添 付 資 料

1．要請書
2．I/A
3．議事録(M/M)
4．面談者リスト
5．収集資料リスト
6．関連資料の収集状況
7．参考資料

1. 要 請 書

TECHNICAL COOPERATION
BY THE GOVERNMENT OF JAPAN

A P P L I C A T I O N

By the Government of the Republic of the Philippines for the Development Study on the Groundwater Development of Metro Manila to the Government of Japan.

PROJECT DIGEST

1. Project Title: Feasibility Study for the Groundwater Development in Metro Manila

2. Location : Metro Manila, Philippines

3. Responsible and Executing Agency:

   Metropolitan Waterworks and Sewerage System (MWSS)

4. Justification of the Project:

   About 4.5 million people of Metro Manila and its environs will benefit from this project. This includes all areas covered by the MWSS Service Area which could not be supplied by surface water. These areas consist of private subdivisions with private water supply systems, industrial, commercial and institutional concerns which are totally dependent on groundwater sources.

   It has been observed that the groundwater system in Metro Manila is fast deteriorating. It has been grossly overdeveloped which will result to continued decline in water levels if not regulated. Intrusion of saline-water which is evident in coastal areas, upconing and other related developments tend to aggravate the problem. A program should be developed to improve the operation, maintenance and development of the groundwater system and establish control on its utilization and exploitation. In order to determine and develop the most technically and economically viable program, a feasibility study is necessary.

This undertaking will have a high impact on the further development and progress of Metro Manila where many of its highly industrialized and commercialized areas depend largely on groundwater sources. Since water is a basic necessity for economic development, this study ranks high in the National Development.

5. Desirable or scheduled time of commencement of the Project : 1990 or as soon as possible

6. Prospective funding source and/or assistance (including external origin) :

Japanese Government through JICA; other resources like personnel, office accomodation and office equipment will come from local component.

7. Other relevant Projects, if any

a) Fringe Areas Water Supply Project (MWSS)

b) Rizal Province Water Supply Improvement Project (MWSS)

c) Groundwater Monitoring of the Laguna Bay Basin (National Hydraulics Research Center)

d) Researches on the Application of Nuclear-Based Techniques in Geohydrology particularly in Determining Groundwater Circulation and Saline-Water Intrusion in the Aquifers. (Philippine Nuclear Research Institute)

TERMS OF REFERENCE

FEASIBILITY STUDY FOR THE GROUNDWATER DEVELOPMENT
IN METRO MANILA

1.0 INTRUDUCTION

Groundwater has been a very important source of water for the Metro Manila for centuries. It has been a significant factor in the economic development of many districts relying on it specifically of the different industrial, commercial, institutional and residential concerns.

At present, the MWSS service area is supplied through the Central Distribution System with water which is largely derived from the Angat-Ipo surface water storage works. Although the groundwater component is only a small fraction of the total supply of the MWSS, it is equally significant since it serves consumers in the nominal service area of the System who could not be supplied because of under capacity constraints or located in outlying areas far from the Central Distribution System.

Over the years, the condition of the groundwater system in Metro Manila has deteriorated in alarming rate. It is grossly overdeveloped which if not abated would result in the continued decline in water levels. Salt-water intrusion pose another great problem particularly in the coastal areas. Other problems related to these tend to aggravate the situation.

In acknowledging its real importance as a primary and/or back-up source, MWSS for its part will undertake a feasibility study for the development, maintenance and wise use and management of the groundwater system in Metro Manila.

2.0 JUSTIFICATION OF THE STUDY

In the early 1980's, many existing MWSS and private deepwells were deactivated when MWSP II was completed and the additional water supply it brought about went on stream and reached their service areas. The wells' reoperation was again considered when water shortage became evident by the mid-'80s which was even more aggravated by the drought of 1986.

The abnormal situation prevailing then has led the MWSS Management to call for the rehabilitation and reoperation of some existing MWSS wells. Also, it has been apparent that the ever-increasing demand in the Metropolis could not be serviced by the existing water supply in the near future. Therefore, in order to solve the impending water shortage problem, different expansion and development programs were proposed. One of these is the Angat Water Supply Optimization Project (AWSOP) which will bring significant additional water supply in the 1990's. The feasibility study and detailed engineering works of the project was recently completed and is now ready for implementation. It is expected to be completed by 1992 if implementation commenced as scheduled. In the meantime, between today and the project's completion, the water supply of the MWSS which will depend largely on the surface water source will not be enough to service the existing demand. Therefore, groundwater will be relied upon as an interim source during this period.

Even with the completion of the AWSOP, there will still be areas that cannot be served by surface water. These areas are currently being studied under the Rizal Province Water Supply Improvement Project and the Fringe Areas Water Supply Project which are basically groundwater based.

It has now became apparent that groundwater will be a significant factor in the water supply of MWSS even after the completion of various pipelined projects which will tap different surface water sources. In this regard, to be able to extract the maximum benefit from groundwater, a program should be developed which will pinpoint the different problems affecting it and recommend solutions to them, formulate policies for its wise management, use and control, improve the maintenance and operation of existing facilities and develop other possible groundwater sources. With this as objective, the MWSS will undertake a feasibility study to develop the most ideal program.

3.0 OBJECTIVES

Complementary to the efforts being undertaken in order to protect, improve and develop the groundwater system in Metro Manila, the MWSS envisions a program to this effect that would be efficient and most feasible using the most economical scheme.

Specifically, the program aims to accomplish the following:

3.1 Improve the operation, maintenance and development of MWSS production wells

3.2 Formulate short-term and long-term policies on groundwater utilization, exploration and control

3.3 Provide a solution or remedial measures and prevention schemes for the saline-water intrusion problem

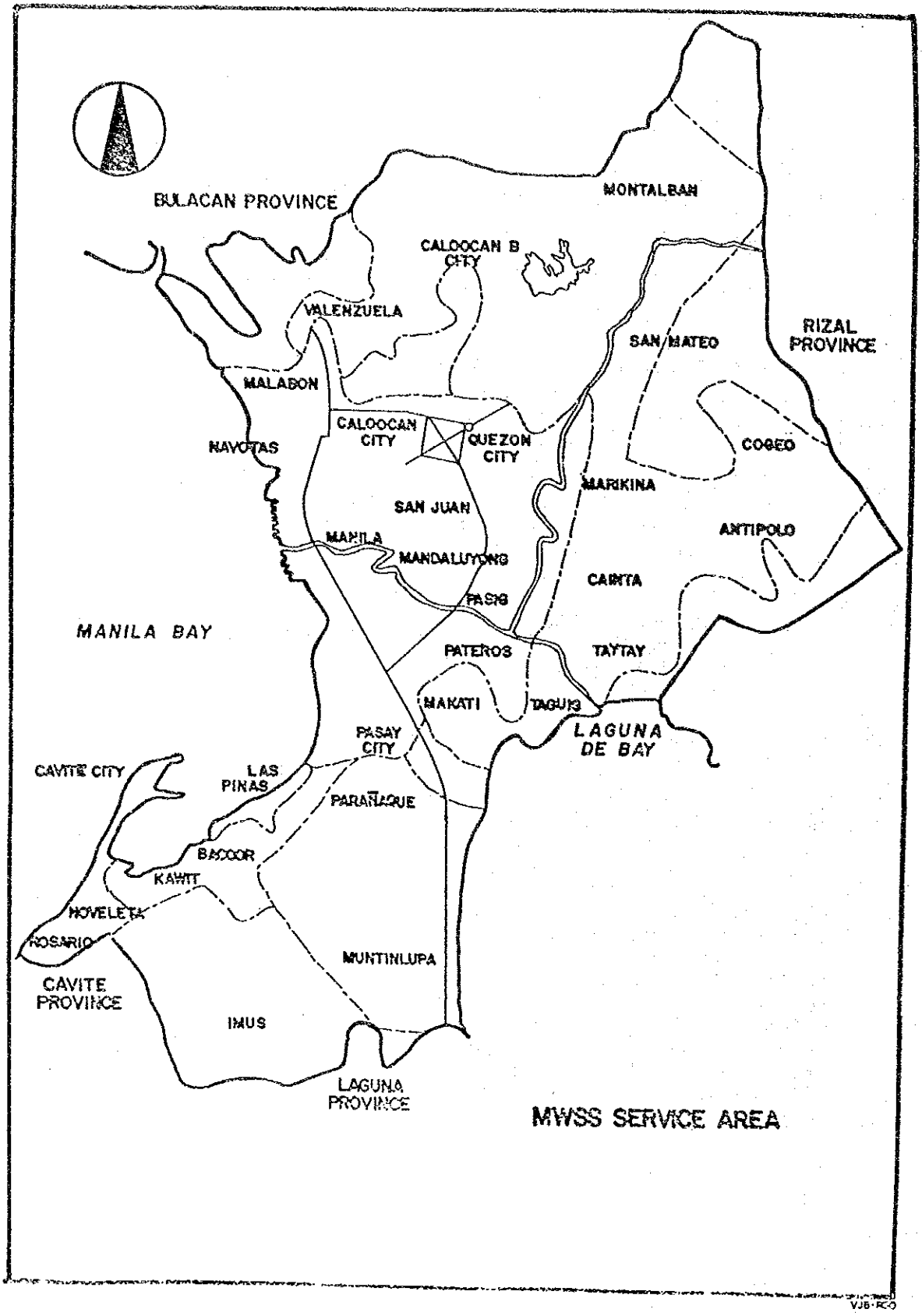
3.4 Develop or establish an efficient scheme for the constant monitoring of the groundwater system in order to evaluate & analyze the changes it is undergoing

3.5 Study applicability of conjunctive use of groundwater with surface water including a pilot study for groundwater recharge.

4.0 STUDY AREA

The study area is the service area of the Metropolitan Waterworks and Sewerage System and is commonly referred to as Metro Manila and its environs. The study area consists of 5 cities and 23 municipalities.

Emphasis for improvement, maintenance and management will be spread throughout the whole service area while studies for further development will be prioritized to areas critically needing additional supply such as those located in far-flung areas out of reach of the Central Distribution System. In the case of Cavite City and 8 municipalities which are also included under the Fringe Areas Water Supply Project, only the former concerns will be undertaken since the project is already involved in the development of additional water sources in these areas.


BULACAN PROVINCE
MONTALBAN
CALOOCAN B CITY
VALENZUELA
SAN MATEO
RIZAL PROVINCE
MALABON
CALOOCAN CITY
QUEZON CITY
NAVOTAS
COGEO
MARIKINA
SAN JUAN
ANTIPOLO
MANILA
MANDALUYONG
CAINTA
PASIG
MANILA BAY
PATEROS
TAYTAY
MAKATI
TAGUIG
LAGUNA DE BAY
PASAY CITY
CAVITE CITY
LAS PINAS
PARAÑAQUE
BACOOR
KAWIT
NOVELETA
ROSARIO
MUNTINLUPA
CAVITE PROVINCE
IMUS
LAGUNA PROVINCE
MWSS SERVICE AREA

5.0 SCOPE OF THE STUDY

5.1 General

The work to be done involves the conduct of a feasibility study aimed at accomplishing all the objectives earlier mentioned. The study will specifically focus on determining the technical, financial, economic and operational viability of the program. The study will be undertaken with the close cooperation between the MWSS and the Consultants. The MWSS will provide a technical staff to work with the consultants for the duration of the study. Both groups will work for the attainment of all the objectives of the study with the preparation of the final report as the minimum end result. The MWSS will provide all the necessary data, services and facilities set forth in the Contract. The Consultants, for their part, are expected to guide the project management and technical staff in all the undertakings and activities necessary for the fulfillment of the study. Their participation in the preparation of project schemes, work programs and methodologies, and data analysis, interpretation and evaluation will also be relied upon.

5.2 Consulting Services

The consultants will provide expertise in the following activities and undertakings:

5.2.1 Data Collection and Retrieval

Data shall be collected such as maps, reports and documented historical records on yield of wells, quality of water and water levels. Well design, construction details and pumping test results shall also be acquired.

5.2.2 Previous Studies

Consider previous studies pertaining to the Project, such as review of the regional hydrogeology of the study area.

5.2.3 Existing Water System

Plans of existing waterworks system, particularly in subdivisions which are not yet served by MWSS but for turn-over to the System, must be secured and evaluated.

5.2.4 Field Studies

5.2.4.1 Monitoring

Conduct the measurements of groundwater level and quality on selected wells around the areas concerned. The basic objective is to achieve an understanding of the behavioural characteristics of the aquifers in response to continous abstraction of groundwater which will allow proper management. Given a modest amount of basic hydrogeological data (well data, pumping tests, construction and design details, etc.), a monitoring system can be devised to make best use of the existing wells.

5.2.4.2 Investigation and Survey

Conduct the investigation of all MWSS wells as well as deepwells of subdivisions for turn-over to MWSS. Intergrate and evaluate primary and secondary data to determine efficiency of wells and pumps reckoning from construction history to actual operating condition.

Also, conduct actual field investigations and site inspections on newly-drilled and to be drilled wells which have applied for proper legistation to NWRB and referred to MWSS.

5.2.5 Saline Water Intrusion/Contamination Study

5.2.5.1 Inventory of basic hydrogeological data

a) Collection and organization of data such as reports on hydrogeology, hydrology, geology and geophysics; chemical analysis of groundwater; lithological, aquifer test and well construction data for all wells, as available; spring and river flow data; rainfall, evaporation and other climatological data.

b) Water Balance Estimation which will include calculation of infiltration from rainfall, evaporation and run-off data to come up with an estimation of recharge.

5.2.5.2 Exploration Methods

a) Conduct exploration and ivestigation by geophysics (using down-the-hole logger) on unlined boreholes or newly-drilled wells.

b) Conduct surface geophysical exploration in the area near the coast or in an area with already historical records on saline contamination and whenever possible with calibration with the nearest deepwells of known lithological characteristics.

5.2.5.3 Water Quality Studies

a) Discharge Sampling

Groundwater samples shall be collected from pumping wells for chloride and electrical conductivity analysis. Also, selected wells shall be collected with water samples for complete physico-chemical analyses.

b) Open-hole Depth Sampling

Using discrete/depth samplers, groundwater samples shall be collected on deactivated open-hole wells at different sections of the aquifer system for chloride and Electrical Conductivity Analyses.

c) Packer Sampling

Since when fresh water mix with saline water the latter stays at the bottom, detection of the source of saline water can be done by sampling water at suspected saline sections using special type of packers.

5.2.6 Groundwater Model

Establish a functional groundwater model based from the data acquisition and monitoring activities for the development of an adequate information system upon which optimization of the operation, maintenance and development of MWSS groundwater supply facilities can be based.

5.2.7 Evaluation and Analysis

5.2.7.1 Monitoring

Determine the rate of water level fluctuation and degree of deterioration on the quality of groundwater.

5.2.7.2 Groundwater Supply Improvement and Development

a) Develop an adequate information system upon which optimization of the operation, maintenance and development of the MWSS groundwater supply facilities can be based.

b) Determine the viability of the wells for turn-over to MWSS with respect to technical, financial and economic aspects.

c) Determine the viability of constructing new deepwells for additional water source and supply in areas where both surface and groundwater sources are limited. Preparation of the general technical specifications for the drilling and construction of new wells shall be included.

5.2.7.3 Saline Water Intrusion/Contamination

a) Determine the extent and causes of saline water contamination and avoid or minimize further contamination of fresh-water aquifer in order to protect the unaffected areas.

b) Provide an adequate information system for technical specifications on the construction and operation of wells in saline-intruded/contaminated areas.

c) Provide technical specifications on the proper abandonment of wells to elimiate the physical hazards of an open well, and also, to preserve the yield and head in aquifers.

d) Quantify and determine the effect of saline contamination/intrusion to social concerns and economy, in terms of monetary value.

e) Provide remedial measures (protective and corrective) as standard techniques to combat saline intrusion and encroachment of groundwater inland.

5.2.8 Training Programme

To ensure operational feasibility of the project, the Consultant, as part of the grant package, shall provide lectures, training programs and seminars to the local personnel of the System directly involved in the project. The fields of water resources management, groundwater development, environmental protection and sanitation, recent trends in groundwater supply and computer modelling as it applies to water supply, shall all be tackled.

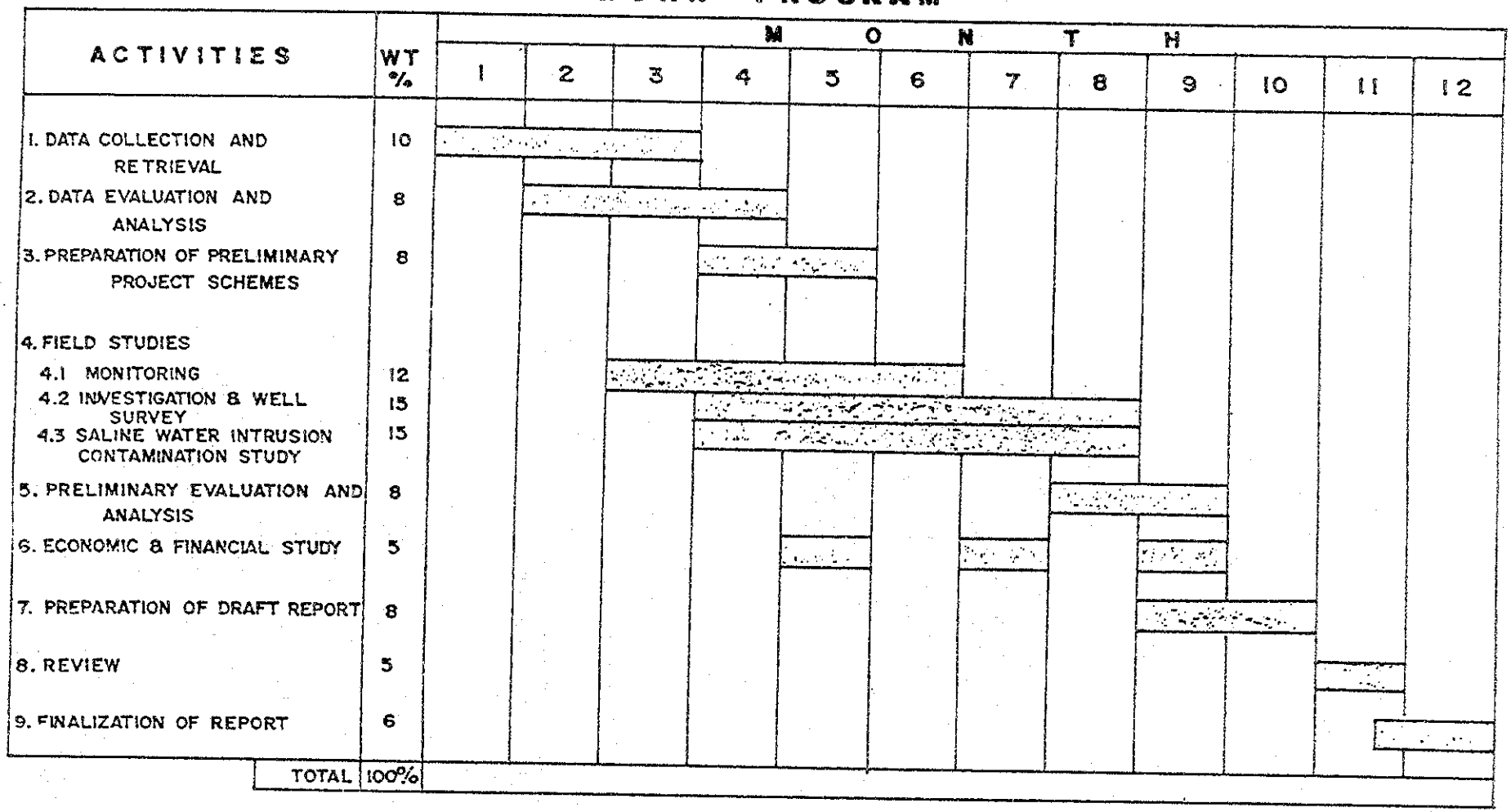
For better understanding of the behaviour of groundwater and to enable to make best use of available resources, private well users shall be provided with sufficient informations through seminar program by the Consultants.

5.2.9 Methodology Manual

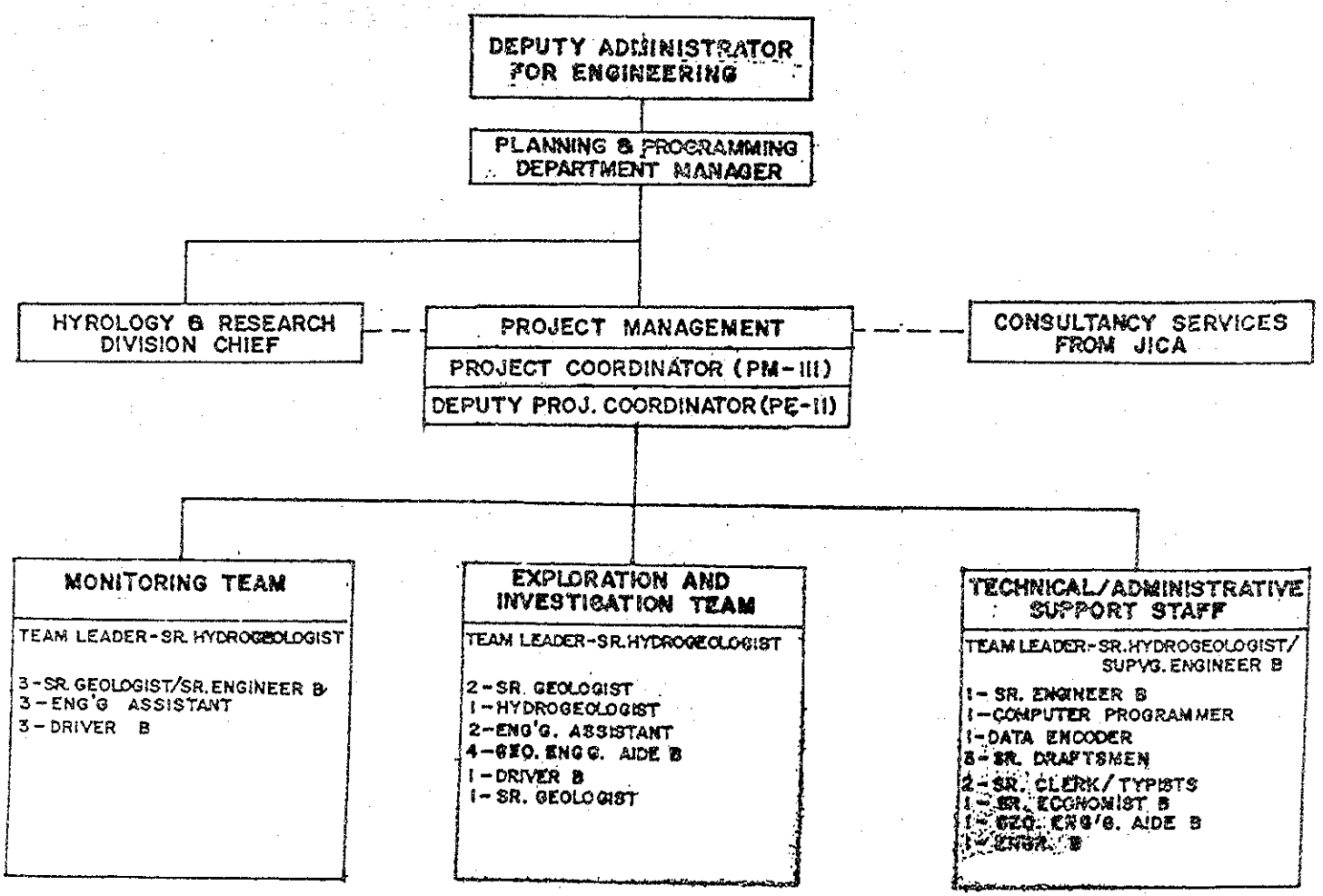
The Consultant are expected to develop a Feasibility Study Methodology Manual that would serve as guidelines for the present and future groundwater supply development programs of the System.

FEASIBILITY STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

WORK PROGRAM



PROPOSED ORGANIZATIONAL CHART FOR THE FEASIBILITY STUDY ON THE GROUNDWATER DEVELOPMENT IN METRO MANILA



FEASIBILITY STUDY TEAM COMPOSITION

A. TECHNICAL CONSULTANTS	Man-Months
Project Leader	9
Hydrogeologist/Hydrologist	6
Water Quality/Water Treatment Specialist	2
Economic/Financial Specialist	2
Institutional Specialist	1
Mechanical/Electrical Engineering Specialist	1
System Analyst (Data/Engineering)	3
	24

B. MWSS MANPOWER COUNTERPART	
Project Management	
Project Coordinator (PM-3)	12
Deputy Project Coordinator (PE-2)	12
Monitoring Team	
Team Leader (Sr. Hydrogeologist)	12
Sr. Geologist/Sr. Engineer B (3)	36
Engineering Assistant B (3)	36
Driver (3)	36
	156
Exploration and Investigation Team	
Team Leader (Sr. hydrogeologist)	12
Sr. Geologist	12
Geologist (2)	24
Hydrogeologist	12
Engineering Assistant (2)	24
Geo. Engineering Aide B (4)	48
Driver B	12
	144
Technical/Administrative Support Staff	
Team Leader (Sr. Hydrogeologist/ Supervising Engineer B)	12
Sr. Engineer B	12
Engineer B	12

Technical/Administrative Support Staff	Man-Months
Computer Programmer	12
Data Encoder	12
Sr. Economist B	12
Draftsman B (3)	36
Sr. Clerk/Typist (2)	24
Geo. Engineering Aide B	12
	144

MWSS Advisory Group

Deputy Administrator for Engineering
Chief Engineer
Planning and Programming Department Manager
Hydrology and Research Division Chief

ESTIMATED FINANCIAL REQUIREMENT

A. FOREIGN COMPONENT (IN U.S. $1,000)

	QTY/ UNIT	UNIT COST	TOTAL AMOUNT
1. Consultancy Service	24 man-months	7	168
2. Computer System	1 system	30	30
3. Technical Equipment	Lump sum	-	117
4. Transportation	4 units	10	40
5. Local Training	6 personnel	2	12
6. Communication & Report	Lump sum	-	5
			372

Using U.S. $1 = 22.00 ==> TOTAL COST IN PESOS = ₱8,184,000.00

B. LOCAL COMPONENT (IN ₱1000)

	TOTAL AMOUNT
1. MWSS Personnel	₱ 1,778,833.00
2. Printing & Supplies	100,000.00
3. Office Equipment	100,000.00
4. Per Diems/Travelling Allowance	50,000.00
5. Overtime Pay	150,000.00
6. Operation & Maintenance	400,000.00
7. Construction of Test Wells	8,000,000.00
8. Miscellaneous	237,167.00
	₱10,816,000.00

C. TOTAL ESTIMATED COST ==> ₱19,000,000.00

DETAILED COST ESTIMATES

A. MWSS PERSONNEL

NO	POSITION	GROSS MONTHLY SALARY	MAN-MONTHS	AMOUNT
PROJECT MANAGEMENT				
1	Project Coordinator (PM III)	₱ 8,598.90	12	₱103,186.80
1	Deputy Project Coordinator (PE II)	7,959.50	12	95,514.00
			TOTAL	₱198,700.80
MONITORING TEAM				
1	Sr. Hydrogeologist (SG-18)	5,513.90	12	66,166.80
3	Sr. Geologist/Sr. Engr. B (SG-16)	4,778.90	36	172,040.40
3	Engineering Assistant (SG-12)	3,661.40	36	131,810.40
3	Driver B (SG-9)	3,074.50	36	110,682.00
			TOTAL	₱480,699.60
EXPLORATION & INVESTIGATION TEAM				
1	Sr. Hydrogeologist	5,513.90	12	66,166.80
1	Sr. Geologist	4,778.90	12	57,346.80
2	Geologist (SG-14)	4,166.15	24	99,843.60
1	Hydrogeologist (SG-16)	4,778.90	12	57,346.80
2	Engineering Assistant	3,661.40	24	87,873.60
4	Geo. Engineering Aide B SG-6)	2,639.50	48	126,696.00
1	Driver B	3,074.50	12	36,894.00
			TOTAL	₱532,167.60

DETAILED COST ESTIMATES

NO	POSITION	GROSS MONTHLY SALARY	MAN-MONTHS	AMOUNT
TECHNICAL/ADMINISTRATIVE SUPPORT STAFF				
1	Sr. Hydrogeolist/ Supervising Engineer B	₱ 5,513.90	12	₱ 66,166.80
1	Sr. Engineer B	4,778.90	12	57,346.80
1	Engineer B (SG-14)	4,160.15	12	49,921.80
1	Computer Programmer (SG-18)	5,513.90	12	66,166.80
1	Data Encoder (SG-10)	3,250.70	12	39,008.40
1	Sr. Economist (SG-18)	5,513.90	12	66,166.80
3	Sr. Draftsman B (SG-10)	3,250.70	36	117,025.20
2	Sr. Clerk/Typist (SG-9)	3,074.50	24	73,788.00
1	Geo. Engineering Aide B	2,639.50	12	31,674.00
			TOTAL	₱ 567,264.60
			GRAND TOTAL	₱1,778,833.00

UNDERTAKINGS OF THE GOVERNMENT OF THE REPUBLIC OF THE PHILIPPINES

In order to facilitate a smooth and efficient conduct of the Study, the Government of the Republic of the Philippines shall take the necessary measures:

1. to secure the safety of the Study team.

2. to permit the members of the Study team to enter, leave and sojourn in the Republic of the Philippines in connection with their resignment therein, and exempt them from alien registration requirement and consular fees.

3. to exempt the Study team from taxes, duties and any other charges on equipement, machinery and other materials brought into and out of the Republic of the Philippines for the conduct of the Study.

4. to exempt the Study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Study team for their services in connection with the implementation of the Study.

5. to provide necessary facilities to the Study team for remittance as well as utilization of the funds introduced in the Republic of the Philippines from Japan in connection with the implementation of the Study.

6. to secure permission for entry into private properties or restricted areas for the conduct of the Study.

7. to secure permission for the Study to take all data, documents and necessary materials related to the Study out of the Republic of the Philippines to Japan.

8. to provide medical services as needed. Its expenses will be chargeable to members of the Study team.

The Government of the Republic of the Philippines shall bear claims, if any arises against member(s) of the Japanese Study team resulting from, occurring in the course of or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the member of the Study team.

The Metropolitan Waterworks and Sewerage System shall act as counterpart agency to the Japanese Study team and also as coordinating body in relation with other governmental and non-governmental organization concerned for the smooth implementation of the Study.

The Government of the Republic of the Philippines assured that the matters referred in this form will be ensured for a smooth conduct of the Development Study by the Japanese Study Team.

