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ON

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MINISTRY OF NATURAL RESOURCES

FEASIBILITY STUDY ON THE AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

VOL. III ANNEXES

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LIST OF ANNEXES

ANNEX H

IRRIGATION ENGINEERING STUDIES

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H1. PROJECT AREA AND PRESENT IRRIGATION SYSTEMS

H1.1 Choluteca Coastal Plain

H1.1.1 Project Area

6. The Choluteca coastal plain extends over 550 km^2 to the south of the Pan-American Highway crossing through the Choluteca Department. The Choluteca river stretches southwest across the center of the coastal plain and debouches into the Pacific Ocean. The Choluteca coastal plain undulates within the altitude of 5 m to 35 m above mean sea level. Choluteca city, with a population of approximately 26,000, is located to the northeast of the plain.

The irrigable area in the plain is delineated by topographic and land capability conditions. The area will be bounded on the north by El Papalon and Ola district, on the east by Sampile river, on the south and west by the uncultivable land facing the Fonseca Bay. The gross irrigable area totals 36,000 ha, out of which 25,500 ha are delineated as net irrigable area, which is called as the Choluteca Plain.

The Choluteca Plain of 25,500 ha is divided into 2 parts, i.e. Western Plain of 16,000 ha and Eastern Plain of 9,500 ha, as shown in Fig. - HI based on the irrigation cost, present land use and soil conditions. The Western Plain is much favorable to the Eastern Plain for an agricultural development in every aspect, and therefore the Western Plain of 16,000 net ha is selected on the Project area.

The climate in the Choluteca Plain is clearly divided into the rainly season from May to October and the dry season from November to April. Nearly 90% of the annual rainfall concentrates in the rainly season.

Table-H1 shows the availability of the meteorological data in the Choluteca Plain, as well as in and around the Choluteca river basin as a whole. According to the available records at the Choluteca meteorological station, the average annual rainfall for the period of 28 years (1943 - 1975) was 1,953 mm. The average annual A-pan evaporation at Choluteca was 2,588 mm. The average monthly temperature and the relative humidity are summarized as follows:

Average monthly temperature and relative humidity at Choluteca

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Temperature (oC)	28.0	28.4	29.0	29.8	28.4	27.3	27.8	27.1	26.0	26.4	26.8	27.3
Humidity(%)	55.7	54.5	58.0	59.6	73.7	80.4	69.6	76.1	83.8	87.1	70.3	58.0

H1.1.2 Present Irrigation System

In the Choluteca Plain, several irrigation systems have been operated, using surface water taken from the Choluteca river and other streams and groundwater. The present surface irrigation facilities cover a total area of about 2,030 ha. Major systems are operated for sugar cane cultivation by the two sugar companies (ACHSA and ACENSA) on the right bank of the Choluteca river. ACHSA farms, located in the center of the Western Plain, have 1 pumping station for surface irrigation of approximately 990 ha. ACENSA farms, scattered around ACHSA farms, have 2 pumping stations for surface irrigation of about 420 ha. In addition, the Lujosa Experimental station has a portable pump for irrigation 30 ha. A few independent farmers also have portable pumps for their own irrigation.

The area having facilities for groundwater irrigation totals some 2,335 ha in the plain. Major systems are also operated by ACHSA (760 ha) and ACENSA (860ha). In addition, the farmers' cooperatives under INA program in the Monjaras - Buena Vista area have wells for groundwater irrigation over a total land of some 400 ha.

The existing irrigation systems in the Choluteca Plain are summarized in Table-H12.

H1.2 Middle Reach Valleys

H1.2.1 Irrigable Area

In the middle reaches of the Choluteca river basin, there extend some terraces suitable for agricultural development. In order to make water balance study of the basin, preliminary study and reconnaissance survey have been made in the Middle Reach Valleys of the Choluteca River.

Through the preliminary study, 6 sub-areas scattered in the valleys within 5-60km distance from Choluteca city have been mapped out as suitable for future irrigation, in addition to the presently irrigated areas. These sub-area are shown in Fig.-H2 and tabulated as follows:

Name of sub-area	Net irrigable area (ha)	Approximate land level from Choluteca river bed (m)
Mololica C	210	17
Mololica D	90	23
Orocuina E	150	23
Orocuina F	250	10
Orocuina G	100	15
Orocuina H	540	15
TOTAL	1,340	

The sub-areas are located at the altitudes ranging from El. 60 m to El. 220 m. At present, the areas are generally the pasture land or small scale rain-fed farm land for cultivation of maize. sorghum, etc. The average annual rainfall in the recent 10 years at Los Encuentros is approximately 1,613 mm. Water of the Choluteca River will possibly pumped up to irrigate these areas in the long run.

H1.2.2 Present Irrigation Systems

5 settlement farms and cooperative farms having the gross irrigable area of approximately 340 ha, and some independent farms are scattered in the terrace of the Orocuina Valley. In these farms,

irrigation facilities such as portable pumps with diesel engines, delivery pipes, pipe lines of shifting type, canals, and small related structures have been constructed. Water of the Choluteca river is pumped up by the portable pumps and conveyed to the farms through canals by free flow, or through pipe lines of the shifting type by pressure flow.

The outline of the present irrigation system is summarized in Table-H13.

H1.3 San Juan de Flores Area

H1.3.1 Irrigable Area

The San Juan de Flores area is located along the Choluteca river, some 35 km to the north-east of Tegucigalpa. The area is formed by flood plain and terraces with altitudes ranging from El. 600m to El. 700m, and is surrounded by moutains of 700-1,300 m in height. The flood plain (El. 600-El. 635 m) and terraces (El. 635-El. 700 m) have ground surface slope of less than 5%.

Climatological data at Paso la Ceiba in the area is available. The average annual rainfall for the period of 8 years (1967-74) was 1,349 mm. The average monthly mean temperature and relative humidity (1972-76), as well as the average monthly evaporation measured with Class A-pan and Piche evaporator for a period of 6 years (1971-76) at Paso la Ceiba are as shown in Table-H8.

In the San Juan de Flores Area, there is a sugar mill under construction by ACANSA at a site about 5 km south from San Juan de Flores village. The mill has processing capacity of 1,814 tons per day, and it is estimated to require about 272,100 tons of sugar cane a year with a net annual processing period of 150 days. If the average unit production of cane is assumed at 118 tons/ha, the cane field necessary for the ACANSA mill will be estimated at 2,300 ha. The net irrigable area in the San Juan de Flores Area is, however, limited to about 1,200 ha.

H1.3.2 Present Irrigation Systems

Irrigation facilities such as intake weir, siphon, desiliting basin, main canal, 9 lateral canals and related structures have been constructed to cover the area of 1,140 ha. The irrigation water taken at the San Juan de Flores weir is conveyed to the desilting basin through head reach on the left bank of the river. A siphon is constructed below the desilting basin, and the water is delivered to the right bank of the river.

The main canal of 13.2 km in total length (partly lined) stretches northwestward along the terrace, and 9 lateral canals branch off from the main canal.

The irrigation water was designed to be taken approximately 1.5 m^3/sec at the San Juan de Flores intake weir. However, the control gate installed in the intake weir of the gravity type was broken about 10 years ago and has not been rehabilitated yet. Accordingly, the control of the design water surface elevation is not kept accurately.

A siphon located at approximately 600 m northeast of the intake weir has no screen in front of its inlet portion, and has silted and sprung numbers of leaks. The discharge at full flow in the canal on the right bank was estimated at around 600 ℓ/sec. The main canal downstream from the siphon stretches alongside the river and faces a 20-m high cliff of the terrace. This stretch is subject to rockfalls, land slides and bank erosion. Likewise, the main canal at a point approximately 200 m from the existing pumping station is also subject to land slides and bank erosion.

Due to the constraints mentioned above, full irrigation water has not been conveyed to the farm land through the existing main canal and related structures, and consequently the actual net irrigable area is estimated at only 200 ha. The rehabilitation of the irrigation systems, therefore, has been planned by MRN and the rehabilitation work is scheduled to start in 1978.

H2. DESIGN IRRIGATION WATER REQUIREMENT

H2.1 Water Requirement in Choluteca Plain

H2.1.1 General

In accordance with the cropping patterns proposed for the project area, crops are sugar cane, maize, cotton, sorghum, beans, sesame, rice, melon, water melon, vegetables, and pasture.

