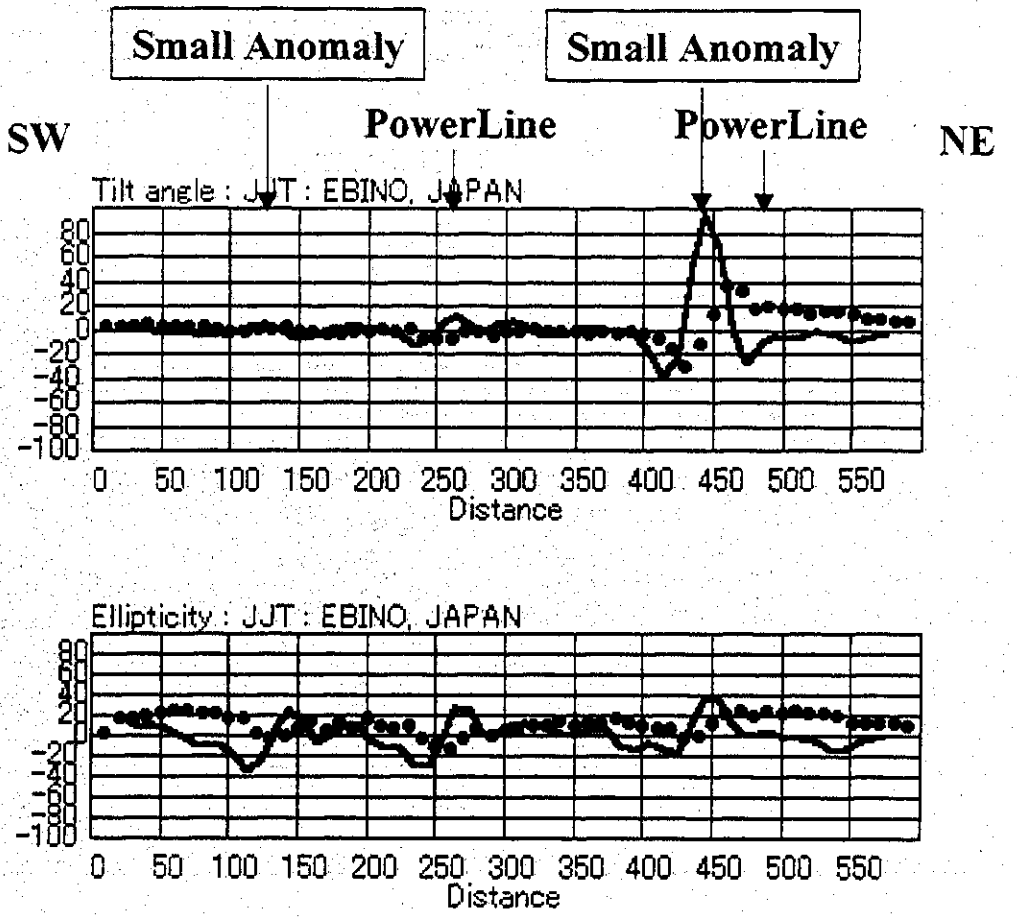


Figure 2.24 VLF Result -Hoa Thuong (HTVLF1)-

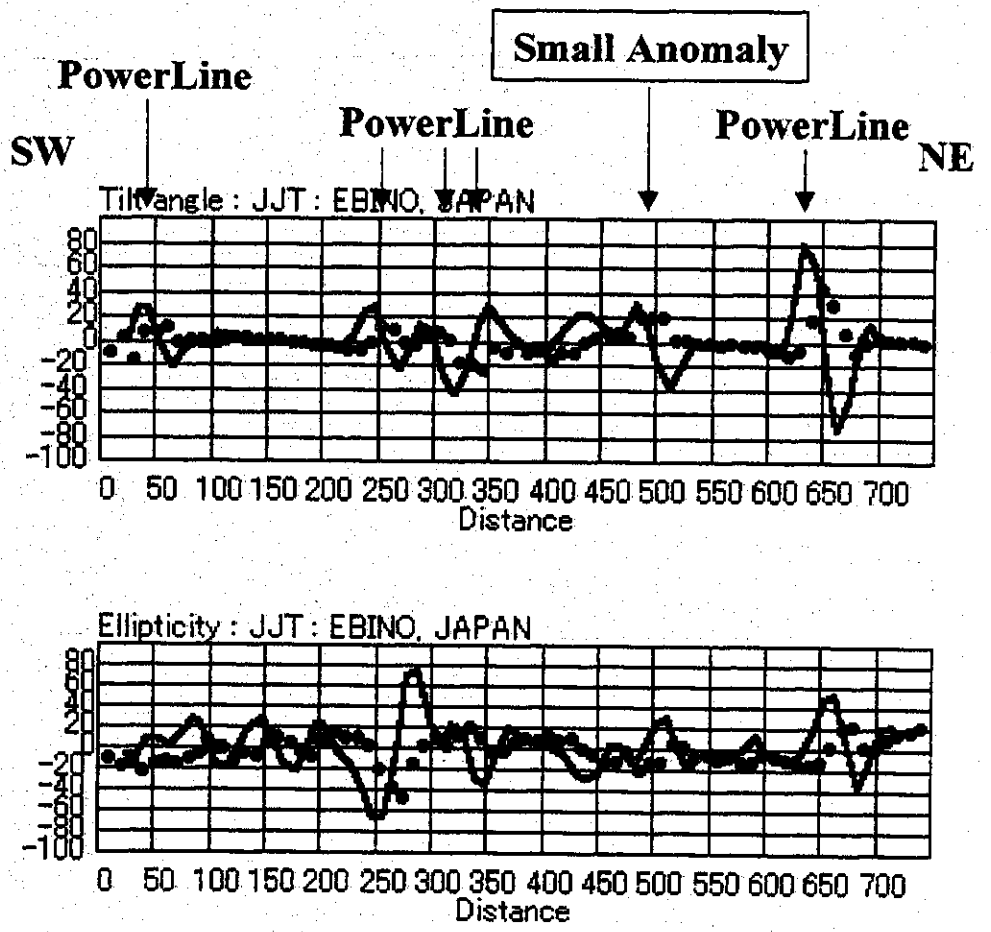


Figure 2.25 VLF Result -Hoa Thuong (HTVLF2)-

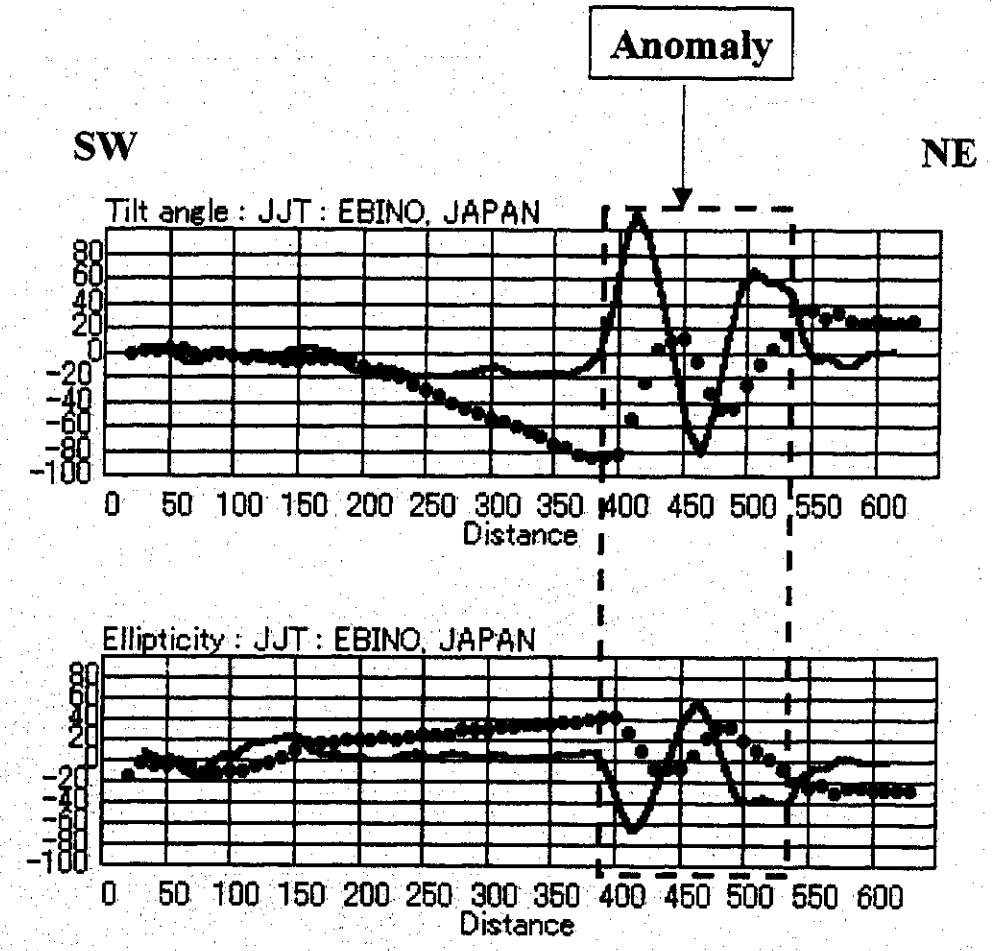


Figure 2.26 VLF Result -Dong Bam(DBVLF1)-

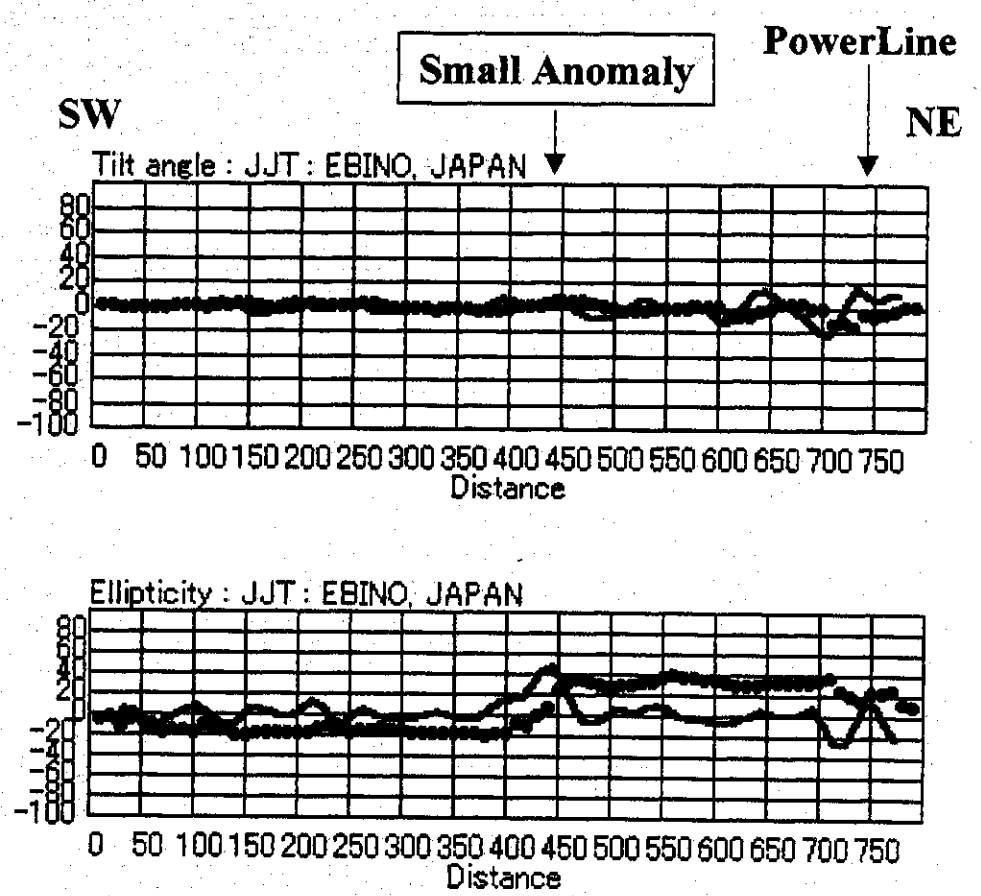


Figure 2.27 VLF Result -Dong Bam(DBVLF2)-

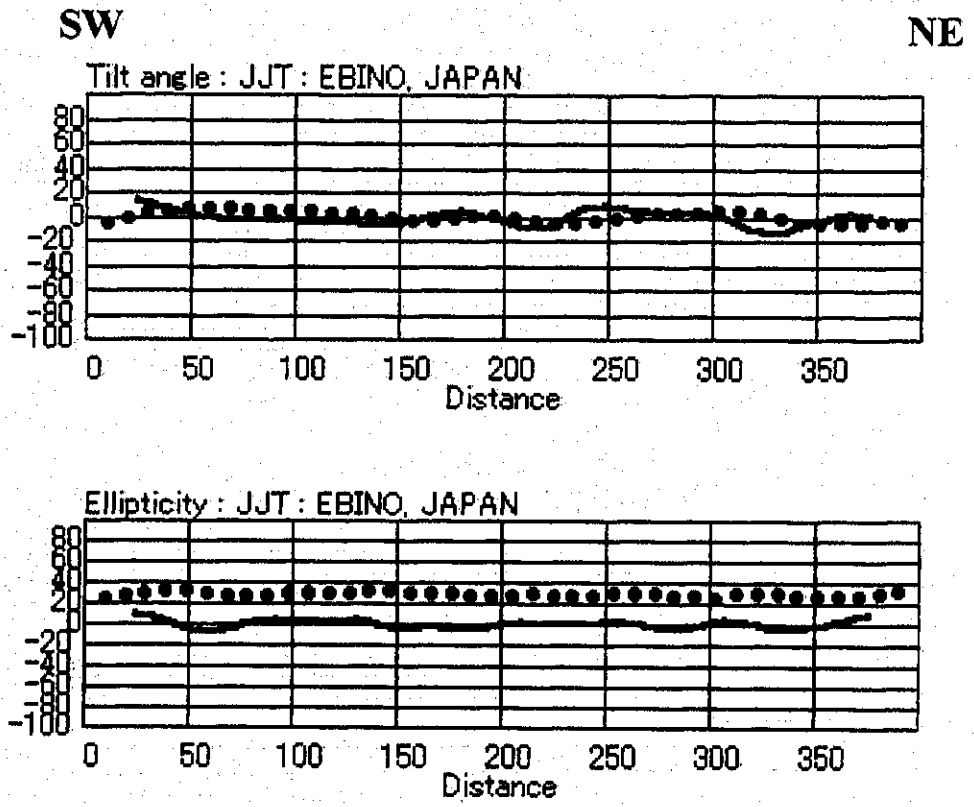


Figure 2.28 VLF Result -Thinh Duc (TDVLF1)-

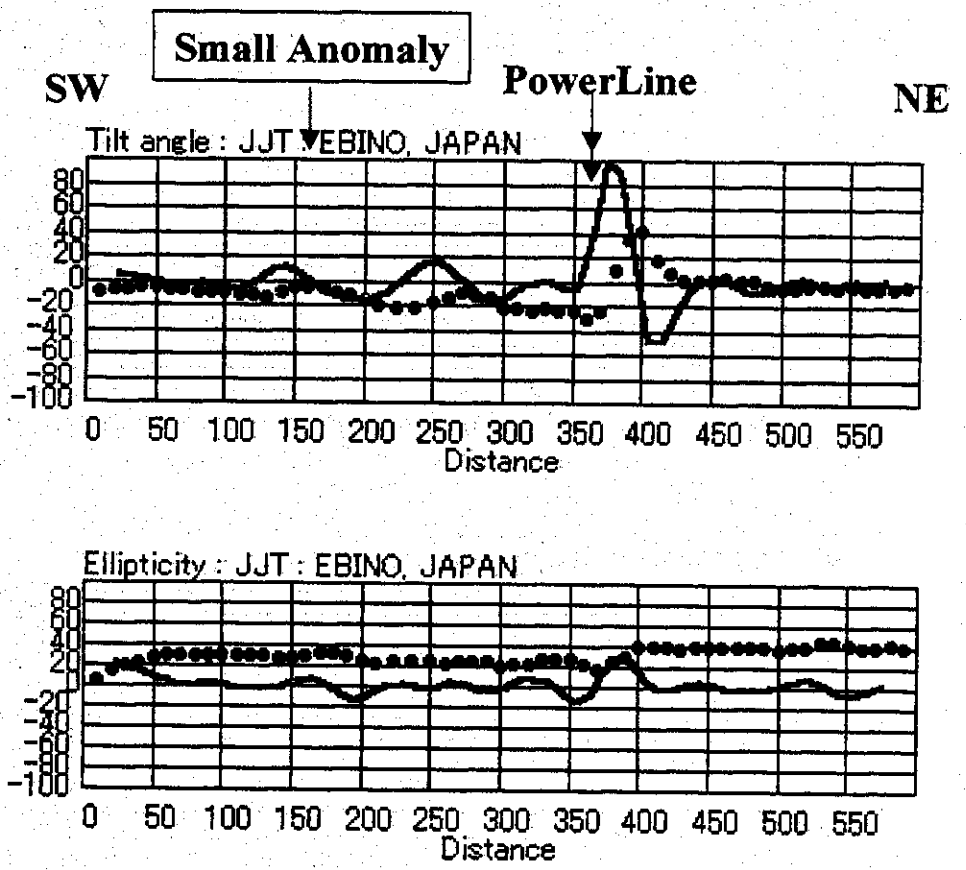


Figure 2.29 VLF Result -Thinh Duc (TDVLF2)-

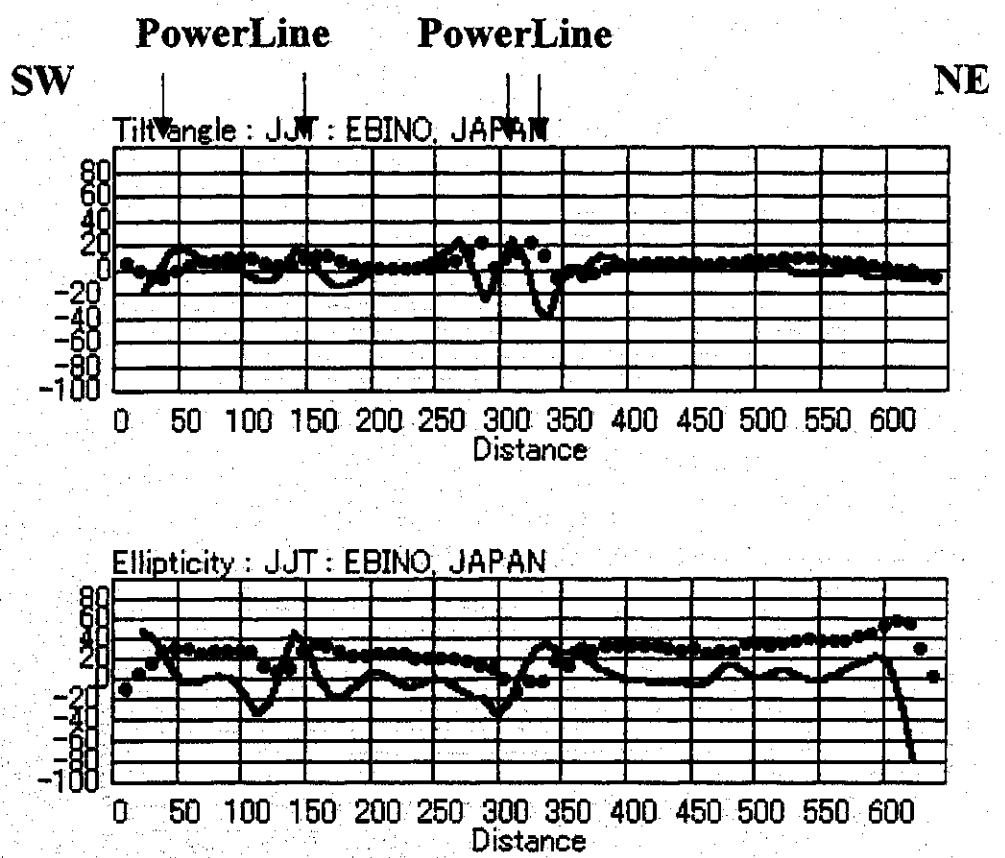


Figure 2.30 VLF Result -Nam Tien (NTVLF1)-

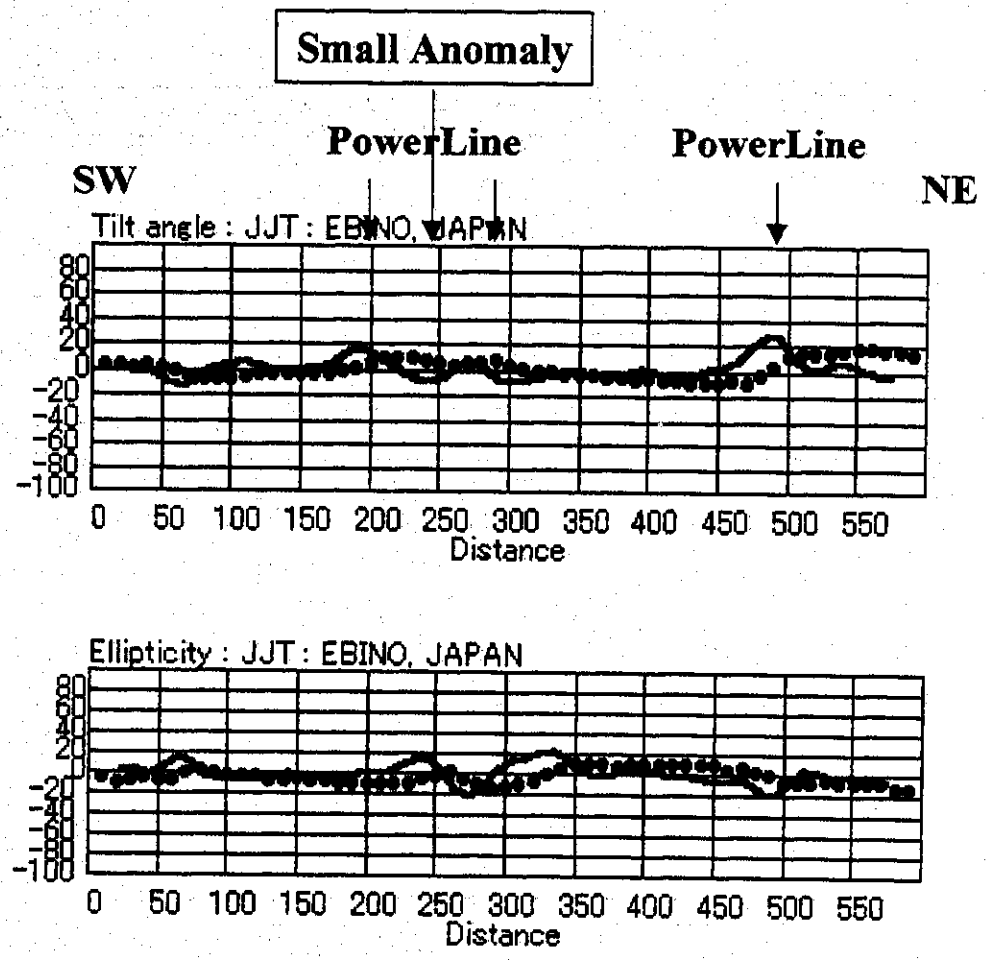


Figure 2.31 VLF Result -Nam Tien (NTVLF2)-

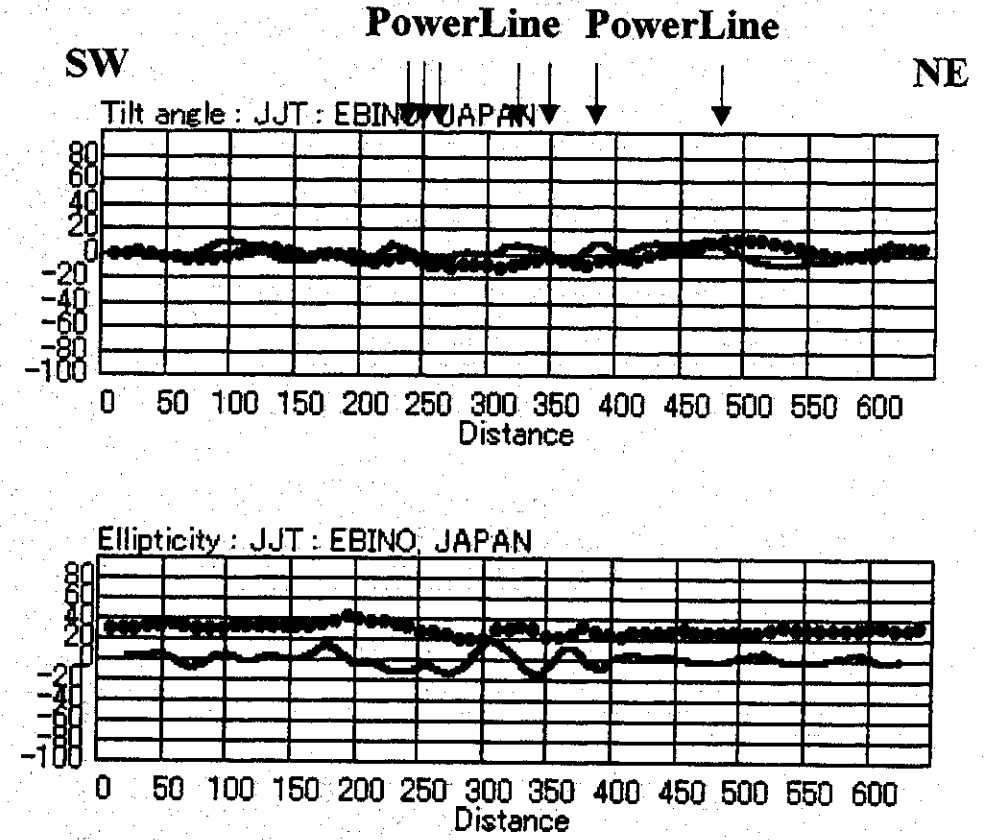


Figure 2.32 VLF Result -Nam Tien (NTVLF3)-

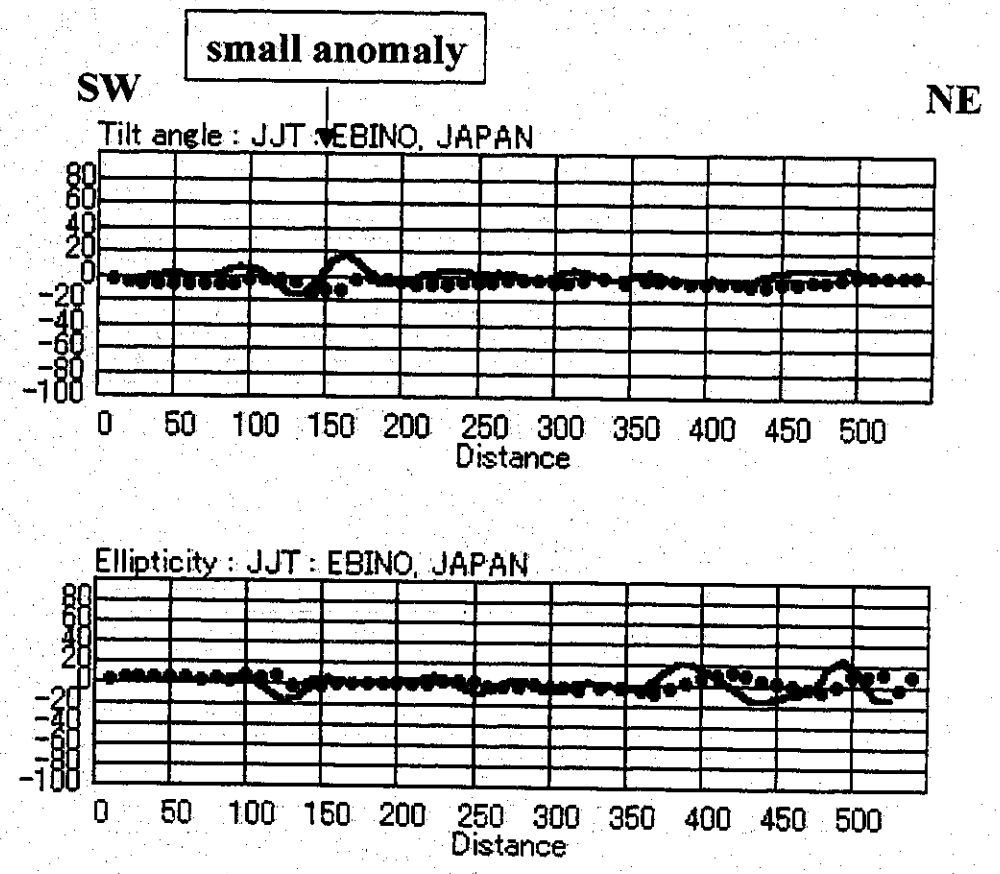


Figure 2.33 VLF Result -Yen Thang (YTVLF1)-

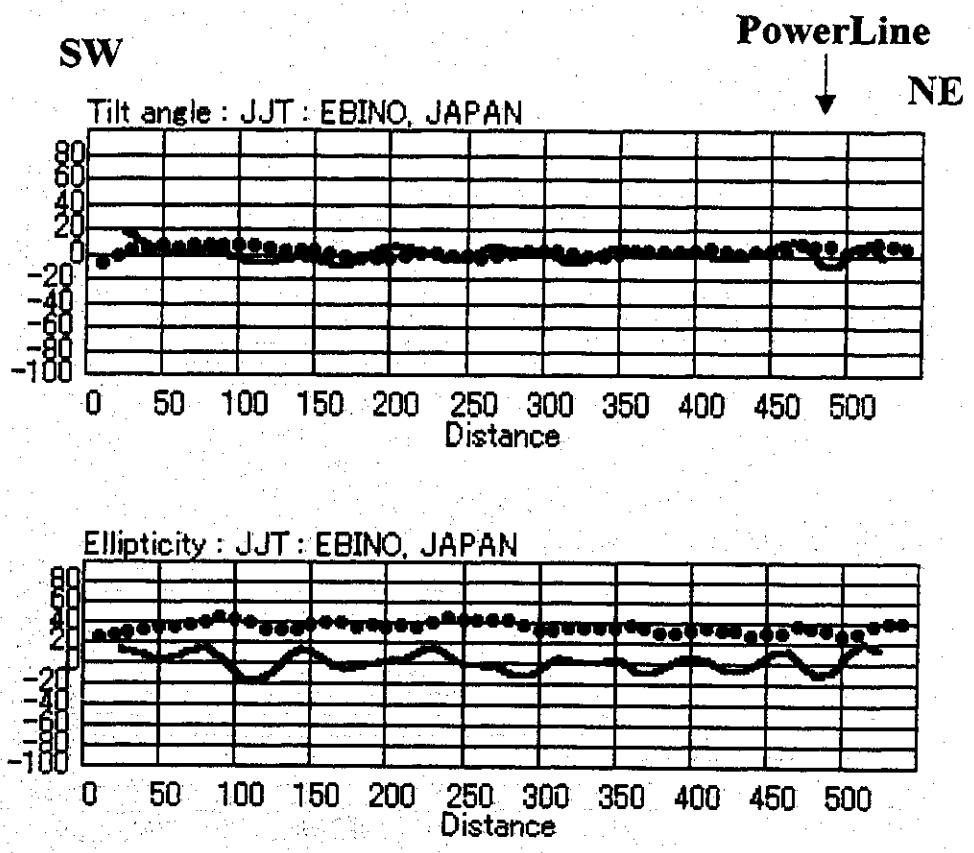


Figure 2.34 VLF Result -Yen Thang (YTVLF2)-

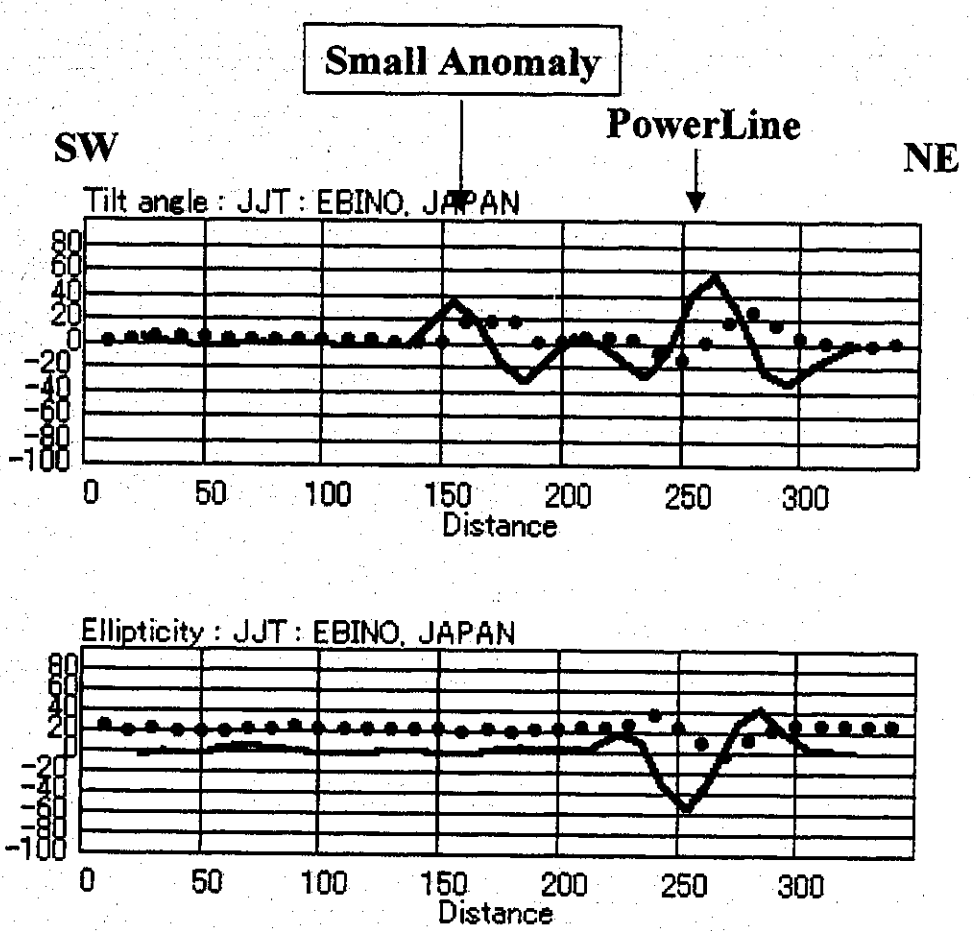


Figure 2.35 VLF Result -Yen Thang (YTVLF3)-

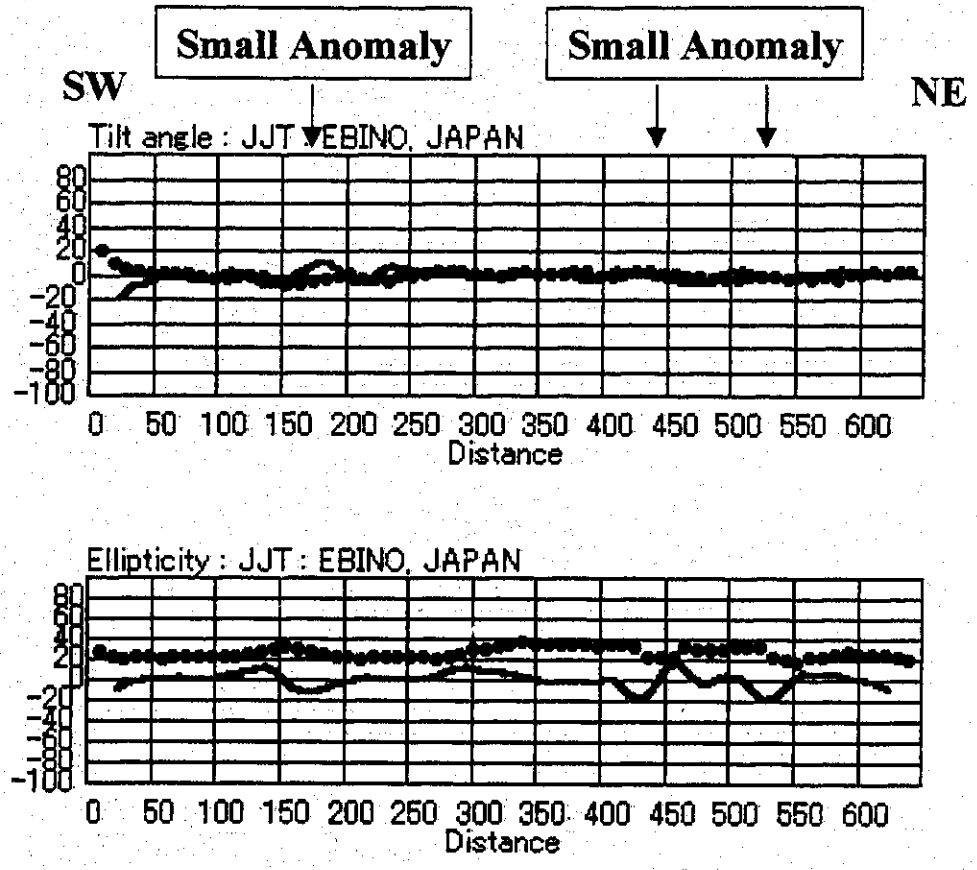


Figure 2.36 VLF Result -Yen Thang (YTVLF4)-

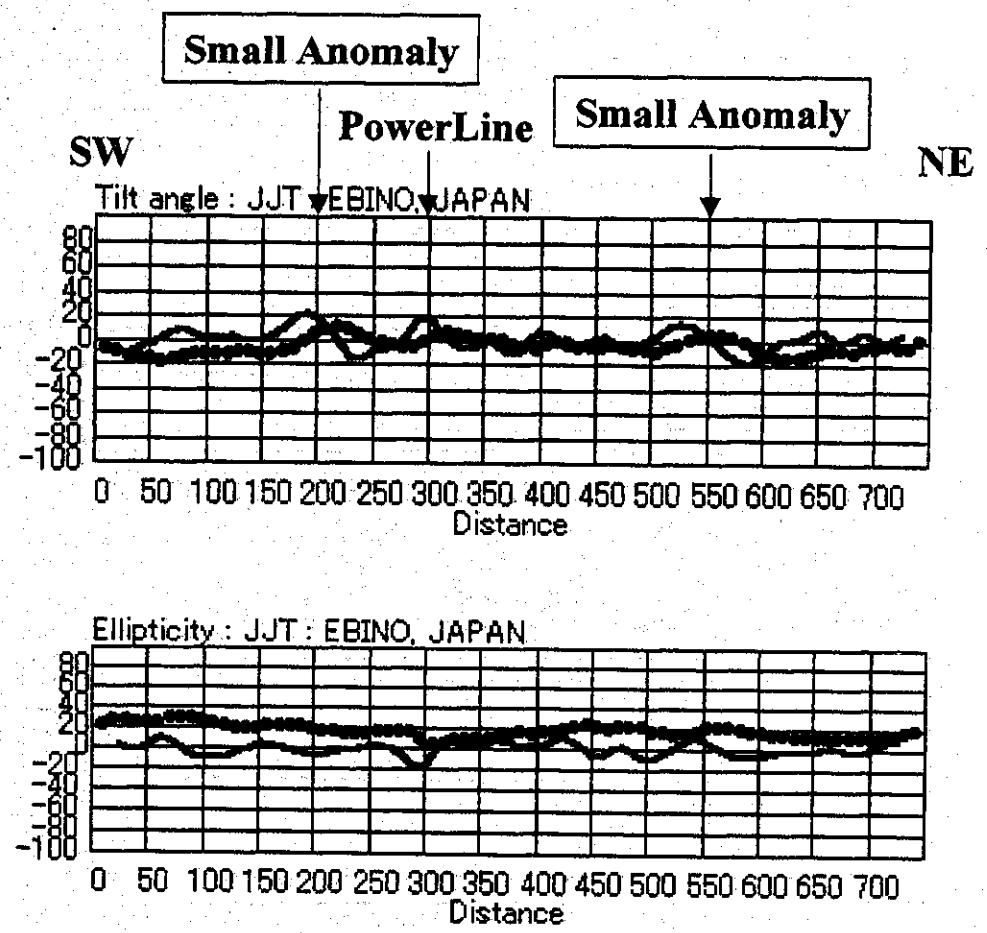


Figure 2.37 VLF Result -Quang Son (QSVLF)-

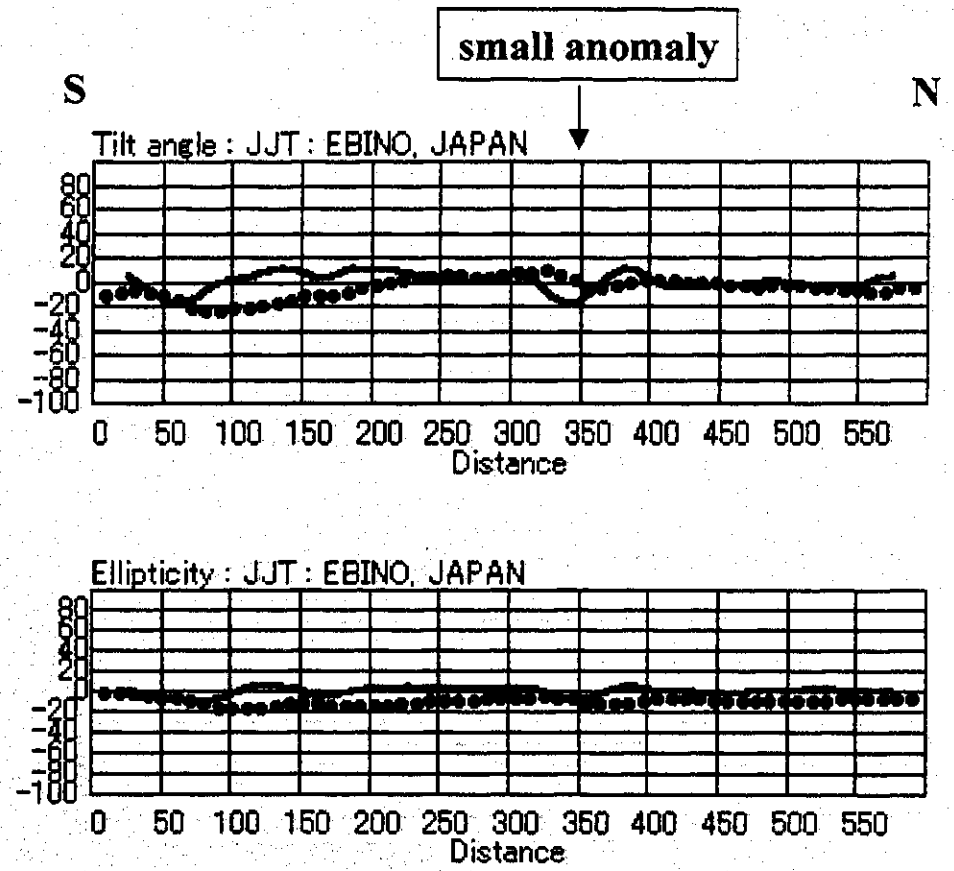


Figure 2.38 VLF Result -Dong Phong (DPVLF1)-

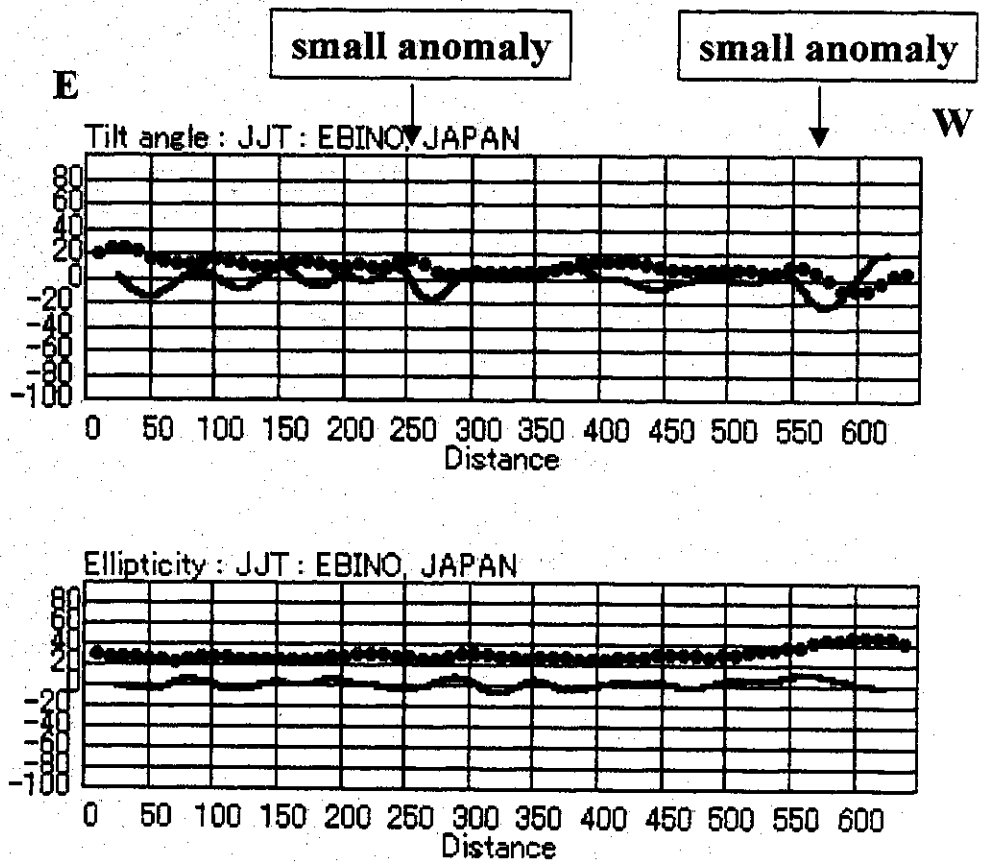


Figure 2.39 VLF Result -Dong Phong (DPVLF2)-

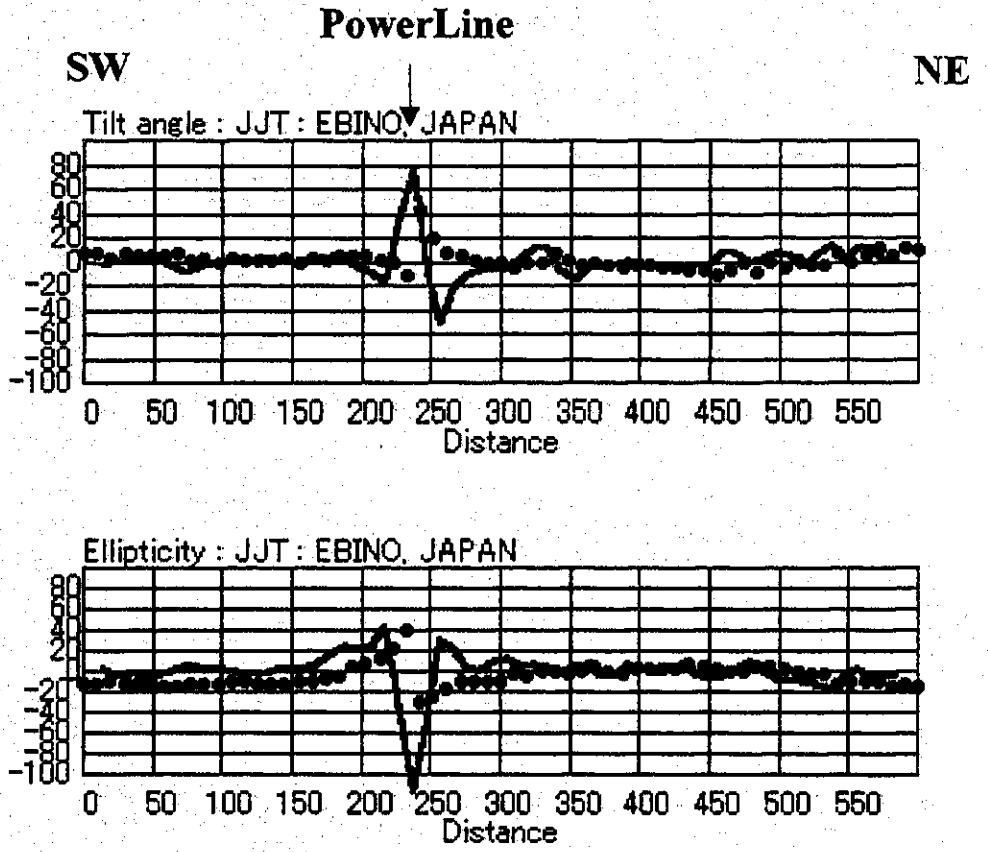


Figure 2.40 VLF Result -Vinh Thanh (VTVLF1)-

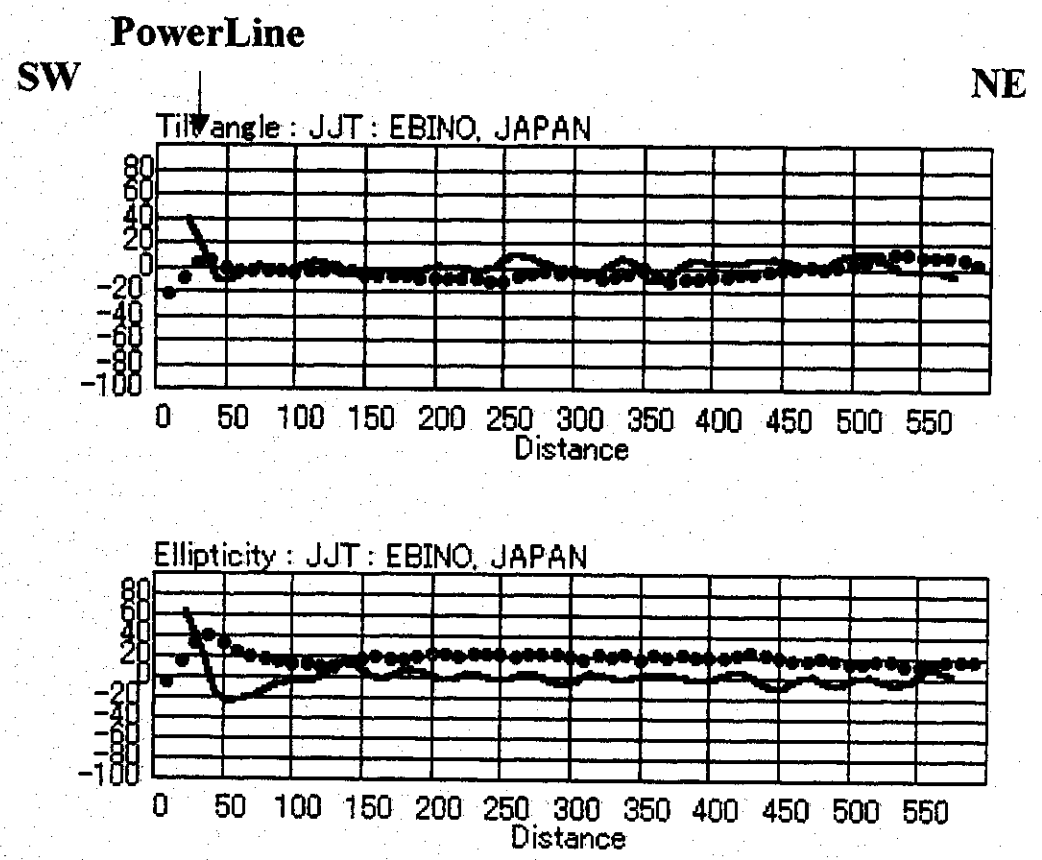


Figure 2.41 VLF Result -Vinh Thanh (VTVLF2)-

CHAPTER 3

PUMPING TEST

CHAPTER 3 PUMPING TEST

3.1 Methodology

Pumping tests were carried out at the test wells to obtain aquifer constants. The tests were performed after installation of casing/screen pipes and well development. The pumping test is comprised of three (3) types of test; viz. step-drawdown test, continuous drawdown test, and recovery test. The step-drawdown test was conducted prior to the continuous pumping test. Four (4) steps with pumping duration of four (4) hours for each step were conducted in each step-drawdown test. The duration of continuous pumping test was 2,880 minutes (48 hours). The recovery test was started just after the continuous pumping test for a duration of 720 minutes (12 hours).

During a well development work at JICA-1 in Dong Bam, Thai Nguyen, the land near the well sank and the neighboring houses were slightly damaged. The Study Team investigated immediately after the incident, then supervised the contractor to stop the well development work. The incident happened after two (2) days from the starting of well development. The discharge rate was about 900 ℓ/min. The Study Team decided not to perform further well development and pumping test at JICA-1 well to prevent expansion of the damages. Therefore, detailed aquifer evaluation based on pumping test is not available at JICA-1 well.

3.2 Step-Drawdown Test

The results of step-drawdown test at test wells are tabulated in Table 3.1. It is noted that the four (4) steps of step-drawdown test could not be carried out at JICA-3 well (Nam Tien, Thai Nguyen) and JICA-13 well (Trung Le, Ha Tinh), because the wells yielded small amount of water so that only two (2) steps' drawdowns were able to be measured.

Based on the test, a specific capacity value of each step was obtained, then aquifer loss coefficient (B) and well loss coefficient (C) were computed. In practice, the drawdown at a well consists of the aquifer loss and the well loss. Jacob (1947) stated that well loss is proportional to some power of the discharge exceeding the first power and approaching the second, so that the total drawdown s_w is given by:

$$s_w = BQ + CQ^n \qquad (3.1)$$

where B is the aquifer loss coefficient, C is the well loss coefficient, and n is a constant greater than one. In the Study, the n value is assumed to be 2.

Well efficiency of each pumping step was also calculated and average well efficiency of each well is obtained. The well efficiency can be defined as the percentage of (BQ / s_w) for a specified duration of pumping.

Graphical interpretation of step-drawdown test at each test well is presented from Figures 3.1 to 3.14.

The results show that the values of aquifer loss coefficient B at JICA-3 (Nam Tien), JICA-4 (Thinh Duc), and JICA-8 (Van Thang) are higher, within a range from 1.0E-2 to 1.0E-1 day/m^2. This is because the aquifers consist of sandstone with less permeability. The B values of JICA-5 (Quang Son) and JICA-6 (Yen Thang) wells are also higher even the aquifer consists of limestone. This can be explained that the porous space in fractured limestone is filled with clayey materials, that may reduce permeability of the aquifer.

The values of well loss coefficient C take a wider range of distribution. Small values of C in a range between 1.0E-7 and 1.0E-8 day^2/m^5, indicating smaller drawdown caused by the well structure, were obtained from JICA-2 (Hoa Thuong), JICA-7 (Dong Phong), JICA-9 (Thieu Hung), and JICA-10 (Dinh Tuong) wells. The C values of JICA-5 (Quang Son) and JICA-6 (Yen Thang) wells are greater, showing the drawdown caused by unit discharge is greater due to the well structure.

The performance of a well can be evaluated from the well efficiency value. If the total drawdown is equal to the drawdown caused by aquifer loss, the well efficiency is 100 %. The test wells of JICA-4 (Thinh Duc) and JICA-7 (Dong Phong) have more than 90 % in well efficiency. Lower well efficiency values below 60 % were obtained from JICA-2 (Hoa Thuong), JICA-11 (Vinh Thanh), JICA-12 (Duc Yen), JICA-14 (Thieu Do), and JICA-15 (Trung Le).