Signed: GODOFREDO A. VERINO

Title: Sr. Deputy Administrator
and concurrently, Acting
Administrator, MWSS

On behalf of the Government of the Republic of the Philippines

Date: August 30, 1989

2. I / A

IMPLEMENTING ARRANGEMENT
ON
THE TECHNICAL COOPERATION
BETWEEN
THE JAPAN INTERNATIONAL COOPERATION AGENCY
AND
METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
FOR
STUDY FOR THE GROUNDWATER DEVELOPMENT
IN METRO MANILA
REPUBLIC OF THE PHILIPPINES

AGREED UPON BETWEEN

METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Mr. Luis V. L. Sison
Administrator
Metropolitan Waterworks
and Sewerage System (MWSS)

Mr. Akira Hizobuchi
Team Leader
Preliminary Survey Team
Japan International
Cooperation Agency (JICA)

JANUARY 18, 1990
Manila

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), the Government of Japan (hereinafter referred to as "GOJ"), has decided to conduct for the Groundwater Development in Metro Manila(here inafter referred to as "the Study"), and exchanged the Note Verbales with GOP concern ing the implementation of the Study.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programms of GOJ, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan.

On the part of GOP, the Metropolitan Waterworks and Sewerage System(hereinafter referred to as "MWSS") shall act as counterpart agency to the Japanese Study Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document constitutes the Implementation Arrangement between JICA and MWSS under the above-mentioned Note Verbales exchanged between the two governments.

Ⅱ. OBJECTIVE OF THE STUDY

The objectives of the study are;

1) To formulate a plan for the rehabilitation, operation, maintenance and development of MWSS supervised wells in the MWSS Service Area (hereinafter referred to as "MSA").

2) To evaluate the groundwater resources potential in the areas out of MSA.

3) To study a solution or remedial measures and preventive schemes for the intensely saline-water penetrated area.

4) To formulate a plan for establishment of groundwater monitoring system in the respective area.

a. m.

Ⅲ. STUDY AREA

The study area shall cover the MWSS service area as shown in the Annex 1 and 2 comprising of five cities and thirty-two municipalities.

Ⅳ. SCOPE OF THE STUDY

The Study shall include the following:

1 DATA COLLECTION AND REVIEW
- A Socio-economic conditions
- B Physical conditions
- C Existing wells
- D Water supply and demand
- E Reports of related studies and projects
- F Water Quality

2 BASIC INVESTIGATIONS
- A Well inventory
- B Reconnaissance survey of topography, geology and land-use
- C Electric prospecting
- D Local contractors

3 DETAILED INVESTIGATION
- A Rehabilitation in MSA
  - 1) Site survey of damaged wells
  - 2) Well sounding and rehabilitation
- B Saline-water affected area
  - 1) Season-wise groundwater measurements
  - 2) Test-well drilling and installation of observatory instruments
  - 3) Pumping test
  - 4) Simultaneous groundwater measurements
- C Area for groundwater development
  - 1) Test-well drilling and installation of observatory instruments

A.M.

2) Pumping test
3) Simultaneous groundwater measurement

4 STUDY AND ANALYSIS
A Rehabilitation measures and effect
B Saline-water penetration
C Groundwater development potential and water balance

5 DEVELOPMENT PLANNING
A Rehabilitation programmes of MWSS wells in MSA
B Pertinent utilization of groundwater and mitigation scheme for saline-water penetrated area
C Groundwater development and management programme for the MSA.
D Structurization of relevant monitoring system
E A comprehensive plan for groundwater development,utilization and management in MSA

V. STUDY SCHEDULE

The Study will be executed in accordance with the attached tentative schedule.

VI. REPORTS

JICA shall prepare and submit the following reports in English to GOP:

(1) Inception Report
Thirty (30) copies at the commencement of the field survey .

(2) Progress Report
Thirty (30) copies within six(6) months after the commencement of the Study.

(3) Interim Report

A.M.

Thirty (30) copies within twelve(12) months after the commencement of the the Study.

(4) Draft Final Report

Thirty (30) copies within seventeen(17) months after the commencement of the Study.

GOP will provide JICA with its comments on the Draft Final Report within thirty (30) days after the receipt of Draft Final Report.

(5) Final report

Fifty (50) copies within one (1) month after JICA's receipt of the said comments on the Draft Final Report.

VI. UNDERTAKINGS OF GOP

In accordance with the Note Verbales exchanged between GOJ and GOP, GOP shall accord privileges, immunities and other assistance to the Japanese Study Team and, through the authorities concerned, take necessary measures to facilitate the smooth conduct of the Study.

1. a) GOP shall be responsible for dealing with claims which may be brought by third parties against the members of the Japanese Study Team and shall hold them harmless in receipt of claims and liabilities arising in the course of, or otherwise conncected with the discharge of their duties in the implementation of the Study, except when such claims or liabilities arise from gross negligence or willful misconduct of the above-mentioned members.

   b) GOP shall secure the reasonable safety of the Study Team during the implementation of the Study.

2. MWSS shall, at its own expense, provide the Japanese Study Team with the following, if necessary, in cooperation with other agencies concerned:

   a) Available data and information related to the Study.

A. M.

c) Suitable office space in Metro Manila and study area ,

d) Credential or identification cards to the members of the Japanese Study Team.

3. MWSS shall make the necessary arrangements upon request of the Japanese Study Team with other governmental and non-government organizations concerned for the following:

a) To secure the safety of the Japanese Study Team;

b) To permit the members of the Japanese Study Team to enter, leave and sojourn in the Philippines for the duration of their assignment therein;

c) To exempt the members of the Japanese Study Team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into the Philippines for the conduct of the Study;

d) To exempt the members of the Japanese Study Team from income tax and other charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese Study Team for their services in connection with the implementation of the Study;

e) To provide necessary facilities to the Japanese Study Team for remittance as well as utilization of the funds introduced into the Philippines from Japan in connection with the implementation of the Study;

f) To secure permission for entry into private properties or other areas for the conduct of the Study;

g) To secure permission to take all data and documents (including photographs) related to the Study out of the Philippines to Japan by the Japanese Study Team;

h) To provide medical services as needed and its expenses will be chargable on the members of the Japanese Study Team.

VII. UNDERTAKINGS OF GOJ

In accordance with the Note Verbales exchanged between GOJ and GOP, GOJ, through JICA, shall take the following measures for the implementation of the Study.

1. To dispatch, at its own expense, a Study Team to the Philippines.

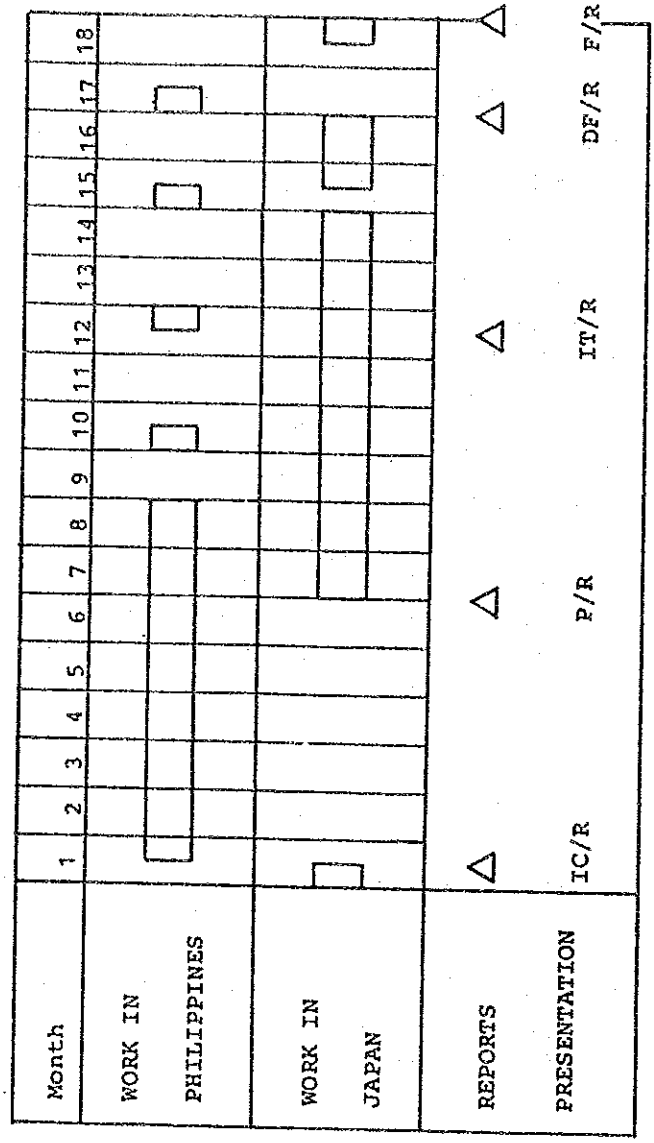
A. M.

2. To pursue technology transfer to the the Philippine counterpart personnel in the course of the Study, by way of training in the Philippines and in Japan.

IX. CONSULTATION

JICA and MWSS shall consult with each other in respect of any matter that may arise from or in connection with the Study.

Tentative Schedule



ANNEX 1

MWSS SERVICE AREA

METRO MANILA :

MANILA, PASAY CITY, QUEZON CITY, CALOOCAN CITY, Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinglupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Tagig and Valenzuela.

CAVITE PROVINCE :

CAVITE CITY, Bacoor, Imus, Kawit, Noveleta and Rosario.

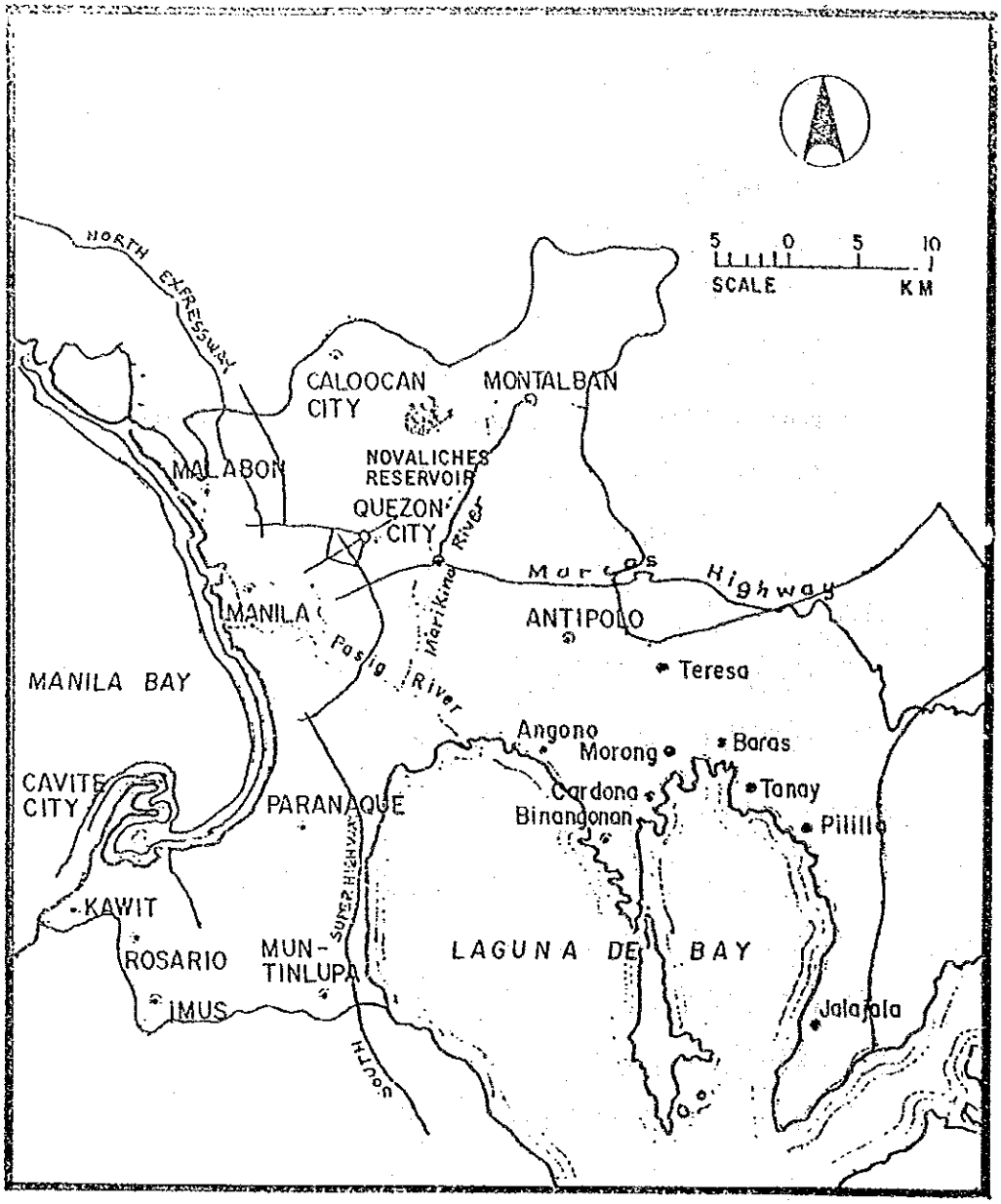
RIZAL PROVINCE :

Antipolo, San Mateo, Taytay, Cainta and Montalban.

BATAS PAMBANSA 799 : Angono, Baras, Binangonan, Cardona, Jala-jala, Morong, Pililia, Tanay and Teresa.

A. M.

ANNEX 2



MWSS SERVICE AREA
TOTAL AREA = 178,500 HAS.

a.m.

3．議事録（M／M）

MINUTES OF MEETING

FOR

THE STUDY FOR THE GROUNDWATER
DEVELOPMENT IN METRO MANILA

IN

THE REPUBLIC OF THE PHILIPPINES

AGREED UPON BETWEEN

THE METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

LUIS V.Z. SISON
ADMINISTRATOR
METROPOLITAN WATERWORKS
AND SEWERAGE SYSTEM
(MWSS)

AKIRA MIZOBUCHI
TEAM LEADER
PRELIMINARY STUDY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

JANUARY 18, 1990

In connection with the Implementing Arrangement (hereinafter referred to as IA) of the Study for the Groundwater Development in Metro Manila (hereinafter referred to as "the Study"), the following major issues were discussed between the JICA Preliminary Study Team (hereinafter referred to as "the Team") and MWSS:

1. The MWSS has pointed out the importance of the Study on the current water supply situation in its service area. Groundwater plays an important role in the water supply of the Metropolis especially when there is a shortfall on the surface water supply during dry seasons which may be aggravated by the occurrence of drought conditions. As such, the improvement and development of the groundwater system in Metro Manila and its environs is the main objective of the Study.
2. In accordance with the IA objectives, the study will focus on three (3) distinct areas of the MWSS, namely:
   a) The MWSS Service Area where well rehabilitation is the study thrust
   b) The Saline-water intruded area where monitoring and computer modelling is the study thrust
   c) The outlying areas where groundwater development is the study thrust.

For Item C, the Team suggested Antipolo as one of the critical areas for a pilot study. However, the MWSS asked that another pilot area in the South should also be included. In connection with this, the Team suggested that the administrative boundaries will not be followed in the Study. Instead, hydrogeological boundaries are to be followed or to any areal extent that the Study may require. MWSS agreed on this.

3. MWSS asked the Team if they can provide for the Study groundwater computer model and/or software to be used in the course of the study.

4. The team requested MWSS to provide them cost estimates of test well drilling and well rehabilitation from local constractors based on JICA specifications which they will give MWSS during their stay. MWSS agreed to provide the team all the other additional data which the team may not be able to collect during their brief stay. All these data will be sent to Japan by MWSS.

5. MWSS requested the team to provide vehicles and the various equipment such as geophysical equipment, pumping unit, water quality analyzer, personal computer, and other tools and equipment necessary for the Study which will be donated to MWSS after the completion of the Study. Likewise, the Team was asked

to provide MWSS a list of the vehicles and equipment they are planning to bring into the Philippines to arrange for their entry and secure permission. Likewise, MWSS indicated that they will provide drivers, fuel and maintenance for the new vehicles.

6. MWSS requested that members of the Study Team should submit their medical history and Medical Examination Results in connection with the undertakings of MWSS to arrange for medical services if necessary.

7. MWSS asked that the preparation and development of five (5) operation manuals be included in the undertakings of the JICA regarding the (a) Rehabilitation of Wells; (b) Saline Water Intrusion Studies; (c) Prospecting Methods; and (d) Well Construction, and (e) Groundwater Potential Simulation Model.

8. MWSS agreed to provide the Study Team with the following, in cooperation with other relevant organizations:

   a) Preparation of data and documents specified in the questionaire submitted by the Team before the Study begins.

   b) Counterpart personnel for each member of the Study Team. MWSS informed the Team that it has proposed to field in 36 personnel or more depending on the need of the Study.

9. To be able to effectively pursue technology transfer, MWSS reiterated to the Team to receive participants especially the counterpart personnel, for training in Japan during the course of the study, in accordance with JICA procedures.

10. MWSS pointed out the importance of a Monitoring System in the Rehabilitation in the MSA phase in addition to the Monitoring System which the Team has proposed for the Saline-water affected Area phase of the Study.

11. JICA requested that MWSS provide the right-of-way and site for test wells. MWSS agreed.

LIST OF ATTENDEES

1. PHILIPPINES SIDE:

LUIS V.Z. SISON	- Administrator , MWSS
GODOFREDO A. VERINO	- Sr. Deputy Administrator, MWSS
EDUARDO M. DEL FIERRO	- Deputy Administrator for Engineering, MWSS
BENIGNO C. AYSON, JR.	- Chief Engineer, Engineering Area, MWSS
ROLANDO E. ROCA	- Chief, Hydrology and Research Division, MWSS
RAMON C. DE MESA	- Chief, Planning and Programming Department, MWSS
ERNESTO E. SAMONTE	- Project Coordinator, Groundwater Development Project in Metro Manila (GWDMM) & Chief, Investigation and Hydrology Section, MWSS
VICTOR J. BALAGTAS	- Assistant Project Coordinator, (GWDMM) Supervising Engineer B, MWSS

2. JAPAN SIDE:

AKIRA MIZOBUCHI	- Team Leader Director, Second Development Study Division, JICA
YUJI MARUO	- Hydrogeology Development Specialist, DSC, Institute for International Cooperation, JICA
MITSUAKI FURUKAWA	- Project Planning Staff, Second Development Study Division, JICA
YUJI UNE	- Groundwater Development Registered Consulting Engineer Overseas Dept., Nissaku Co., LTD.
SHINICHI YOSHIKAWA	- Well Planning Registered Consulting Engineer, Overseas Dept., Nissaku Co., LTD.
NAOMASA ODA	- Water Distribution Expert, JICA Consultant, MWSRP I

4．面談者リスト

4. 面 談 者 リ ス ト

日本大使館 ：

M.D., Koji OKAMOTO (Second Secretery)

JICAフィリピン事務所 ：

Mr. Moriya MIYAMOTO (Resident Representative)

Mr. Katsuhiko OSHIMA (Deputy Resident Representative)

Mr. Katsuhiko OZAWA (Asst. Resident Representative)

JICA派遣専門家 ：

Mr. Naomasa ODA (MWSS / Sanitary & Enviromental Engineer)

MWSS ：

Mr. Luis V.Z. SISON (Administrator)

Mr. Godofredo A. VERINO (Senior Deputy Administrator)

Mr. Eduardo M. DEL FIERRO (Deputy Administrator for Engineering)

Mr. Benigno C. AYSON, JR. (Chief Engineer, Engineering Area)

Mr. Rolando E. ROCA (Ms. Eng'g. Chief, Hydrology & Research Division)

Mr. Raman D. DE MESA (Ms. Eng'g. Chief, Planning Division)

Mr. Victor V. BALAGTAS (Assistant Project Coordinator, GWDMM)

Mr. Ernesto E. SAMONTE (Project Coordinator, Chief, GWDMM)

Mr. Ceferino M. DELA CRUZ (Geology Specialist)

Mr. Senen D. DIZON (Senier Engineer)

Mr. Ben C. PAGDONSOLAN (Supervising Engineer, B)

Mr. Lutgardi S. LARANI (Hydrogeologist, Research Division)

Mrs. Carol V. BALAGTAS (Hydrology & Research Division)

Mr. Mideo PAMTIG (Pump Operator, Dampalit)

Mr. Javier GOMEZ (ADB, Manager, Water Supply Division)

NAMRIA (National Mapping & Resources Information Authority) :

Mr. VENTIREZ

BSWM (Bureau of Soil & Water Management) :

PAGASA (気象統計局) :

Mrs. Araceli L. FONTANO (Chief, Climate Data Section)

NWRB (National Water Resources Board) :

Mr. Antonio P. BASILIO (Chief Civil Engineer)

Mr. Lope VILLENA (Planning Officer)

MGB (Mine & Geoscience Bureau)

5．収集資料リスト

5. 収集資料リスト

	Name of Map	Prepared by	Year
I. GENERAL INFORMATION			
I-1 Project Background & Socio-Economic Conditions			
1.	Medium-Term Public Investiment Program	NEDA	1988
2.	National and Regional Development Plan (The Medium Term Philippines Development Plan, 1988 ~ 1992)	NEDA	
3.	Manila Water Supply III Project Alternative Sources Study Volume 24	Electrowatt Engineering Services and Others	1979
4.	1989 Philippine Statistical Yearbook	National Statistical Coordination Board	1989
I-2 Natural Conditions			
1.	Contoured Map, Metro Manila Area (1:10,000) 57 sheets	JICA	1987
2.	Topographic Map of Manila (1:250,000)	Philippine Coast & Geodetic Sruvey	1954
3.	Aerial Photo Flight Plan of Metro Manila	MWSS	
4.	Land Condition Map, Metro Manila Area (1:10,000) 16 sheets	JICA	1987
5.	Land Use Map, Metro Manila Area (1:10,000) 33 sheets	JICA	1987
6.	Geological Map (1:50,000) Manila and Quezon City Quadrangle	Bureau of Mines & Geosciences	1983
7.	Geological Map (1:50,000) Cavite Quadrangle	Bureau of Mines & Geosciences	1984
8.	Geological Map (1:50,000) Montalban Quadrangl	Bureau of Mines & Geosciences	1983
9.	Geological Map (1:50,000) San Pedro Quadrangle	Bureau of Mines & Geosciences	1983
10.	Soil Map, (1:75,000) Cavite Province	Bureau of Soils	1935
11.	Soil Map (1:100,000) Rizal Province	Bureau of Soils	1935
12.	Land Systems Map of Metro Manila, Watersheds of Manila Bay and Laguna de Bay (1:125,000) 4 Sheets and 1 Legend Sheet	Bureau of Soils	1952

13.	Location Map of Hydrometric Station of Metro Manila, Watersheds of Manila Bay & Laguna de Bay (1: 125,000)	Bereau of Soils	—
14.	Manila Street Map		—
15.	Hydrogeologic Map of Central Luzon, Phillipines	MWSS	
16.	Soil and Land Resource Evaluation Project of Metro Manila (Soil / Physiography)		
17.	- do - (Evalution for Agriculture)		
18.	Preliminary Report on the Groundwater Resources of Manila and Suburbs (unpublished)	H. P. Quiazon Bureau of Mines	1968
19.	Soil Survey of Cavite Province	Bureau of Soils	1935
20.	Geology and Mineral Resources of the Philippines	Bureau of Mines & Geosciences	1982
21.	Climatological Normals / Averages of the Philippines (1951 - 1985)	National Institute of Climatology, PAGASA	1987
22.	Location Map of PAGASA Synoptic & Agromet Stations	National Institute of Climatology, as of PAGASA	1989
23.	Manila Predicted Tide and Current Tables 1990	NAMRIA	1989
24.	Discharge Measurement of Marikina River, 1985 ~ 1989	Bureau of Public Works / National Water Resources Council	1989
25.	Stream Discharge Measurement, Maragondon River, 1989 (Gagekeepers Monthly Report)	National Water Resources Council	1989
26.	Evaporation Data from PAGASA, 1980 ~ 1989	PAGASA	1990
27.	Gauging Stations and Data on Rivers and Lakes		
28.	Annual Records of Lagna Lake Water Level (1980 ~ 1989)		
29.	Stream Discharge Measurment, Alemang River (Gaugekeepers Manthly Report / NWRC)	NWRC	
30.	- do - , Pililla River		
31.	- do - , Morong River		
32.	Framework Plan 4, Laguna Lake Basins / Southern Tagalog (NWRC, Report No.24 - 4A, 1983)		

II. PROJECT INFORMATION

II-1 Project Report

1.	Ground Water Development Manila Water Supply Project II Interim Report and Plates	Electrowatt Engineering Service Ltd. Engineering Geoscience, Inc.	1981
2.	Ground Water Development Manila Water Supply Project II Final Report	Electrowatt Engineering Service Ltd.	1983
3.	Fringe Areas Water Supply Project (FAWSP), Antipolo, Rizal Feasibility Study Report No.1 (unpublished)	MWSS	1989
4.	Fringe Areas Water Supply Project (FAWSP), Montalban, Rizal Feasibility Study Report No. 1 (unpublished)	MWSS	1989
5.	Angat Water Supply Optimization Project, Feasibility Study (Stage 2) Fianl Report and Appendices	DCCD Engineering Corporation Engineering and Development Corporation of the Philippines with the National Hydraulic Research Center	1988
6.	Rizal Province Water Supply Improvement Project (RPWSIP) Feasibility Study Final Report Volume 1 & 2	SOGREAH	1989

II-2 MWSS & Water Works

1.	Organization Chart & Functions of MWSS		1985
2.	No. of MWSS Personnel by Department (Regular : 5,063, Casual : 3,729, Total : 8,792)	MWSS	1990
3.	Functions and Responsiblities of Relevant Organizations	MWSS	1990
4.	MWSS Annual Reports 1984 - 1985	MWSS	—
5.	Manila Water Supply III, Water Demand and Tariff Study Report & Appendices	Electrowatt Engineering Services Renardet S. A.	1983
6.	Philippines Water Code and the Implementing Rules and Regulations	National Water Resources Council (NWRC)	1976
7.	Schematic of the Proposed 1982 Distribution System, Manila Water Supply Project	MWSS	1977
8.	Zone Index Map of Manila Water Supply Rehabilitation Project - I , II	MWSS	1990
9.	National Standards for Drinking Water, 1978	Bureau of Reserch & Laboratories	1978
10.	MWSS Standard Drawings for Watermain Construction on Metropolitan Manila Water Distribution Project	MWSS	—

11.	Sample of Contract Documents including Technical Specification of Test/Production Wells	MWSS	—
12.	Technical Specifications of Pipe Materials		—
13.	Water Quality Records (Central Ravoratory Division/MWSS)		
14.	Operation Records/Operation of Facilities		
15.	Ground Water Development Project, Manila Water Supply Project II Manual No. 1 Well Construction and Inspection	Electrowatt Engineering Services, Engineering Geoscience Inc.	1981
16.	Ground Water Development Project, Manila Water Supply Project II Manual No. 3 Pumping Tests	Electrowatt Engineering Services, Engineering Geoscience Inc.	1981
17.	Memorandum on Results of Several Rehabilitation Works		—
18.	Status Report/Accomplishment Report of MMWDP as of December, 1989	MWSS	1990

II-3 Existing Wells

1.	Well Location Map & Well Inventory of MWSS	MWSS	1990
2.	Sample, Daily and Monthly MWSS Deepwell Operations Report		
3.	Piezometric Map of Metro Manila	MWSS	1988
4.	Iso-Chloride Map of Metro Manila	MWSS	1988
5.	NWRB Inventory of Private Metro Manila Deepwells with Approved Water Permits		
6.	Data on Private Metro Manila Deepwells		
7.	- do -		
8.	Well Data for Rrivate Deepwells in Matro Manila (Quzon City ~ Makati 9地区)		

III. RELEVANT INFORMATION

1.	List of Driller Suppliermembers of WELDAPHIL		
2.	Well Assessment in Las Pinas		
3.	Annual Report '88	Bureau of Mines & Geosciences	1989
4.	Publishment Index of Bureau of Mines & Geosciences	Bureau of Mines & Geosciences	—

6．関連資料の収集状況

6. 関連資料の収集状況

関連資料の収集に当っては、MWSS, NWRB, NAMRIA, BSWM, PAGASA, MGB等を直接訪問したが、MWSSのHydrology & Research Division及びGround Water Monitoring Unitのスタッフ協力によるところが大きかった。又、JICA派遣専門家・小田氏のアドバイスも欠かせぬものであった。

今回の事前調査では、予め作成した「Required Data Questionaire」を持参し、再三各資料の有無、所在、入手の可否等の確認を行った。これらの内容は、次に掲げる一覧表のとおりである。

必要性　：A……緊急的に特に必要な資料

：B……本格調査の開始までに必要な資料

可能性　：◎……事前調査で収集した資料

：△……本格調査開始まで準備可能な資料

：○……2月'90 MWSS郵送分資料

：×……入手不可能な資料

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
I. GENEARL INFORMATION			
A. Project Background	A		
1. Short Term and Long Term National Development Plan		◎	-Medium-Term Public Investment Program, 1988-1992
2. Regional Development Plan in Metro Manila Area		○	-現在編集中で May '90 頃発刊予定 (Medium Term Plan : 郵送分資料リスト No.3参照)
3. Development Plan in Water Supply Sector		◎	-Manila Water Supply Ⅲ Project Alternative Sources Study Report
B. Socio-Economic Conditions	B	◎	-1989 Philippine Yearbook
1. Population and Household (Trends and Forecast)			
2. Living Cost			
3. Race, Religion, Language and Customs			
4. Infrastructure			
(1) Road			
(2) Transportation			
(3) Electricity			
(4) Communication			
(5) Health and Sanitation			
(6) Education			

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
5. Security			
6. Immigration			
7. Living Conditions (1) Accommodations (2) Prices and Availability			
8. Labor Circumstances (1) Labor Condition (2) Wage Level (3) Law, Regulation and Customs (4) Social Security System (5) Labor Level			
9. National Holiday		◎	-1日/1月, 3日/4月, 1日/5月, 1日/6月, 1日/8月, 2日/11月, 2日/12月 (合計11日)
10. Economic Growth Rate		◎	-1989 Philippine Yearbook
11. Gross National Product (GNP)		◎	-同 上
12. National Income per Capita		◎	-同 上
13. Inflation Rate			

Data / Item	Request by the Study Team	Availability	Agency & Name of Reports
C. Natural Conditions	A		
1. Physical Conditions			
(1) Topographic Map and Location of Bench-Mark Station		◎	-Contoured Map, Metro Manila Area (1:10,000) 全57葉及び1:250,000 1葉
(2) Aerophotographs		○	-測線 Index
(3) Land Use Map		◎	-Land Condition Map (1:10,000) 全16葉 Land Use Map (1:10,000) 全33葉
(4) Geological Map		◎	-5万分の1メトロマニラ地質図全4葉
(5) Soil Map		◎	-Cavite, Rizal Province & Soil Map 収集リスト参照
(6) Hydrogeological Map		○	-Central Luzon 1枚、収集資料リスト参照
(7) Road Map		◎	-Manila Street Map
(8) Geological Logging Data and Study Report		◎	-収集資料リスト参照
(9) Soil Analysis Data and Study Report		◎	-同 上
(10) Physical Prospecting Study Report		◎	-FAWSP Antipolo, Rizal Area F/S Report 中に一部報告されている。 (収集資料リスト参照)
2. Hydrology and Meteorology			
1. Location of Weather Station		◎	-PAGASA Synoptic & Agromet Stations Map