The project area i.e. the Western Plain is divided into 3 divisions in accordance with the proposed canal layout, which may facilitate a stage-wise development. The design irrigation water requirements are estimated by the following procedure:

(1) Calculation of the potential evapotranspiration

(2) Calculation of the consumptive use on crops

(3) Calculation of the net irrigation water requirement; deduction of effective rainfall for crop from the consumptive use.

(4) Estimate of irrigation water requirement, dividing the net irrigation water requirement by the overall irrigation efficiency which is estimated on the basis of losses due to application and conveyance.

H2.1.2 Potential Evapotranspiration

Several methods of estimating the potential evapotranspiration have been compared to select the most suitable one, on the basis of such climatic records as temperature, sunshine hours, wind velocity, relative humidity, and Class A-pan evaporation obtained at Choluteca meteo-station.

Four popular methods, namely, Modified Blaney-Cliddle, Modified Penman, Hargreaves, and Christiansen-Hargreaves, have been compared to select the suitable method for estimating the potential evapotranspiration. The results are shown in Table-H4. The comparative analysis revealed that the Modified Blaney-Cliddle method would bring excessively lower values, while the Modified Panman method and

Hargreaves method tend to produce higher values than those of the A-pan records. Consequently, the Christiansen Hargreaves method is supposed to be most suitable for estimating the potential evapo-transpiration in the Project area.

The Christiensen-Hargreaves method is a modification of the Hargreaves formula in terms of wind, sunshine and elevation factors, and the method is explained as follows:

$$Ep = 17.4 \times d \times Tc \times Fh \times Fw \times Fs \times Fe$$

$$Fh = 0.59 - 0.55\ Hn^2$$

$$Fw = 0.75 + 0.0255 \times \sqrt{Wkd}$$

$$Fs = 0.478 + 0.58\ S$$

$$Fe = 0.950 + 0.0001\ E$$

Where,

Hn : Mean noon humidity in decimally (%)

$0.40\ Hm + 0.60\ Hm^2$

Wkd: Mean wind velocity (km/day) at the level of 2 m above the ground surface

S : Mean monthly sunshine hour (%)

Hm : Mean daily relative humidity (%)

E : Elevation above the sea level

H2.1.3 Cunsumptive Use

The consumptive use depends on (1) potential evapotranspiration, (2) crops to be grown, and (3) their growth stages at different times of the year.

The formula for estimating the consumptive use is as follows:

$$C = Ep \times Kc$$

Where,

C : Consumptive use in mm

Ep : Potential evapotranspiration in mm

Kc : Crop consumptive use coefficient.

The data on crop consumptive use coefficient /1 provided by by G. Hargreaves have been adopted. The crop coefficient curves are shown in Fig.-H7 to Fig.-H15. The calculating procedure of the consumptive use is shown in Tables-H29 to H-43, and peak consumptive use for each crop is shown in Table-H55.

H2.1.4 Effective Rainfall

Daily rainfall records for the period of 28 years at Choluteca meteo-station and for the period of 10 years at Azucarera Choluteca (ACHSA) sugar cane farm have been used for estimating the effective rainfall. The effectiveness of rainfall depends on several factors such as the volume and intensity of rainfall, characteristics of soils, rate of consumptive use, and irrigation practices. Accordingly, empirical and practical judgement is necessary in estimating the effective rainfall. Two estimation procedures have been used in conformity with the irrigation practices proposed by the project; namely furrow irrigation in the sugar cane field and other dry crop field, and flooding irrigation in the paddy field.

(1) Probable rainfall in the field of sugar cane and other dry crops:

On the basis of the monthly rainfall records obtained at two stations (Choluteca meteo-station and ACHSA) and other records in Cadeño, the probable drought monthly rainfall of 90 % recurrence for estimating the irrigation water requirement on dry crops is calculated by Gumbel method. The results are summarized as follows:

/1 Source;

(1) Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, March 1968.

(2) Contribución al Plan de Emergencia Nacional para la Produción de Arroz y actros Cultivos Bajo Riego, PROYECTOS PNUD-FAO, Junio 1976.

Name of station	Period of record	90% recurrence annual drought rainfall
1. Choluteca meteo-station	28 years	1,458 mm
2. Szucarera Choluteca	10 years	1,338 mm
3. Cedeño	5 years	1,559 mm
	Average:	1,452 mm

In calculating irrigation water requirement, the average annual drought rainfall (90% recurrence of 1,452 mm) is distributed monthly according to the proportion of average monthly rainfall calculated based on the data obtained at Choluteca meteo-station and ACHSA.

(2) Effective rainfall in the field of sugar cane and other dry crops:

The relationship between average monthly effective rainfall, mean monthly rainfall and average monthly consumptive use has been developed by US Department of Agriculture, Soil Conservation Services (USDA, SCS), and it appears adoptable to the estimate of effective rainfall for sugar cane and other dry crops in the project area. The USDA, SCS has developed a procedure for estimating effective rainfall by processing long term climatic and soil moisture data. To avoid complexity, neither the soil intake rate nor rainfall intensities are considered in the USDA, SCS procedure.

From total rainfall and monthly consumptive use, effective rainfall values were computed and shown in Table-H10. The values were based on a 75 mm net irrigation application, which is equal to the available storage capacity in the root zone at the time of irrigation application. To convert this data to other net depths, factors were worked out and they are shown in Table-H11. The monthly effective rainfall cannot exceed the rate of consumptive use. If it does, lower value of the two is taken as an effective rainfall.

(3) Effective rainfall in the paddy field

Concerning the daily rainfall record for the period of 10 years out of 28 years obtained at Choluteca, the effective rainfall is calculated by daily water balance method under the following assumptions.

1) Daily rainfall R mm — Effective rainfall mm

Daily rainfall R mm	Effective rainfall mm
More than 80 mm	80 x 0.8 = 64
Less than 80 mm but more than 5 mm	R x 0.8
Less than 5 mm	0

2) Percolation — 3 mm/day during the whole year.

On the basis of the results of effective rainfall calculated by the above mentioned method, the probable drought annual effective rainfall with 90 % recurrence is calculated by the Gumbel method. The probable drought annual effective rainfall is distributed in accordance with the proportion of average monthly effective rainfall, and the distributed effective rainfall shown in Table-H6 is adopted in the calculation of the irrigation water requirement of rice.

H2.1.5 Percolation

As a result of permeability test, the permeability coefficient of the subsurface soil at about 1.0 m below topsoil layer is estimated at 10^{-4} cm/sec to 10^{-5} cm/sec. In estimating irrigation requirement of rice, the percolation of paddy field is assumed to be 3 mm/day during the whole year, because the paddy field will be reclamated where the soil has poor draiability.

H2.1.6 Net Irrigation Water Requirement

The net irrigation water requirement is obtained by deducting the effective rainfall from the crops consumptive use. The estimates of the net irrigation water requirement for each crop are shown in Table-H19 to Table-H43.

H2.1.7 Irrigation Efficiency

Irrigation efficiency is the percentage of irrigation water that is stored in the soil to water available for consumptive use by crops.

When the water is measured at the farm head gate, it is called as the application efficiency, and when measured at the point of diversion it may be called as the irrigation efficiency. The following efficiencies in the application and conveyance of irrigation water have been adopted.

(1) Application efficiency (Ea):

Application losses in the fields will include deep percolation and surface runoff. The application efficiency is affected mainly by the skillfullness of irrigators, the irrigation method and soil and topographical conditions. In view of the favorable soil textural and topographical conditions in the project area, the application efficiency is estimated at 65 %. with reference to the standard/2 commonly used in the United States.

(2) Distribution efficiency (Ed1) from branch canal to field inlet:

Distribution efficiency of the unlined and earth lined distribution canals provides for canal water loss from branch canal to the field inlets. The distribution efficiency is taken at 85 %.

(3) Distribution efficiency (Ed2) of headreach and main canals:

Distribution efficiency of the concrete lined canal also provides for water loss in the canal between headreach and main canals. The distribution efficiency is taken at 95 %.

(4) Irrigation efficiency (Ei)

The irrigation efficiency is calculated from the three efficiencies as follows:

$$
\begin{aligned}
Ei\ (\%) &= Ea \times Ed1 \times Ed2 \\
&= 65\% \times 85\% \times 95\% \\
&= 52.5\%
\end{aligned}
$$

/2 Source: AMES IRRIGATION HANDBOOK published by W.R. AMES.

H2.1.8 Irrigation Water Requirement

The irrigation water requirement is the sum of the net irrigation water requirement and the losses mentioned above. It is calculated as;

$$\text{Irrigation water requirement} = \frac{\text{Net irrigation water requirement}}{\text{Irrigation efficiency}}$$

The results of the estimation are shown in Table-H17 to Table-H18.

