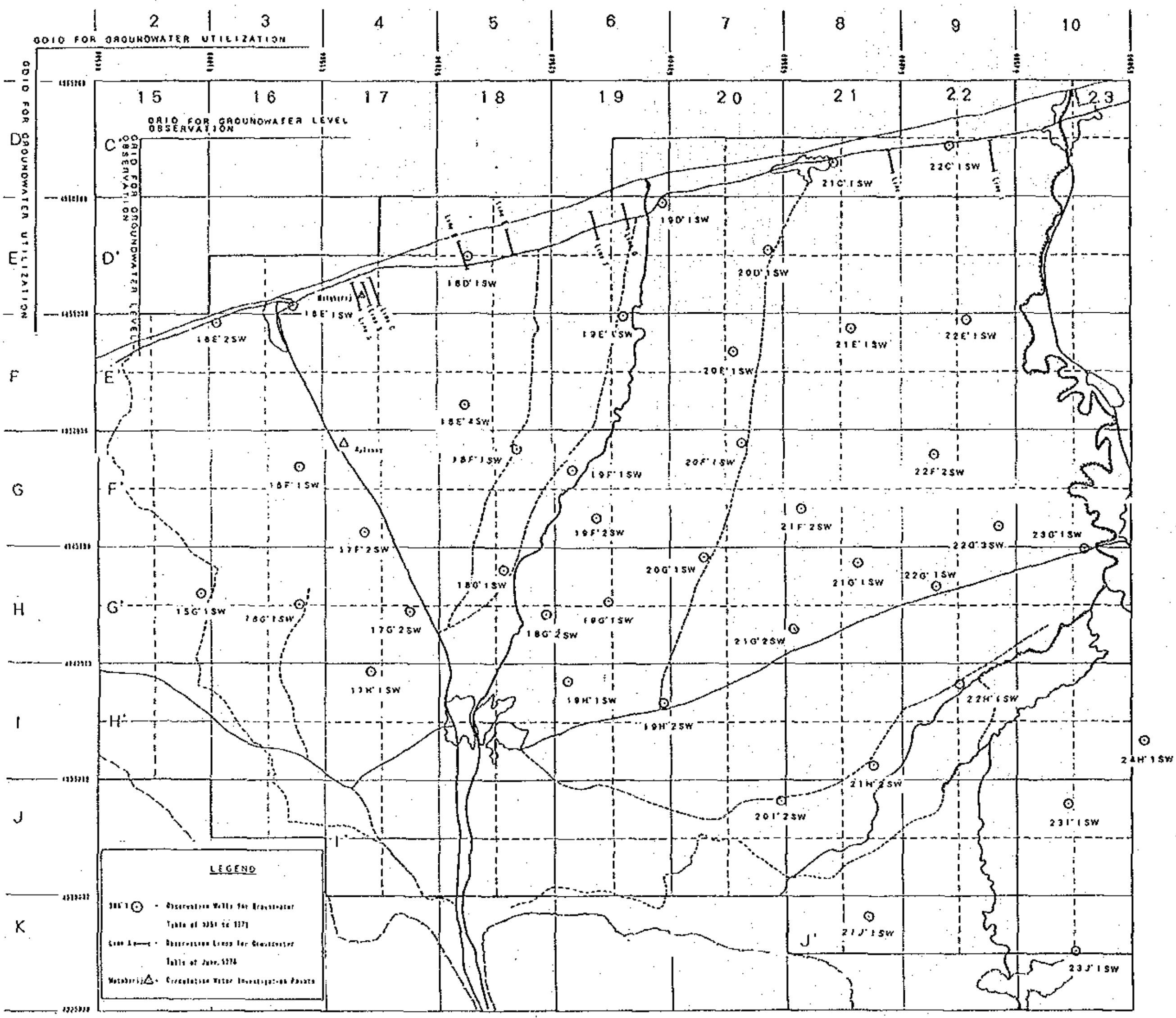
Table A.3.8 Groundwater Utilization Quantity for Project Area

| | GRID | 6D | 7D | 8D | 9D | 10D | 4E | 5E | 6E | 7E | 8E | 9E | 10E | 2F | 3F | 4F | 5F | 6F | 7F | 8F | 9F | 10F | 2G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOS. OF WELL | SHALLOW | 3 | 14 | 20 | 30 | 6 | 111 | 330 | 73 | 3 | 101 | 200 | 46 | 127 | 52 | 233 | 185 | 118 | 43 | 349 | 635 | 129 | 33 |
| | DEEP | 0 | 0 | 0 | 0 | * | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 2 | 0 | 0 | 8 | 1 |
| | ATESIAN | 0 | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 2 |
| | AGRICULTURE | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| | INDUSTRY | 0 | 0 | 0 | 0 | 0 | 0 | * | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | DRIKING | * | * | * | * | 0 | * | * | * | * | * | * | * | * | 0 | * | * | * | 0 | 0 | 0 | 0 | * |
| | TOTAL | 3 | 14 | 20 | 30 | 6 | 111 | 332 | 76 | 3 | 101 | 200 | 46 | 127 | 52 | 234 | 157 | 123 | 48 | 349 | 635 | 136 | 36 |
| | UNCONFIRMED | 3 | 14 | 14 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WELL DRAFT (M3/YEAR) | AGRICULTURE | 0 | - | 46,867 | 0 | 143,540 | 6,288,989 | 6,638,333 | 4,244,341 | 38,880 | 6,694,427 | 8,148,707 | 928,720 | 1,924,248 | 637,767 | 4,462,044 | 0,018,167 | 2,264,779 | 1,215,509 | 5,793,004 | 12,242,326 | 4,946,124 | 2,122,118 |
| | INDUSTRY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | DRIKING | 0 | 0 | 0 | 0 | 0 | 2,642 | 24,606 | 524,966 | 1,856 | 0 | 0 | 2,878 | 52,192 | 0 | 10,812 | 51,840 | 68,040 | 20,401 | 0 | 0 | 0 | 1,010,340 |
| | DRINKING(CITY) | | | | 500,000 | 2,000,000 | | | | | | | | | 1,500,000 | | | | | 2,000,000 | | 1,000,000 | |
| | UNCONFIRMED | 425,736 | 1,986,768 | 1,986,768 | 4,257,360 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 425,736 | 1,986,768 | 2,033,625 | 4,757,360 | 2,143,540 | 6,291,631 | 6,862,959 | 4,769,307 | 40,735 | 6,694,427 | 8,148,707 | 931,398 | 1,976,440 | 2,137,767 | 4,472,556 | 0,070,007 | 2,336,819 | 1,235,910 | 7,793,004 | 12,242,326 | 5,946,124 | 3,133,458 |
| SPRING POUROUT(M3/YEAR) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GROUND TOTAL(M3/YEAR) | | 425,736 | 1,986,768 | 2,033,625 | 4,757,360 | 2,143,540 | 6,291,631 | 6,862,959 | 4,769,307 | 40,735 | 6,694,427 | 6,146,707 | 931,398 | 1,976,440 | 2,137,767 | 4,472,556 | 0,070,007 | 2,336,819 | 1,235,910 | 7,793,004 | 12,242,326 | 5,946,124 | 3,133,458 |
| YIELD | AVERAGE | 0.00 | 0.00 | 4.50 | * | 5.00 | 5.50 | 10.00 | 10.00 | 10.00 | 7.00 | 6.50 | 5.50 | 3.50 | 5.00 | 5.25 | 5.00 | 6.00 | 5.00 | 6.50 | 7.50 | 7.20 | 7.50 |

| | GRID | 3G | 4G | 5G | 6G | 7G | 8G | 9G | 10G | 2H | 3H | 4H | 5H | 6H | 7H | 8H | 9H | 10H | 2I | 3I | 4I | 5I | 6I | 7I | 8I | 9I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOS. OF WELL | SHALLOW | 416 | 218 | 31 | 85 | 280 | 131 | 480 | 307 | 2 | 86 | 0 | 8 | 77 | 8 | 11 | 108 | 147 | 0 | 58 | 0 | 2 | 26 | 0 | 36 | 253 |
| | DEEP | 9 | 5 | 1 | 2 | 5 | 2 | 3 | 3 | 3 | 4 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 2 | 0 | 0 | 2 |
| | ATESIAN | 2 | 1 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 1 | 3 | 2 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 4 | 3 |
| | AGRICULTURE | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | | * | 0 | * | * | * | * | * | * | * |
| | INDUSTRY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | 0 | 0 | 0 |
| | DRIKING | * | 0 | 0 | * | 0 | * | * | 0 | * | * | * | * | 0 | 0 | * | 0 | * | 0 | * | * | * | * | * | * | * |
| | TOTAL | 427 | 224 | 32 | 88 | 295 | 133 | 483 | 310 | 5 | 97 | 2 | 8 | 77 | 9 | 15 | 111 | 150 | 2 | 63 | 4 | 6 | 30 | 1 | 40 | 258 |
| | UNCONFIRMED | 0 | 2 | 0 | 0 | 277 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 |
| WELL DRAFT (M3/YEAR) | AGRICULTURE | 2,668,532 | 0,340,086 | 1,455,782 | 2,463,631 | 541,381 | 0,349,699 | 8,473,812 | 12,350,817 | 100,639 | 1,629,850 | 0 | 146,610 | 0,274,628 | 288,667 | 582,560 | 4,370,350 | 6,067,214 | 468,504 | 2,114,412 | 0 | 36,000 | 184,558 | 113,760 | 879,138 | 5,859,419 |
| | INDUSTRY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 91,121 | 0 | 0 | 0 |
| | DRIKING | 1,009,152 | 0 | 0 | 224,177 | 0 | 36,450 | 157,680 | 0 | 27,276 | 1,051,436 | 0 | 7,480 | 0 | 0 | 189,216 | 0 | 66,830 | 0 | 313,332 | 0 | 0 | 22,649 | 0 | 346,901 | 580,277 |
| | DRINKING(CITY) | | | | | | | | 7,500,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,000,000 | 0 | 0 | 0 | 0 |
| | UNCONFIRMED | 0 | 90,720 | 0 | 0 | 13,556,722 | 0 | 0 | 0 | 0 | 0 | 315,360 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 630,720 | 487,298 | 0 | 0 | 0 | 0 |
| | TOTAL | 3,677,684 | 0,430,786 | 1,455,782 | 2,687,808 | 14,098,103 | 0,386,049 | 8,631,492 | 19,850,817 | 127,917 | 2,681,286 | 315,360 | 154,090 | 0,274,628 | 288,657 | 771,776 | 4,370,350 | 6,134,084 | 468,504 | 2,427,744 | 630,720 | 6,523,298 | 298,328 | 113,760 | 1,226,039 | 7,439,696 |
| SPRING POUROUT(M3/YEAR) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,018,304 | 8,445,032 | 671,454 | 523,498 | 13,140 | 0 | 0 | 0 | 0 | 1,955,232 | 0,153,600 | 0 | 78,731 | 63,072 | 0 | 0 |
| GROUND TOTAL(M3/YEAR) | | 3,677,684 | 0,430,786 | 1,455,782 | 2,687,808 | 14,098,103 | 0,386,049 | 8,631,492 | 19,850,817 | 127,917 | 4,699,590 | 8,760,392 | 825,544 | 0,798,126 | 299,797 | 771,776 | 4,370,350 | 6,134,084 | 468,504 | 4,382,976 | 0,784,320 | 5,523,298 | 377,059 | 176,832 | 1,226,039 | 7,439,696 |
| YIELD | AVERAGE | 5.00 | 5.00 | 5.00 | 5.70 | 5.30 | 5.50 | 7.40 | 10.00 | 11.00 | 10.00 | * | 7.00 | 5.60 | 5.30 | 5.00 | 5.00 | 6.60 | 22 | 10 | * | 6.00 | 6.30 | 3.50 | 3.50 | 10.00 |

| | GRID | 3J | 4J | 5J | 6J | 7J | 8J | 9J | total |
|---|---|---|---|---|---|---|---|---|---|
| NOS. OF WELL | SHALLOW | 1 | 0 | 0 | 0 | 97 | 90 | 46 | 5,837 |
| | DEEP | 1 | 3 | 2 | 8 | 2 | 3 | 1 | 98 |
| | ATESIAN | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| | AGRICULTURE | * | * | * | | * | * | * | * |
| | INDUSTRY | 0 | 0 | 0 | * | 0 | 0 | 0 | * |
| | DRIKING | * | * | * | * | 0 | * | * | * |
| | TOTAL | 3 | 3 | 2 | 8 | 99 | 93 | 47 | 5,983 |
| | UNCONFIRMED | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 351 |
| WELL DRAFT (M3/YEAR) | AGRICULTURE | 117,872 | 429,159 | 0 | 0 | 536,019 | 2,430,947 | 1,013,677 | 135,289,520 |
| | INDUSTRY | 0 | 0 | 0 | 146,000 | 0 | 0 | 0 | 237,121 |
| | DRIKING | 9,504 | 10,950 | 101,702 | 299,304 | 0 | 277,375 | 54,038 | 6,555,813 |
| | DRINKING(CITY) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19,500,000 |
| | UNCONFIRMED | 0 | 0 | 157,680 | 0 | 0 | 0 | 0 | 23,895,130 |
| | TOTAL | 127,376 | 440,109 | 259,382 | 445,304 | 536,019 | 2,708,322 | 1,067,715 | 185,477,586 |
| SPRING POUROUT(M3/YEAR) | | 0 | 0 | 0 | 0 | 0 | 0 | 5,256 | 17,927,319 |
| GROUND TOTAL(M3/YEAR) | | 127,376 | 440,109 | 259,382 | 445,304 | 536,019 | 2,708,322 | 1,072,971 | 203,404,905 |
| YIELD | AVERAGE | 10.50 | 15.00 | 7.00 | 12.75 | 6.40 | 5.00 | 5.00 | 6.57 |

Note : Cumulation excludes a well which is located out of the range of Project area at the border area.
: Unit is shown in $m^3$/year

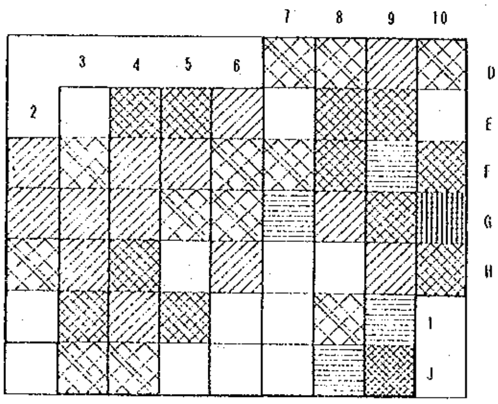



Note : Grid number is correlation with Intensity Map

Figure A.3.11(1) Intensity Map of Groundwater Utilization
-Explanation Map-

GROUNDWATER UTILIZATION QUANTITY IN HARAZ BASIN

- TOTAL QUANTITY OF GROUNDWATER DRAFT -




| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | | | | | | 1987 | 2034 | 4257 | 2144 |
| E | | 0 | 5292 | 8863 | 4769 | 41 | 6694 | 5149 | 931 |
| F | 3900 | 2130 | 4473 | 3070 | 2337 | 1236 | 7793 | 12242 | 5946 |
| G | 3133 | 3678 | 3431 | 1456 | 2688 | 14098 | 3306 | 8631 | 19851 |
| H | 2968 | 4700 | 9760 | 826 | 3798 | 300 | 772 | 4370 | 7941 |
| I | 469 | 5548 | 3784 | 5523 | 372 | 177 | 1226 | 12601 | |
| J | | 1146 | 1320 | 259 | 445 | 536 | 11678 | 21813 | |

Note : Cumulation includes all wells within the drawing grid even which is located out of the range of ?roject area at the border area.
: Unit is shown in 1000 m³/year

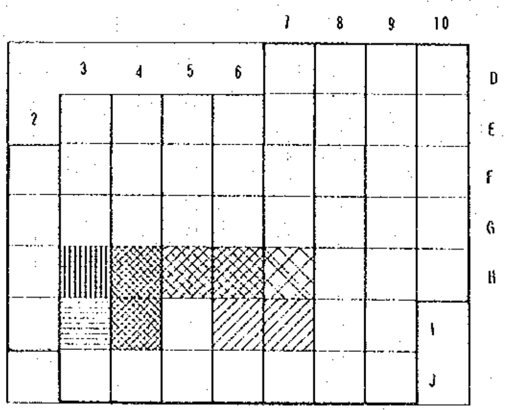
LEGEND x 1000 m³

> 1000 | 1000 - 3000 | 3000 - 5000 | 5000 - 10000 | 10000 - 15000 | 15000 - 20000 | < 20000

Figure A.3.11(2) Intensity Map of Groundwater Utilization -Total Quantity of Groundwater Draft-

GROUNDWATER UTILIZATION QUANTITY IN HARAZ BASIN

- SPRING POUROUT QUANTITY -




| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | | | | | | 0 | 0 | 0 | 0 |
| E | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H | 0 | 2018 | 9445 | 671 | 523 | 13 | 0 | 0 | 0 |
| I | 0 | 1155 | 3154 | 0 | 79 | 63 | 0 | 0 | |
| J | | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |

Note : Cumulation includes all wells within the drawing grid even which is located out of the range of Project area at the border area.
: Unit is shown in 1000 $m^3$/year

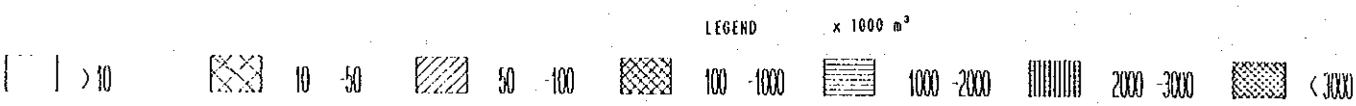
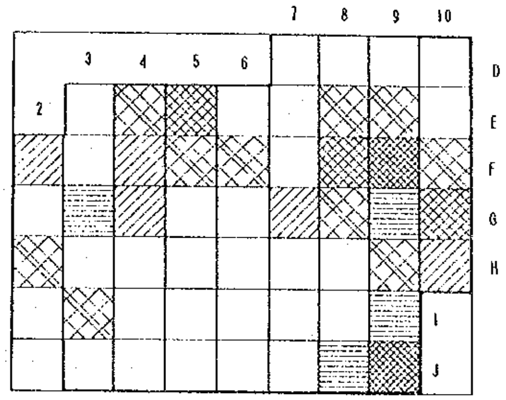



Figure A.3.11(3) Intensity Map of Groundwater Utilization -Spring Pour out Quantity-

GROUNDWATER UTILIZATION QUANTITY IN HARAZ BASIN

- TOTAL WELL NUMBER FOR GROUNDWATER DRAFT -




| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | | | | | | 14 | 20 | 30 | 6 |
| E | | 0 | 111 | 332 | 76 | 3 | 101 | 200 | 46 |
| F | 219 | 52 | 234 | 152 | 123 | 48 | 349 | 635 | 135 |
| G | 36 | 427 | 224 | 52 | 88 | 295 | 133 | 483 | 310 |
| H | 118 | 97 | 2 | 8 | 77 | 9 | 15 | 111 | 232 |
| I | 2 | 114 | 4 | 6 | 30 | 1 | 40 | 447 | |
| J | | 27 | 9 | 2 | 8 | 99 | 401 | 960 | |

Note : Cumulation includes all wells within the drawing grid even which is located out of the rangc of Project area at the border area.
: Unit is shown in 1000 $m^3$/year

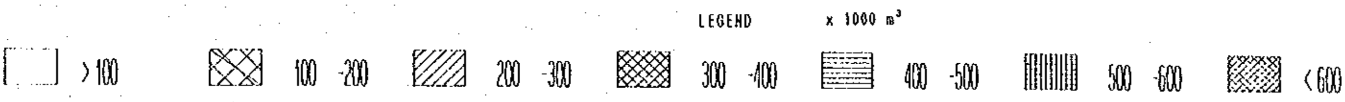
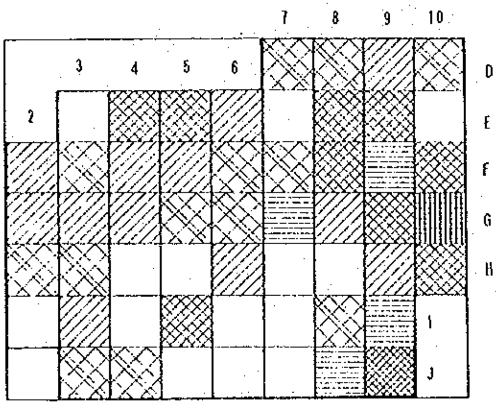



Figure A.3.11(4) Intensity Map of Groundwater Utilization -Total Well Number for Groundwater Draft-

GROUNDWATER UTILIZATION QUANTITY IN HARAZ BASIN

- WELL DRAFT QUANTITY -




| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | | | | | | 1987 | 2034 | 4257 | 2144 |
| E | | 0 | 5292 | 8863 | 4769 | 41 | 6694 | 5149 | 931 |
| F | 3408 | 2130 | 4473 | 3070 | 2337 | 1236 | 7793 | 12242 | 5946 |
| G | 3133 | 3678 | 3431 | 1456 | 2688 | 14090 | 3386 | 8631 | 19851 |
| H | 2968 | 2682 | 315 | 154 | 3275 | 287 | 772 | 4370 | 7941 |
| I | 469 | 4393 | 631 | 5523 | 298 | 114 | 1226 | 12601 | |
| J | | 1146 | 1320 | 259 | 445 | 536 | 11678 | 21808 | |

Note : Cumulation includes all wells within the drawing grid even which is located out of the range of Project area at the border area.
: Unit is shown in 1000 $m^3$/year

LEGEND × 1000 $m^3$

[ ] >1000 · 1000 -3000 · 3000 -5000 · 5000 -10000 · 10000 -15000 · 15000 -20000 · <20000

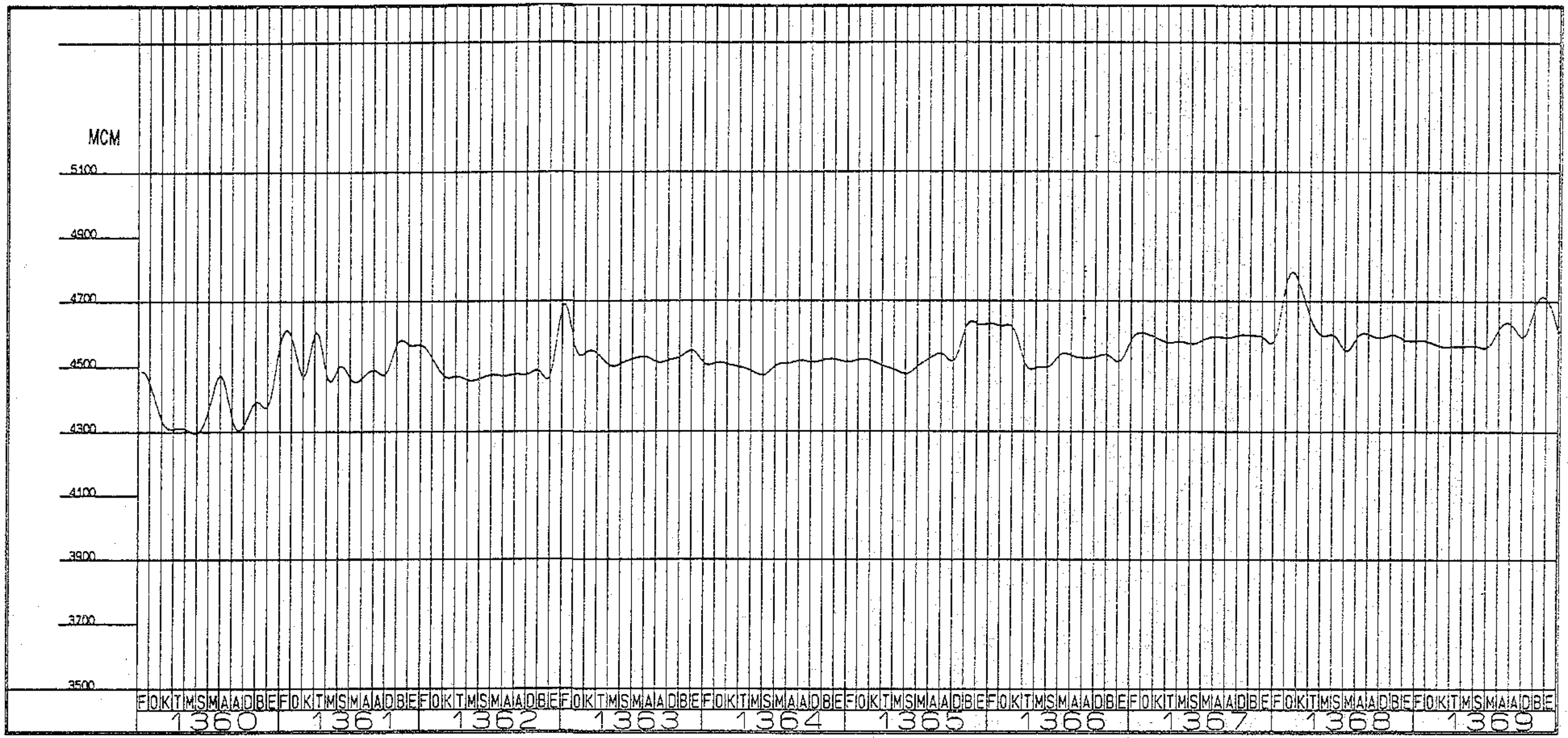
Figure A.3.11(5) Intensity Map of Groundwater Utilization -Well Draft Quantity of Groundwater Draft-

## A. 3. 4 An Estimation of Groundwater Storage Change

### 1. Groundwater Storage Change

(1) Time Series Change of Groundwater Storage

On the basis of the Groundwater Level fluctuation, remaking as a grid data from the well observation result by interpolation, the groundwater storage has been calculated for the last 10 years as shown in Figure A. 3. 12. The estimation has been executed with the use of a fixed standard of Caspian Sea Level of (-)27 m PGD, seeing that the storage quantity is indicated as an apparent volume excluding the sea level changes during calculation period. The general tendency in this curve appears that the storage volume is in a condition which is gradually rising up till the present.




Note : Unit is shown in MCM

Figure A.3.12 Groundwater Storage Change 1360 to 1369

## 2. Groundwater Runoff

### (1) Well Observation for Groundwater Runoff

For obtaining the basic data for the groundwater runoff, the well observation has been conducted with the following items.

- Observation period ranging 1st of June to 24th of June (Table A.3.9).
- Observation line including 9 lines with 62 points (see Figure A. 3. 13).
- Observation items comprising casing elevation, depth of wells, s.w.l./d.w.l., EC and Temperature (see Table A.3.9).

### (2) Dynamic Levels in the Coastal Strip

As shown in comprehensible cross section of Figure A.3.14, the dynamic water level near the seacoast has been positioned beneath the present sea level at the most of observation points. The hydrogeologic condition indicating this level may prove that the groundwater had hardly gone out to the sea in this stage of 1370.