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
2. Meteorological Data			
(1) Precipitation		◎	- Climatological Normals / Averages of the Philippines (1951 - 1985) 毎日のデーターは 1953年以降観測が継続されており、PAGASAにて収集可能
(2) Temperature			
(3) Humidity			
(4) Barometric Pressure			
(5) Sunshine Hour			
(6) Wind			
3. Location of Gauging Station for River-Flow		○	- 収集資料リスト参照
4. Gauging Data of River-Flow		○	- 同　上
5. Location of Gauging Station for Sea Water Level		◎	- Manila Predicted Tide & Current Tables 1990
6. Gauging Data of Sea Water Level		◎	- 同　上
7. Location of Gauging Data Station for Lake Water Level		○	- 収集資料リスト参照
8. Gauging Data of Lake Water Level		○	- 同　上

Data / Item	Request by the Study Team	Availability	Agency & Name of Reports
II. PROJECT INFORMATION			
A. MWSS			
1. Organization	A	◎	- Organization Chart & Functions
2. Function and Roles of Each Section		◎	- 同　上
3. Number of Staff and Employees (Inclusive Foreign Experts)		○	- 収集資料リスト参照
4. Qualification and Speciality of Probable Counterpart		◎	- 事前調査にて確認済
5. Annual Budget and Balance in Last 5 Years		◎	- Annual Report, 1984 - 1988
6. Budgetary Year		◎	- Jan. 1st ~ Dec. 31
7. Water Tariff Structure		◎	- Manila Water Supply Project Ⅲ Water Demand & Tariff Study Report の他、Water Tariff Schedule 有り
8. Equipment Owend		◎	- PPD の他、MWSS 全体の Inventory 有り
(1) Construction Equipment			
(2) Vehicles			
(3) Testing Instrument			
(4) Leveling Equipment			
(5) General Equipment			
9. Competency and Task		×	

Data / Item	Request by the Study Team	Availability	Agency & Name of Reports
10. Relevant Organization		○	-収集資料リスト参照
11. Tender and Contract System to Subcontractor		◎	-Well Drilling, Rehabilitation Works に関するSample有り 収集リスト参照
B. Waterworks			
1. Present Water Supply System	A	◎	-Angat Water Supply Optimization Project Final Report 中に記載
(1) Water Resources			
1) Dam and Reservoir (Location, Capacity)			
2) Surface Water and River (Location, Intake Capacity)			
3) Well (Location, Capacity)			
(2) Purification Plant			
1) Location			
2) Treatment Method			
3) Capacity			
4) Water Quality Standard			
(3) Water Supply Pipe			
1) Location			

Data / Item	Request by the Study Team	Availability	Agency & Name of Reports
2) Supply Method 3) Capacity 4) Pipe Specification (4) Water Distribution 1) Service Reservoir (Location, Capacity) 2) Pumping Station (Location, Capacity, Pressure) 3) Distribution Network or Zone (Location, Area, Location and Specification of Control Valves, Population, Capacity, Usage, Leakage, Shortage) (5) Designed Criteria of Water Comsumption per Capita per Day 2. Operation of the Facilities (1) Operation Records (2) Water Quality Records (3) Maintenance Records (4) Rehabilitation Records	B	○	- MWSS井のPumpingレコードを一部入手 各ポンプステーションに管理人を配置し揚水量、使用電力、圧力等を記録している収集資料リスト参照

Data /Item	Request by the Study Team	Availability	Agency & Name of Reports
3. Laws, Regulations and Customs Related to Water	B	◎	- Philippine Water Code & the Implementing Rules & Regulations (1976)
4. On-going Project and Budgetary	A	◎	- 一覧表あり
5. Future Development Plan and Budgetary Arrangement	A	◎	- 同　上
6. Relevant Received Project Financed by Foreign Aid Agency	A	◎	- 同　上
7. Water Demand Forecast	A		
(1) Population in Service Area			
(2) Water Consumption			
1) Per Capita per Day		◎	- Manila Water Supply Ⅲ, Water Demand and Tariff Study Report
2) Household Usage		◎	- 同　上
3) Commercial Usage		◎	- 同　上
4) Industrial Usage		◎	- 同　上
5) Ohters		◎	- 同　上
8. Design and Construction of Facilities	B	◎	- MWSS Standard Drawings 収集資料リスト参照
(1) Strandards			
(2) System			

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
(3) Manual			
9. Operation and Maintenance of Facilities	A	○	-収集資料リスト参照
(1) Standards			
(2) System			
(3) Manual			
C. Existing Wells			
1. MWSS Supervised Well	A	◎	-収集リスト参照
(1) Location			
(2) Well Inventory			
(3) Well Logging Profile (Geology, Resistivity)			
(4) Pumping Test Data			
(5) Water Quality			
(6) Water Level			
(7) Pumping Discharge Rate			
1) Per Day			
2) Seasonal Fluctuation			

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
(8) Damage Records			
(9) Specification of Well Structure			
(10) Specification of Pumping Facility			
(11) Connecting Method to Waterworks Pipe			
(12) Possible Well as Observation Well of Groundwater Level		◎	- Piezometric Map & Iso-Chloride Map (1988)
2. NWRB Supervised Wells	A		
(1) Location		○	- 収集資料リスト参照
(2) Well Inventory		○	〃
(3) Well Logging Profile (Geology, Resistivity)		○	〃
(4) Pumping Test Data		○	〃
(5) Water Quality			
(6) Water Level		○	〃
(7) Usage			
(8) Pumping Discharge Rate		×	
1) Per Day			

Data /Item	Request by the Study Team	Availability	Agency & Name of Reports
2) Seasonal Fluctuation		×	
(9) Damage Records		×	
(10) Specification of Well Structure and Pumping Facility		◎	
3. Other Private Wells	B	○	-NWRB Supervised Well に同じ
(1) Supervisory Agency			
(2) Location			
(3) Well Inventory			
(4) Well Logging Profile (Geology, Resistivity)			
(5) Pumping Test Data			
(6) Water Quality			
(7) Water Level			
(8) Usage			
(9) Pumping Discharge Rate			
1) Per Day			
2) Seasonal Fluctuation			
(10) Damage Records			

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
(11) Specification of Well Structure and Pumping Facility			
4. General	A		
(1) Laws, Regulations and Customs for Well Construction		◎	-II. B-3に同じ
(2) Standard for Design and Construction of Wells		◎	-収集資料リスト参照
(3) Standard for Operation and Manitenance of Wells		◎	-同 上
(4) Groundwater Demand		◎	-II. A-7に同じ
(5) Study Report Related to Groundwater		◎	-II. C-1.(10)に同じ
III. RELEVANT INFORMATION			
A. Local Well Drilling Contractor	A	◎	-MWSSが起用しているContractor, 一覧表あり
1. Number			
2. Capital and Number of Employees			
3. Equipment Owned			
(1) Drilling Machine (Type, Capacity)			
(2) Vehicles			

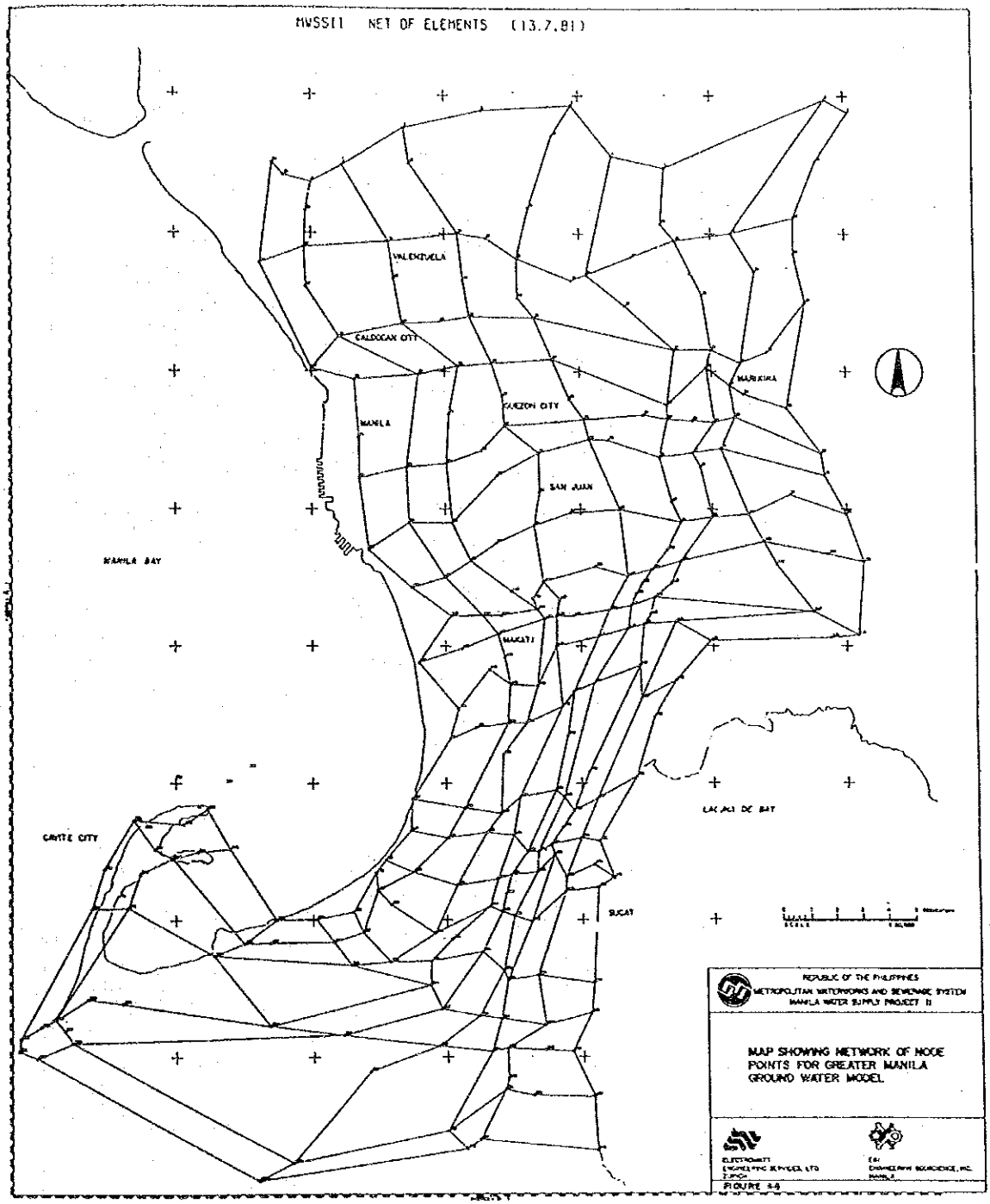
Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
(3) Others			
4. Annual Turnover (Especially Govermental Work)			
5. Association		○	-Well Drillers and Philippines という組織がある (リストNo.3参照)
6. Unit Price of Drilling Works and Rehabilitation Works			-一部入手
B. Local Consultant	B	△	
1. Number			
2. Capital			
3. Number of Qualified Engineer			
4. Annual Turnover			
5. Association			
C. Cost Estimation and Work Schedule			
1. Available Organizations for Surveying	A	△	
(1) Topographic Survey			
(2) Geological Survey			
2. List of Price for Construction Materials	B	○	-MWSSが規定した単価表あり

Data/Item	Request by the Study Team	Availability	Agency & Name of Reports
3. List of Wages	A	◎	-一覧表あり
(1) Laborer			
(2) Driver			
(3) Typist			
(4) Others			
4. Working Hour	A	◎	
(1) Working Time per Day			-80:00-17:00 但し12:00-13:00昼休み
(2) Working Day per Month			
(3) Workability during Rainy Season			-雨期にあっても間けつ的な降雨で、メトロマニラにおいては問題無い
5. Conditions around the Study Office	A	◎	-MWSS内に設けられる Air Conditioned, Furnitured & Telophone equipped.
(1) Possible Location of the Office			
(2) Accommodation and Charges per Month			
(3) Communication Facility			
(4) Hospital			
(5) Personal Security			
D. Formalities for Using of Transceiver	A	◎	-持込み前にPermitionを取る必要あり

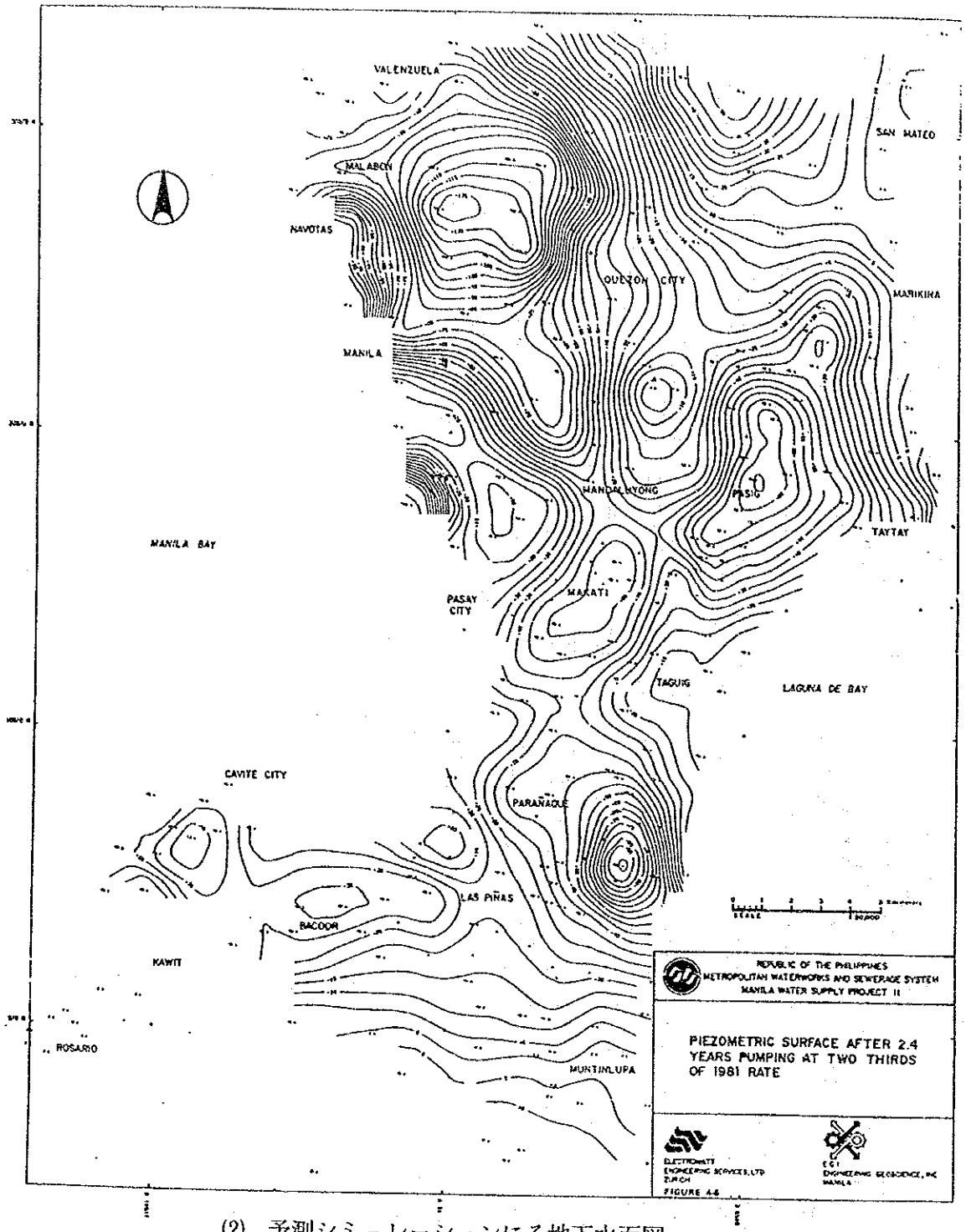
7．参考資料

参 考 資 料 目 次

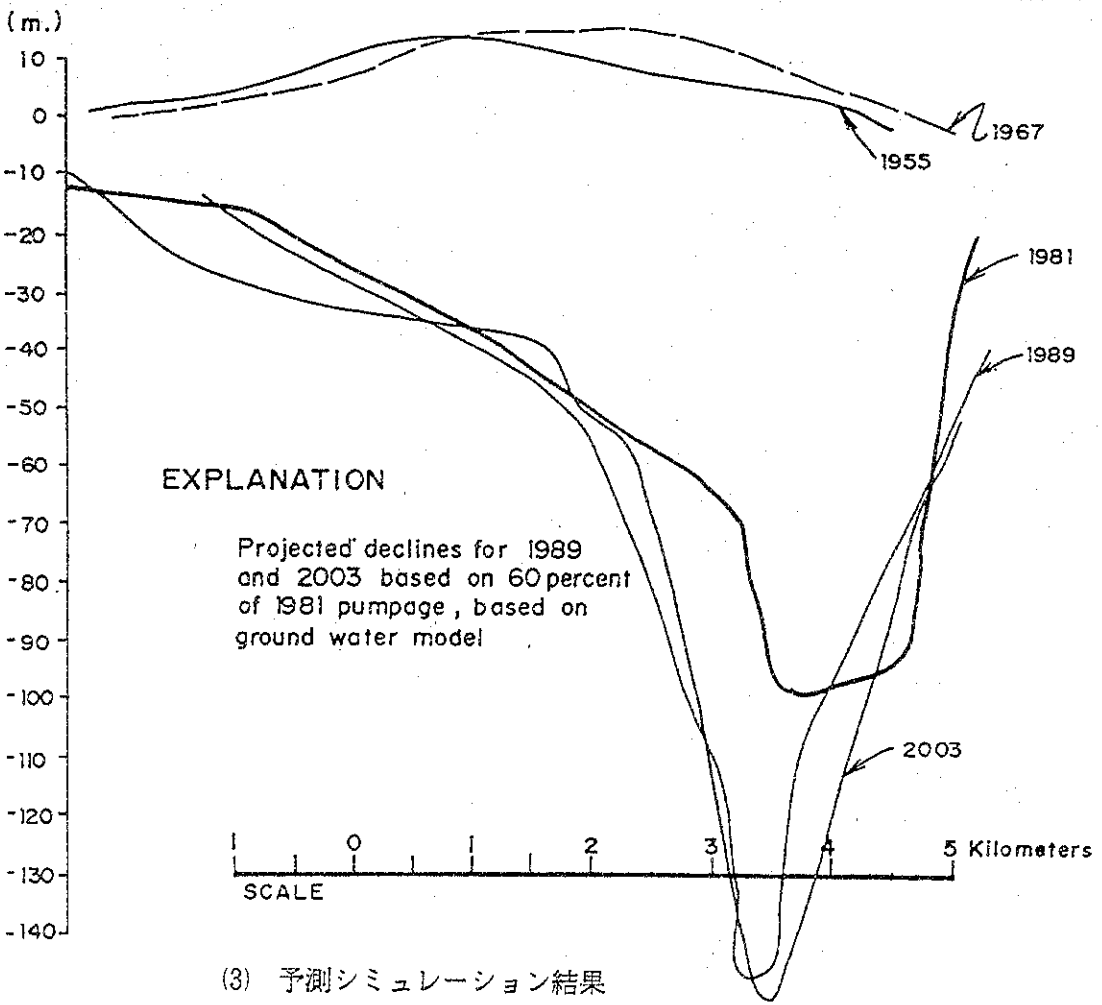
(22) … MWSS Wells & Turned - over Wells	地区別明細表
(23) … Well No. CATMON 21 井, MALABON	電気検層図
(24) … Well No. Merville SUBD., NAVOTAS	電気検層図
(25) … Well No. BLZ - 215, VALENZUELA	地質柱状図
(26) … Well No. 6, PARANAQUE	地質柱状図
(27) … Well No. LPS - 64, LAS PINAS	地質柱状図
(28) … Well No. WD - 1 (C), CAVITE	地質柱状図
(29) … Well No.____, TAGUIG	地質柱状図
(30) … Well No.____, PASIG	ケーシング・ストレーナ位置図
(31) … Well No.____, CAINTA, RIZAL	電気検層図
(32) … Well No.____, MANDALUYONG	電気検層図
(33) … Well No. WD - 06 (A), ANTIPOLO	ケーシング・ストレーナ位置図
(34) … 地下水の塩水化について	
(35) … リハビリテーションについて	



(1) 有限要素法によるシミュレーションモデル多角形区分

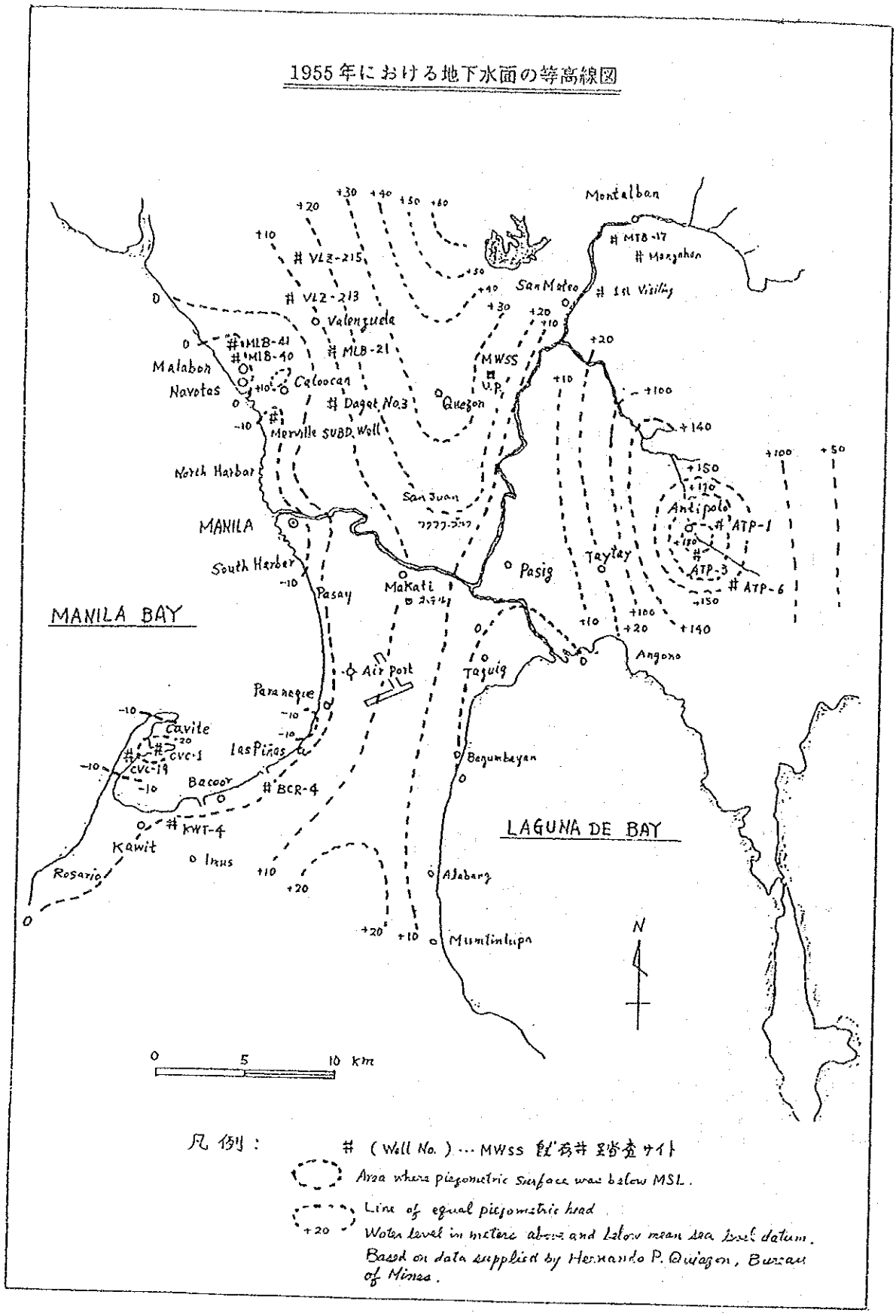


(2) 予測シミュレーションにる地下水面図

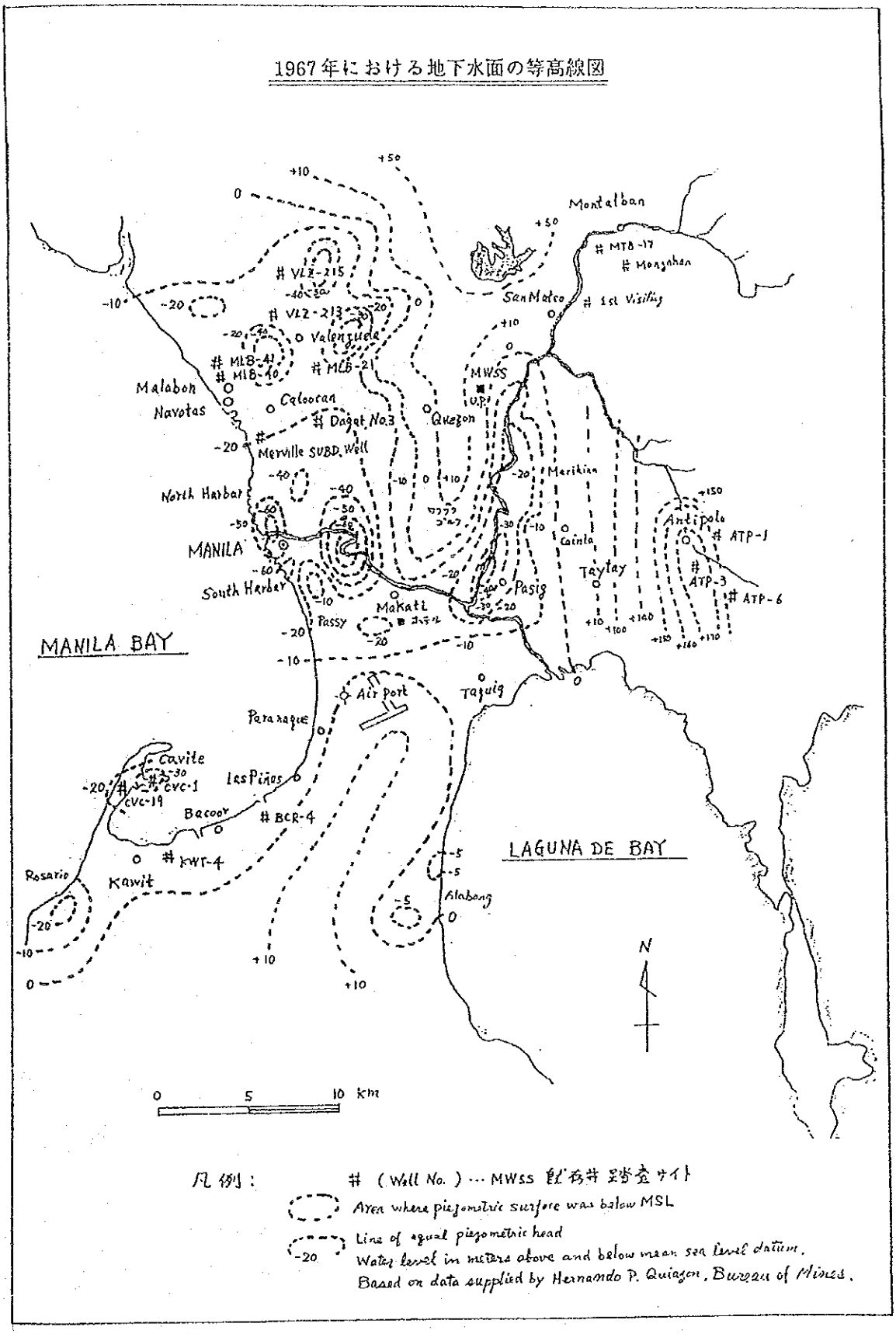


(3) 予測シミュレーション結果

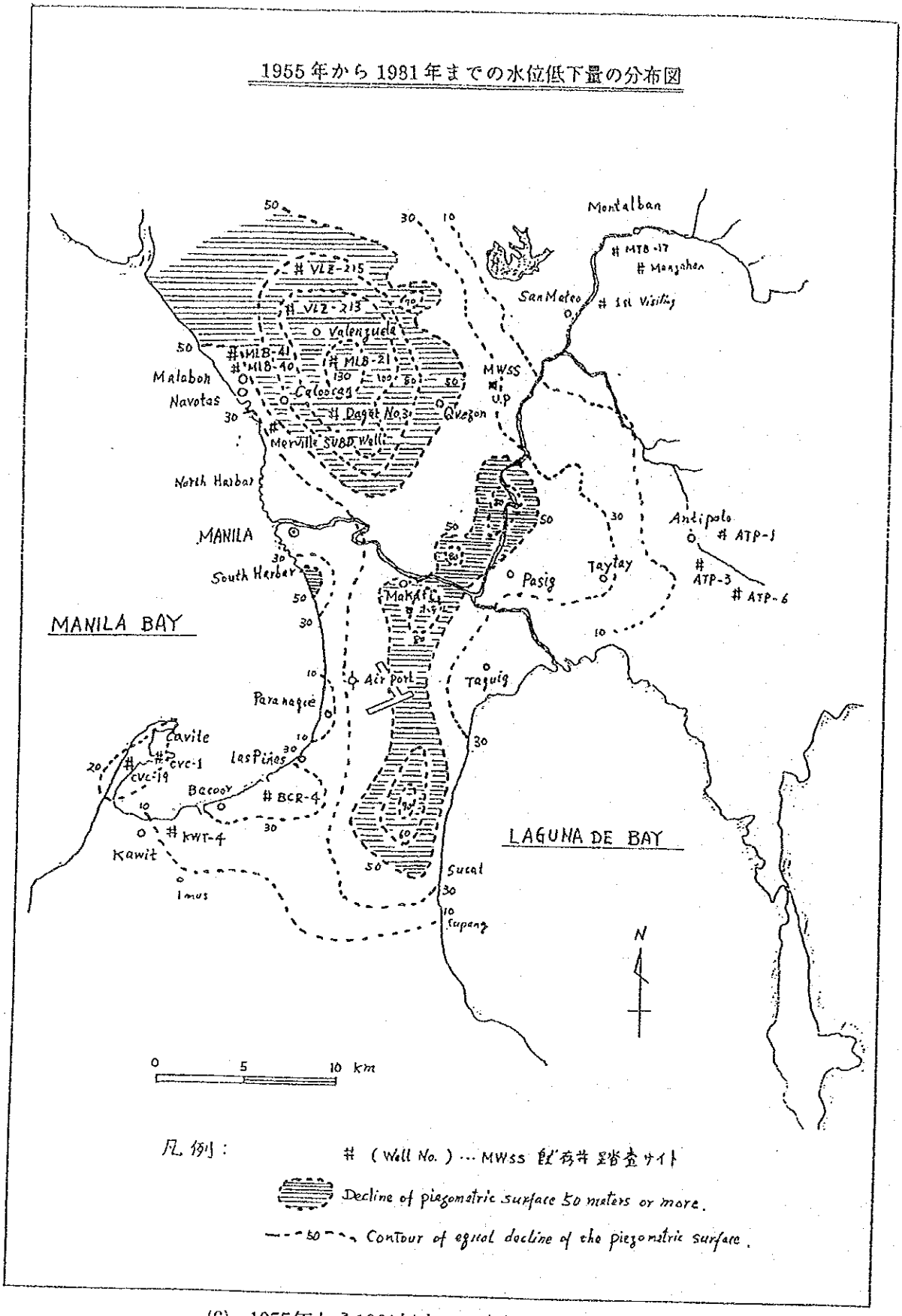
HYDROGRAPHS SHOWING DECLINE AND PROJECTED DECLINES OF WATER LEVELS IN THE SUCAT CONE OF DEPRESSION.



