## Table-4    Yield Logging Data of M-4 Test Well

| Aquifer | Screen section (m) | | | Yield section (m) | | | Yield amount (1/sec) | |
|---------|--------|---|--------|------|---|------|------|------|
| (1) | 83.17 | ~ | 89.67 | | | | 0 | 0 |
| (2) | 113.79 | ~ | 119.92 | 114 | ~ | 120 | 1.9 | 6.7 |
| (3) | 130.82 | ~ | 136.32 | 131 | ~ | 135 | 0.8 | 0.9 |
| (4) | 154.41 | ~ | 165.41 | 160 | ~ | 166 | 13.3 | 20.5 |
| (5) | 177.47 | ~ | 193.77 | 186 | ~ | 194 | 4.0 | 6.9 |
| Total | | | | | | | 20.0 | 35.0 |

It is concluded that the excellent aquifer exists below 150 m in depth though some aquifers lay up to 150 m.

d.  Well loss

Well loss are estimated by employing the step-drawdown test data, as shown in Fig. 10.   Constant values B and C in Jacob's equation are calculated as follows.


B = 0.29
C = (0.31 - 0.29)/45.1 = 0.0004


Thus, $S' = 0.29Q + 0.0004Q^2$

## 5.3 Radius of Influence

Drawdown of water level by pumping is considered to be stable at certain distance owing to recharge from outside and vertical leakage through the confining layer.  Seasonal and long-term changes of water table in large area shall be evaluated by employing a computer simulation based on the future pumping plan.   Therefore, only short-term drawdown of water level by pumping and its influence for 2 days since the pumping has begun is calculated by using the following values measured in M-5 and D-7 test wells and assumed reasonably.

|                                     | M-4              | D-7              |
| ----------------------------------- | ---------------- | ---------------- |
| Transmissivity, T (m²/day)          | 757              | 412              |
| Storage coefficient, S              | 0.005            | 0.005            |
| Peak pumping discharge Q (m³/day)   | 2,160 (25 1/sec) | 3,456 (40 1/sec) |
| Pumping time, t (day)               | 2                | 2                |

From Theis equation,

$$S = (Q/4\pi T)\ W\ (u)$$

$$u = r^2 S/4Tt$$

where, S  :  drawdown

Q  :  constant pumping discharge

T  :  transmissivity

W(u) :  well function

r  :  distance from well

S  :  storage coefficient

t  :  days since pumping has begun

It is judged by the relationship between pumping head and pumping rate that the drawdown of 1 m does not affect to the pumping discharge. Radius of influence in less than 1 m drawdown is estimated to be more than 300 m as shown in Fig. 11. Therefore, it is recommended that the distance among production wells should be more than 600 m.
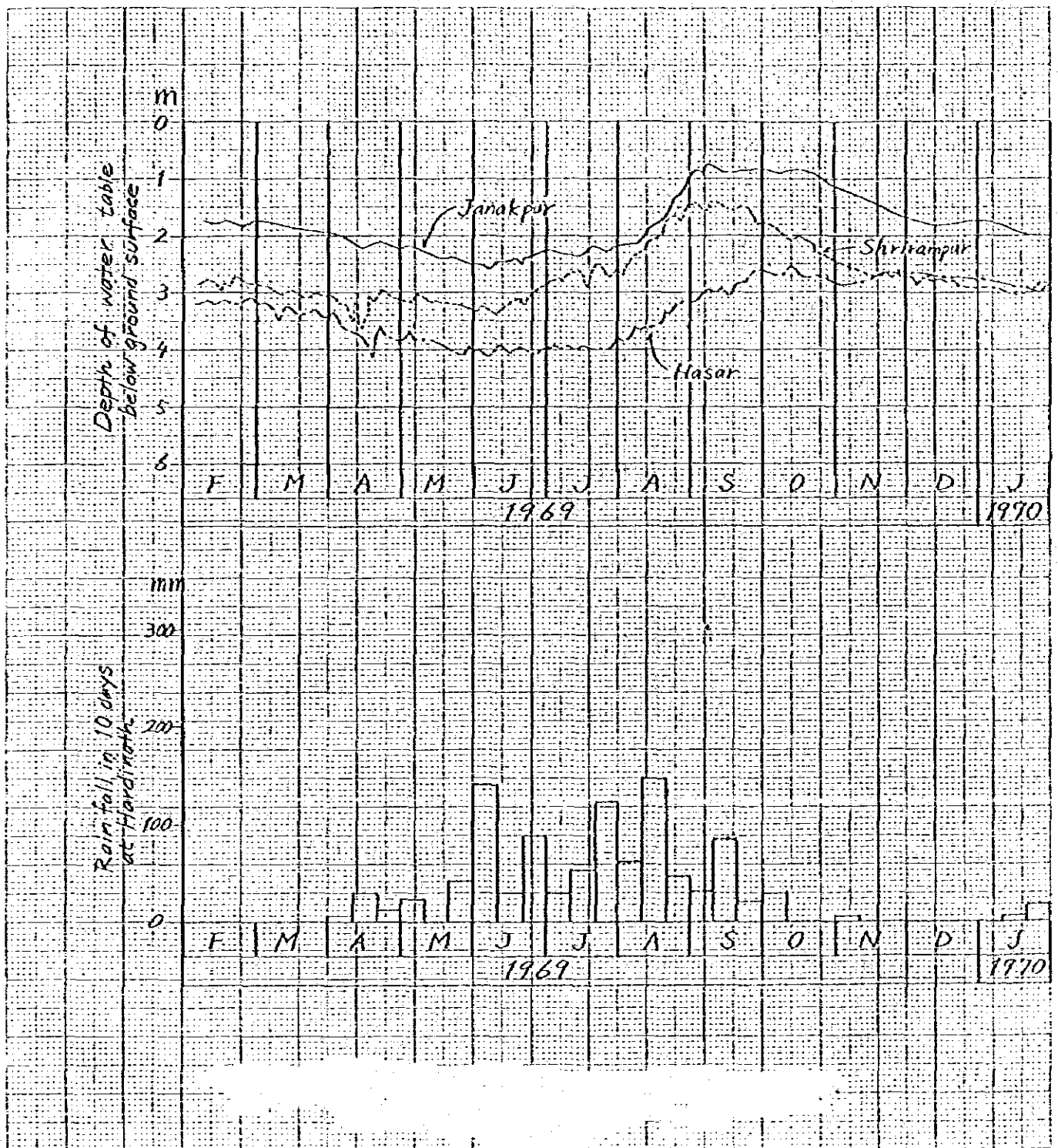
Fig. 1    Seasonal Fluctuation of Water Table
          in the Janakapur Area