Table A.3.9(1) Result of Well Observation - for Groundwater Runoff and Utilization-

| NO. | WELL NO. OF WELL MAP | WELL NO. OF LEVELING | LOCATION CODE | village | LINE | CASING ELEVATION (EL.m) | DEPTH OF WELL (m) | PUMP DIAMETRE (inch) | PUMP CAPACITY (l/min) | ENIGINE TYPE & CAPACITY (HP-RPM) | IRRIGATED AREA (ha) | OBSERVED DATE (1) | PUMPING RATE (l/sec) | PUMPING HOUR (h/DAY) | PUMPING PERIOD (month) | TOTAL QUAN OF PUMPING (m3 /y) | RATE OF PUMPING (l/ha/s) | S.W.L -GL TO WL- (GL m) | S.W.L -GL TO WL- (EL. m) | D.W.L. -GL TO WL- (GL m) | D.W.L. -GL TO WL- (EL. m) | EC (uS) | T (°C) | WELL NO. OF LEVELING | OBSERVED DATE (2) | S.W.L -GL TO WL- (GL m) | S -GL (E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 68 | HD1 | 4E | Harab Deh | A | -21.71 | | 3 | 900 | | 1.5 | 1/6/91 | 2.00 | 24.0 | 3.5 | 18,446 | 1.33 | 0.70 | -22.41 | 3.66 | -25.37 | 730 | 16.9 | HD1 | 17/6/91 | | |
| 2 | 82 | HD2 | 4E | Harab Deh | A | -21.49 | | | | 4.5-750 | | 1/6/91 | 4.00 | 24.0 | 3.5 | 36,893 | | 0.70 | -22.19 | 3.59 | -25.08 | | | HD2 | 17/6/91 | | |
| 3 | (88) | HD3 | 4E | Harab Deh | A | -21.68 | | 3 | 900 | | | 1/6/91 | 2.00 | 24.0 | 3.5 | 18,446 | | | | 5.15 | -26.83 | | | HD3 | 17/6/91 | 2.28 | |
| 4 | 94 | HD4 | 4E | Harab Deh | A | -20.71 | | | | 4.5-750 | | 1/6/91 | 4.00 | 24.0 | 3.5 | 36,893 | | 0.70 | -21.41 | 7.20 | -27.91 | 595 | 16.3 | HD4 | 17/6/91 | | |
| 5 | - | HD5 | 4E | Harab Deh | A | -20.33 | | | | | 0.1 | 12/6/91 | 2.34 | 12.0 | 3.5 | 10,800 | 11.71 | | | 6.00 | -26.33 | | | HD5 | 17/6/91 | 2.82 | |
| 6 | 102 | HD6 | 4E | Harab Deh | B | -20.53 | | 3 | | 4.5-2400 | 1.5 | 2/6/91 | 2.63 | 24.0 | 3.5 | 24,272 | 1.75 | | | 6.57 | -27.10 | | | HD6 | 17/6/91 | | |
| 7 | - | HD7 | 4E | Harab Deh | B | -20.89 | | | | | | 2/6/91 | | | | | | 0.86 | -21.75 | | | | | HD7 | 17/6/91 | 2.84 | |
| 8 | 20 | HD8 | 4F | Harab Deh | B | -20.03 | | 2 | | 4.5-750 | 1.5 | 2/6/91 | 2.73 | 24.0 | 3.5 | 25,154 | 1.82 | | | 3.05 | -23.08 | | | HD8 | 17/6/91 | | |
| 9 | 24 | HD9 | 4F | Harab Deh | B | -19.11 | | 3 | | 9.0-2400 | 3.0 | 2/6/91 | 12.00 | 24.0 | 3.5 | 110,678 | 4.00 | | | 6.22 | -25.33 | | | HD9 | 17/6/91 | | |
| 10 | deep well | - | 4E | Motoberij | C | - | 55 | 4 | | 50- | | 1/6/91 | | | | | | 3.00 | - | 23.00 | - | | | - | 17/6/91 | | |
| 11 | 35 | MR1 | 4E | Motoberij | C | -21.62 | | | | | | 12/6/91 | | | | | | 0.98 | -22.60 | | | | | MR1 | 17/6/91 | 1.11 | - |
| 12 | 50 | MR2 | 4E | Motoberij | C | -21.30 | | | | | | 1/6/91 | | | | | | 0.91 | -22.21 | | | | | MR2 | 19/6/91 | | |
| 13 | 45 | MR3 | 4E | Motoberij | C | - | | | | | | 1/6/91 | | | | | | 0.85 | - | | | 620 | 16.8 | MR3 | 18/6/91 | 1.22 | |
| 14 | 67 | MR4 | 4E | Motoberij | C | -20.63 | | | | | | 12/6/91 | | | | | | 1.19 | -21.82 | | | | | MR4 | 17/6/91 | | |
| 15 | - | MR4' | 4E | Motoberij | C | - | | | | | 3.5 | 17/6/91 | 3.69 | 20 | 3.5 | 28,397 | 0.88 | | | | | | | MR4' | 17/6/91 | | |
| 16 | 69 | MR5 | 4E | Motoberij | C | -20.92 | | 3 | | 4.5-750 | 1.5 | 2/6/91 | 6.70 | 24.0 | 3.5 | 61,795 | 4.47 | 2.87 | -23.79 | | | | | MR5 | 17/6/91 | | |
| 17 | 110 | MR6 | 4E | Motoberij | C | -21.55 | | 2 | | 4.5-750 | 1.5 | 2/6/91 | 3.33 | 24.0 | 3.5 | 30,744 | 2.22 | | | 7.39 | -28.94 | | | MR6 | 17/6/91 | | |
| 18 | - | MR7 | 4E | Motoberij | C | -20.63 | | | | | | 12/6/91 | | | | | | 4.78 | -25.41 | | | | | MR7 | 17/6/91 | | |
| 19 | - | MR8 | 4E | Motoberij | C | -20.59 | | 3 | | 4.5-750 | 1.2 | 12/6/91 | 4.07 | 20.0 | 3.5 | 31,286 | 2.83 | | | 6.78 | -27.37 | | | MR8 | 17/6/91 | | |
| 20 | - | MR8' | 4E | Motoberij | C | - | | 2 | | | 0.7 | 12/6/91 | 1.82 | 12.1 | 3.5 | 8,429 | 1.31 | | | | | | | MR8' | 17/6/91 | | |
| 21 | 25 | MR9 | 4F | Motoberij | C | -18.68 | | 2 | | | 0.8 | 2/6/91 | 5.45 | 12.0 | 3.5 | 25,154 | 3.41 | | | 3.00 | -21.68 | | | MR9 | 17/6/91 | | |
| 22 | 33 | - | 5E | Bisheh kola | D | - | 40 | 4 | | 60-1500 | | 3/6/91 | 11.11 | 20.0 | 12.0 | 292,800 | | | | | | 700 | 17.5 | - | - | | |
| 23 | - | BK1 | 5E | Bisheh kola | D | -22.68 | 13 | | | | 0.7 | 10/6/91 | 2.26 | 20.0 | 3.5 | 17,389 | 2.69 | | | 6.32 | -29.00 | 980 | 18.1 | BK1 | 18/6/91 | 4.39 | - |
| 24 | 125 | BK2 | 5E | Bisheh kola | D | -21.62 | | 2 | | | 0.5 | 3/6/91 | 6.67 | 7.0 | 3.5 | 17,934 | 3.89 | 5.00 | -26.62 | 7.17 | -28.79 | | | BK2 | 18/6/91 | | |
| 25 | 140 | BK3 | 5E | Bisheh kola | D | -21.25 | | | | | | 3/6/91 | | | | | | 3.31 | -24.56 | | | | | BK3 | 18/6/91 | 3.82 | - |
| 26 | 155 | BK4 | 5E | Bisheh kola | D | -19.97 | | 3 | 709 | 4-400 | | 3/6/91 | 2.68 | 20.0 | 3.5 | 20,588 | | | | 4.00 | -23.97 | | | BK4 | 18/6/91 | | |
| 27 | - | BK5 | 5E | Bisheh kola | D | -20.65 | | 3 | | | | 3/6/91 | 3.53 | 20.0 | 3.5 | 27,127 | | | | 6.56 | -27.21 | | | BK5 | 18/6/91 | | |
| 28 | - | BK6 | 5E | Bisheh kola | D | -20.54 | | | | 8.5-2400 | 8.0 | 3/6/91 | 4.92 | 20.0 | 3.5 | 37,800 | 0.51 | | | 7.35 | -27.89 | | | BK6 | 18/6/91 | | |
| 29 | - | EZ1 | 5E | Ezzatabad | E | -22.13 | | | | | | 10/6/91 | | | | | | 3.28 | -25.41 | | | | | EZ1 | 18/6/91 | | |
| 30 | - | EZ2 | 5E | Ezzatabad | E | -22.34 | | | | | | 10/6/91 | 3.62 | 11.0 | 3.5 | 15,298 | | | | 4.18 | -26.52 | | | EZ2 | 18/6/91 | | |
| 31 | - | EZ3 | 5E | Ezzatabad | E | -23.13 | | 2 | 550 | 2.6-3600 | 0.7 | 10/6/91 | 4.86 | 20.0 | 3.5 | 37,371 | 5.79 | | | 3.16 | -26.29 | | | EZ3 | 18/6/91 | 3.09 | - |
| 32 | - | EZ3' | 5E | Ezzatabad | E | - | | 3 | | 4.5-750 | | - | | | | | | | | | | | | EZ3' | 18/6/91 | | |
| 33 | - | EZ4 | 5E | Ezzatabad | E | -22.78 | | | | | | 10/6/91 | | | | | | 2.18 | -24.96 | | | | | EZ4 | 18/6/91 | | |
| 34 | - | EZ5 | 5E | Ezzatabad | E | -21.70 | | 3 | | 4.5-750 | 2.0 | 10/6/91 | 4.02 | 24.0 | 3.5 | 37,091 | 2.01 | | | 4.09 | -25.79 | | | EZ5 | 18/6/91 | | |
| 35 | - | EZ6 | 5E | Ezzatabad | E | -22.24 | | | | | | 10/6/91 | | | | | | 2.62 | -24.86 | | | | | EZ6 | 18/6/91 | | |
| 36 | - | EZ6' | 5E | Ezzatabad | E | - | | | | | | - | | | | | | 2.62 | - | | | | | EZ6' | 18/6/91 | | |
| 37 | 78 | EZ7 | 5E | Ezzatabad | E | -21.86 | | | | | | 10/6/91 | | | | | | 2.84 | -24.70 | | | | | EZ7 | 18/6/91 | | |
| 38 | 79 | EZ8 | 5E | Ezzatabad | E | -21.93 | | 2 | 550 | 2.6-3600 | 2.0 | 10/6/91 | 4.29 | 13.0 | 3.5 | 21,411 | 1.16 | | | 4.18 | -26.11 | | | EZ8 | 18/6/91 | | |
| 39 | - | DA1 | 6E | Darvisabad | F | -22.40 | | | | | | 10/6/91 | | | | | | 1.83 | -24.23 | | | | | DA1 | 24/6/91 | 1.93 | - |
| 40 | - | DA2 | 6E | Darvisabad | F | -22.00 | | 3 | | 4.5-750 | 2.0 | 10/6/91 | 6.00 | 13.0 | 3.5 | 29,975 | 1.63 | | | 3.82 | -25.82 | | | DA2 | 24/6/91 | | |
| 41 | - | HK1 | 6E | Haji kola | F | -21.38 | | | | | 0.5 | 10/6/91 | 1.83 | 20.0 | 3.5 | 14,043 | 3.05 | | | 5.60 | -26.98 | | | HK1 | 24/6/91 | | |
| 42 | - | HK2 | 6E | Haji kola | F | -21.05 | | | 550 | 2.6-3600 | 0.5 | 10/6/91 | 2.19 | 13.0 | 3.5 | 10,948 | 2.37 | | | | | | | HK2 | 24/6/91 | 3.51 | - |
| 43 | - | HK2' | 6E | Haji kola | F | - | | | | | | - | | | | | | | | | | | | HK2' | 24/6/91 | 3.21 | |
| 44 | - | HK3 | 6E | Haji kola | F | -20.11 | | | | | | 10/6/91 | | | | | | 4.46 | -24.57 | | | | | HK3 | 24/6/91 | 4.13 | - |
| 45 | - | HK4 | 6E | Haji kola | F | -20.78 | | | | | | 10/6/91 | | | | | | | | 3.54 | -24.32 | | | HK4 | 24/6/91 | 3.58 | - |
| 46 | - | CH1 | 6E | Chaksar | G | -21.99 | | | | | | 11/6/91 | | | | | | 0.77 | -22.76 | | | 950-14 | 17.9 | CH1 | 24/6/91 | 0.77 | - |
| 47 | - | CH2 | 6E | Chaksar | G | -22.18 | | | | | | 11/6/91 | | | | | | 1.55 | -23.73 | | | 750 | 17.1 | CH2 | 24/6/91 | 1.74 | - |
| 48 | - | CH3 | 6E | Chaksar | G | -22.14 | | | | | | 11/6/91 | | | | | | 1.15 | -23.29 | | | | | CH3 | 24/6/91 | 1.48 | - |
| 49 | - | CH4 | 6E | Chaksar | G | -22.07 | | | | | | 11/6/91 | | | | | | 1.20 | -23.27 | | | 570 | 16.0 | CH4 | 24/6/91 | 1.74 | - |
| 50 | - | CH5 | 6E | Chaksar | G | -20.74 | | 2 | | | | 11/6/91 | | | | | | 2.42 | -23.16 | | | 760 | 17.6 | CH5 | 24/6/91 | 1.76 | - |
| 51 | - | CH6 | 6E | Chaksar | G | -20.81 | | 3 | | | 1.5 | 11/6/91 | 10.87 | 4.5 | 3.5 | 18,797 | 1.36 | 2.42 | -23.23 | | | | | CH6 | 24/6/91 | 1.93 | - |
| 52 | - | FK1 | 8D | Fereydun Kenar | H | -22.78 | | 2 | | 4.5-750 | 0.2 | 9/6/91 | 2.00 | 7.5 | 3.5 | 5,761 | 3.12 | | | 3.34 | -26.12 | | | FK1 | 24/6/91 | | |
| 53 | - | FK2 | 8D | Fereydun Kenar | H | -22.81 | | 2 | 550 | 2.6-3600 | 0.1 | 9/6/91 | 2.78 | 13.0 | 3.5 | 13,865 | 12.53 | 2.50 | -25.31 | 3.75 | -26.56 | | | FK2 | 24/6/91 | | |
| 54 | - | FK3 | 8D | Fereydun Kenar | H | -22.70 | | | | | 1.5 | 9/6/91 | 5.96 | 13.0 | 3.5 | 29,797 | 2.15 | 2.20 | -24.90 | 3.25 | -25.95 | | | FK3 | 24/6/91 | | |
| 55 | - | FK3" | 8D | Fereydun Kenar | H | - | | 2 | | 4.5-750 | 0.3 | 9/6/91 | 3.16 | 6.5 | 3.5 | 7,888 | 2.85 | | | | | | | FK3" | 24/6/91 | | |
| 56 | - | FK3' | 8D | Fereydun Kenar | H | - | | | | | | 9/6/91 | | | | | | 1.70 | - | | | | | FK3' | 24/6/91 | | |
| 57 | - | FK4 | 8D | Fereydun Kenar | H | -21.41 | | 2 | | 4.5-750 | 0.6 | 9/6/91 | 2.93 | 20.0 | 3.5 | 22,518 | 4.07 | | | 5.29 | -26.70 | 1470 | 18.0 | FK4 | 24/6/91 | 3.34 | - |
| 58 | - | US1 | 9D | Ujaksar | I | -23.59 | | | | | 1.0 | 9/6/91 | 6.22 | 5.0 | 3.5 | 11,960 | 1.30 | 0.70 | -24.29 | 1.28 | -24.87 | | | US1 | 24/6/91 | | |
| 59 | - | US2 | 9D | Ujaksar | I | -22.35 | | 3 | | 4.5-750 | 0.9 | 9/6/91 | 4.55 | 8.0 | 3.5 | 13,975 | 1.68 | 2.00 | -24.35 | 2.50 | -24.85 | | | US2 | 24/6/91 | | |
| 60 | - | US3 | 9D | Ujaksar | I | -21.43 | | | | | 2.0 | 9/6/91 | 5.31 | 6.0 | 3.5 | 12,238 | 0.66 | 1.50 | -22.93 | 3.75 | -25.18 | | | US3 | 24/6/91 | | |
| 61 | - | US4 | 9D | Ujaksar | I | -22.04 | | 2 | | | 0.3 | 9/6/91 | 1.30 | 6.0 | 3.5 | 3,008 | 1.09 | 1.70 | -23.74 | 3.75 | -25.79 | | | US4 | 24/6/91 | | |
| 62 | - | US5 | 9D | Ujaksar | I | -21.21 | 25-35 | | | | | 9/6/91 | | | | | | 2.64 | -23.85 | | | 2800 | 17.8 | US5 | 24/6/91 | 2.69 | - |

Table A.3.9(1) Result of Well Observation - for Groundwater Runoff and Utilization-

| OBSERVED DATE (1) | PUMPING RATE (l/sec) | PUMPING HOUR (h/DAY) | PUMPING PERIOD (month) | TOTAL QUAN OF PUMPING (m3 [illegible]) | RATE OF PUMPING (l/ha/s) | S.W.L -GL TO WL- (GL m) | S.W.L -GL TO WL- (EL. m) | D.W.L. -GL TO WL- (GL m) | D.W.L. -GL TO WL- (EL. m) | EC (uS) | T (°C) | WELL NO. OF LEVELING | OBSERVED DATE (2) | S.W.L -GL TO WL- (GL m) | S.W.L -GL TO WL- (EL. m) | D.W.L. -GL TO WL- (GL m) | D.W.L. -GL TO WL- (EL. m) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/6/91 | 2.00 | 24.0 | 3.5 | 18,446 | 1.33 | 0.70 | -22.41 | 3.66 | -25.37 | 730 | 16.9 | HD1 | 17/6/91 | | | 4.66 | -26.37 | Pumping quantity is not enough for 1.5 ha irrigation field. |
| 1/6/91 | 4.00 | 24.0 | 3.5 | 36,893 | | 0.70 | -22.19 | 3.59 | -25.08 | | | HD2 | 17/6/91 | | | 4.00 | -25.49 | |
| 1/6/91 | 2.00 | 24.0 | 3.5 | 18,446 | | | | 5.15 | -26.83 | | | HD3 | 17/6/91 | 2.28 | -23.96 | | | |
| 1/6/91 | 4.00 | 24.0 | 3.5 | 36,893 | | 0.70 | -21.41 | 7.20 | -27.91 | 595 | 16.3 | HD4 | 17/6/91 | | | 7.66 | -28.37 | |
| 12/6/91 | 2.34 | 12.0 | 3.5 | 10,800 | 11.71 | | | 6.00 | -26.33 | | | HD5 | 17/6/91 | 2.82 | -23.15 | | | The well is located at the nothern part of Haradeh Buzorg. |
| 2/6/91 | 2.63 | 24.0 | 3.5 | 24,272 | 1.75 | | | 6.57 | -27.10 | | | HD6 | 17/6/91 | | | 7.16 | -27.69 | S.W.L. has been measured around here. |
| 2/6/91 | | | | | | 0.86 | -21.75 | | | | | HD7 | 17/6/91 | 2.84 | -23.73 | | | Pump has not been installed yet |
| 2/6/91 | 2.73 | 24.0 | 3.5 | 25,154 | 1.82 | | | 3.05 | -23.08 | | | HD8 | 17/6/91 | | | 5.84 | -25.87 | |
| 2/6/91 | 12.00 | 24.0 | 3.5 | 110,678 | 4.00 | | | 6.22 | -25.33 | | | HD9 | 17/6/91 | | | 6.35 | -25.46 | The well shows the highest productivety in the surrounding area. |
| 1/6/91 | | | | | | 3.00 | - | 23.00 | - | | | - | 17/6/91 | | | | | The well has been installed 4 inch borehole pump. |
| 12/6/91 | | | | | | 0.98 | -22.60 | | | | | MR1 | 17/6/91 | 1.11 | -22.73 | | | The pump has not been installed since the deep well is available close. |
| 1/6/91 | | | | | | 0.91 | -22.21 | | | | | MR2 | 19/6/91 | | | 5.10 | -26.40 | |
| 1/6/91 | | | | | | 0.85 | - | | | 620 | 16.8 | MR3 | 18/6/91 | 1.22 | -1.22 | | | |
| 12/6/91 | | | | | | 1.19 | -21.82 | | | | | MR4 | 17/6/91 | | | 2.91 | -23.54 | The pump has not been installed but the new well has been made beside it. |
| 17/6/91 | 3.69 | 20 | 3.5 | 28,397 | 0.88 | | | | | | | MR4' | 17/6/91 | | | 6.95 | - | The new well had been constructed at 17/6/'91 |
| 2/6/91 | 6.70 | 24.0 | 3.5 | 61,795 | 4.47 | 2.87 | -23.79 | | | | | MR5 | 17/6/91 | | | 7.66 | -28.58 | Irrigation area is of totally 3 ha for both MR6 and MR5 wells. |
| 2/6/91 | 3.33 | 24.0 | 3.5 | 30,744 | 2.22 | | | 7.39 | -28.94 | | | MR6 | 17/6/91 | | | 7.62 | -29.17 | Irrigation area is of totally 3 ha for both MR6 and MR5 wells. |
| 12/6/91 | | | | | | 4.78 | -25.41 | | | | | MR7 | 17/6/91 | | | 7.43 | -28.06 | The well had been re-drilled at 12/6/'91 for well restoration. |
| 12/6/91 | 4.07 | 20.0 | 3.5 | 31,286 | 2.83 | | | 6.78 | -27.37 | | | MR8 | 17/6/91 | | | 7.79 | -28.38 | Percolation test site, and pumping for 2 ha togather with MR8'. |
| 12/6/91 | 1.82 | 12.1 | 3.5 | 8,429 | 1.31 | | | | | | | MR8' | 17/6/91 | | | 6.57 | | Percolation test site, and pumping for 2 ha togather with MR8. |
| 2/6/91 | 5.45 | 12.0 | 3.5 | 25,154 | 3.41 | | | 3.00 | -21.68 | | | MR9 | 17/6/91 | | | 4.14 | -22.82 | |
| 3/6/91 | 11.11 | 20.0 | 12.0 | 292,800 | | | | | | 700 | 17.5 | - | - | | | | | Deep well and it is located about 500 m close to the sea. |
| 10/6/91 | 2.26 | 20.0 | 3.5 | 17,389 | 2.69 | | | 6.32 | -29.00 | 980 | 18.1 | BK1 | 18/6/91 | 4.39 | -27.07 | | | The well is close to the Marine Camp and the sea |
| 3/6/91 | 6.67 | 7.0 | 3.5 | 17,934 | 3.89 | 5.00 | -26.62 | 7.17 | -28.79 | | | BK2 | 18/6/91 | | | 6.86 | -28.48 | The well shows the pumping must be stopped after 7 h continuously. |
| 3/6/91 | | | | | | 3.31 | -24.56 | | | | | BK3 | 18/6/91 | 3.82 | -25.07 | | | The pump has not installed, the water is inflowing from shallow horizon. |
| 3/6/91 | 2.68 | 20.0 | 3.5 | 20,588 | | | | 4.00 | -23.97 | | | BK4 | 18/6/91 | | | 4.62 | -24.59 | The pumping has done for 8 ha togather with BK5,6. |
| 3/6/91 | 3.53 | 20.0 | 3.5 | 27,127 | | | | 6.56 | -27.21 | | | BK5 | 18/6/91 | | | 6.33 | -26.98 | The pumping has done for 8 ha togather with BK4,6. |
| 3/6/91 | 4.92 | 20.0 | 3.5 | 37,800 | 0.51 | | | 7.35 | -27.89 | | | BK6 | 18/6/91 | | | 6.56 | -27.10 | The pumping has done for 8 ha togather with BK4,5. |
| 10/6/91 | | | | | | 3.28 | -25.41 | | | | | EZ1 | 18/6/91 | | | 3.93 | -26.06 | The pump has not been installed. |
| 10/6/91 | 3.62 | 11.0 | 3.5 | 15,298 | | | | 4.18 | -26.52 | | | EZ2 | 18/6/91 | | | 4.94 | -27.28 | Well location is close to EZ1 |
| 10/6/91 | 4.86 | 20.0 | 3.5 | 37,371 | 5.79 | | | 3.16 | -26.29 | | | EZ3 | 18/6/91 | 3.09 | -26.22 | | | Well location is close to EZ4 |
| - | | | | | | | | | | | | EZ3' | 18/6/91 | | | 4.40 | - | |
| 10/6/91 | | | | | | 2.18 | -24.96 | | | | | EZ4 | 18/6/91 | | | 3.82 | -26.60 | The pump has not installed yet. |
| 10/6/91 | 4.02 | 24.0 | 3.5 | 37,091 | 2.01 | | | 4.09 | -25.79 | | | EZ5 | 18/6/91 | | | 4.97 | -26.67 | The location is about 74 metres apart from EZ6. |
| 10/6/91 | | | | | | 2.62 | -24.86 | | | | | EZ6 | 18/6/91 | | | 3.39 | -25.63 | The pump installation is temporary, it is located 25 m from EB6. |
| - | | | | | | 2.62 | - | | | | | EZ6' | 18/6/91 | | | 3.67 | - | The pump installation is temporary, it is located 9 m from EB5. |
| 10/6/91 | | | | | | 2.84 | -24.70 | | | | | EZ7 | 18/6/91 | | | 4.32 | -26.18 | The pump has not installed yet, it is close to EZ7. |
| 10/6/91 | 4.29 | 13.0 | 3.5 | 21,411 | 1.16 | | | 4.18 | -26.11 | | | EZ8 | 18/6/91 | | | 5.00 | -26.93 | |
| 10/6/91 | | | | | | 1.83 | -24.23 | | | | | DA1 | 24/6/91 | 1.93 | -24.33 | | | The well is not for agricultural use. |
| 10/6/91 | 6.00 | 13.0 | 3.5 | 29,976 | 1.63 | | | 3.82 | -25.82 | | | DA2 | 24/6/91 | | | 3.76 | -25.76 | |
| 10/6/91 | 1.83 | 20.0 | 3.5 | 14,043 | 3.05 | | | 5.60 | -26.98 | | | HK1 | 24/6/91 | | | 6.30 | -27.68 | The well is situated in the Hajikola village |
| 10/6/91 | 2.19 | 13.0 | 3.5 | 10,948 | 2.37 | | | | | | | HK2 | 24/6/91 | 3.51 | -24.56 | | | The pumping must be stopping after 3h running, percolation site is close. |
| - | | | | | | | | | | | | HK2' | 24/6/91 | 3.21 | | | | The pumping must be stopping after 3h running, percolation site is close. |
| 10/6/91 | | | | | | 4.46 | -24.57 | | | | | HK3 | 24/6/91 | 4.13 | -24.24 | | | The well is for industrial use in village |
| 10/6/91 | | | | | | | | 3.54 | -24.32 | | | HK4 | 24/6/91 | 3.58 | -24.36 | | | Electric motor has been installed. |
| 11/6/91 | | | | | | 0.77 | -22.76 | | | 950-14 | 17.9 | CH1 | 24/6/91 | 0.77 | -22.76 | | | The pump has not installed for the surface water inflowing. |
| 11/6/91 | | | | | | 1.55 | -23.73 | | | 750 | 17.1 | CH2 | 24/6/91 | 1.74 | -23.92 | | | The pump has not installed for the surface water inflowing. |
| 11/6/91 | | | | | | 1.15 | -23.29 | | | | | CH3 | 24/6/91 | 1.48 | -23.62 | | | The pump has not installed for the surface water inflowing. |
| 11/6/91 | | | | | | 1.20 | -23.27 | | | 570 | 16.0 | CH4 | 24/6/91 | 1.74 | -23.81 | | | The pump has not installed for the surface water inflowing. |
| 11/6/91 | | | | | | 2.42 | -23.16 | | | 760 | 17.6 | CH5 | 24/6/91 | 1.76 | -22.50 | | | Well locality is close to CH6 |
| 11/6/91 | 10.87 | 4.5 | 3.5 | 18,797 | 1.36 | 2.42 | -23.23 | | | | | CH6 | 24/6/91 | 1.93 | -22.74 | | | Well locality is close to CH5, it shows the high productivety. |
| 9/6/91 | 2.00 | 7.5 | 3.5 | 5,761 | 3.12 | | | 3.34 | -26.12 | | | FK1 | 24/6/91 | | | 3.62 | -26.40 | FK2 is close. |
| 9/6/91 | 2.78 | 13.0 | 3.5 | 13,865 | 12.53 | 2.50 | -25.31 | 3.75 | -26.56 | | | FK2 | 24/6/91 | | | 3.43 | -26.24 | FK1 is close. |
| 9/6/91 | 5.96 | 13.0 | 3.5 | 29,797 | 2.15 | 2.20 | -24.90 | 3.25 | -25.95 | | | FK3 | 24/6/91 | | | 3.65 | -26.35 | FK3" is located close, the BH(KL-9-1BM-5) is situated beside this well. |
| 9/6/91 | 3.16 | 6.5 | 3.5 | 7,888 | 2.85 | | | | | | | FK3" | 24/6/91 | | | | | FK3 is located close. |
| 9/6/91 | | | | | | 1.70 | - | | | | | FK3' | 24/6/91 | | | 3.83 | - | FK3 is located close. |
| 9/6/91 | 2.93 | 20.0 | 3.5 | 22,518 | 4.07 | | | 5.29 | -26.70 | 1470 | 18.0 | FK4 | 24/6/91 | 3.34 | -24.75 | | | Well diametre shows the larger than 2 metres. |
| 9/6/91 | 6.22 | 5.0 | 3.5 | 11,960 | 1.30 | 0.70 | -24.29 | 1.28 | -24.87 | | | US1 | 24/6/91 | | | 1.62 | -25.21 | The well diametre is about 5 x 60 m. |
| 9/6/91 | 4.55 | 8.0 | 3.5 | 13,976 | 1.68 | 2.00 | -24.35 | 2.50 | -24.85 | | | US2 | 24/6/91 | | | 3.30 | -25.65 | The well diametre is about 5 x 20 m. |
| 9/6/91 | 5.31 | 6.0 | 3.5 | 12,238 | 0.66 | 1.50 | -22.93 | 3.75 | -25.18 | | | US3 | 24/6/91 | | | 2.70 | -24.13 | The well diametre is about 5 x 10 m. |
| 9/6/91 | 1.30 | 6.0 | 3.5 | 3,008 | 1.09 | 1.70 | -23.74 | 3.75 | -25.79 | | | US4 | 24/6/91 | | | 3.93 | -25.97 | The pumping must be stopping after 6 h running. |
| 9/6/91 | | | | | | 2.64 | -23.85 | | | 2800 | 17.8 | US5 | 24/6/91 | 2.69 | -23.90 | | | The pump has not been installed for saline water pollution at 25-35m. |

## Table A.3.9(2) Result of Well Observation - for Groundwater Runoff-

| WELL NO. | LINE | DISTANCE FROM SEA (km) | CASING ELEVATION (EL.m) | GROUNDWATER LEVEL 1/6/'91 - 12/6/'91 S.W.L -GL TO WL- (GL m) | S.W.L -GL TO WL- (EL. m) | D.W.L. -GL TO WL- (GL m) | D.W.L. -GL TO WL- (EL. m) | GROUNDWATER LEVEL 17/6/'91 - 24/6/'91 S.W.L -GL TO WL- (GL m) | S.W.L -GL TO WL- (EL. m) | D.W.L. -GL TO WL- (GL m) | D.W.L. -GL TO WL- (EL. m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HD1 | A | 0.538 | -21.71 | 0.70 | -22.41 | 3.66 | -25.37 | | | 4.66 | -26.37 |
| HD2 | A | 0.873 | -21.49 | 0.70 | -22.19 | 3.59 | -25.08 | | | 4.00 | -25.49 |
| HD3 | A | 1.183 | -21.68 | | | 5.15 | -26.83 | 2.28 | -23.96 | | |
| HD4 | A | 1.320 | -20.71 | 0.70 | -21.41 | 7.20 | -27.91 | | | 7.66 | -28.37 |
| HD5 | A | 1.918 | -20.33 | | | 6.00 | -26.33 | 2.82 | -23.15 | | |
| HD6 | B | 1.563 | -20.53 | | | 6.57 | -27.10 | | | 7.16 | -27.69 |
| HD7 | B | 1.600 | -20.89 | 0.86 | -21.75 | | | 2.84 | -23.73 | | |
| HD8 | B | 1.742 | -20.03 | | | 3.05 | -23.08 | | | 5.84 | -25.87 |
| HD9 | B | 1.882 | -19.11 | | | 6.22 | -25.33 | | | 6.35 | -25.46 |
| MR1 | C | 0.552 | -21.62 | 0.98 | -22.60 | | | 1.11 | -22.73 | | |
| MR2 | C | 0.767 | -21.30 | 0.91 | -22.21 | | | | | 5.10 | -26.40 |
| MR4 | C | 1.114 | -20.63 | 1.19 | -21.82 | | | | | 2.91 | -23.54 |
| MR5 | C | 1.074 | -20.92 | 2.87 | -23.79 | | | | | 7.66 | -28.58 |
| MR6 | C | 1.117 | -21.55 | | | 7.39 | -28.94 | | | 7.62 | -29.17 |
| MR7 | C | 1.370 | -20.63 | 4.78 | -25.41 | | | | | 7.43 | -28.06 |
| MR8 | C | 1.409 | -20.59 | | | 6.78 | -27.37 | | | 7.79 | -28.38 |
| MR9 | C | 1.969 | -18.68 | | | 3.00 | -21.68 | | | 4.14 | -22.82 |
| BK1 | D | 0.381 | -22.68 | | | 6.32 | -29.00 | 4.39 | -27.07 | | |
| BK2 | D | 0.868 | -21.62 | 5.00 | -26.62 | 7.17 | -28.79 | | | 6.86 | -28.48 |
| BK3 | D | 1.063 | -21.25 | 3.31 | -24.56 | | | 3.82 | -25.07 | | |
| BK4 | D | 1.316 | -19.97 | | | 4.00 | -23.97 | | | 4.62 | -24.59 |
| BK5 | D | 1.337 | -20.65 | | | 6.56 | -27.21 | | | 6.33 | -26.98 |
| BK6 | D | 1.369 | -20.54 | | | 7.35 | -27.89 | | | 6.56 | -27.10 |
| EZ1 | E | 0.644 | -22.13 | 3.28 | -25.41 | | | | | 3.93 | -26.06 |
| EZ2 | E | 0.645 | -22.34 | | | 4.18 | -26.52 | | | 4.94 | -27.28 |
| EZ3 | E | 0.655 | -23.13 | | | 3.16 | -26.29 | 3.09 | -26.22 | | |
| EZ4 | E | 0.680 | -22.78 | 2.18 | -24.96 | | | | | 3.82 | -26.60 |
| EZ5 | E | 0.930 | -21.70 | | | 4.09 | -25.79 | | | 4.97 | -26.67 |
| EZ6 | E | 0.992 | -22.24 | 2.62 | -24.86 | | | | | 3.39 | -25.63 |
| EZ7 | E | 1.148 | -21.86 | 2.84 | -24.70 | | | | | 4.32 | -26.18 |
| EZ8 | E | 1.194 | -21.93 | | | 4.18 | -26.11 | | | 5.00 | -26.93 |
| DA1 | F | 0.590 | -22.40 | 1.83 | -24.23 | | | 1.93 | -24.33 | | |
| DA2 | F | 1.033 | -22.00 | | | 3.82 | -25.82 | | | 3.76 | -25.76 |
| HK1 | F | 1.439 | -21.38 | | | 5.60 | -26.98 | | | 6.30 | -27.69 |
| HK2 | F | 1.653 | -21.05 | | | | | 3.51 | -24.56 | | |
| HK3 | F | 1.818 | -20.11 | 4.46 | -24.57 | | | 4.13 | -24.24 | | |
| HK4 | F | 1.815 | -20.78 | | | 3.54 | -24.32 | 3.58 | -24.36 | | |
| CH1 | G | 0.840 | -21.99 | 0.77 | -22.76 | | | 0.77 | -22.76 | | |
| CH2 | G | 0.907 | -22.18 | 1.55 | -23.73 | | | 1.74 | -23.92 | | |
| CH3 | G | 1.167 | -22.14 | 1.15 | -23.29 | | | 1.48 | -23.62 | | |
| CH4 | G | 1.690 | -22.07 | 1.20 | -23.27 | | | 1.74 | -23.81 | | |
| CH5 | G | 1.961 | -20.74 | 2.42 | -23.16 | | | 1.76 | -22.50 | | |
| CH6 | G | 1.918 | -20.81 | 2.42 | -23.23 | | | 1.93 | -22.74 | | |
| FK1 | H | 0.716 | -22.78 | | | 3.34 | -26.12 | | | 3.62 | -26.40 |
| FK2 | H | 0.810 | -22.81 | 2.50 | -25.31 | 3.75 | -26.56 | | | 3.43 | -26.24 |
| FK3 | H | 1.296 | -22.70 | 2.20 | -24.90 | 3.25 | -25.95 | | | 3.65 | -26.35 |
| FK4 | H | 1.628 | -21.41 | | | 5.29 | -26.70 | 3.34 | -24.75 | | |
| US1 | I | 1.694 | -23.59 | 0.70 | -24.29 | 1.28 | -24.87 | | | 1.62 | -25.21 |
| US2 | I | 1.998 | -22.35 | 2.00 | -24.35 | 2.50 | -24.85 | | | 3.30 | -25.65 |
| US3 | I | 2.672 | -21.43 | 1.50 | -22.93 | 3.75 | -25.18 | | | 2.70 | -24.13 |
| US4 | I | 2.663 | -22.04 | 1.70 | -23.74 | 3.75 | -25.79 | | | 3.93 | -25.97 |
| US5 | I | 2.538 | -21.21 | 2.64 | -23.85 | | | 2.69 | -23.90 | | |