H2.2 Water Requirement in Middle Reach Valleys

In accordance with the cropping pattern proposed in the middle reach valleys, crops are rice, beans, maize, and vegetables.

The design irrigation water requirements for the Middle Reach Valleys have been estimated at 3.44 ℓ/sec/ha, as explained hereunder.

(1) Potential evapotranspiration:

The potential evapotranspiration calculated for the Choluteca coastal plain according to the Christiansen-Hargreaves method has been applied to the Middle Reach Valleys because no meteorological data to estimate potential evapotranspiration are available in the valleys.

(2) Consumptive use:

The calculating procedure is shown in Table-H45 to Table-H49. Peak consumptive use for each crop is shown in Table-H55.

(3) Effective rainfall:

Daily rainfall records for the period of 28 years at Choluteca meteo-station and for the period of 10 years at Los Encuentros have been used for estimating the effective rainfall.

a) Probable rainfall in field of dry crops:

According to monthly rainfall records obtained at the two stations, the probable drought rainfall with 90 % recurrence is calculated by the Gumbel method for estimating the monthly effective rainfall for dry crops. The results are as follows:

Name of station	Period of record	90% recurrence annual drought rainfall
Choluteca meteo-station	28 years	1,458 mm
Los Encuentros	10 years	852 mm
Average		1,155 mm

In calculating the irrigation water requirement, the average annual drought rainfall with 90 % recurrence of 1,155 mm is distributed to each month according to the proportion of average monthly rainfall calculated from records at Choluteca and Los Encuentros.

b) Effective rainfall for dry crops:

The effective rainfall for dry crops is estimated according to the USDA, SCS method and the results are shown in Table-H10 to Table-H11.

c) Effective rainfall for paddy:

The probable monthly effective rainfall for paddy has been assumed to be the same value as calculated for the Choluteca coastal plain.

(4) Percolation:

The percolation of paddy field is assumed at 3 mm/day throuout the year, the same as for the Choluteca coastal plain.

(5) Net irrigation water requirement

The net irrigation water requirements for the proposed cropping patterns are shown in Table-H45 to Table-H49.

(6) Irrigation efficiency:

The following irrigation efficiencies are assumed in calculating the design irrigation water requirement.

(Irrigation efficiency)

Application efficiency in the farm: 65 %

Distribution efficiency from secondary canal to farm ditch: 85 %

Distribution efficiency in delivery pipe and main canal: 95 %

Therefore, the irrigation efficiency is estimated at 52.5 %.

(7) Irrigation water requirement:

Table-H44 shows the monthly irrigation water requirement, and the design irrigation water requirement is estimated at 1.72 ℓ/sec/ha, basing on the pump operation for 12 hours.

H2.3 Water Requirement in San Juan de Flores Area

In accordance with the proposed cropping pattern in the San Juan de Flores Area, the crop is only sugarcane. The design irrigation water requirement is estimated at 1.44 ℓ/sec/ha, as explained hereunder.

(1) Potential evapotranspiration:

Several climatic records such as monthly mean temerature, monthly relative humidity and monthly evaporation measured with Class A-pan and Piche evaporator are available at Paso La Ceiba meteo-station. According to these climatic records, the potential evapotranspiration is calculated by G. Hargreaves method. The estimated value of the potential evapotranspiration tends to be higher than the observed value of the evaporation measured with Class A-pan and Piche evaporator. Accordingly, the average value of the evaporation measured with Class A-pan is adopted for estimating the design irrigation water requirement.

Potential Evapotranspiration and Evaporation in San Juan de Flores Valley

Unit: mm

	Potential E.P.T. G. Hargreaves (5 years)	E.P. A-pan (6 years)	E.P. Piche Evaporation (6 years)
JAN.	163.6	110.7	121.4
FEB.	166.8	130.6	141.8
MAR.	234.3	184.6	210.3
APR.	251.9	189.2	218.0
MAY	234.3	172.5	176.0
JUN.	172.0	129.6	104.3
JUL.	194.0	125.5	105.8
AUG.	184.4	128.8	108.7
SEP.	171.4	122.4	91.1
OCT.	145.0	111.1	84.5
NOV.	152.0	93.0	85.0
DEC.	140.4	99.1	110.0
Annual	2,210.1	1,597.1	1,556.6

(2) Consumptive use:

The calculating procedure is shown in Table-H51 to H53. Peak consumptive use for each crop is shown in Table-H55.

(3) Effective rainfall:

Daily rainfall records for the period of 8 years at Paso La Ceiba have been used in estimating the effective rainfall. The monthly rainfalls are shown in Table-H9.

Since the data duration is only 8 years, minimum value of annual rainfall of 533.1 mm is adopted as design monthly drought rainfall in estimating the effective rainfall. The effective rainfall is estimated by using the standard table given in Table-H10 to Table-H11.

(4) Net irrigation water requirement:

The net irrigation water requirement is obtained by deducting the effective rainfall from the consumptive use for crops. The results of the calculation are shown in Table-H50.

(5) Irrigation efficiency:

The irrigation efficiency is assumed as follows:

Application efficiency (Ea)		65 %
Distribution efficiency		
Pump and stilling pond	(Ed1)	95 %
Main canal and secondary canal	(Ed2)	85 %
Irrigation efficiency		Ei = Ea x Ed1 x Ed2
		= 52.5 %

(6) Irrigation Water Requirement:

Table-H50 shows monthly irrigation water requirement, and the design irrigation water requirement is estimated at 1.44 ℓ/sec/ha, basing on the pump operation for 12 hours.

H3 SOIL WATER CHARACTERISTICS AND WATER QUALITY

H3.1 Effective Root Zone and Moisture Extraction Pattern

According to the field survey, the effective root zones of sugar cane appeared to range from 0.6 to 0.9 m. The effective root zones of other dry crops are determined on the basis of the data /3 provided by G. Hargreaves. They are summarized as follows:

Crop	Effective root zone (m)	Representative effective root zone (m)
Sugar cane	0.6 - 0.9	0.9
Beans	0.6	0.6
Maize	0.6 - 0.9	0.9
Cotton	0.9 - 1.2	1.2
Melon	0.6 - 0.75	0.75
Water Melon	0.6 - 0.75	0.75
Sorghum	0.6	0.6
Sesame	0.6 - 0.9	0.9
Pasture	0.45 - 0.75	0.75

The moisture extraction pattern of each crop is determined in accordance with the patterns proposed in "AMES Irrigation Handbook" published by W.R. AMES. The moisture extraction pattern of each crop is shown in Fig.-H29.

H3.2 Soil-Water Characteristics

According to the field investigations (cylinder intake rate test at 10 spots in the Choluteca coastal plain and 2 spots in San Juan de Flores Area) and the laboratory test on soil-water characteristics, such as i) basic intake rate, ii) field capacities, iii) wilting point, iv) available moisture, and v) readily available moisture have been estimated as follows:

/3 Source; WATER REQUIREMENTS MANUAL FOR IRRIGATED CROPS AND RAINFED AGRICULTURE, Utah State University, 1977.

H3.2.1 Basic Intake Rate

The cylinder intake rate of soils are obtained by the following formula.

$$I = KT^{n}$$

where,

I : Cylinder intake rate in mm/hr.

T : Time in minutes

k, n : Coefficient

The basic intake rate is calculated with T as 600x (1-n). The results range from 3.4 to 32.4 mm/hr as shown in Table-H62 and in Fig.-H18 to Fig.-H28.

H3.2.2 Field Capacity

Full water is supplied to soil, and then water content of the soil is measured after 24 hours. The water content of the soil is field capacity. The field capacity of the soil in the Project area was measured at the MRN laboratory in Tegucigalpa, the results are shown in Table-H63.

H3.2.3 Wilting Point

The wilting points for crops have been estimated by dividing the water contents of the soil for PF. 3.0 by 1.84. The results are shown in Table-H63.

H3.2.4 Available Moisture

The available moistures per soil depth of 10 cm are estimated by the following formula.

A.M. = (F.C - W.P) x A.S.G.

Where,

A.M. : Available Moisture in percent/10 cm

F.C : Field Capacity in percent

W.P : Wilting Point in percent

A.S.G. : Apparent Specific Gravity

The results range from 14 to 26 mm/10 cm as shown in Table-H63.