          ("Report on the groundwater investigation
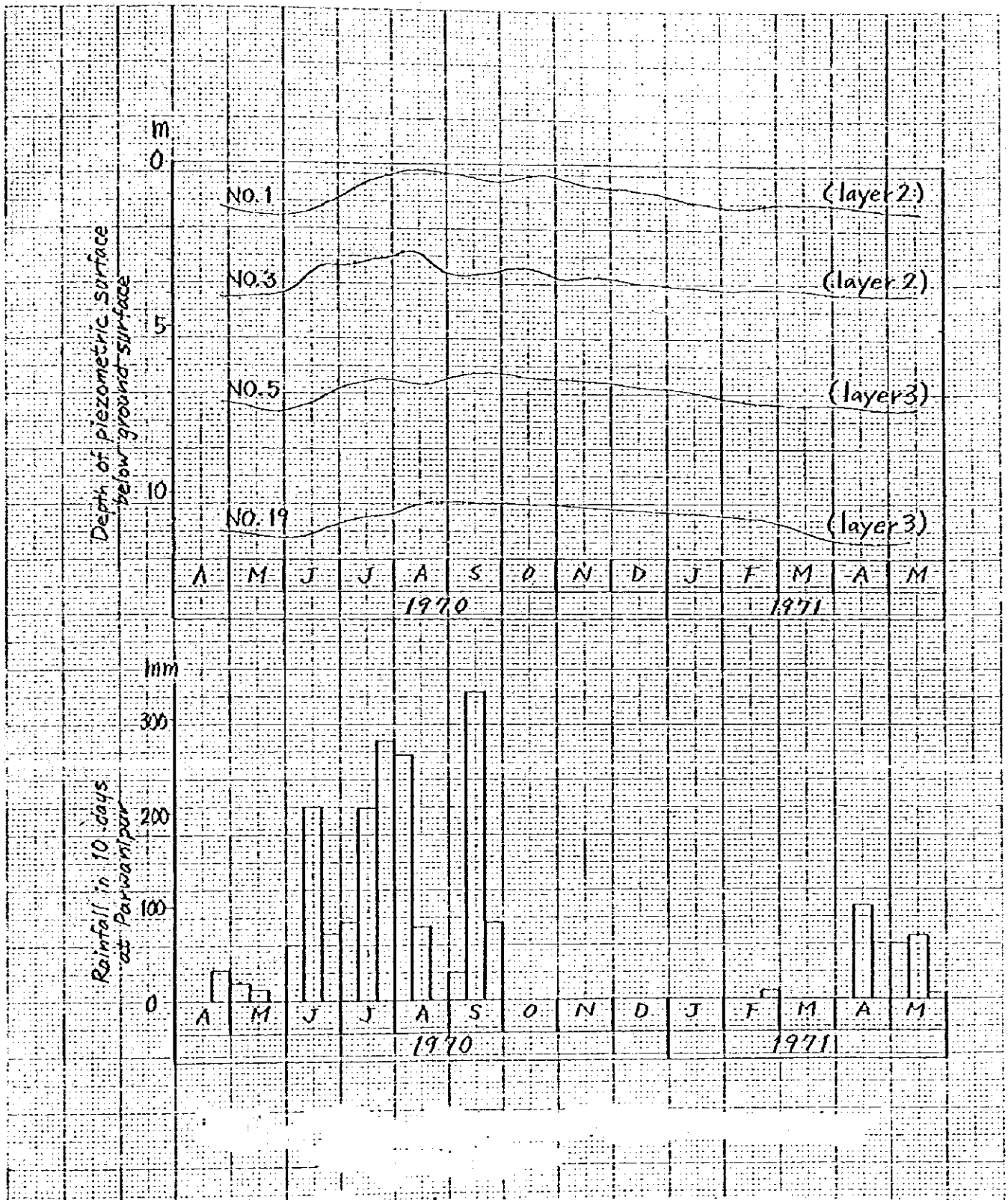          in the Sunkoshi Terai project", FAO)

Fig. 2  Seasonal Fluctuation of Piezometric Head in
Birganj Area

("Feasibility of a Combined Surface and Groundwater
Project in Birganj Area" ANNEX V, FAO)

# LOC. M-4  WELL LOG

CASING DATE: 4TH MAR. '88

RIG     : YRD-501, NAS-7
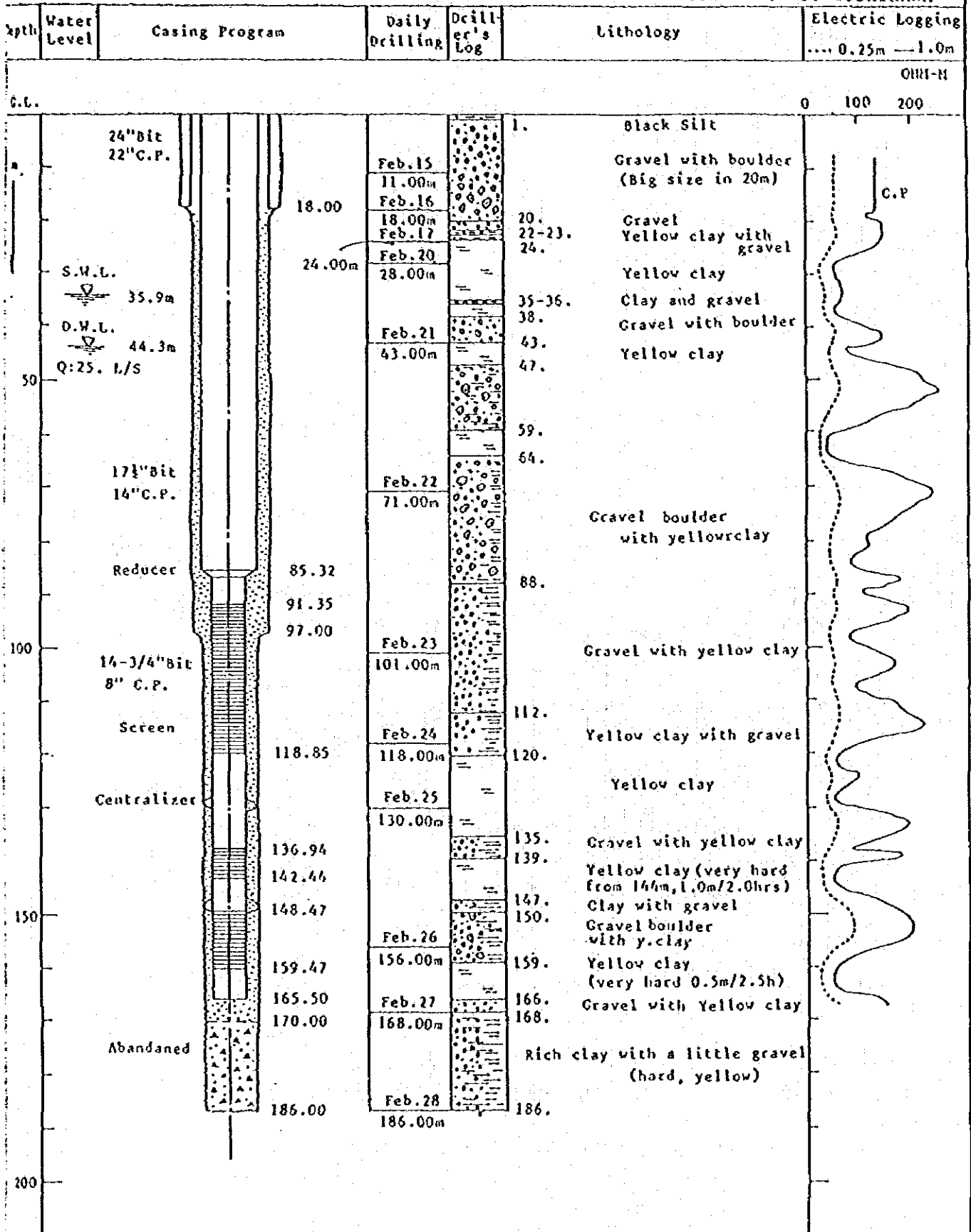DRILLER: D. N. SEN
SPV     : S. YOSHIKAWA