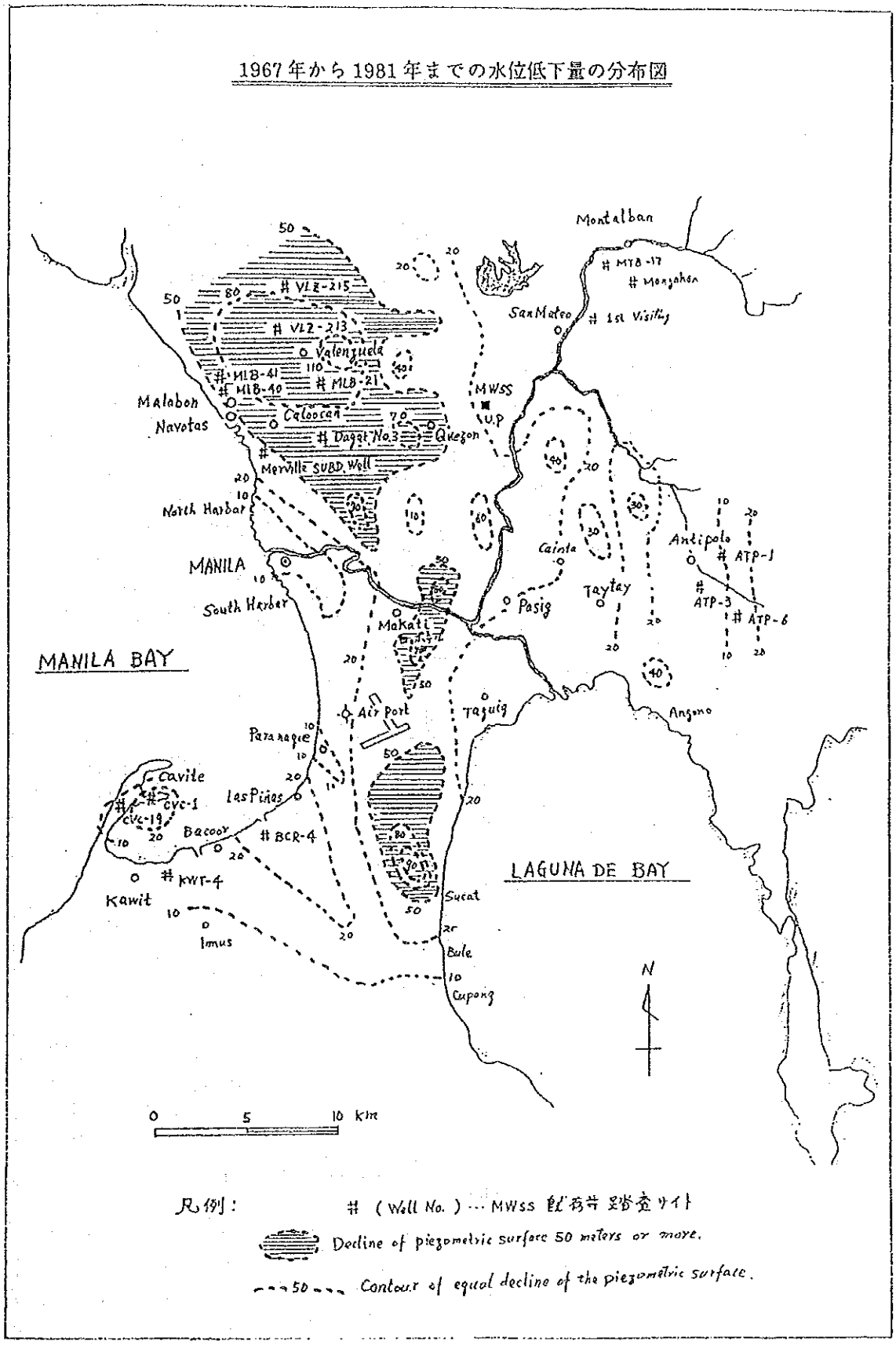
(4) 1955年における地下水面の等高線図



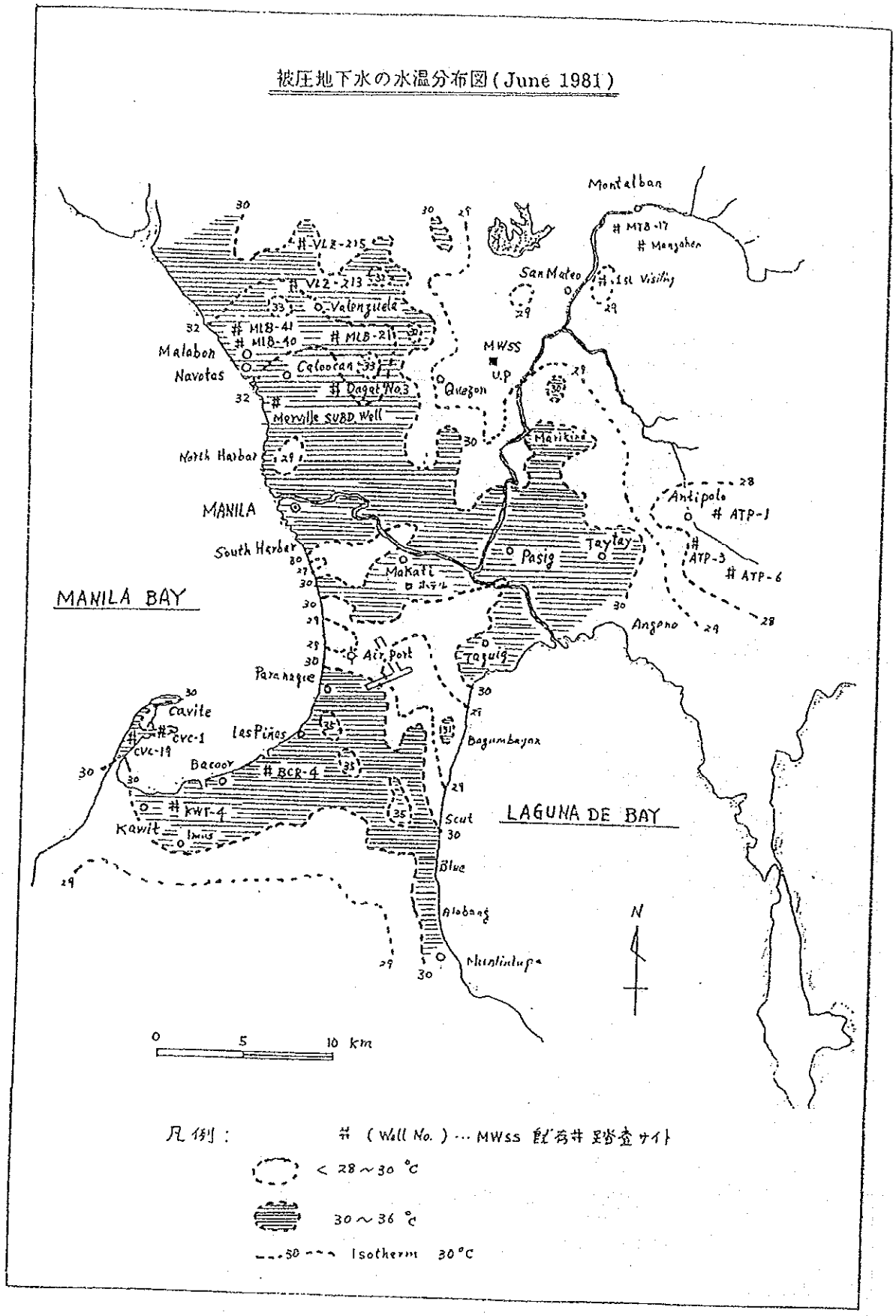
(5) 1967年における地下水面の等高線図



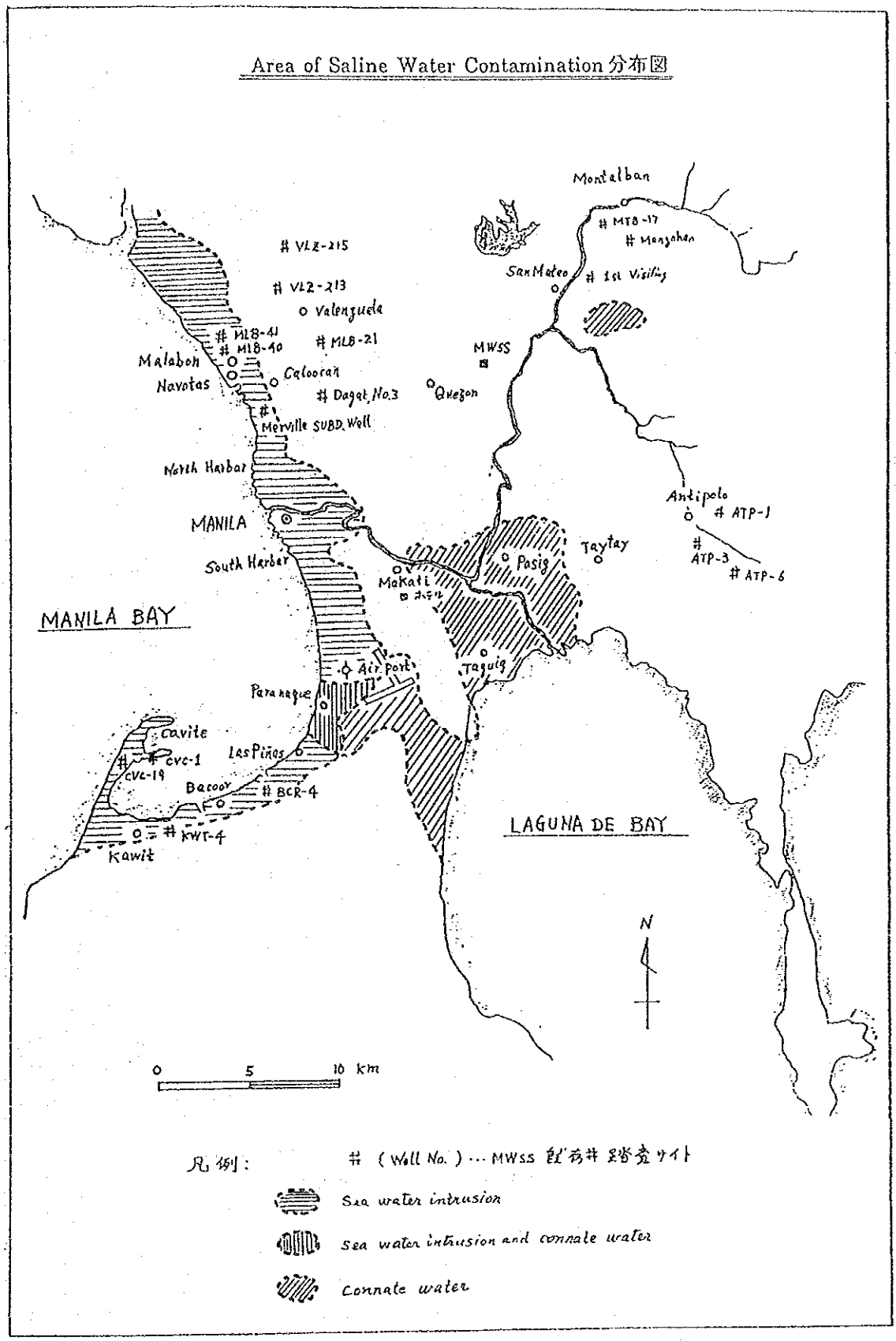
(6) 1955年から1981年までの水位低下量の分布図



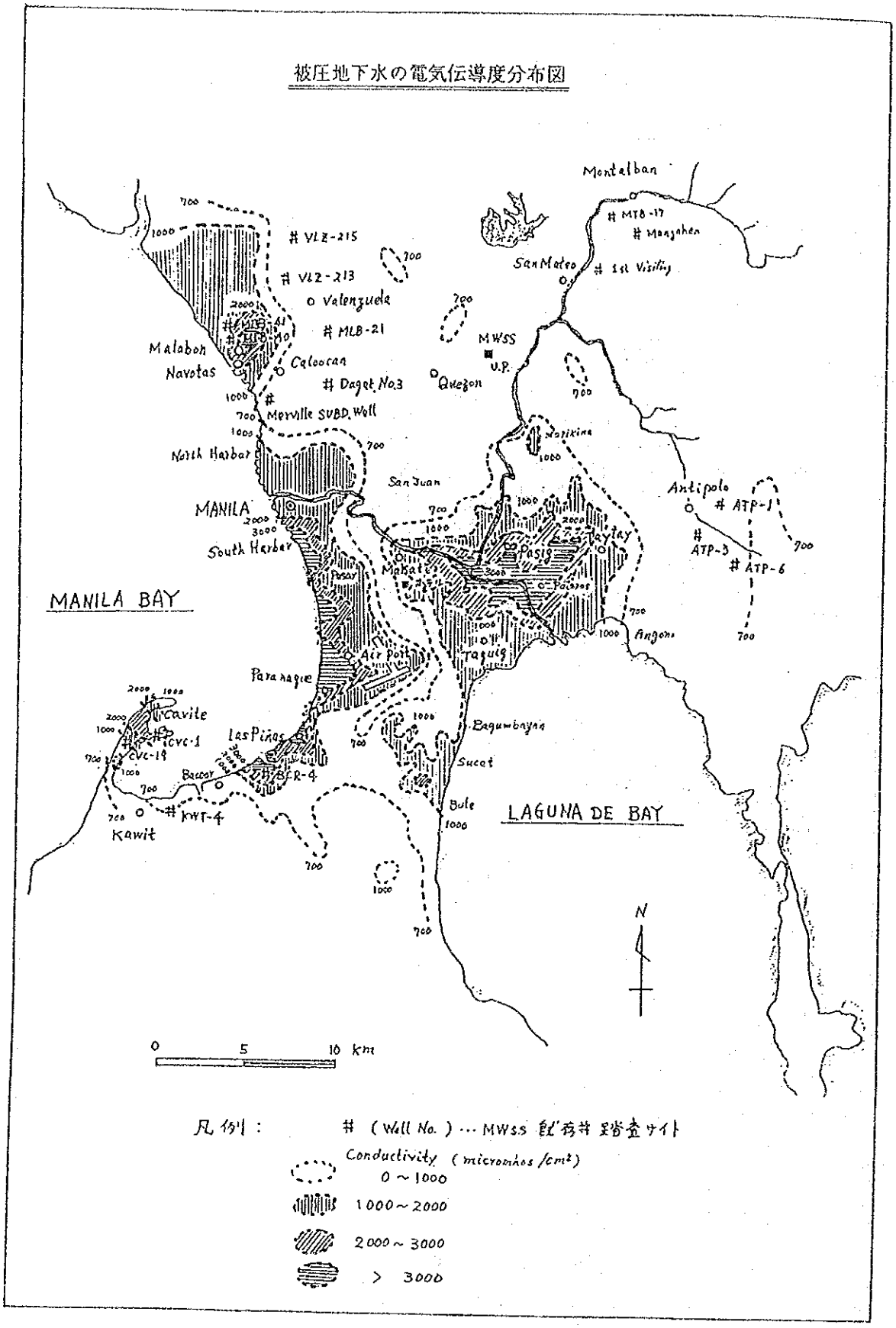
(7) 1967年から1981年までの水位低下量の分布図



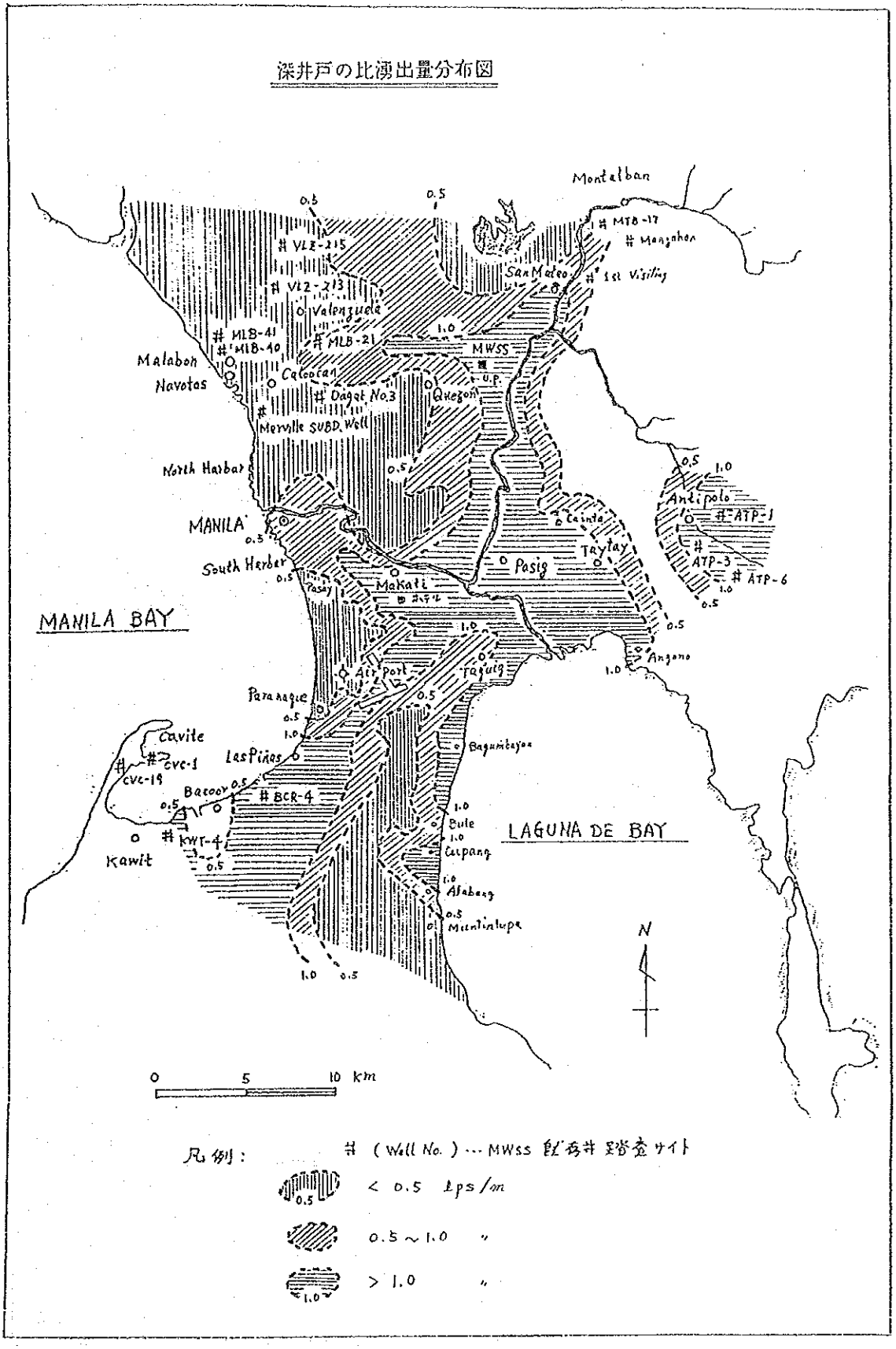
(8) 被圧地下水の水温分布図 (June 1981)



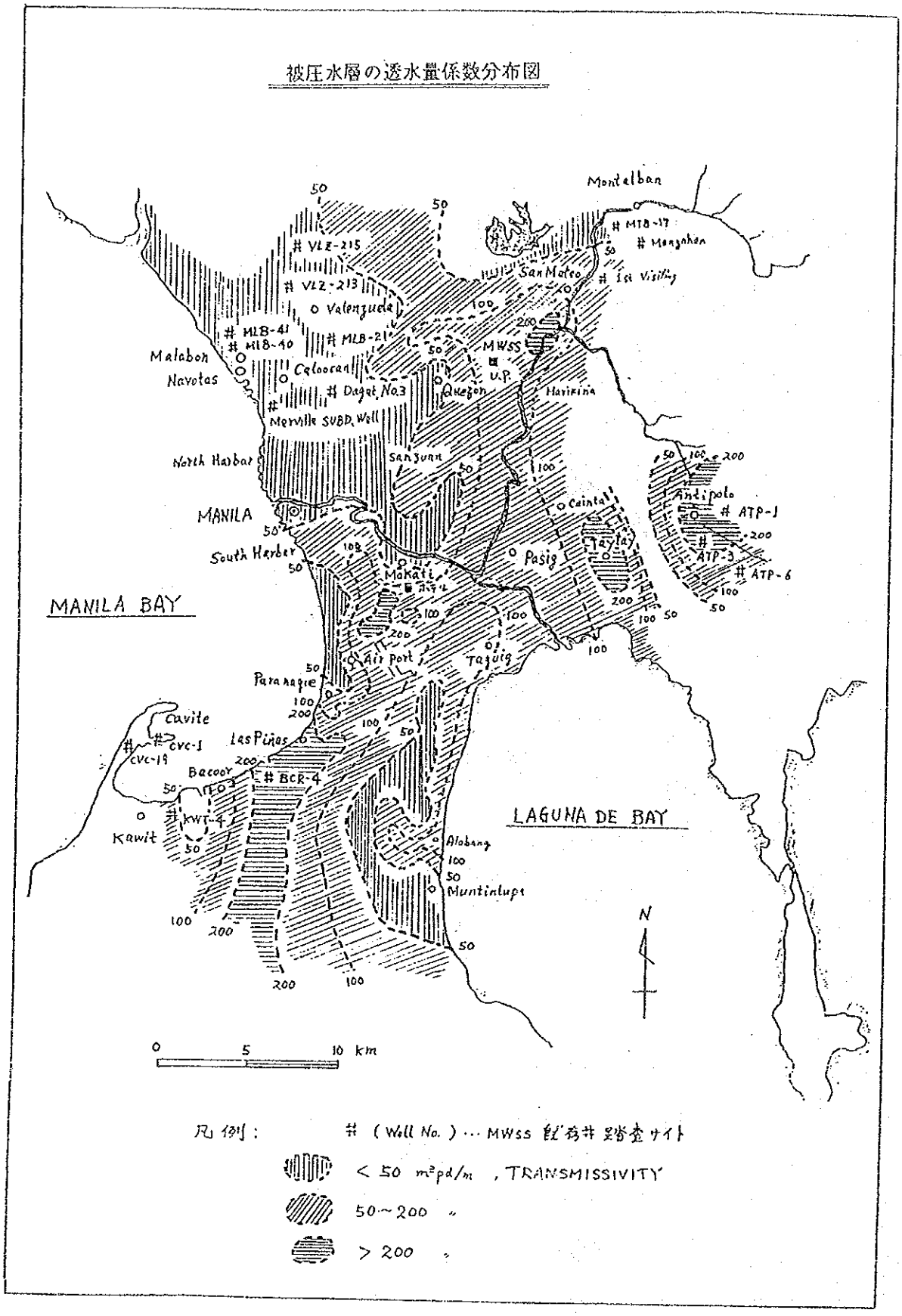
(9) Area of Saline Water Contamination 分布図



(10) 被圧地下水の電気伝導度分布図



(11) 深井戸の比湧出量分布図



(12) 被圧水層の透水量係数分布図

(13) 揚水試験結果と採水層の状況表

PUMPING TEST RESULTS AND AQUIFER CHARACTERISTICS OF SELECTED WELLS IN METRO MANILA

MWSS No.	OWNER	DEPTH (m)	SWL (m)	DRAWDOWN (m)	TEST PUMPING RATE l/s	SPECIFIC CAPACITY l/s/m	TRANSMISSIVITY m^2/d	AQUIFER TRAPPED
ATP – 54	Sumulong # 7	183	28	11	18	1.6	210	GP
BCR – 4	Bo. Niog	274	39	15	30	2	220	Qal. Qt.
BCR – 11	Magdiwang Realty Corp.	152	17	1	6	6	700	Qal. Qt.
CTA – 19	San Juan	213	31	6	13	2.2	255	Qal. Qt.
IMS – 3	Topacio	244	15	15	18	1.2	100	Qal. Qt.
LPS – 37	Naga Rd. # 1	306	43	36	10	0.3	28	Qal. Qt.
LPS – 48	General Motors Inc. # 1	305	43	36	10	0.3	28	Qal. Qt.
LPS – 64	Las Piñas Elem. School	228	37	10	21	2.1	243	Qal. Qt.
MKT – 11	Cambridge Circle F. Park	306	17	31	32	1	118	GS
MKT – 12	Kayamanan "O"	310	14	19	32	1.7	212	GS
MKT – 18	Ayala # 21	263	15	19	30	1.6	189	GS
MKT – 23	Ayala # 26	214	11	15	36	2.4	275	GS
MKT – 25	Ayala # 28	206	10	25	30	1.2	120	GS
MKT – 31	Ayala # 31	201	9	33	11	0.3	50	GS
MKT – 33	Ayala # 36	310	35	44	6	0.1	20	GS
MKT – 46	Bank of America Bldg.	305	18	42	7	0.2	32	GS
MKT – 48	China Banking Corporation	274	25	53	9	0.2	22	GS
MKT – 67	Peninsula Hotel	305	45	29	7	0.2	30	GS
MKT – 122	Banaba Circle	204	20	17	9	0.5	70	GS
MKT – 136	Eastern Telecom	305	50	30	33	1.1	135	GS
MLB – 20	Brgy. Catmon	263	82	35	5	0.1	21	Qal. Qt.
MLB – 32	Bo. Dampalit	233	31	52	8	0.2	25	Qal. Qt.
MLB – 57	MWSS Niugan	305	20	61	13	0.2	22	Qal. Qt.
MDL – 10	National Mental Hospital	201	31	20	11	0.5	65	Qal. Qt.
MNL – 101	F.E.U.	305	8	75	4	0.1	9	Qal. Qt.
MRK – 3	Industrial Valley	178	39	12	13	1.1	120	Qal. Qt.
MTL – 1	Bliss Project	305	11	105	12	0.1	12	Qal. GS
MTL – 7	CDCP Sucat Interchange	152	15	7	4	0.6	68	Qal. GS
MTL – 8	Ford Philippines	305	43	90	7	0.1	13	Qal. GS
MTL – 22	Tahanan Village # 3	305	24	51	15	0.3	40	Qal. GS
MTL – 23	Tahanan Village # 1	215	24	33	17	0.5	70	Qal. GS
MTL – 27	Ayala Corp. Well B	305	13	110	33	0.3	31	Qal. GS
MTL – 44	Pacific Multi Homes Inc.	305	50	24	20	0.8	110	Qal. GS
MTL – 59	International Textile	363	37	85	11	0.1	13	Qal. GS
MTL – 69	PECCO	249	7	29	24	0.8	105	Qal. GS
MTL – 91	Ayala # 12	305	52	67	19	0.3	40	Qal. GS
NAV – 3	NHA # 4	244	20	33	11	0.3	45	Qal. GS
NAV – 4	NHA # 5	277	76	24	7	0.3	38	Qal. GS
NAV – 8	NHA # 3	305	8	45	10	0.2	30	Qal. GS
NAV – 17	Merville, Tanza	305	92	28	7	0.3	30	Qal. GS
PRN – 8	Gelmart Inc.	244	52	43	22	0.5	61	Qal. GS
PRN – 14	Standard Elec. Mfg.	230	72	37	5	0.1	13	Qal. GS
PRN – 20	Naga Road # 2	244	32	9	15	1.6	197	Qal. GS
PRN – 66	Packaging Product # 2	274	42	36	10	0.3	35	Qal. GS
PRN – 74	Bo. San Dionisio	181	26	47	21	0.4	55	Qal. GS
PRN – 78	MIA # 2	256	29	44	20	0.5	65	Qal. GS
PRN – 77	MIA # 1	256	28	19	21	1.1	135	Qal. GS
PRN – 135	Johnson & Johnson	244	42	14	12	0.9	105	Qal. GS
PSC – 44	Manila Sanitarium	305	81	27	4	0.1	9	Qal. GS
PSC – 49	Maricaban	244	44	25	15	0.6	81	Qal. GS
PSC – 55	Nayong Kabataan # 1	152	11	11	3	0.3	33	Qal. GS
PSG – 12	Meralco	366	37	26	11	0.4	47	Qal. GS
QCT – 65	ABS-CBN # 2	122	40	17	3	0.2	22	Qal. GP
QCT – 86	Capital Hills Golf Club # 1	171	37	10	12	1.2	130	Qal. GP
QCT – 121	Veterans Hospital # 1	290	25	43	14	0.3	45	GS. GP
QCT – 122	Veteran Hospital # 2	271	31	13	15	1.2	135	GS. GP
QCT – 195	Constitution Hill # 1	274	16	67	15	0.2	30	GS. GP
QCT – 250	Poblacion Novaliches	244	26	15	14	0.9	109	GS. GP
QCT – 251	Bo. Bagbag	200	35	26	14	0.5	63	GS. GP
QCT – 257	Project 8, Congressional	274	101	12	11	0.9	110	GS. GP
QCT – 269	Bo. Escopa Proj. 4	274	85	20	13	0.7	100	GS. GP
QCT – 276	D. Tuazon Pumping Station	244	11	59	8	0.1	15	GS. GP
QCT – 277	D. Tuazon Elem. School	244	11	104	8	0.1	8	GS. GP
QCT – 330	Constitution Hill # 4	305	56	27	12	0.4	45	GS. GP
SJN – 6	Bo. Once, San Juan	220	5	49	12	0.2	29	GS. GP

MWSS No.	OWNER	DEPTH (m)	SWL (m)	DRAWDOWN (m)	TEST PUMPING RATE l/s	SPECIFIC CAPACITY l/s/m	TRANSMISSIVITY m^2/d	AQUIFER TRAPPED
SMT – 2	Bo. Ampid	152	6	12	35	2.9	365	Qal. Qt.
SMT – 3	Bo. Malanday	183	12	24	14	0.6	70	Qal. Qt.
SMT – 4	Bo. Maly	208	12	54	14	0.3	40	Qal. Qt.
TGG – 16	Triumph Builders	213	34	68	6	0.1	10	Qal. Qt.
TGG – 18	Tuktukan	183	20	25	17	0.7	87	Qal. Qt.
TGG – 19	Maharlika Village	183	29	33	19	0.6	70	Qal. Qt.
TGG – 24	Bicutan Military	183	21	5	13	2.6	320	Qal. Qt.
TGG – 48	Century Canning	244	50	51	11	0.2	30	Qal. Qt.
TGG – 32	Mrs. Betina de Leon	152	28	20	8	0.4	51	Qal. Qt.
TYY – 10	Bo. San Isidro	179	26	7	40	5.7	700	Qal. GS
TYY – 11	Sta. Ana	153	27	6	16	2.7	330	Qal. GS
VLZ – 18	Bo. Marulas	305	128	16	5	0.3	38	Qal. GS
VLZ – 37	Tamarraw Hills	305	95	53	6	0.1	13	Qal. GS
VLZ – 106	Isla Valenzuela	274	38	61	9	0.1	14	Qal. GS