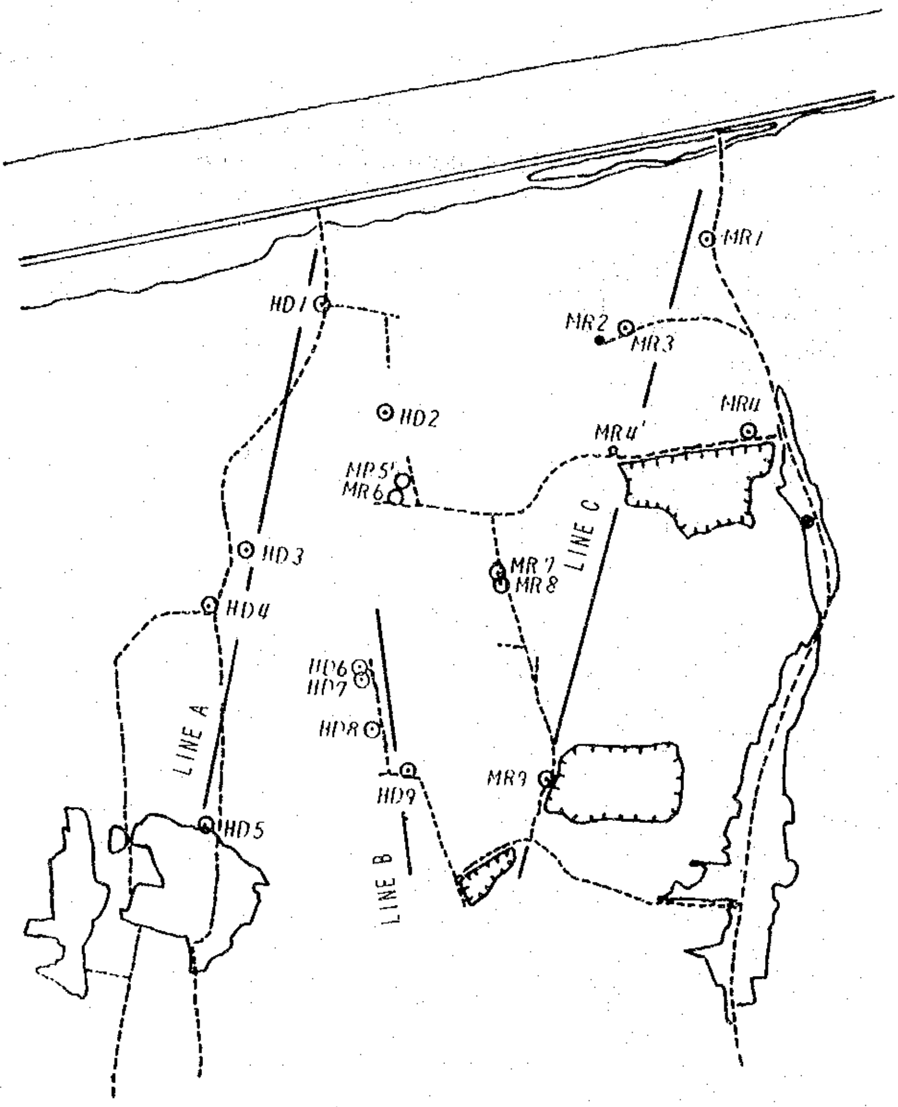



Figure A.3.13(1) Location Map of Observation Well
-Hadadeh/Motobarij Site, Line A,B,C
, Scale=1:20,300-

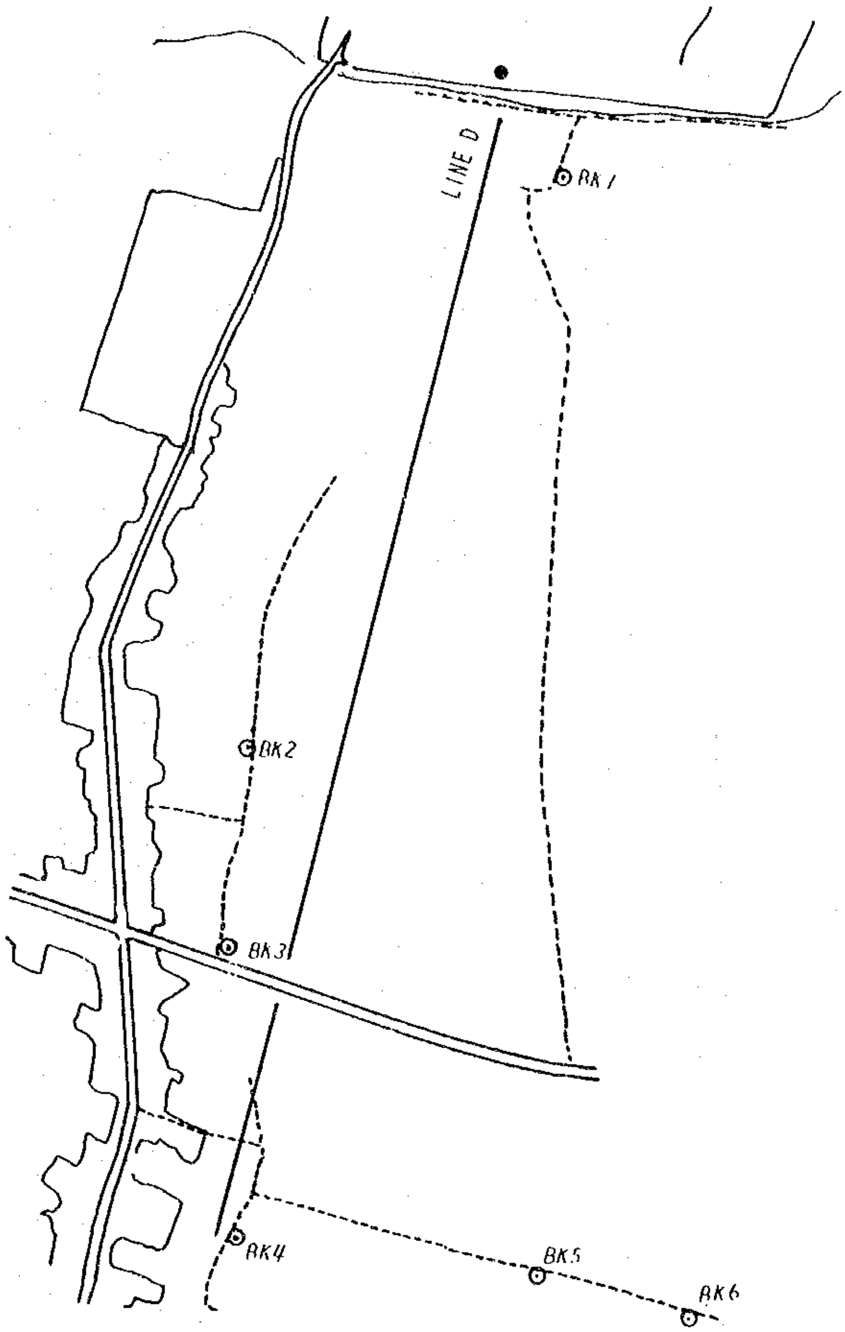



Figure A.3.13(2) Location Map of Observation Well
-Bisheh Kola Site, Line D, Scale=1:6,300-

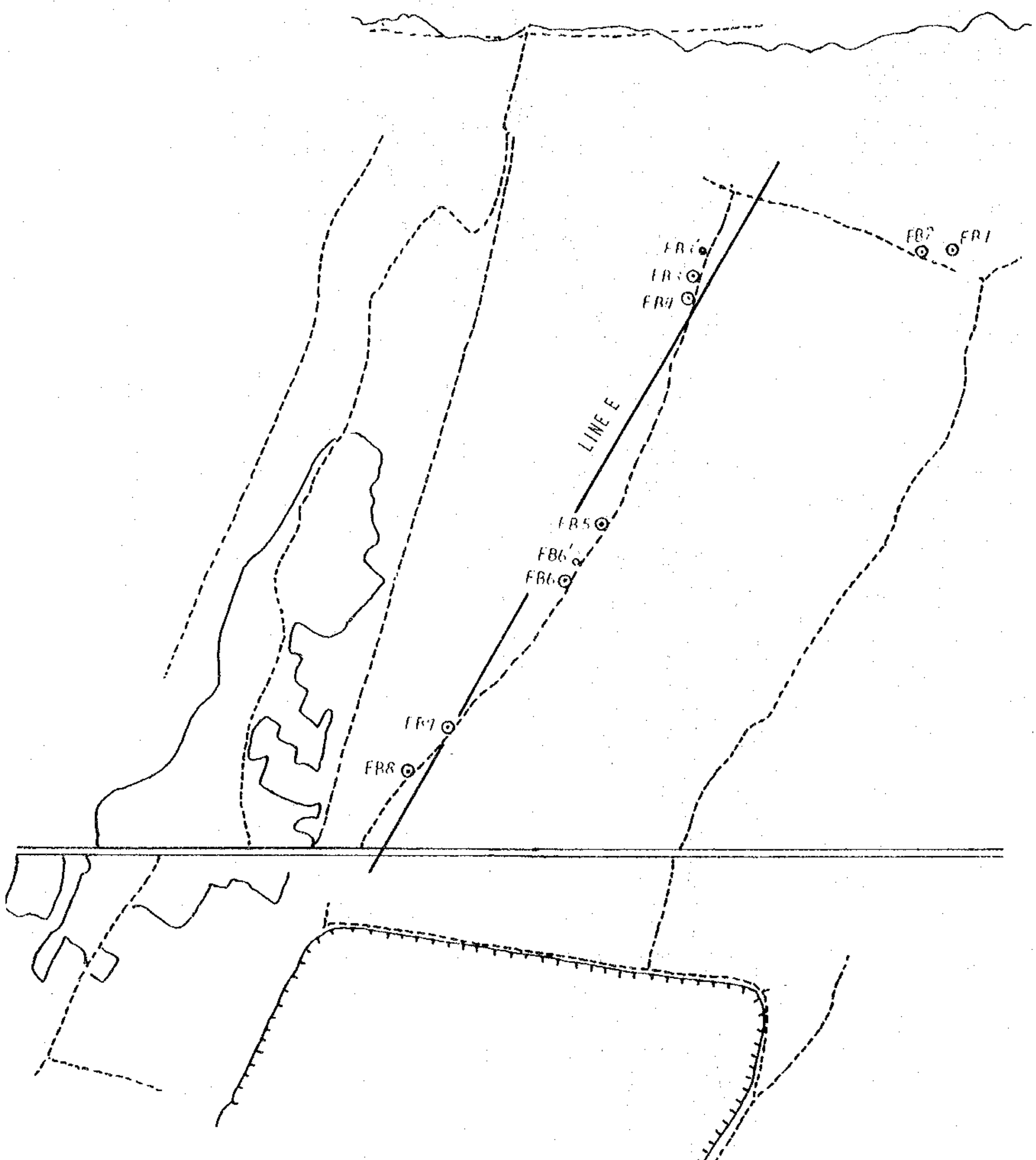



Figure A.3.13(3) Location Map of Observation Well
-Ezzatabad Site, Line E, Scale=1:6,500-

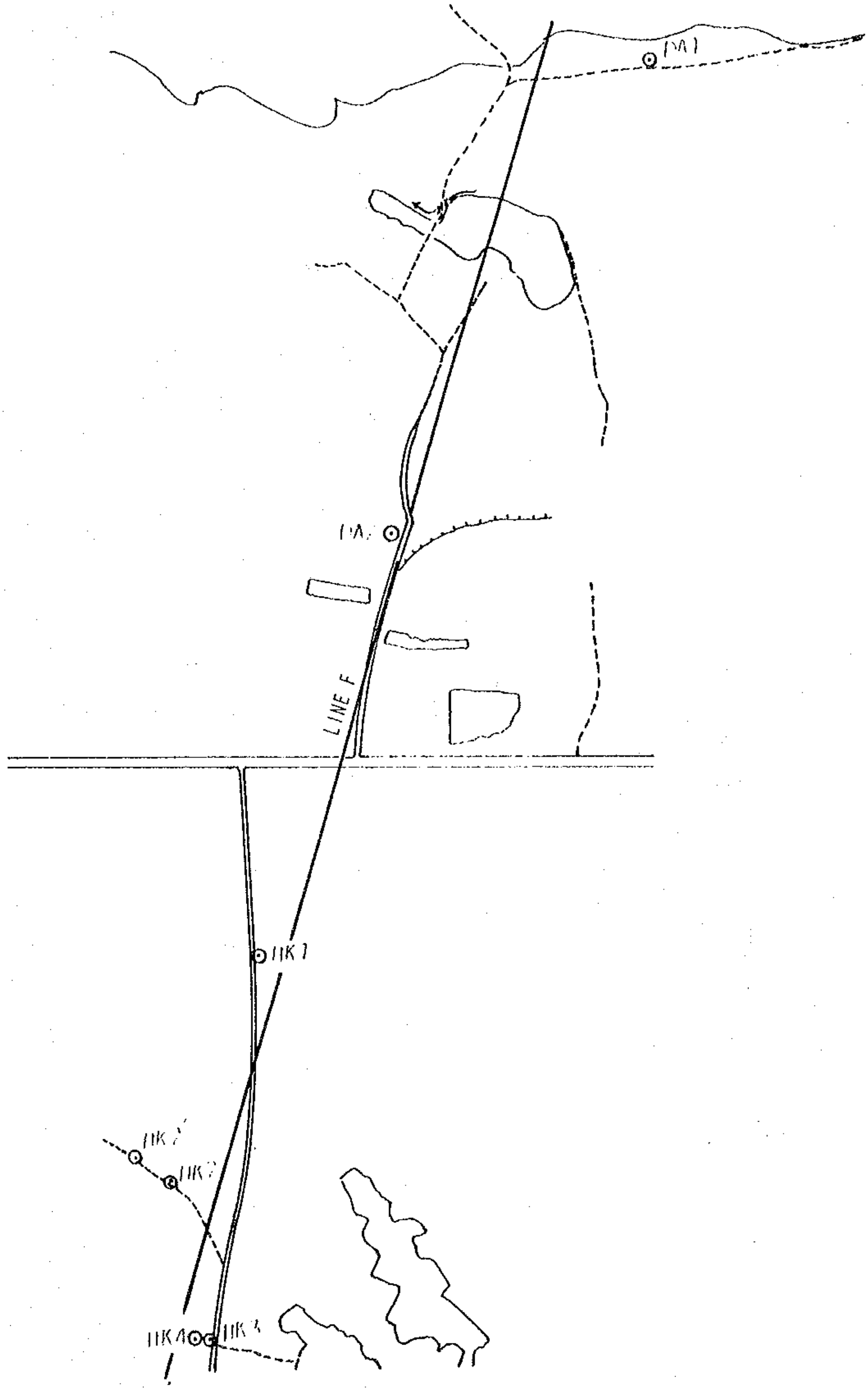



Figure A.3.13(4)  Location Map of Observation Well
-Darubisabad/Haji Kola Site, Line F,Scale=1:6,200-

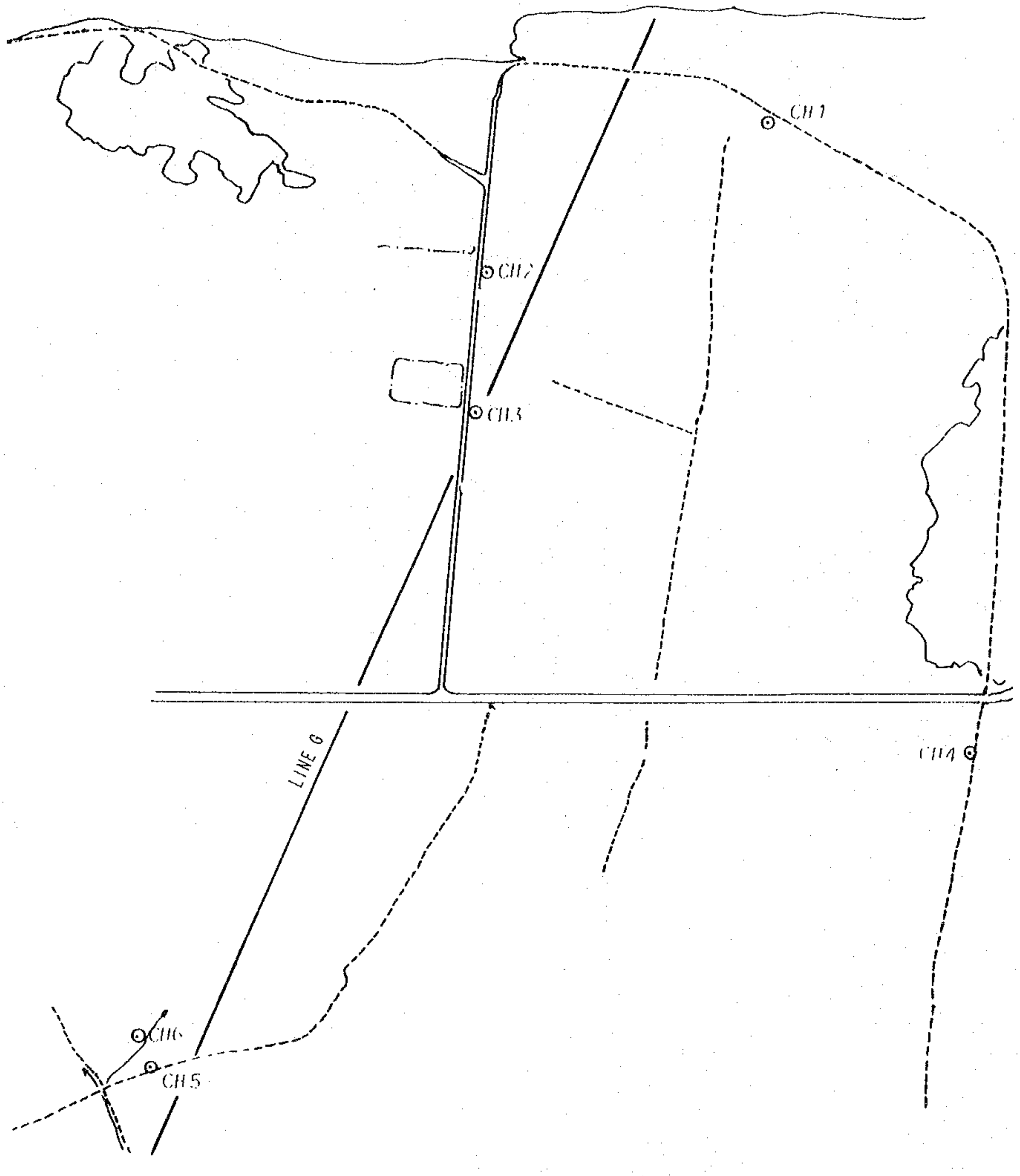



Figure A.3.13(5) Location Map of Observation Well
-Chaksar Site, Line G, Scale=1:7,300-

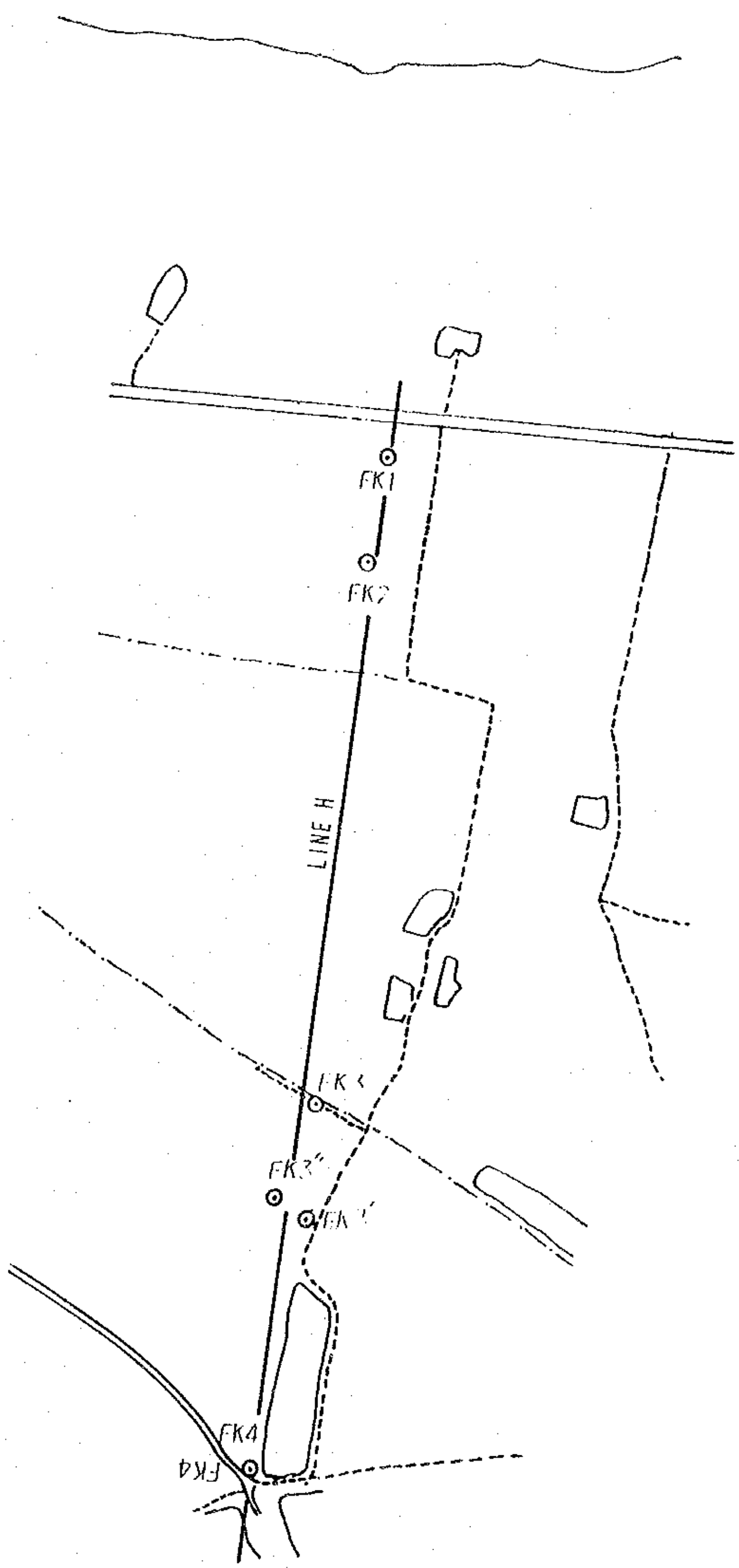



Figure A.3.13(6) Location Map of Observation Well
-Fereydon Kanar Site, Line H, Scale=1:6,400-

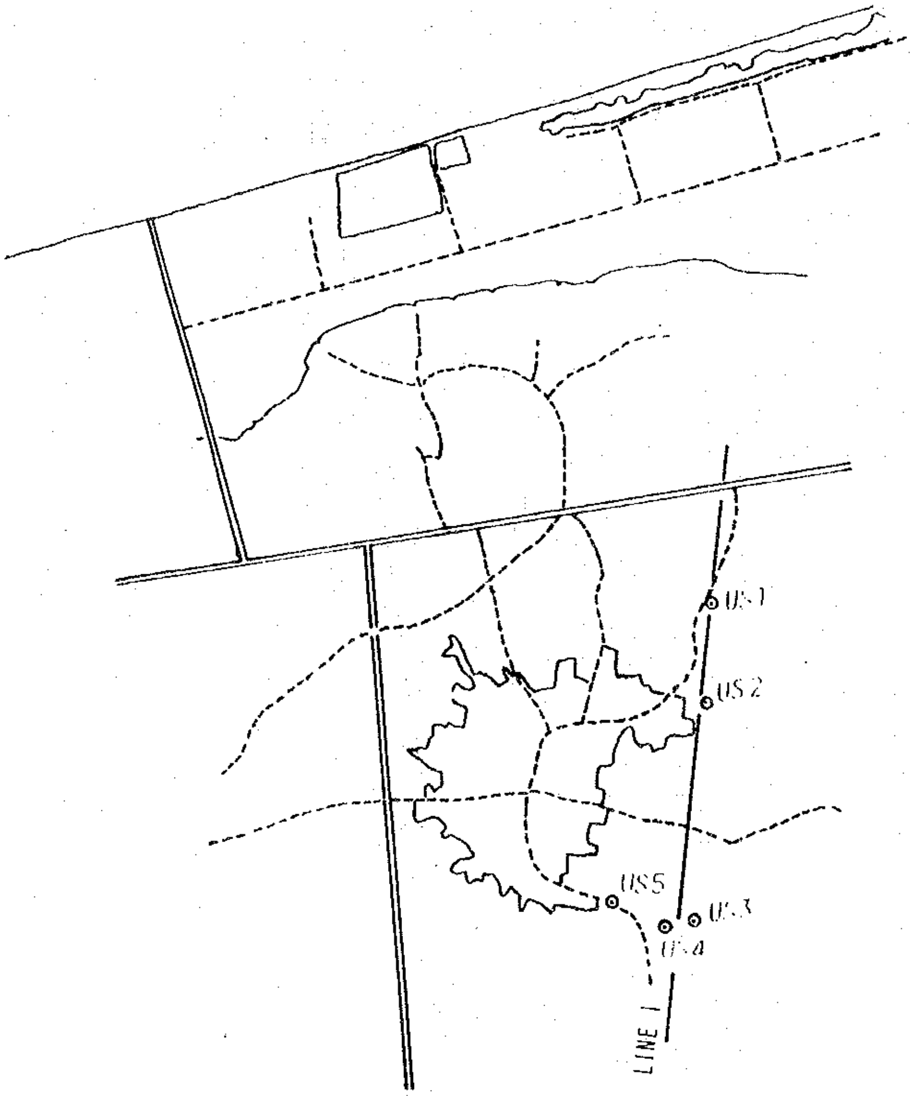
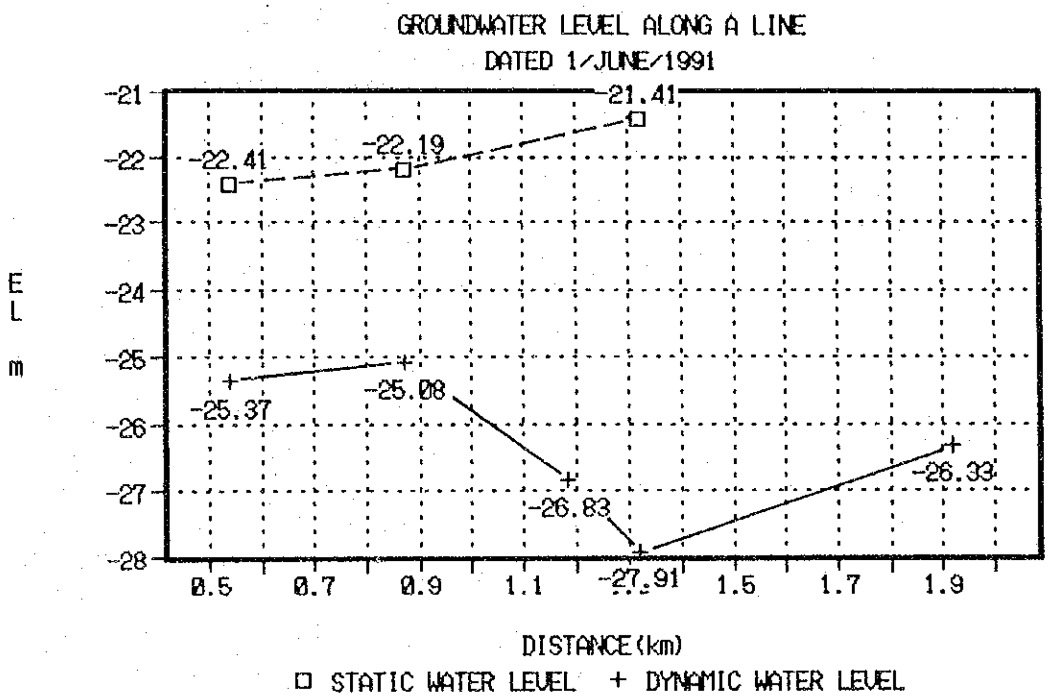