| Depth | Water Level | Casing Program | Daily Drilling | Driller's Log | Lithology | Electric Logging ···· 0.25m —— 1.0m |
|---|---|---|---|---|---|---|
| | | | | | | OHM-M |
| G.L. | | | | | | 0    100    200 |

Casing Program column:
- 24"Bit 22"C.P.
- S.W.L. ▽ 35.9m
- O.W.L. ▽ 44.3m
- Q:25. L/S
- 17½"Bit 14"C.P.
- Reducer          85.32
- 91.35
- 97.00
- 14-3/4"Bit 8" C.P.
- Screen
- 118.85
- Centralizer
- 136.94
- 142.46
- 148.47
- 159.47
- 165.50
- 170.00
- Abandaned
- 186.00
- 18.00
- 24.00m

Daily Drilling column:
- Feb.15  11.00m
- Feb.16  18.00m
- Feb.17
- Feb.20  28.00m
- Feb.21  43.00m
- Feb.22  71.00m
- Feb.23  101.00m
- Feb.24  118.00m
- Feb.25  130.00m
- Feb.26  156.00m
- Feb.27  168.00m
- Feb.28  186.00m

Lithology column:
- 1.      Black Silt
- Gravel with boulder (Big size in 20m)
- 20.     Gravel
- 22-23.  Yellow clay with gravel
- 24.
- Yellow clay
- 35-36.  Clay and gravel
- 38.     Gravel with boulder
- 43.     Yellow clay
- 47.
- 59.
- 64.
- Gravel boulder with yellow clay
- 88.
- Gravel with yellow clay
- 112.
- Yellow clay with gravel
- 120.    Yellow clay
- 135.    Gravel with yellow clay
- 139.    Yellow clay (very hard from 144m,1.0m/2.0hrs)
- 147.    Clay with gravel
- 150.    Gravel boulder with y.clay
- 159.    Yellow clay (very hard 0.5m/2.5h)
- 166.    Gravel with Yellow clay
- 168.
- Rich clay with a little gravel (hard, yellow)
- 186.

Electric Logging: C.P

Depth scale marks: 50, 100, 150, 200

Fig. 3    Well Log at M-4

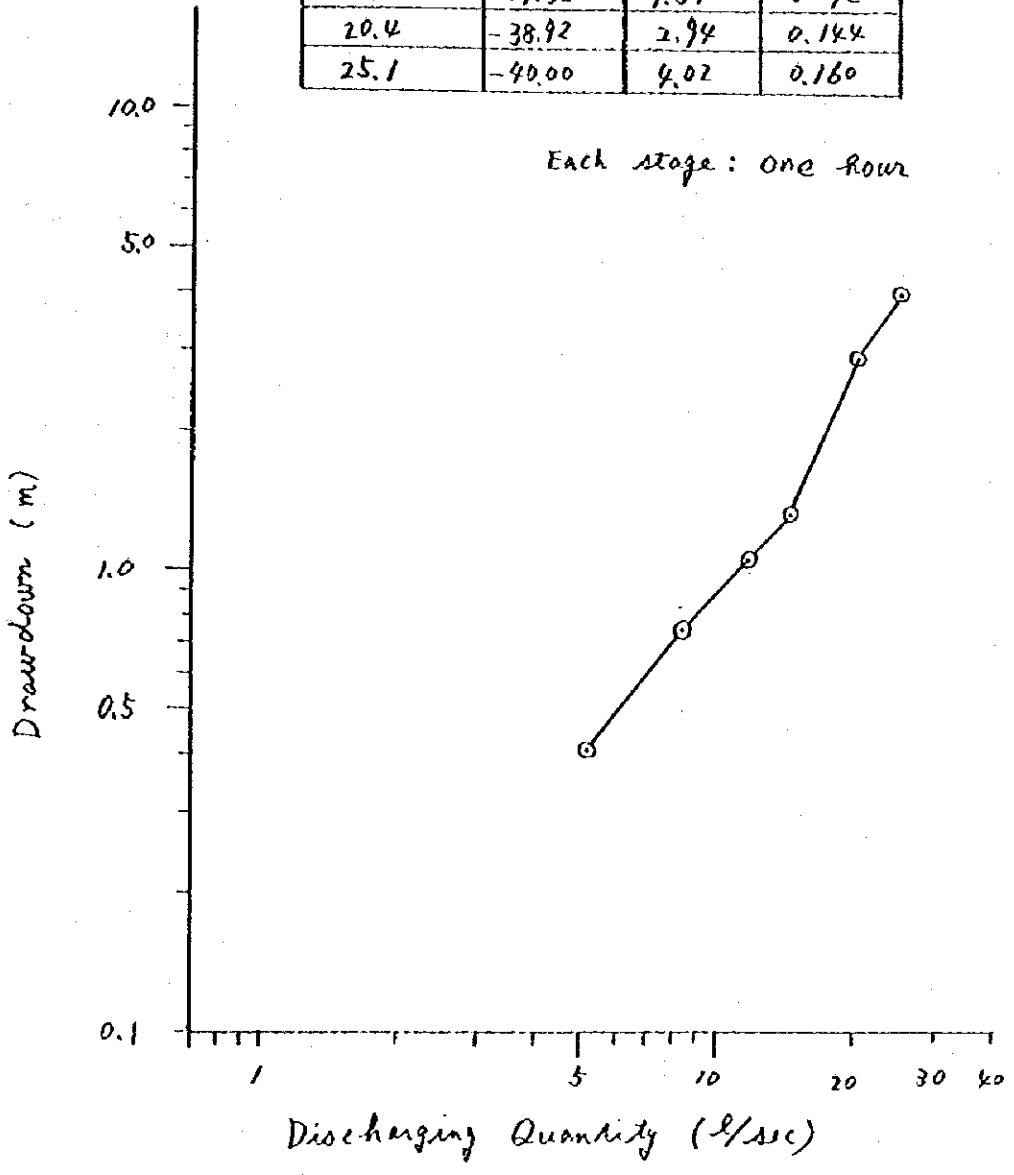| Discharge (Q) | D. W. L | Dd (S) | S/Q |
|---|---|---|---|
| 0 ℓ/sec | -35.98 m | 0 m | — |
| 5.2 | -36.39 | 0.41 | 0.079 |
| 8.4 | -36.73 | 0.75 | 0.089 |
| 11.9 | -37.06 | 1.08 | 0.091 |
| 14.6 | -37.32 | 1.34 | 0.092 |
| 20.4 | -38.92 | 2.94 | 0.144 |
| 25.1 | -40.00 | 4.02 | 0.160 |