The relationship between discharge rate Q and drawdown s is plotted on a log-log graph. If the Q-s curve is vended upward, the Q value at the turning point is called "critical discharge rate" of the well. It can be said that the discharge rate above the turning point may not suitable for continuous pumping. For example at JICA-2 well (Hoa Thuong), the drawdown curve of the step-drawdown test became almost stable in each step until step-3 ($Q_3$51,080 m^3/day), however, the curve in step-4 ($Q_4$51,440 m^3/day) was not stabilize within the duration of 240 minutes. Therefore, the Q-s curve is vended at step-3 and the Q-s plot at step-4 is

plotted above the extended portion of the linear line between step-1 and step-3. Such critical discharge rates are found at wells of JICA-5 (Quang Son, $Q5259.2$ m^3/day), JICA-6 (Yen Thang, $Q5172.8$ m^3/day), JICA-14 (Thieu Do, $Q51425.6$ m^3/day), and JICA-15 (Trung Le, $Q5259.2$ m^3/day).

3.3 Continuous Pumping Test and Recovery Test

The results of continuous pumping test and recovery test are summarized in Table 3.2. The values of transmissivity are obtained by Cooper-Jacob method, Theis method, and Recovery method. The values of storativity are obtained by Cooper-Jacob method and Theis method.

Cooper-Jacob method uses a semi-log plot of drawdown s versus the logarithm of time t. The plots usually form a straight line, and the transmissivity T can be computed by obtaining the drawdown difference Δs per log cycle of t. Storativity (or storage coefficient) S is computed by obtaining t_0; the value of t_0 can be obtained by projecting the straight line of semi-log plots to $s50$.

Theis method uses a log-log plot of drawdown s versus time t. The log-log type curve of $W(u)$ versus $1/u$ is prepared to find a matching point of superposition on the drawdown curve to obtain S and T. Usually the match point is found by manually graphic method, however, in this Study, a compute code called "AQUITEST" was used to obtain S and T values by automatic curve fitting.

Recovery method is similar to Cooper-Jacob method, using a semi-log plot of residual drawdown s' versus time ratio t/t'. From the straight portion of the plots, $\Delta s'$ per log cycle of t/t' can be obtained, then T is computed.

The results of continuous pumping test and recovery test by Cooper-Jacob method and Recovery method are shown in Figures 3.15 to 3.28. The results of continuous pumping test analysis by Theis method are shown in Figures 3.29 to 3.42. It is noted that the time-drawdown curves of JICA-5 (Quang Son), JICA-9 (Thieu Hung), and JICA-14 (Thieu Do) wells show a leaky type confined aquifer, so that Hantush method was applied to obtain aquifer parameters.

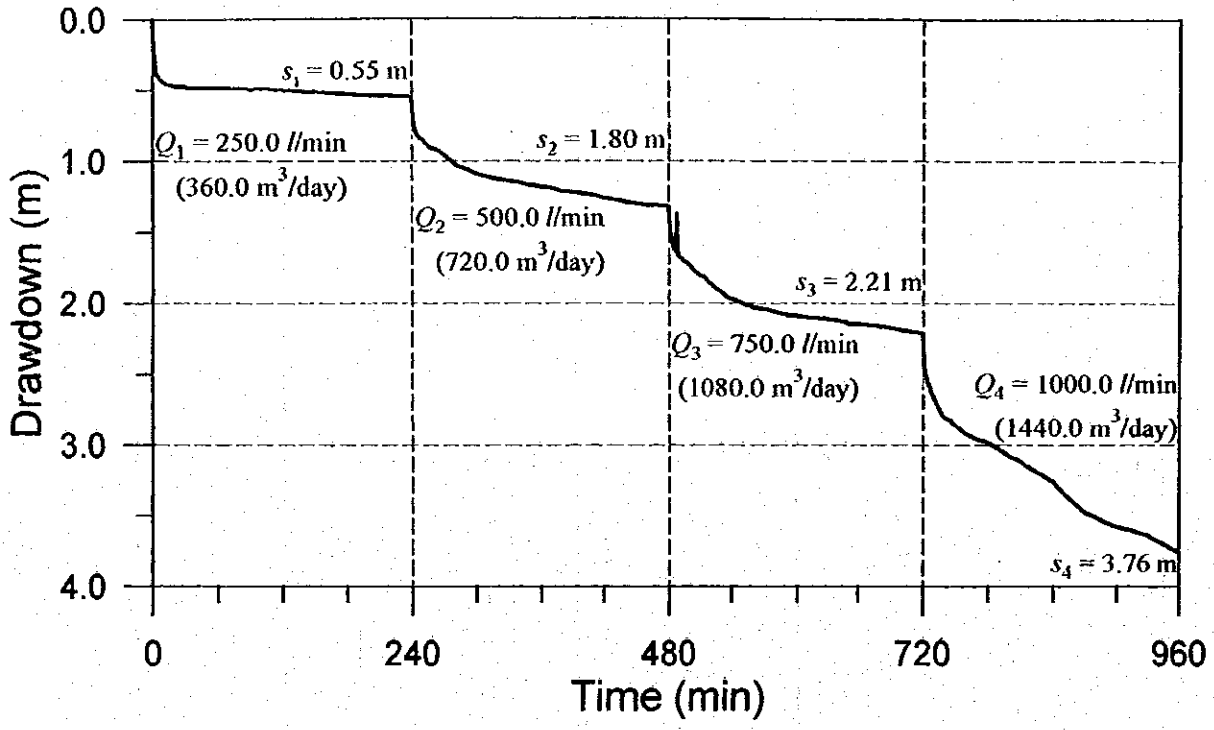
Table 3.1 Results of Step-Drawdown Test at JICA Test Wells

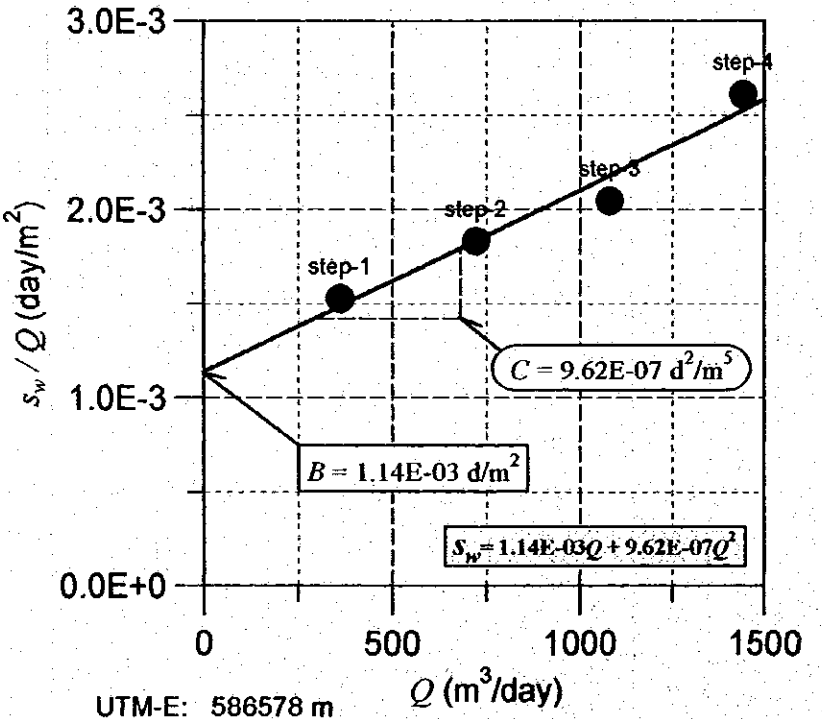
Test Well No.	Commune District Province	UTM-E (m)	UTM-N (m)	Drilling Depth (m)	Well Depth (m)	Screen Depth(s) (m)	Step-drawdown Test							
							Date(dd/mm/yy) Static Water Level (m below G.L.)	Q1(m^3/day) s1(m) So1(m^2/day)	Q2(m^3/day) s2(m) So2(m^2/day)	Q3(m^3/day) s3(m) So3(m^2/day)	Q4(m^3/day) s4(m) So4(m^2/day)	Aquifer Loss Coefficient B (d/m^2)	Well Loss Coefficient C (d^2/m^5)	Average Well Efficiency (%)
JICA-1	Đồng Bẩm Đồng Hỷ Thái Nguyên	587420	2389687	100	76	40 to 72	-	-	-	-	-	-	-	-
JICA-2	Hoá Thượng Đồng Hỷ Thái Nguyên	586578	2393846	150	92	24 to 32 56 to 64 76 to 88	03/06/1999 3.10	360.00 0.55 654.55	720.00 1.00 400.00	1080.00 2.21 488.69	1440.00 3.76 382.98	1.14E-03	9.62E-07	54.90
JICA-3	Nam Tiến Phổ Yên Thái Nguyên	590257	2366017	100	21.5	5.5 to 17.5	15/04/1999 1.50	69.12 1.75 39.50	138.24 3.66 37.77	- - -	- - -	2.42E-02	1.67E-05	93.49
JICA-4	Thịnh Đức Thị trấn Thái Nguyên Thái Nguyên	584201	2380475	100	68	8 to 16 52 to 60 60 to 64	27/05/1999 2.00	43.20 4.37 9.89	94.18 9.50 9.91	146.88 14.72 9.98	188.35 18.80 10.02	1.02E-01	-8.59E-06	101.48
JICA-5	Quang Sơn Thị trấn Tam Điệp Ninh Bình	592553	2228660	150	120	72 to 116	05/03/1999 10.80	86.40 8.00 10.80	172.80 15.20 11.37	259.20 21.90 11.84	345.60 43.00 8.04	7.44E-02	1.06E-04	78.20
JICA-6	Yên Thắng Yên Mỗ Ninh Bình	600941	2228665	150	136	76 to 84 92 to 104 124 to 132	17/03/1999 1.23	57.60 10.87 5.30	115.20 22.89 5.03	172.80 35.77 4.83	230.40 54.97 4.19	1.69E-01	2.74E-04	81.77
JICA-7	Đông Phong Nho Quan Ninh Bình	577617	2248929	150	130	92 to 126	23/05/1999 0.80	432.00 2.07 208.70	864.00 4.56 189.47	1296.00 6.48 200.00	1728.00 8.54 202.34	4.96E-03	4.01E-08	99.26
JICA-8	Vạn Thắng Nông Cống Thanh Hoá	565030	2170050	150	150	99 to 119	05/02/1999 5.70	158.40 9.83 16.11	271.54 20.98 12.94	475.20 41.60 11.42	633.60 56.53 11.21	5.80E-02	5.48E-05	74.95
JICA-9	Thiệu Hưng Thiệu Hoá Thanh Hoá	571655	2199306	80	52	32 to 48	10/02/1999 4.00	352.80 2.40 147.00	705.60 4.55 155.08	1058.40 7.12 148.65	1411.20 10.01 140.96	5.79E-03	9.14E-07	85.85
JICA-10	Định Tường Yên Định Thanh Hoá	568421	2207260	91.2	91.2	23.2 to 39.2 47.2 to 63.2	10/04/1999 4.80	432.00 1.26 342.86	864.00 3.02 286.09	1296.00 4.92 263.41	1728.00 7.04 245.45	2.63E-03	8.73E-07	74.81
JICA-11	Vĩnh Thành Vĩnh Lộc Thanh Hoá	564793	2216162	148	80	32 to 48 60 to 76	24/04/1999 7.55	352.00 1.66 194.62	734.40 4.90 149.88	1123.20 9.80 114.61	1512.00 14.27 105.96	3.85E-03	3.90E-06	54.39
JICA-12	Đức Yên Đức Thọ Hà Tĩnh	563705	2048152	106	104	20 to 26 84 to 100	05/03/1999 2.90	108.00 1.36 79.41	216.00 3.24 66.67	324.00 6.11 53.03	432.00 9.27 46.60	9.36E-03	2.82E-05	57.50
JICA-13	Trung Lễ Đức Thọ Hà Tĩnh	566783	2046329	100	100	58 to 82	08/04/1999 2.80	12.96 2.56 5.06	25.92 14.60 1.78	- - -	- - -	-	-	-
JICA-14	Thiệu Đô Thiệu Hoá Thanh Hoá	572185	2197515	70	68	18 to 50 58 to 64	29/03/1999 2.85	475.20 2.08 228.46	950.40 4.21 225.75	1425.60 7.01 203.37	1900.80 13.67 139.05	3.00E-03	1.88E-06	59.75
JICA-15	Trung Lễ Đức Thọ Hà Tĩnh	567186	2046557	70	40	16 to 36	01/04/1999 2.48	64.80 0.85 76.24	129.60 1.80 72.00	259.20 3.09 83.88	345.60 6.93 49.87	6.69E-03	6.61E-05	47.16