Figure A.3.13(7) Location Map of Observation Well
-Ujaksar Site, Line I, Scale=1:23,500-



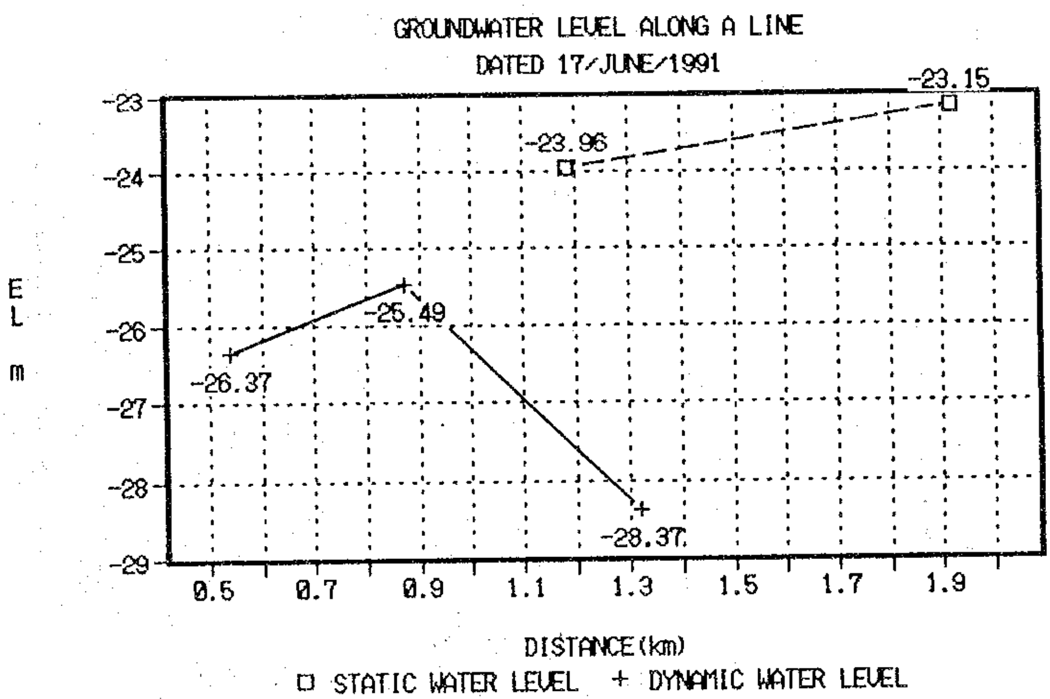
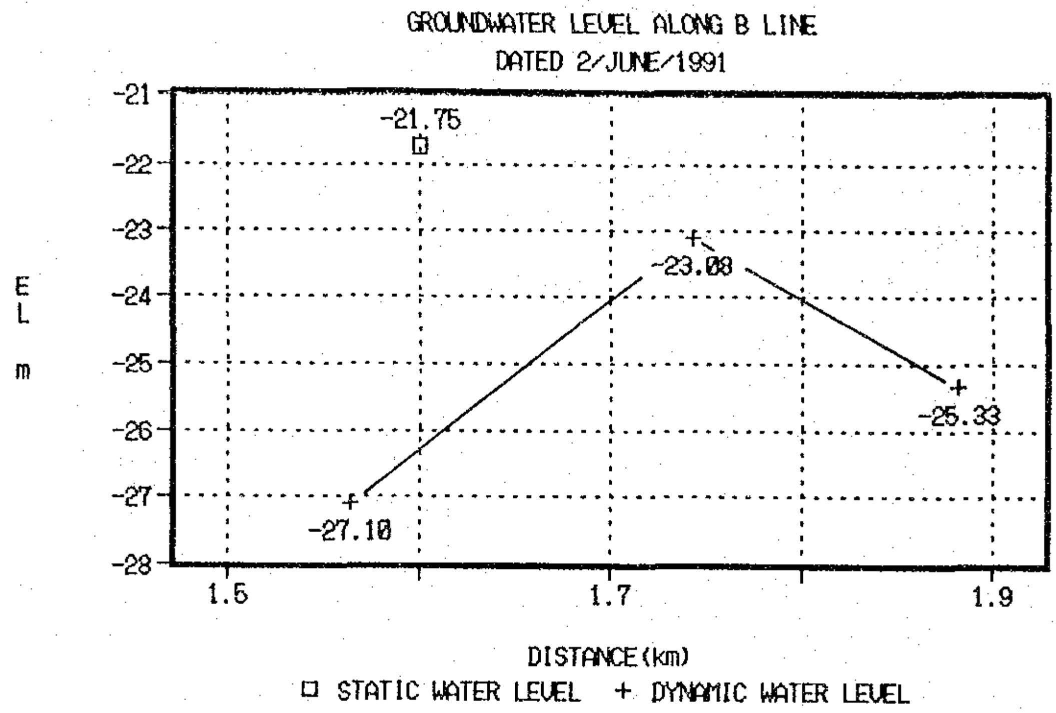




Figure A.3.14(1) Groundwater Level along Observation Line
-Line A-



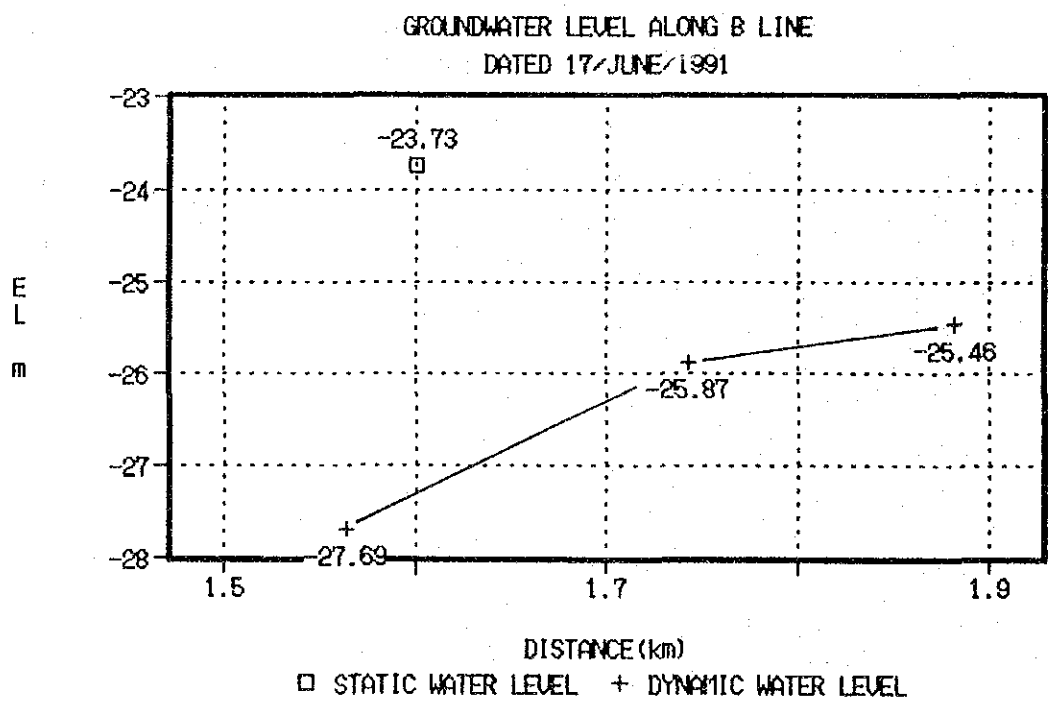
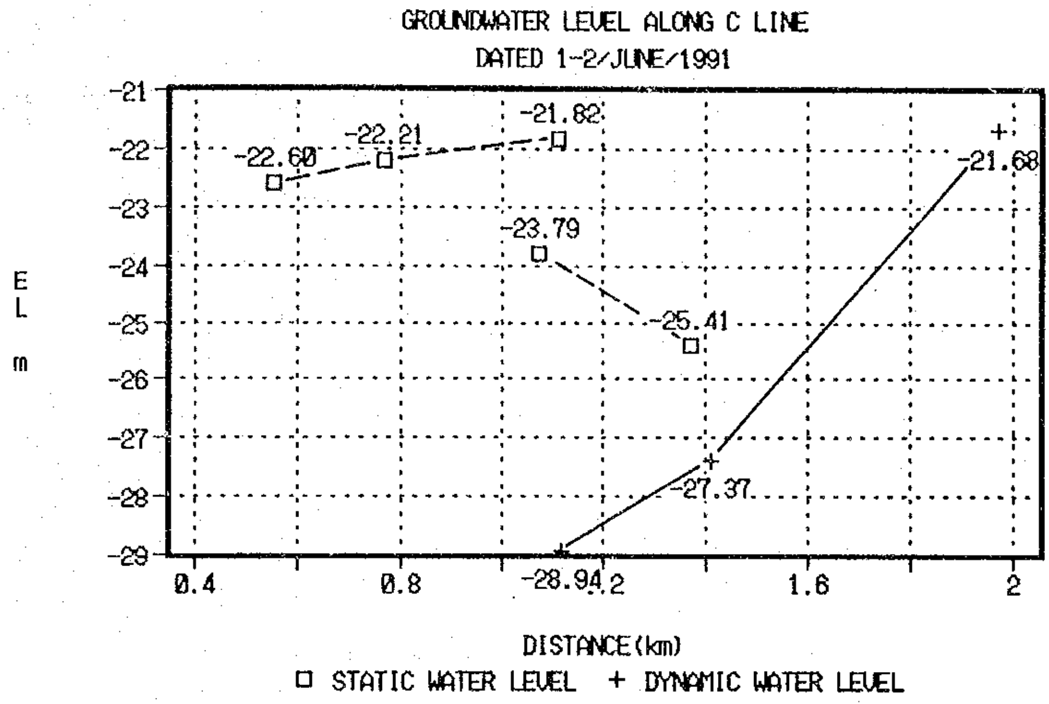




Figure A.3.14(2) Groundwater Level along Observation Line -Line B-



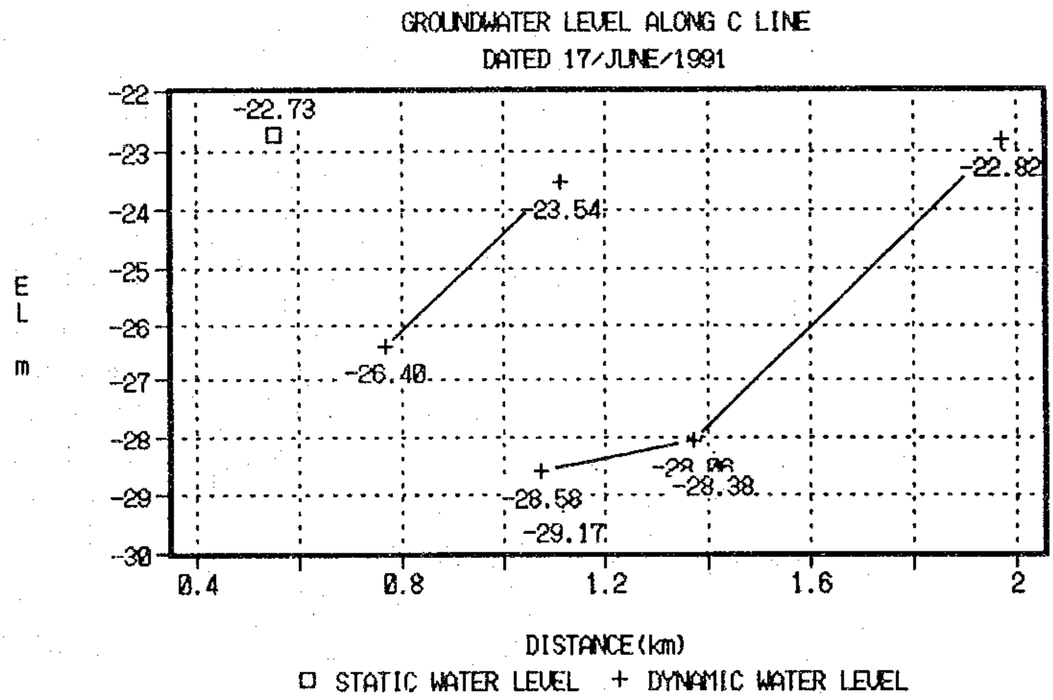
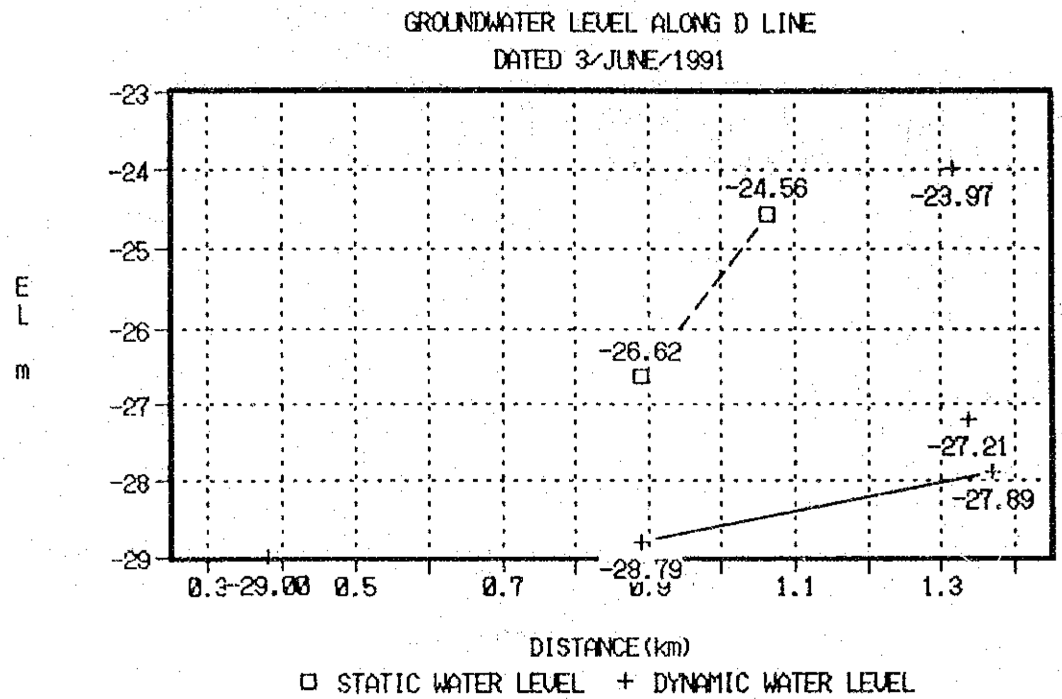




Figure A.3.14(3) Groundwater Level along Observation Line -Line C-



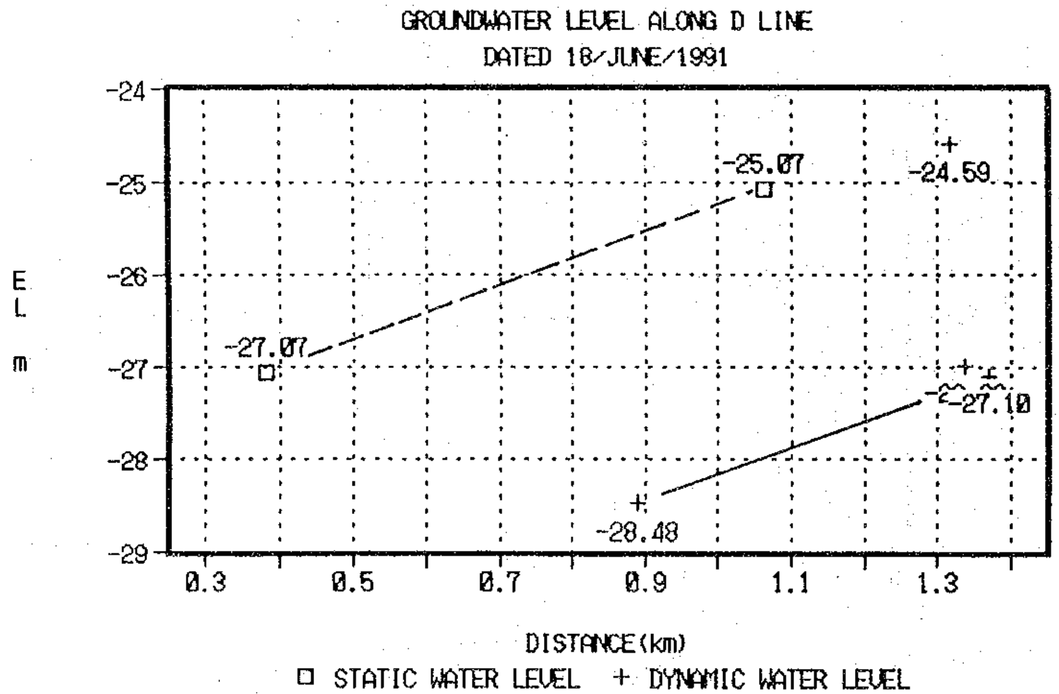
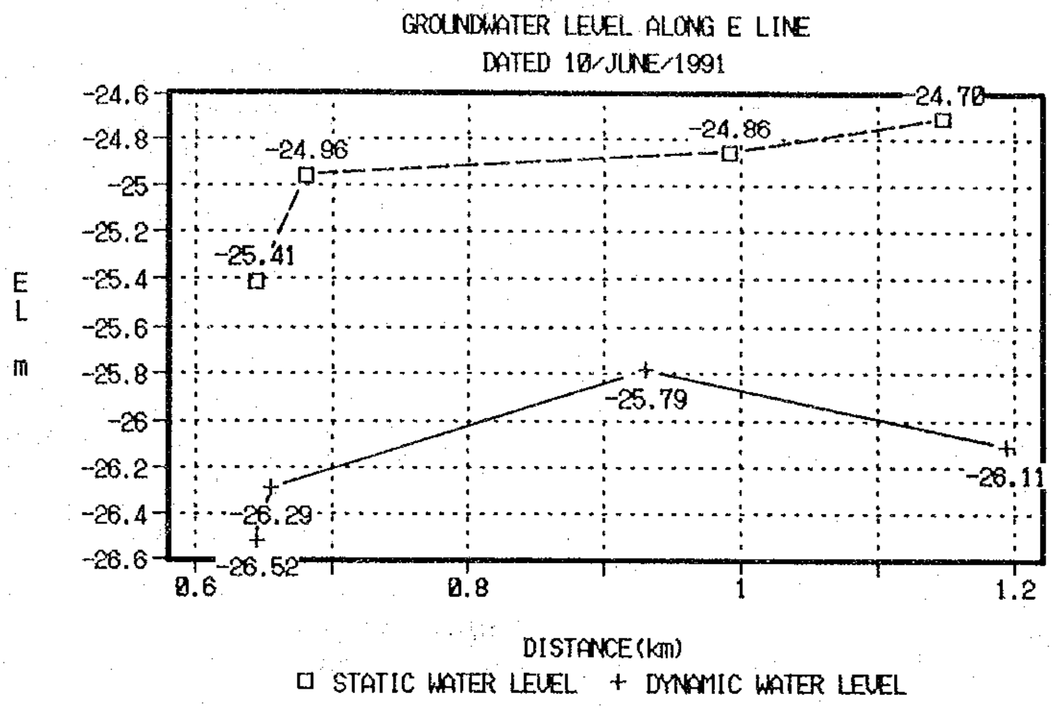




Figure A.3.14(4) Groundwater Level along Observation Line -Line D-



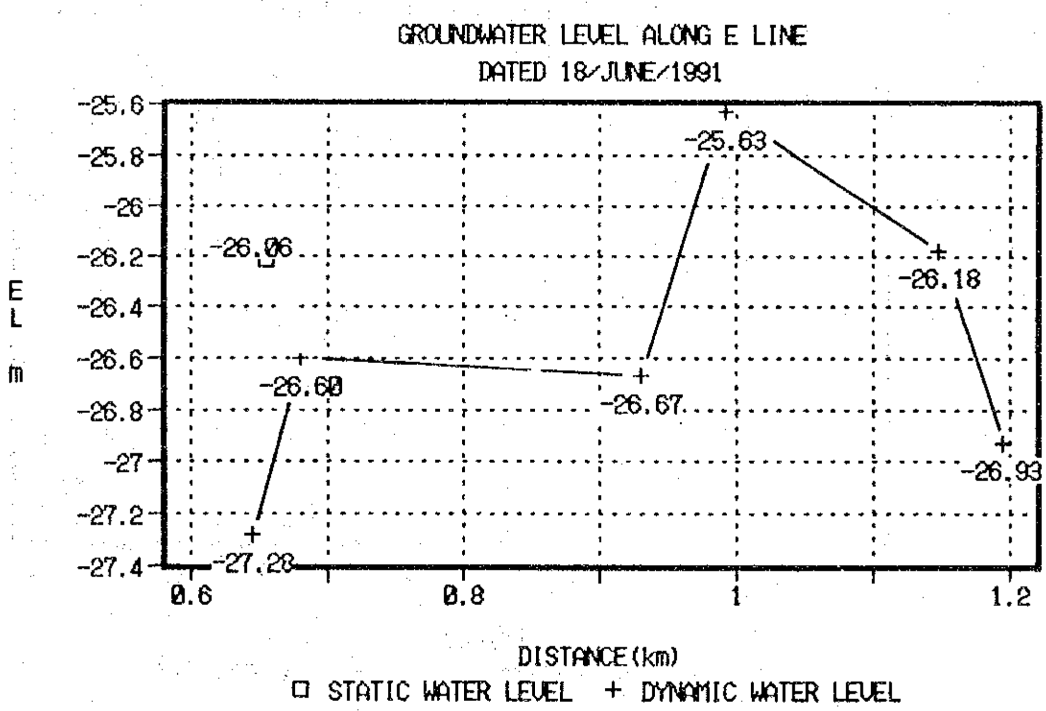
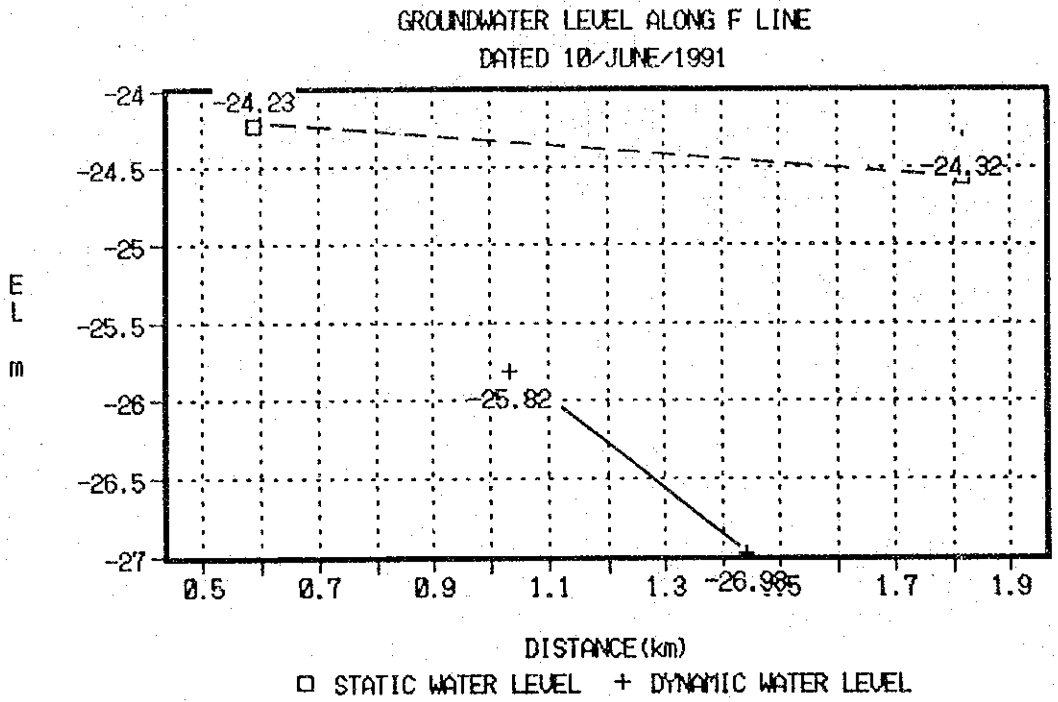




Figure A.3.14(5) Groundwater Level along Observation Line -Line E-



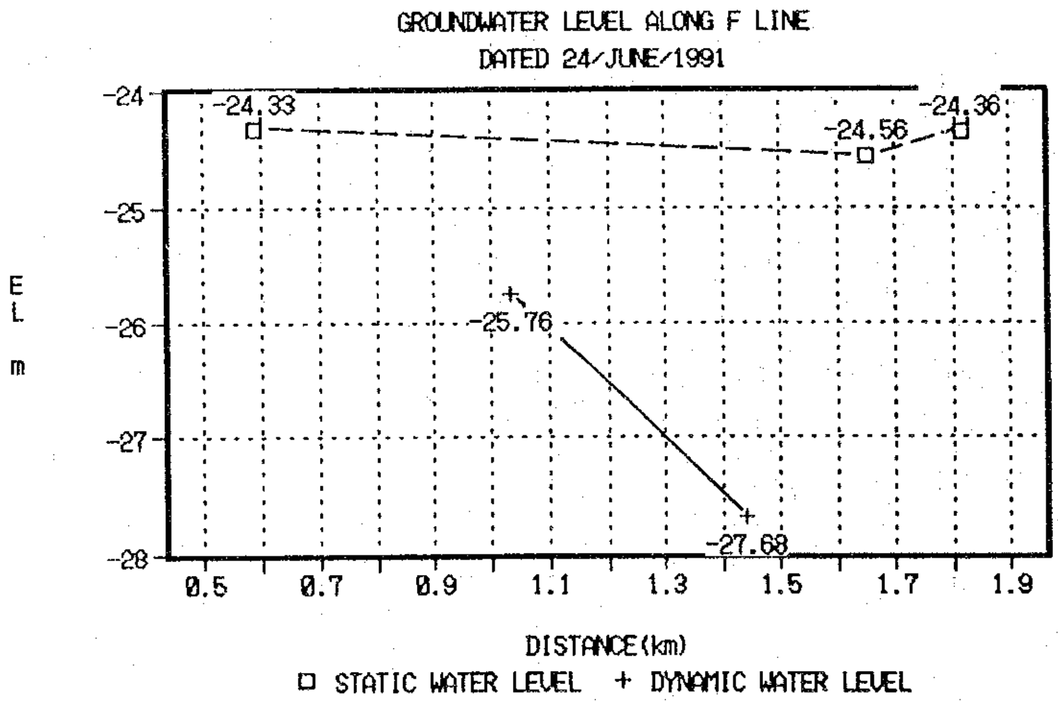
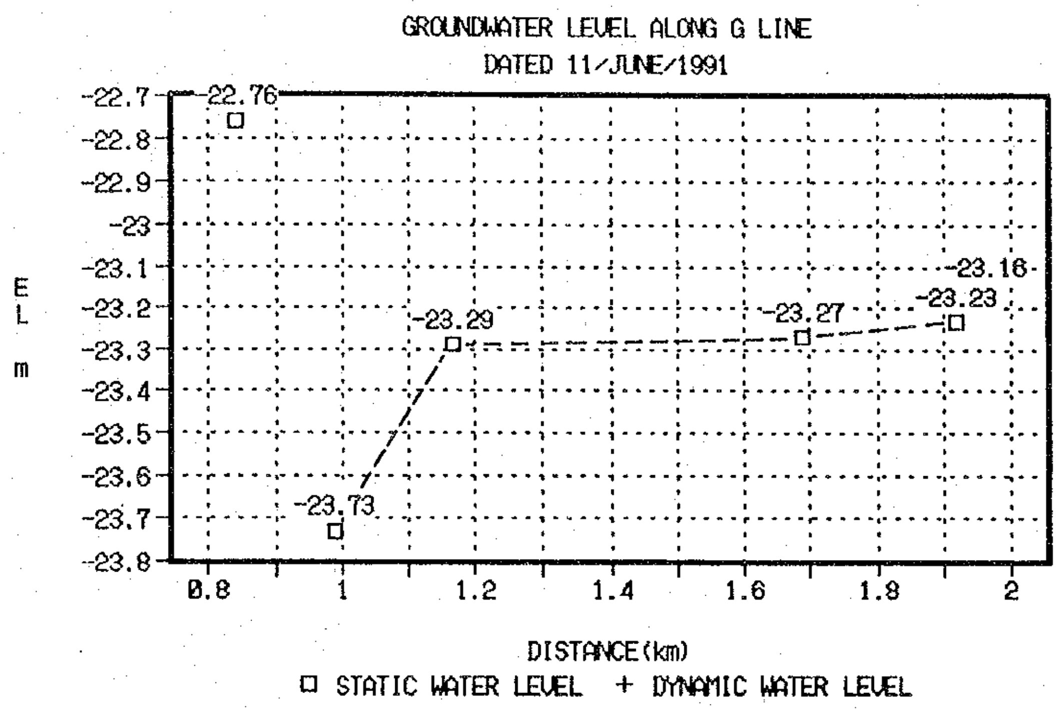