Each stage: one hour



Fig. 4    Step Drawdown Test Curve (M-4) (Mar. 11th, '88)

5 - 12

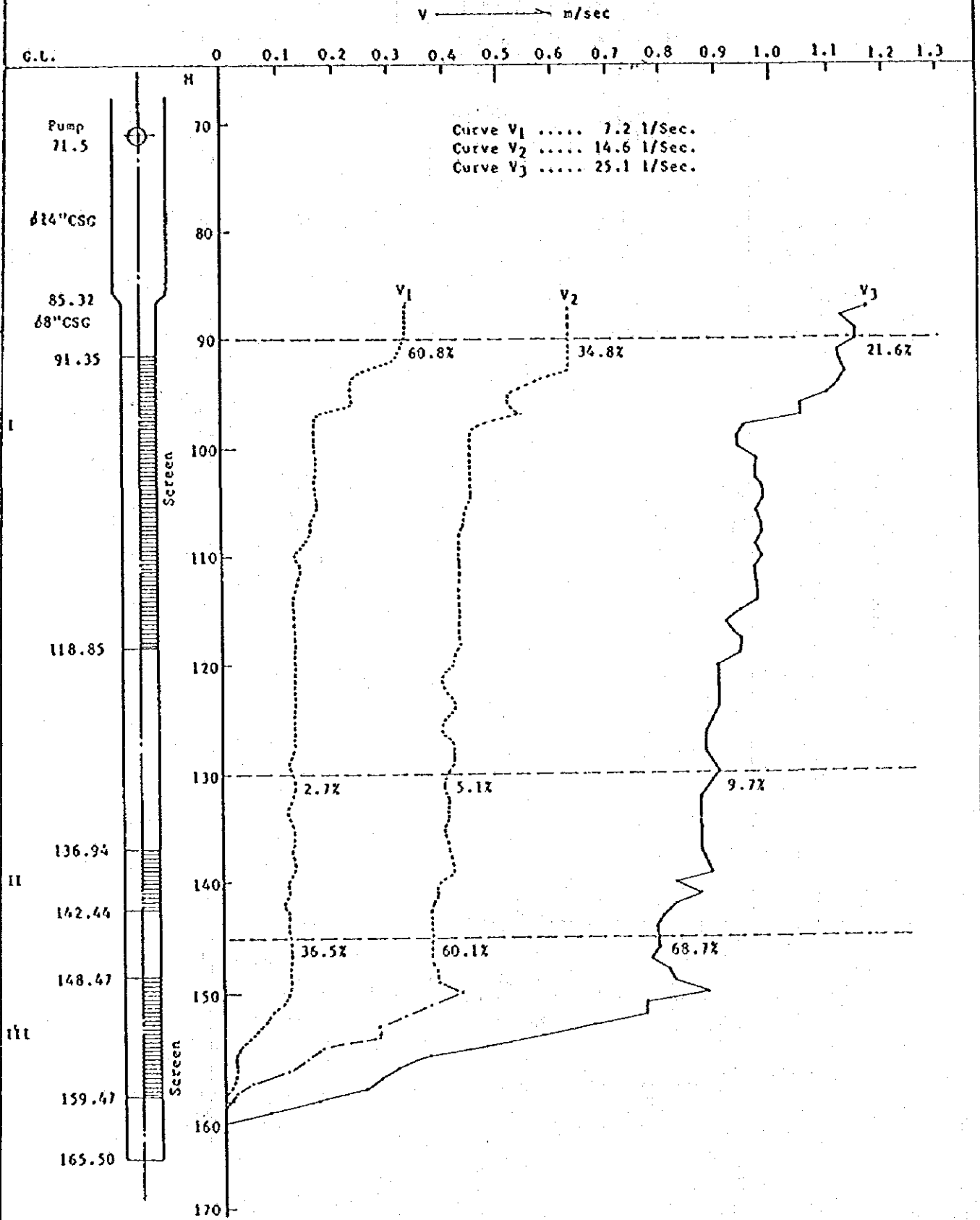# LOC. M-4  WELL CURRENT MEASURING CHART

## (PRODUCTION RATIO OF EACH AQUIFER)

12th MAR. '88
S. YOSHIKAWA

V ———→ m/sec

Curve $V_1$ ..... 7.2 1/Sec.
Curve $V_2$ ..... 14.6 1/Sec.
Curve $V_3$ ..... 25.1 1/Sec.

Fig. 5    Well Current Measuring Chart at M-4
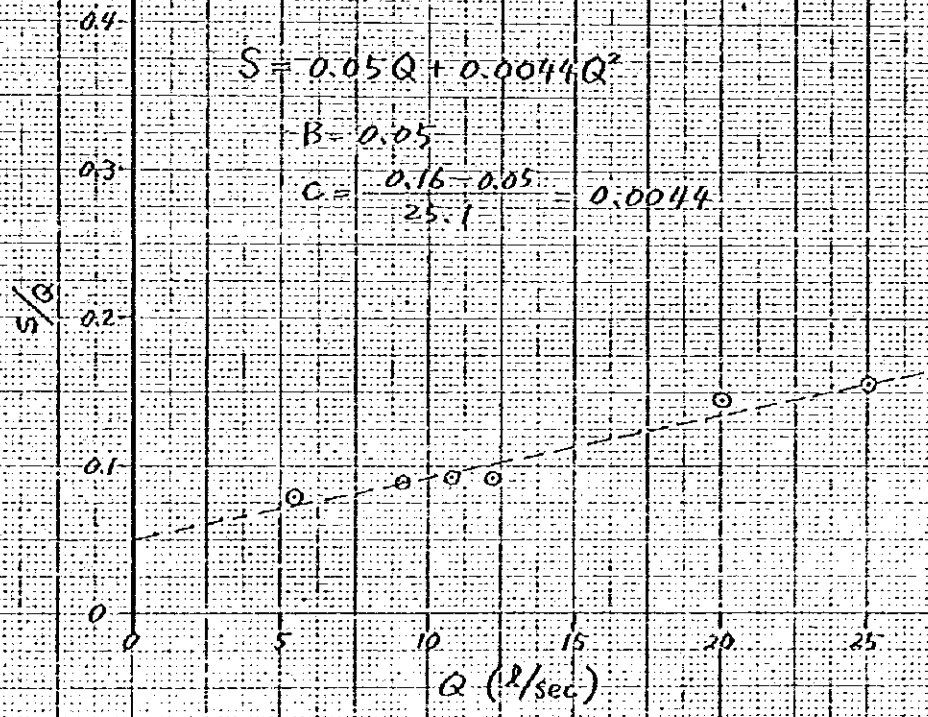
$$S = 0.05Q + 0.0044Q^2$$