H3.2.5 Total Readily Available Moisture

On the basis of the effective root zone of each crop, moisture extraction patterns have been assumed in each soil. The available moisture calculated by the formula given in H3.2.4 was applied to the effective root zone of each crop, and according to the moisture extraction pattern on each crops, the available moisture of each soil layer have been obtained.

In calculating the moisture extractions of each soil layer, an important soil layer for growth of crops has been found, and its' moisture extraction is judged as the total readily available moisture. The results are shown in Table-H64.

H3.2.6 Irrigation Intervals

The minimum irrigation intervals of each crop are estimated by the following formula:

$$\text{Min. Irrigation Interval} = \frac{\text{Total Readily Available Moisture (mm)}}{\text{Max. Consumptive use (mm/day)}}$$

The results are shown in Table-H65.

H3.4.7 Furrow Length

The furrow intake rate test could not be carried out due to the continued rainfall during the period of field investigation. Therefore, the maximum furrow length is estimated on the basis of the cylinder intake rate and available moisture.

In accordance with the USDA-SCS standard, the soil types have been classified into the following 3 types basing on the cylinder intake rate and available moisture obtained by field and laboratory tests.

Soil Type in The Project Area

Soil Type	Available Moisture (mm/10cm)	Basic Intake Rate (mm/hr) (Slope 0-2%)
(1) Moderately coarse textured sandy loams and fine sandy loams	12.5 - 19.2	12.7 - 38.1
(2) Medium textured very fine sandy loams and silt loams	14.6 - 20.9	6.4 - 19.1
(3) Fine textured sandy clay silty clays and clay	13.4 - 20.9	2.5 - 7.6

Further, the maximum length of run for furrow under USDA-SCS standard is as follows:

Maximum Length of Runs for Furrow

(Unit: mm)

Slope %	Moderate coarse textured sandy loams and fine sandy loams	Medium textured very fine sandy loams and silt loams	Fine textured sandy clay, silty clays and clay
0.25(1/400)	456 - 319	395 - 289	350 - 250
0.50(1/200)	304 - 220	273 - 198	236 - 167
0.75(1/130)	243 - 175	213 - 152	190 - 129

The length of run for furrow on existing farm in the Project area is 200 to 250 m, and irrigation water is supplied into farm without troubles. Considering the existing furrow length and the maxium furrow length estimated for each soil type, the length of run for furrow of 200 m is adopted for the design of the irrigation systems.

H3.3 Water Quality

H3.3.1 Choluteca Coastal Plain

The water quality of the Choluteca river and groundwater in the Project area was investigated at site from August to September, 1977. PH test and electric conductivity test were carried out, and the results as presented in Table-H60 and Fig.-H30, indicate that the water quality is adequate for continued profitable agriculture, without adversely affecting the crop growth, impairing the quality of crop products, or damaging the soil on which crops are grown.

H3.3.2 San Juan de Flores Area

The water quality of the Choluteca river adjacent to the San Juan de Flores sugar cane field was investigated at site in September 1977. PH test and electric conductivity test on the water were carried out, and the results of the investigation as shown in Table-H60 and Fig.-H 31, indicate that the water quality is adequate for irrigation purpose.

H4 IRRIGATION METHOD

H4.1 Alternatives

Various alternative methods of irrigation will be conceivable in the Project area. They include:

a) Surface irrigation method:
   - furrow irrigation method
   - flooding irrigation method
   - border strip irrigation method

b) Spray irrigation method:
   - sprinkler irrigation method

c) Subirrigation method

d) Trickle irrigation method

Characteristics of each method are discussed hereunder.

(A) Surface Irrigation Method

The surface irrigation methods such as furrow irrigation method, flooding irrigation method and border stripe irrigation method are suitable for deep soils of slow, moderate and moderately rapid permeability, planted with deep-rooted crops in areas with uniform, but relatively flat slopes ranging from 0 to 3 %.

The Project area is undulated gently, and the slope of the ground surface varies within the range of 0 to 2 %. The basic intake rate calculated on the basis of the results of cylinder intake rate tests varied within the range of 3 to 32 mm/hr.

Therefore, any of the surface irrigation methods mentioned above is applicable to the Project area. However, the border strip irrigation method requires more careful land levelling than the furrow irrigation method, and the installation cost of the border strip irrigation method tends to be more expensive than that of the furrow irrigation system.

(B) Spray irrigation method

The sprinkler irrigation method is generally applicable to rapidly permeable and shallow soils in the regions where the slope is too steep or the topography is too irregular for other method and the climatic conditions are humid.

However, the sprinkler irrigation method has a disadvantage of decreasing the irrigation efficiency due to the influence of wind velocity. The monthly and seasonal average of daily maximum wind velocity at the Choluteca station are as follows:

Wind velocity

(m/sec)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average wind velocity	5.7	5.7	4.3	4.3	3.1	2.3	3.8	3.1	2.4	2.5	3.7	5.4

Note; Records during the period of 7 years (1970 - 76):

	Average Seasonal Wind Velocity (m/sec)
Dry season (Nov. - Apr.)	4.85
Rainy season (May - Oct.)	2.87

According to the wind velocity data, the lateral spacing of sprinkler is designed as 30 % of the diameter of the coverage. Accordingly, the installation cost of the sprinkler system will increase when it is designed according to the standard design criteria. Therefore, the sprinkler irrigation system is not recommended in the Project area.

(C) Subirrigation method and trickle irrigation method

From the viewpoint of irrigation water saving, these 2 artificial irrigation methods are applicable to medium to very light textured top soil and stable subsoil of moderately rapid permeability in the semi-arid and arid zones where the slope of field surface is very flat.

However, the subirrigation method and trickle irrigation method need the installation of special equipment for irrigation such as aluminum pipe lines, raisers, nozzles, vinyl pipes, etc. The installation cost of the subirrigation method and trickle irrigation method will therefore tend to be more expensive than that of the surface irrigation method.

H4.2 Recommendable Irrigation Method

The 6 alternative irrigation methods outlined above have been compared in the light of the soil water characteristics in the irrigation area as described in Chapter H3. For sugar cane and other dry crop cultivation, three alternative methods have been economically compared in detail. They are:

1) Furrow irrigation method
2) Border strip irrigation method
3) Sprinkler irrigation method

As shown in Table-H16, the furrow irrigation method appears most economical. In view of the economical viability, as well as operational simplicity, it is recommended to apply the furrow irrigation method for cultivation of sugar cane and other dry crops.

For cultivation of paddy and pasture, the flooding irrigation method will only be applicable technically and economically.

H5. DESIGN OF IRRIGATION AND DRAINAGE FACILITIES

H5.1 Irrigation System for Choluteca Coastal Plain

H5.1.1 Existing Pumping Stations of ACHSA and ACENSA

Two existing pumping stations of ACHSA and ACENSA taking irrigation water from the Choluteca river, have enough capacities and suitable operation system for irrigating approximately 1,630 ha. Accordingly, the following alternatives have been studied:

(a) Existing pumping stations remain to be utilized for the irrigation of ACHSA and ACENSA farms of 1,630 ha in the future.

(b) Gravity irrigation with water taken from the intake weir at El Papalón and distributed by the branch canal RB-1 will be newly planned.

The economic comparison of the two alternatives resulted that Plan (a) is more economical. The existing pumping stations will be planned. therefore, to be integrated in the Project.

In planning the irrigation systems, the use of the existing wells for groundwater irrigation in the ACHSA and ACENSA farms will not be considered because of the scarcity of water and difficulty in operation and maintenance of such wells.

H5.1.2 Canal Layout

Two alternative intake weir sites have been planned, one at El Papalón and the other at Las Basas so as to convey irrigation water by gravity. The irrigation systems will be divided into the Western Plain Area and the Eastern Plain Area. The overall canal layout of the Western Plain Area and Eastern Plain Area is shown in Fig.-H1.

(1) Canal Layout for Western Plain Area:

The net irrigable area is 14,370 ha excluding ACHSA and ACENSA farms of 1,630 ha (net) irrigated by the existing pumping stations. The irrigation water is taken at El Papalón intake weir, and conveyed through main canals, branch canals and secondary canals to each tertiary canal.

The net irrigable area of 3,600 ha on the left bank of the Choluteca river is irrigated by water conveyed through a siphon from the right bank.

One booster pumping station will be installed at a point 3.5 km west of the El Papalón intake weir to supply irrigation water to 350 ha (net) in the Ola area.