Figure A.3.14(6) Groundwater Level along Observation Line -Line F-



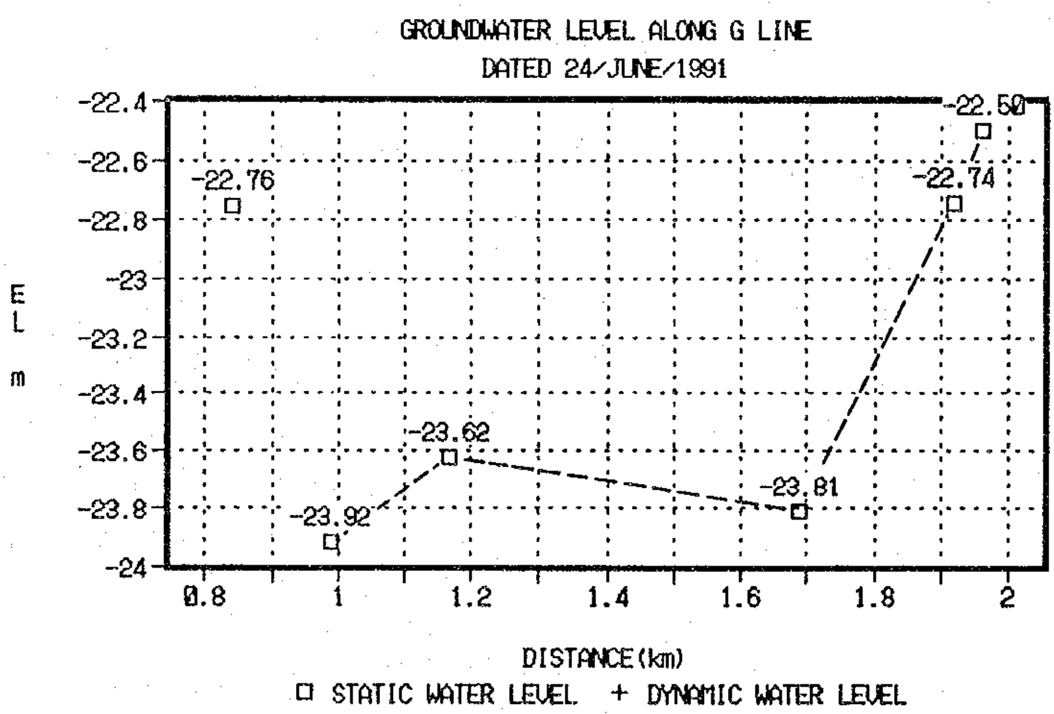
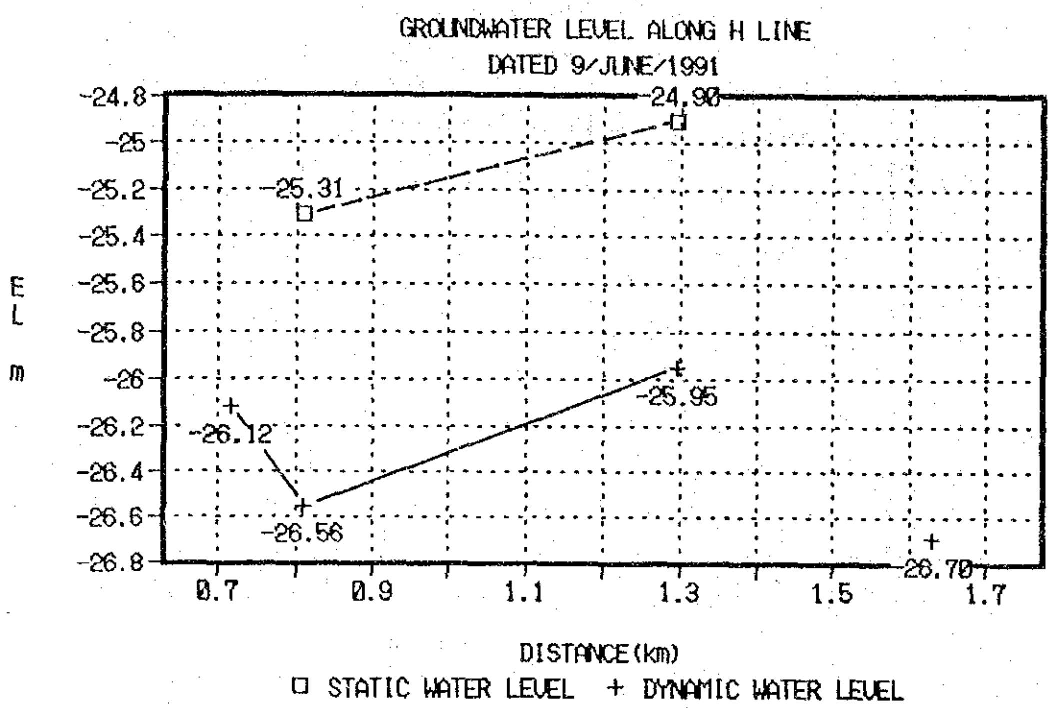




Figure A.3.14(7) Groundwater Level along Observation Line -Line G-



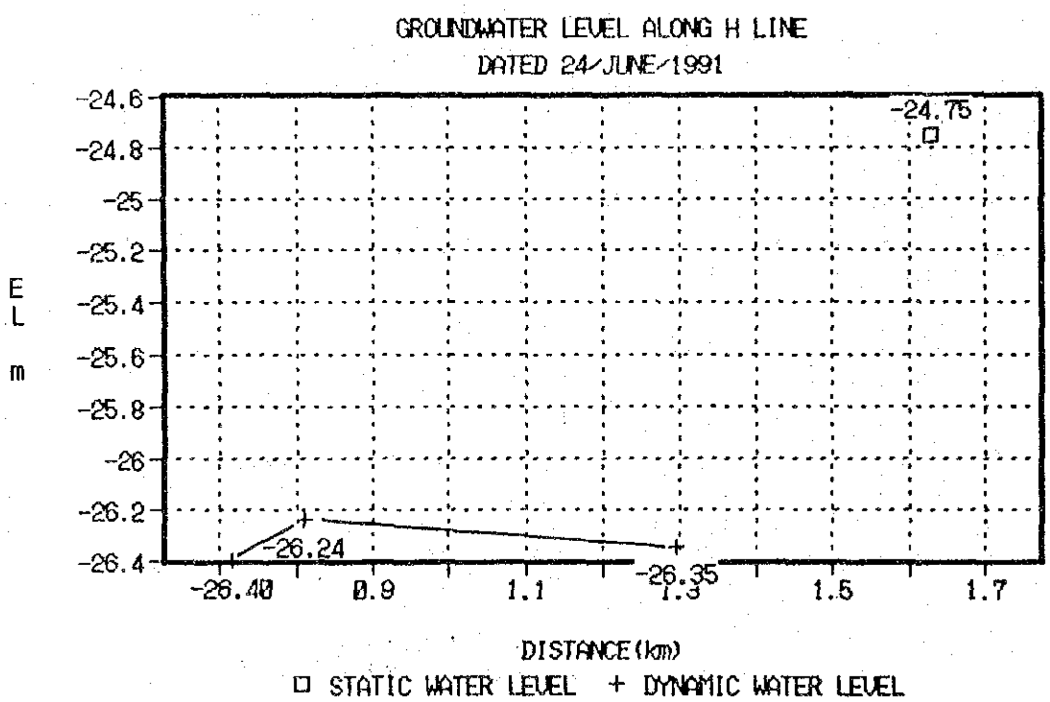
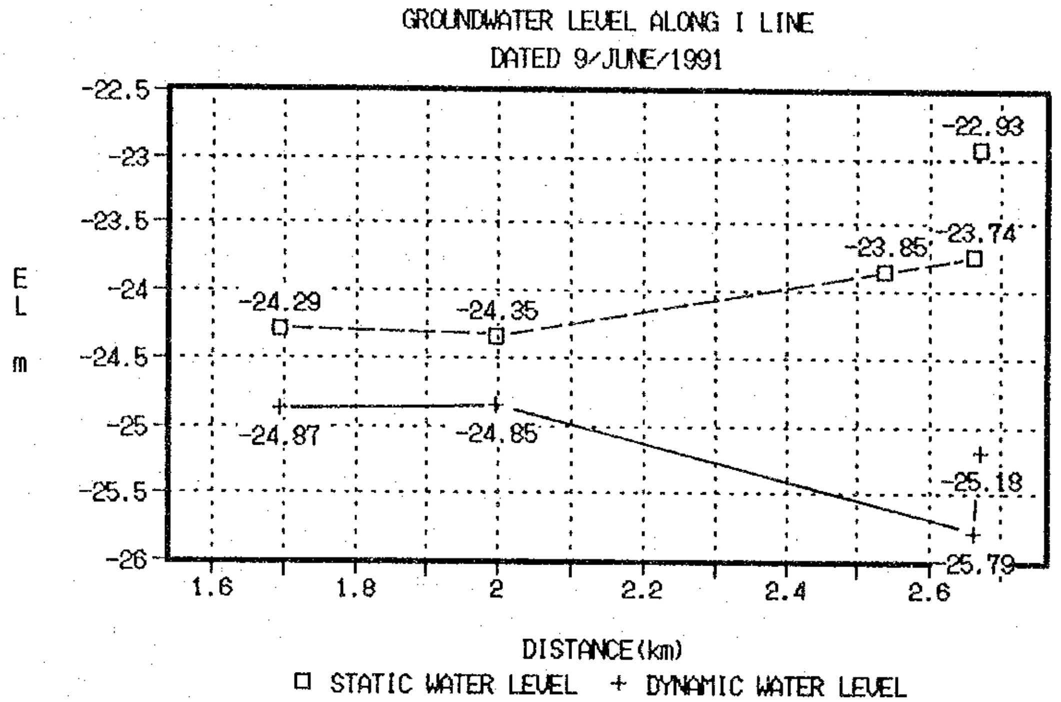




Figure A.3.14(8) Groundwater Level along Observation Line
-Line H-



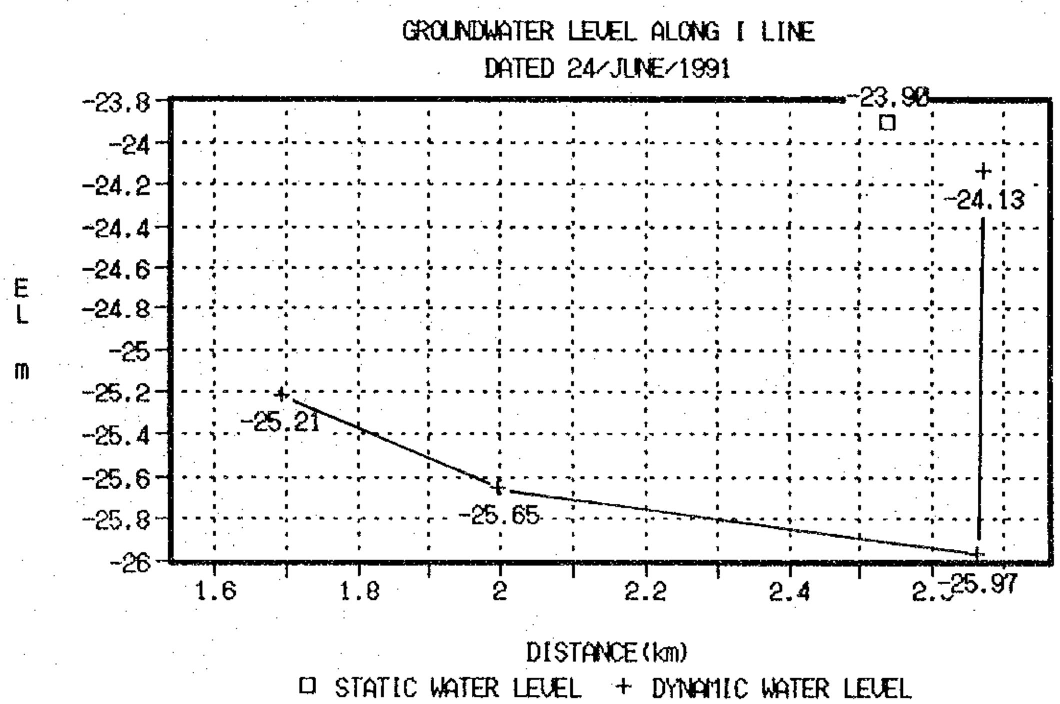




Figure A.3.14(9) Groundwater Level along Observation Line -Line I-

## 3. Caspian Sea Level Change

### (1) Caspian Sea Level

The Caspian Sea fluctuation have been collected and arranged as shown in Figure A. 3. 15. And so, the data has been treated by the Fast Fourier Transformation Analysis (FFT), hereafter, it had been rebuild to the fluctuation curve again for taking the meaningful average of its fluctuation eliminating the trivial changes. The process of this analysis is shown in Figure A.3.16, and 17.

### (2) Influence to Groundwater Level

It can be imagined that the Caspian Sea Level affects not only the groundwater level but the apparent storage of groundwater near the coastal strip. Depending on the information of observation data which the Caspian sea level has risen up during last 10 years from 1360, the difference between the observation groundwater level and specific level when the sea level is stable can be presumed to some extend. In Figure A. 3. 18 and Table A. 3. 10, the degree of influence by sea transgression and apparent increment storage volume corresponding to the practical movement are expressed.

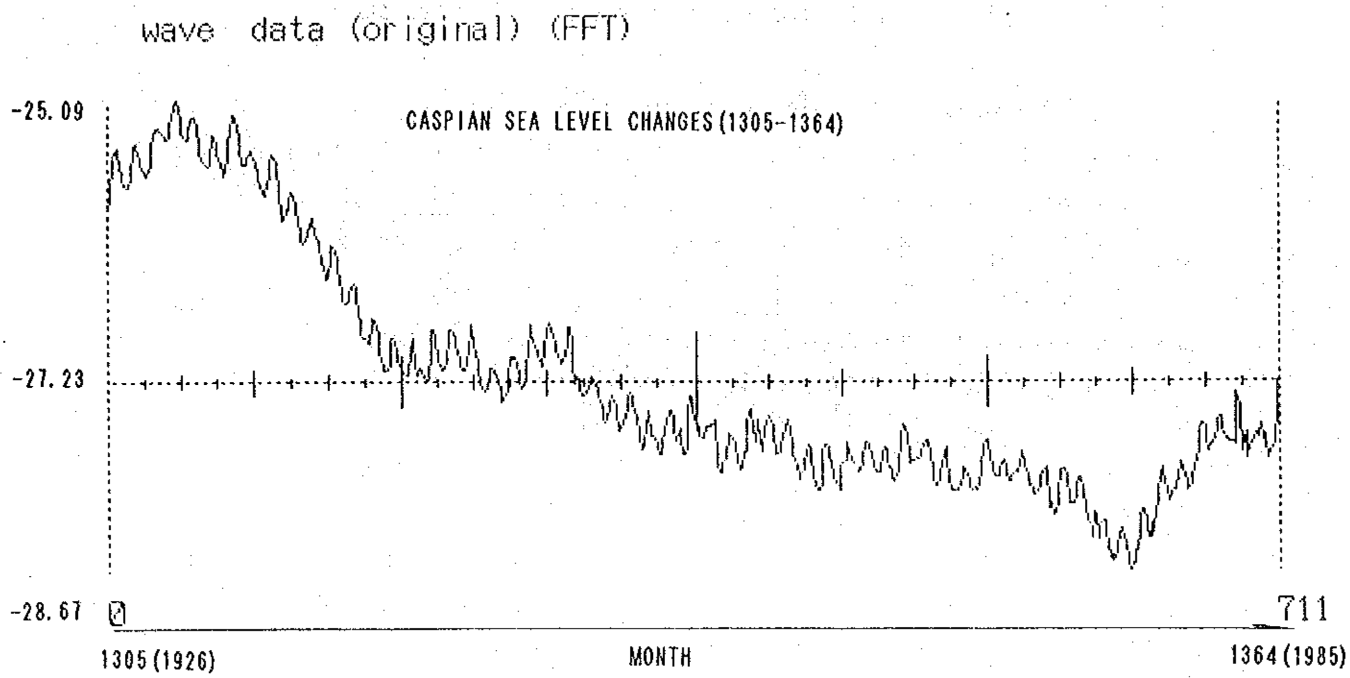
## 4. Revised Groundwater Storage

### (1) Groundwater Storage Fluctuation

The estimated Caspian Sea fluctuation during 1360 to 1370, which is correlative with the analytical period for groundwater storage capacity, is made by interpolation as shown in Figure A. 3. 19. And the increment storage volume relating to this curve have been also calculated by a method as described above chapter. Hereafter, the devised groundwater storage, it means that the influence of Caspian transgression is reduced from the original, have been led as shown in Figure A. 3. 19, and 20.

(2) Relation between Groundwater Storage and Precipitation

The outline of precipitation and surface runoff in this area is summarized as Figure A. 3. 21 and a relationship among them is also indicative of in Figure A. 3. 21. Otherwise, the correlation between calculated groundwater storage fluctuation and other hydrogical items have been considered as shown in Table A. 3. 11 and Figure A. 3. 22, and 23. The strongest correlation coefficient among their sets, it is about 0.73, can be taken from a relation between non-irrigation precipitation to groundwater storage.



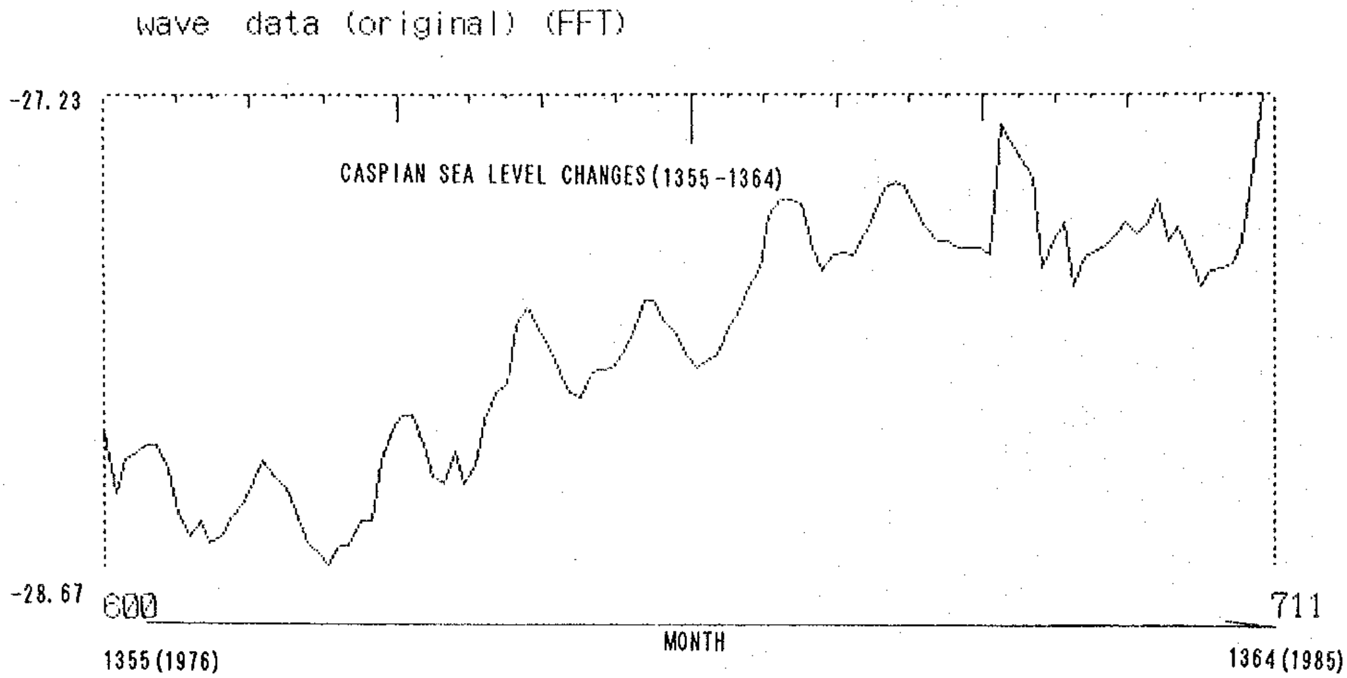
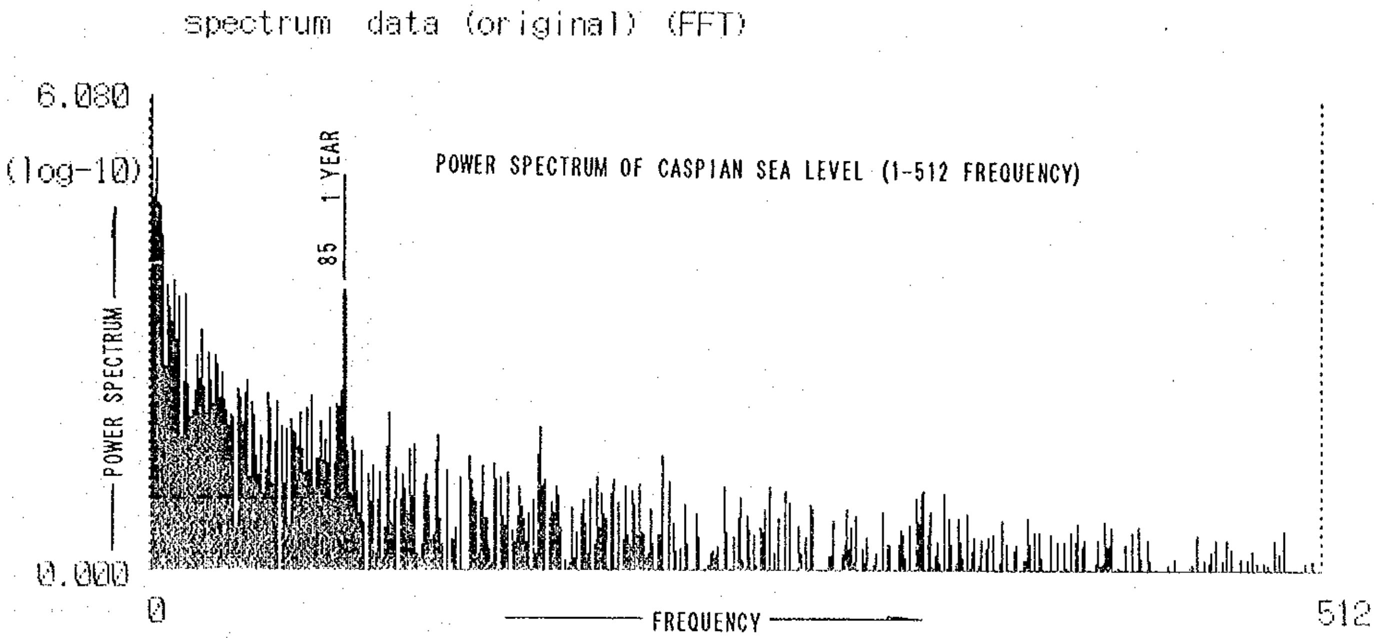




Figure A.3.15 Caspian Sea Fluctuation 1305-1364



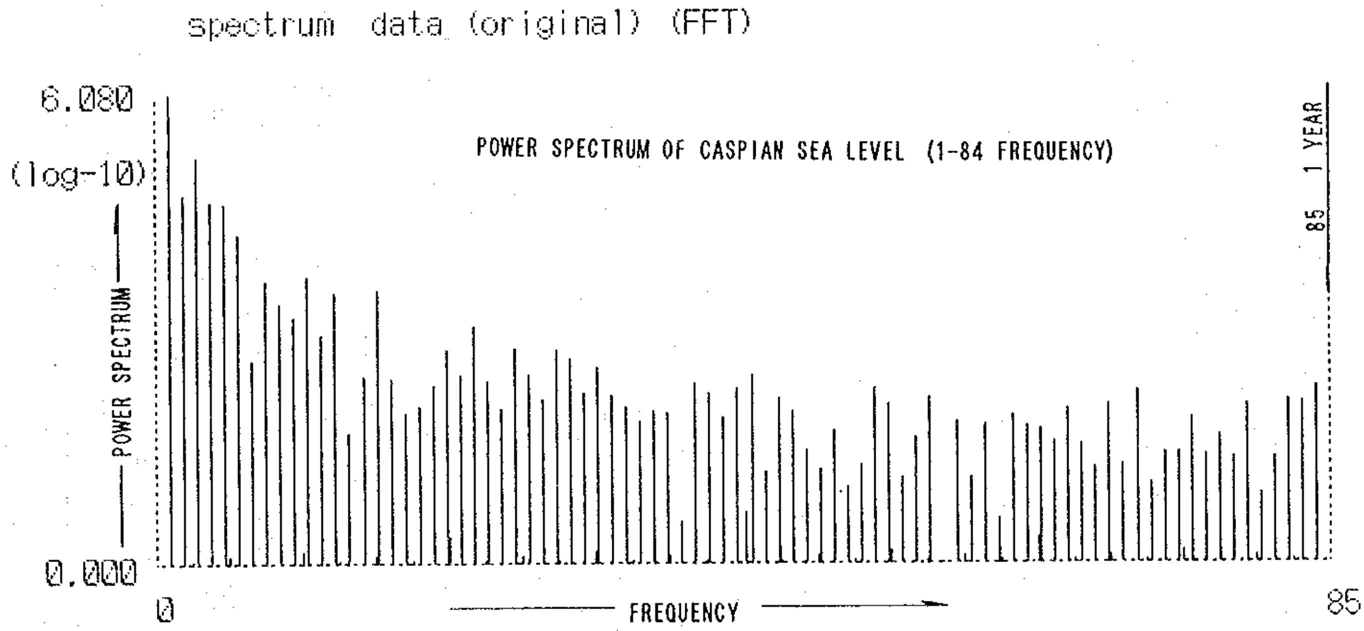
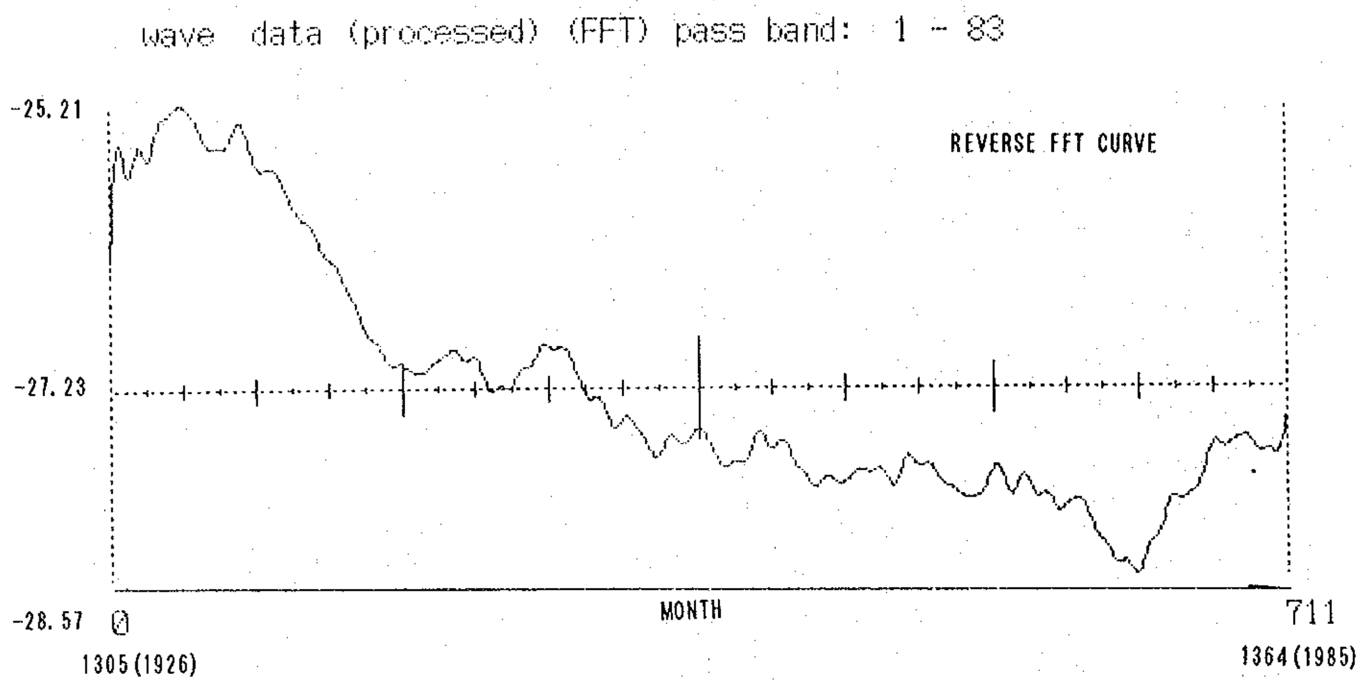




Figure A.3.16 Power Spectrum of Caspian Sea Level



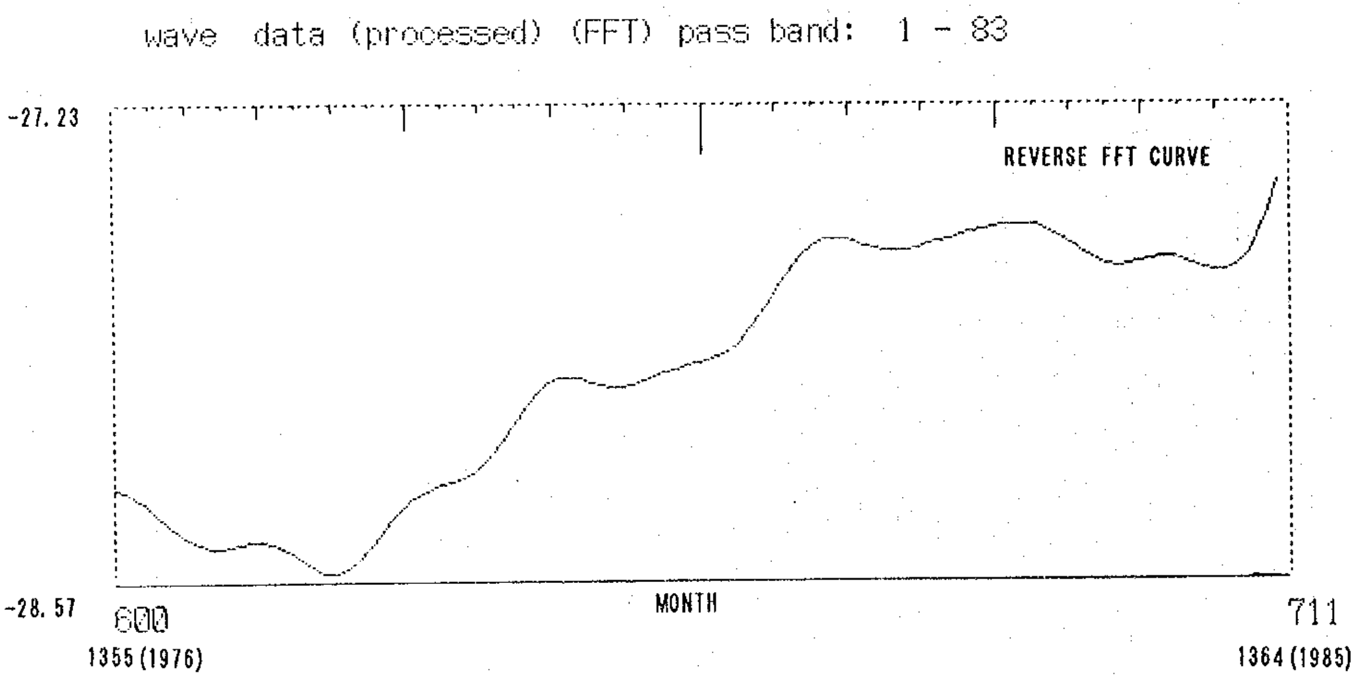
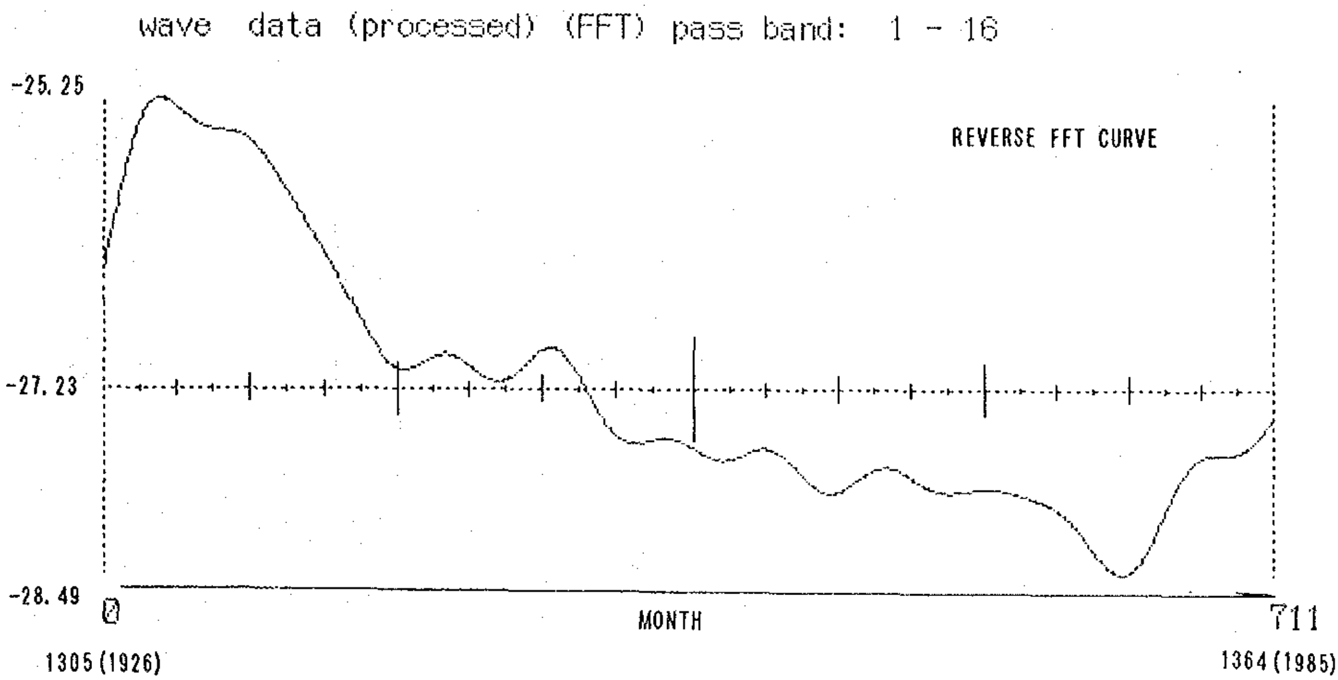