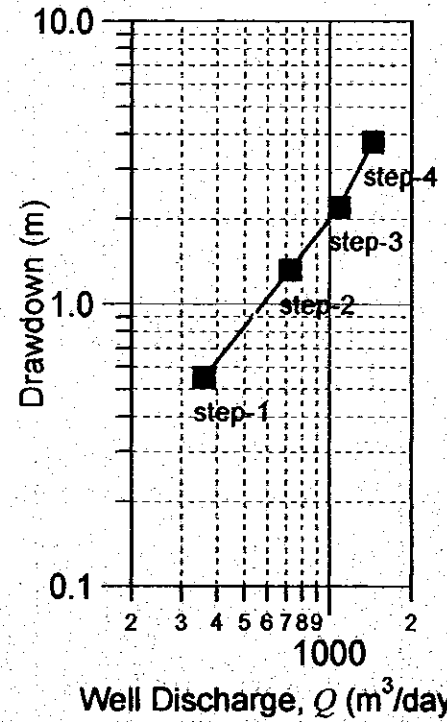
Table 3.2 Results of Continuous Pumping Test and Recovery Test at JICA Test Wells

Test Well No.	Commune District Province	UTM-E (m)	UTM-N (m)	Drilling Depth (m)	Well Depth (m)	Screen Depth(s) (m)	Screen Length (m)	Continuous Pumping Test										Recovery Test, Recovery Method	
								Date (dd-mm-yy)	Static Water Level (m below G.L.)	Pumping Rate, Q (m^3/day)	Final Drawdown, s (m)	Specific Capacity, Sc (m^2/day)	Theis Method T (m^2/day)	Theis Method k_{ave} (m/day)	Theis Method S	Cooper-Jacob Method T (m^2/day)	Cooper-Jacob Method k_{ave} (m/day)	Cooper-Jacob Method S	T (m^2/day)	k_{ave} (m/day)
JICA-1	Đồng Bẩm Đồng Hỷ Thái Nguyên	587420	2389887	100	76	40 to 72	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-
JICA-2	Hoá Thượng Đồng Hỷ Thái Nguyên	586578	2393846	150	92	24 to 32 56 to 64 76 to 88	28.0	04/06/1999	3.10	1440.00	5.55	259.46	173.00	6.18E+00	3.01E-01	129.34	4.62E+00	1.37E-02	145.66	5.20E+00
JICA-3	Nam Tiến Phổ Yên Thái Nguyên	590257	2386017	100	21.5	6.5 to 17.5	12.0	16/04/1999	1.50	138.24	4.75	29.10	24.00	2.00E+00	7.09E-01	23.8	1.98E+00	8.48E-01	28.12	2.34E+00
JICA-4	Thịnh Đức Thị trấn Thái Nguyên Thái Nguyên	584201	2380475	100	88	8 to 18 52 to 60 68 to 84	32.0	28/05/1999	2.00	188.35	16.58	10.14	33.20	1.04E+00	3.71E-15	36.4	1.14E+00	1.93E-16	11.4	3.56E-01
JICA-5	Quang Sơn Thị trấn Tam Điệp Ninh Bình	592553	2228660	150	120	72 to 116	44.0	07/03/1999	10.80	345.60	42.60	8.11	Hantush's method 1.21	2.75E-02 c = 1.84E+00 (day)	2.15E-01	35.69	8.11E-01	7.73E-22	102.6	2.33E+00
JICA-6	Yên Thắng Yên Mô Ninh Bình	600941	2228665	150	136	76 to 84 92 to 104 124 to 132	28.0	18/03/1999	1.23	230.40	54.79	4.21	15.30	5.46E-01	5.42E-18	17.59	0.28E-01	1.01E-20	54.85	1.96E+00
JICA-7	Đồng Phong Nho Quan Ninh Bình	577617	2246929	150	130	92 to 126	34.0	24/05/1999	0.60	1728.00	6.77	197.04	862.00	2.54E+01	6.82E-19	1096.3	3.22E+01	2.51E-25	627.8	1.85E+01
JICA-8	Vạn Thắng Nông Cống Thanh Hoá	565030	2170050	150	150	99 to 119	20.0	06/02/1999	5.00	613.16	63.58	9.64	47.00	2.35E+00	1.56E-24	151.93	7.60E+00	2.78E-81	134.03	6.70E+00
JICA-9	Thiệu Hưng Thiệu Hoá Thanh Hoá	571865	2199306	80	52	32 to 48	16.0	12/02/1999	4.00	1411.20	10.02	140.84	Hantush's method 118.00	7.38E+00 c = 4.79E-01 (day)	1.87E-03	672.57	4.20E+01	1.93E-22	895.18	5.59E+01
JICA-10	Đinh Tường Yên Định Thanh Hoá	568421	2207260	91.2	91.2	23.2 to 39.2 47.2 to 63.2	32.0	11/04/1999	4.90	1728.00	7.07	244.41	674.00	2.11E+01	1.34E-10	759.31	2.37E+01	3.48E-12	681.7	2.13E+01
JICA-11	Vĩnh Thành Vĩnh Lộc Thanh Hoá	564793	2216162	148	80	32 to 48 60 to 76	32.0	27/04/1999	7.55	1512.00	16.29	92.82	86.90	2.72E+00	2.52E-01	80.56	2.52E+00	4.78E-01	77.76	2.43E+00
JICA-12	Đức Yên Đức Thọ Hà Tĩnh	563705	2048152	106	104	20 to 28 84 to 100	24.0	06/03/1999	3.20	432.00	14.43	29.94	51.30	2.14E+00	5.41E-02	54.18	2.26E+00	3.53E-02	61.75	2.57E+00
JICA-13	Trung Lễ Đức Thọ Hà Tĩnh	566783	2046329	100	100	58 to 82	24.0	09/04/1999	2.80	25.92	22.76	1.14	0.49	2.05E-02	1.59E+00	0.461	1.92E-02	1.69E+00	0.356	1.48E-02
JICA-14	Thiệu Đô Thiệu Hoá Thanh Hoá	572185	2197515	70	68	18 to 50 58 to 64	38.0	30/03/1999	2.85	1900.80	14.19	133.95	Hantush's method 141.00	3.71E+00 c = 3.98E-01 (day)	1.98E-02	140.07	3.69E+00	2.90E-02	144.07	3.79E+00
JICA-15	Trung Lễ Đức Thọ Hà Tĩnh	567186	2046557	70	40	16 to 36	20.0	02/04/1999	2.48	259.20	6.75	38.40	43.50	2.18E+00	2.07E-02	43.79	2.19E+00	2.46E-02	100.45	5.02E+00

c: Hydraulic Resistance







UTM-E: 586578 m
UTM-N: 2393846 m
Long.: 105-50-13E (d-m-s)
Lati.: 21-38-51N (d-m-s)

Date: 03/06/1999 Static W.L.: 3.10 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	150 m
District:	Đồng Hỷ	Well Depth:	92 m
Commune:	Hóa Thượng	Screen Depth(s):	24 to 32 m
			56 to 64 m
			76 to 88 m

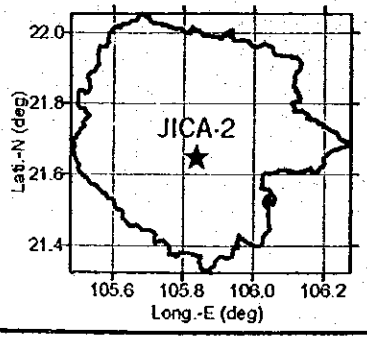
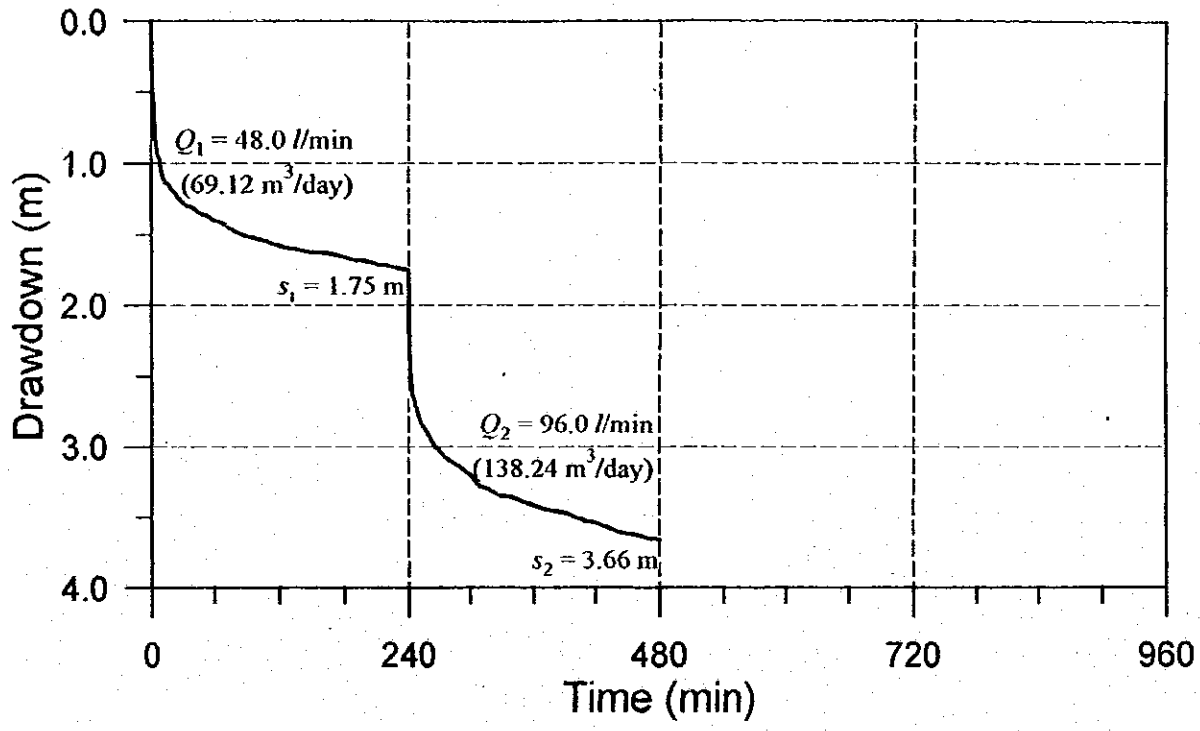
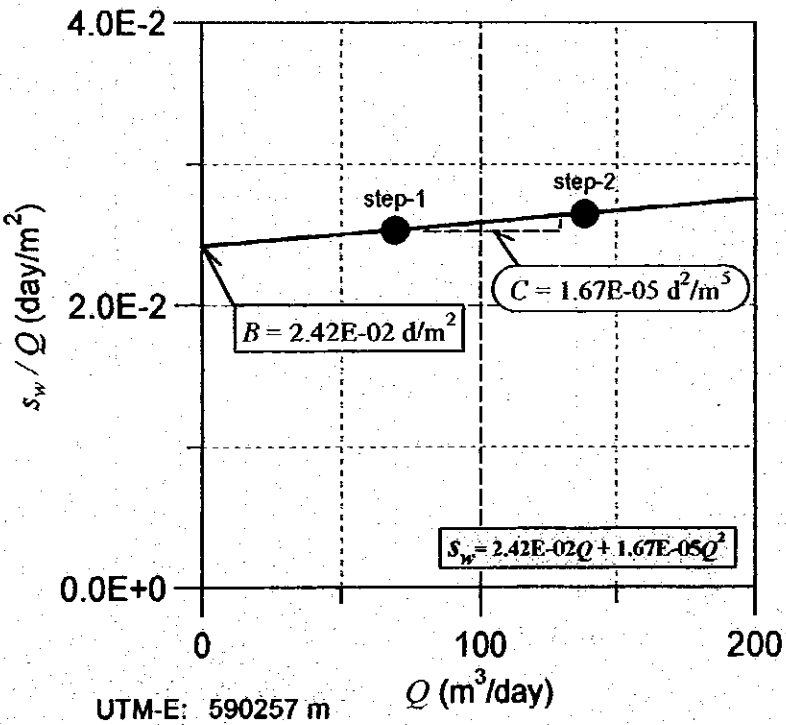
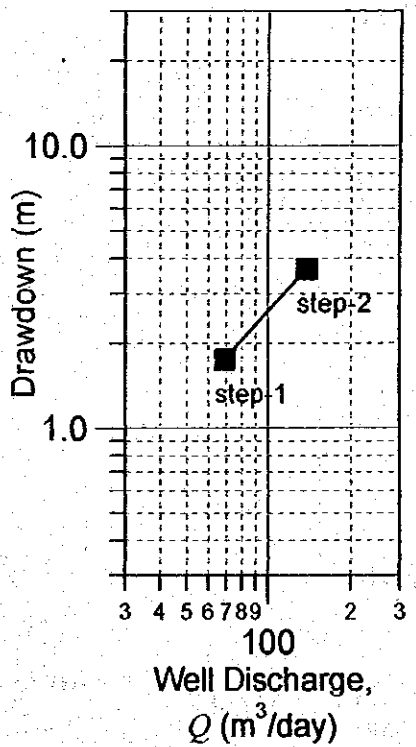


Figure 3.1	**Results of Step-drawdown Test at JICA-2, Hóa Thượng Commune, Thái Nguyên Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







UTM-E: 590257 m
UTM-N: 2366017 m
Long.: 105-52-15E (d-m-s)
Lati.: 21-23-45N (d-m-s)

Date: 15/04/1999 Static W.L.: 1.50 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	100 m
District:	Phổ Yên	Well Depth:	21.5 m
Commune:	Nam Tiến	Screen Depth(s):	5.5 to 17.5 m

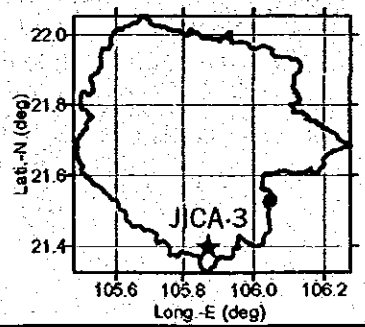
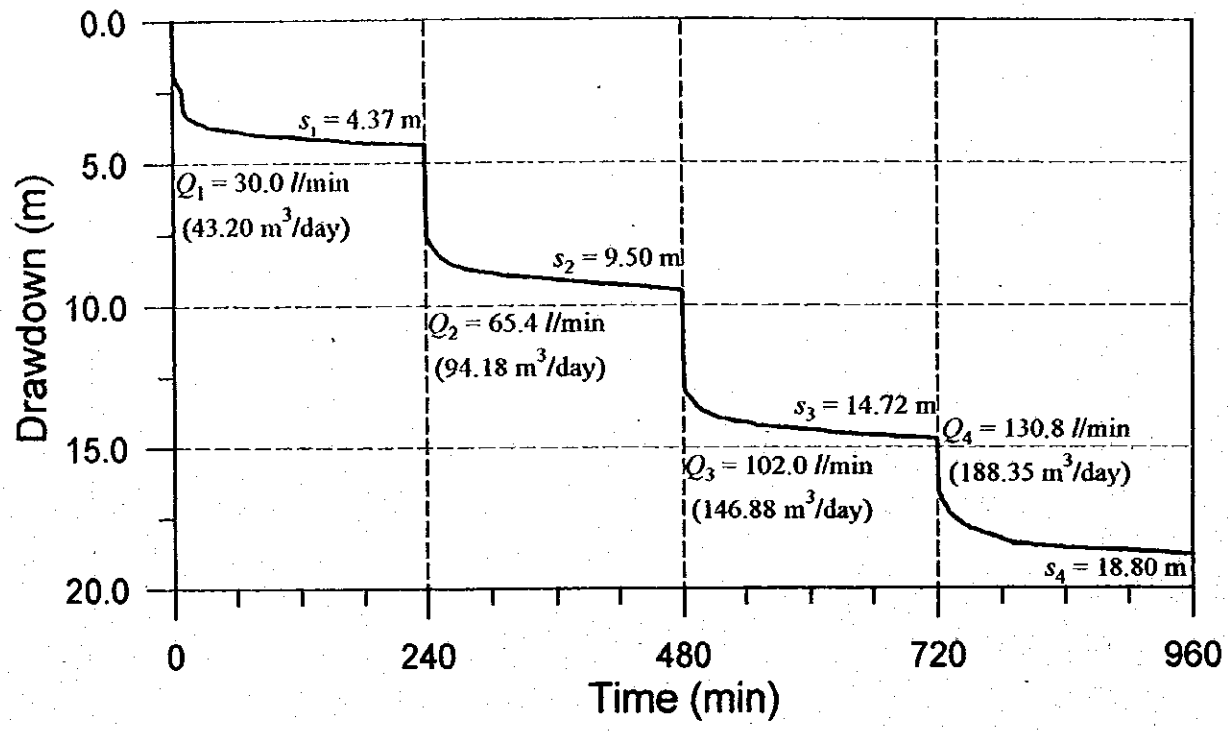
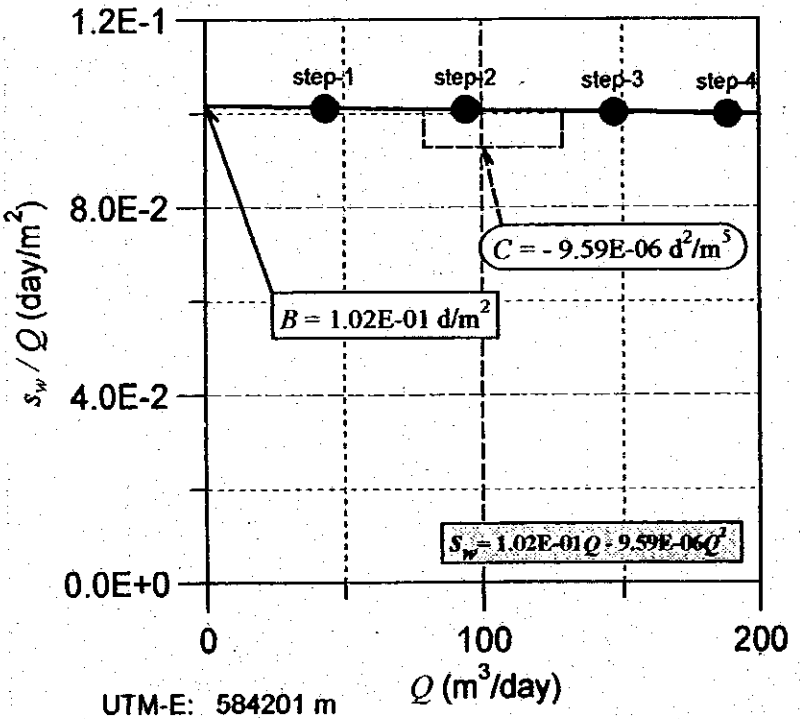
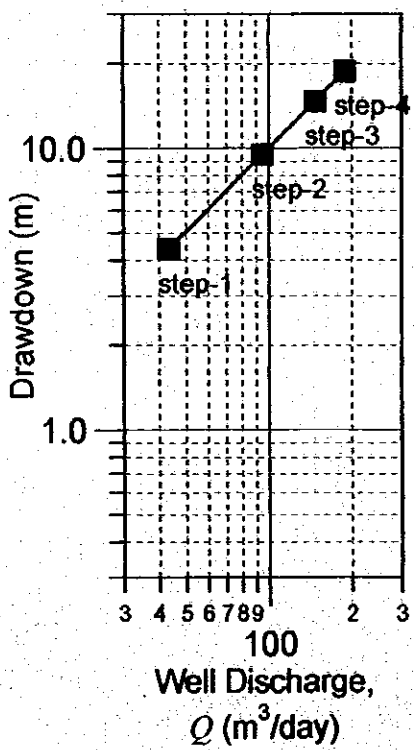


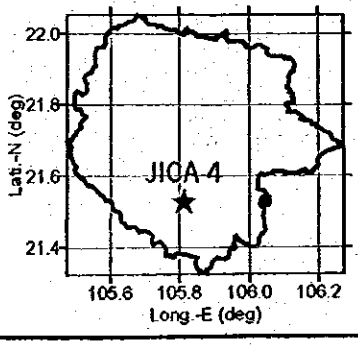
Figure 3.2	Results of Step-drawdown Test at JICA-3, Nam Tiến Commune, Thái Nguyên Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







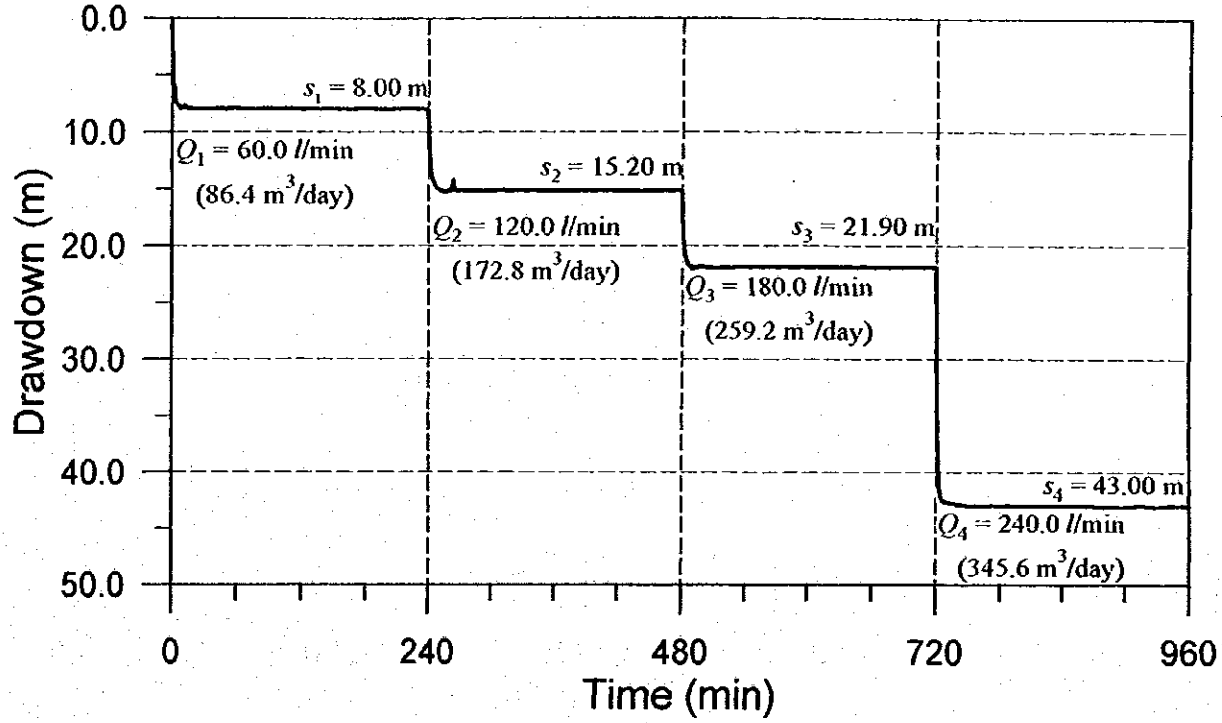
UTM-E: 584201 m
UTM-N: 2380475 m
Long.: 105-48-47E (d-m-s)
Lati.: 21-31-36N (d-m-s)

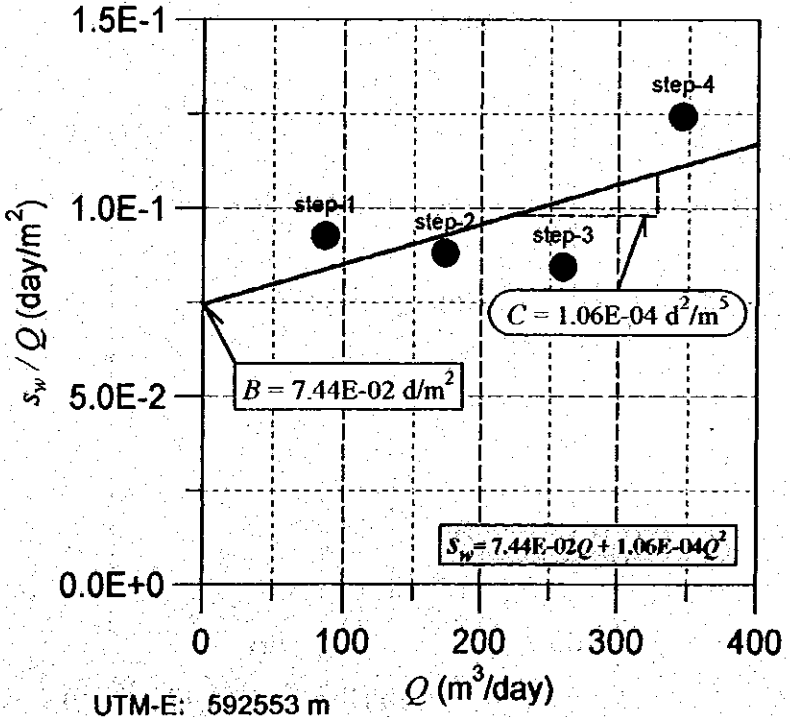


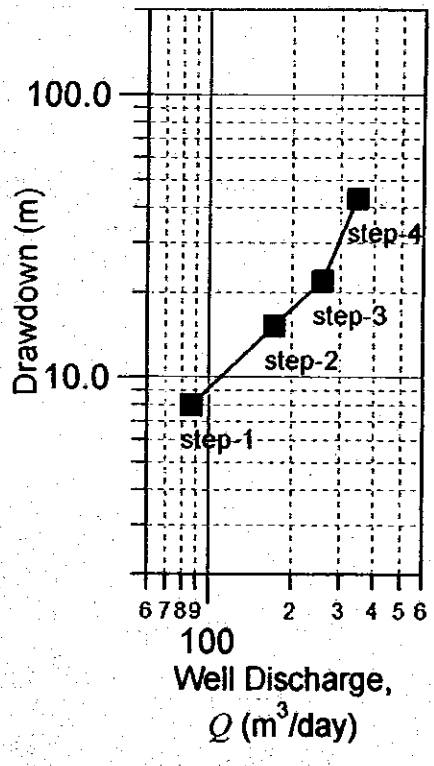
Date: 27/05/1999 Static W.L.: 2.00 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	100 m
District:	Thị trấn Thái Nguyên	Well Depth:	100 m
Commune:	Thịnh Đức	Screen Depth(s):	52 to 60 m 68 to 84 m

Figure 3.3	**Results of Step-drawdown Test at JICA-4, Thịnh Đức Commune, Thái Nguyên Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







UTM-E: 592553 m
UTM-N: 2228660 m
Long.: 105-58-09E (d-m-s)
Lati.: 20-09-17N (d-m-s)

Date: 05/03/1999 Static W.L.: 10.80 m below G.L.