The total length of the canals for the Western Plain Area is as follows:

	Canal Length (km)
Main Canal	26.3
Branch Canal	46.5
Secondary Canal	84.8

(2) Canal Layout for Eastern Plain Area

The net irrigable area in the Eastern Plain Area is 9,500 ha.

The irrigation water will be taken at Las Basas located at about 5 km north of the Choluteca city, and conveyed through head reach, main canals, secondary canals and tertiary canals to each farm.

The total length of the canals for the Eastern Plain Area is summarized as follows:

	Canal Length (km)
Head reach	6.4
Main canal	17
Branch canal	22
Secondary canal	58

H5.1.3 Typical Farm Layout

Generally, topographical conditions in the Cholutec Coastal Plain is characterized by gentle undulation with the slope of less than 2%.

As discussed in Chapter H4, the furrow irrigation method (with average furrow length of 200 m) for sugar cane and other dry crops and the flooding irrigation method for rice will be applied. In deciding the service unit for irrigation, the average length of farm ditch will be set at 600 m, in view of the topographic conditions and the operation and maintenance aspects.

A typical tertiary canal will cover 12 service units. Typical farm layout below the tertiary canals is shown in PLATE No. 20 of the main report.

H5.2 Disign of Choluteca Coastal Plan Irrigation Systems

H5.2.1 Topographical Maps

In this design, topographical maps of 1/5,000 scale with one meter contour intervals covering an area of 15,820 ha on the right bank of the Choluteca river have been used. For the design of irrigation systems of the area where the large scale map is not available, the maps of 1/50,000 scale with 20 m conter intervals have been used.

For design of the intake structures, a map of 1/1.000 scale was prepared for the El Papalón and Las Basas sites during the field survey period.

H5.2.2 Design of Typical Canal Cross Sections

(1) Flow Formula

Manning's formula is adopted for design of the irrigation canals.

Manning's formula

$$V = \frac{1}{n} R^{2/3} I^{1/2}$$

$$Q = V.A$$

Where

V: Mean velocity (m/sec)

n: Coefficient of roughness

R: Hydraulic radius, A/P (m)

P: Wetted perimeter (m)

I: Hydraulic gradient

Q: Discharge (m^3/sec)

A: Flow area (m^2)

(2) Coefficient of Roughness

Adopted coefficient of roughness, n, is as follows:

	n
Concrete lined canal	0.017
Earth lined canal	0.033
Earth canal	0.035

(3) Allowable Velocity

The allowable velocity of canal flow is set within the following ranges:

	Min. (m/sec)	Max. (m/sec)
Concrete lined canal	0.5	1.5
Earth lined canal, and earth canal	0.2	0.6

(4) Canal Bottom Width (B)/Water Depth(h) Ratio

B/h ratio is determined in accordance with the empirical data mentioned in "Canal and Related Structures" published by U.S.B.R. The B/h ratio in the design of canals is shown in Table-H56.

(5) Side Slope

The side slope of each type of canal is adopted as follows:

Concrete lined canal 1:1.5

Earthen lined canal and earth canal $B \leq 0.7$ m, 1:1

Earthen lined canal and earth canal $B > 0.7$ m, 1:1.5

(6) Free Board

Free board is determined according to canal water depth, fluctuation of roughness coefficient and wave actions. However, as for the free board of head reach, main canals, branch canals and secondary canals, the peak design discharge is designed to flow within one-third of the free board in the ordinary design. Therefore, the free board on each canal is determined as shown in Table-H56.

(7) Canal Lining

Rocks, gravels and coarse sand will be underlain, and canal lining will be required to control seepage losses. Therefore, two types of canal lining is designed as follows:

Canal lining

Type of lining	Thickness of lining (cm)	Remarks
Concrete lining	10	For head reach and Main canal
Earthern lining	60	For branch canal

(8) Typical Canal Cross Section

According to the above-mentioned item (1) to (7), typical cross sections for the irrigation canals have been designed as shown in Fig.-H32 to Fig.-H34 and PLATE No.16 of the main report.

H5.2.3 Design of Structures Related to Irrigation System

A number of structures such as weirs, bifurcation structure, siphon, turnouts, cross regulators, drops, culverts, bridges, spillways, and water measuring devices are required in conjunction with the irrigation canals. The locations of these structures in the Western Plain are shown in PLATE No. 14 of the main report, and the number of the required structures is given in Table-H69.

For design of the related structures, the following flow formula and the coefficient of roughness have been applied:

Manning's formula: $V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2}$

Coefficient of roughness

Concrete structures: $n = 0.017$

Precast concrete pipe: $n = 0.016$

(1) Intake Weir

H-Q curve of the intake weir is estimated on the basis of the profile sections of the river, cross sections of the site and discharge records obtained at Los Encuentros. Peak flood discharge, 1% chance of recurrence calculated from the discharge records is estimated to be 2,600 m^3/sec at the El Papalón intake weir. The design of intake weir is shown in PLATE No. 17 of the main report, and the principal features of the intake weir are summarized as follows:

Principal Features of El Papalón Intake Weir

1.	Type of Weir	Ogee Crest Concrete Weir
2.	River Bed Elevation at Weir (m)	20.50
3.	Intake Water Level (m)	23.80
4.	Max Intake Discharge (m^3/sec)	20.45
5.	Crest Elevation of Weir (m)	23.80
6.	Flood Water Level (m)	28.40
7.	Design Flood Discharge (m^3/sec)	2,600
8.	Total Length of Weir (m)	140.0
9.	Length of Fixed Weir (m)	125.0
10.	Width of Scouring Sluice (m)	9.0
11.	Height of Weir (m)	4.8
12.	Length of Apron (m)	15.0

(2) Intake Structure

The 3 intake gates are installed at a point 22.5 m downstream from the trash rack at the intake bay for the design discharge of 20.45 m^3/sec. The intake gates are of the roller gate type with motors. The intake water level for the design discharge is fixed at 23.80 m.

(3) Desilting Basin

The desilting basin is installed at a point 13 m downstream of the intake, and designed to evacuate suspended loads of more than 1.0 cm in diameter.

(4) Booster Pumping Station

A booster pumping station is designed to supply irrigation water to the secondary canal R-0-1. The pumping station with 5 centrifugal type pumps and 1 stand-by pump is designed to be operated for 16 hours a day will have a total capacity of 44 m^3/min, with the total head of 5 m.

(5) Flood Protection Bank

The flood protection banks are required in the upstream section of El Papalón intake weir site along the Choluteca river. The crest of the banks is designed to be 1.5 m above the flood water elevation. The side slope of the banks is 1 to 2, and the crest width is 5m. The banks are required for a total length of 17 km.

(6) Bifurcation Structure

A bifurcation structure is required at the junction of headreach and main canals, to bifurcate irrigation water. The parshall flumes are also provided at the downstream of the bifurcation structure to measure and control the discharge.

(7) Siphon

A siphon is required on the branch canal RB-1 at approximately 2 km north of El Palenque to convey the canal water across the Cholateca river. The flow in the barrel is a pressure flow, and the flow velocity in the barrel is designed to be 1.5 times the velocity in the upstream canal to avoid silting.

(8) Turnouts

A turnout is a structure to distribute water from a canal to a lower grade canal. In designing, turnouts are classified into the following 3 types:

Type	Barrel	Discharge	Remarks
A-I	Box	$Q > 0.7\ m^3/sec$	For Main Brach, Secondary canal
A-II	Precast Con. Pipe	$Q \leqq 0.7\ m^3/sec$	
B		$Q < 0.7\ m^3/sec$	For tertiary canal

(9) Cross Regulators

In order to maintain a certain water level at the points of diversion or off-taking irrespective of the discharge, cross regulators are provided where a number of turnouts are densely provided or where a fairly large discharge is diverted. The following 8 types of the cross regulators are designed, according to the design discharge of the structures and types of canals.

Type	Canal	Discharge (m^3/sec)	Remarks
A-I	Concrete lining canal	$Q \geqq 19$	With double box barrels
A-II	"	$Q \geqq 19$	Flume type
A-III	"	$19 > Q \geqq 15$	With single box barrels
B-I	Earth canal	$10 > Q \geqq 0.7$	With single box barrel
B-II	"	$0.7 > Q \geqq 0.55$	With precast con. pipe
B-III	"	$0.7 > Q \geqq 0.55$	Flume type
C-I	"	$Q < 0.5$	With precast con. pipe
C-II	"	$Q < 0.5$	Flume type

(10) Drop

Drops are required where the topography along the canal has a steeper slope than that of proposed hydraulic gradient in the canal. Wooden stoplogs are provided on the structure to keep the flow velocity low and the upstream water surface high enough to permit the distribution through the upstream turnout.