Figure A.3.17(1) Rebuilding Curve by Filtering
-Pass Band 1 to 83-



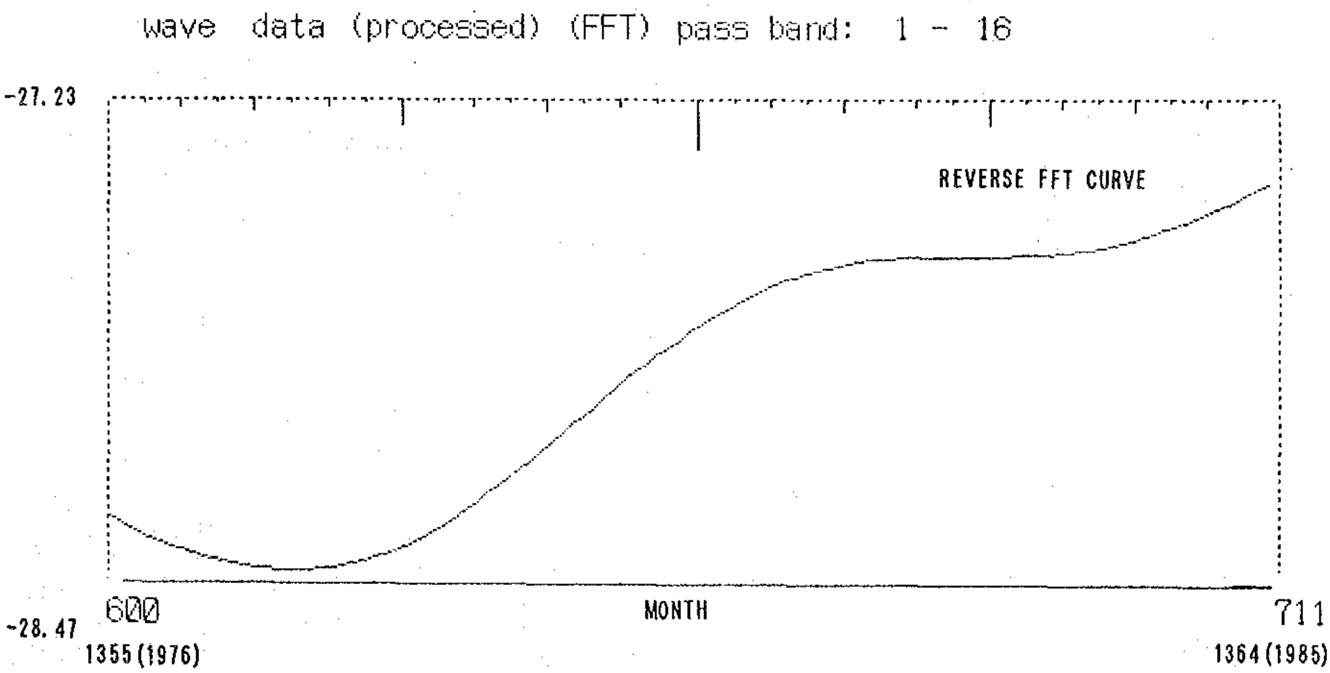
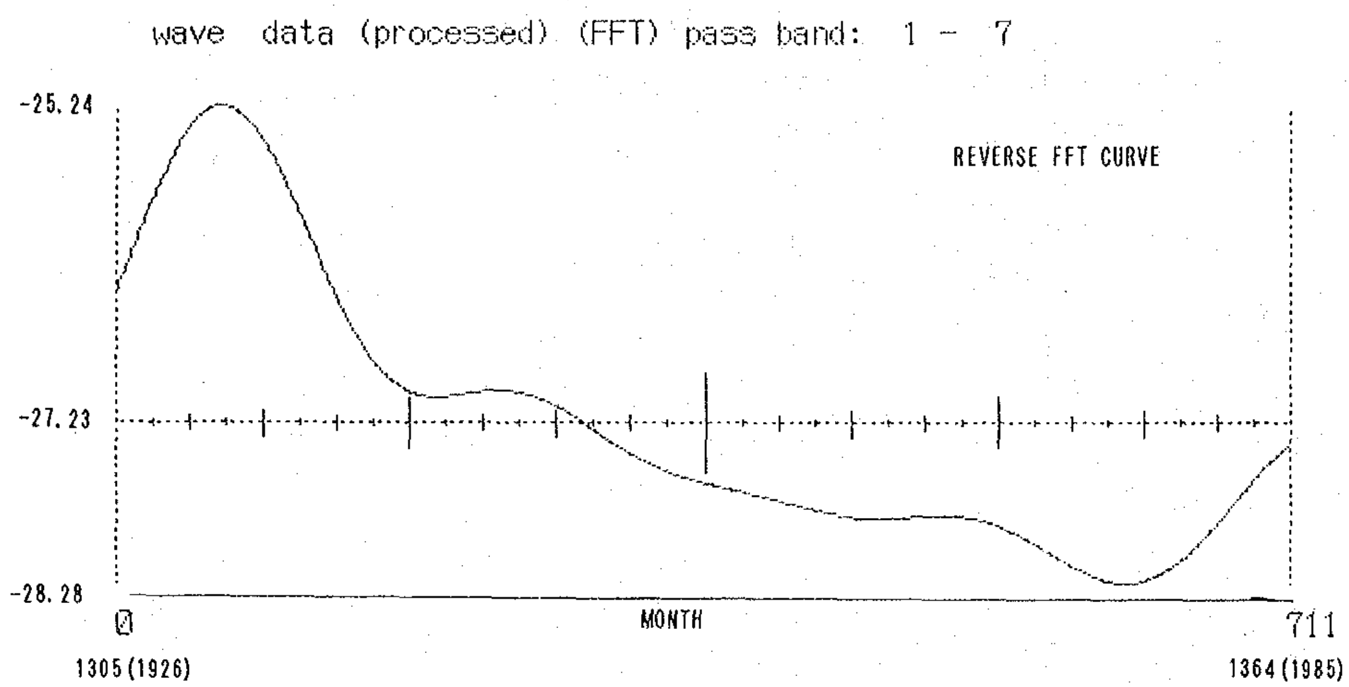




Figure A.3.17(2) Rebuilding Curve by Filtering
-Pass Band 1 to 16-



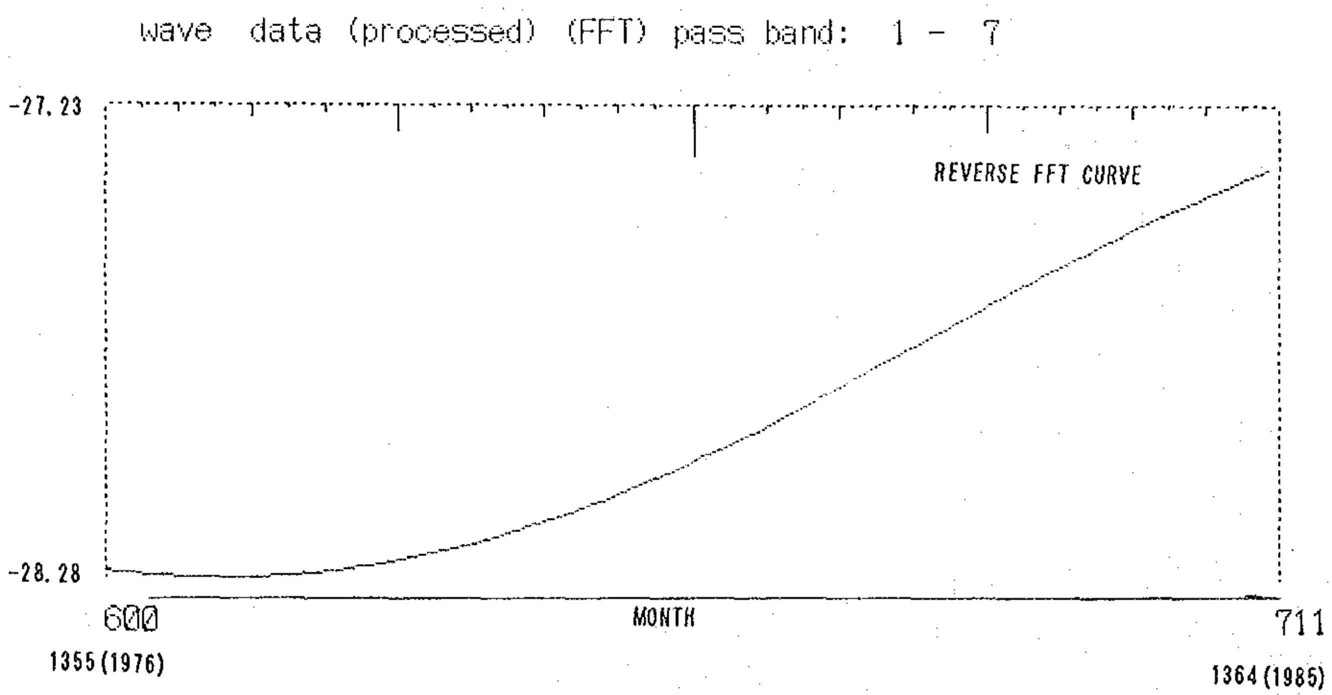
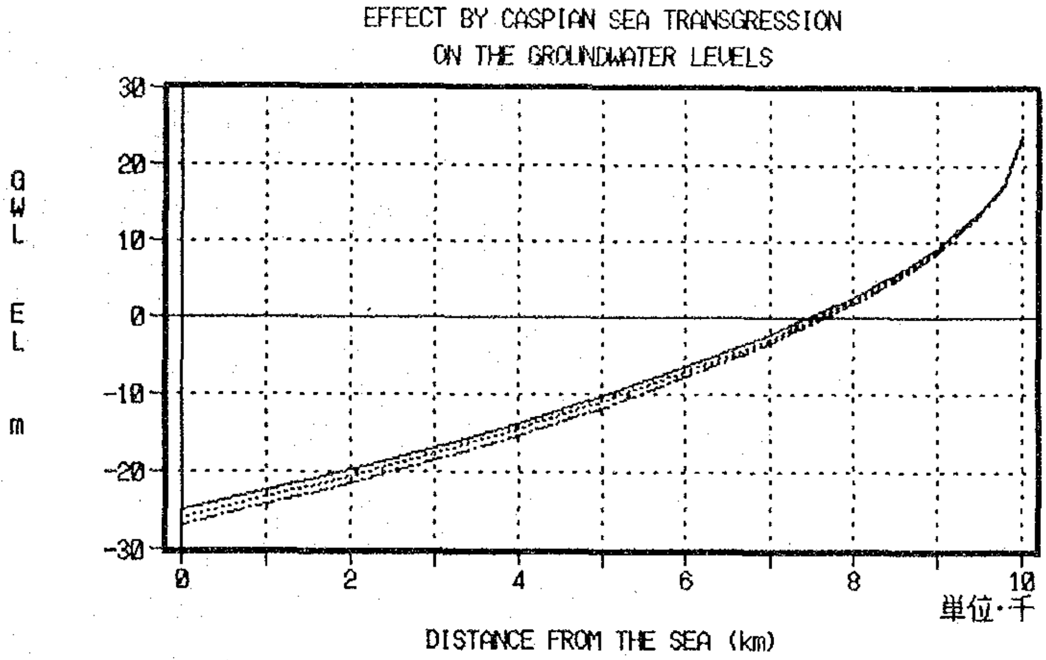




Figure A.3.17(3) Rebuilding Curve by Filtering
-Pass Band 1 to 7-



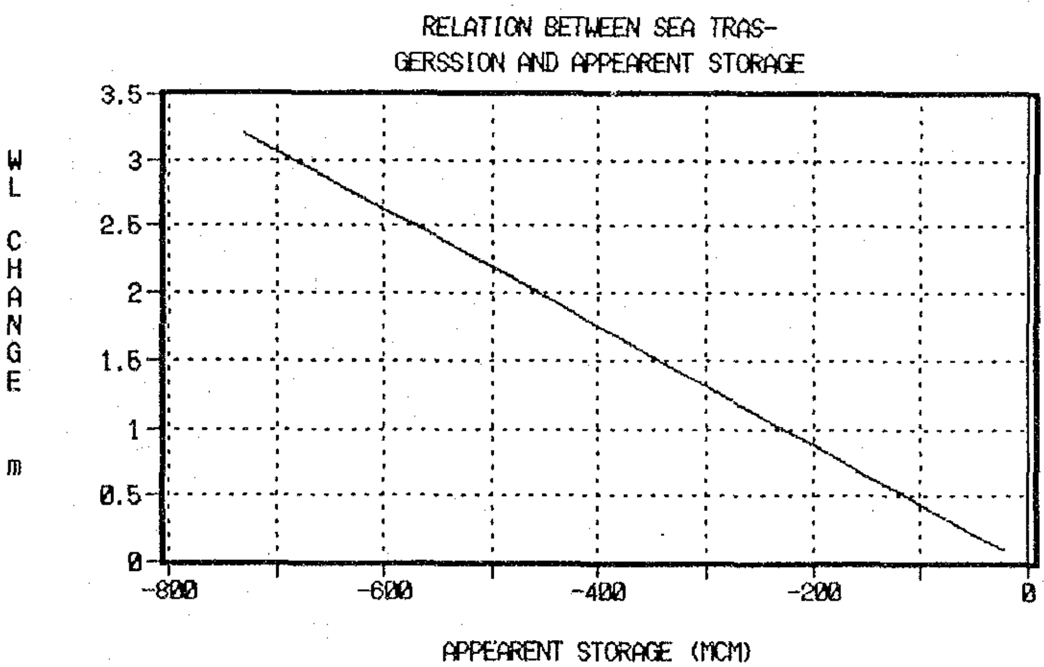
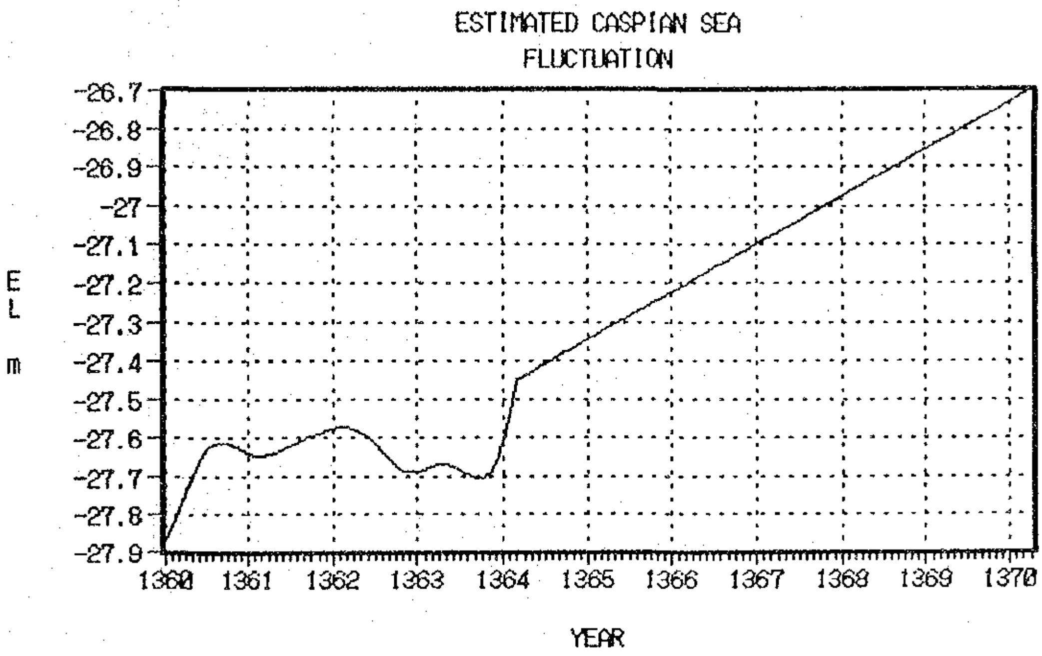




Figure A.3.18 Influence by Caspian Sea Transgression

Table A.3.10 Estimation of Apparent Increment Storage Volume

| SEA LEVEL TRANSGRESSION EL -27 m (m) | APPEARENT INCREMENT RATE (m3/m) | LENGTH OF SEACOAST IN AREA (m) | APPEARENT INCREMENT VOLUME (MCM) | STORAGE COEFFICIENT | APPEARENT INCREMENT VOLUME (MCM) |
|---|---|---|---|---|---|
| 0.1 | -701 | 465000 | -326 | 0.07 | -22.8 |
| 0.2 | -1402 | | -652 | | -45.6 |
| 0.3 | -2103 | | -978 | | -68.5 |
| 0.4 | -2804 | | -1304 | | -91.3 |
| 0.5 | -3505 | | -1630 | | -114.1 |
| 0.6 | -4206 | | -1956 | | -136.9 |
| 0.7 | -4907 | | -2282 | | -159.7 |
| 0.8 | -5608 | | -2608 | | -182.6 |
| 0.9 | -6309 | | -2934 | | -205.4 |
| 1.0 | -7010 | | -3260 | | -228.2 |
| 1.1 | -7711 | | -3586 | | -251.0 |
| 1.2 | -8412 | | -3912 | | -273.8 |
| 1.3 | -9114 | | -4238 | | -296.6 |
| 1.4 | -9815 | | -4564 | | -319.5 |
| 1.5 | -10516 | | -4890 | | -342.3 |
| 1.6 | -11217 | | -5216 | | -365.1 |
| 1.7 | -11918 | | -5542 | | -387.9 |
| 1.8 | -12619 | | -5868 | | -410.7 |
| 1.9 | -13320 | | -6194 | | -433.6 |
| 2.0 | -14021 | | -6520 | | -456.4 |
| 2.1 | -14722 | | -6846 | | -479.2 |
| 2.2 | -15423 | | -7172 | | -502.0 |
| 2.3 | -16124 | | -7498 | | -524.8 |
| 2.4 | -16825 | | -7824 | | -547.7 |
| 2.5 | -17526 | | -8150 | | -570.5 |
| 2.6 | -18227 | | -8476 | | -593.3 |
| 2.7 | -18928 | | -8802 | | -616.1 |
| 2.8 | -19629 | | -9128 | | -638.9 |
| 2.9 | -20330 | | -9454 | | -661.8 |
| 3.0 | -21031 | | -9780 | | -684.6 |
| 3.1 | -21732 | | -10106 | | -707.4 |
| 3.2 | -22434 | | -10432 | | -730.2 |



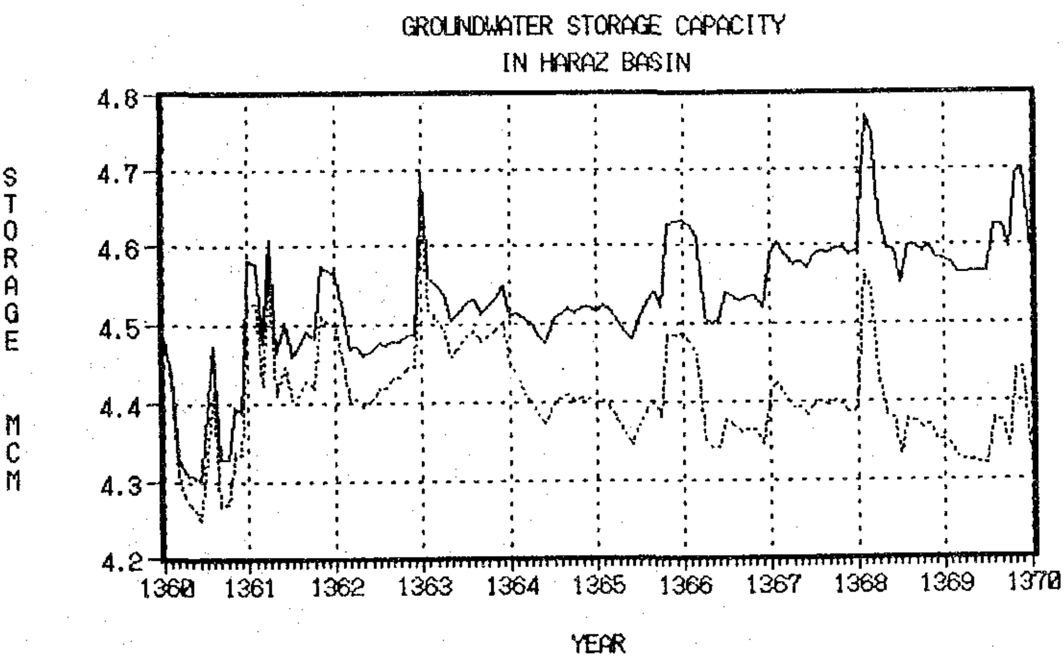
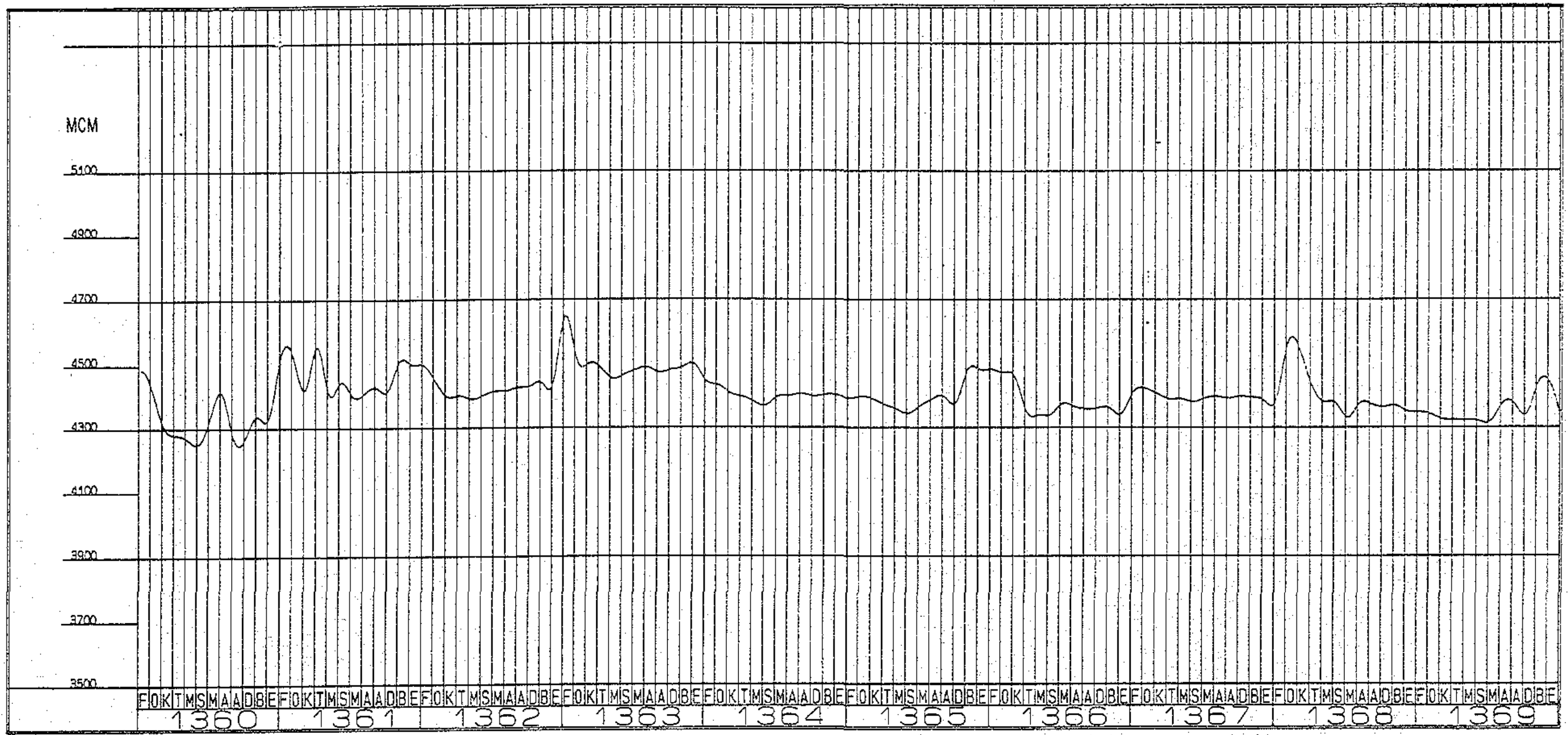
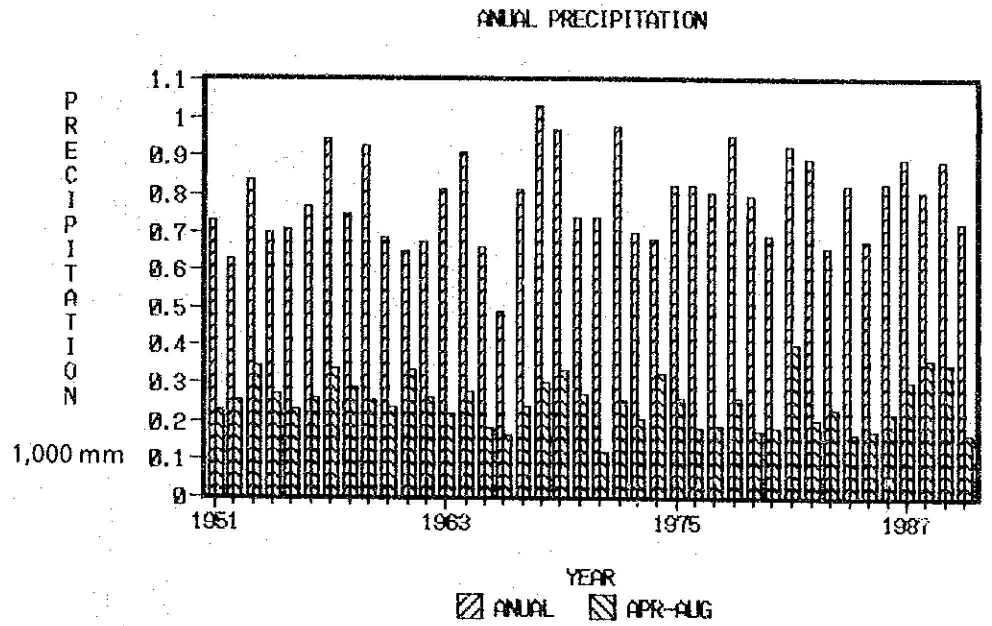




Figure A.3.19 Estimated Caspian Sea Level Fluctuation and Groundwater Storage Capacity




Note : Unit is shown in MCM

Figure A.3.20 Devised Curve of Groundwater Storage Change 1360 - 1369



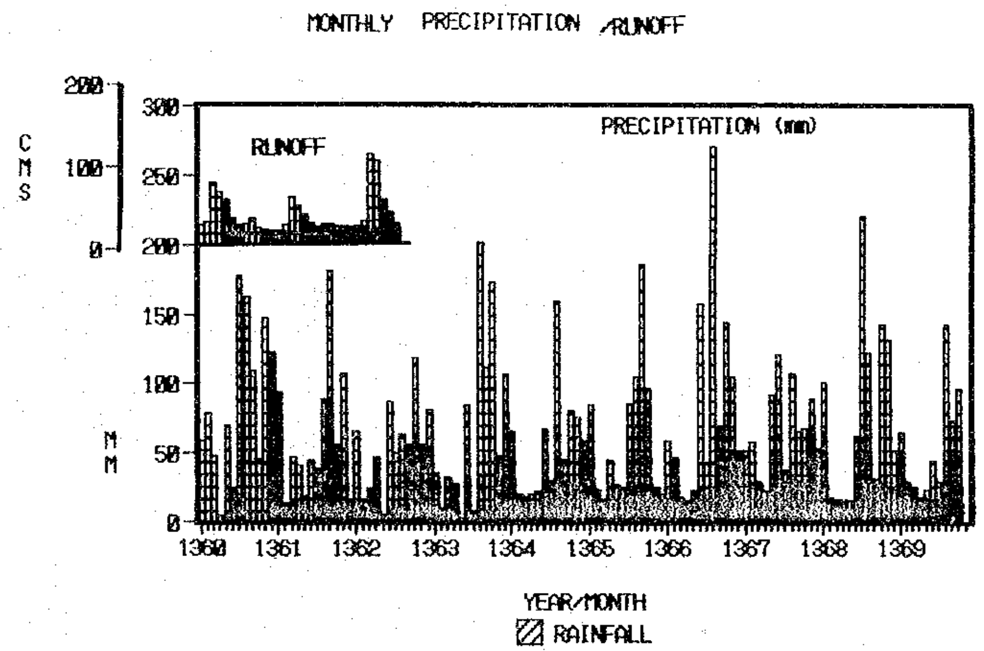
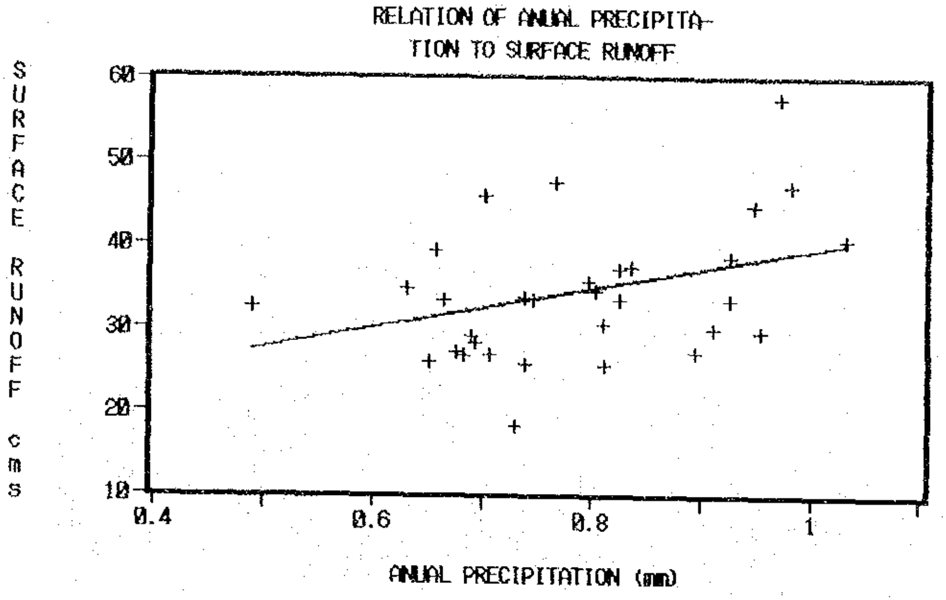
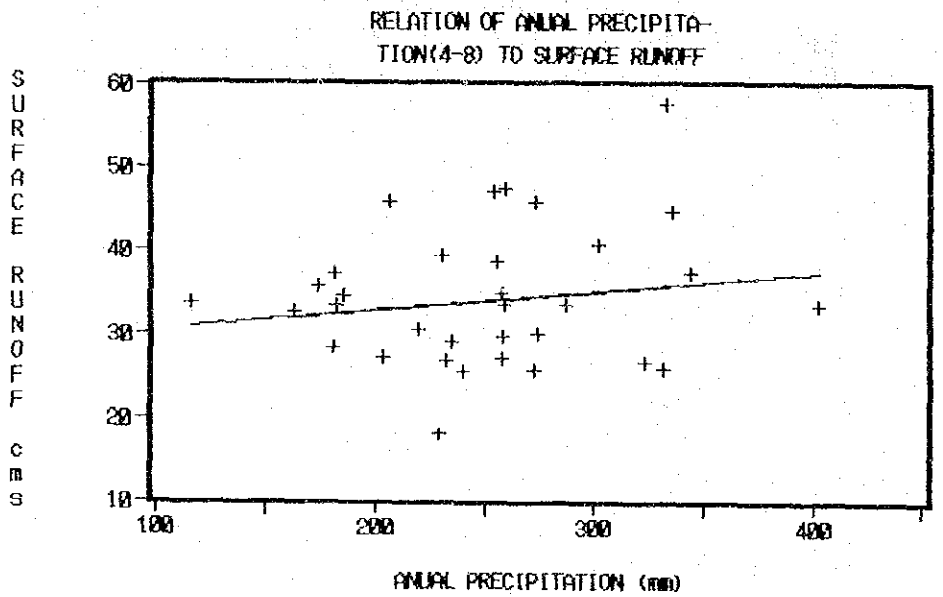