— 1981 現在 —

(14) キャビテ市における地下水の塩分変化状況表

CHLORIDE CONTENT OF GROUND WATER AT CAVITE CITY, 1980-1981

Well	1980					1981					
	8-15	9-1	10-1	11-19	12-12	1-20	2-24	3-25	4-29	6-1	6-26	7-30
MWSS No. 1	490		385	415	450		450	455	455	393	454	545
MWSS No. 2	180	150	140	170	120	120	150	182	152	128	159	159
MWSS No. 3	85	60	60	65		53	38	30	30			68
MWSS No. 4	240	210	185	220	220	220	240	364	212	303	272	303
MWSS No. 5	455	355	340	375	360	390	450	394	394	394	424	454
MWSS No. 6	85	55	70	90	90	90	45	30	30	45	53	60
MWSS No. 7									333			
MWSS No. 8	90									68		
MWSS No. 9	125	110								45		
MWSS No. 10	75	65	65	85	45	45	53	38	45	45	68	75
MWSS No. 11	70					45				45		
MWSS No. 12	355	95	85	115	115	83	120	60	61	61	98	106
MWSS No. 13	55					53						
MWSS No. 14	200					128						
MWSS No. 15	45		40			45						
MWSS No. 16	165					23						
MWSS No. 17	80					30						
MWSS No. 18	40	50	40		60	38	60	45	30	45	38	53
MWSS No. 19	60	47	45	50	50	45	45	38	45	53	53	60
Sangley Pt. No. 1				70			45	31	23	38	32	53
Sangley Pt. No. 2	300	310					510	364	30	333		364
Sangley Pt. No. 3	560	500	550	585	450	600	510	515	333	545	575	4,484
Sangley Pt. No. 4	115	105	100	80	90	90	90	68	68	76	106	113
Sangley Pt. No. 5	115	105	100	115	120	90	120	83	68	83	91	113
Sangley Pt. No. 6	135	140					180	114	106	98	136	174
Sangley Pt. No. 7	115	100	100	110	67	90	82	83	60	83	91	151
Ft. San Felipe 1A												1,605
Ft. San Felipe 1	500	450	585	350	510	510	510	606	545	666	547	666
Ft. San Felipe 2	532	725	750	715	900	810	780	606	727	727	788	878
Ft. San Felipe 3	780	750					690	818	697	817	909	909
Ft. San Felipe 4	305	250	120	145	180	120	150	76	114	90	91	129
Ft. San Felipe 5				695	480	510	750	515	758	878	939	1,181

(15) Chemical Analysis

PERFORMED BY METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM

WELL NO.	WELL NAME	DATE 1981	LAB No	pH	ACIDITY mg/l	FREE CO_2 mg/l	ALKALINITY mg/l	BICARBONATES mg/l	CHLORIDE mg/l	HARDNESS mg/l	TOTAL IRON mg/l	TOTAL SOLIDS mg/l	SILICA mg/l	R_2O_3 mg/l	ALUMINUM mg/l	SULFATE mg/l	CALCIUM mg/l	MAGNESIUM mg/l	TOTAL HARDNESS mg/l	FLOURIDE mg/l
TGG 83	Process Chem	1-2	VI	7.90	NIL	NIL	268	327	26	96	0.14	410	73.60	50	26.35	56	26	8	96	0.04
TGG 84	Vernal, Inc.	1-2	VII	7.40	4	3.52	224	273	10	106	0.08	334	53.60	22.40	11.79	87	27	9	105	0.06
TGG 89	Pan Phil. Alloys Mktg.Corp.	1-2	VIII	7.50	4	3.52	148	181	460	226	0.16	1,235	55.20	40.40	21.25	200	72	11	225	0.00
TGG 87	Jubric Canning Corp.	1-2	IX	7.70	8	7.04	298	364	17	80	0.10	422	82	2.80	1.41	55	21	7	80	0.06
TGG 77	Filipro	1-2	X	8.10	NIL	NIL	206	349	13	114	0.08	411	78.00	1.60	0.79	65	29	10	113	NIL
TGG 78	Maritex	1-2	XI	7.95	NIL	NIL	232	259	16	134	0.10	370	62	5.20	2.68	47	26	15	153	0.07
TGG 85	Panelon Phil. Inc.	1-2	XII	7.70	8	7.04	204	245	15	108	0.10	318	70.40	3.20	1.62	31	26	11	100	0.00
TGG105	Panell Comm'l. Co., Inc.	1-2	XIII	7.35	30	26.40	238	290	10	120	0.06	336	44.80	5.60	2.92	31	27	14	127	0.04
TGG 86	Armel	1-2	XIV	8.10	NIL	NIL	122	137	446	138	0.14	1,211	47.60	6.40	3.28	205	51	2	138	0.06
PSC 50	U.S. Sea Front, Roxas Blvd.	1-2	XV	7.70	6	5.28	260	317	188	28	0.40	626	55.60	17.20	8.80	194	6	3	28	0.00
MNL 18	Ermita Center, Roxas Blvd.	1-2	XVI	7.50	10	8.80	230	280	685	88	0.18	1,371	70.80	21.60	11.20	101	24	7	89	0.05
MNL146	R. Magsaysay Center Roxas Boulevard	1-2	XVII	7.25	36	31.68	170	207	12,000	3,470	0.20	18,481	150	94.40	49.87	345	1,076	223	3,455	NIL
PSC 42	Asian Development Bank Roxas Boulevard	1-2	XVIII	7.30	40	35.20	454	554	8,600	2,520	0.20	14,343	171.60	94.80	50.07	810	274	274	2,500	0.02
MLB101	Bo. Tanza	1-5		7.20	76	67	294	358	7,000	844	0.35	7,996	87	253	134	38	208	76	839	NIL
MLB102	Armando Cruz Ice Plant	1-5		7.30	4	3.52	60	83	900	168	0.10	1,673	49	12	6.49	26	54	8	167	0.14
MLB105	Rufina Patis, Arellano St.	1-5	III	7.20	10	8.80	118	144	670	235	0.08	2,281	70	612	324	92	80	8	234	0.16
MLB 32	MWSS, Dampalit	1-5	IV	7.70	4	3.52	106	129	250	30	0.08	550	28	10	5.27	47	10	1	30	0.18
VLZ121	Dr. Tan, Obando	1-5	V	8.50	NIL	NIL	138	143	20	8	0.07	226	63	8	4.18	39	2	1	8	0.00
VLZ 53	Panghulo, Obando	1-5	VI	8.30	NIL	NIL	184	200	20	8	0.06	241	56	6.00	3.55	27	2	1	8	0.50
VLZ 81	Pag-asa, Obando	1-5	VII	7.90	NIL	NIL	152	171	245	36	0.08	555	60	8.80	4.60	43	12	1	36	0.18
VLZ 52	Pallvas Market	1-5	VIII	8.50	NIL	NIL	164	176	10	10	0.00	222	32	18	9.46	20	3	0.5	10	0.40
VLZ 51	Paco, Obando Pump #1	1-5	IX	8.50	NIL	NIL	154	154	45	10	0.08	294	25	8.00	4.60	45	2	1	10	0.14
VLZ 84	Paco, Obando Pump #2	1-5	X	7.90	NIL	NIL	152	132	46	10	0.10	294	22	4.40	2.25	48	2	1	10	0.16
VLZ 97	Hulo #2	1-5	XI	8.40	NIL	NIL	138	105	145	20	0.10	384	32	11	5.43	39	6	1	19	0.12
MLB 76	Silver Swan, Pump #1	1-5	XII	8	NIL	NIL	166	164	1,100	340	0.10	2,206	82	14	7.33	168	64	43	330	0.16
VLZ 76	Puzon Industries Pulang Lupa	1-5	XIII	7.50	NIL	NIL	234	242	7	10	0.06	271	34	2.40	1.20	64	2	1	10	0.08

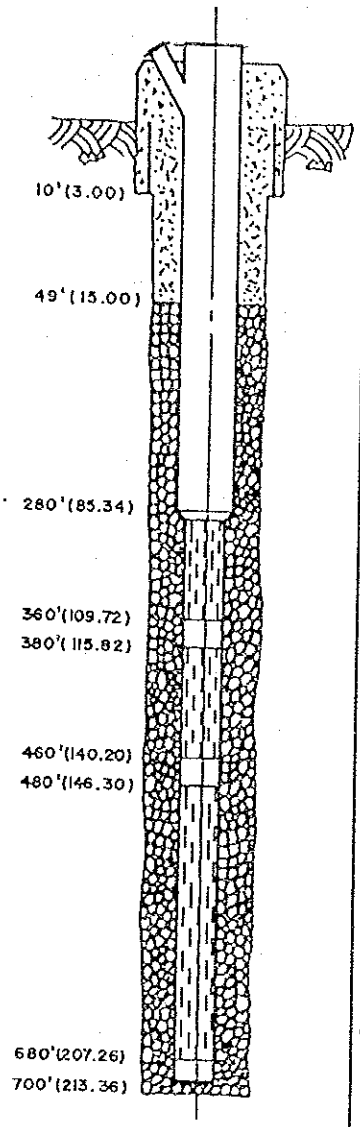
(16) MWSS WELL (1)

WELL NO. TGG-97

WELL CONSTRUCTION SUMMARY

LOCATION: UPPER BICUTAN, TAGUIG, METRO MANILA

DRILLING CONTRACTOR: (NIA) NATIONAL IRRIGATION ADMINISTRATION



DRILLING SUMMARY:

TOTAL DEPTH 700' (213.36)

BOREHOLE DIAMETER 16"Ø

DRILLER NATIONAL IRRIGATION ADMINISTRATION

RIG DIAMANT BOART (BELGIUM)

BIT(S) 29"Ø FISHTAIL BIT, 12 1/4"Ø ROCK BIT, 16"Ø REAMED BIT.

DRILLING FLUID PREMIUM-GEL

SURFACE CASING 24"ØX3m.

WELL DESIGN:

BASIS: GEOLOGIC LOG ✓ GEOPHYSICAL LOG ✓

CASING-STRING(S) C= CASING			S= SCREEN		
0	280'	10"Ø	280'	360'	8"Ø
360'	380'	8"Ø	380'	460'	8"Ø
460'	480'	8"Ø	480'	680'	8"Ø
680'	700'	8"Ø			

CASING:
280'=10"Ø BLANK CASING
60'= 8"Ø BLANK CASNG

SCREEN:
360'=8"Ø PERFORATED CASING

CENTRALIZERS: EVERY 40' OF THE INSTALLED CASING.

FILTER MATERIAL 841 CANS OF GRAVEL PACKED

CEMENT (NOTE) CONTINOUS GRAVEL PACKED

OTHER: 10 BAGS SODIUM-HEXAMETA PHOSPHATE WAS APPLIED PRIOR TO WELL DEVELOPING.

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING:				
SURFACE CASNG	12-3-80		1-14-80	
PLOT BORE	1-16-80		2-13-80	
REAMING	2-22-80		3-19-80	
GEOPHYS. LOGGING:	2-20-80		2-21-80	
CASING: (24"ØX3m.)				
SURFACE CASING	1-15-80		1-15-80	
10"ØX280', 8"ØX420'	3-20-80		3-20-80	
FILTER PLACEMENT	3-20-80		4-10-80	
CEMENTING:				
DEVELOPMENT:	4-17-80		6-9-80	
OTHER:				
DEV. BY PUMPING	JAN. 19-20-1981		FINAL	
TEST.				
PUMPING	JAN. 22,'81		10:15 A.M.)	
	JAN. 25,'81		10:15 A.M.)	
RECOVERY TEST	JAN 25, 81			

WELL DEVELOPMENT:

SURGING & BAILING = 48 HRS.
AIR SURGING (COMPRESSOR) = 24 HRS.
WELL DEV. BY PUMPING = 24 HRS.
FINAL TEST PUMPING = 72 HRS.
168 HRS.

WATER LEVELS:

SWL 190'
PWL 375' AT 181' GPM (L/S)
AFTER 72 HOURS

COMMENTS:

WELL DELOPING AND FINAL TEST PUMPING WAS PERFORMED BY PACHECO DRILLING TO THE REASON THAT THE PUMPING UNIT (TURBINE PUMP) OWNED BY NIA IS NOT APPLICABLE DURING THE TESTING CONDUCTED THERE AT.

ROMULO M. LIBO-ON
PROJECT ENGINEER
MWSS-OMP-GWSP

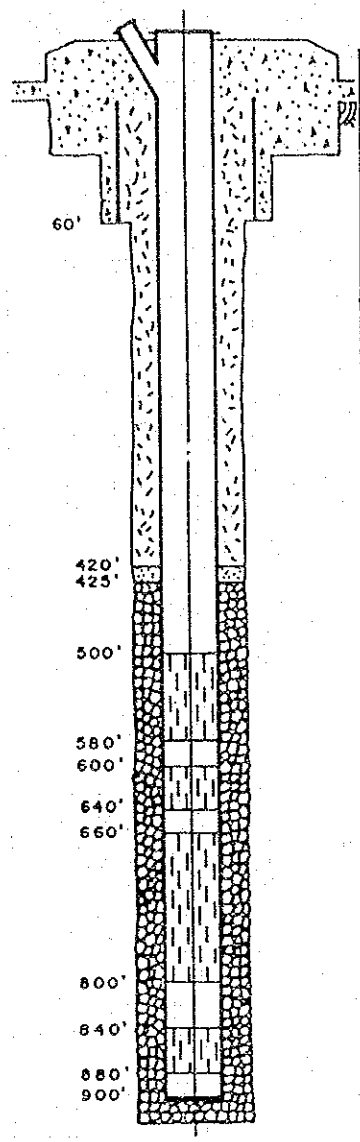
(17) MWSS WELL (2)

WELL NO. BCR-4

WELL CONSTRUCTION SUMMARY

LOCATION: BO. NIOG, BACOOR, CAVITE

DRILLING CONTRACTOR: CONDRILL CONTINENTAL WELL DRILLING



DRILLING SUMMARY:

TOTAL DEPTH 900'

BOREHOLE DIAMETER 18" Ø

DRILLER (CONDRILL) CONTINENTAL WELL DRILLING

RIG ROTARY

BIT(S) 8½"Ø, 18"Ø, 24"Ø

DRILLING FLUID AQUA GEL

SURFACE CASING 20"Ø X 60'

WELL DESIGN:

BASIS: GEOLOGIC LOG ✓ GEOPHYSICAL LOG ✓

CASING-STRING(S) C=CASING S= SCREEN

0	-	500'	C	500'	- 580' S
580'	-	600'	S	600'	- 640' S
640'	-	660'	S	660'	- 800' S
800'	-	840'	S	840'	- 880' S
880'	-	900'	S		-
	-				-
	-				-
	-				-

CASING: 600'=10"Ø BLANK CASING

SCREEN: 300'=10"Ø PERFORATED CASING.

CENTRALIZERS: TO EVERY 40' OF THE INSTALLED CASING.

FILTER MATERIAL 638 CANS OF 20 LITERS CONTENT; GRADED GRAVEL.

CEMENT 396 BAGS OF CEMENT.

OTHER: 2376 GALS. OF WATER. 12 BAGS BENTONITE 33 BAGS OF CEMENT

GROUTED TO CONDUCTOR PIPE ANNULAR SPACE

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING:				
8½"Ø BIT	1-23-80		2-7-80	
18"Ø BIT	2-9-80		2-14-80	
GEOPHYS. LOGGING:				
CASING:				
20"Ø X 60'	1-25-80	8:00PM	1-25-80	3:00 PM
10"Ø X 900'	3-5-80	12:00 PM	3-6-80	1:30 AM
FILTER PLACEMENT:	3-6-80		3-11-80	
CEMENTING:	3-13-80	4:00PM	3-13-80	11:00 PM
DEVELOPMENT:	3-25-80		4-15-80	
OTHER:				

WELL DEVELOPMENT:

SURGING/BAILING = 3-25-80 ; 4-1-80 29 HRS.

DEV. BY COMPRESSOR & AIR LIFTING = 3-29-80 ; 4-1-80 24 HRS.

DEV. BY PUMPING = 4-10-80 ; 4-15-80 64 HRS.

WATER LEVELS:

SWL 127'

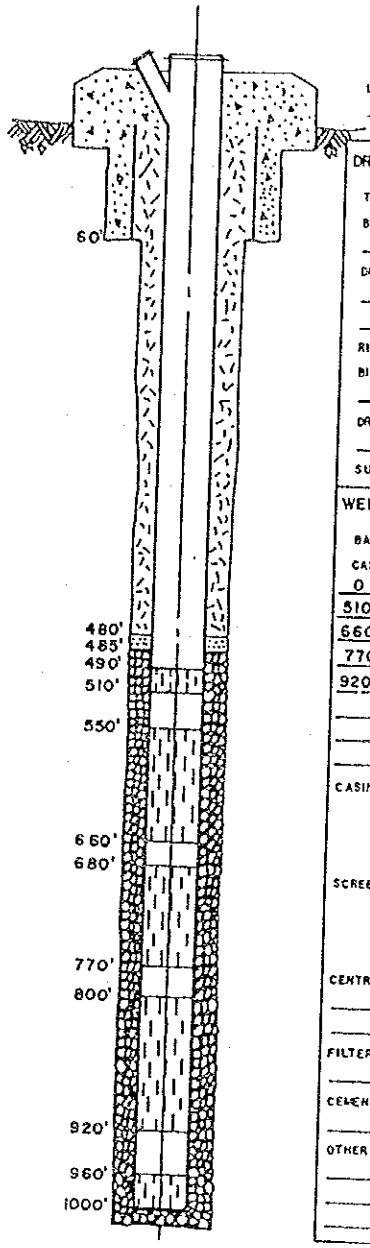
PWL 176' AT 500 GPM (l/s) AFTER 24 HOURS

COMMENTS:

AFTER THE CONDUCTION OF PUMPING TEST, DRAWDOWN IS 49 FT. ONLY AND THEREFORE THE WELL MAY PRODUCE 600 GPM. WITH P.W.L. = 180' DEPTH.

ROMULO M. LIBO-ON
PROJECT ENGINEER
MWSS-DSP-GWSP

(18) MWSS WELL (3)



WELL NO. VLZ-106

WELL CONSTRUCTION SUMMARY

LOCATION: BRGY. ISLA, VALENZUELA METRO MANILA

DRILLING CONTRACTOR: GOLDWATER DRILLING & MACHINERY CORPORATION

DRILLING SUMMARY:

TOTAL DEPTH 1000 FEET
BOREHOLE DIAMETER 16"Ø
DRILLER GOLDWATER DRILLING & MACHINERY CORPORATION
RIG PORTADRILL
BIT(S) 24"Ø; 9 7/8"Ø; 16"Ø
DRILLING FLUID PREMUIM GEL / QUICK GEL
SURFACE CASING 18"Ø X 60'

WELL DESIGN:

BASIS: GEOLOGIC LOG ___ GEOPHYSICAL LOG ___

CASING-STRING SIZE & CASING				SCREEN			
0	- 490'	8"Ø		490'	- 510'	8"Ø	
510'	- 550'	8"Ø		550'	- 660'	8"Ø	
660'	- 680'	8"Ø		680'	- 770'	8"Ø	
770'	- 800'	8"Ø		800'	- 920'	8"Ø	
920'	- 960'	8"Ø		960'	- 1000'	8"Ø	
	-				-		
	-				-		
	-				-		

CASING: 680' = 8"Ø BLANK CASING

SCREEN: 380' = 8"Ø PERFORATED CASING

CENTRALIZERS:

FILTER MATERIAL GRAVEL PACKING SATISFACTORY
CEMENT SATISFACTORY
OTHER:

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING: SURFACE CASING	4-24-80		5-16-80	
PILOT BORE	5-21-80		5-29-80	
REAMING	6-2-80		6-7-81	
GEOPHYS. LOGGING:	MAY 29	9:00 PM	MAY 31	2:00 PM
CASING:				
FILTER PLACEMENT:				
CEMENTING:				
DEVELOPMENT:	1-15-81		1-22-81	
OTHER: DEVELOPING BY SURGING/JETTING BAILING = 24 HRS.				

WELL DEVELOPMENT:

SURGING/JETTING - 24 HRS.
DEV. BY PUMPING - 32 HRS.
FINAL TEST PUMPING-68 HRS.
124 HRS.

WATER LEVELS: AFTER: SURGING/JETTING / PUMPING DEV.

SWL 100/138/126
PWL 324' AT 137 GPM (l/s)
AFTER 68 HOURS

COMMENTS:

20 HP SUBMERSIBLE WAS USED DURING DEVELOPING BY PUMPING / TEST PUMPING
LOST DRILL BIT WITH COLLAR WAS RECOVERED.
FOUND ABANDONED WELL NEAR THE NEWLY CONSTRUCTED WELL.

ROMULO M. LIBO-ON
PROJECT ENGINEER
MWSS-OSP-OWSP

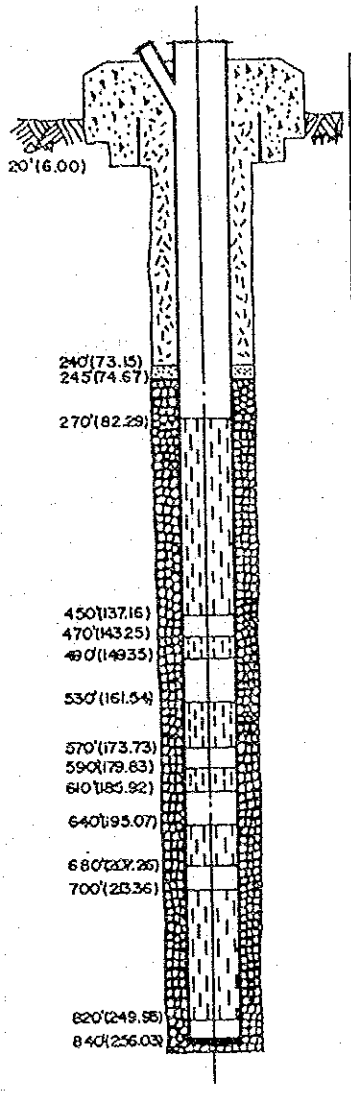
(19) MWSS WELL (4)

WELL NO. PRN-78

WELL CONSTRUCTION SUMMARY

LOCATION: MIA COMPLEX, PARAÑAQUE METRO MANILA

DRILLING CONTRACTOR: (NIA) NATIONAL IRRIGATION ADMINISTRATION



DRILLING SUMMARY:

TOTAL DEPTH: 256 m. = 840'

BOREHOLE DIAMETER: 18"Ø & 22"Ø FOR PUMP CHAMBER

DRILLER: (NIA) NATIONAL IRRIGATION ADMINISTRATION

RIG: DIAMANT BOART (BELGIUM)

BIT(S): 28"Ø FISHTAIL, 9⅞"Ø ROCK BIT, 22"Ø ROCK BIT & 18"Ø REAMED.

DRILLING FLUID: PREMIUM GEL

SURFACE CASING: 24"Ø X 20'

WELL DESIGN:

BASIS: GEOLOGIC LOG ✓ GEOPHYSICAL LOG ✓

CASING-STRING(S) & CASING			SCREEN		
0 m.	82.29	13⅜"Ø	82.29	137.16	10"Ø
137.16	143.25	10"Ø	143.25	149.35	10"Ø
149.35	161.54	10"Ø	161.54	173.73	10"Ø
173.73	179.83	10"Ø	179.83	185.92	10"Ø
185.92	195.07	10"Ø	195.07	207.26	10"Ø
207.26	213.36	10"Ø	213.36	249.93	10"Ø
249.93	256.03	10"Ø			

CASING: 420'= 127 m BLANK CASING

SCREEN: 420'=127m PERFORATED CASING

CENTRALIZERS: EVERY 30' OF THE PERFORATED CASING

FILTER MATERIAL: 770 CANS OF GRAVEL

CEMENT: 290 BAGS OF CEMENT

OTHER: 350 CANS OF WATER 8.5 BENTONITE BAGS.

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING:				
FOR SURFACE CASING	6-13-80		6-16-80	
PILOT BORE	6-19-80		7-1-80	
REAMING	7-13-80		7-27-80	
GEOPHYS. LOGGING:	7-2-80		7-2-80	
CASING:				
10"Ø X 173.74 m.	6-3-80	12:45 PM	6-4-80	6:46 AM
13⅜"Ø X 82.29 m	6-4-80	7:00 AM	6-4-80	1:10 PM
24"Ø X 20'	6-17-80		6-17-80	
FILTER PLACEMENT	6-4-80	4:30 PM	6-5-80	10:03 PM
	6-7-80	9:05 AM	6-7-80	3:02 PM
CEMENTING:				
DEVELOPMENT:	6-11-80	9:00 AM	6-20-80	4:45 PM
OTHER:				
FINAL TEST PUMPING	6-21-80	11:00 AM	6-24-80	11:40 AM
RECOVERY TEST	6-24-80	11:40 AM	6-26-80	7:40 AM

WELL DEVELOPMENT:

SURGING & BAILING = 48 HRS.
AIR COMPRESSION = 24 HRS.
DEV. BY PUMPING = 24 HRS.
FINAL TEST PUMPING = 72 HRS.
TOTAL: 168 HRS.

WATER LEVELS:

SWL 29 m.
PWL 44.94 m. AT 318 GPM (U/S) AFTER 72 HOURS

COMMENTS:

ROMULO M. LIBO-ON
PROJECT ENGINEER
MWSS-OSP-GWSP

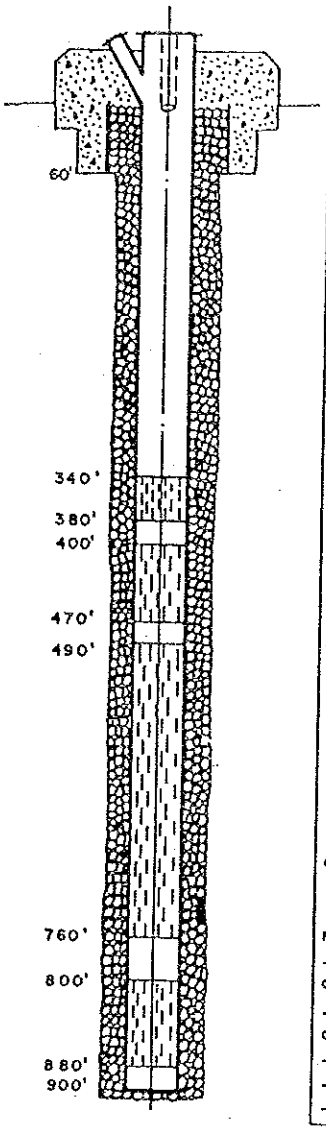
(20) MWSS WELL (5)

WELL NO. MKT-128

WELL CONSTRUCTION SUMMARY

LOCATION: POBLACION ELEM. SCHOOL MAKATI, METRO MANILA

DRILLING CONTRACTOR: LOPEZ/SHAMROCK WELL DRILLING



DRILLING SUMMARY:

TOTAL DEPTH 900'

BOREHOLE DIAMETER 18"Ø

DRILLER LOPEZ/SHAMROCK WELL DRILLING

RIG (FAILING) ROTARY RIG SERIES 1500

BIT(S) 9⅞"Ø, 18"Ø, 24"Ø

DRILLING FLUID PREMIUM GEL

SURFACE CASING 20"Ø X 60'

WELL DESIGN:

BASIS: GEOLOGIC LOG ___ GEOPHYSICAL LOG ___

CASING-STRING(S) C+CASING			S+ SCREEN		
0	340'	10"Ø	340'	380'	10"Ø
380'	400'	10"Ø	400'	470'	10"Ø
470'	490'	10"Ø	490'	760'	10"Ø
760'	800'	10"Ø	800'	880'	10"Ø
880'	900'	10"Ø			

CASING: 440'+10"Ø BLANK CASING

SCREEN: 460'+10"Ø PERFORATED CASING

CENTRALIZERS: 4 SETS; TO 800'; 680'; 580'; 490'.

FILTER MATERIAL 80.13% OF GRADED PEBBLES.

CEMENT NONE

OTHER: CONTINOUS GRAVEL PACKED WELL.

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING:				
24"Ø BIT	7-11-80		7-18-80	
9⅞"Ø BIT	5-21-80		6-29-80	
18"Ø BIT	7-1-80		7-15-80	
GEOPHYS. LOGGING:	7-1-80		7-1-80	
CASING:				
20"ØX60'	6-19-80		6-20-80	
10"ØX900'	7-25-80		7-26-80	
FILTER PLACEMENT:	7-27-80		7-28-80	
CEMENTING:				
DEVELOPMENT:	7-29-80		8-10-80	
OTHER:				

WELL DEVELOPMENT:

1.) WELL DEV. BY AIRLIFTING (COMPRESSOR)

2.) WELL DEV. BY PUMPING.

WATER LEVELS:

SWL 256'

PWL 419'5" AT 205 GPM (l/s) AFTER 48 HOURS

COMMENTS:

ROMULO M. LIBO-ON
PROJECT ENGINEER
MWSS - OEP - GWSP

Republic of the Philippines
NATIONAL WATER RESOURCES COUNCIL
8TH Floor Nia Building E.D.S.A., Q.C.