The following two types of drops are designed, according to the design discharge.

Design discharge	Drop type
$Q > 2\ m^3/sec$	Inclined drop
$Q \leqq 2\ m^3/sec$	Vertical drop

(11) Culverts

Culverts are required where canals cross a farm road or a linked road. The size of culvert is determined to pass the design discharge as a free-flow with an ample clearance. The flow velocity in the barrel is designed to be 1.3 times the velocity in the adjacent canal to avoid silting.

Culverts are classified into the following two types, according to the design discharge.

Type	Design discharge
i) Precast concrete pipe type	$Q \leqq 0.7\ m^3/sec$
ii) Concrete box barrel type.	$Q > 0.7\ m^3/sec$

(12) Bridges

Bridges will be constructed at location where the width of canal is more than 10 m, as a result of the economical comparison between culverts and bridges.

The effective widths of bridges are 6 m for main farm roads and 3 m for secondary roads. Bridges are designed to pass a 30-ton trailer truck for main farm roads and a 20-ton trailer truck for secondary roads. The minimum clearance between the water surface and the girder bottom is 1.0m.

(13) Spillway

Two types of spillways are adopted in this canal system. One is a spillway with slide gate. This type of spillway is required at the end of main canals, branch canals, and secondary canals to empty the canal in case of emergency or clearing and repairing the canal. Another is an overflow type spillway. This type of spillway is provided to spill out excess water which would otherwise cause unfavorable high water surface in the canal. The discharge spilled out is released to a stream or drainage canal.

(14) Water measuring device

The day-to-day measurement of water is required to know a daily water use and to compare it with inflow, reserves and demands. This can only be accomplished by knowing, with reasonable accuracy, the amount of water being diverted, withdrawn from storage and delivered. Accurate and reliable measurement is essential for the efficient use of water, and is also needed to establish the charges to water users. In this design, on the basis of technical comparison of water measuring devices, the following two types of the measuring structures are proposed to be provided at the head of every canal.

	Measuring device	Flow condition in barrel	Remarks
Type-A	Parshall flume	Open flow	For turnouts related to Main, Branch, Secondary canal
Type-B	Constant head orifice gate	Pressure flow	For turnouts related to tertiary canal

H5.3 Design of Choluteca Coastal Plain Drainage Systems

H5.3.1 Design Surface Drainage Requirement

The drainage requirement in the Choluteca Coastal Plain has been estimated at 6.0 ℓ/sec/ha of its drainage area on the basis of the following assumptions and procedures:

(1) Design rainfall:

The design daily rainfall is determined at 148 mm, equivalent to the rainfall with 10 % chance of recurrence according to the rainfall records at Choluteca, since the rainfall pattern in the area is almost the high intensity rainfall. The probable rainfall shown in Fig.-H16 is calculated by the Gumbel method. The recorded maximum daily rainfalls at the Choluteca station are as follows:

Maximum daily rainfall (mm)

Year	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Max. daily rainfall(mm)	84	-	117	55	109	99	92	83	119	139	148	89

(2) Runoff:

In considering the rainfall consumed in farm as evapotranspiration, approximately 70% of the design rainfall is assumed to be the runoff.

(3) Drainage period:

The excess water will be designed to be drained within 2 days.

H5.3.2 Layout of Drainage System

The drainage canal layout is prepared to make maximum utilization of the numerous natural channels on the right bank of the Choluteca river. Particularly the old course of the Choluteca river will be utilized as the main drain in the drainage system.

34 main drains, 19 secondary drains, and a number of collector drains branching off from main drains and secondary drains will be provided to collect the excess water conveyed through field drains,

and release the water to the Choluteca river and other streams.

The total length of main drains is approximately 190 km, and the drainage canal layout is shown in Fig.-H1.

Numerous field drains are provided to convey the water in farms, and the layout of field drains is shown in the typical farm layout in PLATE NO. 20 of the main report.

H5.3.3 Design of Drainage Canals and Related Structures

(1) Design Criteria of Typical Drainage Sections:

a) Flow formula:

Manning's formula is adopted for the design of the drainage channels:

Manning's formula

$$V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2}$$

where,

n: Coefficient of roughness (0.035)

b) Allowable velocity:

The allowable maximum velocity of drainage flow adopted is 0.9 m/sec.

c) B/h ratio, shape of canal embankment and free board:

The B/h ratio, slope of canal embankment, and free board are determined in accordance with the same design criteria mentioned in Chapter H5.2.

(2) Typical Drainage Canal Cross Section:

On the basic design criteria mentioned under (a) to (c) above, 9-types of typical drainage canal cross sections have been designed as shown in Fig.-H34.

(3) Related Structures:

Numerous related structures such as drops, cross drains, and bridges are required in relation to the drainage canals. The number of structures required is given in Table-H69. The related structures are designed based on the same design criteria and procedures mentioned in Chapter H5.2.

H5.4 Design of Farm Road Systems

H5.4.1 Present Road Systems

Major existing asphalt paved roads in and around the Choluteca coastal plain are i) Pan American Highway running to the north of the plain, and ii) highway running from the point 8km from Choluteca city on the Pan American Highway to Cedeno. The last highway runs through the center of the right bank of the Choluteca river, along which two sugar factories and other major villages are located.

Numerous non-paved roads branch off from the above highways and from Choluteca city. However, it is necessary to establish a systematic road network to attain efficient transportation of goods and supplies to the project area, for transport of farm products, for communication between farmers' settlements, for operation and maintenance of project facilities, and for farm operation.

H5.4.2 Proposed Link Road and Farm Road Systems

(1) Link road:

A link road is proposed to be the gravel metaled road. The proposed network of link roads in the Choluteca Plain is shown in Fig.-H1. It will link up two sugar cane factories, Pan American Highway, Choluteca city and Cedeno, crossing the Choluteca river. The total length is 16 km.

(2) Farm roads:

The farm roads will be classified into the following 3 types:

(a) Main farm road

Main farm road of 78 km long is proposed along head reach, main canals and branch canals, and is designed as gravel-paved road.

(b) Secondary farm road

Secondary farm road of 118 km long is proposed along secondary canals, and is designed as non-paved road.

(c) Tertiary farm road

Numerous tertiary farm roads are proposed along tertiary canals, and typical layout is shown in PLATE NO. 20 of the main report.

H5.4.3 Design of Roads and Related Structures

(1) Design of Link Road and Farm Road:

a) Live load

Following truck load is adopted:

Class of road	load
1. Link road and main farm road	T-30
2. Secondary road	T-20
3. Tertiary road	T-14

b) Horizontal and vertical alignment:

Class of road	Slope	Max.Local slope	Max. length of local slope	Min. Radius
1. Linked road and main farm road	4 %	3 %	300 m	15 m
2. Secondary farm road	4 %	7 %	140 m	10 m
3. Tertiary farm road	4 %	7 %	140 m	10 m

c) Typical road cross section:

Typical road cross sections of the link road and the farm road are shown in PLATE NO. 16 of the main report.

(2) Design of Related Structures:

Proposed road system has numbers of related structures such as causeways, culverts, bridges and cross drains. The locations of these structures are shown in PLATE NO. 14 of the main report. The structures are designed as follows:

a) Causeway:

Causeway is proposed at the point where the link road crosses the Choluteca river, located near El Palenque. Design live load is T-20.

The causeway is designed so that the maximum clearance between the water surface and the girder bottom is kept at 0.5 m in dry season, and the structures are submerged in the water in the rainy season, because the causeways will be utilized for transporting harvested sugar cane and supplies to and from sugar cane farms in the dry season.

b) Culverts, bridges and cross drains:

The structures are designed based on the same design criteria mentioned in H5.2, since the structures are related to the proposed irrigation and drainage systems.

H5.5 On-Farm Development

H5.5.1 Land Clearance

For land preparation in the Project area, clearance of bush, stumping, removal of gravels and land grading will be necessitated. The land preparation work will carried out in the following way:

(1) Bush clearing:

The forest area is generally bush land with scattered trees. The bush is not so high and does not exceed 1 m. The bush is cut down using a rotary grass cutter pulled by a tractor, and then burnt after drying on the field.

(2) Tree felling, stumping and removal:

Following the bush clearing, tree felling is carried out by pushing over or digging out with the rake dozer. Root cutting will be necessary before pushing over some large trees. The roots remaining on the ground surface should be uprooted and taken out by scarifying the ground surface. The felled trees and the uprooted roots will be collected on the spot, and burnt after drying.