$$B = 0.05$$

$$C = \frac{0.16 - 0.05}{25.1} = 0.0044$$

Fig. 6   Well Loss Calculation Curve
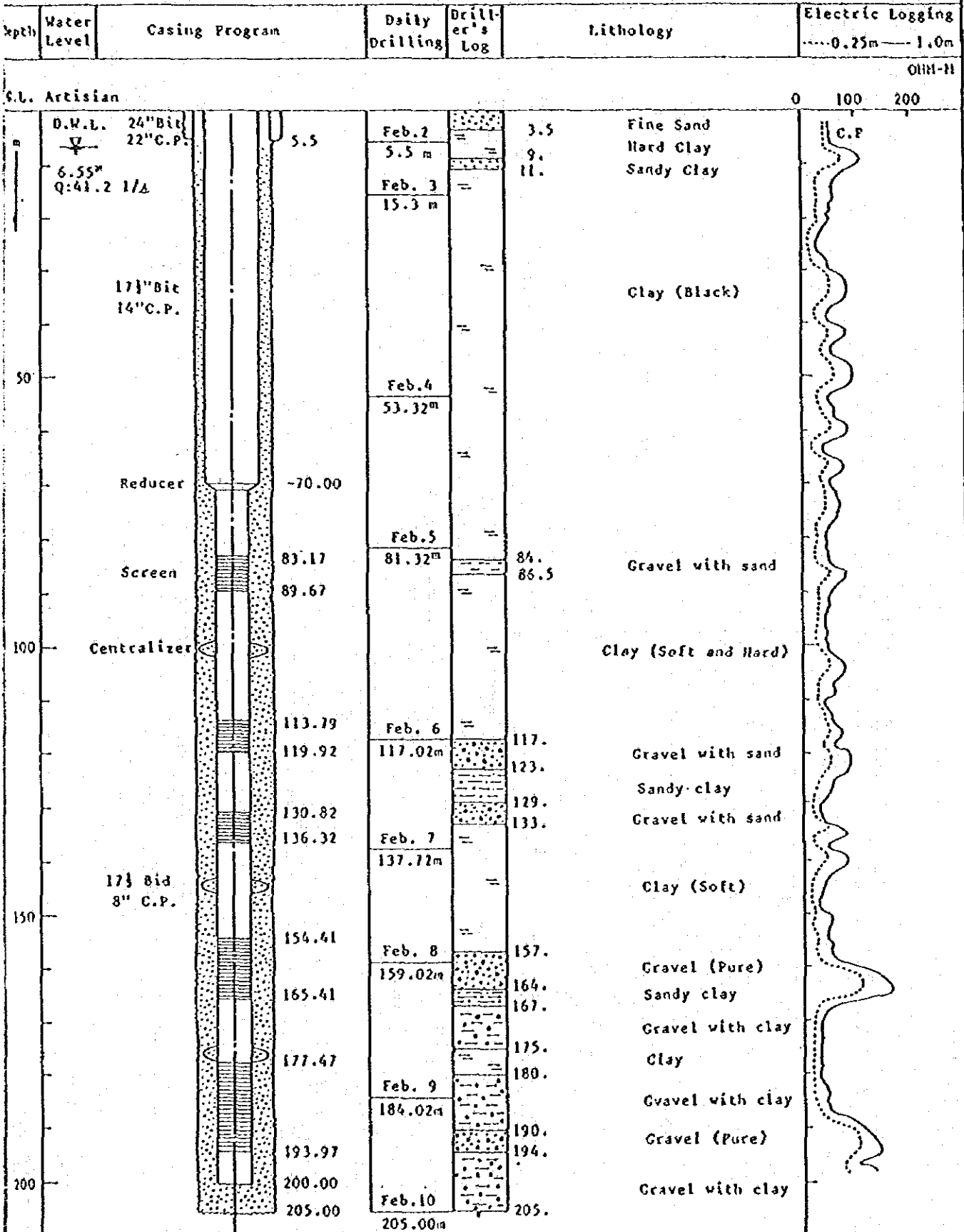
Fig. 7   Well Log at D-7

| Discharge(Q) | D.W.L | Dd (S) | S/Q |
|---|---|---|---|
| 0 ℓ/sec | + 6.00 m | 0 m | —— |
| 20.0 (自噴) | 0 | 6.0 | 0.30 |
| 25.1 | - 1.46 | 7.46 | 0.29 |
| 30.2 | - 3.57 | 9.57 | 0.32 |
| 35.6 | - 4.58 | 10.58 | 0.30 |
| 41.2 | - 6.90 | 12.90 | 0.31 |
| 45.1 | - 8.02 | 14.02 | 0.31 |
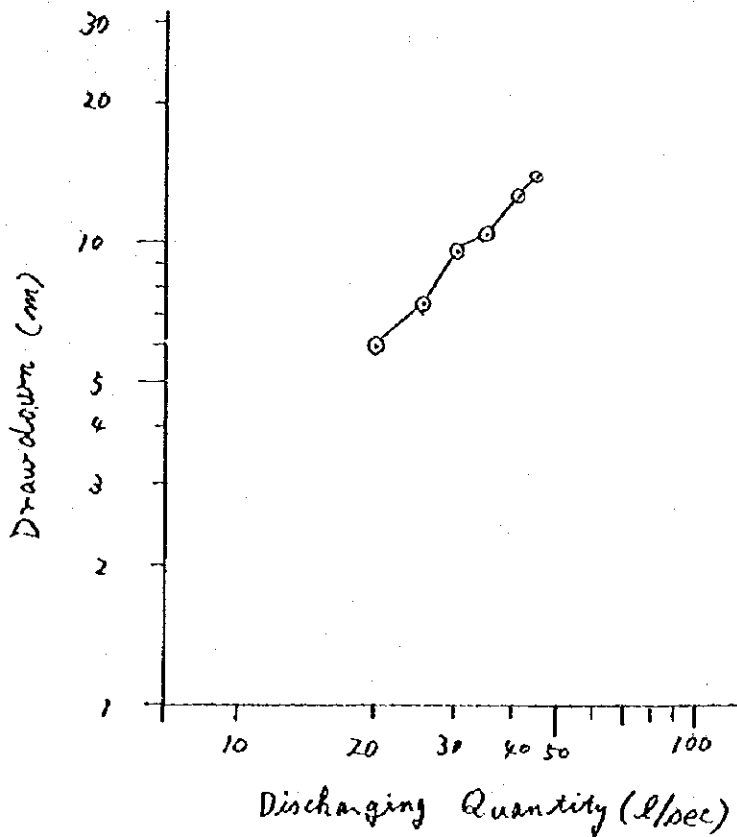