Province: Ninh Bình Drilling Depth: 150 m
District: Thị trấn Tam Điệp Well Depth: 120 m
Commune: Quang Sơn Screen Depth(s): 72 to 116 m

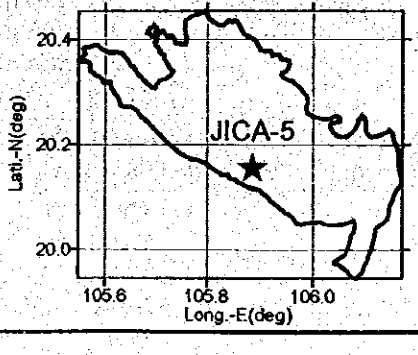
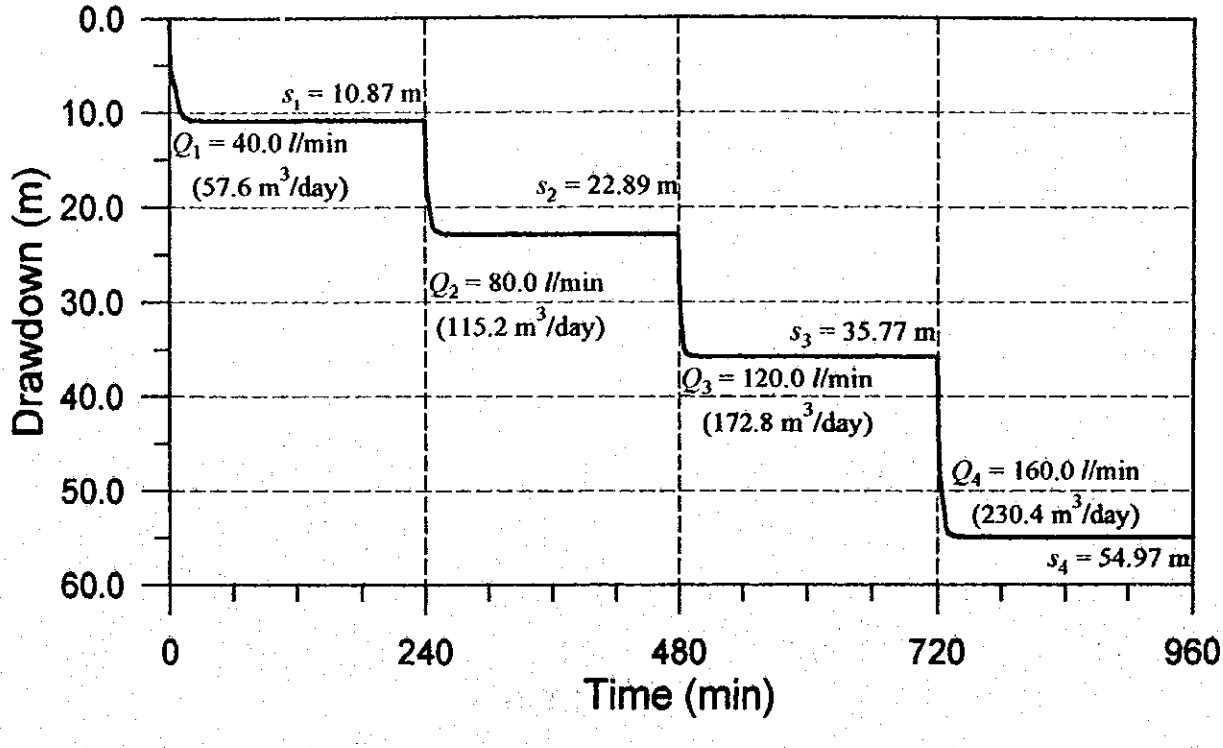
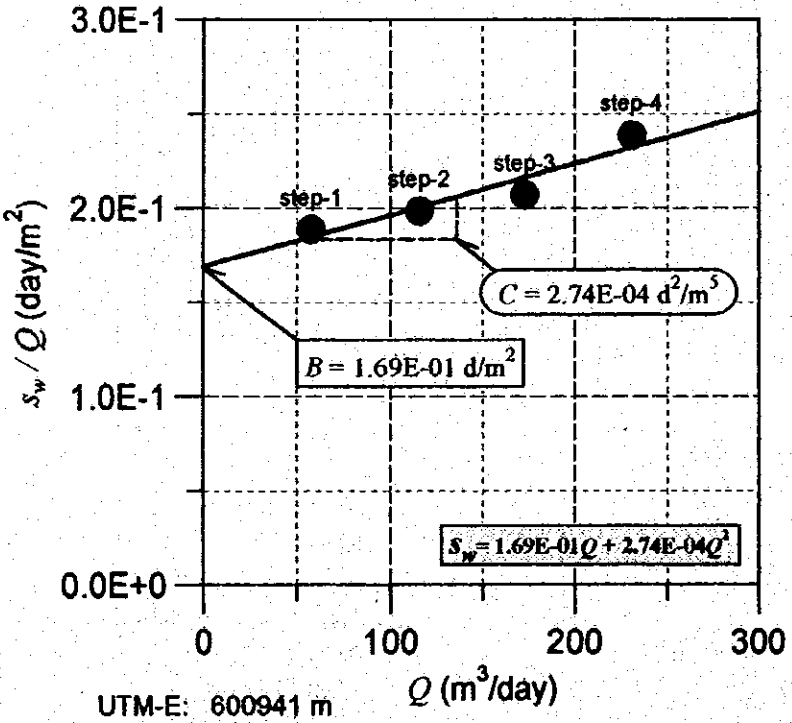
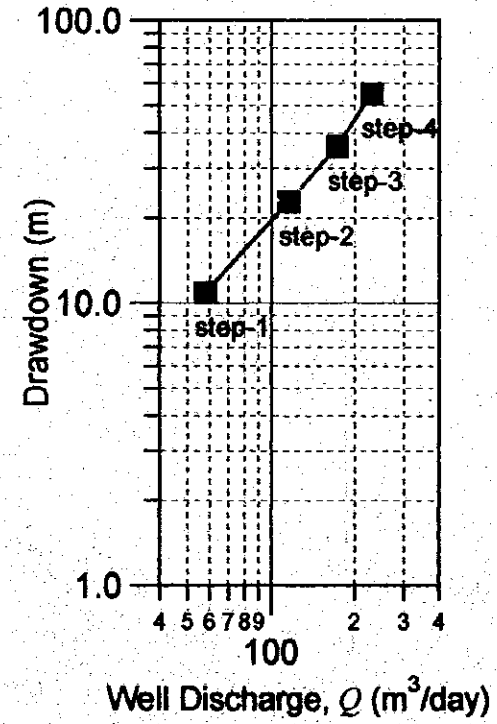


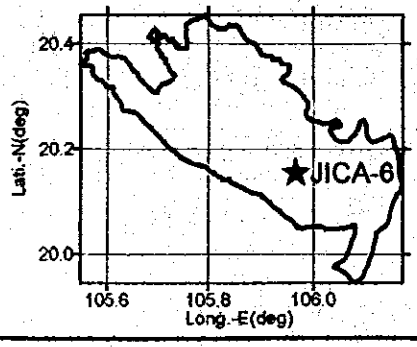
Figure 3.4	Results of Step-drawdown Test at JICA-5, Quang Sơn Commune, Ninh Bình Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







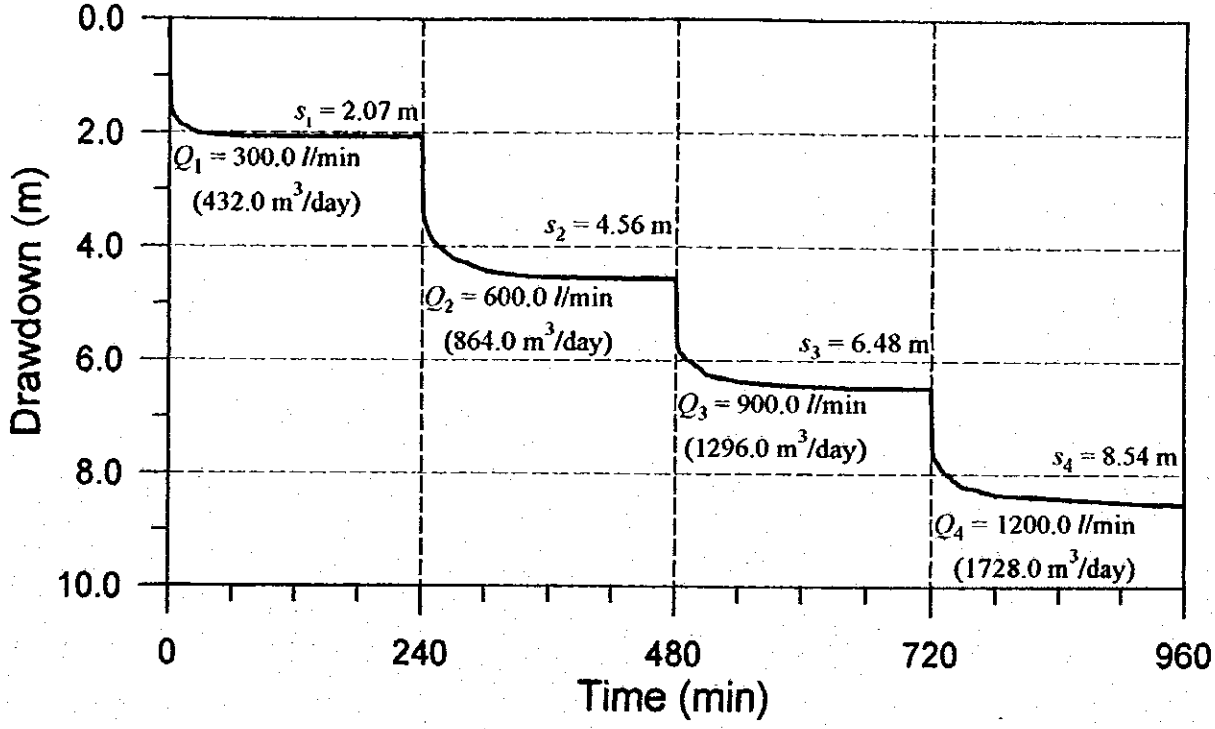
UTM-E: 600941 m
UTM-N: 2228665 m
Long.: 105-57-58E (d-m-s)
Lati.: 20-09-15N (d-m-s)

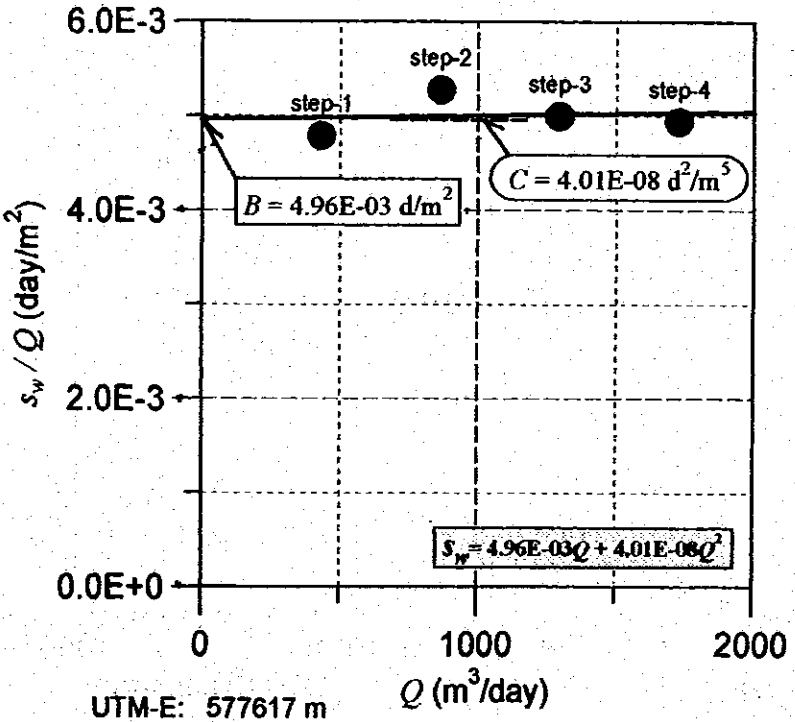


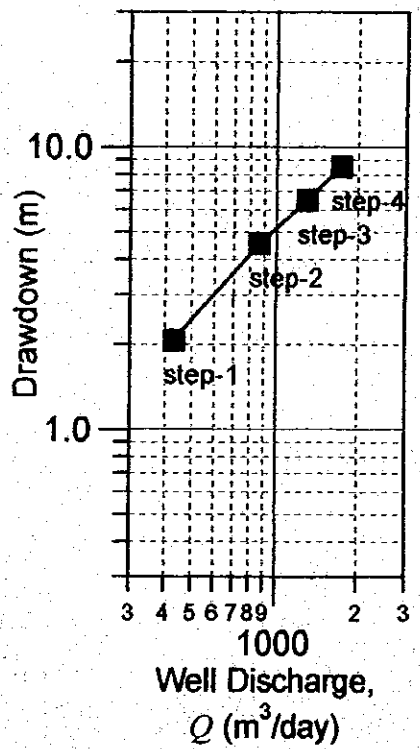
Date: 17/03/1999 Static W.L.: 1.23 m below G.L.

Province:	Ninh Binh	Drilling Depth:	150 m
District:	Yên Mô	Well Depth:	136 m
Commune:	Yên Thắng	Screen Depth(s):	75 to 86 m
			93 to 104 m
			122 to 130 m

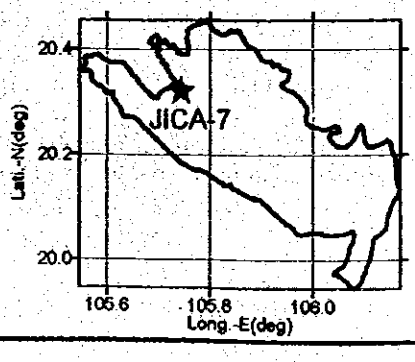
Figure 3.5	**Results of Step-drawdown Test at JICA-6, Yên Thắng Commune, Ninh Binh Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







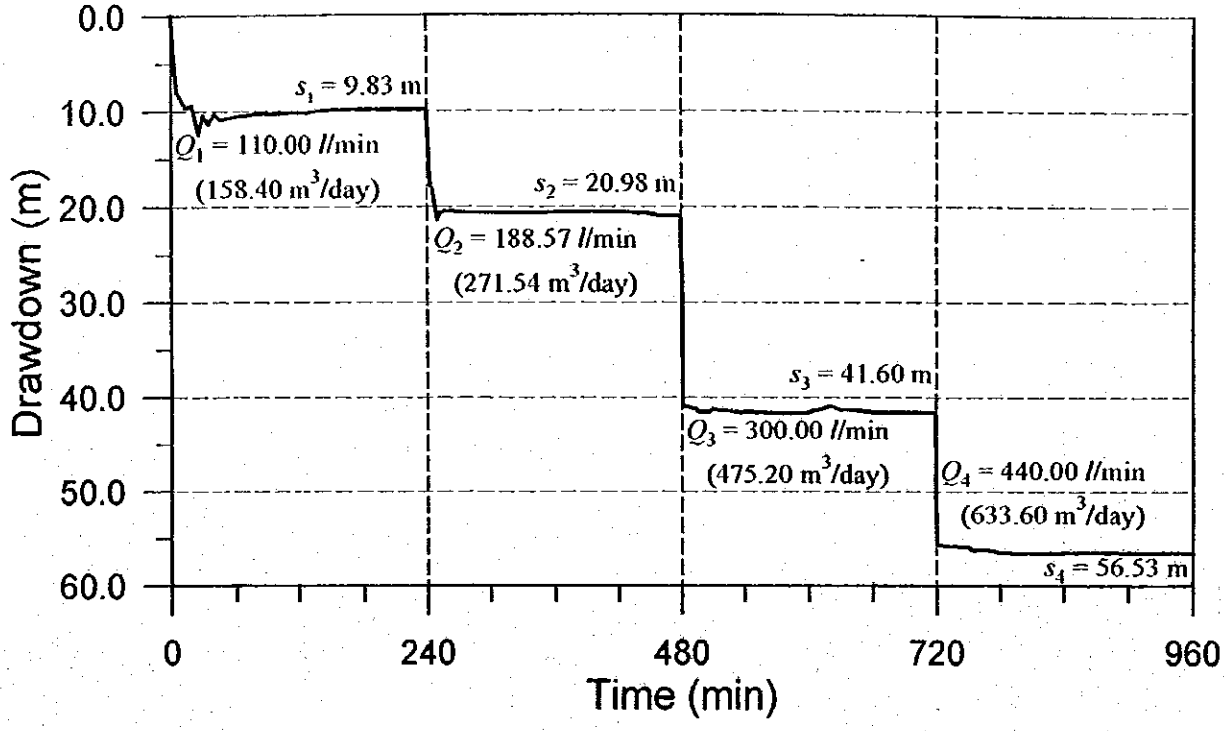
UTM-E: 577617 m
UTM-N: 2246929 m
Long.: 105-44-37E (d-m-s)
Lati.: 20-19-14N (d-m-s)

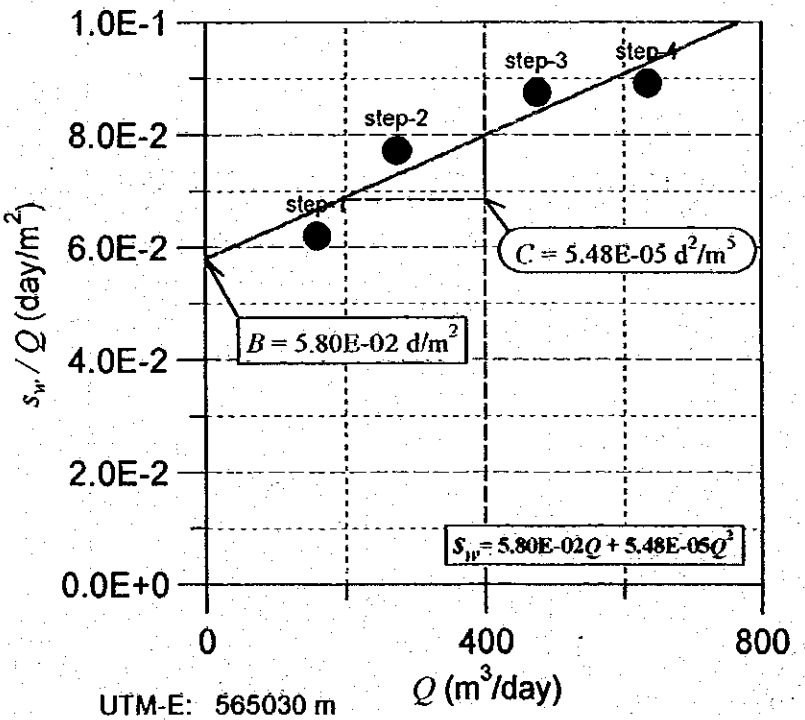


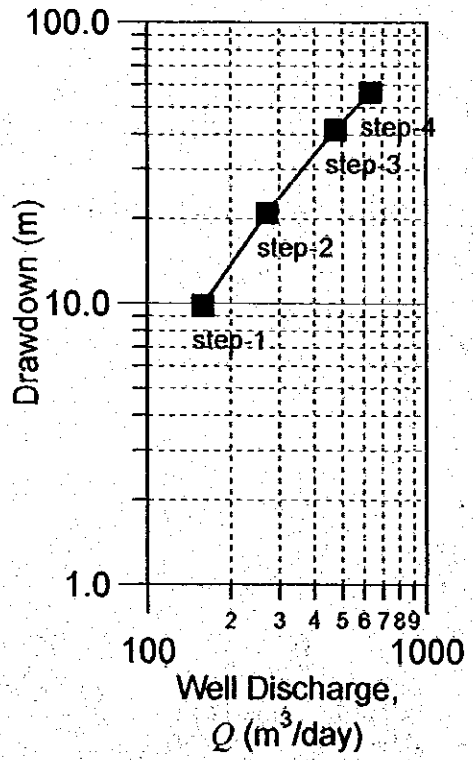
Date: 23/05/1999 Static W.L.: 0.60 m below G.L.

Province:	Ninh Binh	Drilling Depth:	150 m
District:	Nho Quan	Well Depth:	130 m
Commune:	Đồng Phong	Screen Depth(s):	92 to 126 m

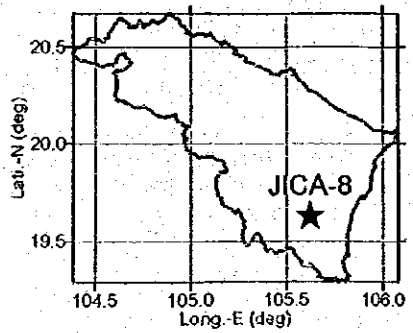
Figure 3.6	**Results of Step-drawdown Test at JICA-7, Đồng Phong Commune, Ninh Binh Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







UTM-E: 565030 m
UTM-N: 2170050 m
Long.: 105-37-13E (d-m-s)
Lati.: 19-37-34N (d-m-s)



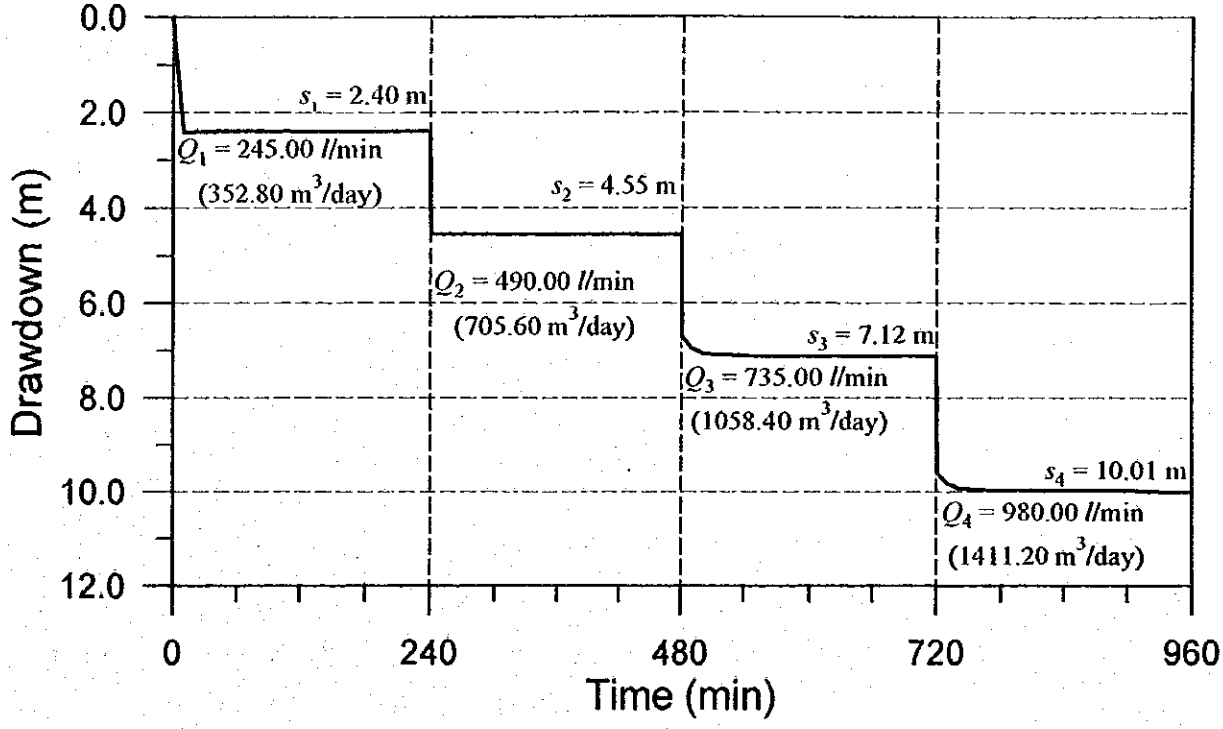
Date: 05/02/1999 Static W.L.: 5.70 m below G.L.

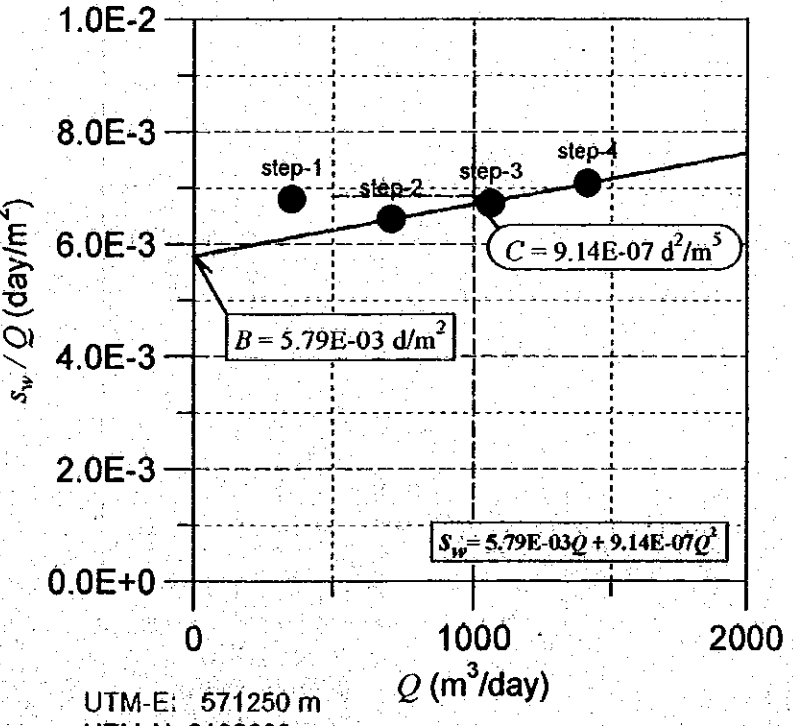
Commune:	Vạn Thắng	Drilling Depth:	150 m
District:	Nông Cống	Well Depth:	150 m
Province:	Thanh Hóa	Screen Depth(s):	99 to 119 m

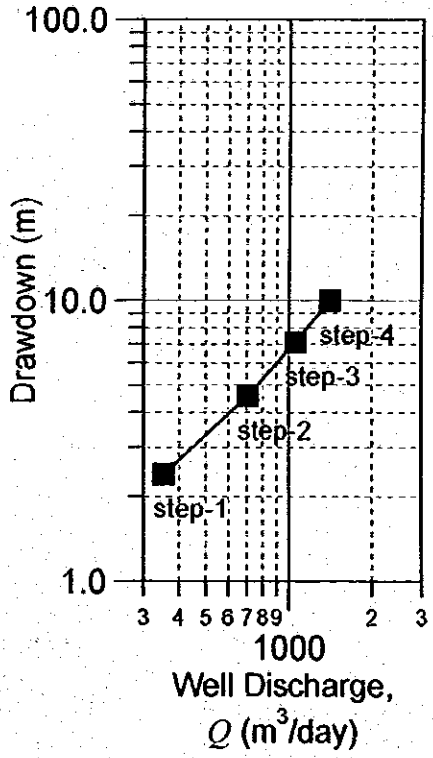
Figure 3.7	**Results of Step-drawdown Test at JICA-8, Vạn Thắng Commune, Thanh Hóa Province**

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)







UTM-E: 571250 m
UTM-N: 2198900 m
Long.: 105-40-51E (d-m-s)
Lati.: 19-53-12N (d-m-s)

Date: 10/02/1999 Static W.L.: 4.00 m below G.L.

Commune:	Thiệu Hưng	Drilling Depth:	80 m
District:	Thiệu Hóa	Well Depth:	52 m
Province:	Thanh Hóa	Screen Depth(s):	32 to 48 m

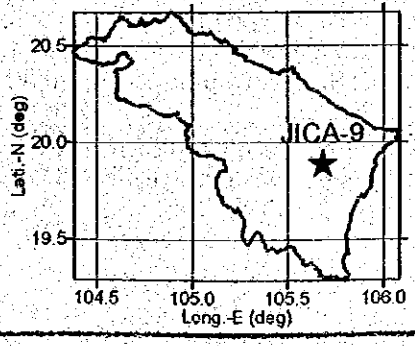
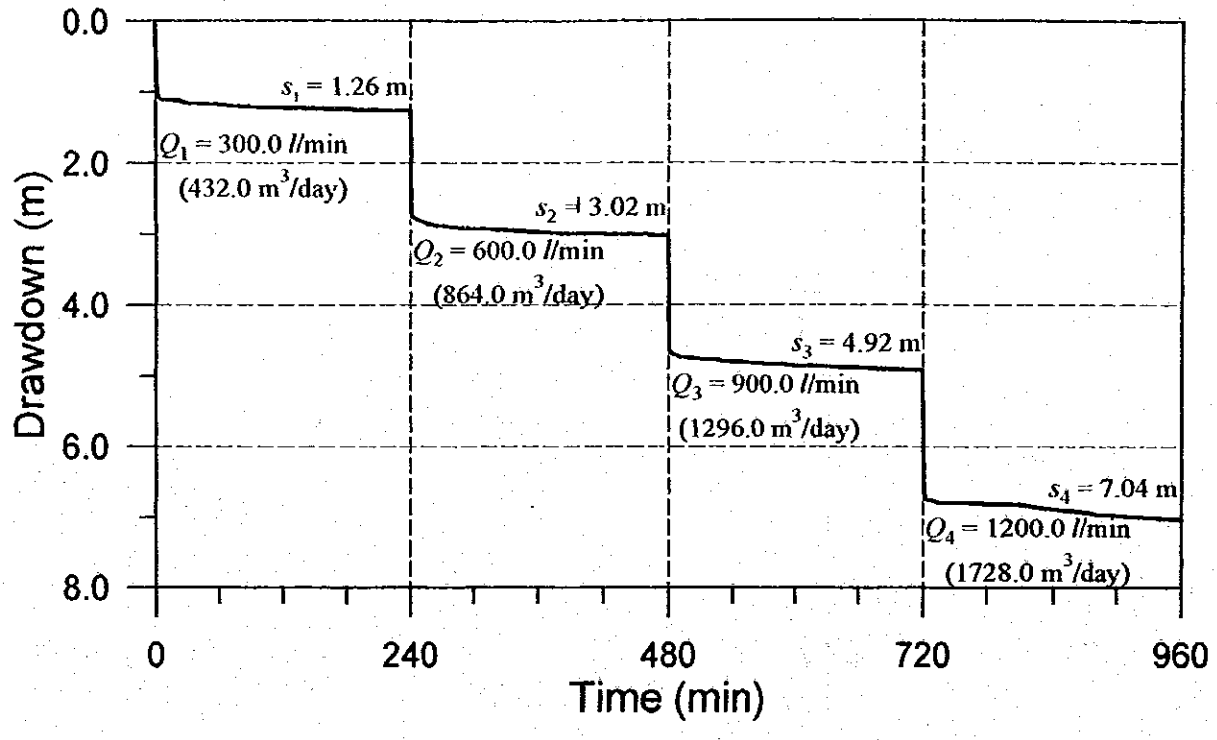
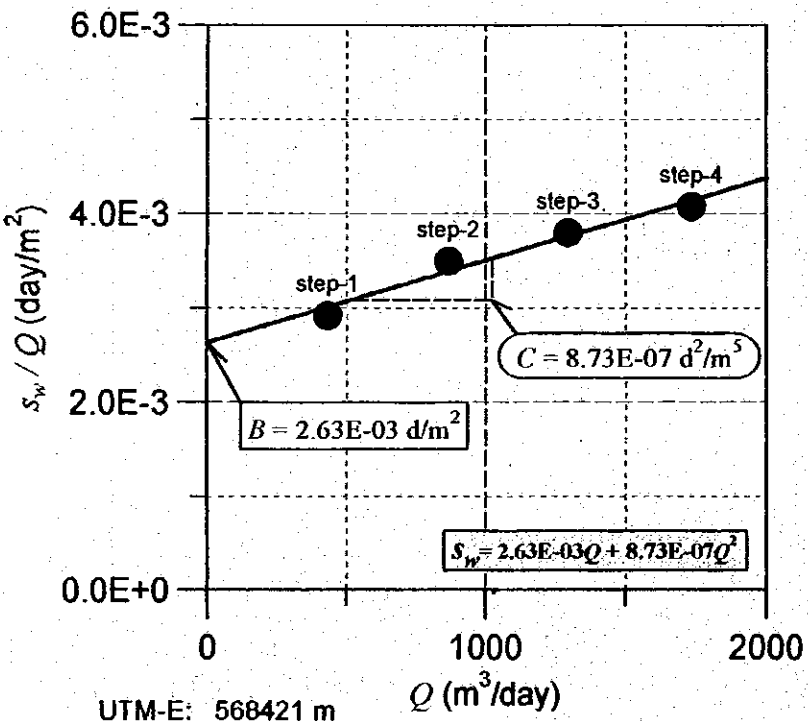


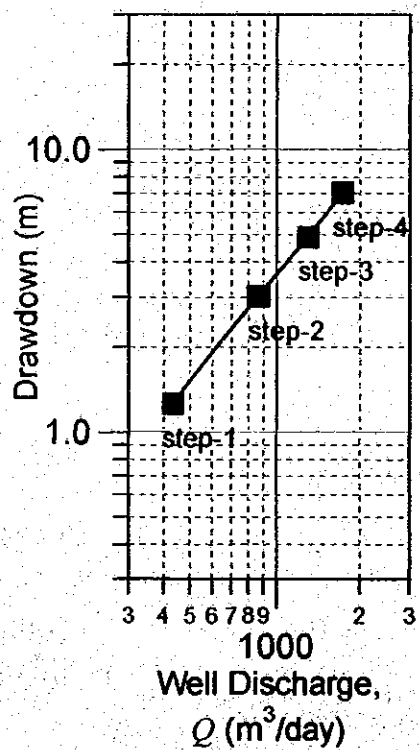
Figure 3.8 Results of Step-drawdown Test at JICA-9, Thiệu Hưng Commune, Thanh Hóa Province

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM

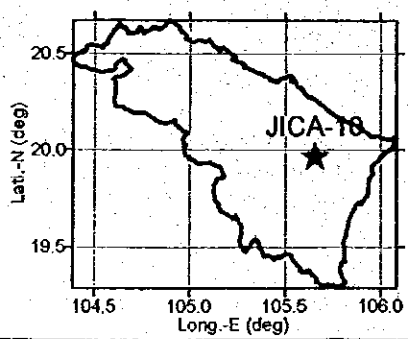
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)







UTM-E: 568421 m
UTM-N: 2207260 m
Long.: 105-39-14E (d-m-s)
Lati.: 19-57-44N (d-m-s)



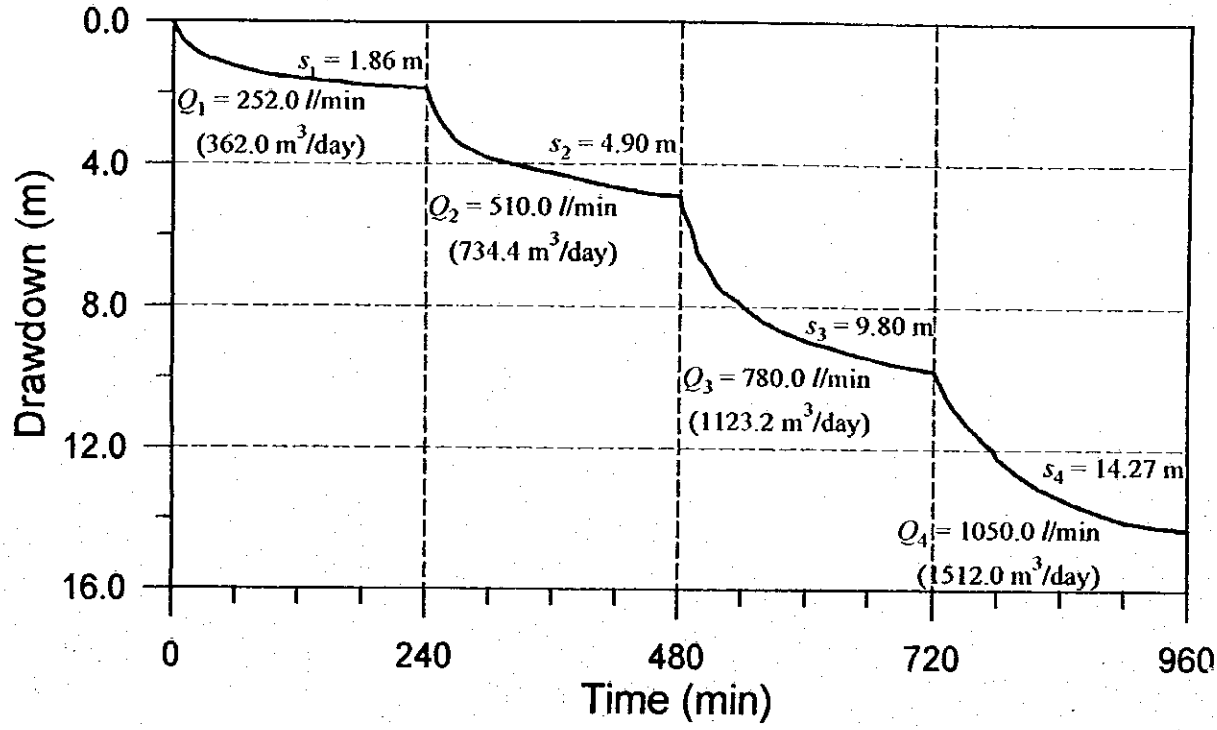
Date: 10/04/1999 Static W.L.: 4.90 m below G.L.