(3) Grass clearing:

The grass in the pasture land and bush land is not so high or less than 0.6 m in height. The grass is cut down using a bush cleaner, and then burnt after drying on the field.

(4) Removal of gravel and land grading:

Following the tree felling, numerous cobble stones and gravel are taken out by scarifying the ground surface with the rake dozer. Remaining small stones are taken out by man power.

After the removal of gravel and stones, minor levelling is required for upland field. More precise levelling will be required for paddy fields.

H5.5.2 On-Farm Facilities

(1) Irrigation and Drainage Facilities

The construction of irrigation and drainage facilities will cover tertiary canals, collector drains, field ditches and field drains. The capacities and sizes of the irrigation facilities vary in accordance with the size of farms, irrigation intervals and kinds of crops. However, the bottom width of the farm ditches will not be smaller than 0.3 m to permit mechanized construction.

Small embankments of canals will have a height about 0.5 m, crest width of about 0.3 m and side slopes of 1:1.0. *These on-farm facilities* are shown in PLATE NO. 20 of the main report.

(2) Initial Plowing

At the final stage of land preparation, the field is plowed up to the depth of about 0.5 m. This work is carried out by using the plow pulled by a tractor. This is the initial plowing, and further plowing and harrowing will be required before planting crops.

H5.6 Irrigation and Drainage Systems in Middle Reach Valleys and San Juan de Flores Area

H5.6.1 Layout of Irrigation System

(1) Middle Reach Valleys:

The irrigable areas in the Middle Reach Valleys are presently used for pasture land and small-scale rainfed farms, scattered on the terrace of the Choluteca river. The height of the terrace is approximately 10 m to 40 m above the river bed. The acreage of the 6 sub-areas varies within the range of 90 ha to 540 ha.

The irrigation in these sub-areas, water will be pumped up from the Choluteca river. The pumped water is designed to be stored in the stilling pool temporarily, and then conveyed to the farms through the earth canals. The canal cross section is determined by the Manning's formula. The layout of the irrigation systems in the Middle Reach Valleys is shown in PLATE NO. 15 of the main report.

(2) San Juan de Flores Area:

The rehabilitation of the existing irrigation systems in the San Juan de Flores area is being implemented by MRN. In addition to the land covered by the existing systems, there extend some lands irrigable by the Choluteca water. These irrigable lands extend in an area of 230 ha on the left bank of the Choluteca river near the bridge on the road from San Juan de Flores to Talanga, and the elevated land of 110 ha adjoining to the existing sugar cane farm. These lands totaling 340 ha can be irrigated by water to be pumped up from the Choluteca river. The layout of irrigation systems for these lands is shown in PLATE NO. 15 of the main report.

H5.6.2 Design of Pumping Station

Design of the pumping stations is prepared on the basis of the following assumptions and procedures:

(1) Design discharge:

Daily operation hour of the pump is assumed at 12 hours, in view of the actual operation hour of the existing pumping station in this area. The design discharge of the pump is determined on the basis of the proposed operation hour and the peak irrigation water requirement calculated in accordance with the proposed cropping pattern. The design discharges of the pumps are 0.198 m^3/min/ha for the Middle Reach Valleys and 0.086 m^3/min/ha for the San Juan de Flores area, as calculated in Table-H57. The minimum storage capacity of the stilling pool of the pumping station will be 3 times the design discharge of the pump.

(2) Numbers and Capacity of Pumps:

Numbers and capacity of pumps required for irrigation in the Middle Reach Valleys and San Juan de Flores area have been determined on the basis of conditions and comparison between applicability of pumps and construction costs of pumping stations:

(a) Same type of pumps will be installed to facilitate repair and maintenance.

(b) Minimum capacity of a pump will be 7.0 m^3/min, economically.

(c) A set of stand-by pump will be installed.

The applicability and suitable efficiency of the pumps will be decided on the basis of the following formula:

$$Ai = Vi/Vpi \leq 1.0$$

$$A = \sum D.Vi.Ai / \sum D.Vi$$

Where:

Ai : Applicability and suitable efficiency of pumps to monthly design discharge.

Vi : Monthly design discharge.

Vpi : Max. capacity of operating pumps.

A : Applicability and efficiency of pumping station during the whole year.

D : Numbers of days in a month.

A sample calculation is shown in Table-H58. The results of required capacity of pump and numbers of pumps at each station are shown in Table-H57.

(3) Capacity of Motor :

The capacity of motor is determined in accordance with the following formula:

$$P = \frac{K \cdot r \cdot Q \cdot H}{p} x (1 + R)$$

Where

P : Capacity of motor in kW

K : Coefficient 0.163

r : Specific gravity of water

Q : Discharge of pump in m^3/min

H : Total head of pump in m

p : Efficiency of pump

R : Efficiency of motor

The results are shown in Table-H57.

H5.6.3 Drainage Facilities

(1) Drainage Requirement :

The drainage requirement in the is estimated at 6.3 l/sec/ha in the Middle reach Valleys and at 4.6 l/sec/ha in San Fuan de Flores Area. In calculating the drainage requirement, the design rainfall has been estimated at 156 mm in the Middle Reach Valleys and 114 mm in the San Juan de Flores Area on the basis of maximum daily rainfall as tabulated hereunder.

Maximum Daily Rainfall

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Los Encuentros	77	55	67	60	64	61	165	161	64	114
Paso La Ceiba	114	191	70	76	48	38	76	68	-	-

The probable rainfall at Los Eucuentros is shown in Fig.-H17. and the average probable rainfall at Los Eucuentros and Choluteca is used as the design rainfall for the Middle Reach Valleys as calculated hereunder.

Probable Rainfall (mm)
(10% chance of recurrence)

Choluteca meteo-station	164
Los Encuentros	148
Average (Design rainfall)	156

The probable rainfall with 10% chance of recurrence at Paso la Leiba is used as the design rainfall to the San Juan de Flores Area.

(2) Drainage Systems :

Drainage system is designed to release excess rain water to the river through numerous collector drains. The design of drainage canals and related structures will be the same as that of the Choluteca coastal plain. The typical layout of the drainage canals is shown in PLATE NO. 14 of the main report.

H6. CONSTRUCTION PLAN

H6.1 Pre-construction Works

H6.1.1 Preparatory Works

The preparatory works will be required for the construction of the proposed Choluteca Plain Irrigation System, including i) assignment of consultants for the detail design and supervision of the Project, and ii) aerial photo survey and preparation of maps on a scale of 1/5,000 with one-meter contour intervals.

Aerial photo shooting and ground control survey should be started not later than November in 1978. Mapping for the Western Plain area (360 km^2) will be started in the midcourse of ground control survey, and should be finished before the commencement of the detail design works. Mapping for the remaining area (190 km^2) will be carried out when the work is required.

Other preparatory works as i) telecommunication system and ii) building should be completed prior to the tendering for construction of the intake weir, main canal and branch canals.

H6.1.2 Survey and Design

The Project is divided into 3 Construction Divisions so that the agricultural development could be implemented smoothly. The divisions are tabulated hereunder and are shown in Fig.-H3.

Construction Division

Division	Net irrigation Area
1	3,300 (ha)
2	9,100
3	3,600
Total	16,000

During the dry season from November, 1978 to the middle of May, 1979 the first field survey and detail design on the intake weir and the Division 2 will be started as soon as possible on the basis of the map prepared by IECO in 1968 on a scale of 1/5,000 with one-meter contour intervals. During the first four months, the design work should be concentrated on the building and telecommunication system.

The second field survey and detail design on the Division 1 will be carried out from the middle of February, 1980 to March 1981, and the third field survey and detail design on the Division 3 will be carried out from the middle of October, 1980 to December, 1981.

The field survey and detail design on the land preparation and the on-farm development will be carried out as follows.

Division	Period
1	Feb. 1980 - March 1981
2	Dec. 1978 - Jan. 1980
3	Oct. 1980 - Dec. 1981

H6.1.3 Tenders and Contracts

The works related to the irrigation and drainage will be contracted on a group or Division basis. For each contract about 5 months will be required from the issuance of tender notice to the award of contract. The contracts will be divided into the followings.