Figure A.3.21(1) Annual and Monthly Precipitation and Runoff



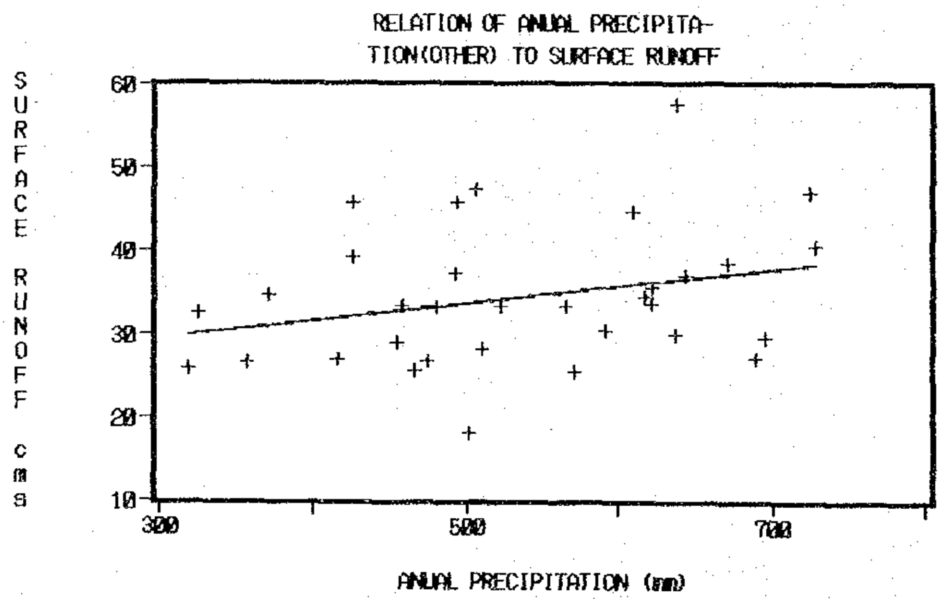
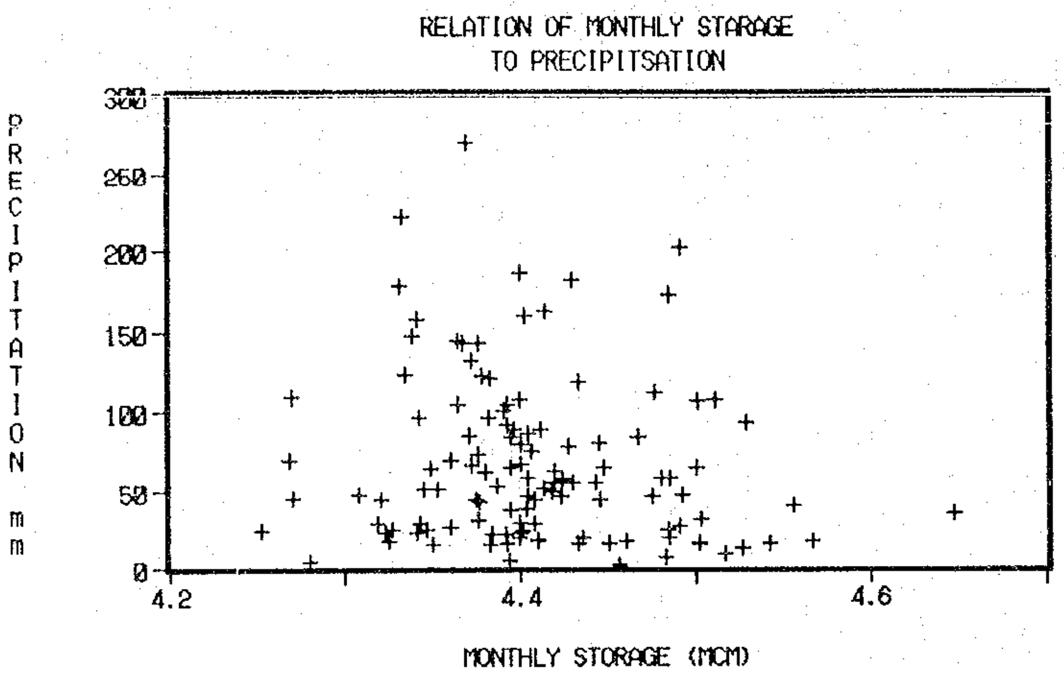




Figure A.3.21(2) Annual and Monthly Precipitation and Runoff

Table A.3.11 Annual/Periodical Transition of Precipitation, Surface Runoff and Groundwater Storage

| YEAR | PRECIPITATION | | | SURFACE RUNOFF | | STORAGE |
|---|---|---|---|---|---|---|
| | YEAR(mm) | APR-AUG(mm) | OTHER(mm) | AVG.(cms) | AMOUNT(MCM) | CHANGE(MCM) |
| 1951 | 729.6 | 228.2 | 501.4 | 18.15 | 572 | |
| 1952 | 629.4 | 257.7 | 371.7 | 34.66 | 1,093 | |
| 1953 | 835.7 | 343.7 | 492.0 | 37.30 | 1,176 | |
| 1954 | 698.8 | 273.3 | 425.5 | 45.83 | 1,445 | |
| 1955 | 705.3 | 232.0 | 473.3 | 26.80 | 845 | |
| 1956 | 765.7 | 259.7 | 506.0 | 47.43 | 1,496 | |
| 1957 | 945.5 | 335.6 | 609.9 | 44.63 | 1,407 | |
| 1958 | 745.2 | 287.5 | 457.7 | 33.44 | 1,055 | |
| 1959 | 925.3 | 255.4 | 669.9 | 38.53 | 1,215 | |
| 1960 | 687.9 | 234.1 | 453.8 | 29.03 | 915 | |
| 1961 | 650.5 | 332.0 | 318.5 | 25.85 | 815 | |
| 1962 | 674.2 | 258.2 | 416.0 | 26.90 | 848 | |
| 1963 | 810.4 | 219.2 | 591.2 | 30.41 | 959 | |
| 1964 | 910.4 | 274.1 | 636.3 | 29.91 | 943 | |
| 1965 | 662.4 | 182.4 | 480.0 | 33.18 | 1,046 | |
| 1966 | 489.1 | 163.0 | 326.1 | 32.51 | 1,025 | |
| 1967 | 810.6 | 239.5 | 571.1 | 25.59 | 807 | |
| 1968 | 1,030.0 | 302.1 | 727.9 | 40.60 | 1,280 | |
| 1969 | 969.5 | 332.5 | 637.0 | 57.61 | 1,817 | |
| 1970 | 738.8 | 273.0 | 465.8 | 25.63 | 808 | |
| 1971 | 736.9 | 115.9 | 621.0 | 33.67 | 1,062 | |
| 1972 | 978.9 | 254.0 | 724.9 | 47.04 | 1,483 | |
| 1973 | 699.6 | 206.5 | 493.1 | 45.82 | 1,445 | |
| 1974 | 681.0 | 323.5 | 357.5 | 26.65 | 840 | |
| 1975 | 824.9 | 259.0 | 565.9 | 33.47 | 1,056 | |
| 1976 | 825.3 | 181.6 | 643.7 | 37.03 | 1,168 | |
| 1977 | 802.1 | 186.0 | 616.1 | 34.58 | 1,091 | |
| 1978 | 952.4 | 258.0 | 694.4 | 29.61 | 934 | |
| 1979 | 795.9 | 174.4 | 621.5 | 35.70 | 1,126 | |
| 1980 | 691.6 | 181.3 | 510.3 | 28.24 | 891 | |
| 1981 | 925.6 | 402.3 | 523.3 | 33.41 | 1,054 | -209.2 |
| 1982 | 892.6 | 203.3 | 689.3 | 27.08 | 854 | 148.0 |
| 1983 | 656.2 | 230.2 | 426.0 | 39.30 | 1,239 | 14.1 |
| 1984 | 822.4 | 164.7 | 657.7 | | | 50.5 |
| 1985 | 676.9 | 174.7 | 502.2 | | | -82.9 |
| 1986 | 827.8 | 221.2 | 606.6 | | | -19.1 |
| 1987 | 891.5 | 303.0 | 588.5 | | | -18.0 |
| 1988 | 806.4 | 359.7 | 446.7 | | | 37.0 |
| 1989 | 887.8 | 349.7 | 538.1 | | | -34.1 |
| 1990 | 726.0 | 167.8 | 558.2 | | | -23.9 |
| AVERAGE | 787.9 | 250.0 | 537.9 | 34.41 | 1,085 | -16 |



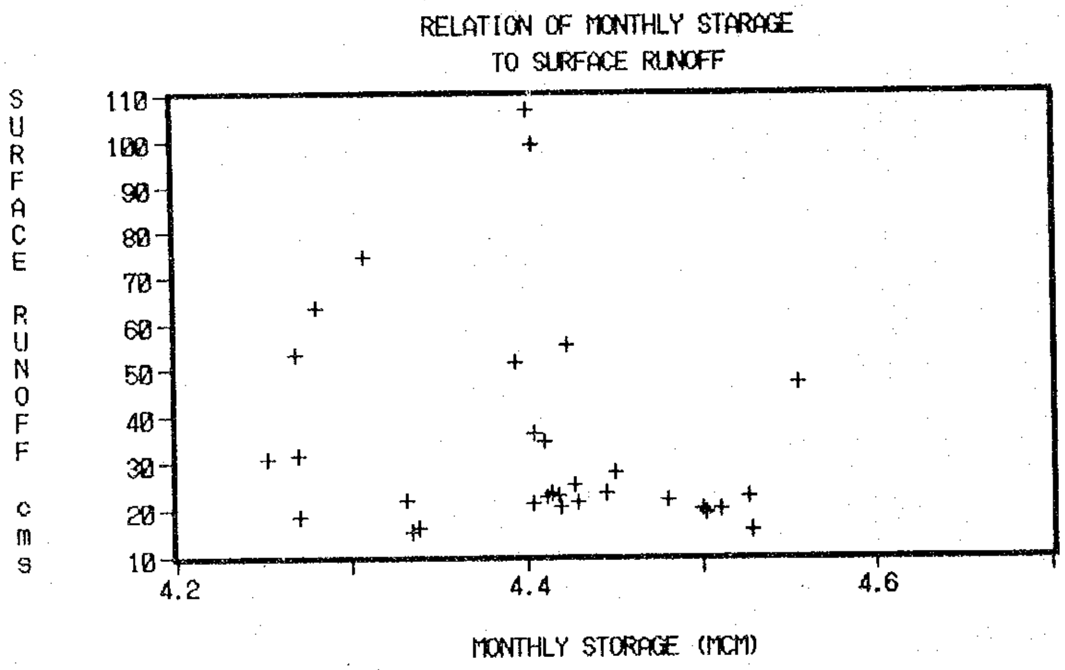
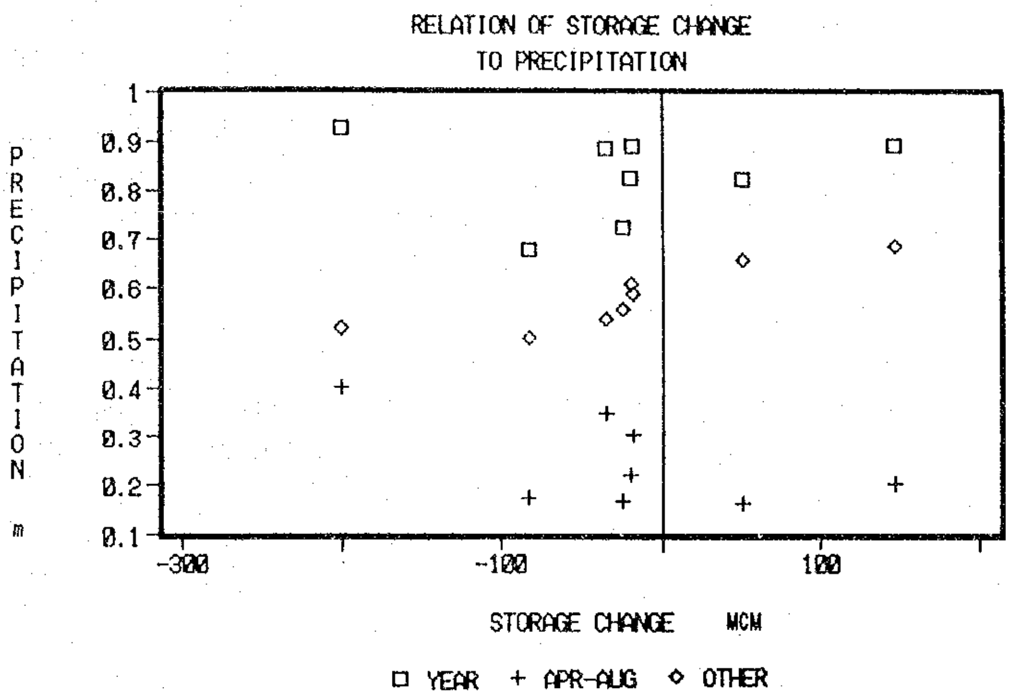




Figure A.3.22 Relation among Monthly Groundwater Storage, Precipitation and Surface Runoff



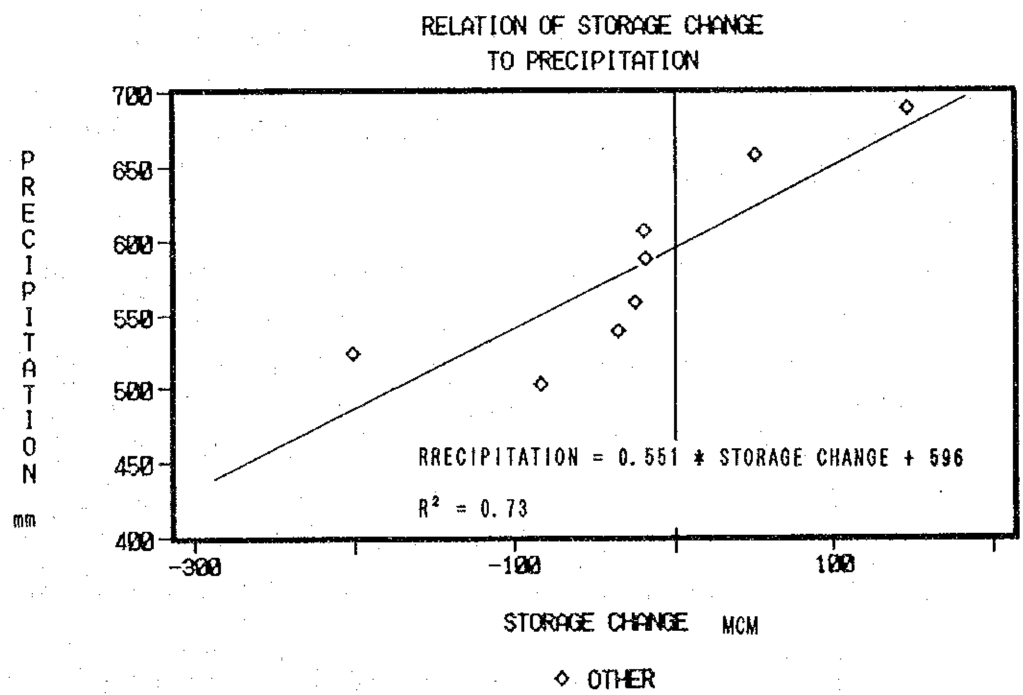




Figure A.3.23 Relation between Groundwater Storage and Annual/Periodical Precipitation

## A. 3. 5 Groundwater Development Criterion

### (1) Safe Yield for Groundwater Resources

As shown in Figure A. 3. 24, and 25, the estimated groundwater storage, which is presumable as a storage amount upon the Caspian Sea level, is on a significant tendency that the total storage volume is gradually deceasing in last five years whereas the short term changes, such as monthly or annual movements, show a temporary increasing.

Otherwise in this period, the precipitation appears to be higher of 800 mm/year than an average precipitation of the 787.9 mm/year for 40 years average. Although these desirable condition for groundwater recharge in this period, this phenomenon of lowering the storage volume must be considered to depend upon a highly groundwater utilization for recent years.

While the groundwater utilization investigation had done during 1361 to 1365 at time when the groundwater storage had became to decrease. For all that, the total groundwater draft is estimated as about 200 MCM/year for this period. Taking this timing of groundwater draft investigation and the groundwater storage changes into consideration, the groundwater utilization for last five years is conjectured to be exceeded over 200 MCM especially in the drought year such as this stage of 1991.

Even in the groundwater utilization investigation of this period, many wells had been newly planned at many places where were located beside registered well. And further, these highly pumping had caused the depletion of aquifer which had undergone an unfavorable condition for saline water pollution. That is to say, not only a dynamic groundwater level but also static ground level had been positioned beneath the present Caspian Sea level. And so, it had brought about a serious event which was anxious much about extraction of the sea water when these pumping continued for a long term.

Safe yield defines generally that the quantities of water perennially available from a groundwater basin and they are limited solely by the adverse side-effects which may arise as a result of pumping and basin operation. In view of the whole hydrogeological condition mentioned above, the safe yield for this area is considered as a similar amount of 200 MCM which dose not cause a lowering of groundwater storage as well as any hazard for the future welfare of associated community.

(2) Priority of Groundwater Resources

It is preferred that the usage of water in this area is followed a management by a conjunctive manner. This is a procedure which involves coordinating the operation of both surface water and groundwater resources. It based upon the assumption that surface stream and reservoirs, such as canal, paddy field storage.

In practical usage for irrigation in this area, the purpose of surface water and groundwater are seem to be rather different. The former is intended to the supply water for various uses mainly on an annual basis whereas the latter is stored with the aim of catering for cyclic storage requirements, in a word, providing a reserve for years in which there is a lower-than-usual precipitation.

When excess precipitation occurs, the surface resources may be utilized to maximum extent possible and some may also be introduced below the ground through canal, paddy field and abbandan which ultimately may add substantially to the groundwater reserve. On the other hand, when drought prevails, the below-normal surface resources can be supplemented by pumping out more groundwater.

However, a management study for this conjunctive usage entails acquiring data on both surface and groundwater resources together with a sufficient information of geology in this area, also the purposes for which water supply is necessary and how wastewater is to be handled. Inevitably, this approach incorporates investigating system dynamics, making a mathematical model and verifying this so that a viable simulation of coordinated operations can be made available.

Such a study provides a means of determining probable responses of the real basin to variations in some of the parameters example for about recharge and pumping. As a result, it becomes feasible to devise optimal operation procedures in this area.

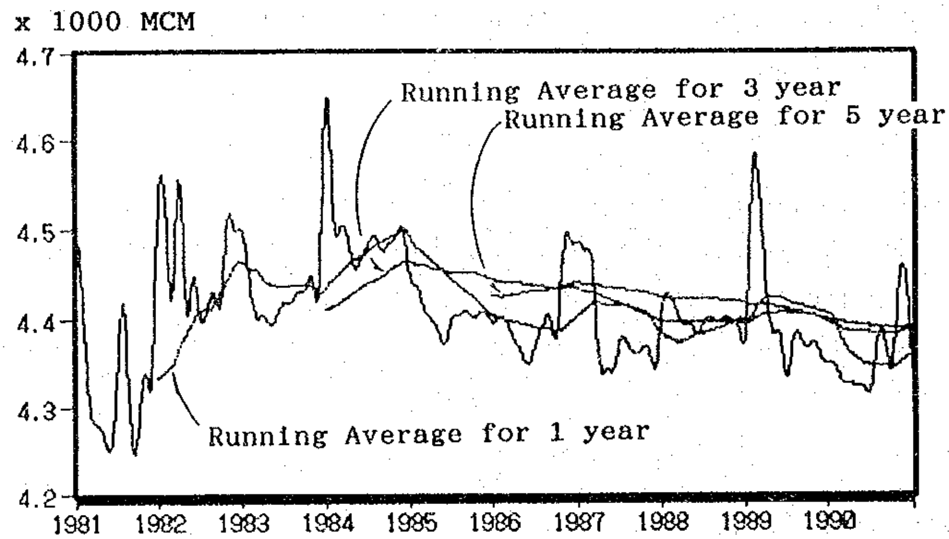



Figure A.3.24 Groundwater Storage Fluctuation and its Tendency

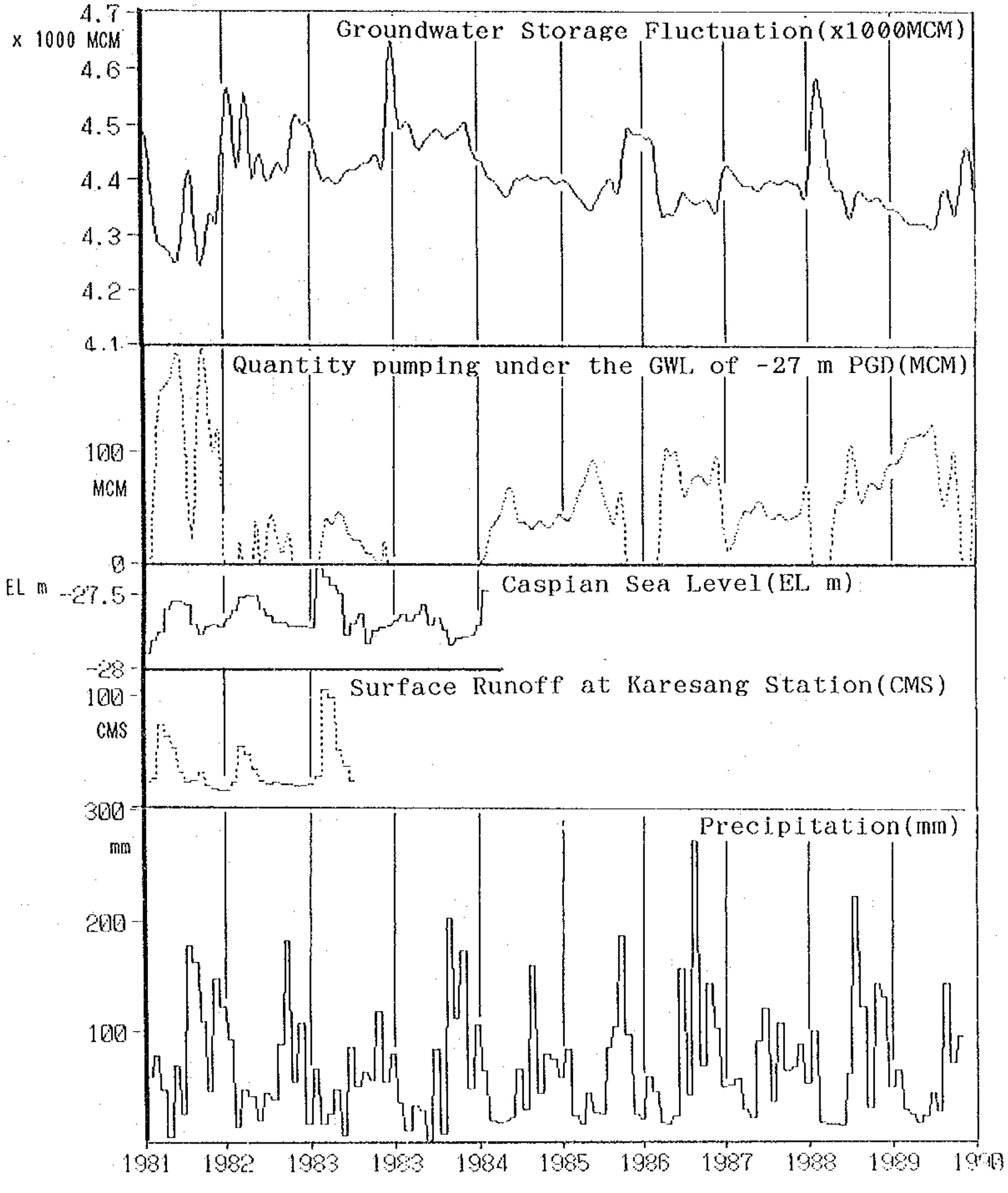



Figure A.3.25 Time Series Chart of Hydrogeologic Events

# APPENDIX A. 4 SOIL

## CONTENTS

### LIST OF TABLES


| | | Page |
|---|---|---|
| Table A. 4 - 1 | Characteristics of Soil Series in Project Area | A4-1 |
| Table A. 4 - 2 | Soil Structure and Chemical Properties | A4-2 |
| Table A. 4 - 3 | Soil Bearing Test in Harvesting Period | A4-3 |
| Table A. 4 - 4 | Soil Structure of Soil Series Distributed in the Project Area | A4-4 |
| Table A. 4 - 5 | Land Classification Specification | A4-5 |
| Table A. 4 - 6 | Soil Classification and Correlation | A4-6 |


### LIST OF FIGURES


| | | |
|---|---|---|
| Figure A.4-1 | Location Map of Soil Sampling Sites | A4-7 |
| Figure A.4-2 | Location Map of Soil Bearing Test | A4-8 |

## TABLE A. 4 - 1 CHARACTERISTICS OF SOIL SERIES IN PROJECT AREA

| Soil Series | Texture | EC ms/cm | pH | P. Content | Drainage Condition | Fertility |
|---|---|---|---|---|---|---|
| Nursar (Nu) | CL | 1.5 ~ 4.5 | 7.5 ~ 7.7 | Normal | Poor | Good |
| Darzi Kola (Da) | L ~ Sil | < 2.0 | 7.8 ~ 8.2 | Poor | Poor | Somewhat Good |
| Babol (Ba) | Si ~ CL | < 2.0 | 7.5 ~ 8.0 | Normal | Poor | Good |
| Form (Fo) | CL ~SiL | < 2.0 | 7.5 ~ 8.0 | - | Poor | Good |
| Kelayhan (Ke) | L | 3.5 | 5.8 | Poor | Somewhat Good | Somewhat Good |
| Borj (Bo) | L ~ SiL | < 1.5 | 8.2 | - | Good | Good |
| Khaza (Kz) | S ~ Ls | < 1.0 | 7.6 ~ 8.0 | - | Poor | Poor |
| Ganjafrun (Ga) | CL ~SiL | < 2.0 | 7.8 ~ 8.2 | Normal | Poor | Good |
| Sufimahaleh (Su) | L ~ LS | 1.0 | 7.0 ~ 7.9 | High | Poor | Somewhat Good |
| Afratakht (Af) | SiL ~ Ls | 2.7 | 7.9 | Normal | Poor | Good |
| Miantalar (Mt) | SiL | < 1.0 | 6.7 ~ 7.9 | High | Poor | Good |
| Gavlangar (Gi) | CL | < 2.0 | 7.4 ~ 7.9 | Normal | Poor | Good |
| Bannikola (Bn) | Si ~ CL | < 2.0 | 6.7 ~ 7.9 | Poor | Poor | Good |

## TABLE A.4-2 SOIL STRUCTURE AND CHEMICAL PROPERTIES

| Soil Series | Soil Color | Depth | Horizon | Size of Particles | | | Texture |
|---|---|---|---|---|---|---|---|
| | | | | Sand | Silt | Clay | |
| (Aquents) | | cm | | % | % | % | |
| Da | 2.5Y3.5/0 | 0-20 | Aps | 49 | 34 | 17 | SL |
| | 2.5Y5/2 | 20-35 | C1g | 44 | 38 | 18 | SL |
| | 2.5Y4.5/2 | 35-55 | C2g | 28 | 50 | 22 | SiL |
| | 2.5Y5/2 | 55-95 | C3g | 29 | 49 | 22 | L |
| Ba | 2.5Y3.5/2 | 0-15 | Apg | 11 | 42 | 47 | SiC |
| | 2.5Y4.5/2 | 15-30 | B21g | 9 | 41 | 50 | SiC |
| | 2.5Y4/2 | 45-80 | B22g | 11 | 40 | 40 | SiC |
| | 10YR4/2 | 80-130 | B23g | 16 | 38 | 46 | C |
| (Aqluolls) | | | | | | | |
| Su | 10YR3/2 | 0-15 | A11 | 42 | 46 | 12 | L |
| | 10Y3.5/2 | 15-30 | A12 | 33 | 43 | 24 | L |
| | 10YR44/1 | 30-50 | C1g | 7 | 54 | 39 | SiCL |
| | 10YR44/1 | 50-140 | C2g | 4 | 55 | 41 | SiC |
| Af | 10YR3/3 | 0-25 | A | 29 | 50 | 21 | SiL |
| | 2.5Y4/2 | 25-60 | C1g | 84 | 10 | 6 | LS |
| | 2.5Y5/1 | 60-105 | C2g | 48 | 38 | 14 | L |
| | 2.5Y4/1 | 105-130 | C3g | 19 | 60 | 21 | SiL |

| Soil Series | ECe X103 | pH | T.N | P | K |
|---|---|---|---|---|---|
| (Aquents) | ms/cm | | % | PPM | PPM |
| Da | 1.09 | 7.9 | 20 | 5.0 | 80 |
| | 0.72 | 8.1 | 20 | 2.5 | 96 |
| | 0.64 | 8.0 | 16 | - | - |
| | 0.57 | 8.0 | 16.5 | - | - |
| Ba | 1.38 | 7.5 | 2.0 | - | 190 |
| | 0.60 | 7.7 | 1.5 | - | 190 |
| | 0.44 | 7.9 | 2.0 | - | - |
| | 0.43 | 8.0 | 4.5 | - | - |
| Su | 0.43 | 7.7 | - | 14 | 70 |
| | 1.60 | 7.0 | - | 15 | 60 |
| | 1.30 | 7.9 | - | 4 | 50 |
| | 0.51 | 7.9 | - | - | - |
| Af | 2.4 | 8.0 | 17.5 | - | 90 |
| | 1.8 | 7.8 | 21.0 | - | 50 |
| | 5.0 | 8.0 | 24.0 | - | - |
| | 5.6 | 8.0 | 15.0 | - | - |

NOTE: Data of Master Plan(1985)

1)Aquents(Mollic Fluvaquents)

These Soil Series belonging to Grops have characteristics of Darzikola (Da)and Babol(Ba),typical series this category.These soils have loamy to clayey textures,distributed on the plains with exceedingly gentle slope, with poor drainage ability giving glei-strong glei nature.