SCHEME FOR LOCATION OF BOREHOLE

A Water Permit Application No.	B Drilling Permit No.	C National Ref. No.
D Water Permit No.	E Region Number	F Basin No. & Name

1a Present Owner Name and Address

1b Owners Number	2 Former Owner	
3 Local Number	4 Agency	5 Water Use Association

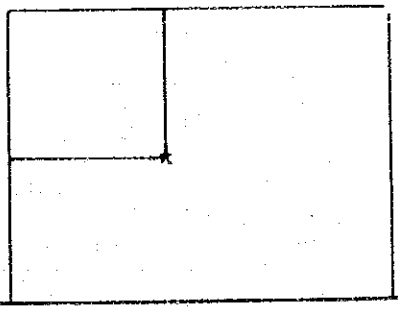
DATA	a TRANSFERRED FROM WELL LOG		b ON SITE GATHERED DATA		
6 Drilling Completed Date/By	a		b		18 Possibilities for Measuring Water Level YES NO
7 Casing Diameter	Metric	English	Metric	English	19 Ground Elevation M A B M.S.L.
	a		b		20 Measuring Point (MP) M A B G.R.
8 Drilling Depth	a		b		21 MP Elev. M A B M.S.L.
9 Water Level Depth B.GR.	a		b		22 Water Level Depth M A B M.P.
10 Discharge	a		b		23 Water Level Elev. M A B M.S.L.
11 Drawdown	a		b		24 Water Level S D
12 Type of Screen and Perforation	a		b		25 Sketch of Well Top with MP
13 Information Written By/Date			14 Type/HP of Pump		
26 Remarks			15 Water Analysis P C B		
			16 Use		
			17 Information Given by		

27 Well Point

Map No. _____

Scale: _____

Distances from the Edges of the Map in Millimeters



29 Sketch of Well Site

28 Coordinates

Long. _____

Lat. _____

30 Located Date

By:

㉑ ELECTROWATT 井戸台帳フォーム

(22) MWSS Wells and Turned-Over Wells 地区別井戸状況明細 (Oct. 9 '89)

Municipality : Antipolo, Rizal (*1)

コードNo.	Location	現状	完成年	深度m	管径cm	揚水量ℓ/s	備　考
APT-0	Saguinsin	Op				16.33	
-1	M.L. Quezon	〃		83.8	15	3.31	
-2	STO. Nino	〃		163.1	20	9.07	
-3	P. Burgos	〃		150.9	15	9.35	
-4	Nursery	〃			20	10.34	
-5	Circumferential	〃		151.8	15	3.43	
-6	Road to Teresa	〃		135.3	20	4.09	
-17	Cogeo No.3	In	1979		20	0.00	モーター故障
-18	Cogeo No.4	Op	1980		25	10.73	
-29	Cogeo No.1	〃	1976	91.0	15	2.05	S.W.L=108.00m 改修ずみ
-30	Cogeo No.2	〃		73.0	15	0.44	
-31	Cogeo No.5	〃		40.0	20	10.18	S.W.L=13.68m 改修ずみ
-54	Sumulong Elem. Sch.	〃	1981	183.0	20	16.12	
-73	San Isidred Elem. Sch,	〃	1981	177.0	20	20.35	
-101	Ang Tahanan	〃		213.0	25	18.26	
-102	Cogeo No.6	〃				3.58	
	小計 16井					137.63	
	(平均)	(15井)				(9.1ℓ/s)	

Municipality : Bacoor, Cavite （＊2）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
BCR-0	Combalay	Op				8.53	
-0	Central	〃				10.84	
-0	Balsahan	〃				11.76	
-1	Daang Bukid	〃	1978	108.2	15	10.12	
-2	Poblacion	〃	1978	129.5	25	3.67	
-3	Bo. Banalo	Ab	1978	243.8	25	0.00	
-4	Bo. Niog	Op	1980	274.3	25	12.34	
-5	Bo. Talaba	〃	1954	211.9	10	10.72	
	小計8井					67.98	
	(平均)	(7井)				(9.7ℓ/s)	

Municipality : Las Pinas （＊3）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
LPS-0	Poblacion	In				0.00	モーター故障
-37	No.1 Naga Road	Ab	1979	243.8	25	0.00	S.W.L : 11.00 m 廃止
-39	No.2 Naga Road	Op	1978	243.8	25	12.77	
-40	Pulang Lupa No.2	Ab	1940	152.4	15	0.00	
-54	Zapote	Op	1975	243.8	20	10.19	
-63	Manuyo	In		98.4	15	0.00	改修対象
-64	Las Pinas Elem Sch.	Ab	1980	288.6	25	0.00	
	小計7井					22.96	
	(平均)	(2井)				(11.5ℓ/s)	

Municipality : Malabon （*4）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
MLB-0	Panghulo	Sb		304.8	20	0.00	
-0	Dona Juana (Dampalit No.2)	Op				6.70	
-0	Santolan	Sb				0.00	モーター故障
-21	Catmon	Op	1979	268.2	20	2.56	改修対象
-31	Bo. Dampalit Old Well	Ab				0.00	セメント埋立
-32	Dampalit	Op	1977	233.0	20	2.04	
-40	No.4A Bo. Hulong Duhat	Ab	1978	304.8	25	0.00	セメント埋立
-41	No.5 Hulong Duhat	Ab	1977	304.8	45	0.00	セメント埋立
-57	Niogan	Op	1980	304.8	20	8.09	
	小計9井					19.39	
	(平均)	(4井)				(4.8ℓ/s)	

Municipality : Navotas （*5）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
NAB-5	NHA No.1	Op	1976	243.8	20	2.34	
-17	Tanza	Op	1980	304.8	20	4.28	
	小計2井					6.62	
	(平均)	(2井)				(3.31ℓ/s)	

Municipality : Paranaque （*6）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
PRN-19	Sucat Rd. No.1	Ab	1977	243.0	25	0.00	
-20	Sucat Rd. No.2	Op	1980	244.0	25	9.63	
-37	Sto. Nino	In	1977	57.7	20	0.00	高塩分
-73	La Huerta	In				0.00	〃
-78	M.I.A. No.2	In	1980	256.0	30	0.00	〃
-79	M.I.A. No.5	In	1980	256.0	25	0.00	〃
-80	M.I.A. No.6	In	1980	304.9	25	0.00	〃
-153	Sucat Rd. No.3	In	1981	176.8	20	0.00	S.W.L. : 28.15m モーター故障
	小計 8井					9.63	
	(平均)	(1井)				(9.6ℓ/s)	

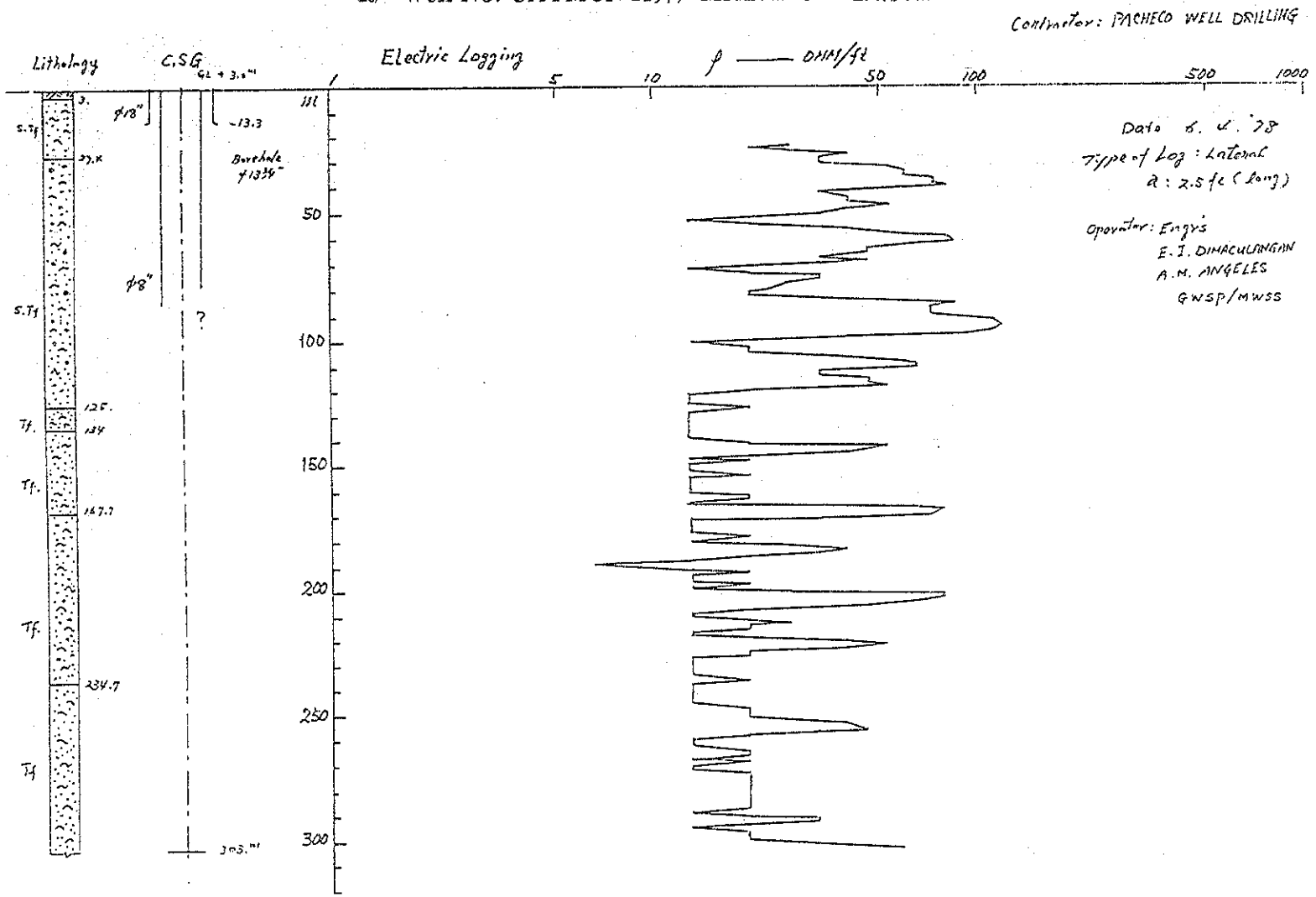
Municipality : Taguig （*7）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
TGG-17	Tipas	Ab	1976	63.7	20	0.00	廃止井
-18	Taktukan	In	1978	182.9	25	0.00	S.W.L. : 24.00m 改修対象
-19	Maharlika	In	1978	182.9		0.00	oper. By Muslim
-20	Ususan	In	1978	180.0	25	0.00	S.W.L. : 24.00m 改修対象
-95	Upper Bicutan	Op	1980	213.4	25	2.27	
-138	Signal Village I	In	1981	177.0	25	0.00	House Conn'tion
-139	Signal Village II	In	1981	171.0	25	0.00	House Conn'tion
	小計 7井					2.27	
	(平均)	(1井)				(2.3ℓ/s)	

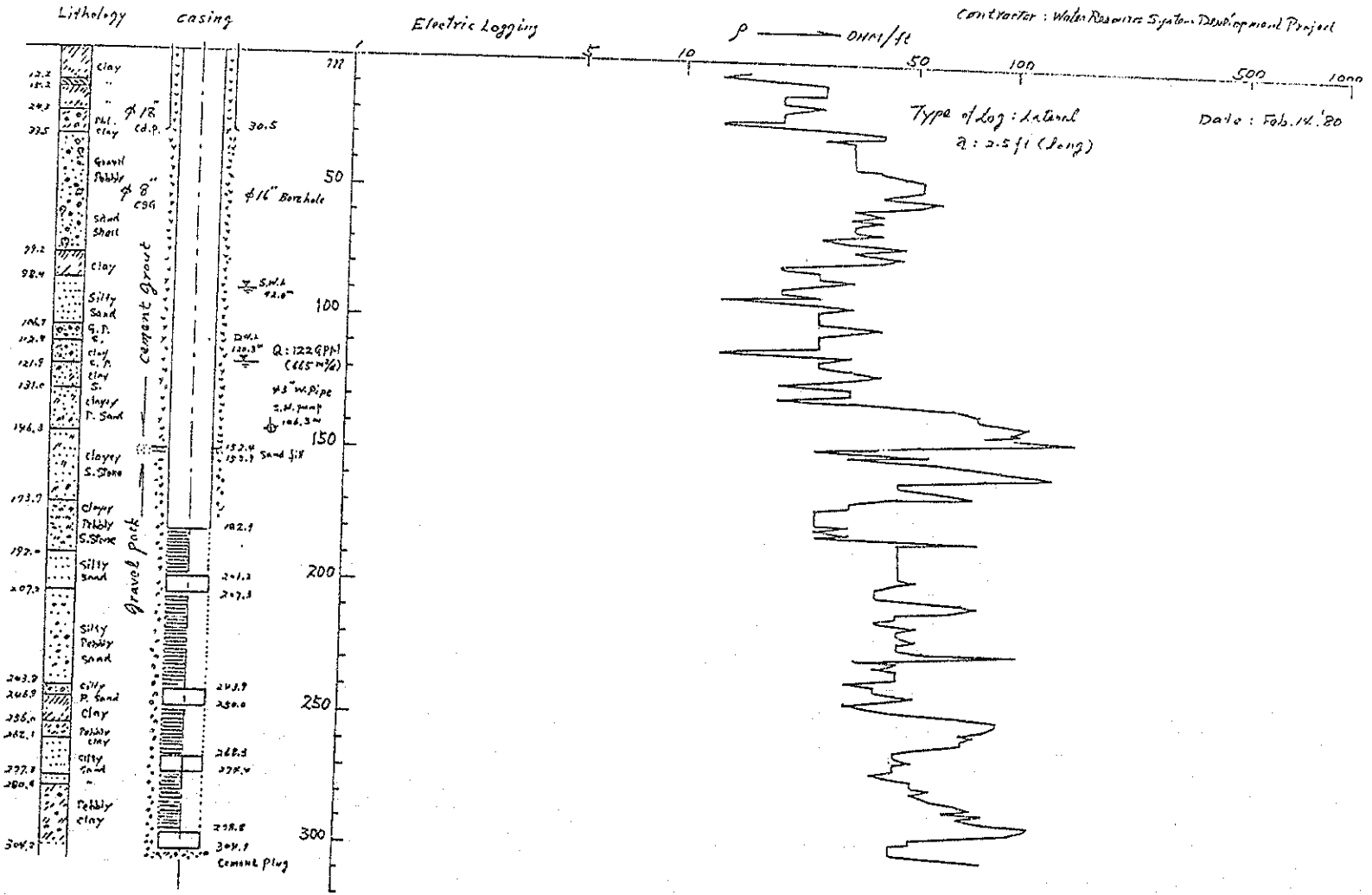
Municipality : Valenzuela （*8）

コードNo.	Location	現況	完成年	深度m	管径cm	揚水量ℓ/s	備　考
VLZ-0	Pasolo Elem. Sch.	Op				7.82	
-8	Constantino	Ab	1978	304.9		0.00	
-18	Marulas Elem. Sch.	In	1980	305.0		0.00	
-37	Tamaraw Hills	Ab	1978	305.0	25	0.00	
-125	T. De Leon	Op		213.4	10	4.31	
-212	Malinta	Ab		308.0		0.00	
-213	Arkong Bato	Op		305.0		6.03	
-215	Kadiwa Center (Malanday)	In		304.0		0.00	
	小計 8井					18.16	
	(平均)	(3井)				(6.1ℓ/s)	

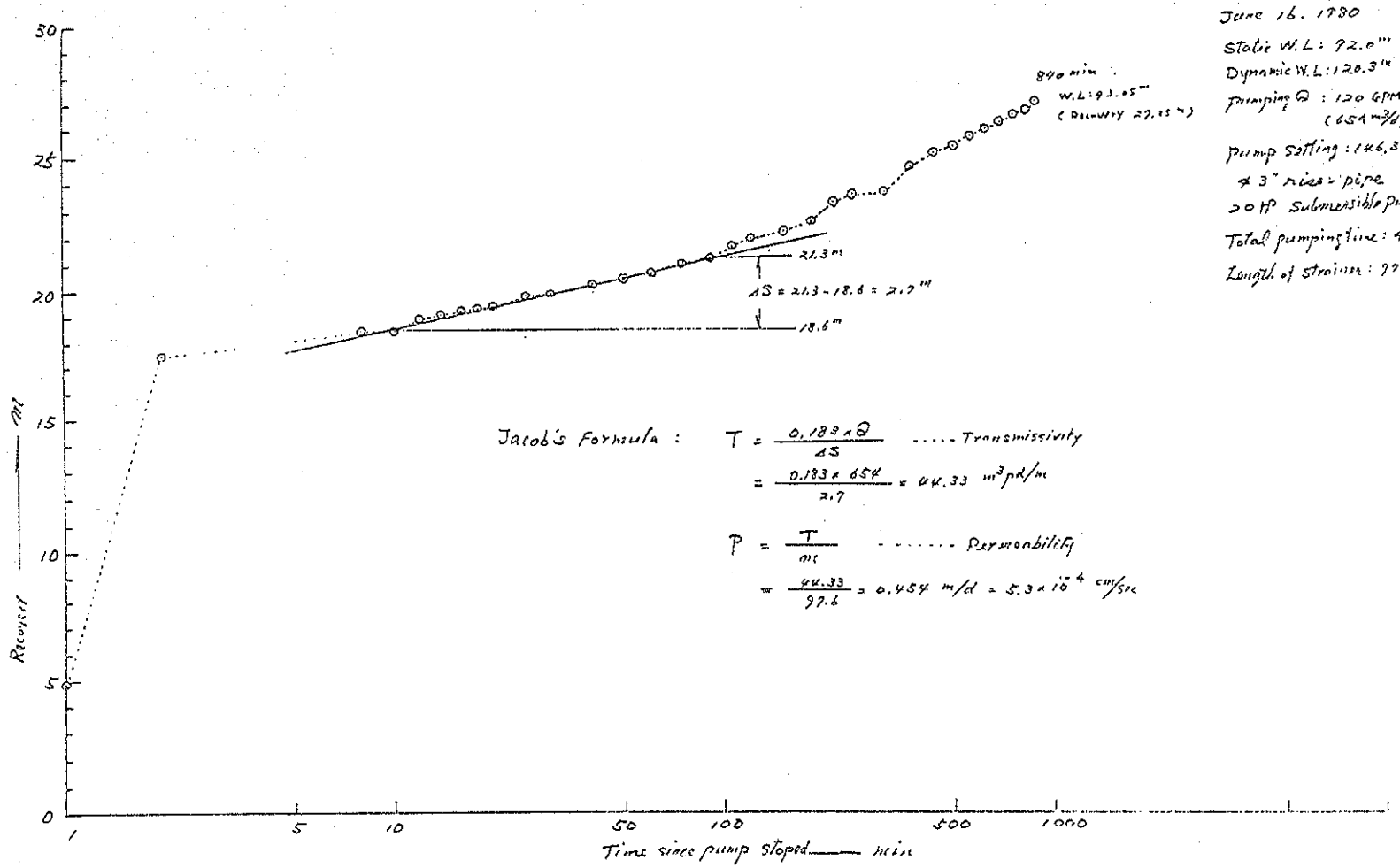
㉓ Well No. CATMON 21井, MALABON 電気検層図



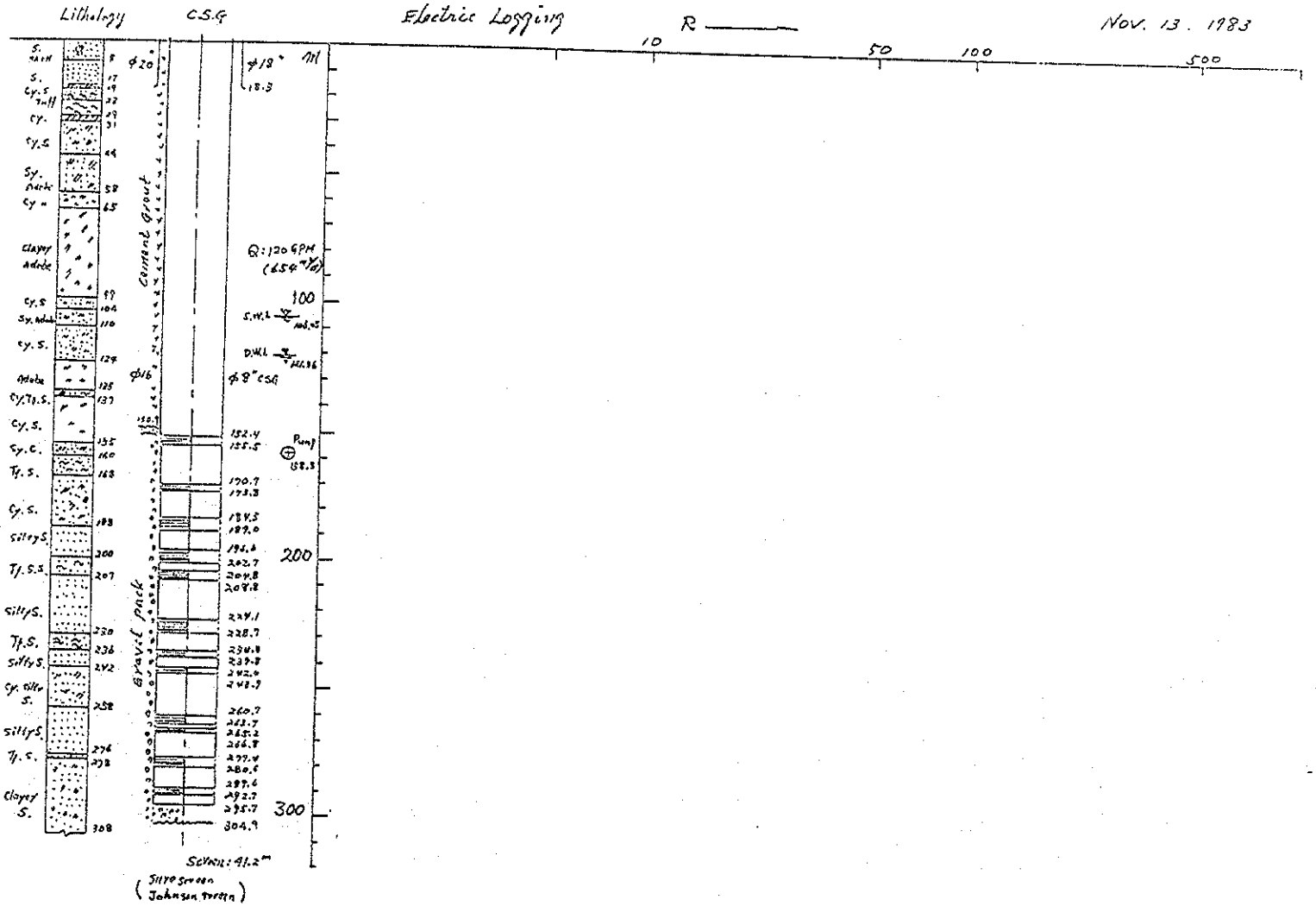
(24) Well No. Merville SUBD., NAVOTAS 電気検層図



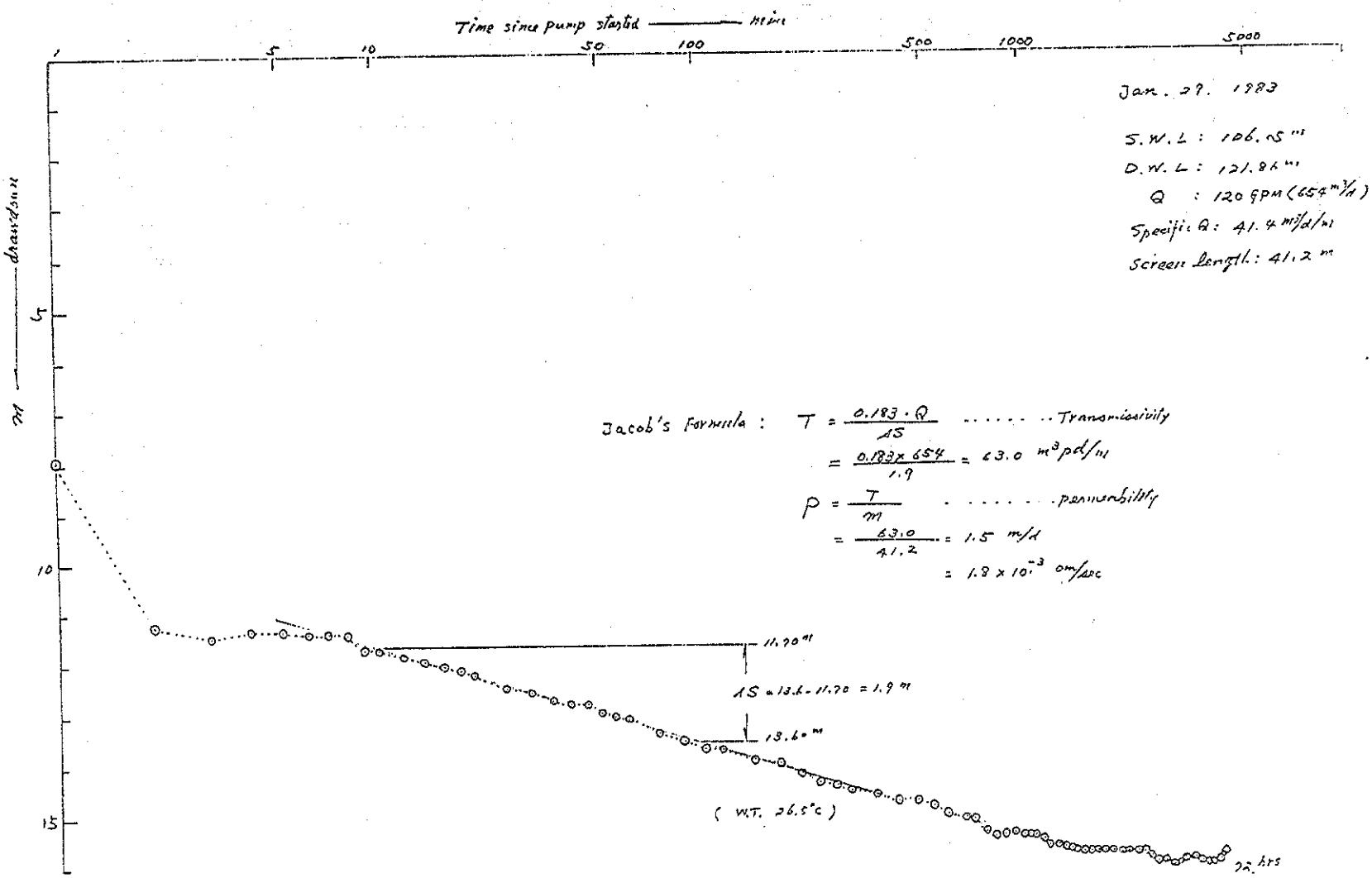
㉔－2　Well No. Merville SUBD., NAVOTAS 水位回復試験曲線



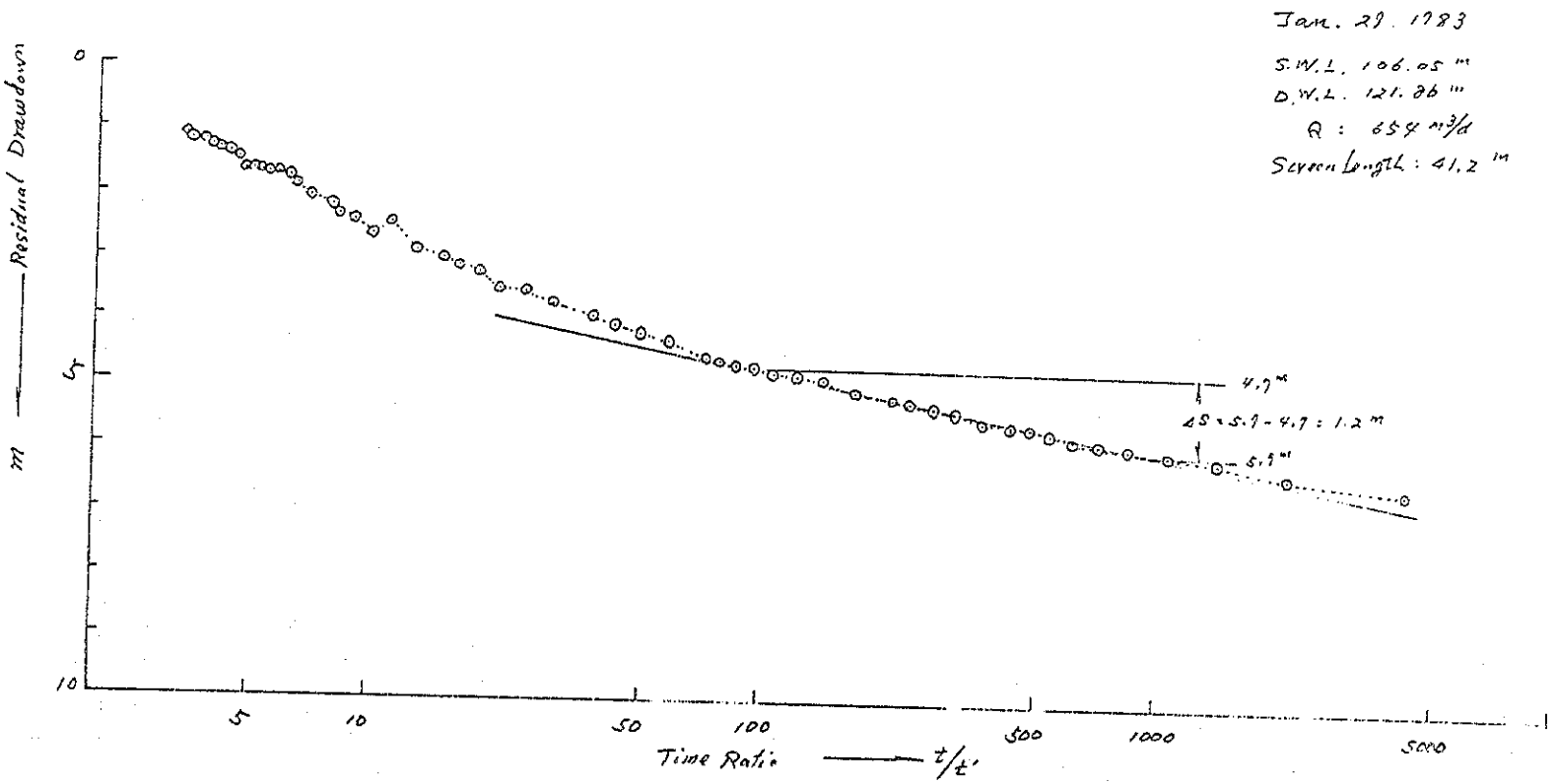
(25) Well No. BLZ−215, VALENZUELA 地質柱状図



㉕－2　Well No. BLZ-215, VALENZUELA 水位降下試験曲線



(25) − 3　Well No. BLZ−215, VALENZUELA 水位回復試験曲線



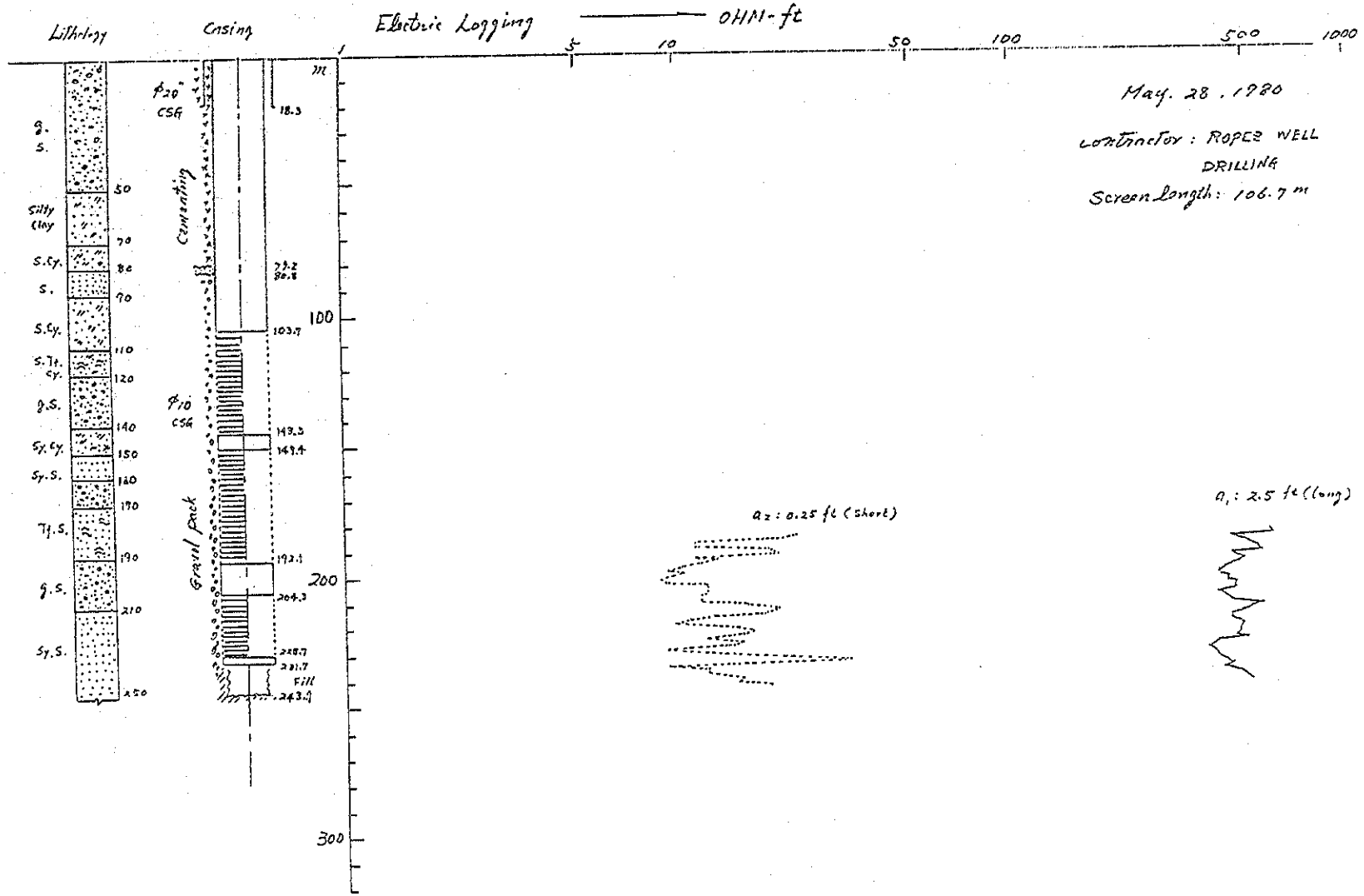
Jacob's Formula　$T = \frac{0.183 \cdot Q}{\Delta S}$