Fig. 8    Step Drawdown Test Curve (D-7)

LOC. D-7 WELL CURRENT MEASURING CHART

(PRODUCTION RATIO OF EACH AQUIFER)

28th Feb. '88
T. SUZUHURA

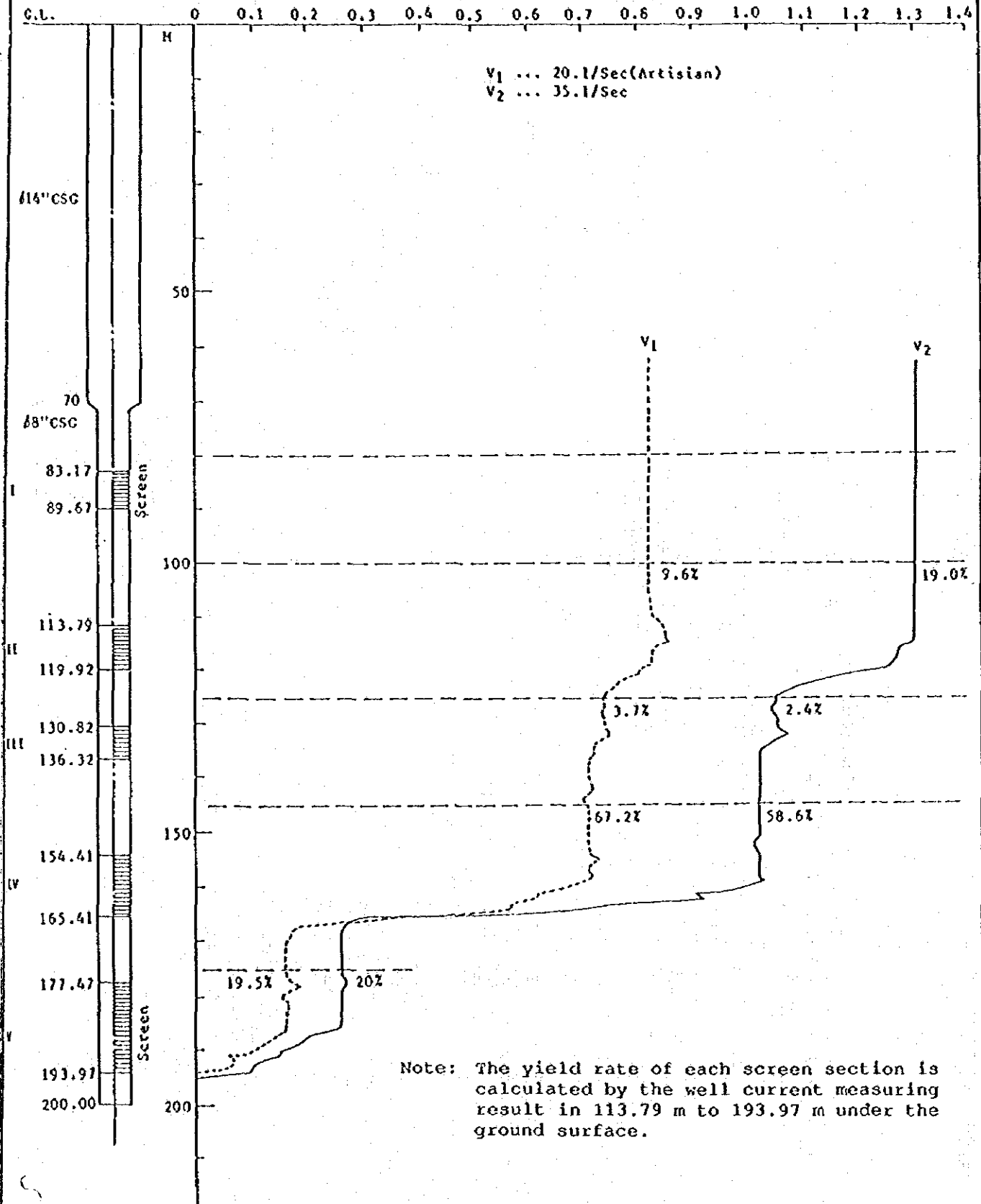V ————————➤ m/sec

$V_1$ ... 20.l/Sec(Artisian)
$V_2$ ... 35.l/Sec

Note: The yield rate of each screen section is calculated by the well current measuring result in 113.79 m to 193.97 m under the ground surface.

Fig. 9    Well Current Measuring Chart at D-7

$$S = 0.29Q + 0.0004Q^2$$

$$B = 0.29$$
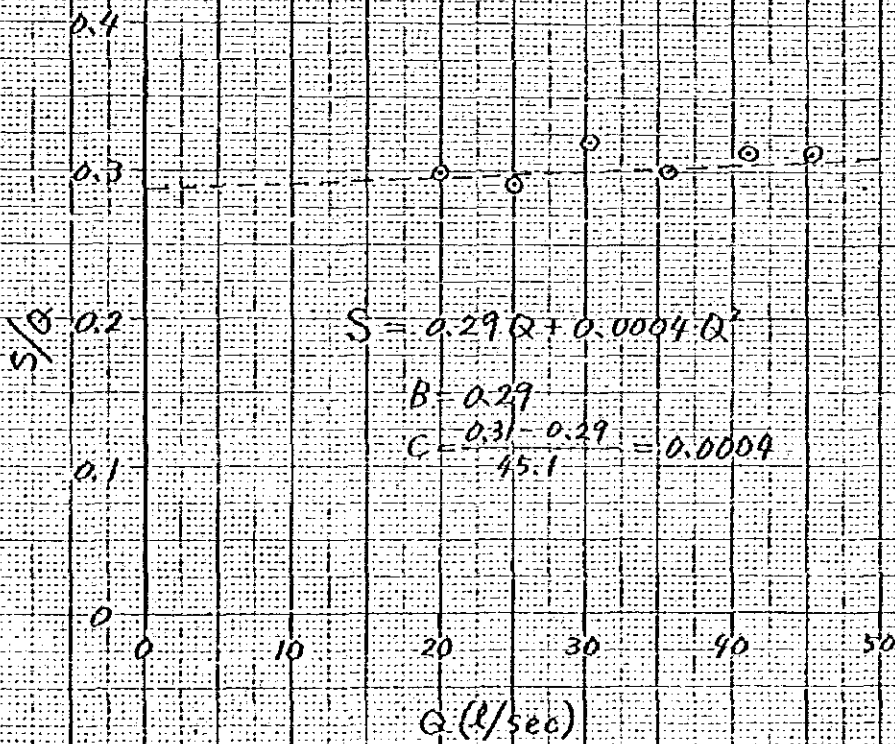
$$C = \frac{0.31 - 0.29}{45.1} = 0.0004$$