Paddy growth on these soils has moderrate to slightly poor prrformance.

Particularly,poor drainage of these soils often affects root system, inhibiting respiratory metabolism,to 「lead to leaf」scalding as a damage from recurrent flooding over soil surface.In oder to avoid such damade, soil drying or soil oxidation through middl-summer drainage practice is badly required.

2)Afluolls(Fluventic Haplaquolls)

These soils are found in flat plains with gentle slope.Their texture ranges from loam to clay, with poorly drainad character in spite of somewhat coarser particle distribution than the association described above.they are derived from basic parent materials under forest covering , resulted in high humus content and high base saturation throughout the whole sole, giving richer inherent fertility to them as compared with those mentioned above.These soils are most suitable to develop vegetable production by improving their drainage condition.The following gives characteristics of Sufimafaleh(Su)and Afratakht(Af),typical series this category.

## TABLE A. 4-3 SOIL BEARING TEST IN HARVESTING PERIOD

| Test Period | Survey Item | Depth | No. 6 A | No. 6 B | No. 17 A | No. 17 B | No. 33 A | No. 33 B | NO. 36 A | NO. 36 B |
|---|---|---|---|---|---|---|---|---|---|---|
| J. H | Bearing Force (kg/cm²) | 0~ 5 | 5.36 | 4.49 | 5.63 | 5.69 | 3.01 | 1.96 | 3.01 | 3.66 |
| | | 5~10 | 8.24 | 4.97 | 6.22 | 5.23 | 2.94 | 2.57 | 4.19 | 3.66 |
| | | 10~15 | 10.80 | 9.81 | 5.89 | 6.28 | 5.56 | 4.25 | 5.94 | 5.50 |
| | | 15~20 | 15.70 | 14.39 | 5.76 | 6.86 | 6.08 | 7.85 | 10.86 | 12.43 |
| | Soil Moisture (%) | 0~ 5 | 31.3 | 30.6 | 37.0 | 35.2 | 43.0 | 43.0 | 32.2 | 30.0 |
| | | 5~10 | 29.1 | 31.4 | 37.8 | 39.0 | 39.0 | 41.0 | 33.4 | 26.4 |
| | | 10~15 | 24.2 | 23.5 | 39.7 | 39.0 | 33.7 | 33.3 | 24.6 | 19.8 |
| | | 15~20 | 23.1 | 22.6 | 33.4 | 27.0 | 29.1 | 30.4 | 28.9 | 22.3 |
| | Soil Grain Size (%) 0~ 5 | Sand | 14 | 18 | 18 | 18 | 20 | 16 | 34 | 34 |
| | | Silt | 62 | 58 | 60 | 58 | 64 | 70 | 50 | 52 |
| | | Clay | 24 | 24 | 22 | 24 | 16 | 14 | 16 | 14 |
| | 5~10 | Sand | 16 | 16 | 16 | 22 | 22 | 16 | 32 | 36 |
| | | Silt | 60 | 60 | 58 | 52 | 60 | 70 | 52 | 52 |
| | | Clay | 24 | 24 | 26 | 26 | 18 | 14 | 16 | 12 |
| | 10~15 | Sand | 16 | 14 | 22 | 16 | 18 | 12 | 32 | 48 |
| | | Silt | 60 | 62 | 54 | 54 | 62 | 70 | 54 | 44 |
| | | Clay | 24 | 24 | 24 | 30 | 20 | 18 | 14 | 8 |
| | 15~20 | Sand | 10 | 22 | 18 | 18 | 14 | 10 | 18 | 28 |
| | | Silt | 64 | 62 | 54 | 52 | 64 | 70 | 64 | 54 |
| | | Clay | 26 | 26 | 28 | 30 | 22 | 20 | 18 | 18 |
| AFT 24hr | Bearing Force (kg/cm²) | 0~ 5 | - | - | - | - | 1.18 | 1.96 | 2.42 | 2.81 |
| | | 5~10 | | | | | 1.14 | 2.15 | 2.94 | 3.86 |
| | | 10~15 | | | | | 3.40 | 4.25 | 5.63 | 4.84 |
| | | 15~20 | | | | | 8.18 | 7.85 | 15.70 | 13.04 |
| | Soil Moisture (%) | 0~ 5 | - | - | - | - | 48.9 | 45.2 | 33.0 | 32.3 |
| | | 5~10 | | | | | 49.9 | 47.4 | 31.8 | 28.5 |
| | | 10~15 | | | | | 31.7 | 41.8 | 24.8 | 27.8 |
| | | 15~20 | | | | | 32.6 | 31.0 | 18.9 | 29.1 |
| | Soil Grain Size (%) 0~ 5 | Sand | - | - | - | - | 18 | 22 | 28 | 32 |
| | | Silt | | | | | 64 | 62 | 58 | 54 |
| | | Clay | | | | | 18 | 16 | 14 | 14 |
| | 5~10 | Sand | | | | | 16 | 22 | 30 | 34 |
| | | Silt | | | | | 66 | 62 | 54 | 50 |
| | | Clay | | | | | 18 | 16 | 16 | 16 |
| | 10~15 | Sand | | | | | 16 | 26 | 36 | 36 |
| | | Silt | | | | | 62 | 56 | 50 | 48 |
| | | Clay | | | | | 22 | 18 | 14 | 16 |
| | 15~20 | Sand | | | | | 14 | 22 | 50 | 16 |
| | | Silt | | | | | 66 | 64 | 38 | 62 |
| | | Clay | | | | | 20 | 14 | 12 | 22 |

Notes:

(1) Soil bearing test had been achieved at 58 sites in the Project Area during the Master Plan Study, it grasped only bearing force under present condition during autumn and winter.

However, for the Project formulation, further detail factors are to be grasped for mechanization of harvesting by additional soil bearing test. in Aug, 1991 years.

(2) Testing Period~ J.H=Just after Harvest. AFT.24hr=After 24 hours of J.H.

## TABLE A. 4-4 SOIL STRUCTURE OF SOIL SERIES DISTRIBUTED IN THE PROJECT AREA

| NO | Soil Series | Sampling Site | Soil Texture | Particle Size Distribution Sand (%) | Silt (%) | Clay (%) | Depth of Plow-sole cm | Moisture Ratio (%) | Puer Apparente Specific Gravity (gr/cm³) | Apparent Specific Gravity (gr/cm³) | Three Phase Distribution Solid (%) | Liqid (%) | Gaseous (%) | Porosity (%) | Coffecient of Permeability (cm/sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | Mt | Marzun kola | L | 60 | 27 | 13 | 30~35 | 20.3 | 2.667 | 2.02 | 68.1 | 20.3 | 11.6 | 31.9 | $8.80 \times 10^{-4}$ |
| 1-2 | | Shahueh Kola | LiC | 22 | 35 | 43 | 20~25 | 39.4 | 2.620 | 1.81 | 54.0 | 39.4 | 6.6 | 46.0 | $2.40 \times 10^{-3}$ |
| 2-1 | Da-Nu-Su | Ansari Mahaleh | SiC | 23 | 48 | 29 | 15~20 | 32.8 | 2.644 | 1.90 | 19.5 | 32.7 | 7.8 | 40.5 | $2.40 \times 10^{-3}$ |
| 2-2 | | Posha Kola | CL | 37 | 40 | 23 | 20~25 | 28.8 | 2.706 | 1.93 | 60.7 | 28.8 | 10.5 | 39.3 | $7.10 \times 10^{-3}$ |
| 3-1 | Bn-Gi | Laluk | CL | 48 | 35 | 17 | 20~25 | 24.9 | 2.708 | 1.94 | 62.4 | 24.9 | 12.7 | 37.6 | $7.10 \times 10^{-3}$ |
| 3-2 | | Pain Baziar | SiCL | 31 | 47 | 22 | 15~20 | 35.9 | 2.704 | 1.82 | 54.0 | 35.9 | 10.1 | 46.0 | $7.10 \times 10^{-4}$ |
| 4-1 | Da | Talikran | SiL | 28 | 56 | 16 | 20~25 | 36.7 | 2.604 | 1.36 | 52.2 | 36.7 | 11.1 | 47.8 | $3.12 \times 10^{-4}$ |
| 4-2 | | Golmahaleh | SiC | 28 | 45 | 27 | 30~35 | 41.6 | 2.619 | 1.76 | 51.4 | 41.6 | 7.0 | 48.6 | $9.40 \times 10^{-3}$ |
| 5-1 | Ba | Shah Kola | C | 2 | 30 | 68 | 20~25 | 49.6 | 2.633 | 1.17 | 44.4 | 49.6 | 6.0 | 55.6 | $1.24 \times 10^{-4}$ |
| 5-2 | | KhordmKolabala | CL~L | 57 | 28 | 15 | 20~25 | 22.9 | 2.678 | 2.01 | 66.5 | 22.9 | 10.6 | 33.5 | $2.30 \times 10^{-4}$ |
| 6-1 | Ke-Su | Sherefti | SiL | 44 | 48 | 8 | 20~25 | 34.8 | 2.714 | 0.80 | 29.4 | 34.7 | 35.9 | 70.6 | $3.15 \times 10^{-4}$ |
| 6-2 | | Shurestagh | CL | 14 | 48 | 38 | 30~35 | 40.6 | 2.703 | 1.30 | 48.1 | 40.6 | 11.3 | 51.9 | $1.46 \times 10^{-4}$ |
| 7-1 | Da-Su | Abumahallen | SiL | 18 | 68 | 14 | 20~25 | 43.8 | 2.616 | 1.30 | 49.7 | 43.8 | 6.5 | 50.3 | $1.42 \times 10^{-5}$ |
| 7-2 | | Tajenale | SiL | 28 | 60 | 12 | 25~30 | 35.9 | 2.680 | 1.37 | 51.1 | 35.9 | 13.0 | 48.9 | $3.34 \times 10^{-5}$ |
| 8-1 | Af-Da | Gel Mahallen | SiL | 36 | 54 | 10 | 20~25 | 30.2 | 2.642 | 1.48 | 55.9 | 30.2 | 13.9 | 44.0 | $1.02 \times 10^{-4}$ |
| 8-2 | | Mehamm adabad | SiL | 28 | 54 | 18 | 20~25 | 39.8 | 2.602 | 1.25 | 48.0 | 39.8 | 12.2 | 52.0 | $8.83 \times 10^{-5}$ |
| 9-1 | Ba-Ga-Af | Sadat Mahalleh | — | — | — | — | 20~25 | 59.6 | 2.587 | 1.58 | 38.0 | 59.6 | 2.4 | 62.0 | $4.02 \times 10^{-6}$ |
| 9-2 | | Lari Mahalleh | | | | | 20~25 | 39.3 | 2.610 | 1.83 | 55.1 | 39.2 | 5.7 | 44.9 | $1.60 \times 10^{-5}$ |
| 10-1 | Bo | Kalleh best | — | — | — | — | 20~25 | 46.0 | 2.623 | 1.93 | 56.0 | 42.0 | 2.0 | 44.0 | $8.40 \times 10^{-6}$ |
| 10-2 | | Barik Kola | | | | | 20~25 | 35.2 | 2.652 | 1.74 | 52.3 | 35.2 | 12.5 | 47,7 | $1.10 \times 10^{-6}$ |
| 11-1 | Ga | Khoshk rud | — | — | — | — | 20~25 | 42.0 | 2.603 | 1.78 | 51.9 | 42.0 | 6.1 | 48.1 | $2.70 \times 10^{-6}$ |
| 11-2 | | Kasar | | | | | 20~25 | 61.3 | 2.591 | 1.60 | 38.1 | 61.3 | 0.6 | 61.9 | $1.50 \times 10^{-5}$ |

Note: 1)Soil samples for Paticle size Distribution have been obtaived from the plowed soil and other soil samples have been obtaived from the plowsole.
2) — is not analized.

## TABLE A. 4-5 LAND CLASSIFICATION SPECIFICATION

| Land Characteristics | For Paddy Rice Production | | | For Upland Crop Production | | |
|---|---|---|---|---|---|---|
| | Class R1 | Class R2 | Class R3 | Class U1 | Class U2 | Class U3 |
| Soil<br>Soil texture<br>(Surface, 0-30 cm) | Clay Loam to very slowly permeable clay | Fine sandy Lome to very slowly permeable clay | Lomy fine sand to very slowly permeable clay | Fine sandy loam to friable clay loam | Loamy fine sand to permeable clay | Loamy coarse sand to slowly permeable clay |
| (Subsurface) | Silty clay loam to slowly permeable clay | Loamy fine sand to very slowly permeable clay | Loame fine sand to very slowly permeably clay | Coarse sandy loam to clay loam | Loamy fine sand to permeable clay | Loamy coarse sand to slowly permeable clay |
| Soil depth | >90cm | >60cm | > 30cm | >120cm | >90cm | >60cm |
| Soil stoniness % vol, topsoil | <15% | <35% | < 75% | <15% | <35% | <75% |
| Soil PH | 5.0~7.5 | 4.5~8.0 | 4.0~8.5 | 5.5~7.5 | 5.0~8.0 | 4.5~8.5 |
| Natural Soil Fertility | Medium | Medium | Less | Medium | Medium | Less |
| Soil salinity, EC.X10$^{3}$ | <$4_{ms}$/cm | <$8_{ms}$/cm | <$16_{ms}$/cm | <$4_{ms}$/cm | <$8_{ms}$/cm | <$16_{ms}$/ cm |
| Cation exchange capacity | >$10_{meq}$/100g | >$3_{meq}$/100g | >$3_{meq}$/100g | >$10_{meq}$/100g | >$5_{meq}$/100g | >$5_{meq}$/100g |
| Soil permeability | | | | 2~6cm/hr | 0.1~25cm/hr | >25cm/hr~<0.1cm/hr |
| Infiltration rate | not applicable | not applicable | not applicable | >2cm/hr | 1~2cm/hr | 0.2~1cm/hr |
| Topography<br>Overall slope | <1% | <2% | <52% | 0.25~2% | <5% | <8% |
| Micro-relief | smooth | smooth | uneven | smooth | unevent | rough |
| Present erosion status | no apparent | slight | moderate | no apparent | slight | moderate |
| Drainage<br>Surface | good | fair | poor | good | good~fair | fair~good |
| Internal | fair-somewhat poor | good~poor | good~very poor | good | good~fair | fair~good |
| Groundwater table | not applicable | not applicable | not applicable | >2m | >1.2m | >0.75m |
| Flooding & ponding | occasional damaging | periodic damaging | annual damaging | none | occasional damaging | periodic damaging |

Note:Class 6 Non-arable includes lands which do not meet the minimum requirement for other land class.

## TABLE A. 4 - 6 LAND CLASSIFICATION AND CORRELATION

| Soil Series & Mapping Symbo | USDA soill Taxonomy | | | FAO 1974 | Iranian |
|---|---|---|---|---|---|
| | Family | Sub Group | Oder | | |
| Nur(Nu) | Fine Mixed Thermic | Mollic Ochraqualfs | Alfisols | Humic Gleysols | Humic Gley Soils |
| Darzikola(Da) | Fine Loamy Mixed Calcareous Thermic | Mollic Fluvaquents | Entisols | Mollic Gleysols | Humic Gley Soils |
| Babol(Ba) | Fine Mixed Non-acid Thermic | Mollic Fluvaquents | Entisols | Mollic Gleysols | Humic Gley Soils |
| Form(Fo) | Fine Mixed Calcareous Thermic | Typic Fluvaquents | Entisols | Calcaric Gleysols | Low Humic Gley Soils |
| Kelayban(Ke) | Fine Loamy Mixed Non-acid Thermic | Mollic Udifluvents | Entisols | Calcaric Fluvisols | Alluvial Soils |
| borj(Bo) | Fine Loamy Mixed Calcareous Thermic | Typic Xerofluvents | Entisols | Calcaric Fluvisols | Alluvial Soils |
| Khazar(Kz) | Mixed Calcareous Thermic | Typic Xeropsamments | Entisols | Calcaric Regosols | Regosoils |
| Ganjafruz(Ga) | Fine Mixed Thermic | Typic Calciaquolls | Mollisols | Mollic Gleysols | Humic Gley Soils |
| Sufimahaleh(Su) | Fine Mixed Non-acid Thermic | Fluventic Haplaquolls | Mollisols | Mollic Gleysols | Humic Gley Soils |
| Afratakht(Af) | Coarse Loamy Mixed Calcareous Thermic | Fluventic Haplaquolls | Mollisols | Mollic Gleysols | Humic Gley Soils |
| Miantalar(Mt) | Fine Mixed Thermic | Typic Argiudolls | Mollisols | Luvic Phaeozems | Prairi Soils |
| Gavlangar(Gl) | Fine Mixed Thermic | Calcic Argixerolls | Mollisols | Calcic Kastanezems | Chestnut Soils |
| Banikola(Bn) | Fine Mixed Thermic | Typic Argxerolls | Mollisols | Calcic Kastanezems | Chestnu Soilst |

Note: According to Semi-Detailed and Reconnaissance Studies of West Mazandaran (1984)by M/p report

SAMPLING SITE FOR SOIL/ANALYSIS IN PROJECT AREA(1992)

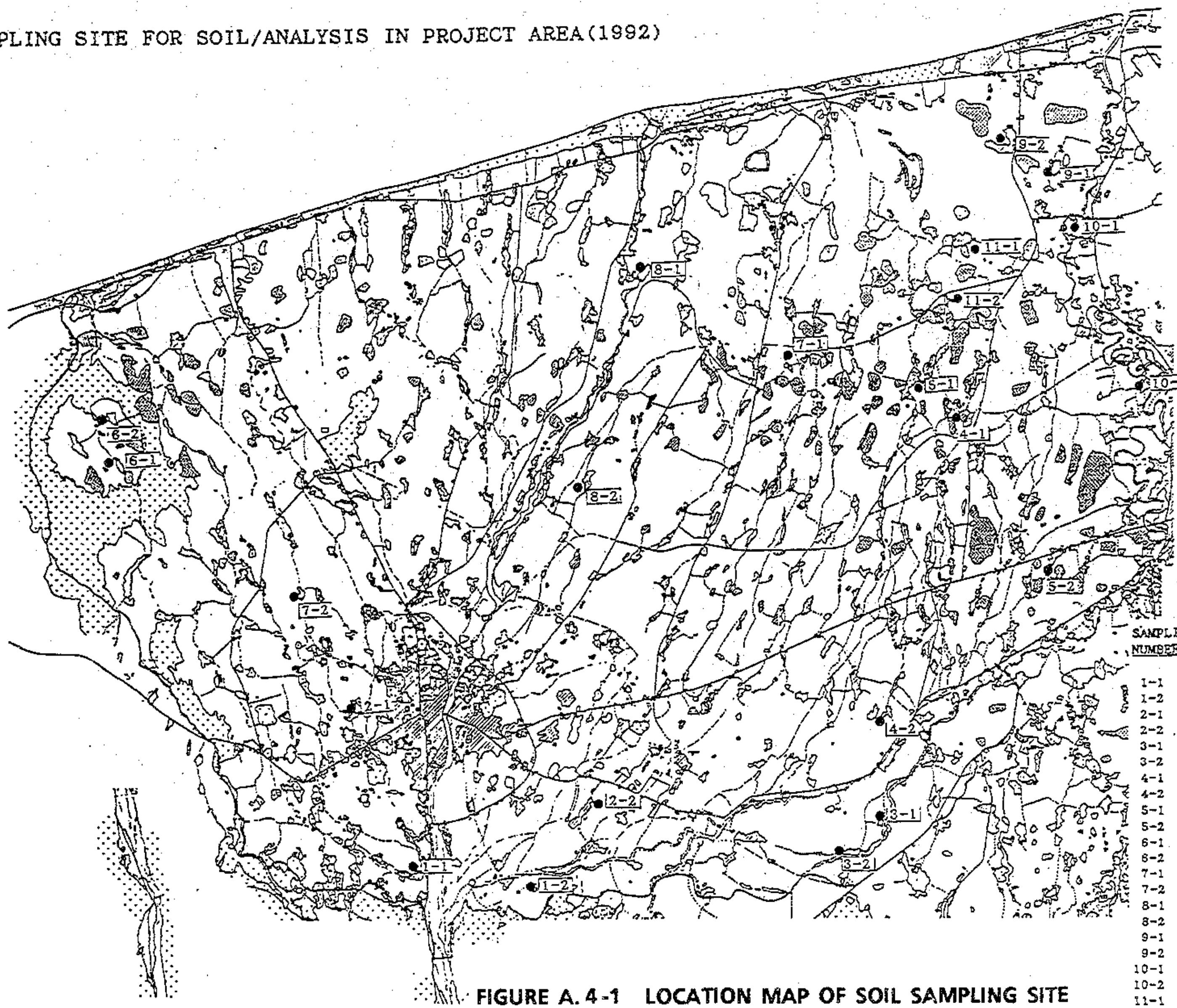



FIGURE A. 4-1 LOCATION MAP OF SOIL SAMPLING SITE

| SAMPLING NUMBER | SOIL SERIES | SAMPLING SITE |
|---|---|---|
| 1-1 | Mt | MarzunKola |
| 1-2 | Mt | ShahuehKola |
| 2-1 | Da. Nu. Su | AnsariMahaleh |
| 2-2 | Da. Nu. Su | PashaKola |
| 3-1 | Bn. Gi | Laluk |
| 3-2 | Bn. Gi | PainBaziar |
| 4-1 | Da | Talikran |
| 4-2 | Da | Golmahaleh |
| 5-1 | Ba | ShahKola |
| 5-2 | Ba | KhordmKolaBala |
| 6-1 | Ke. Su | Sherefti |
| 6-2 | Ke. Su | Shurestagh |
| 7-1 | Da. Su | Abumahallen |
| 7-2 | Da. Su | Tajenale |
| 8-1 | Af. Da | GelMahallen |
| 8-2 | Af. Da | Mehammad |
| 9-1 | Ba. Ga. Af | Ujaksar |
| 9-2 | Ba. Ga. Af | GarganMahalleh |
| 10-1 | Bo | Kallehbest |
| 10-2 | Bo | BarikKola |
| 11-1 | Ga | Khskkrud |
| 11-2 | Gs | Kasar |

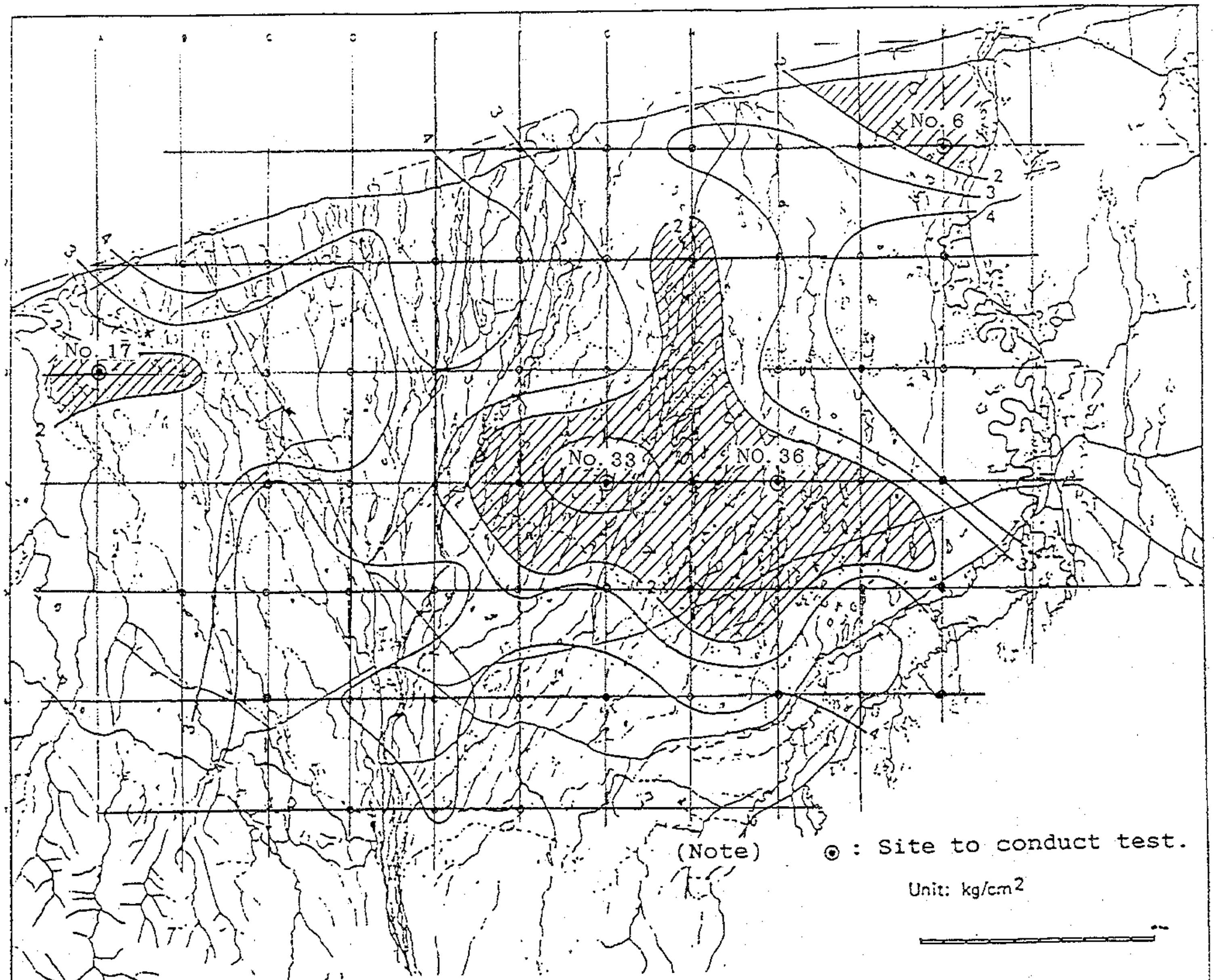



FIGURE A. 4-2 LOCATION MAP OF SOIL BEARING TEST

# APPENDIX B. IRRIGATION AND DRAINAGE

# APPENDIX B. IRRIGATION AND DRAINAGE

## CONTENTS


| | | | Page |
|---|---|---|---|
| B. 1 | Water Resources | | B1-i |
| | B. 1. 1 | Availability of Water Resources | B1-1 |
| | B. 1. 2 | Preliminary Study of New Water Resources Development | B1-21 |
| | B. 1. 3 | Outline of Geology in Mangol Damsite | B1-41 |
| | B. 1. 4 | Preliminary Water Balance Study in Case of Lar Dam Only | B1-47 |
| B. 2 | Irrigation | | B2-i |
| | B. 2. 1 | TIB Survey on Irrigation | B2-1 |
| | B. 2. 2 | Water Right | B2-29 |
| | B. 2. 3 | Irrigable area by Zone-wise | B2-58 |
| | B. 2. 4 | Plan of Irrigation Canal System | B2-63 |
| | B. 2. 5 | Irrigation Water Requirement | B2-73 |
| | B. 2. 6 | Operation and Maintenance | B2-93 |
| | B. 2. 7 | Relation Between Yield of Rice and Water Shortage | B2-95 |
| B. 3 | Drainage | | B3-i |
| | B. 3. 1 | Existing Drainage Network and Condition | B3-1 |
| | B. 3. 2 | Drainage Monitoring | B3-17 |
| | B. 3. 3 | TIB Survey on Drainage | B3-23 |
| | B. 3. 4 | Evaluation of Drainage Design Year | B3-30 |
| | B. 3. 5 | Concepts on Drainage Canal Profile and Depth | B3-35 |
| | B. 3. 6 | Proposed Surface Drainage | B3-41 |
| | B. 3. 7 | Proposed Subsurface Drainage | B3-55 |
| B. 4 | On-Farm Facilities | | B4-i |
| | B. 4. 1 | Soil Bearing Test | B4-1 |
| | B. 4. 2 | Present Conditions of Sample Area | B4-1 |
| | B. 4. 3 | Sample Designs | B4-2 |
| | B. 4. 4 | Earth Work Volumes of Sample Designs | B4-4 |
| | B. 4. 5 | Application Method of Sample Designs to the Entire Project Area | B4-13 |

## APPENDIX B. 1 WATER RESOURCES

CONTENTS


Page

B. 1. 1 Availability of Water Resources ........ B1-1

1. Effective Rainfall ........ B1-1
2. Surface Water ........ B1-1
3. Groundwater ........ B1-2
4. Farm Pond (Abbandan) ........ B1-3
5. Return Flow ........ B1-5
6. Irrigation Area by Water Resources at Present Stage ........ B1-7

B. 1. 2 Preliminary Study of New Water Resources Development ........ B1-21

1. Introduction ........ B1-21
2. Basic Input Data of the Simulation ........ B1-23
3. Water Balance Simulation ........ B1-26

B. 1. 3 Outline of Geology in Mangol Damsite ........ B1-41

B. 1. 4 Preliminary Water Balance Study in Case of Lar Dam Only ........ B1-47

1. Introduction ........ B1-47
2. Operation Case and Rule of Water Resources Facility ........ B1-49
3. Runoff Discharge of the Haraz River ........ B1-52
4. Storage Capacity of Abbandan and Available Release of Lar Dam ........ B1-52
5. Calculation of Water Balance ........ B1-52
6. Conclusions ........ B1-54