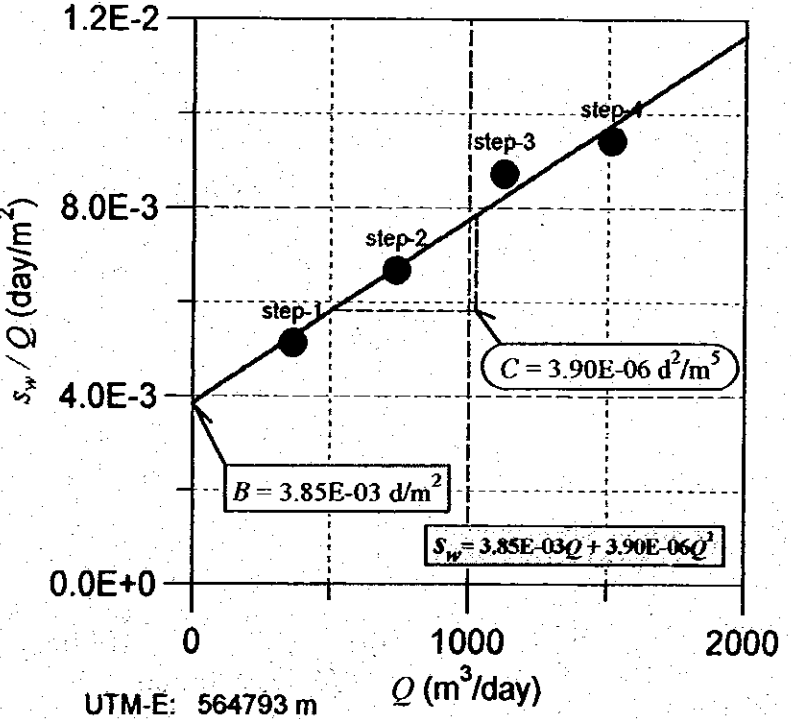
Province:	Thanh Hóa	Drilling Depth:	150 m
District:	Yên Định	Well Depth:	91.2 m
Commune:	Định Tường	Screen Depth(s):	23.2 to 39.2 m 47.2 to 63.2 m

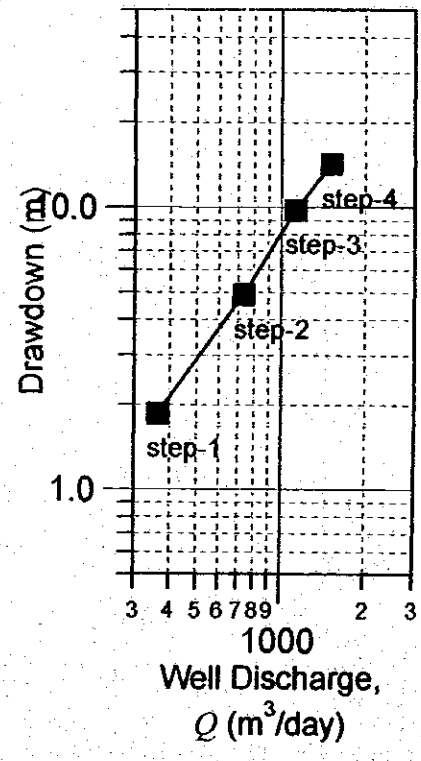
Figure 3.9 **Results of Step-drawdown Test at JICA-10, Định Tường Commune, Thanh Hóa Province**

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM

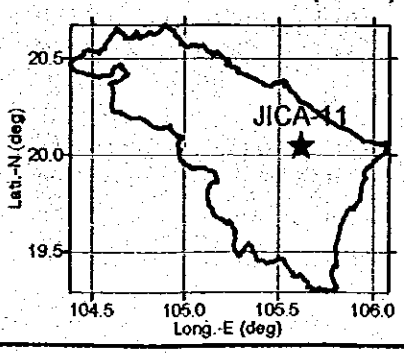
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)







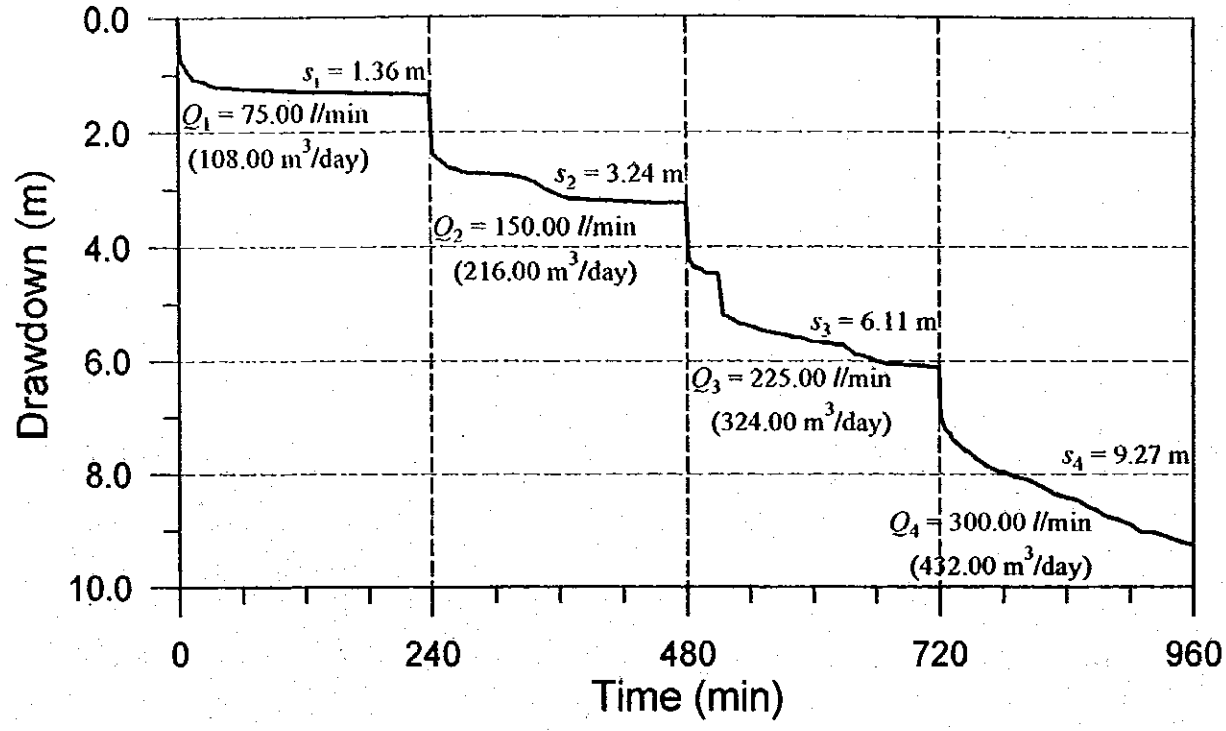
UTM-E: 564793 m
UTM-N: 2216162 m
Long.: 105-37-11E (d-m-s)
Lati.: 20-02-34N (d-m-s)

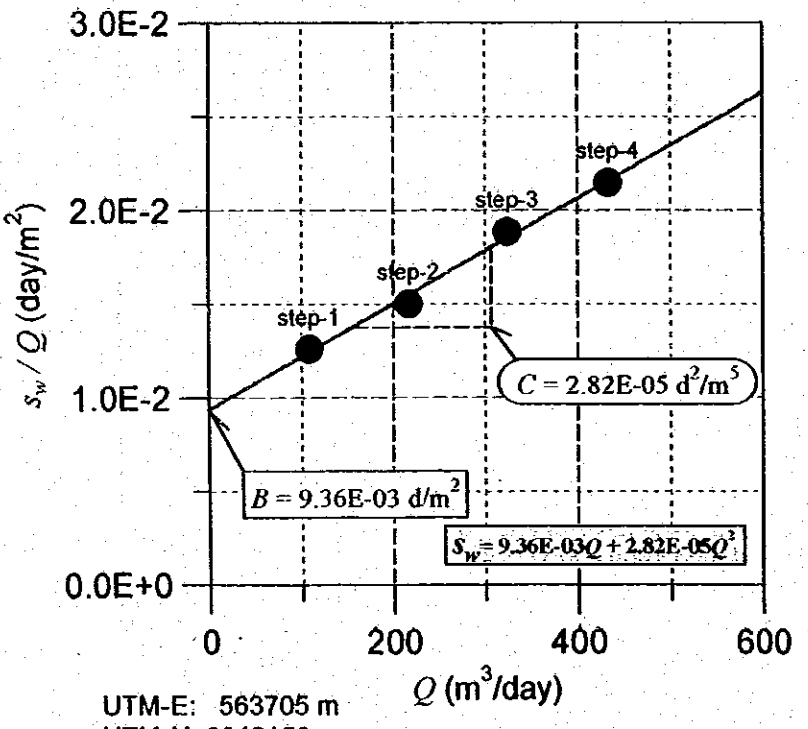


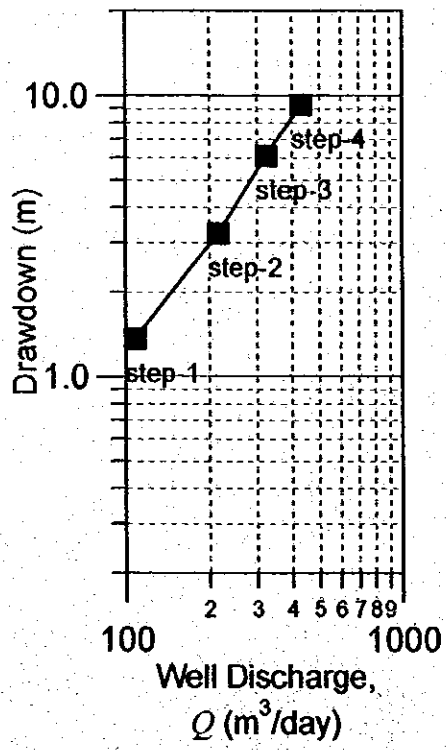
Date: 24/04/1999 Static W.L.: 7.55 m below G.L.

Province:	Thanh Hóa	Drilling Depth:	148 m
District:	Vĩnh Lộc	Well Depth:	130 m
Commune:	Vĩnh Thành	Screen Depth(s):	32 to 48 m
			60 to 76 m

Figure 3.10	**Results of Step-drawdown Test at JICA-11, Vĩnh Thành Commune, Thanh Hóa Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	







UTM-E: 563705 m
UTM-N: 2048152 m
Long.: 105-36-13E (d-m-s)
Lati.: 18-31-28N (d-m-s)

Date: 05/03/1999 Static W.L.: 2.90 m below G.L.

Commune:	Hà Tĩnh	Drilling Depth:	106 m
District:	Đức Thọ	Well Depth:	104 m
Province:	Đức Yên	Screen Depth(s):	20 to 28 m
			84 to 100 m

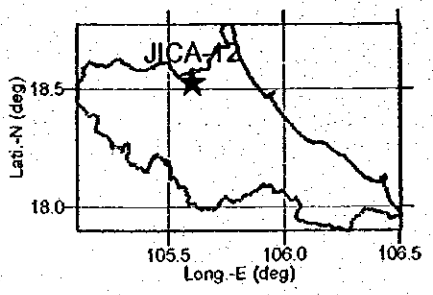


Figure 3.11	**Results of Step-drawdown Test at JICA-12, Đức Yên Commune, Hà Tĩnh Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
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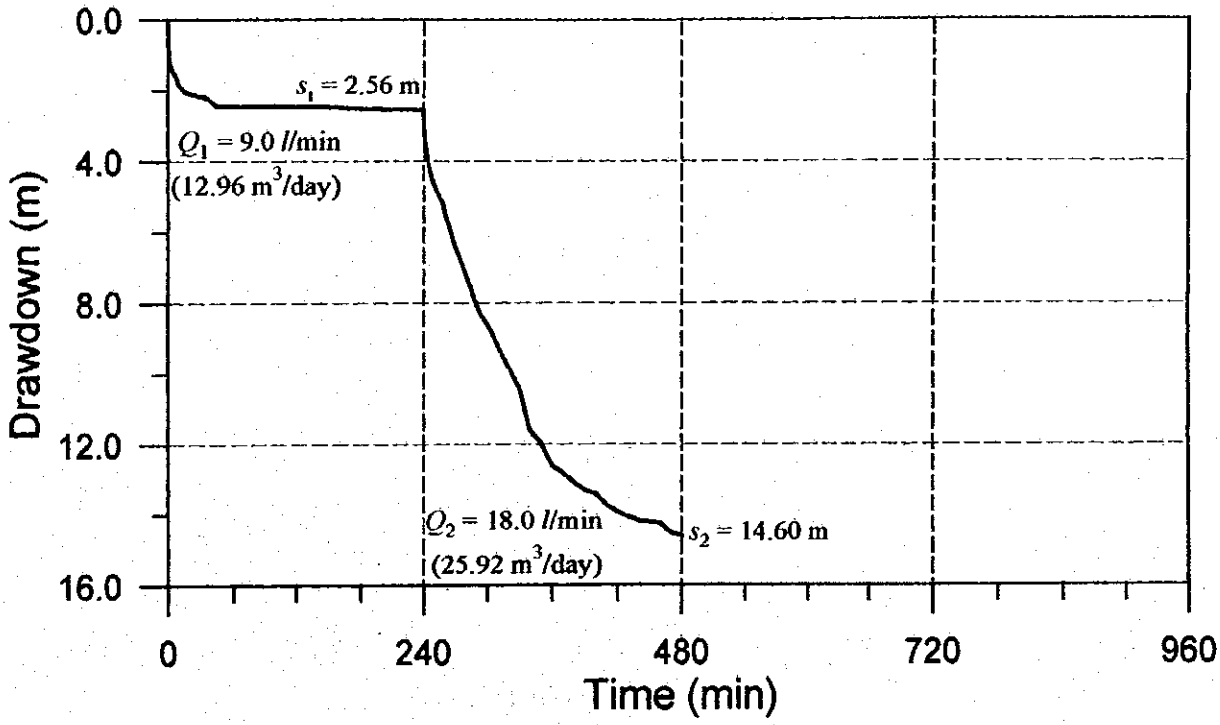

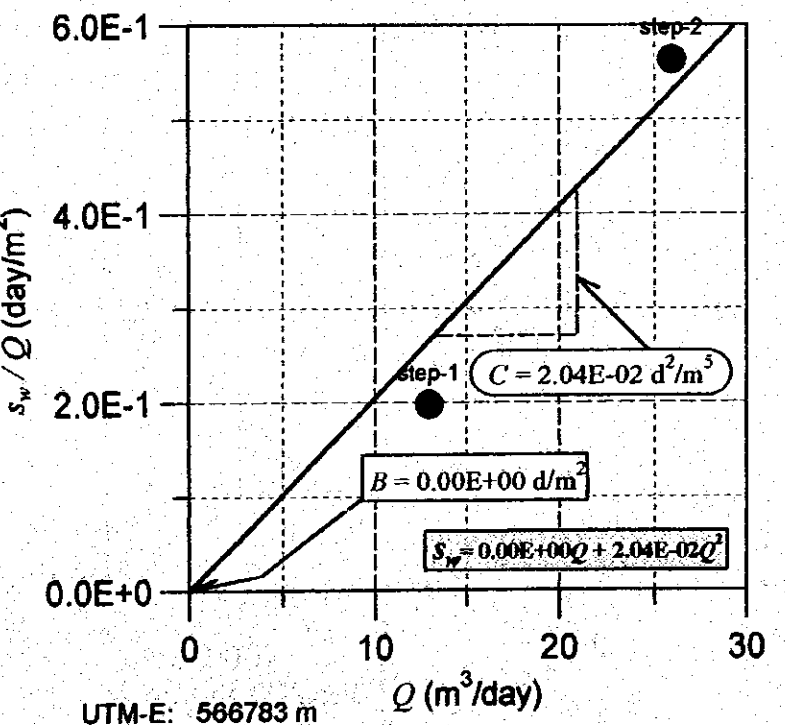

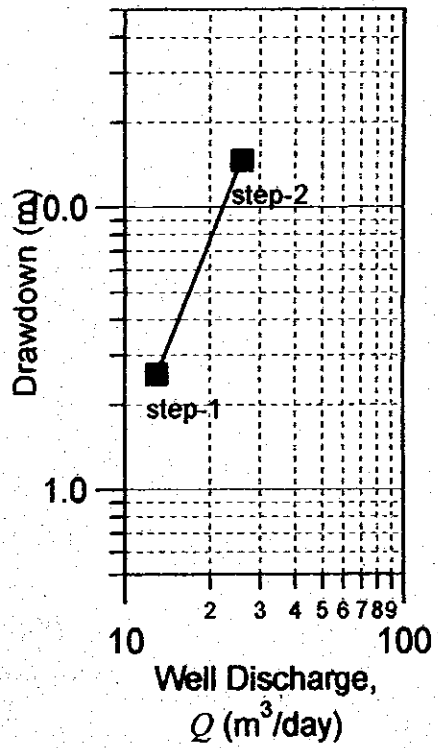

UTM-E: 566783 m
UTM-N: 2046329 m
Long.: 105-37-58E (d-m-s)
Lati.: 18-30-28N (d-m-s)

Date: 08/04/1999 Static W.L.: 2.60 m below G.L.

Province:	Hà Tĩnh	Drilling Depth:	100 m
District:	Đức Thọ	Well Depth:	100 m
Commune:	Trung Lễ	Screen Depth(s):	58 to 82 m

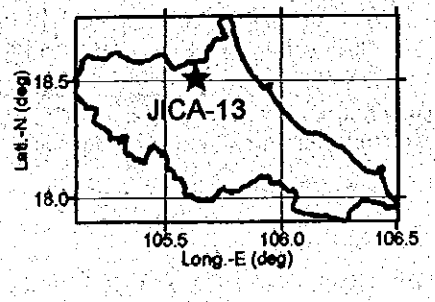

Figure 3.12	Results of Step-drawdown Test at JICA-13, Trung Lễ Commune, Hà Tĩnh Province

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM

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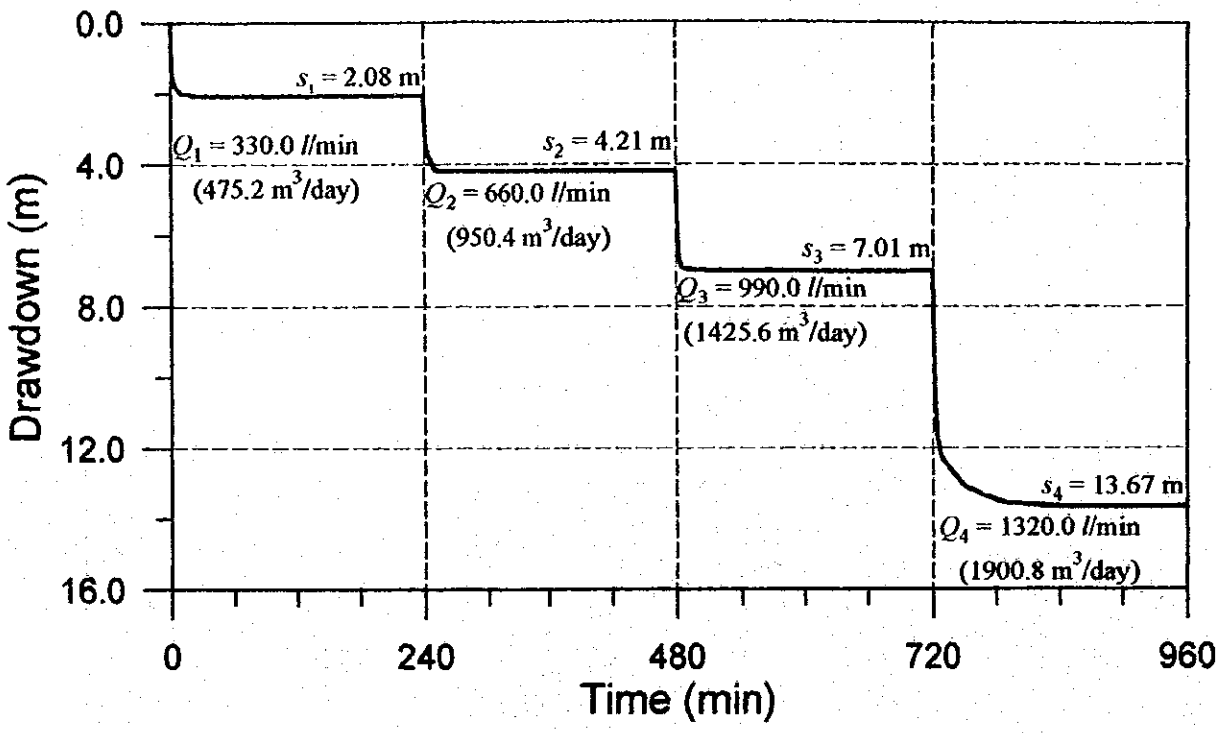
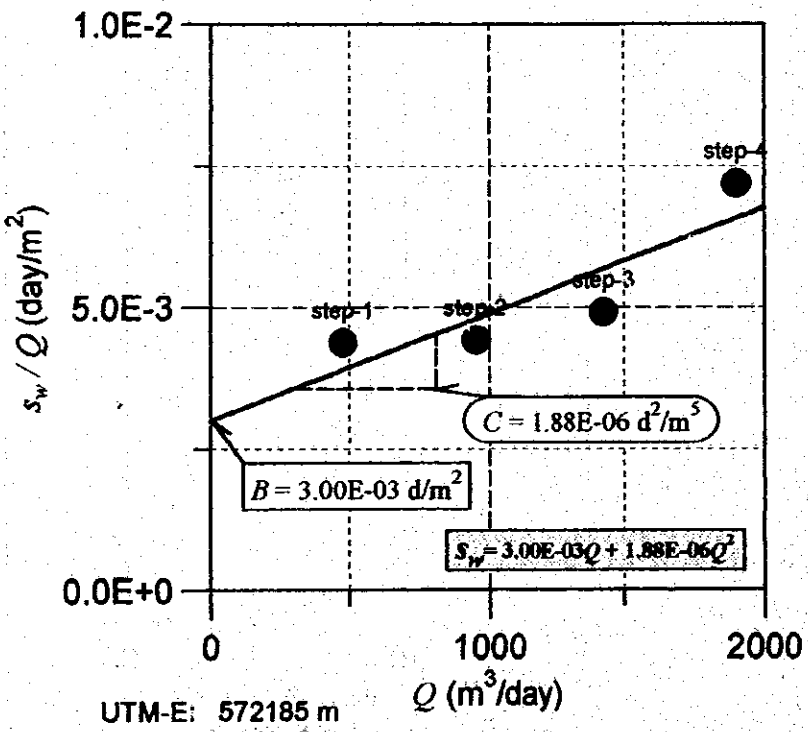
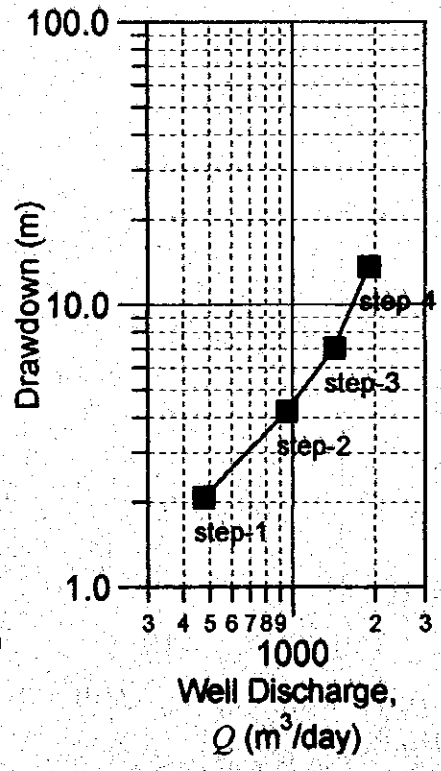
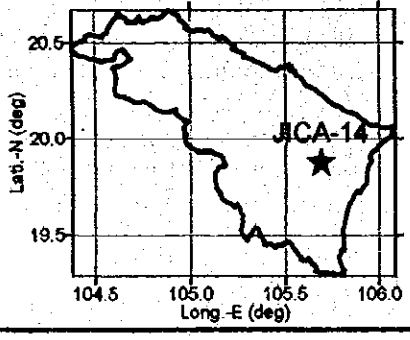






UTM-E: 572185 m
UTM-N: 2197515 m
Long.: 105-41-23E (d-m-s)
Lati.: 19-52-27N (d-m-s)



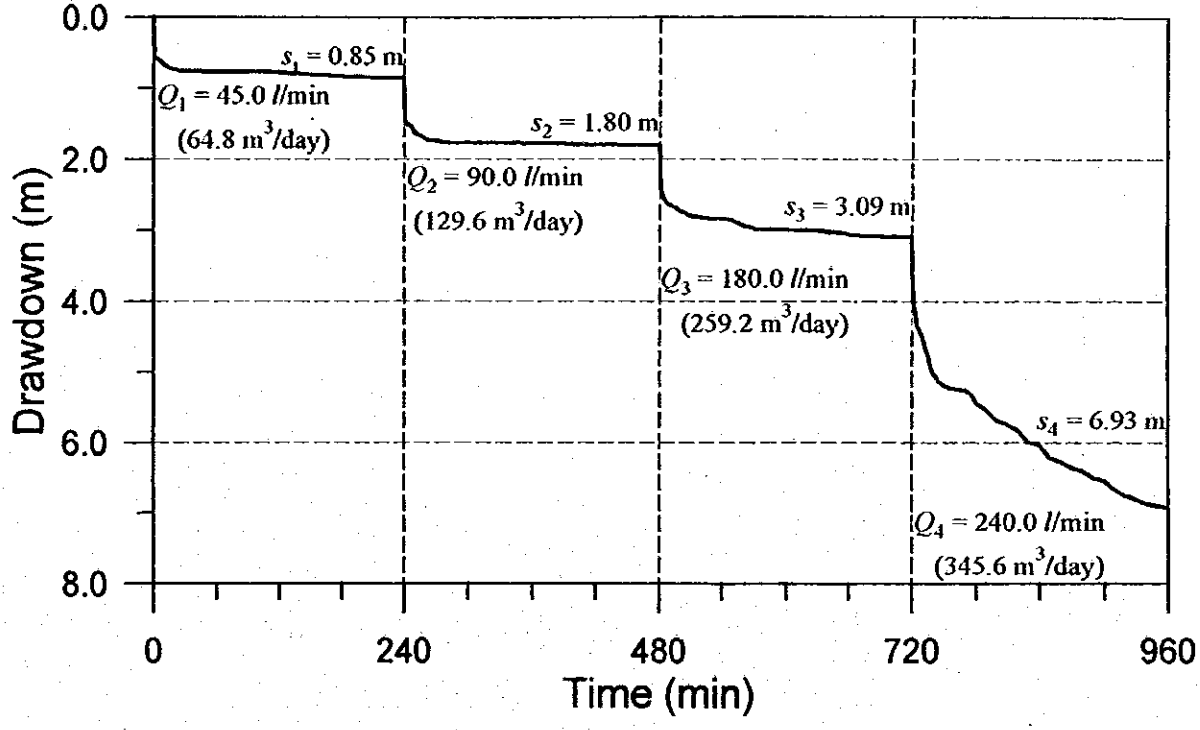
Date: 29/03/1999 Static W.L.: 2.85 m below G.L.

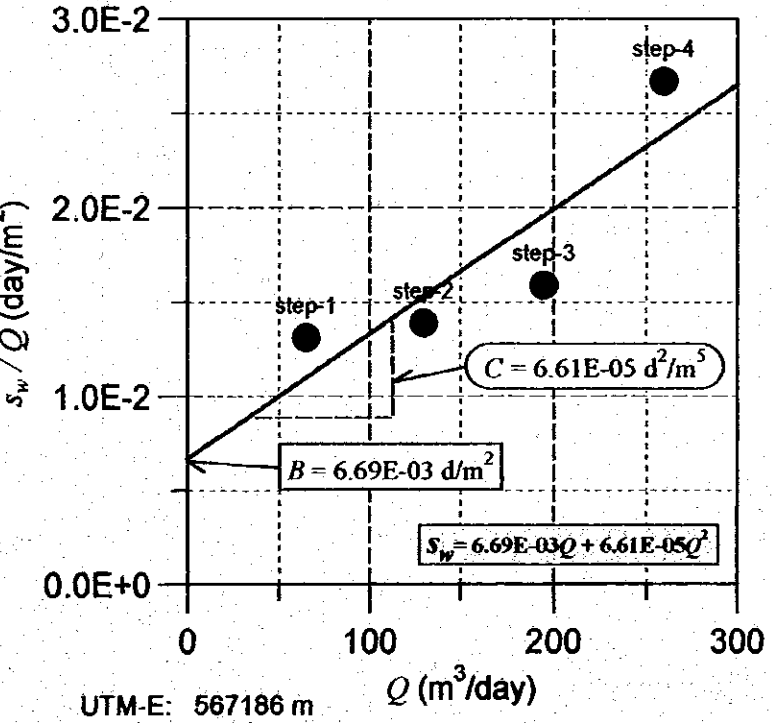
Province:	Thanh Hóa	Drilling Depth:	70 m
District:	Thiệu Hóa	Well Depth:	40 m
Commune:	Thiệu Đô	Screen Depth(s):	16 to 36 m

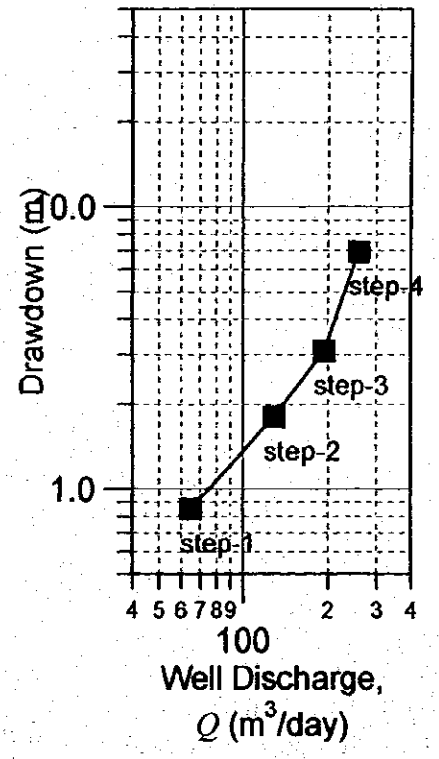
Figure 3.13	Results of Step-drawdown Test at JICA-14, Thiệu Đô Commune, Thanh Hóa Province

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)







UTM-E: 567186 m
UTM-N: 2046557 m
Long.: 105-38-12E (d-m-s)
Lati.: 18-30-36N (d-m-s)

Date: 01/04/1999 Static W.L.: 2.48 m below G.L.