Q (ℓ/sec)

Fig. 10 Well Loss Calculation Curve

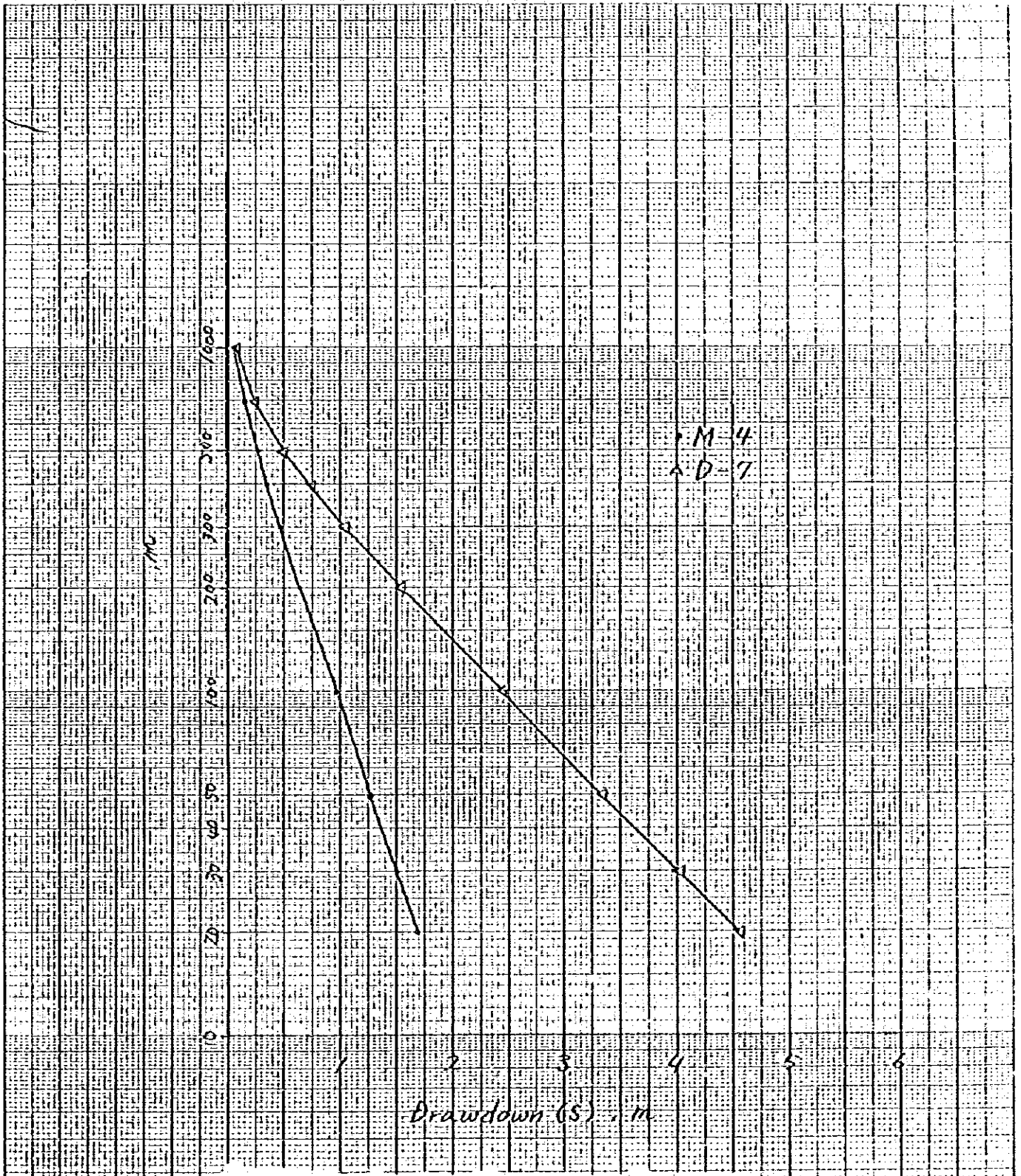Fig. 11  Influence Radius and Drawdown

## APPENDIX 6.   IMPROVEMENT OF FARMHOUSE ECONOMY EXPECTED BY THE PROJECT

In order to forecast improvement of farmhouse economy to be brought from the increment of agricultural production by the Project, an average farmhouse's economy is examined about three cases: present condition, without-project condition and with-project condition.

## 6.1 Present Agriculture in the Development Areas (400 ha) within D-7 and D-15 Blocks

(1)  Cropping area and cropping intensity

|  | Cropping area (ha) | Cropping intensity (percent against 400 ha) |
|---|---|---|
| Rainy season paddy | 360 | 90 |
| Wheat | 240 | 60 |
| Mustard | 30 | 7.5 |
| Vegetables (Potato, etc.) | 10 | 2.5 |
| Total | 640 | 160 |

Note:  Above figures were estimated based on the farm economic survey carried out in the Phases-I and II study.

(2)  Crop unit yield and production

|  | Unit yield (ton/ha) | Cropping area (ha) | Production (ton) |
|---|---|---|---|
| Rainy season paddy | 2.0 | 360 | 720 |
| Wheat | 1.8 | 240 | 432 |
| Mustard | 0.5 | 30 | 15 |
| Vegetables (Potato, etc.) | 6.0 | 10 | 60 |

Note:  Above figures were estimated based on the farm economic survey carried out in the Phase-I and II study.

(3) Agricultural production amount

| | Production (ton) | Farm gate price (Rs/kg) | Production amount (Rs x 1,000) |
|---|---|---|---|
| Rainy season paddy | 720 | 3.2 | 2,304 |
| Wheat | 432 | 3.0 | 1,296 |
| Mustard | 15 | 7.0 | 105 |
| Vegetables (Potato, etc.) | 60 | 3.0 | 180 |
| Total | | | 3,885 (Rs. 9,713/ha) |

Note: Farm gate price of each crop is an average of the prices obtained by the farm economic survey and market survey conducted in the Phases-I and II study.