$= \frac{0.183 \times 654}{1.2} = 99.7\ m^3pd/m$

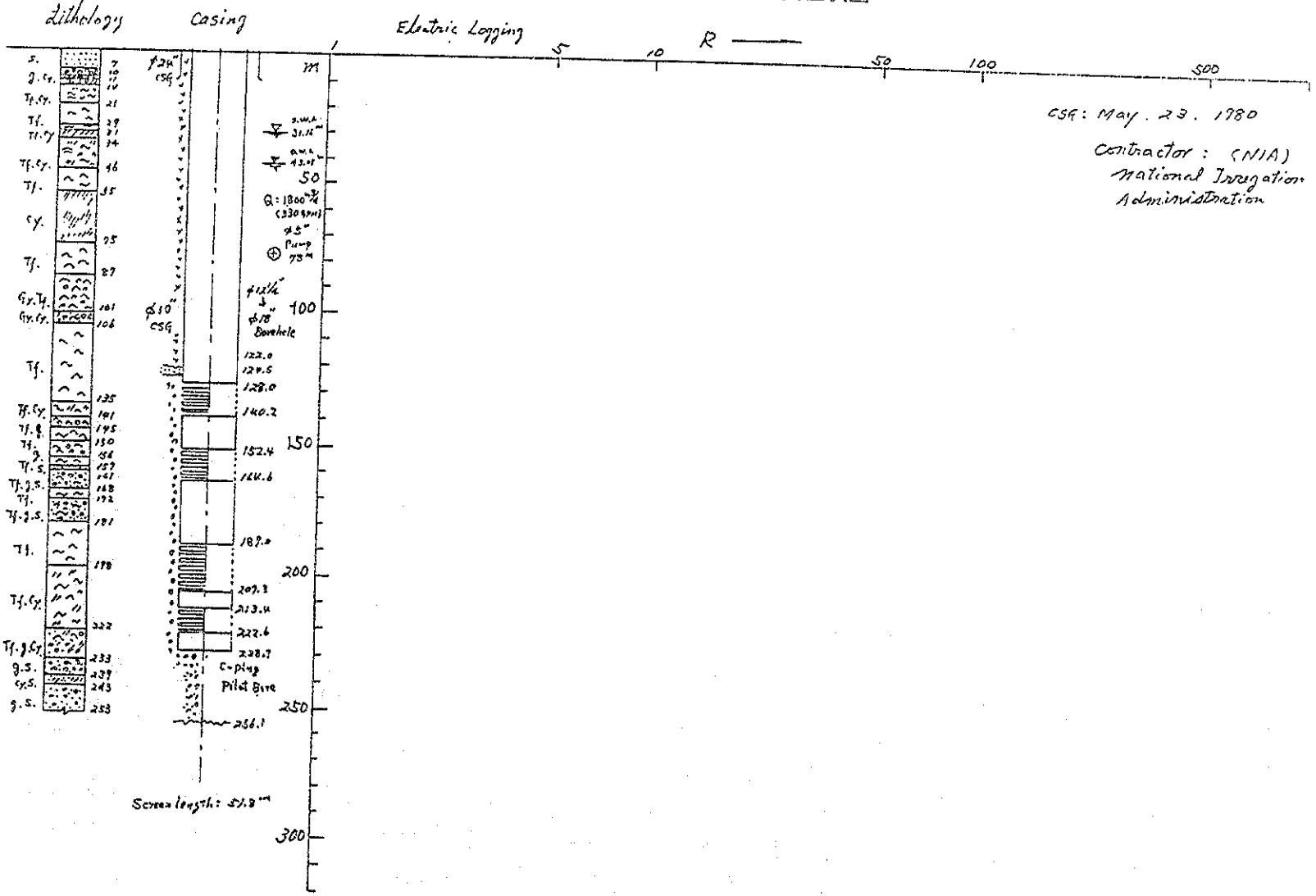
$P = \frac{T}{m} = \frac{99.7}{41.2} = 2.4\ m/d$

$= 2.8 \times 10^{-3}\ cm/sec$

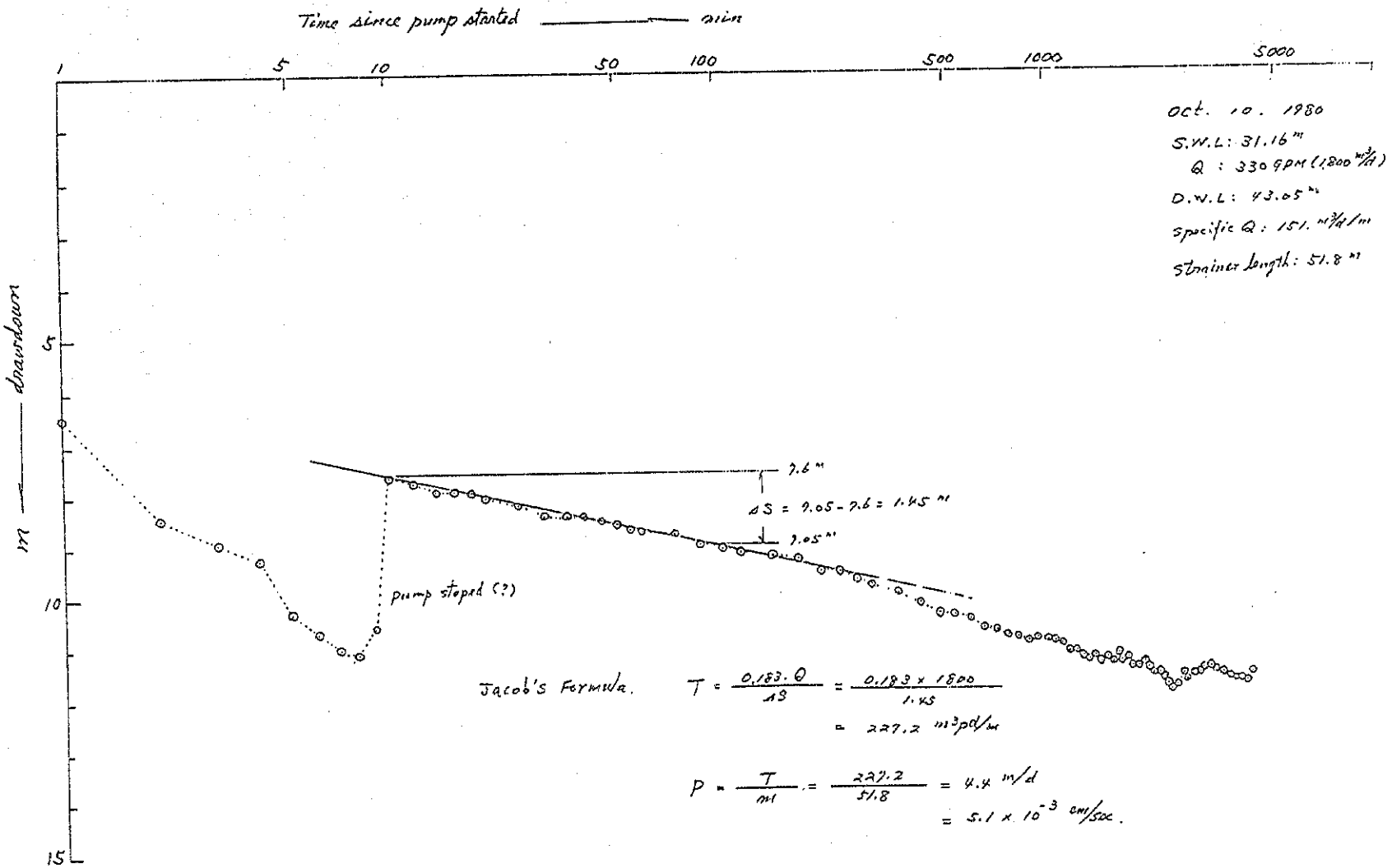
㉖ Well No. 6, PARANAQUE 地質柱状図



(27) Well No. LPS-64, LAS PINAS 地質柱状図



(27) − 2　Well No. LPS−64, LAS PINAS 水位回復試験曲線



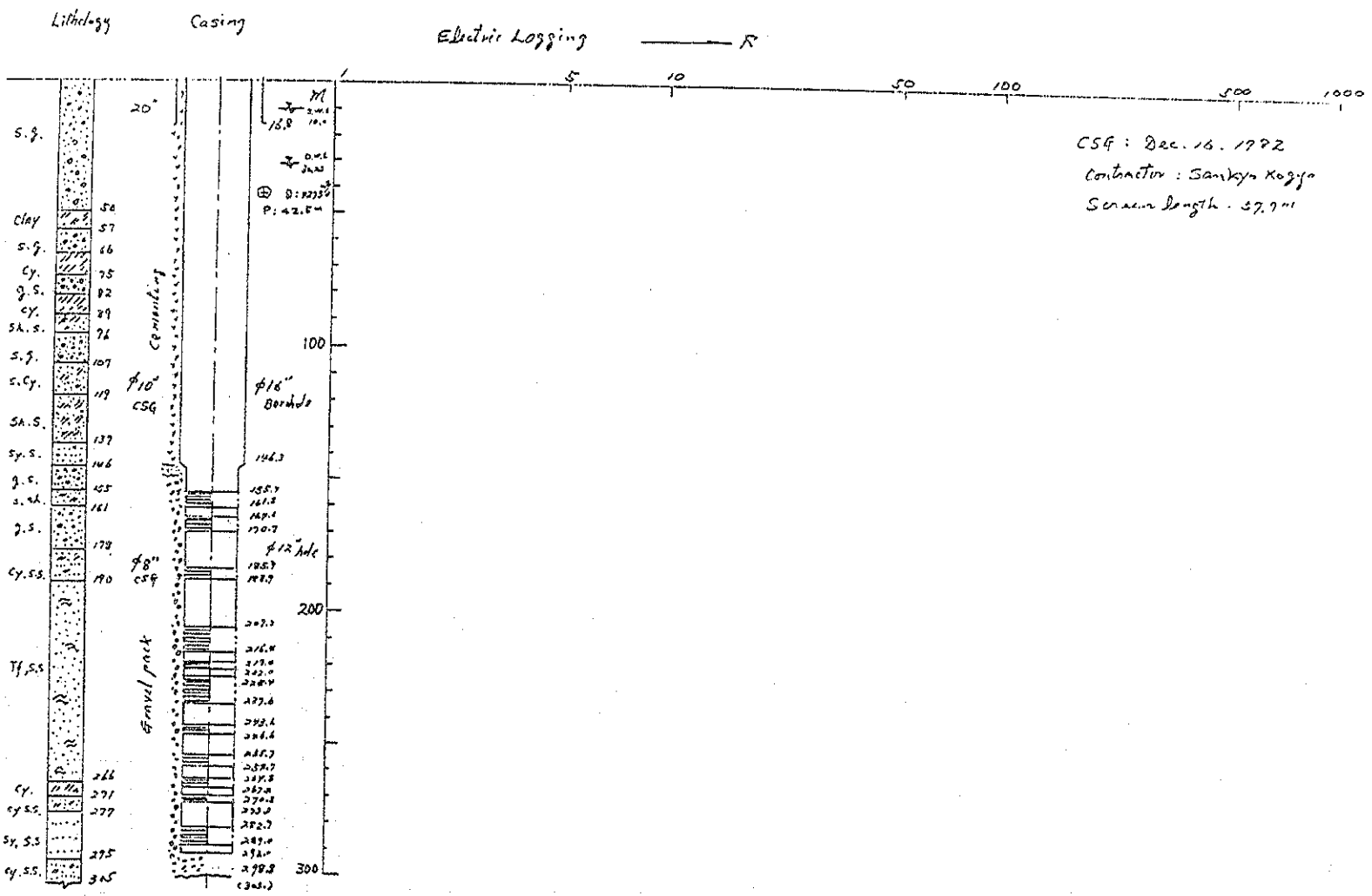
Jacob's Formula.　$T = \frac{0.183 \cdot Q}{\Delta S} = \frac{0.183 \times 1800}{1.45}$

$= 227.2 \ m^3pd/m$

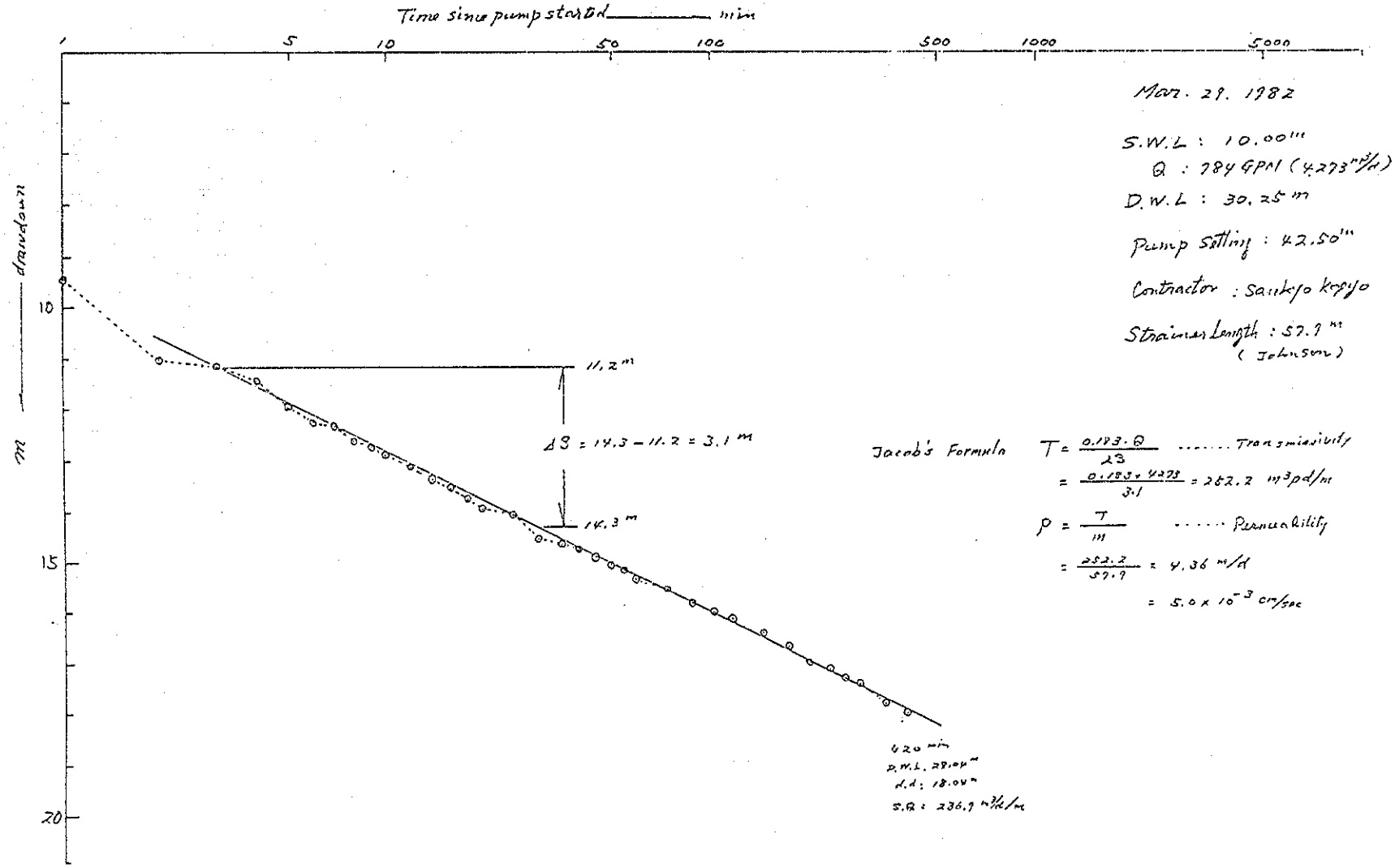
$P = \frac{T}{m} = \frac{227.2}{51.8} = 4.4 \ m/d$

$= 5.1 \times 10^{-3} \ cm/sec.$

(28) Well No. WD－1 (C), CAVITE 地質柱状図

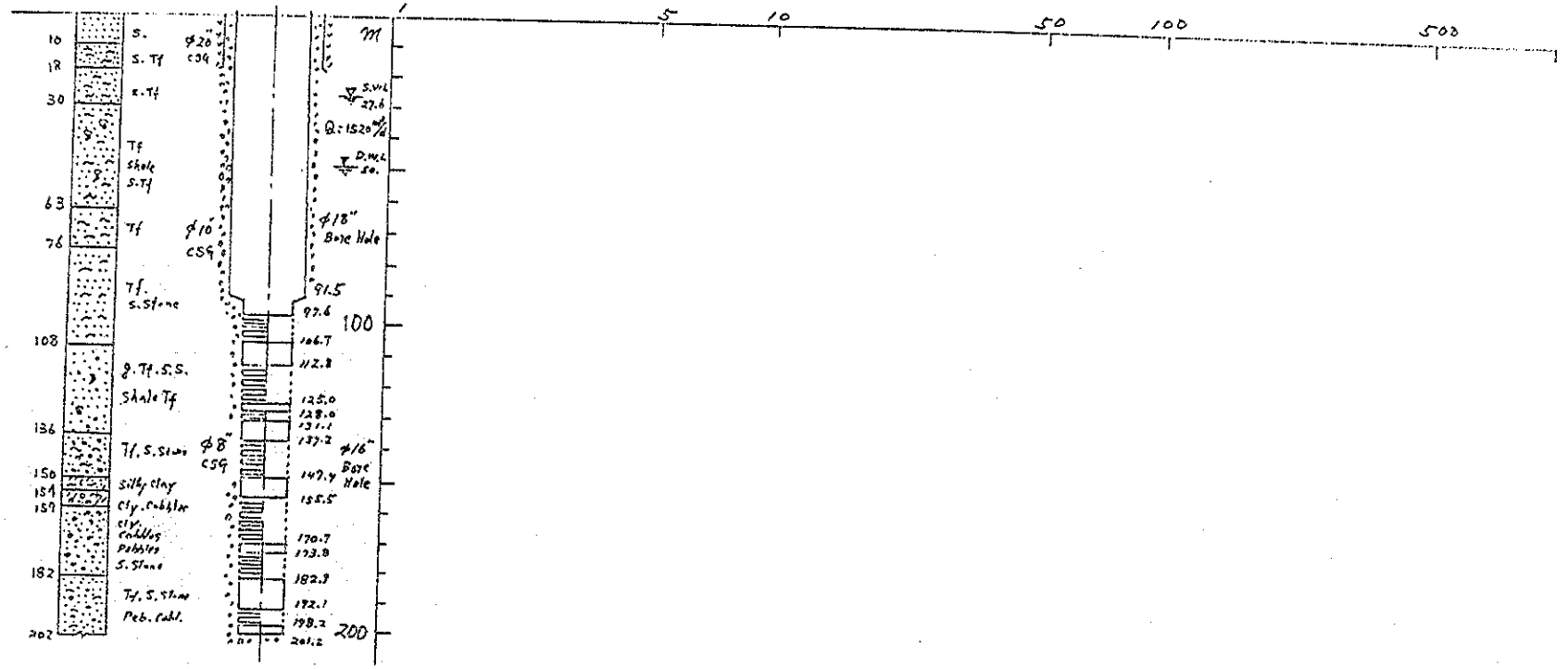


㉘－2　Well No. WD－1 (C), CAVITE 水位降下試験曲線



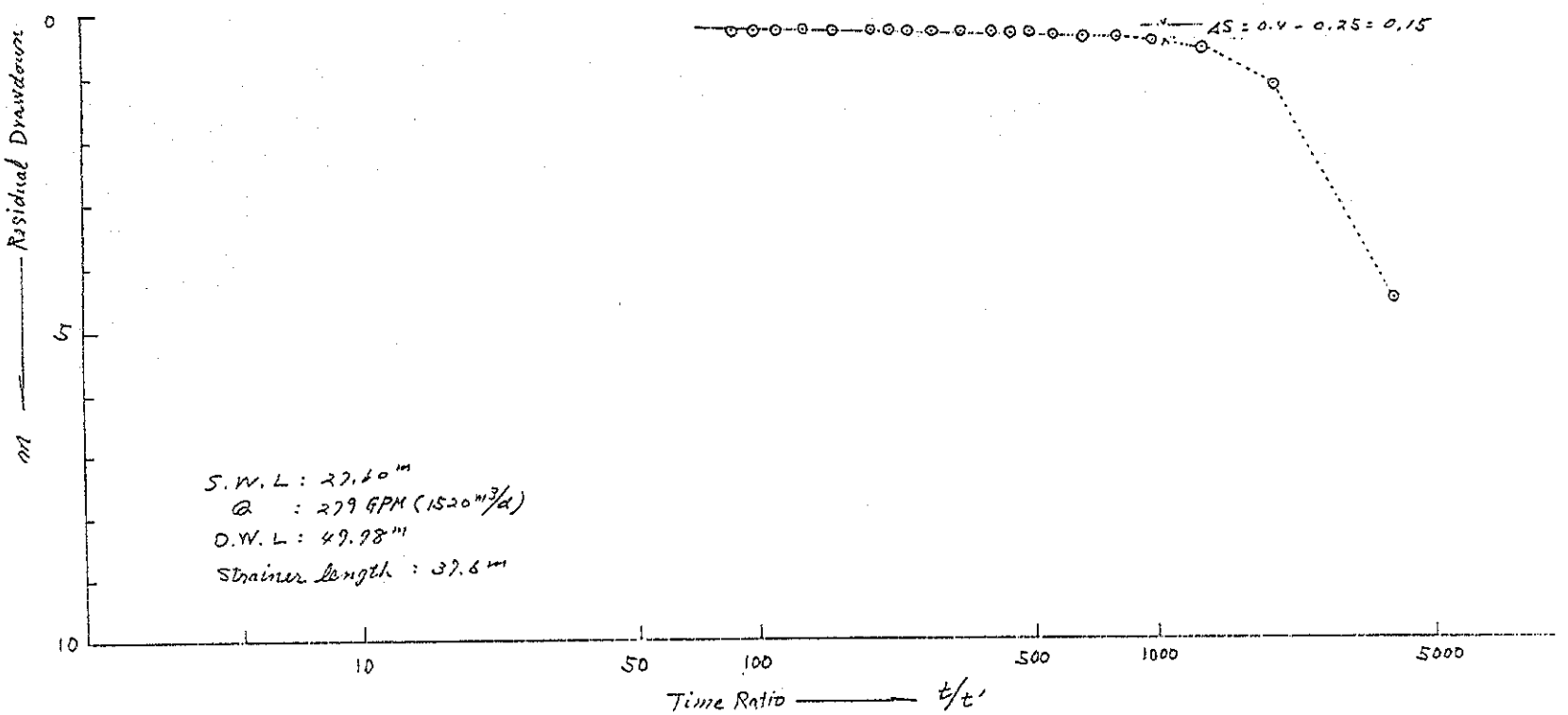
(29) Well No._____, TAGUIG 地質柱状図

Loc. Resettlement Center
May. 11. 1993



㉙－2　Well No._____, TAGUIG 水位降下試験曲線

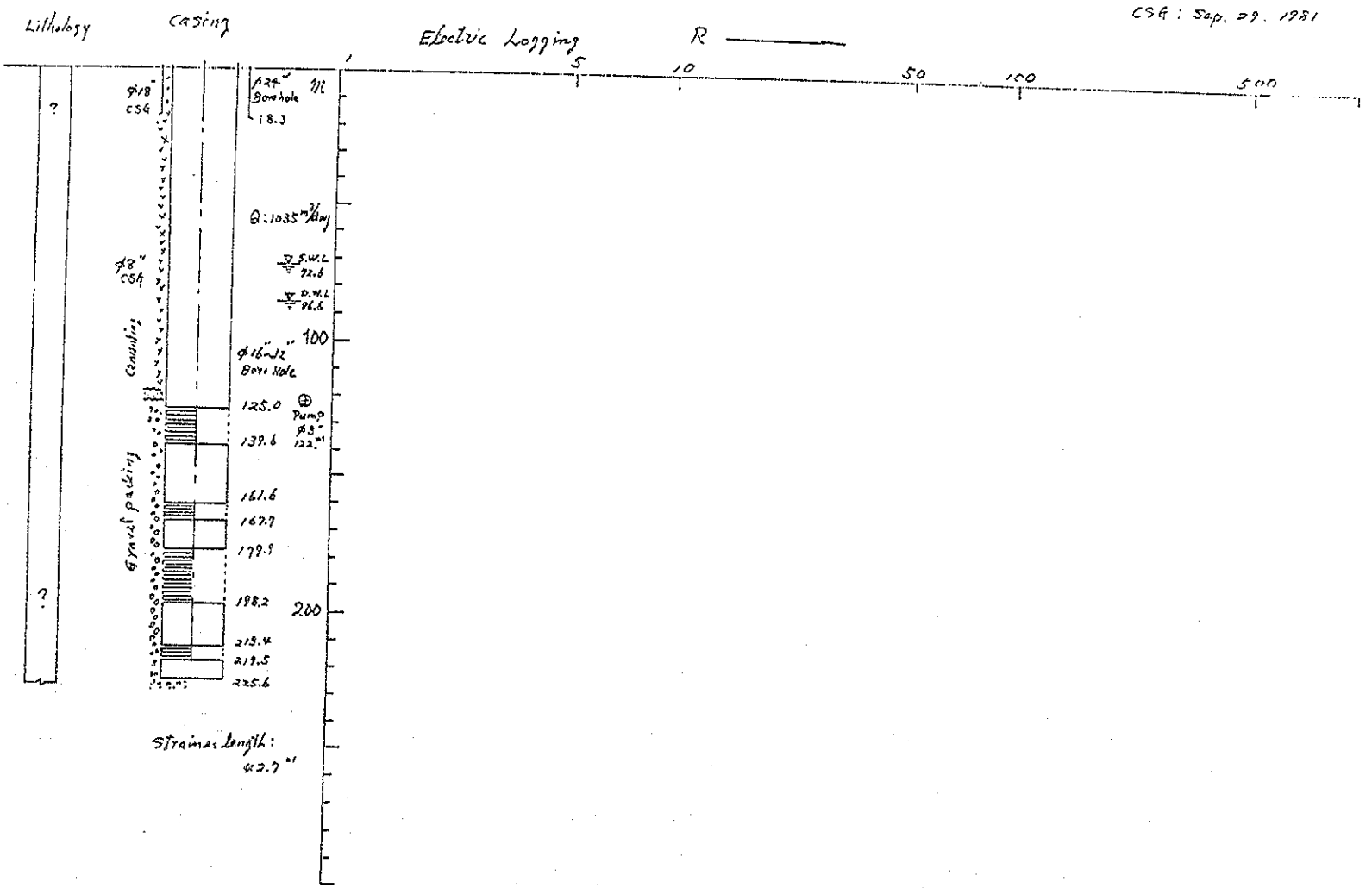
Loc. Resettlement Center　　June 20, 1983



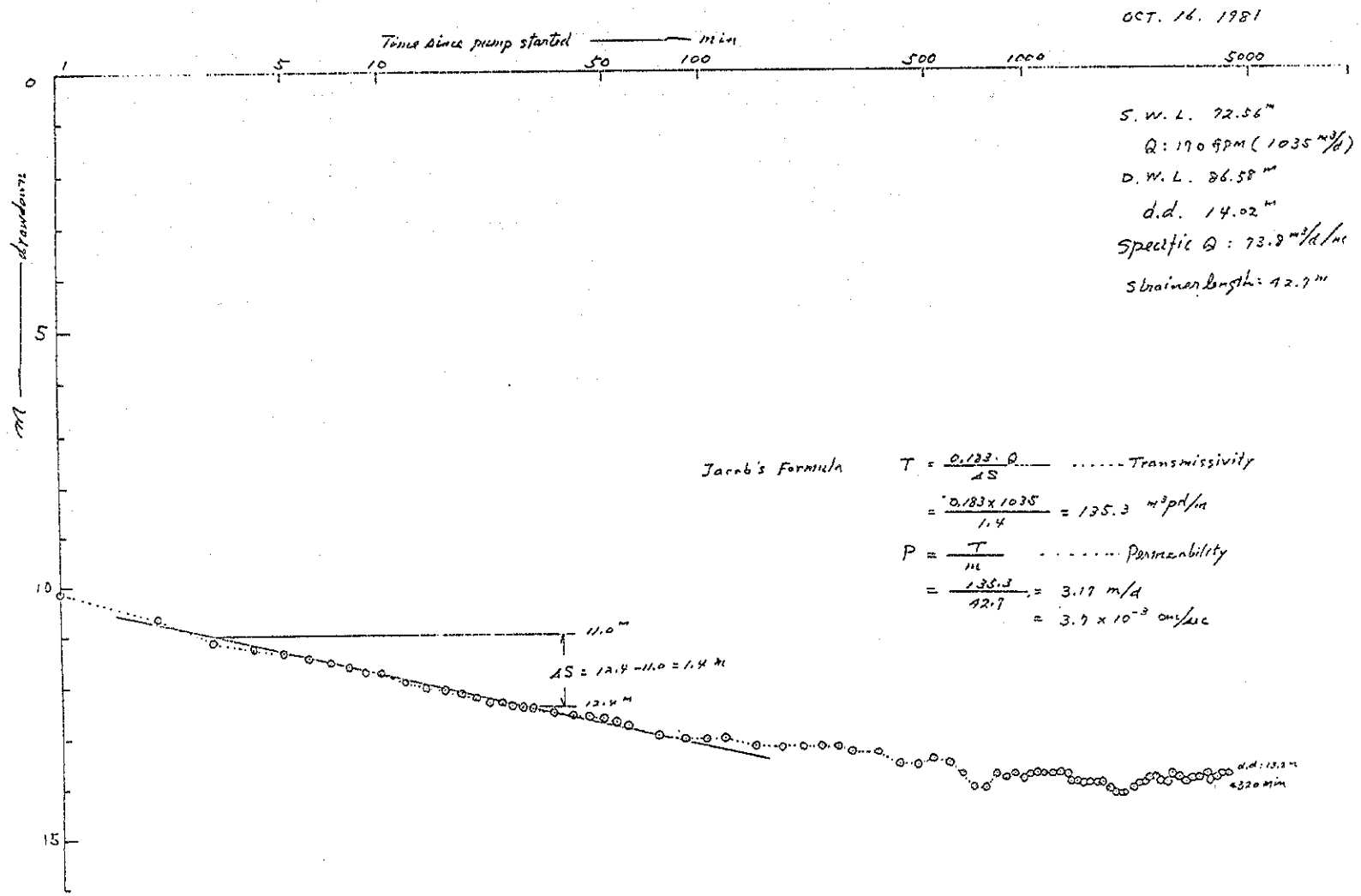
Jacob's Formula : $T = \frac{0.183 \cdot Q}{\Delta S} = \frac{0.183 \times 1520}{0.15} = 1854.4\ m^3/pd/m$