Province:	Hà Tĩnh	Drilling Depth:	70 m
District:	Đức Thọ	Well Depth:	40 m
Commune:	Trung Lễ	Screen Depth(s):	16 to 36 m

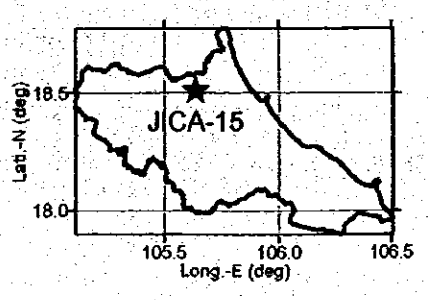
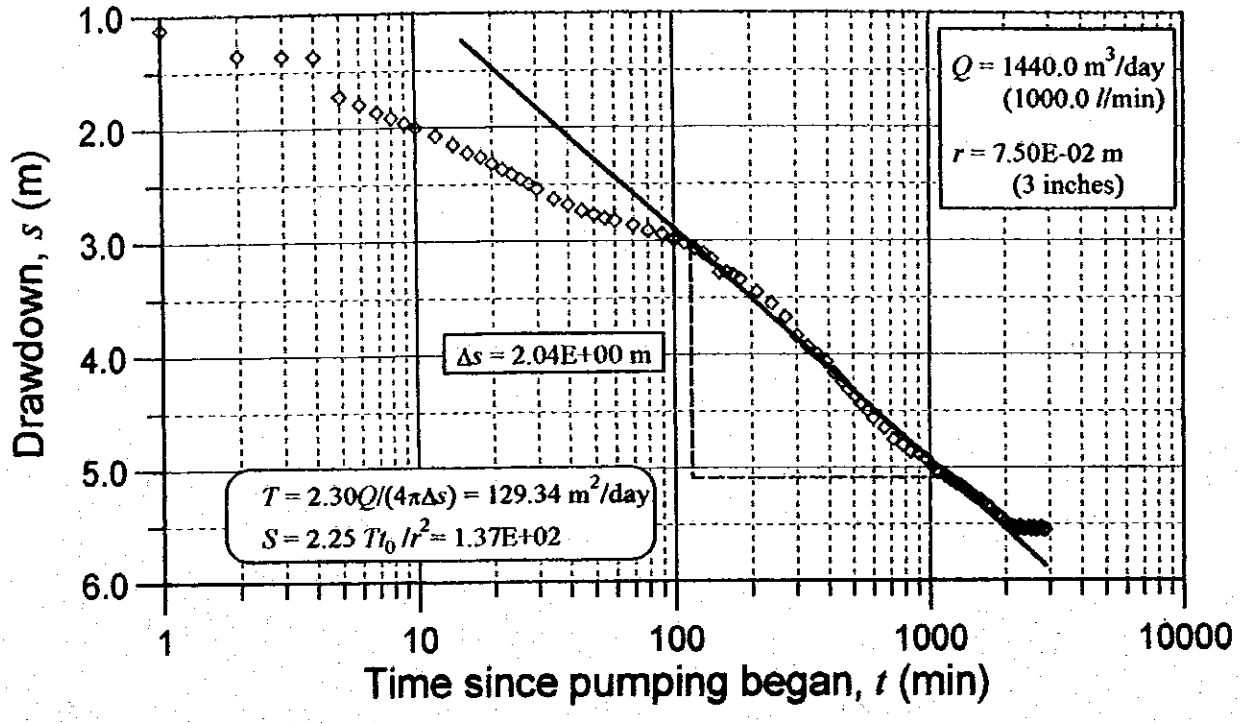
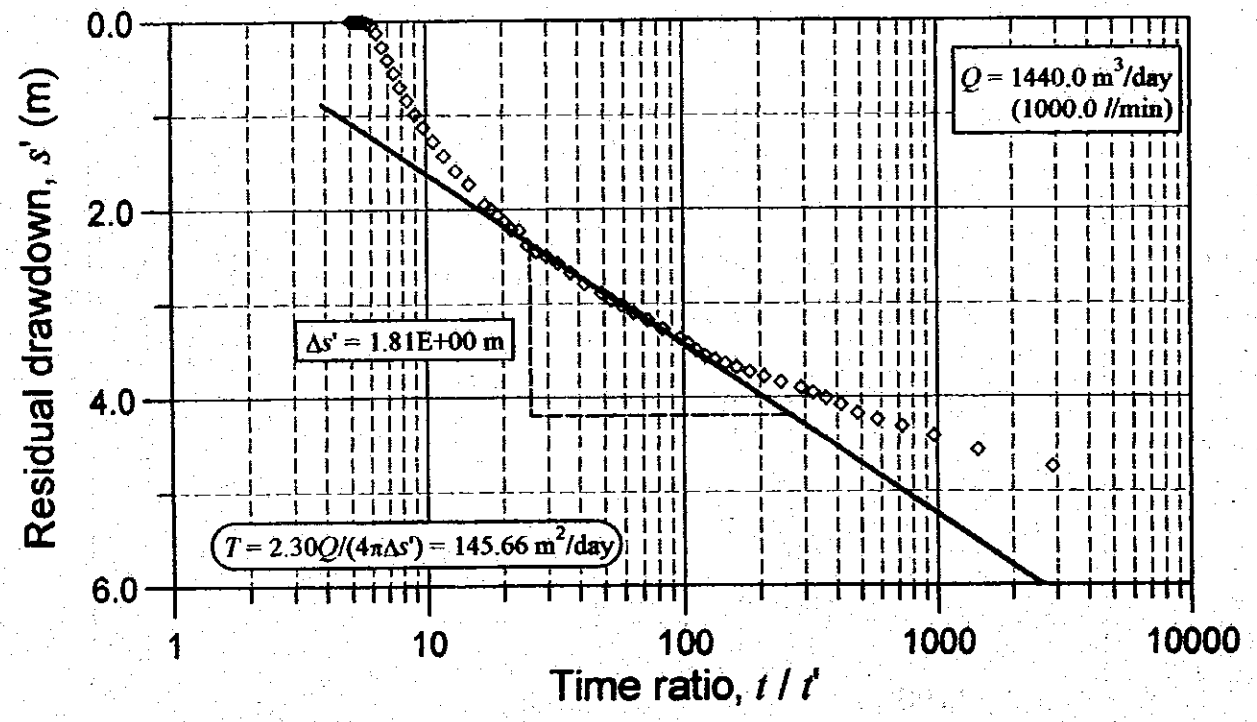


Figure 3.14	Results of Step-drawdown Test at JICA-15, Trung Lễ Commune, Hà Tĩnh Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

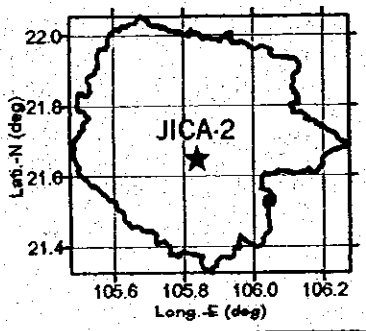


a) Continuous Drawdown Test



b) Recovery Test

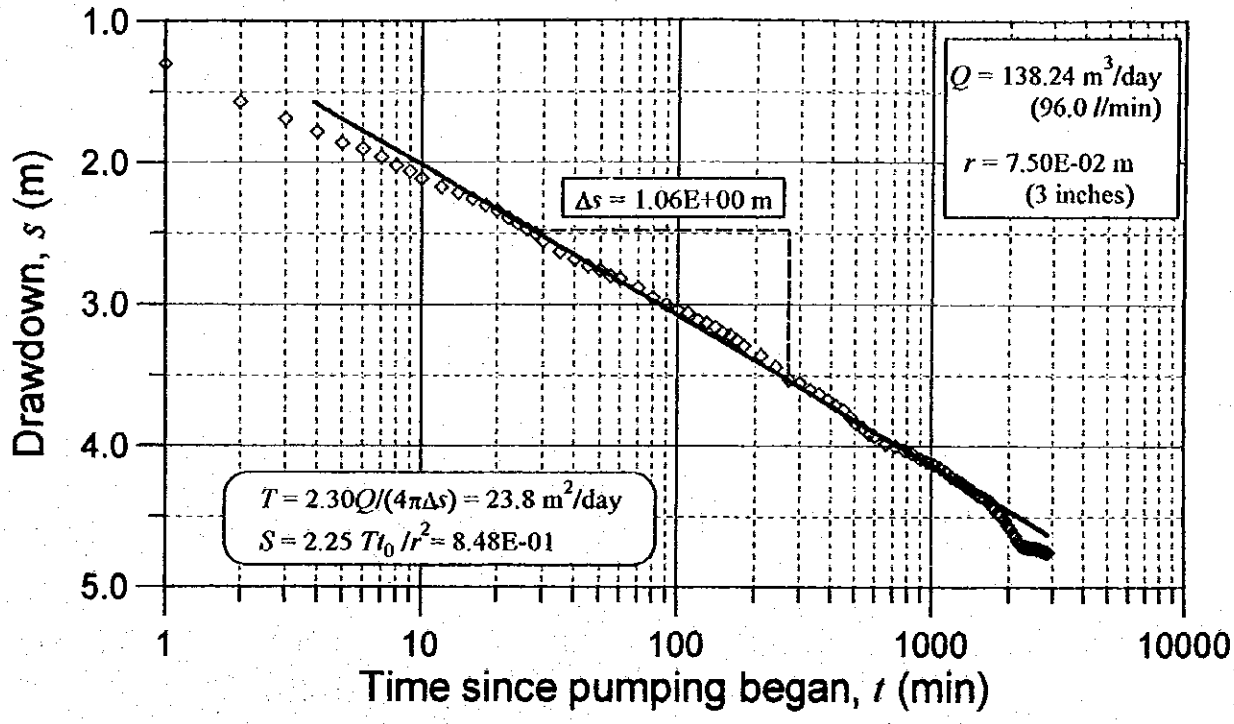
UTM-E: 586578 m
UTM-N: 2393846 m
Long.: 105-50-13E (d-m-s)
Lati.: 21-38-51N (d-m-s)



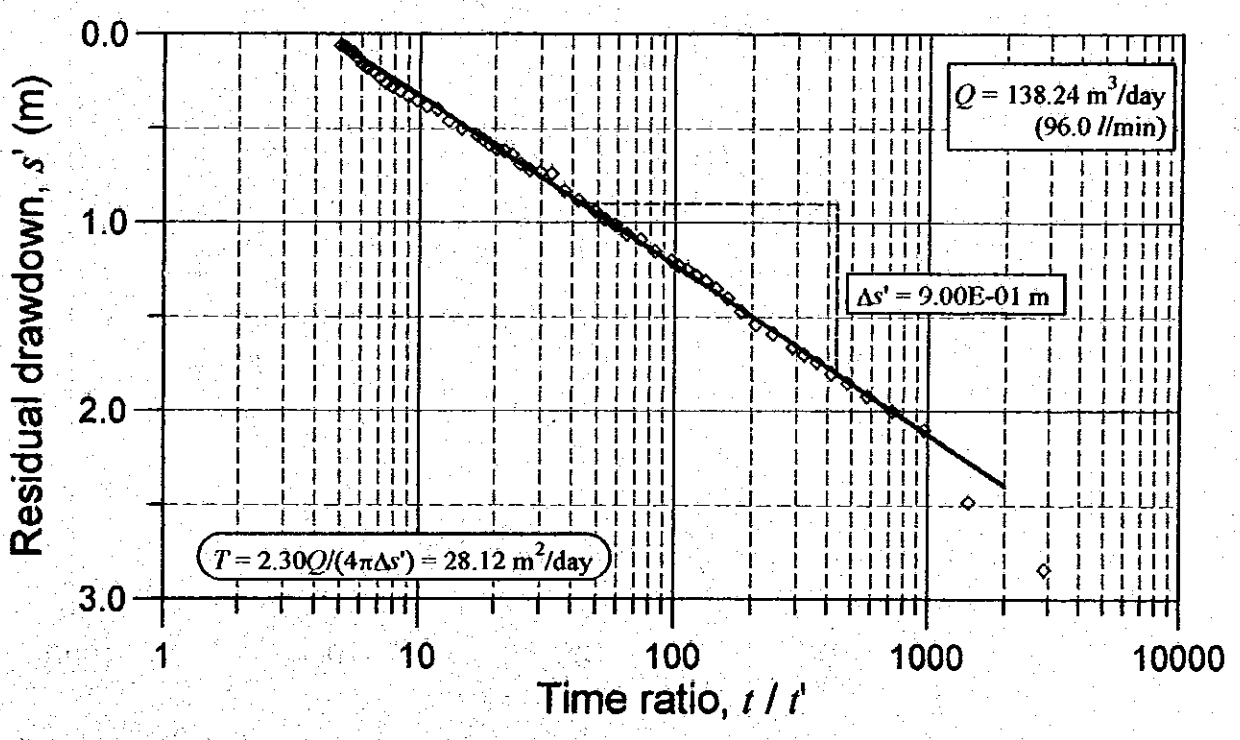
Date: 04/06/1999 Static W.L.: 3.10 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	150 m
District:	Đồng Hỷ	Well Depth:	92 m
Commune:	Hóa Thượng	Screen Depth(s):	24 to 32 m
			56 to 64 m
			76 to 88 m

Figure 3.15	Results of Continuous Pumping Test and Recovery Test at JICA-2, Hóa Thượng Commune, Thái Nguyên Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

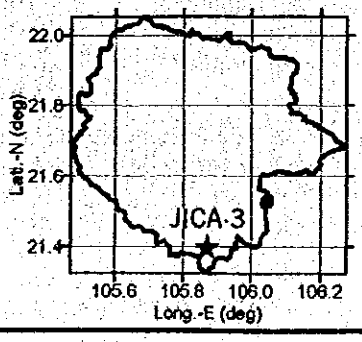


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 590257 m
UTM-N: 2366017 m
Long.: 105-52-15E (d-m-s)
Lati.: 21-23-45N (d-m-s)



Date: 16/04/1999 Static W.L.: 1.50 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	100 m
District:	Phổ Yên	Well Depth:	21.5 m
Commune:	Nam Tiến	Screen Depth(s):	5.5 to 17.5 m

Figure 3.16	**Results of Continuous Pumping Test and Recovery Test at JICA-3, Nam Tiến Commune, Thái Nguyên Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
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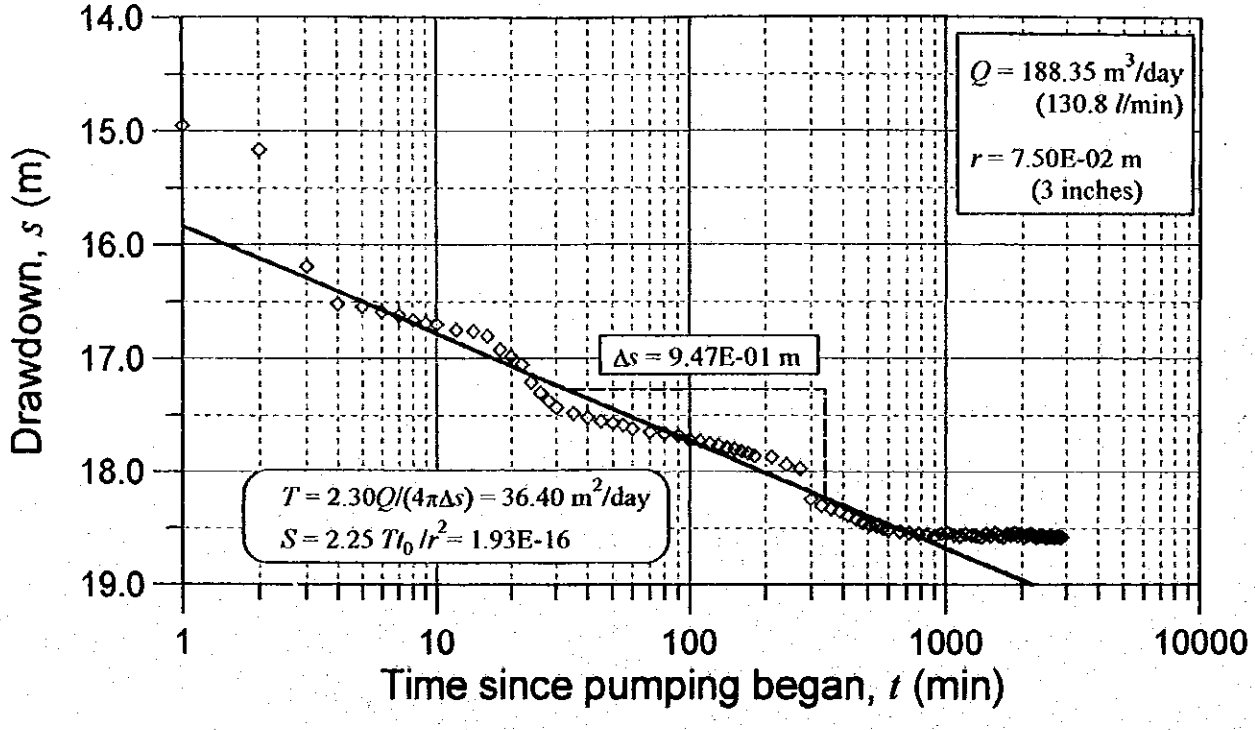
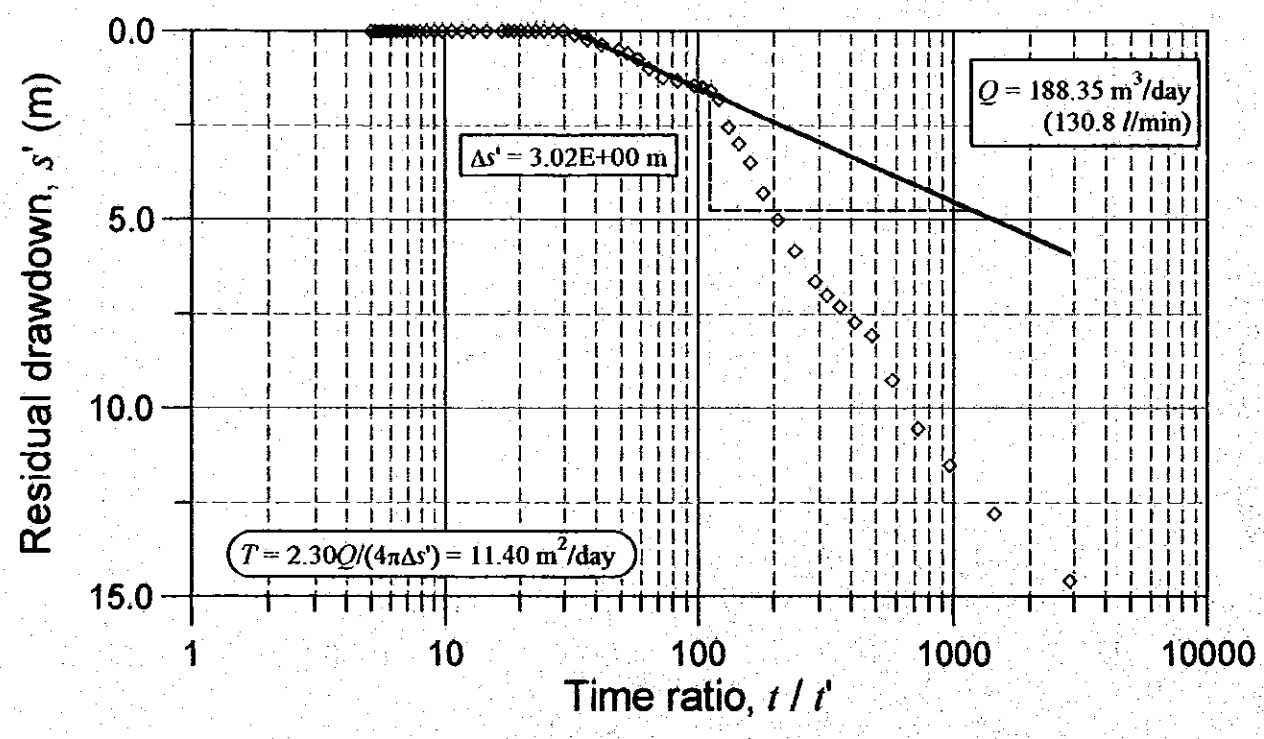
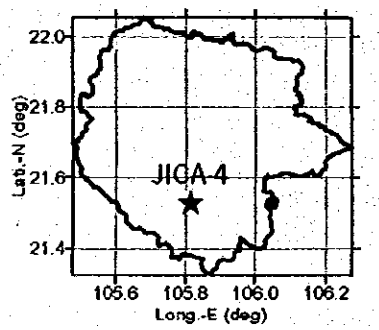


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 584201 m
UTM-N: 2380475 m
Long.: 105-48-47E (d-m-s)
Lati.: 21-31-36N (d-m-s)



Date: 28/05/1999 Static W.L.: 2.00 m below G.L.

Province:	Thái Nguyên	Drilling Depth:	100 m
District:	Thị trấn Thái Nguyên	Well Depth:	100 m
Commune:	Thịnh Đức	Screen Depth(s):	52 to 60 m
			68 to 84 m

Figure 3.17	**Results of Continuous Pumping Test and Recovery Test at JICA-4, Thịnh Đức Commune, Thái Nguyên Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
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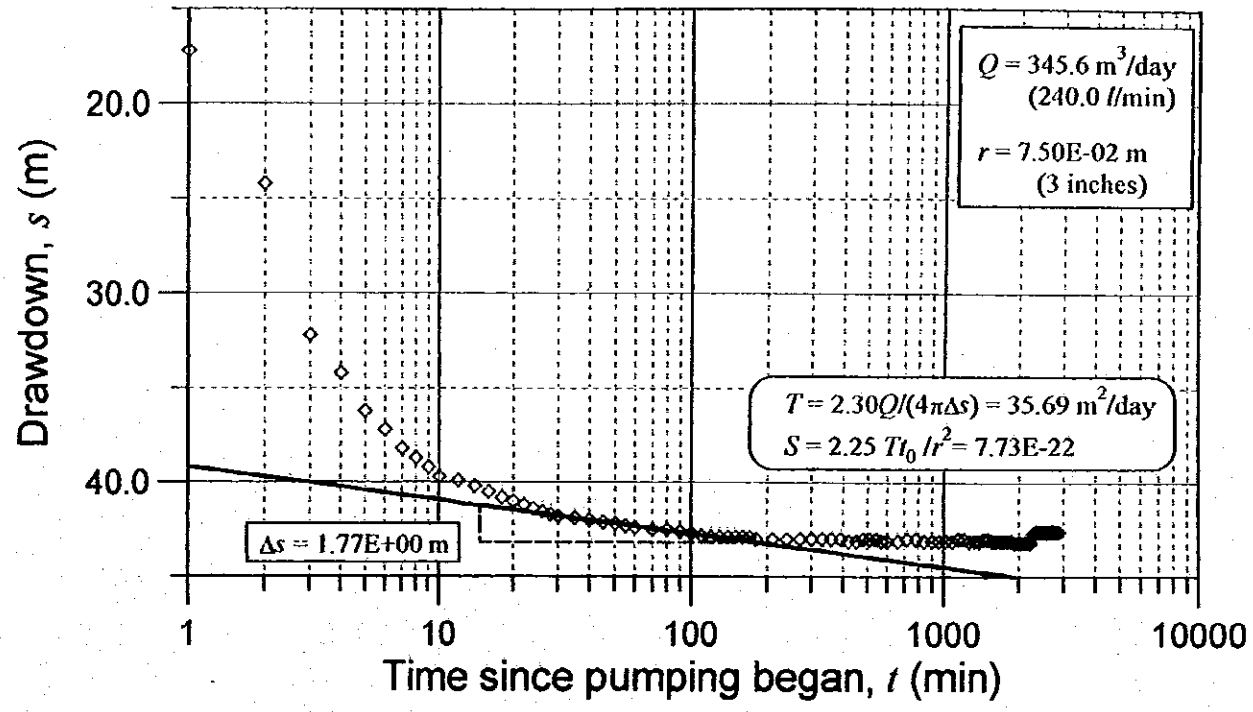
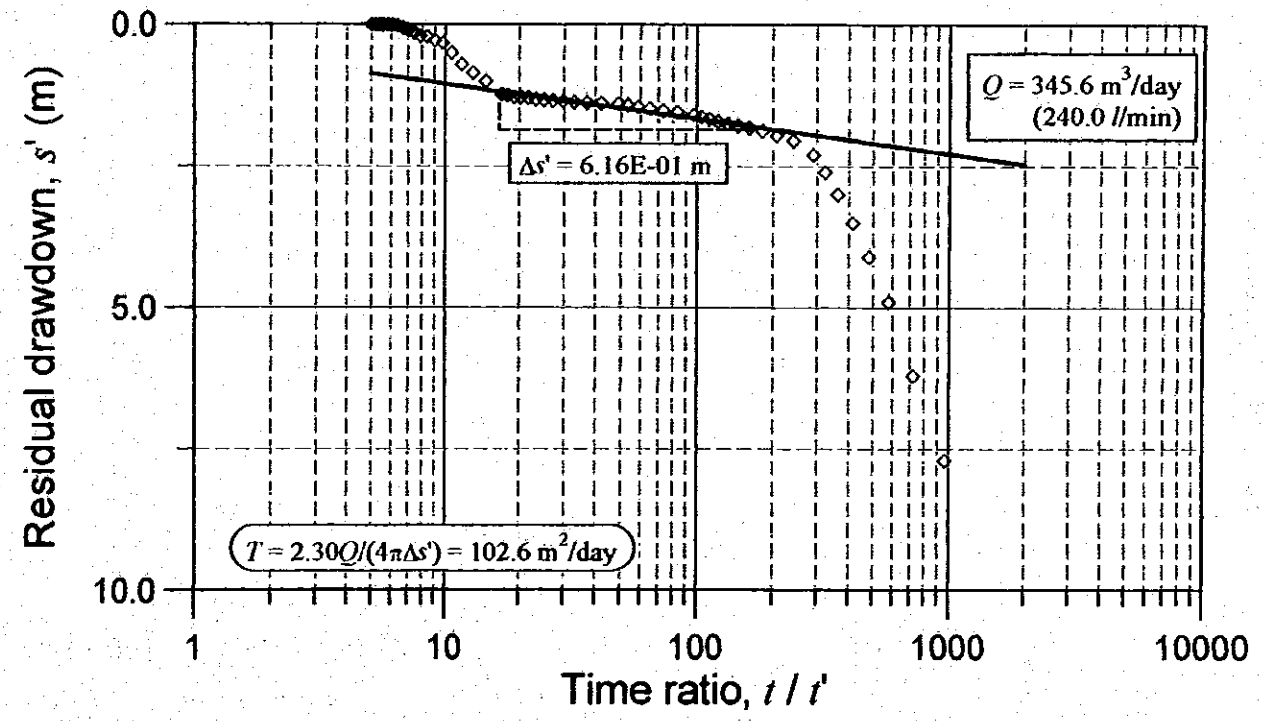
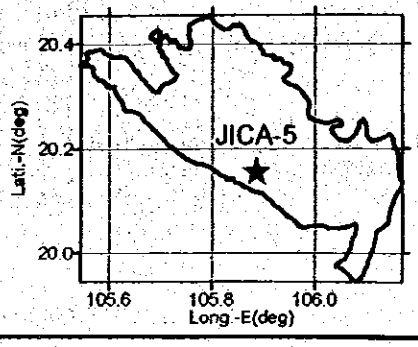


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 592553 m
UTM-N: 2228660 m
Long.: 105-58-09E (d-m-s)
Lati.: 20-09-17N (d-m-s)



Date: 07/03/1999 Static W.L.: 10.80 m below G.L.