6.2 Agriculture Plan in the Development Areas within D-7 and D-15 Blocks

(1) Cropping area and cropping intensity

| | Cropping area (ha) | Cropping intensity (percent against 400 ha) |
|---|---|---|
| Early season paddy | 80 | 20 |
| Rainy season paddy | 360 | 90 |
| Wheat | 280 | 70 |
| Mustard | 60 | 15 |
| Vegetables (Potato, etc.) | 40 | 10 |
| Tomato | 20 | 5 |
| Total | 840 | 210 |

## (2) Crop unit yield and production

| | Unit yield under the without-project condition | | With-project condition | | |
|---|---|---|---|---|---|
| | Present (ton/ha) | Without-project (ton/ha) | Unit yield (ton/ha) | Cropping area (ha) | Production (ton) |
| Early season paddy | 2.0 | 2.5 | 4.0 | 80 | 320 |
| Rainy season paddy | 2.0 | 2.5 | 4.0 | 360 | 1,440 |
| Wheat | 1.8 | 2.0 | 2.5 | 280 | 700 |
| Mustard | 0.5 | 0.6 | 0.8 | 60 | 48 |
| Vegetables (Potato, etc.) | 6.0 | 8.0 | 12.0 | 40 | 480 |
| Tomato | - | 8.0 | 12.0 | 20 | 240 |

Note: (1) Unit yield of each crop under the with-project condition is almost same to that in other irrigation projects such as Narayani, Sunsari Morang, East Rapti, etc. in the Terai plain, and is a target yield in and after 5th year after completion of irrigation facilities.

(2) Presently, tomato is not cultivated in the development areas. However, its extensive cultivation has been practised in the neighboring areas.

(3) A marketing route to Kathmandu, Birganj, Biratnagar, etc., has to be assured for increment of agricultural production by the Project, particularly tomato and vegetables.

(3)   Agricultural production amount

|  | Production (ton) | Farm gate price (Rs/kg) | Production amount (Rs x 1,000) |
|---|---|---|---|
| Paddy | 1,760 | 3.2 | 5,632 |
| Wheat | 700 | 3.0 | 2,100 |
| Mustard | 48 | 7.0 | 336 |
| Vegetables (Potato, etc.) | 480 | 3.0 | 1,440 |
| Tomato | 240 | 4.0 | 960 |
| Total |  |  | 10,468 (Rs. 26,170/ha) |

(4)   Incremental amount of agricultural production

|  | Present condition (Rs. x 1,000) | With-project (Rs x 1,000) | Increment (Rs x 1,000) |
|---|---|---|---|
| Paddy | 2,304 | 5,632 | 3,328 |
| Wheat | 1,296 | 2,100 | 804 |
| Mustard | 105 | 336 | 231 |
| Vegetables (Potato, etc) | 180 | 1,440 | 1,260 |
| Tomato | – | 960 | 960 |
| Total | 3,885 (Rs. 9,710/ha) | 10,468 (Rs. 26,170/ha) | 6,583 (Rs. 16,460/ha) |

## 6.3 Agricultural Benefit per Ha

### (1) Present condition

|  | Yield (ton/ha) | Farm gate price (Rs./ton) | Gross income (Rs./ha) | Production cost (Rs./ha) | Agricultural benefit (Rs./ha) |
|---|---|---|---|---|---|
| Paddy | 2.0 | 3,200 | 6,400 | 3,690 | 2,710 |
| Wheat | 1.8 | 3,000 | 5,400 | 2,580 | 2,820 |
| Mustard | 0.5 | 7,000 | 3,500 | 1,580 | 1,920 |
| Vegetables (Potato, etc.) | 6.0 | 3,000 | 18,000 | 7,800 | 10,200 |

### (2) Without-project condition

|  | Yield (ton/ha) | Farm gate price (Rs./ton) | Gross income (Rs./ha) | Production cost (Rs./ha) | Agricultural benefit (Rs./ha) |
|---|---|---|---|---|---|
| Paddy | 2.5 | 3,200 | 8,000 | 4,610 | 3,390 |
| Wheat | 2.0 | 3,000 | 6,000 | 3,050 | 2,950 |
| Mustard | 0.6 | 7,000 | 4,200 | 1,750 | 2,450 |
| Vegetables (Potato, etc.) | 8.0 | 3,000 | 24,000 | 8,670 | 15,330 |

### (3) With-project condition

|  | Yield (ton/ha) | Farm gate price (Rs./ton) | Gross income (Rs./ha) | Production cost (Rs./ha) | Agricultural benefit (Rs./ha) |
|---|---|---|---|---|---|
| Paddy | 4.0 | 3,200 | 12,800 | 5,990 | 6,810 |
| Wheat | 2.5 | 3,000 | 7,500 | 4,400 | 3,100 |
| Mustard | 0.8 | 7,000 | 5,600 | 2,220 | 3,380 |
| Vegetables (Potato, etc.) | 12.0 | 3,000 | 36,000 | 16,250 | 19,750 |
| Tomato | 12.0 | 4,000 | 48,000 | 27,360 | 20,640 |

## 6.4 Agricultural Income of Average Farmhouse (Land Holding: 1.0 /Ha)

### (1) Present condition

|  | Agricultural benefit (Rs./ha) | Cropping area (ha) | Agricultural income (Rs.) |
|---|---|---|---|
| Rainy season paddy | 2,710 | 0.9 | 2,439 |
| Wheat | 2,820 | 0.6 | 1,692 |
| Mustard | 1,920 | 0.075 | 144 |
| Vegetables (Potato, etc.) | 10,200 | 0.025 | 255 |
| Total |  |  | 4,530 |

### (2) Without-project condition

|  | Agricultural benefit (Rs./ha) | Cropping area (ha) | Agricultural income (Rs.) |
|---|---|---|---|
| Rainy season paddy | 3,390 | 0.9 | 3,051 |
| Wheat | 2,950 | 0.6 | 1,770 |
| Mustard | 2,450 | 0.075 | 184 |
| Vegetables (Potato, etc.) | 15,330 | 0.025 | 383 |
| Total |  |  | 5,388 |

### (3) With-project condition

|  | Agricultural benefit (Rs./ha) | Cropping area (ha) | Agricultural income (Rs.) |
|---|---|---|---|
| Paddy (Early season paddy + Rainy season paddy) | 6,810 | 1.1 | 7,491 |
| Wheat | 3,100 | 0.7 | 2,170 |
| Mustard | 3,380 | 0.15 | 507 |
| Vegetables (Potato, etc.) | 19,750 | 0.10 | 1,975 |
| Tomato | 20,640 | 0.05 | 1,032 |
| Total |  |  | 13,175 |

JICA