$P = \frac{T}{m} = \frac{1854.4}{37.6} \times 46.83\ m/d \cdots 5.4 \times 10^{-2}\ cm/sec$

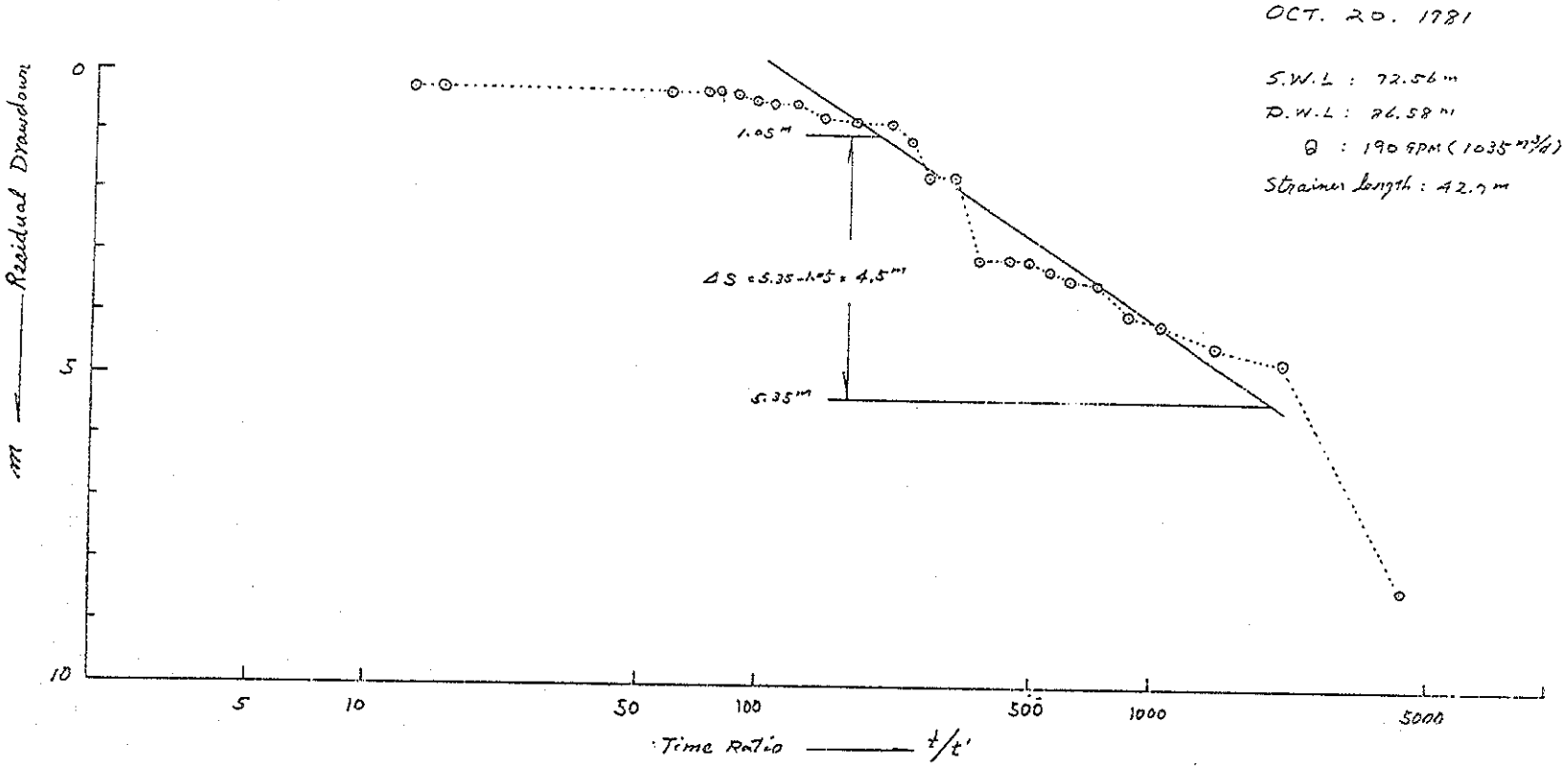
㉚ Well No._____, PASIG ケーシング・ストレーナ位置図



㉚－2　Well No._____, PASIG 水位降下試験曲線



(30) − 3　Well No._____, PASIG 水位回復試験曲線



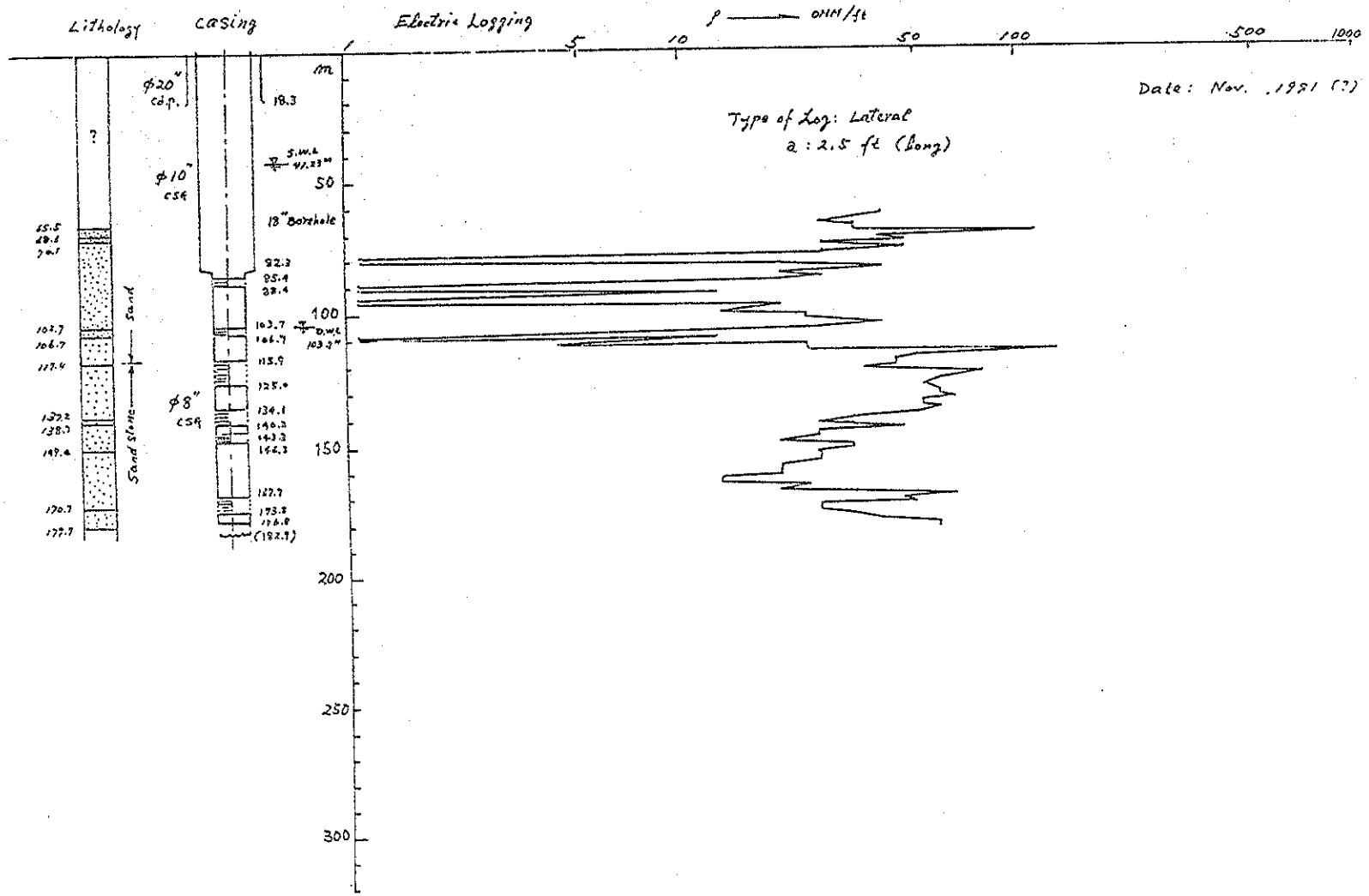
Jacob's Formula :　$T = \frac{0.183 \cdot Q}{\Delta S} = \frac{0.183 \times 1035}{4.5} = 42.1$ m³pd/m .... Transmissivity

$P = \frac{T}{m} = \frac{42.1}{42.7} = 0.99$ m/d ..... Permeability

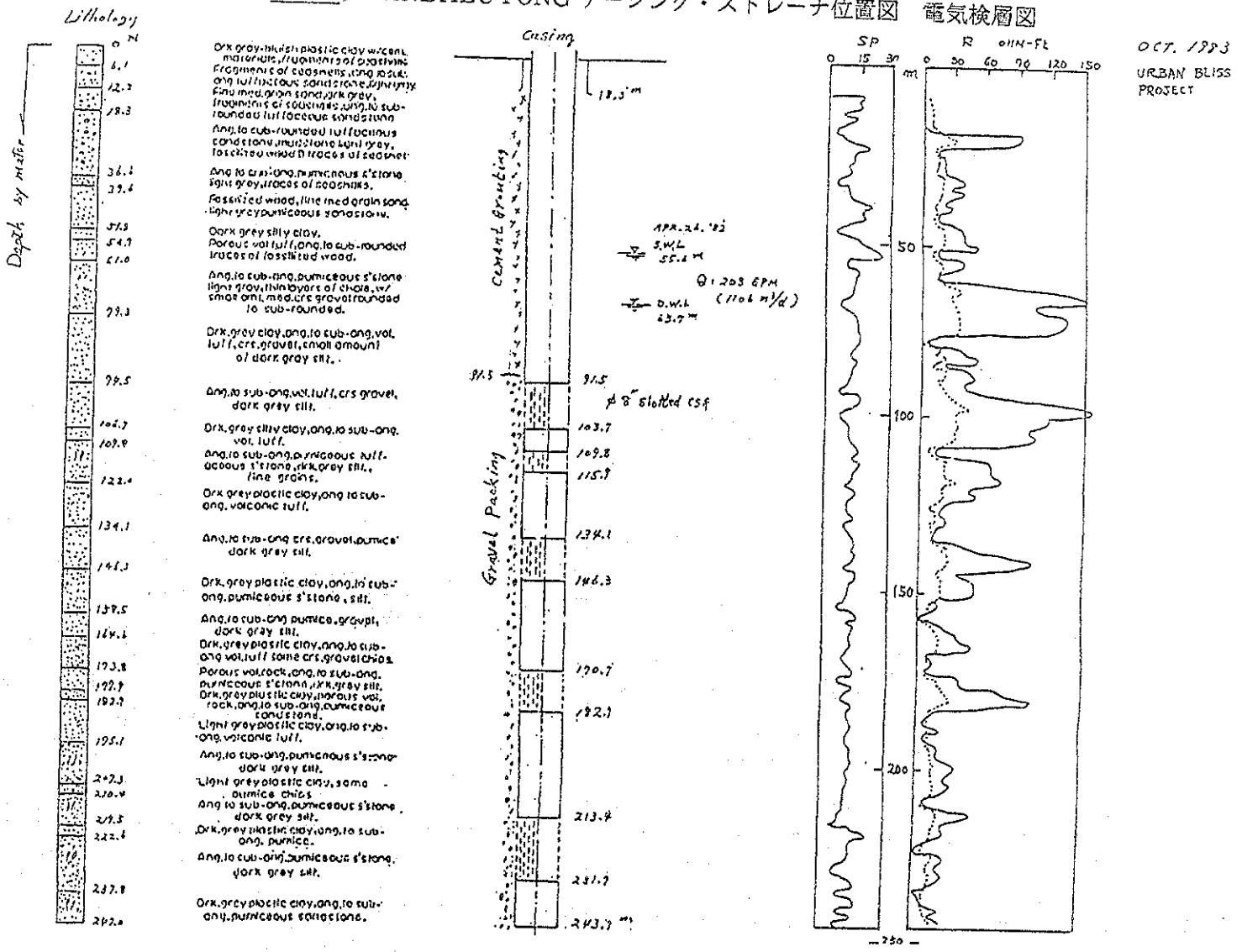
$= 1.1 \times 10^{-3}$ cm/sec

(31) Well No._____, CAINTA, RIZAL 電気検層図

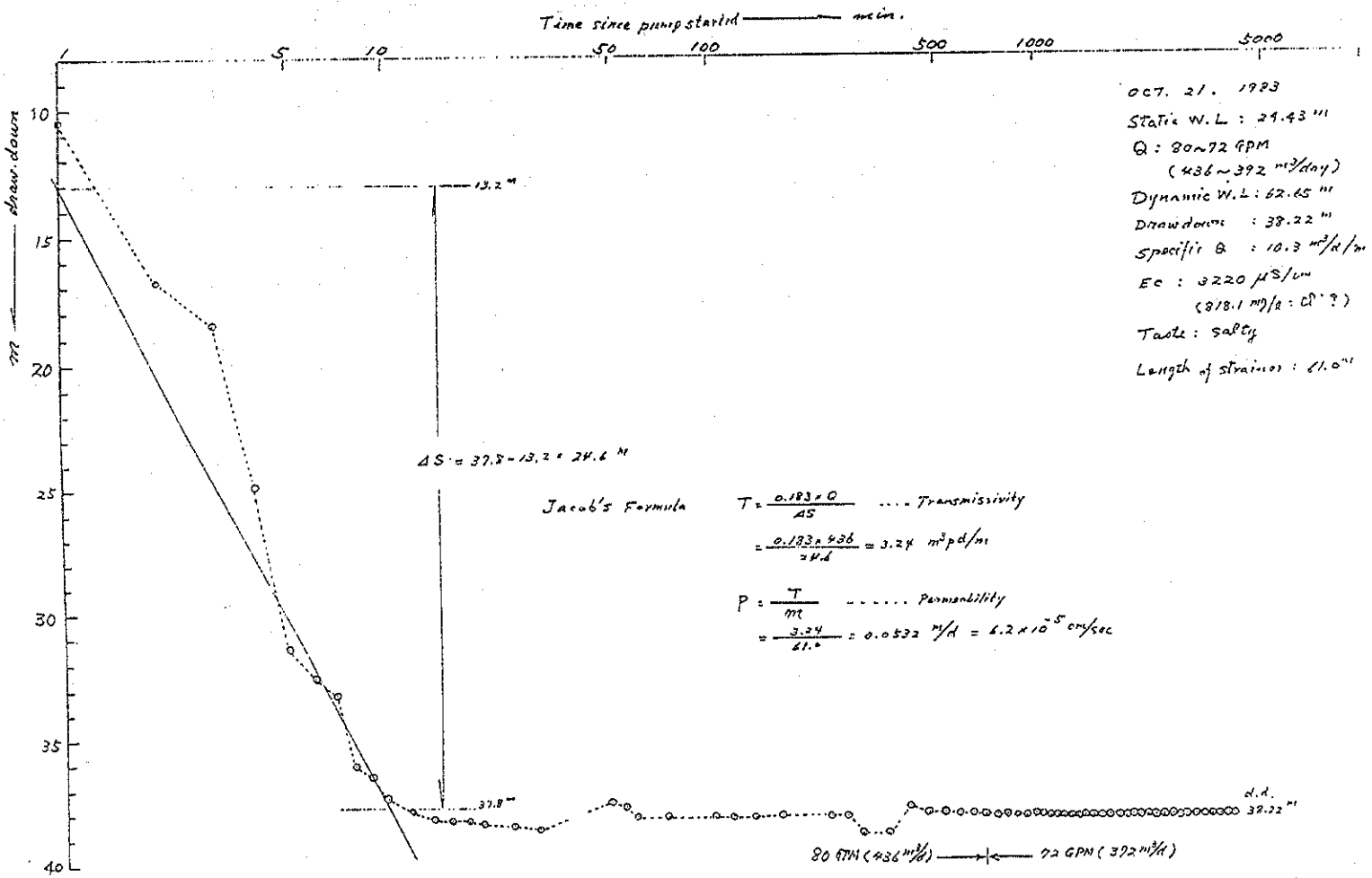
Loc. E. IRMA ST.
contractor : P.E. DRILLING



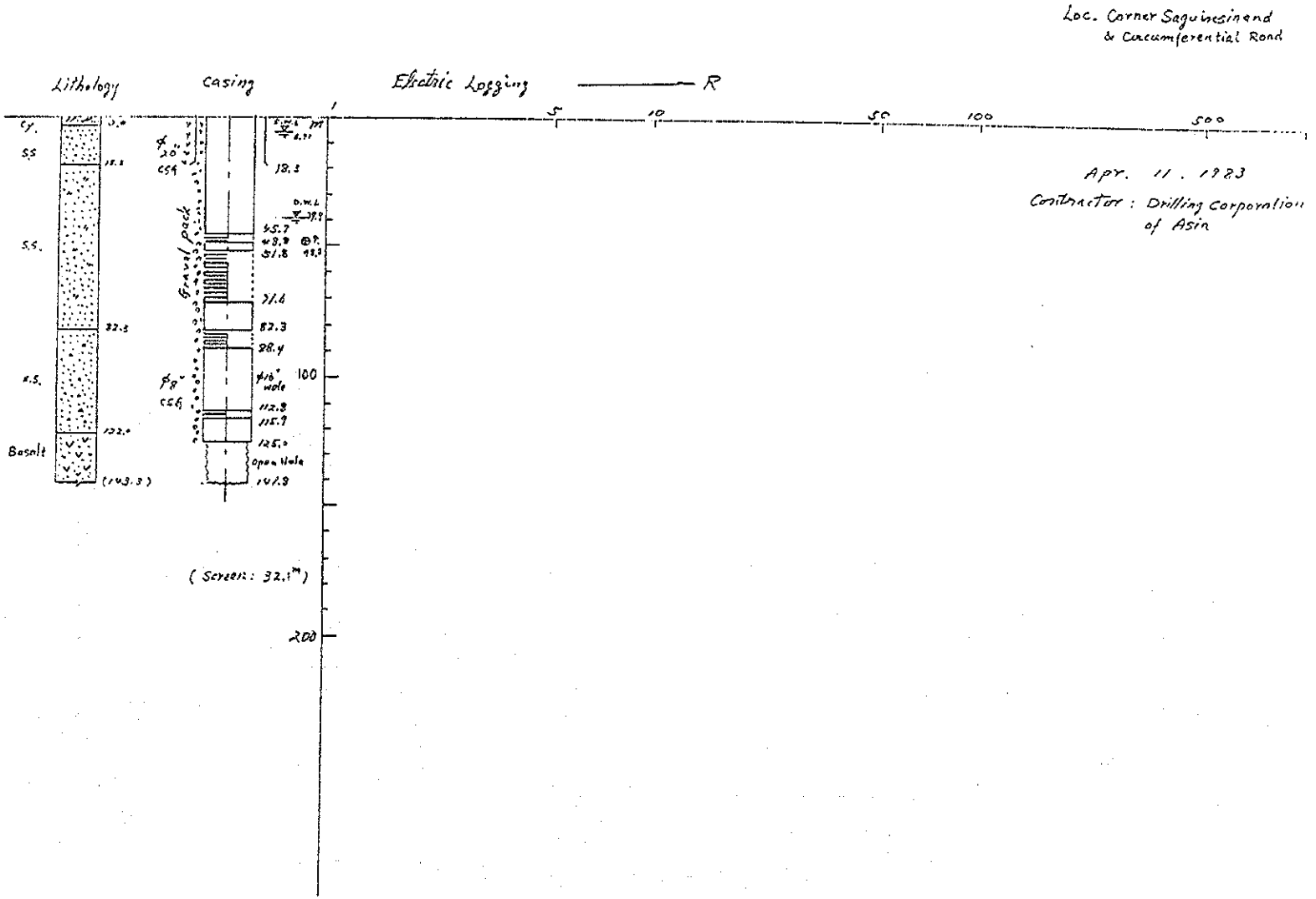
(32) Well No._____, MANDALUYONG ケーシング・ストレーナ位置図　電気検層図



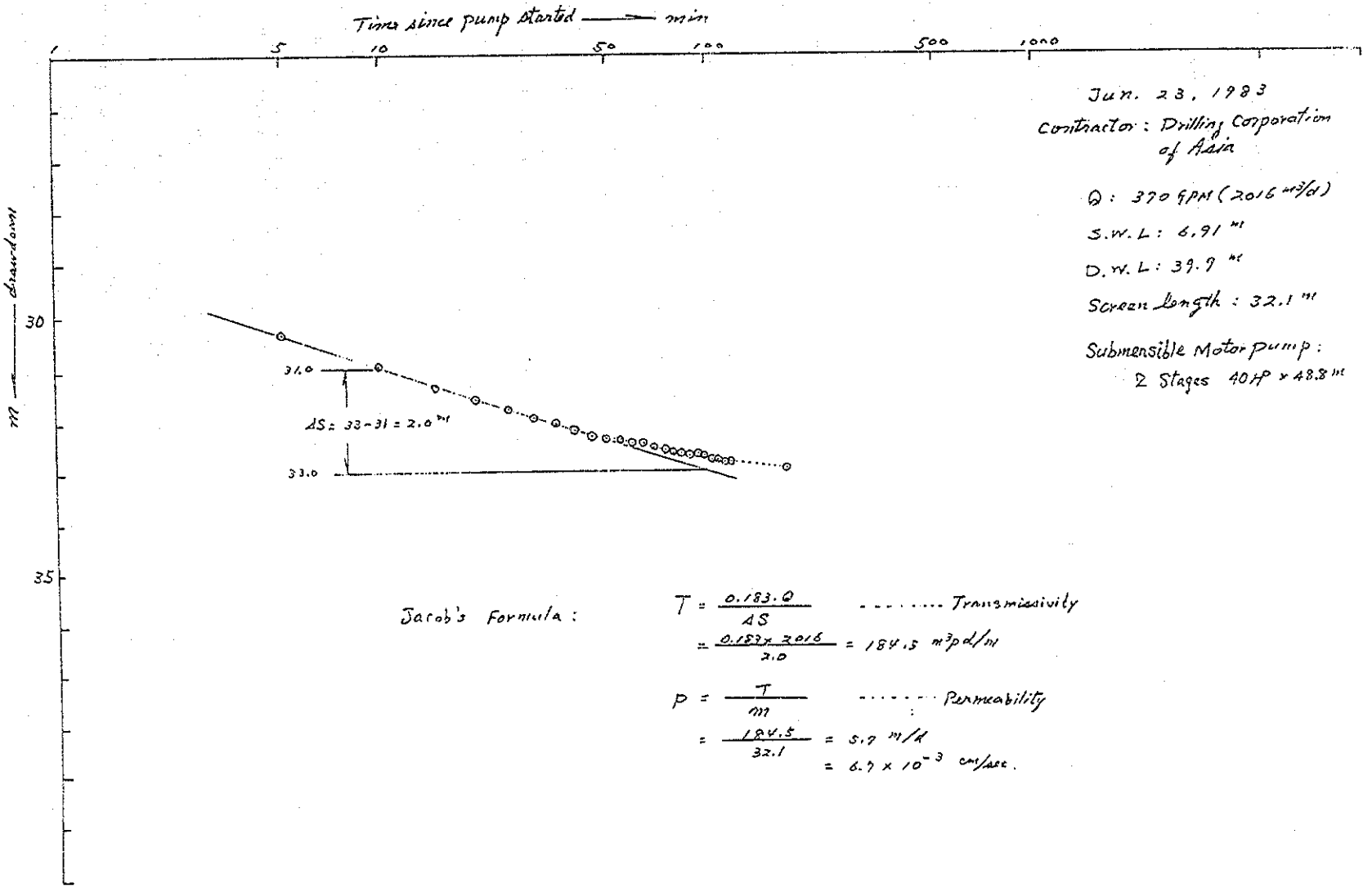
(32) − 2　Well No._____, MANDALUYONG 水位降下試験曲線



㉝ Well No. WD−06 (A), ANTIPOLO ケーシング・ストレーナ位置図



(33) − 2　Well No. WD−06 (A), ANTIPOLO 水位降下試験曲線



Jun. 23, 1983

Contractor : Drilling Corporation of Asia

Q : 370 GPM (2016 m³/d)

S.W.L : 6.91 m

D.W.L : 39.9 m

Screen length : 32.1 m

Submersible Motor pump :
2 Stages 40HP × 48.8 m

Jacob's Formula :

$$T = \frac{0.183 \cdot Q}{\Delta S} \quad \cdots\cdots \text{Transmissivity}$$

$$= \frac{0.183 \times 2016}{2.0} = 184.5 \ m^3pd/m$$

$$P = \frac{T}{m} \quad \cdots\cdots \text{Permeability}$$

$$= \frac{184.5}{32.1} = 5.7 \ m/d$$

$$= 6.7 \times 10^{-3} \ cm/sec.$$

(34) 地下水の塩水化について

A) 塩水侵入の発生

地下水の塩水化は元来海岸地特有の現象で、地下水の汲み上げによる水位低下に起因して発生する地下水障害の一つである。一般的には、淡水帯水層中に塩水が侵入する機構の中で、人為的現象によるものに次の4点が挙げられる。

(1) 動水勾配の減少と逆転(注:内陸側の水位が下って、勾配が逆になること)

(2) 不透水層の破壊

(3) 淡水と塩水の置換

(4) 廃井処置の欠陥

日本では、海岸地帯で自然の補給量を上回る大量の地下水を汲み上げた結果、動水勾配の減少と逆転によって、塩水の侵入を引きおこした例が多い。

海岸では、河床の低下による地下水補給料の減少、港湾や掘込み水路に伴う不透水層の破壊、又、淡水層に隣接する塩水層を不用意に開発したための塩水侵入などである。

B) 塩水の定義

淡水は固形物総量が1,000mg/l未満、かん水はそれを越える水である(U.S. Public Health Service, 1946)。これは電気伝導度(EC)では1,400μs/cm(25°C)に相当する。

WHOの水質基準及び日本の水道法(厚生省令)での飲適基準としては、Cl-200mg/l以下とされている。従って、この値を越える塩化物イオンを含有する水は「塩水」と呼ぶことができよう。

この値はECで表わすと約850μs/cm(25°C)に相当する。従って地下水がこの値を示すようになれば、一応、塩水の侵入があると考えてよい。

C) 塩水侵入の機構

海岸地帯の自由面地下水は海水の比重が淡水の約1.025倍であることから、海面上の淡水柱の約40倍の水柱で海水と平衡状態を保つことが、Ghyben-Herzbergの関係から明らかである。この関係が乱れると塩水の侵入が始まることになる。これを「塩水くさび」と一般に呼ばれている。

D) 一般的対策

一般に、塩水化防止対策の基本は、地下水位の「海高陸低」という塩水化の不均衡を矯正することである。

(1) 内陸側の動水勾配を自然状態に戻す。
そのためには、汲み上げ量を削減して、地下水位面が海面より常に高い状態に保つ必要がある。

(2) 海岸線の地下水位を海面より高めて、塩水の内陸侵入を防ぐ。そのためには、人工地下水涵養(注入)の手法を用いて、海岸線に地下水嶺をつくる。

(3) 海岸線で常時揚水して、極端な水位低下地帯をつくって、その線までは塩水侵入を許すが、内陸への侵入を阻止する。

これら上述の対策は理論的な方法であるが、実施には極めて困難を伴い、莫大な費用を要する。
特に、標高差の小さい海岸平野地帯では、極めて難しい問題である。なお、井戸自体の欠陥によって塩水化した井戸を改修する措置

も重要な塩水化防止対策の一つである。いずれにしても、既設井戸の汲み上げ、及び新設する井戸の構造には、何らかの制約を加える必要があろう。

地下水の塩水化は一般に、自然環境を人為的に変えることによって発生するから、自然の均衡が保たれるように、地下水の開発と管理が行われねばならない。

(35) リハビリテーションについて

A) 井戸が使用不能に至る原因

(1) 過剰揚水による出砂でスクリンの目詰りと埋没

(2) 出砂によって生じた空洞が崩壊し、重圧を受けたスクリンの圧壊

(3) 充填砂利の沈下引張りによる摩擦のためのケーシング接続部分の破損

(4) 鉄バクテリヤの発生による酸化鉄のスケール附着

(5) スクリン・スロットでの石灰分のスケール附着

(6) 帯水層から発生される遊離炭酸ガスによるスクリンの腐食

(7) ケーシング内壁に接触している水中モーターポンプの振動と打撃によるケーシングの破損

(8) 送電線からの漏電が大きい場合のケーシング鉄管の電食破孔

(9) 地下水位の低下によるポンプの揚程不足

(10) 塩水侵入によって鋼管ケーシングの腐食破孔

(11) 地震によるケーシング管の屈曲や切断

B) リハビリテーションを実施するための事前の調査

まず次の事項について資料を収集し、対象とされる井戸の周辺の事情を知っておく必要がある。

(1) 地域的水理地質

a) 地質図

b) 地層断面図

c) 帯水層等高線図

d) 地下水位等高線図

e) 地下水位の季節変動

f) 帯水層の形態と地質

g) 気象資料

h) 地盤沈下

i) 地震と洪水

j) 土地利用

(2) 管井戸の明細

a) 位置図、井戸の登録番号と標高

b) 完成資料、掘さく業者

c) 掘さく深度、口径、掘さく方法

d) サーフェイス・パイプの仕様、水止め埋立、又は、間隙セメンチング

材質、口径、肉厚、挿入深度、充填方法、位置、容量

e) ケーシングとスクリンの仕様

材質、口径、肉厚接続方法、ケーシング深度、スクリンのタイプ、挿入位置、スロット・サイズ、開孔率

f) 砂利充填

粒径、品質、充填量と充填頭の深度

g) ウエル・ログ

トリラーの掘さく柱状図と電気検層図(R, SP)

h)　帯水層の礫や掘さくスライムの粒度分析(粒径加積曲線図)

i)　当初及び現在の自然水位、動水位と水位降下

j)　当初及び現在の揚水量と比湧出量

h)　当初及び現在の水質と出砂量

JICA