Province:	Ninh Bình	Drilling Depth:	150 m
District:	Thị trấn Tam Điệp	Well Depth:	120 m
Commune:	Quang Sơn	Screen Depth(s):	72 to 116 m

Figure 3.18	**Results of Continuous Pumping Test and Recovery Test at JICA-5, Quang Sơn Commune, Ninh Bình Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
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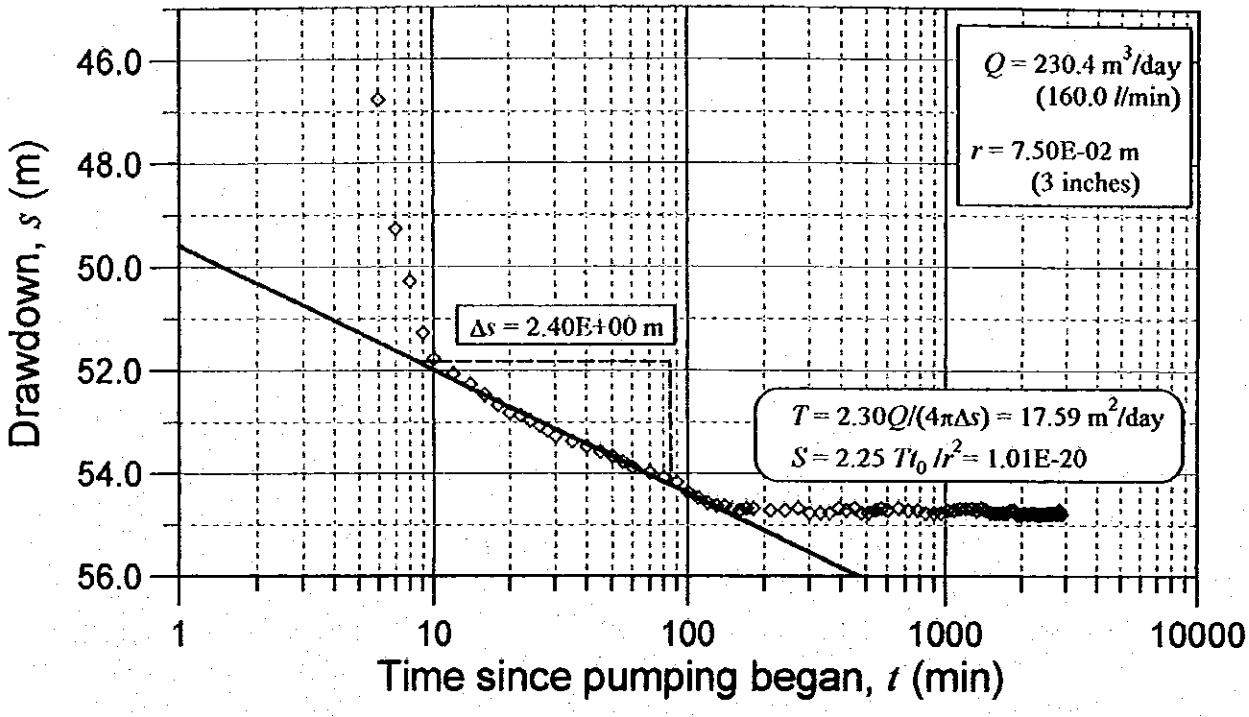
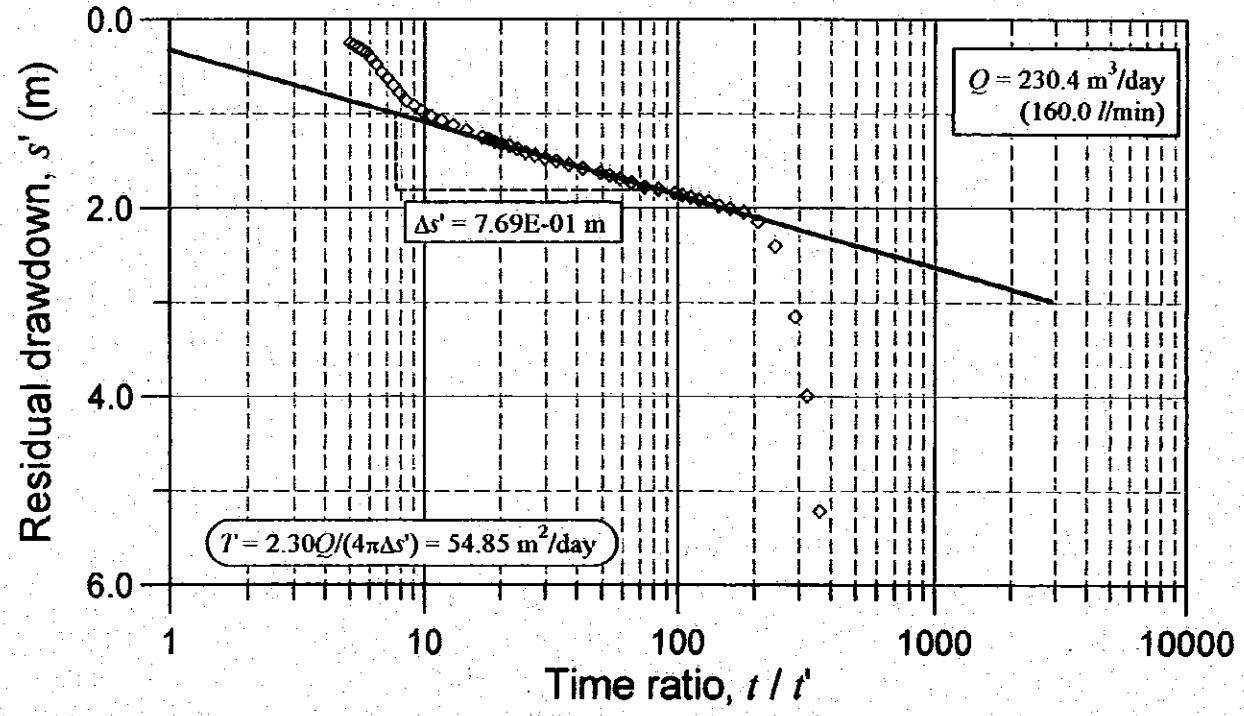
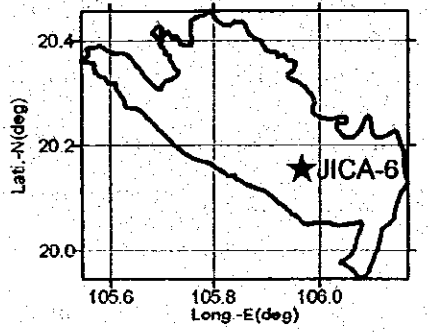


a) Continuous Drawdown Test



b) Recovery Test

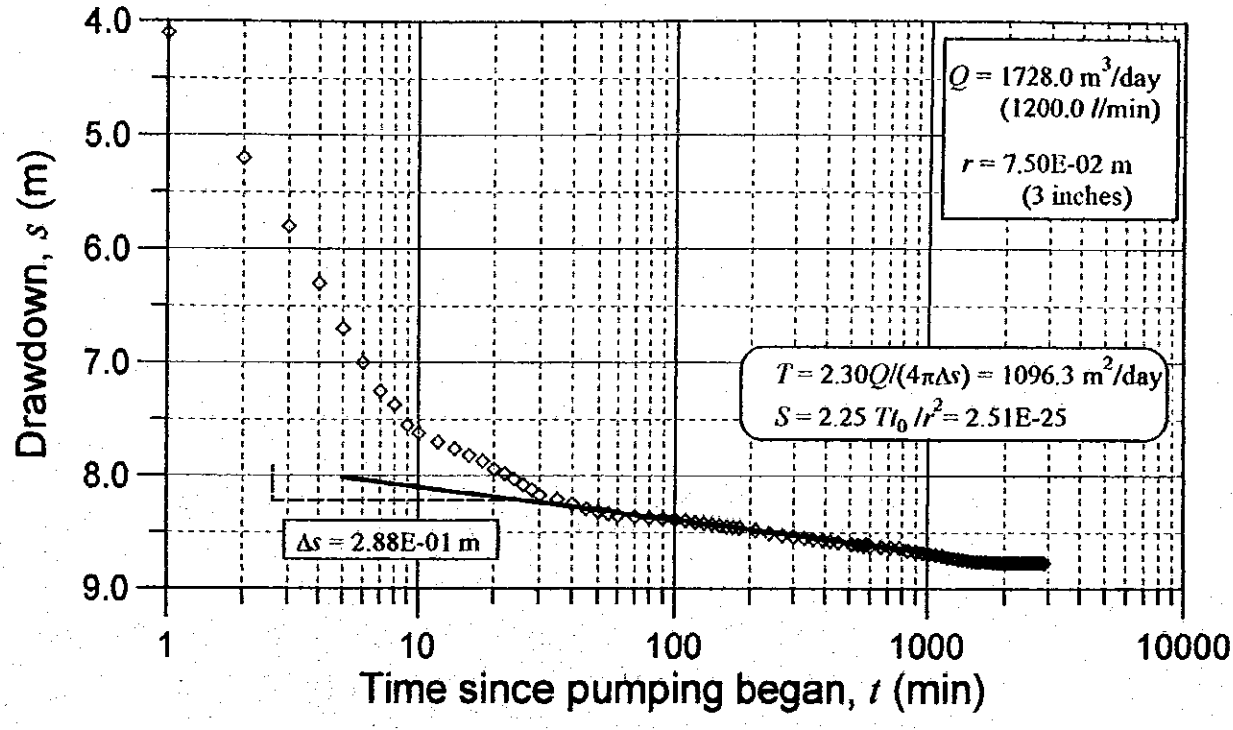
UTM-E: 600941 m
UTM-N: 2228665 m
Long.: 105-57-58E (d-m-s)
Lati.: 20-09-15N (d-m-s)



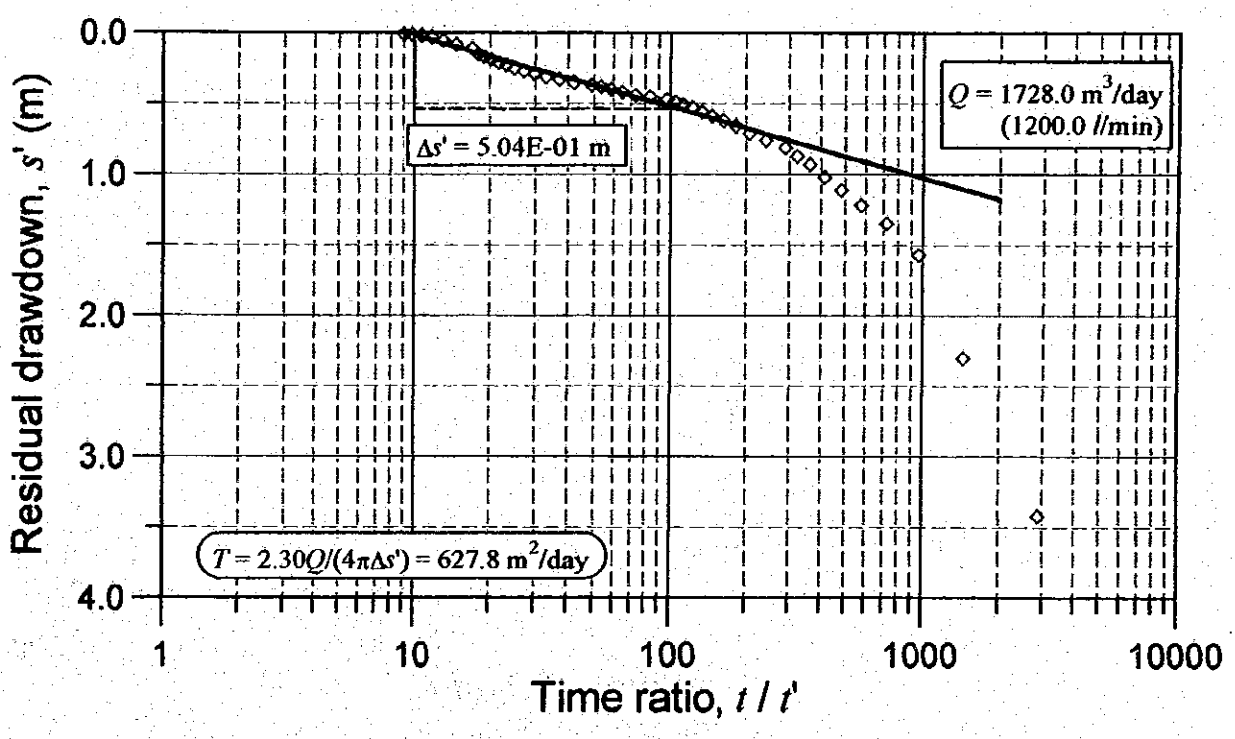
Date: 18/03/1999 Static W.L.: 1.23 m below G.L.

Province:	Ninh Bình	Drilling Depth:	150 m
District:	Yên Mỗ	Well Depth:	136 m
Commune:	Yên Thắng	Screen Depth(s):	75 to 86 m
			93 to 104 m
			122 to 130 m

Figure 3.19	Results of Continuous Pumping Test and Recovery Test at JICA-6, Yên Thắng Commune, Ninh Bình Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

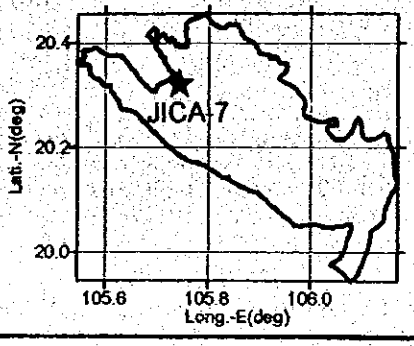


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 577617 m
UTM-N: 2246929 m
Long.: 105-44-37E (d-m-s)
Lati.: 20-19-14N (d-m-s)



Date: 24/05/1999 Static W.L.: 0.60 m below G.L.

Province:	Ninh Bình	Drilling Depth:	150 m
District:	Nho Quan	Well Depth:	130 m
Commune:	Đồng Phong	Screen Depth(s):	92 to 126 m

Figure 3.20	Results of Continuous Pumping Test and Recovery Test at JICA-7, Đồng Phong Commune, Ninh Bình Province
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
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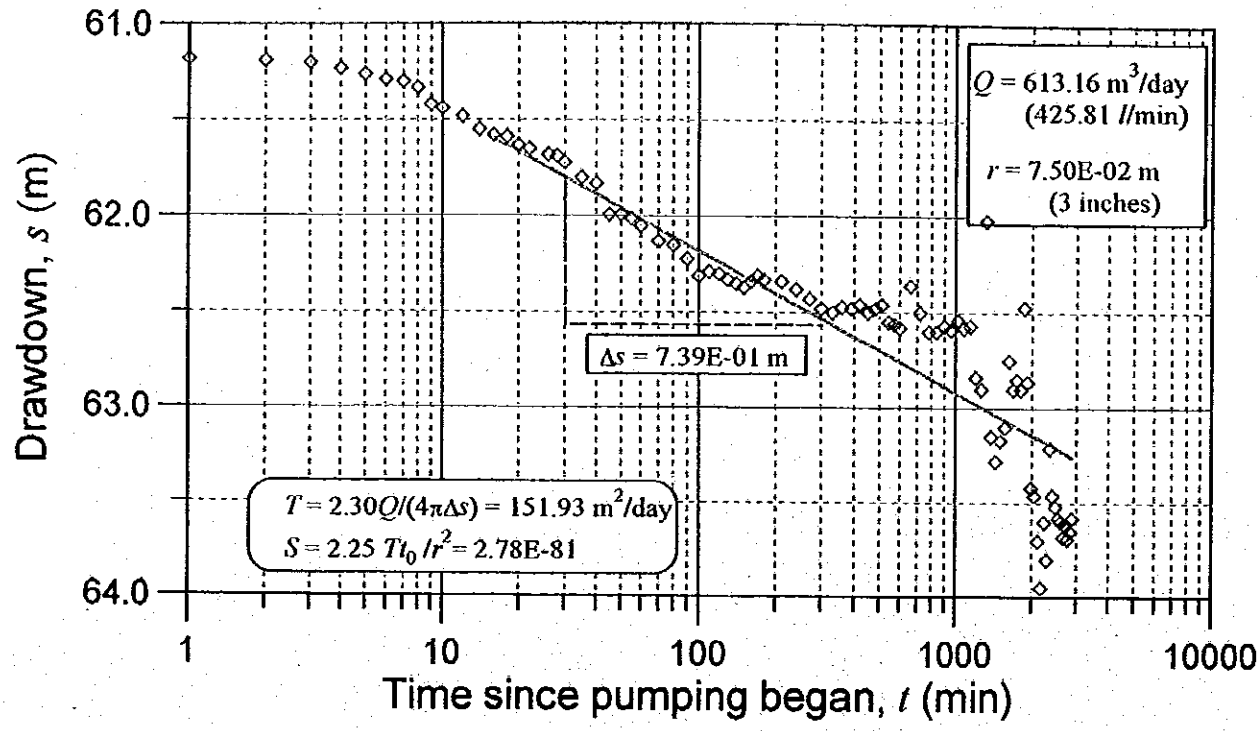
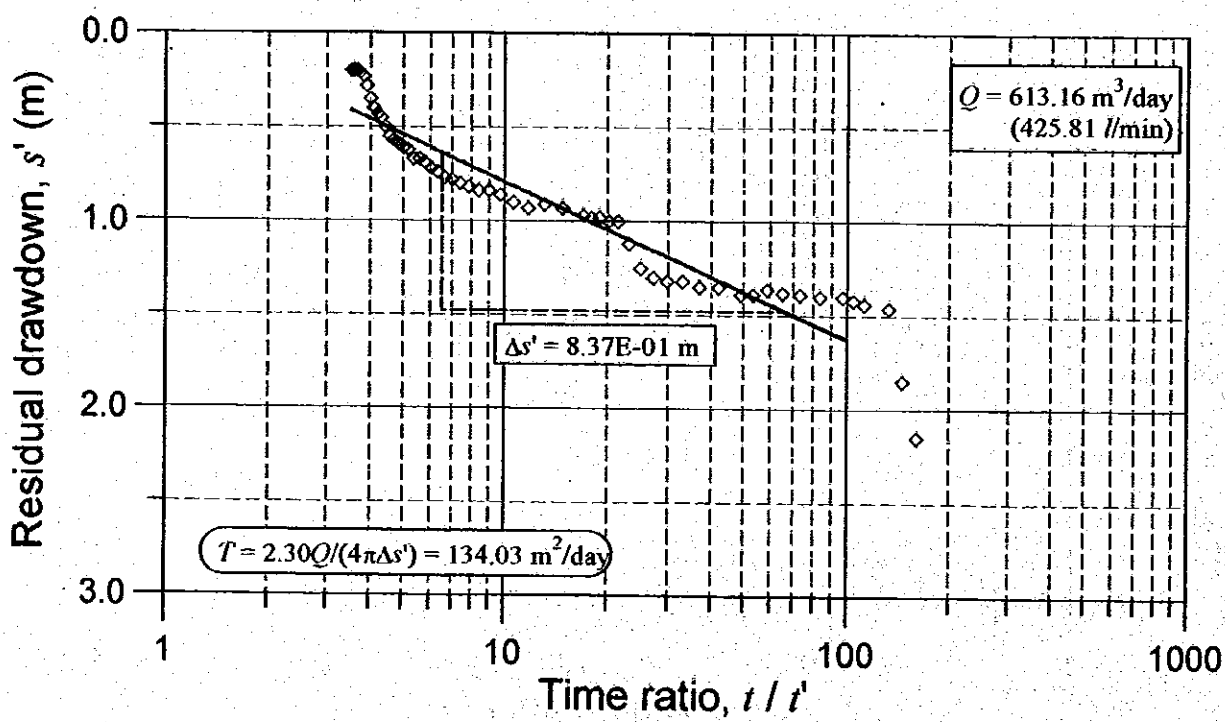
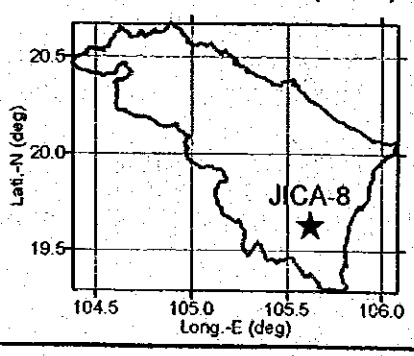


a) Continuous Drawdown Test



b) Recovery Test

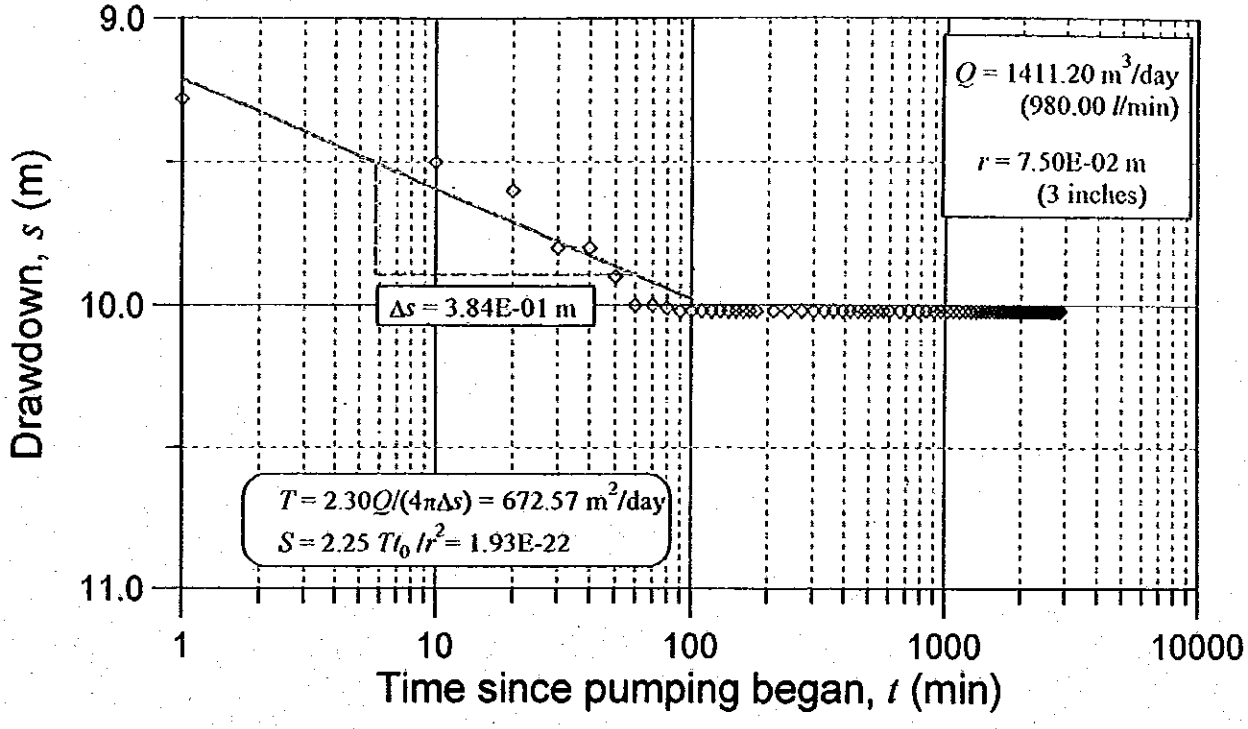
UTM-E: 565030 m
UTM-N: 2170050 m
Long.: 105-37-13E (d-m-s)
Lati.: 19-37-34N (d-m-s)



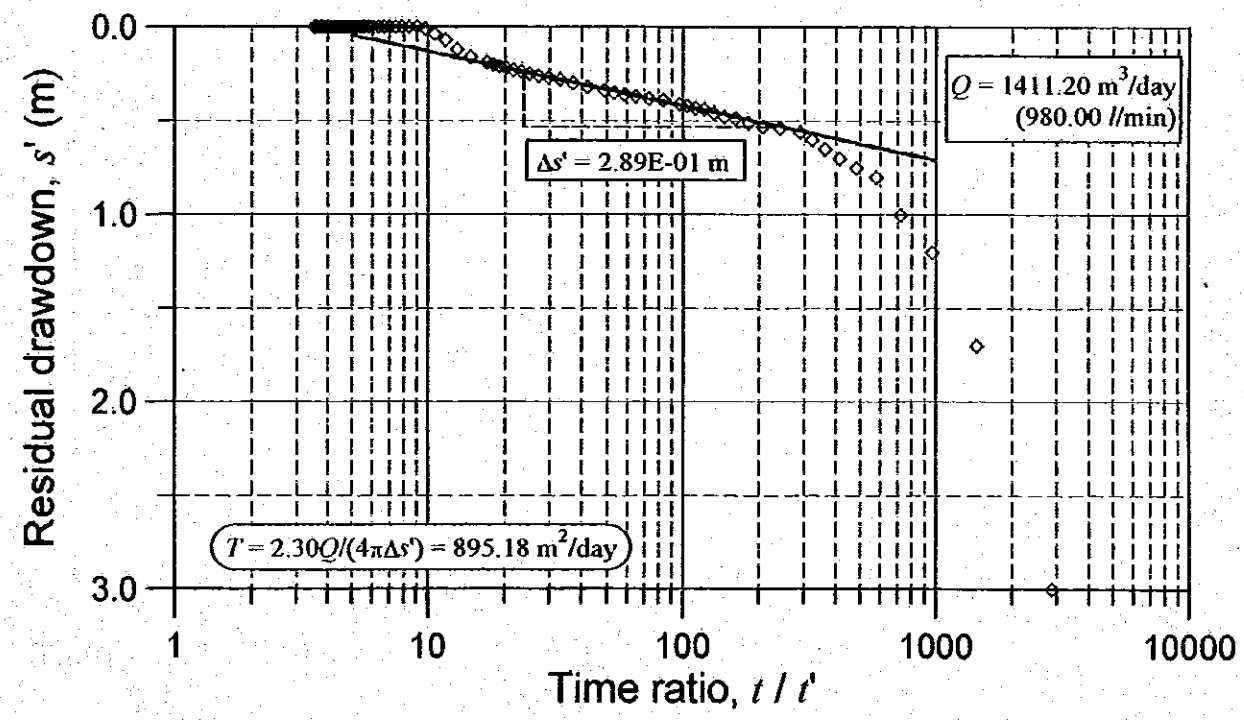
Date: 06/02/1999 Static W.L.: 5.00 m below G.L.

Commune:	Vạn Thắng	Drilling Depth:	150 m
District:	Nông Cống	Well Depth:	150 m
Province:	Thanh Hóa	Screen Depth(s):	99 to 119 m

Figure 3.21	**Results of Continuous Pumping Test and Recovery Test at JICA-8, Vạn Thắng Commune, Thanh Hóa Province**
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF NORTHERN PART IN THE SOCIALIST REPUBLIC OF VIETNAM	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

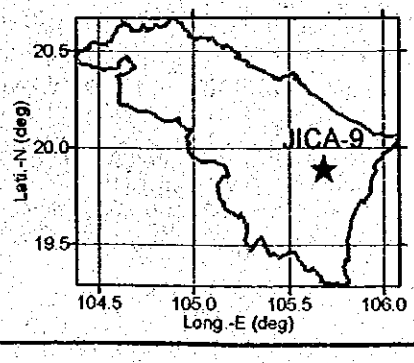


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 571250 m
UTM-N: 2198900 m
Long.: 105-40-51E (d-m-s)
Lati.: 19-53-12N (d-m-s)



Date: 12/02/1999 Static W.L.: 4.00 m below G.L.

Commune:	Thiệu Hưng	Drilling Depth:	80 m
District:	Thiệu Hóa	Well Depth:	52 m
Province:	Thanh Hóa	Screen Depth(s):	32 to 48 m

Figure 3.22	**Results of Continuous Pumping Test and Recovery Test at JICA-9, Thiệu Hưng Commune, Thanh Hóa Province**
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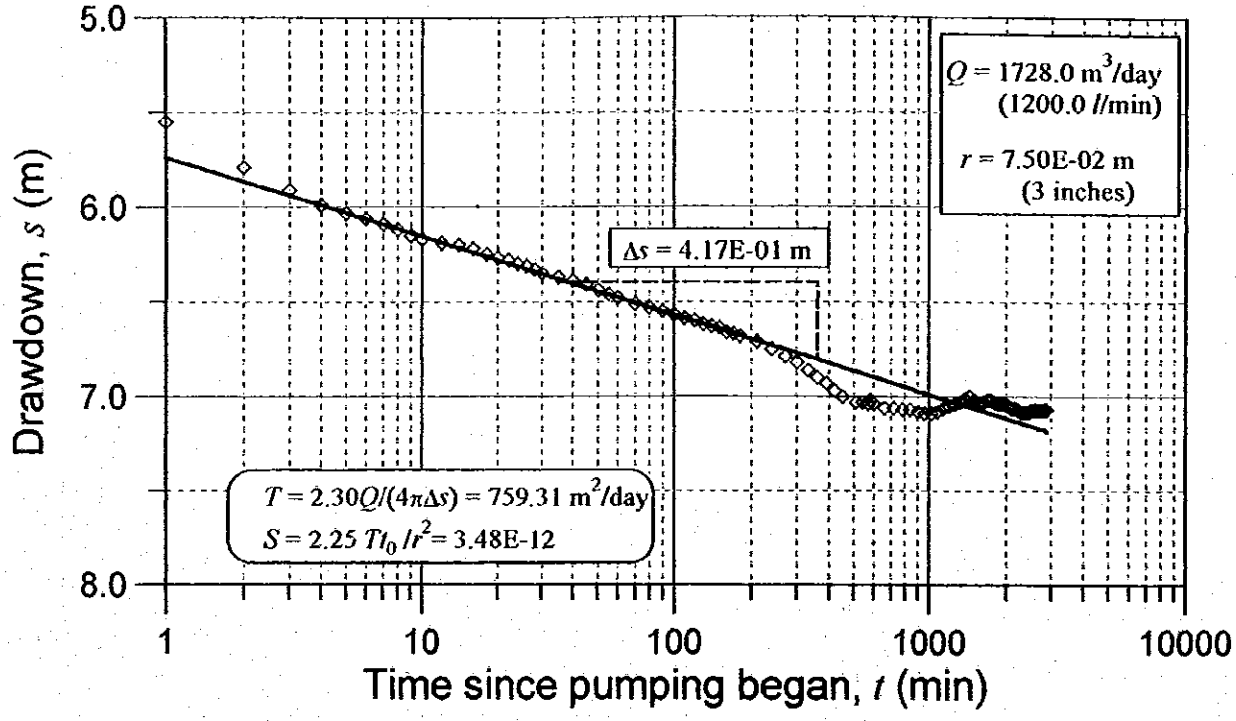
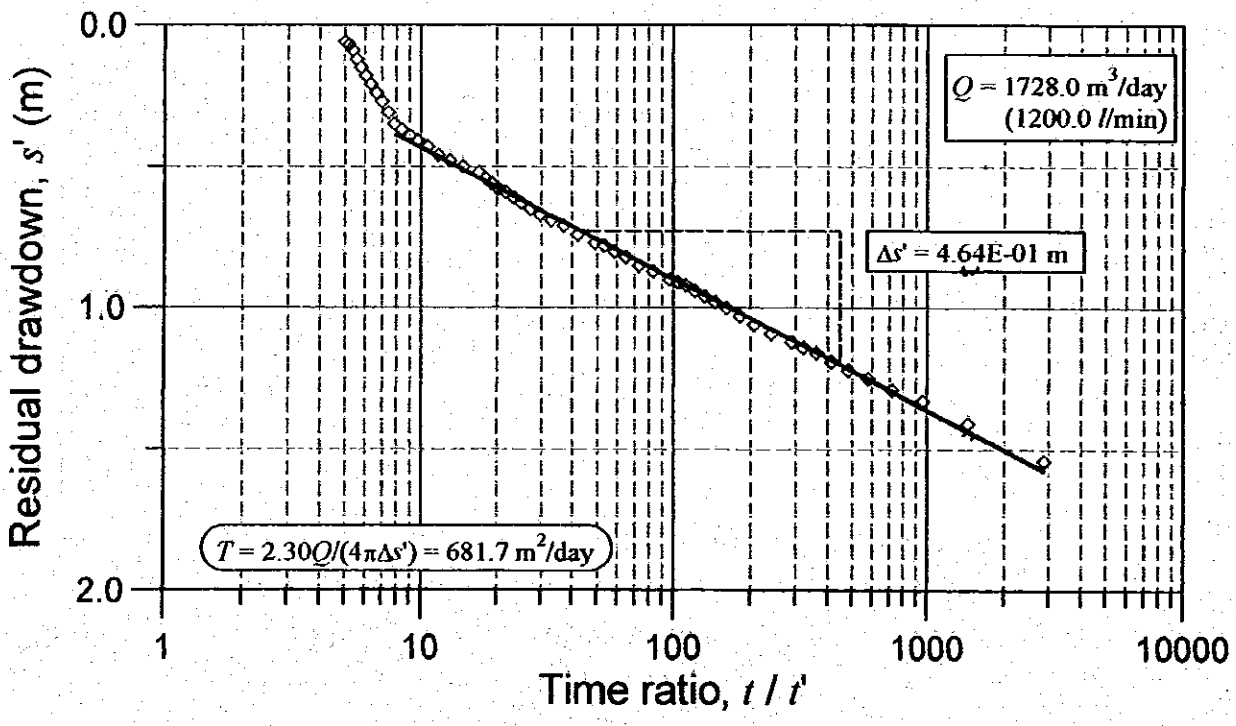
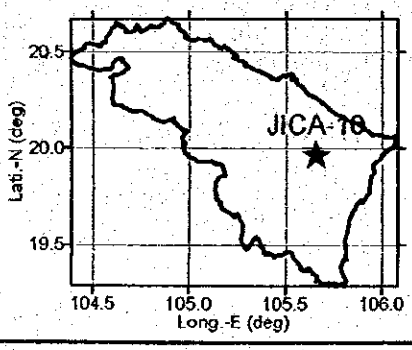


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 568421 m
UTM-N: 2207260 m
Long.: 105-39-14E (d-m-s)
Lati.: 19-57-44N (d-m-s)



Date: 11/04/1999 Static W.L.: 4.90 m below G.L.

Province:	Thanh Hóa	Drilling Depth:	150 m
District:	Yên Định	Well Depth:	91.2 m
Commune:	Định Tường	Screen Depth(s):	23.2 to 39.2 m 47.2 to 63.2 m

Figure 3.23	**Results of Continuous Pumping Test and Recovery Test at JICA-10, Định Tường Commune, Thanh Hóa Province**
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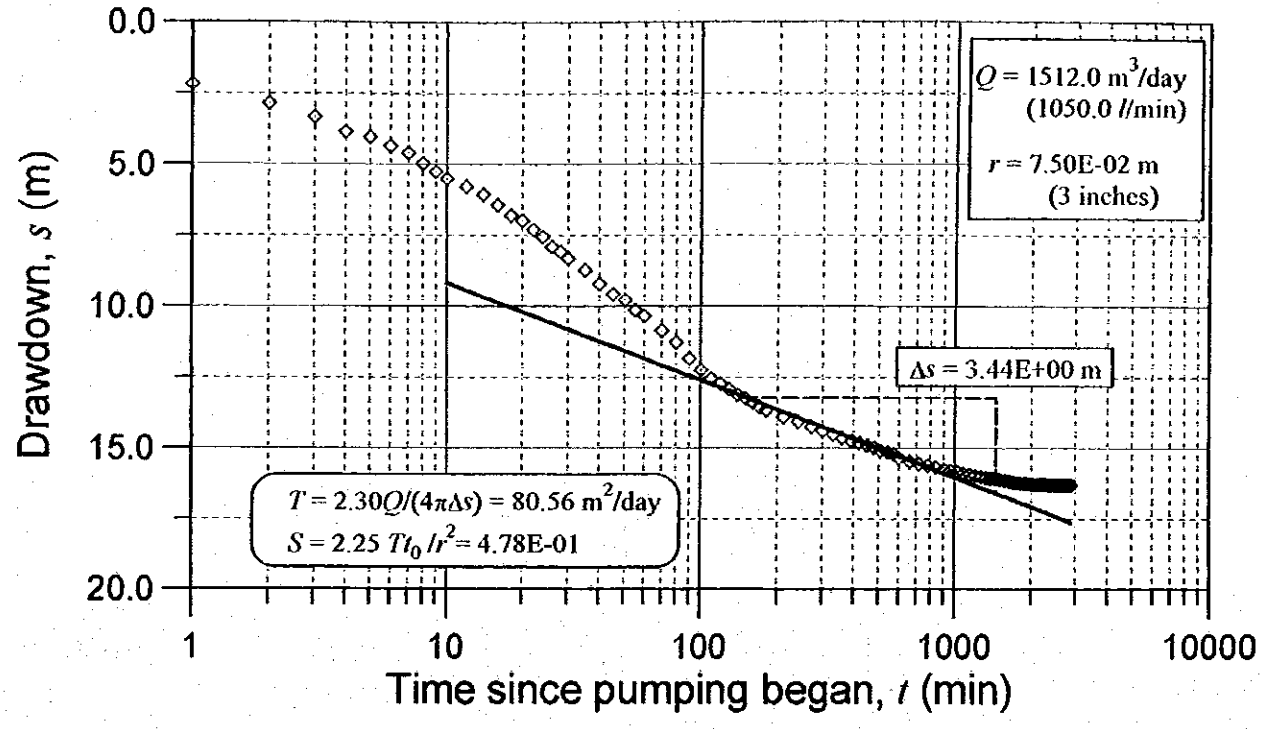
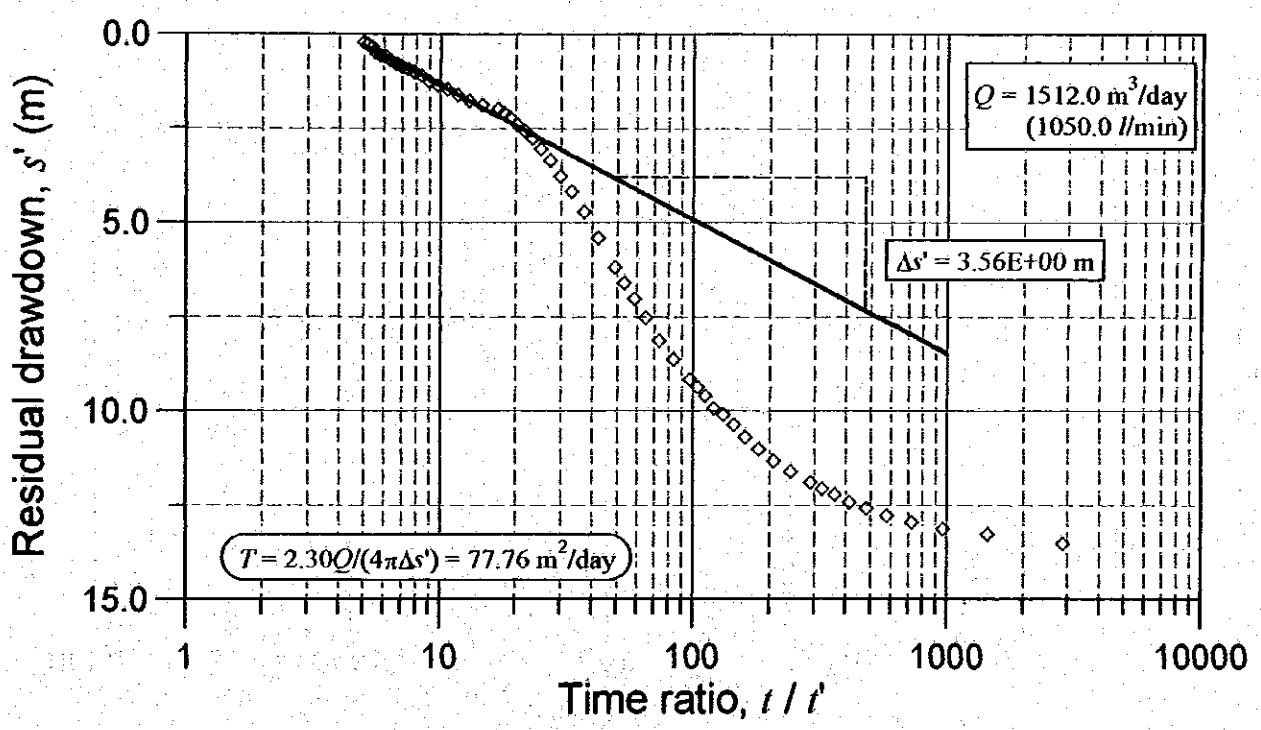
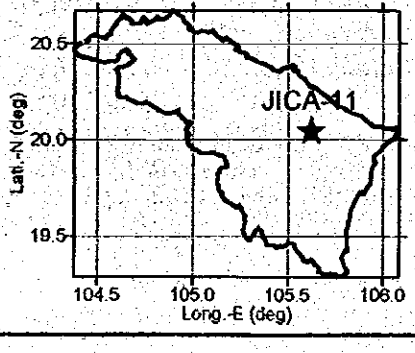


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 564793 m
UTM-N: 2216162 m
Long.: 105-37-11E (d-m-s)
Lati.: 20-02-34N (d-m-s)



Date: 27/04/1999 Static W.L.: 7.55 m below G.L.

Province:	Thanh Hóa	Drilling Depth:	148 m
District:	Vĩnh Lộc	Well Depth:	130 m
Commune:	Vĩnh Thành	Screen Depth(s):	32 to 48 m
			60 to 76 m

Figure 3.24	Results of Continuous Pumping Test and Recovery Test at JICA-11, Vĩnh Thành Commune, Thanh Hóa Province
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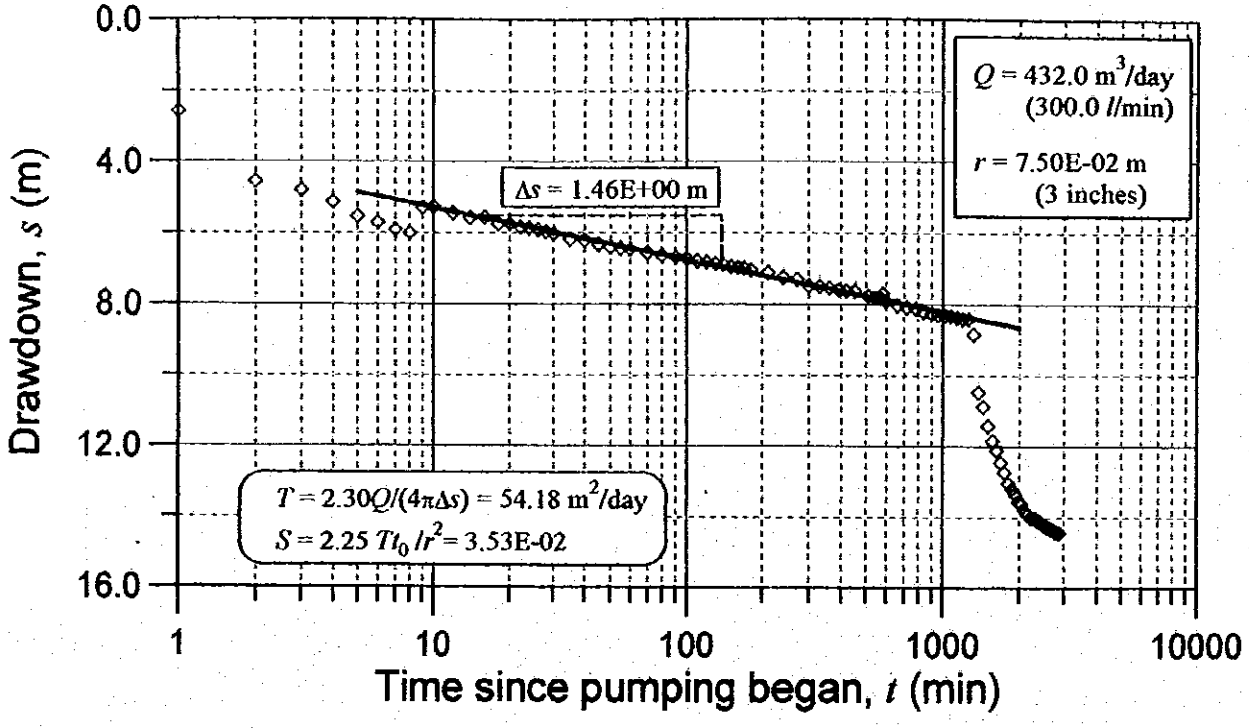
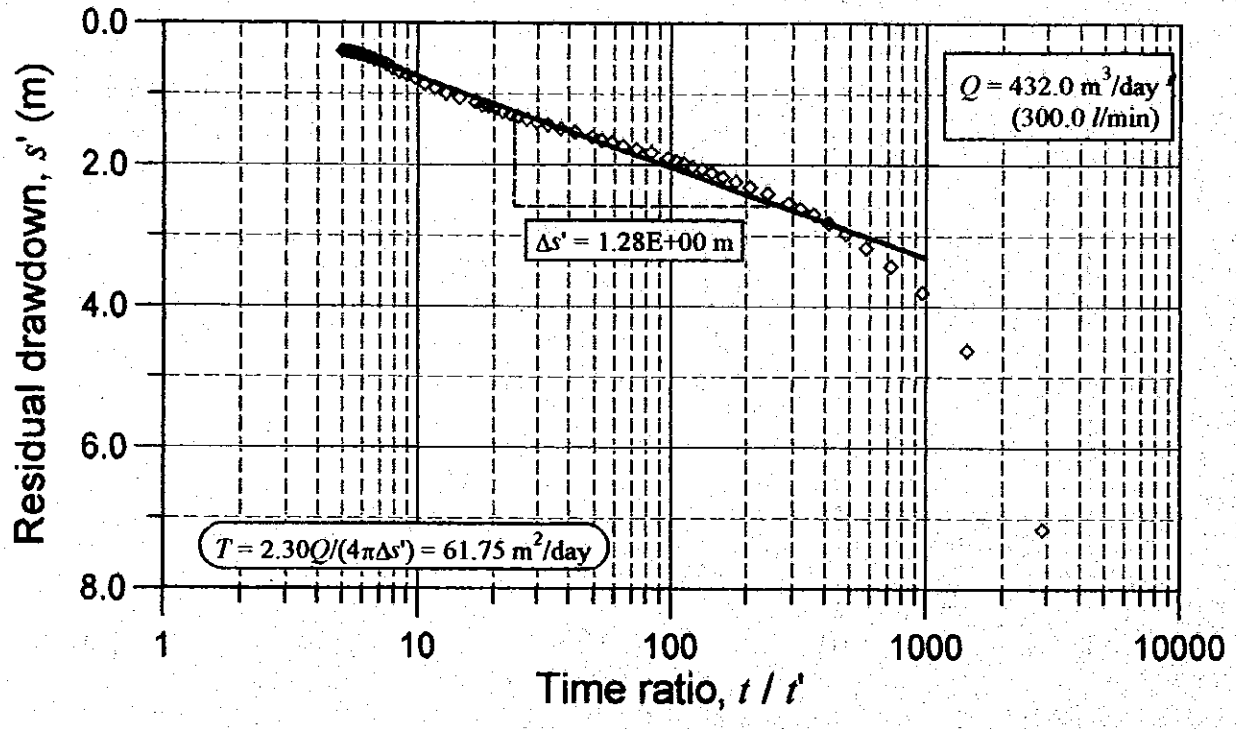
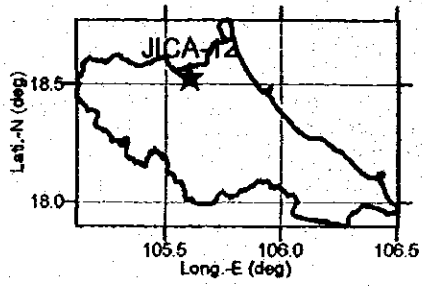


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 563705 m
UTM-N: 2048152 m
Long.: 105-36-13E (d-m-s)
Lati.: 18-31-28N (d-m-s)



Date: 06/03/1999 Static W.L.: 3.20 m below G.L.

Commune:	Hà Tĩnh	Drilling Depth:	106 m
District:	Đức Thọ	Well Depth:	104 m
Province:	Đức Yên	Screen Depth(s):	20 to 28 m
			84 to 100 m

Figure 3.25	Results of Continuous Pumping Test and Recovery Test at JICA-12, Đức Yên Commune, Hà Tĩnh Province
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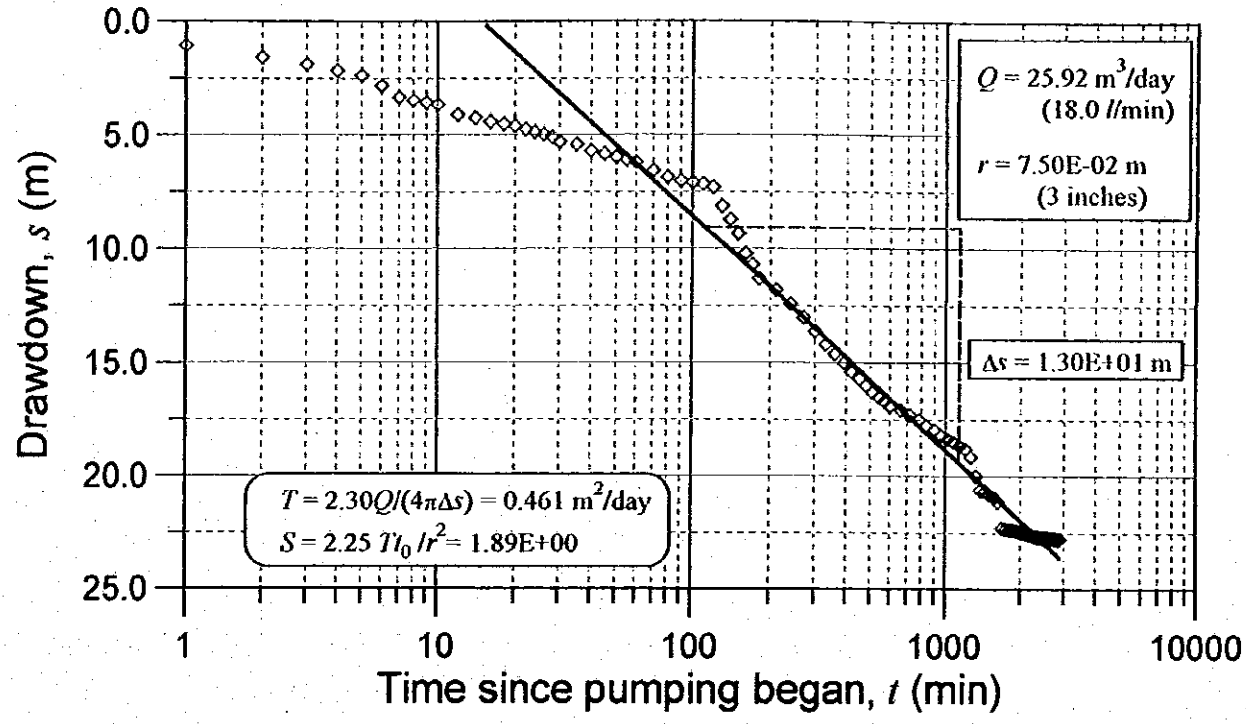
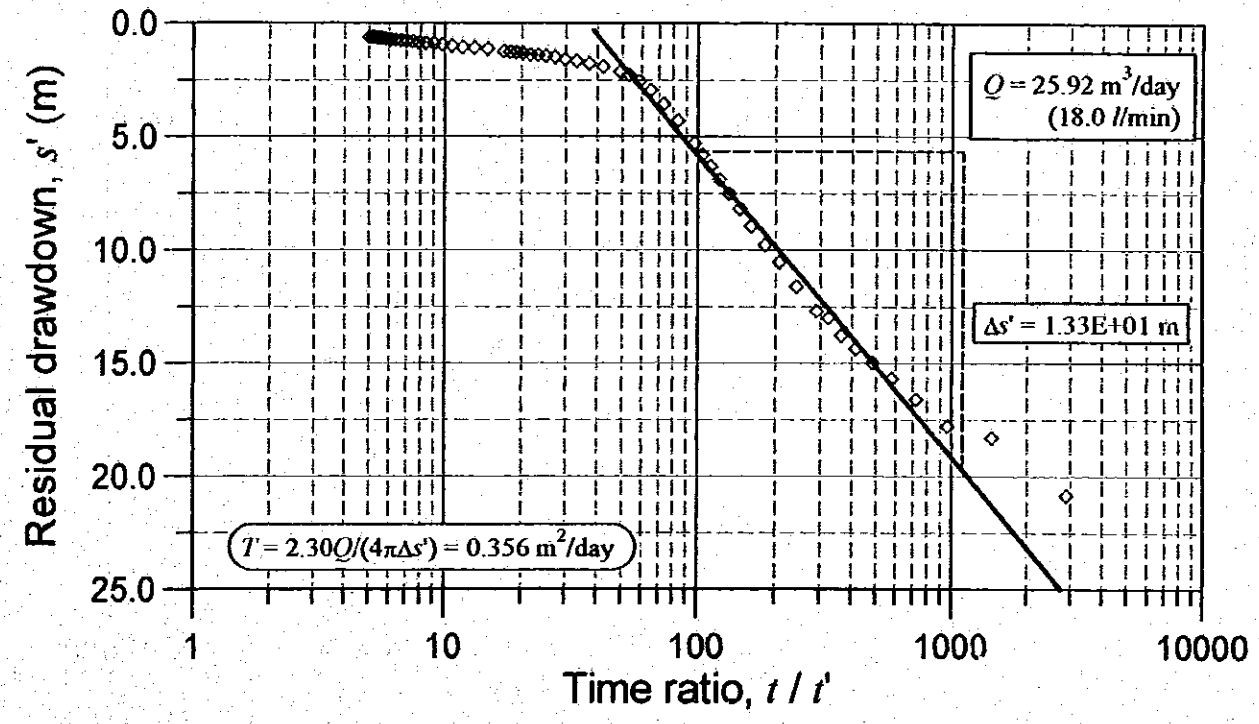
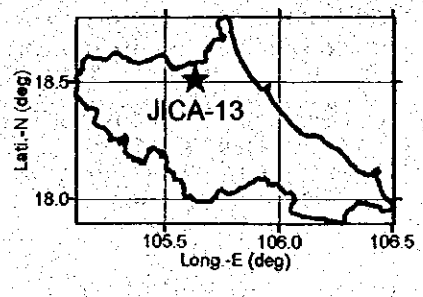


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 566783 m
UTM-N: 2046329 m
Long.: 105-37-58E (d-m-s)
Lati.: 18-30-28N (d-m-s)



Date: 09/04/1999 Static W.L.: 2.80 m below G.L.

Province:	Hà Tĩnh	Drilling Depth:	100 m
District:	Đức Thọ	Well Depth:	100 m
Commune:	Trung Lễ	Screen Depth(s):	58 to 82 m

Figure 3.26	**Results of Continuous Pumping Test and Recovery Test at JICA-13, Trung Lễ Commune, Hà Tĩnh Province**
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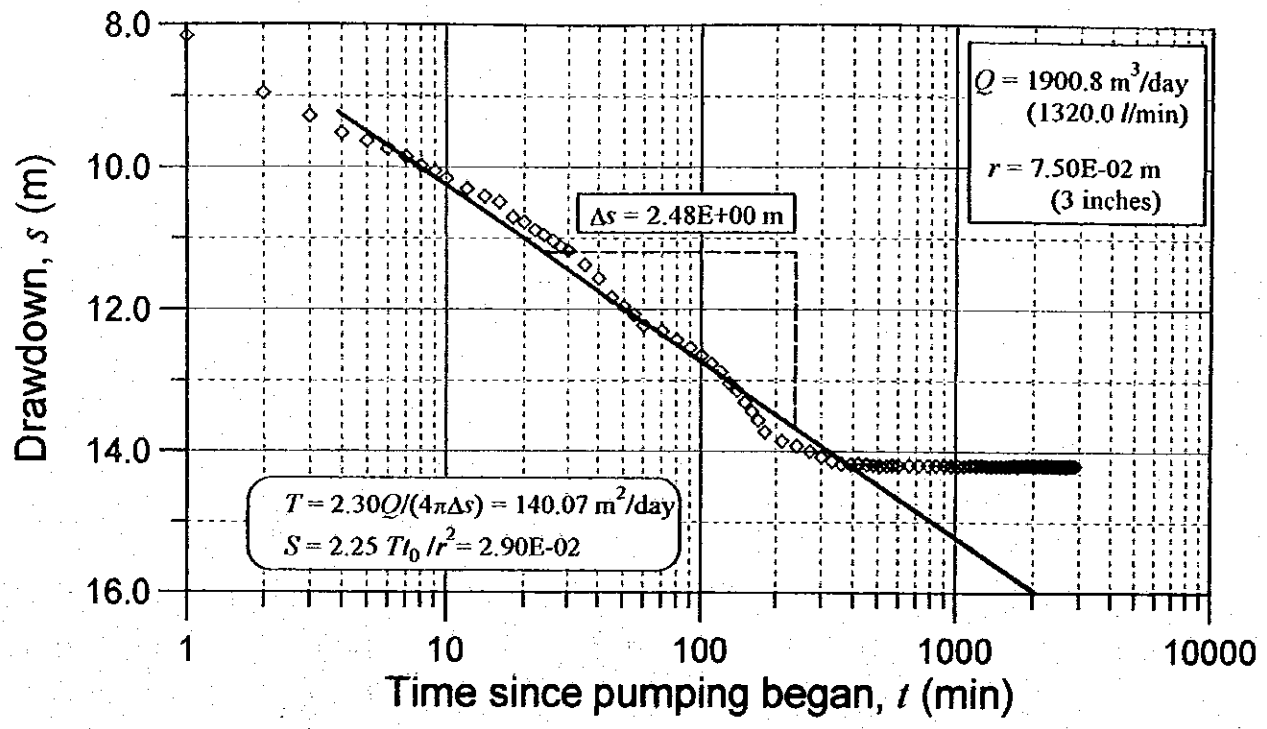
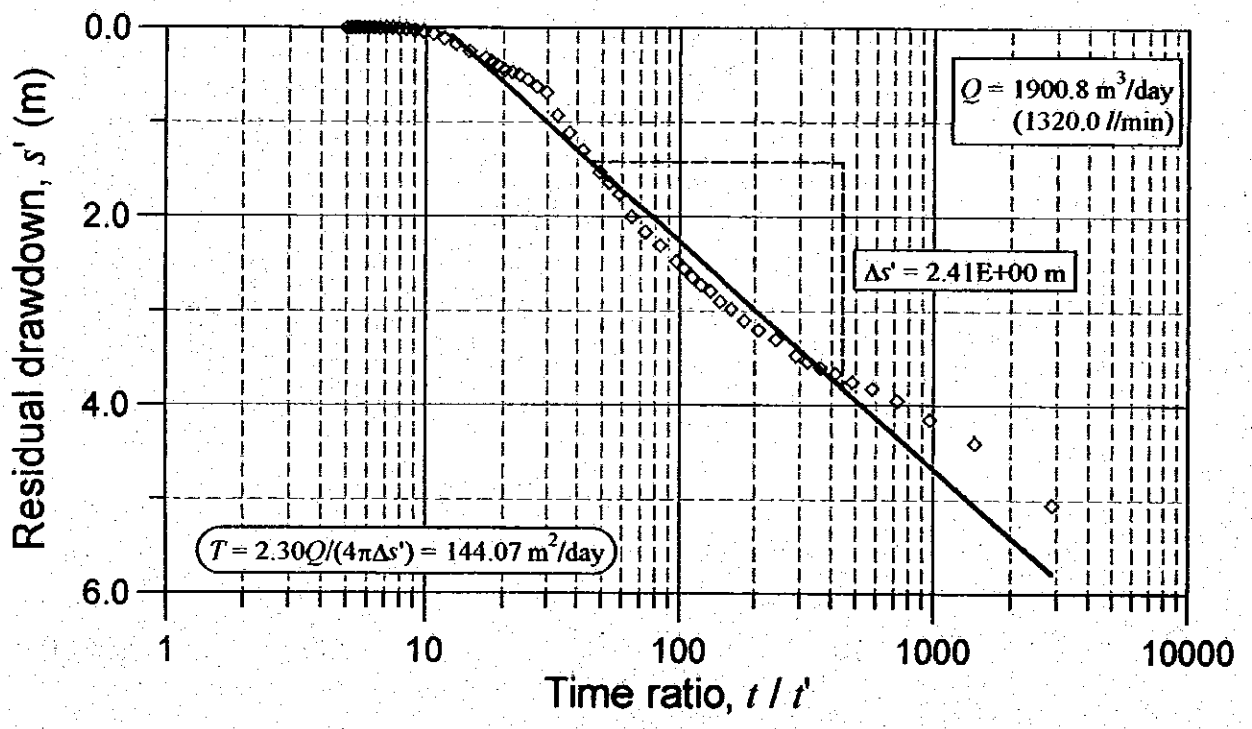
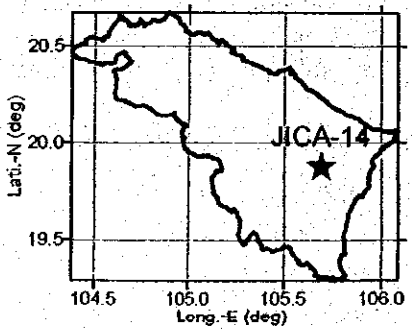


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 572185 m
UTM-N: 2197515 m
Long.: 105-41-23E (d-m-s)
Lati.: 19-52-27N (d-m-s)



Date: 30/03/1999 Static W.L.: 2.85 m below G.L.

Province:	Thanh Hóa	Drilling Depth:	70 m
District:	Thiệu Hóa	Well Depth:	40 m
Commune:	Thiệu Đô	Screen Depth(s):	16 to 36 m

Figure 3.27	Results of Continuous Pumping Test and Recovery Test at JICA-14, Thiệu Đô Commune, Thanh Hóa Province
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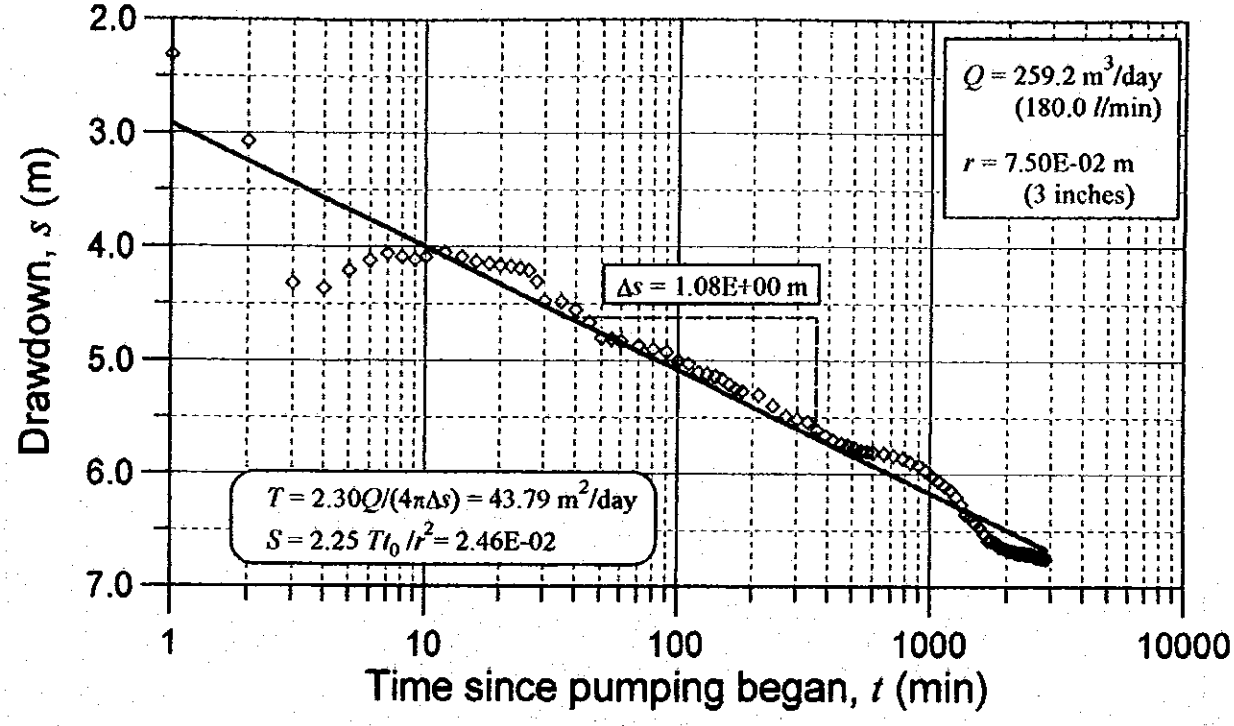
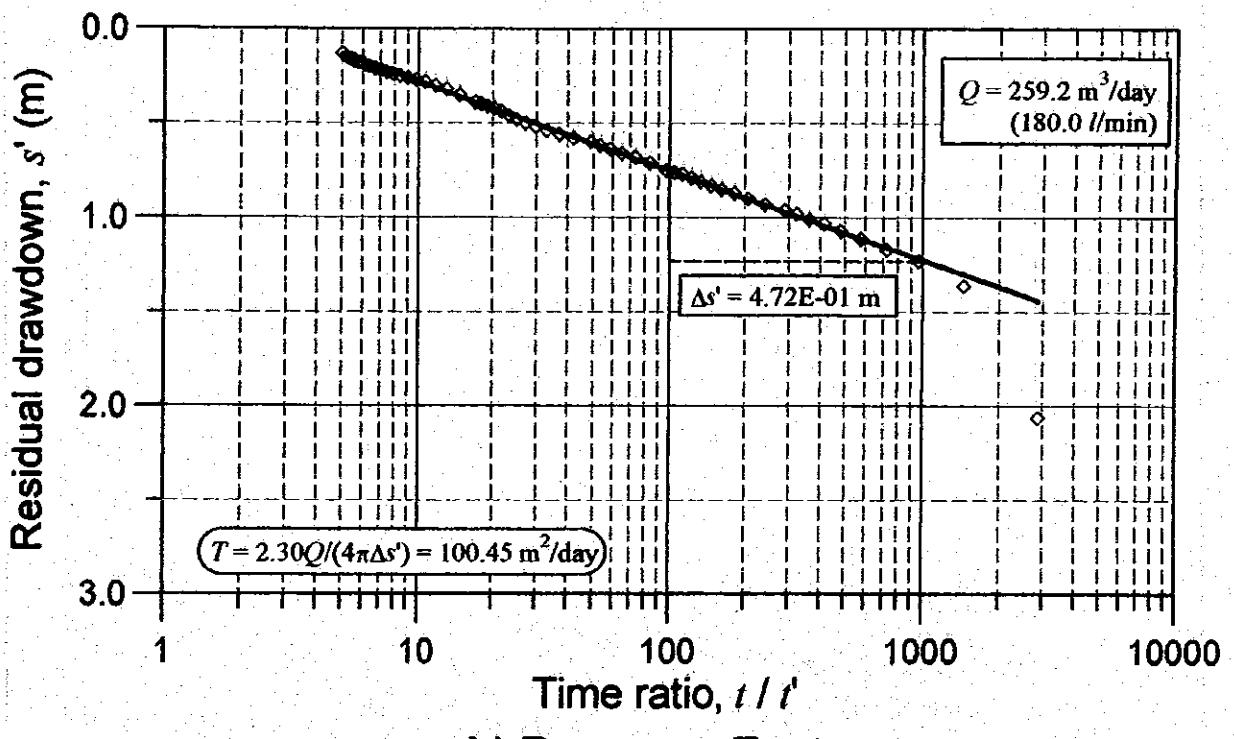
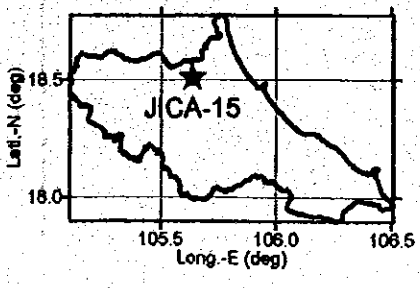


a) Continuous Drawdown Test



b) Recovery Test

UTM-E: 567186 m
UTM-N: 2046557 m
Long.: 105-38-12E (d-m-s)
Lati.: 18-30-36N (d-m-s)



Date: 02/04/1999 Static W.L.: 2.48 m below G.L.

Province:	Hà Tĩnh	Drilling Depth:	70 m
District:	Đức Thọ	Well Depth:	40 m
Commune:	Trung Lễ	Screen Depth(s):	16 to 36 m

Figure 3.28	**Results of Continuous Pumping Test and Recovery Test at JICA-15, Trung Lễ Commune, Hà Tĩnh Province**
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