Group			Award
1st	1)	Aerial photo survey	1978
2nd	2)	Building	1979
	3)	Telecommunication	1979
3rd	4)	Construction of intake weir, and Division 2	1980
4th	5)	Construction of Division 1	1981
5th	6)	Construction of Division 3	1982

H6.2 Construction Plan

H6.2.1 Workable Days

The number of workable days is estimated, on the basis of the daily rainfall records for a period of 10 years obtained at the Choluteca, as well as on the basis of the following assumptions and procedures:

1) Construction work can be carried out in case the daily rainfall is less than 5 mm.
2) During the dry season from November to April, the construction work will not be carried out on Sundays and holidays.
3) During the rainy season from May to October, the construction work may be carried out even on Sundays and holidays.

The number of workable days is calculated as shown in Table-H66.

H6.2.2 Work Quantity and Construction Materials

The work quantity and construction materials have been estimated on the basis of the design for the typical area covered by maps on a scale of 1/5,000 with one-meter contour intervals.

The results are shown in Table-H70.

H6.2.3 Construction Facilities

(1) Irrigation and Drainage Canals:

Embankment material shall be the excavated materials from canals or adjacent barrow pits. Silt and sand should not be used for embankment. Compaction of the embankment will be done by tamper and tyre-roller.

The construction of irrigation and drainage canals will be carried out by using the machineries, in view of the construction period and quality control. Machinery required for the construction of the canals will include dragline, backhoe, tractor shovel, dump truck, bulldozer, motor scraper, tyre roller, motor grader and tamper. Machinery required for the concrete lining of the main canal will be concrete mixer, truck mixer, concrete pump, slopeform and vibrator.

Quality control of earth works and concrete works is required through the laboratory test during the construction period.

(2) El Papalón Intake Weir:

The construction of the intake weir will be carried out in two steps by means of coffering a half of the river course. The left side portion of the weir will be constructed in the first year and the other half of the weir will be constructed in the second year. Accordingly, the coffering with steel piles and unwatering works are needed for the construction.

Prior to the commencement of the construction, the construction of an access road of about 1.0 km long and crushing plant will be also needed.

(3) Causeway and Siphon:

Constructions of the causeway and siphon, including access roads of 0.5 km long in total, will be carried out in one dry season. The construction will be carried out in two steps by means of coffering a half of the river.

H6.2.4 Construction Machineries

The machineries required for the construction of irrigation and drainage facilities for the Western Plain area of 14,370 ha are estimated as shown in Table-H72.

H6.2.5 Construction Schedule

The construction works for the irrigation and drainage facilities have been scheduled as shown in Fig. 5 of the main report. The estimated time required for the construction is 56.5 months, including the preconstruction works.

H7. OPERATION AND MAINTENANCE

H7.1 Organization and Staff

Construction office, tentatively called on Choluteca Construction Office, will be established under the Project Manager who will be appointed by MRN. The function of Choluteca Construction Office will be land acquisition, approval of construction method, approval of construction schedule, preparation of revised design, proposal of contract amendment, progress check survey, check of quality control, approval of progress payment, progress payment to the contractors and issuance of completion certificate. The organization of Choluteca Construction Office is shown in Fig. 6 of the main report and the staffing is estimated as shown in Table-H71.

Afthe the implementation of the construction, Choluteca Construction Office will be changed to Choluteca Water Management Office for the operation and maintenance of the project. Choluteca Water Management Office will execute the operation and maintenance of irrigation, drainage and road systems of the project, including measurement of macro and micro-climates, soil moisture and distributed discharge. 5 branch offices will be established for the five branch canals, becuase of smooth operation and maintenance. The organization of Choluteca Water Management Office is shown in Fig. 8 of the main report and the staffing is estimated as shown in Table-H71.

H7.2 Buildings, Quarters and Telecommunication system

Main office. motor pool and the quarters to be constructed at Lujosa for the construction staff will be used for the operation and maintenance of the Project. 5 branch offices and their quarters will be also used for the operation and maintenance.

Telecommunication system connecting the main office to 5 branch offices gate operator at the intake site, dam site and Tegucigalpa will be necessary for the efficient operation and maintenance of the Project. VHF/UHF system is considered appropriate for such communication.

H7.3 Operation and Maintenance of Project Facilities

In accordance with the proposed cropping pattern, water will not be taken at the El Papalón intake weir during the months from August to September every year. Therefore, the maintenance of irrigation canals and related structures will be carried out during this period. The maintenance of drainage canals, farm roads and related structures will be carried out during every dry season.

H7.4 Machinery for Operation and Maintenance

Machinery required for the operation and maintenance of facilities should be delivered to the project site at the end of 1979, since the training of mechanics and operators will need training time.

H7.5 Operation and Maintenance Cost

The operation and maintenance cost of the machineries are estimated as shown in Table-H73.

Table-H1

AVAILABLE METEOROLOGICAL RECORD

Station	Record	Period
Choluteca	Temperature (Daily)	Jan. 1966-Apr. 1977 (12 years)
EL. 47.5 m	Relative humidity (Daily)	Jan. 1970-Dec. 1976 (7 years)
N. 13°18'	Rainfall (Daily)	Aug. 1963-Dec. 1975 (13 years)
W. 87°12'	Wind velocity (Daily)	Jul. 1963-Jul. 1965
		May. 1966-Sep. 1976 (14 years)
	Sunshine hour (Daily)	Jan. 1970-Jul. 1977 (8 years)
	A-pan evaporation (Daily)	Jan. 1970-Dec. 1976 (7 years)
Azucarela Choluteca	Rainfall (Monthly)	1967 - 1976 (10 years)
Los Encuentros	Rainfall (Daily)	1967 - 1976 (10 years)
EL. 100 m		
N. 13°28'		
W. 87°05'		
Paso La Ceiba	Mean. max. min.	Jan. 1972-Dec. 1976 (5 years)
EL. 670 m	temperature (Monthly)	
N. 14°10'	Relative humidity (Monthly)	Jan. 1972-Dec. 1976 (5 years)
W. 86°57'	Rainfall (Daily)	1967 - 1976 (10 years)
	A-pan evaporation (Daily)	Jan. 1972-Dec. 1974
		Jan. - Nov. 1971
		Nov. - Dec. 1975 (6 years)
		Jan. - Sep. 1976
	Piche evaporation	Jan. 1971-Sep. 1976 (6 years)
Tegucigalpa	Temperature (Monthly)	Jan. 1951-Dec. 1976 (26 years)
EL. 1,007 m	Relative humidity (Daily)	Jan. 1970-Dec. 1974 (5 years)
N. 14°03'	Rainfall (Monthly)	Jan. 1938-Dec. 1972 (35 years)
W. 87°13'	Wind velocity (Monthly)	Jan. 1950-Dec. 1974 (25 years)
	Extream max. wind velocity	1971, 1972

Station	Record	Period
	Radiation (Daily)	Jan. 1970-Dec. 1975 (5 years)
	Cloud cover (Monthly)	Jan. 1945-Dec. 1975 (31 years)
	Atomospheric pressure (Monthly)	Jan. - Dec. 1970 (1 year)
	Piche evaporation (Monthly)	Jan. 1970-Dec. 1976 (7 years)
La Venta	Relative humidity (Monthly)	Jan. 1972-Dec. 1976 (5 years)
EL. 890 m	Temperature (Monthly)	Jan. 1972-Dec. 1976 (5 years)
N. 87°00'	A-pan evaporation (Daily)	Jan. 1972-Oct. 1975
W. 14°19'		May 1970 (7 years)
		Jan.-Sep., Nov.-Dec. 1976

Table-H2 ESTIMATED AVERAGE POTENTIAL EVAPOTRANSPIRATION (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
A-pan (6 years)	290.3	308.2	314.5	282.6	186.9	170.7	200.4	169.4	147.7	159.7	195.3	251.7	2,587.9
Modified Blaney Cliddle (7 years)	229.1	209.4	212.0	184.8	147.9	138.3	145.1	135.5	126.6	125.6	116.7	263.7	1,983.7
Modified Penman (7 years)	270.3	265.7	267.8	274.0	211.4	170.1	233.1	195.3	156.3	151.9	204.9	257.6	2,658.4
Christiansen - Hargreaves (6 years)	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9	2,517.9
Hargreaves(10 years)	305.2	290.3	321.0	317.9	208.7	149.7	234.3	193.8	117.8	135.3	206.3	277.0	2,757.3

Table-H3 EVAPORATION AT CHOLUTECA METEO-STATION (Class A-Pan) (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1970	321.0	403.0	336.2	318.8	223.2	164.0	153.0	171.1	202.5	180.2	278.8	238.0	3,034.3
1971	313.5	254.1	355.9	295.1	191.3	203.4	183.6	143.2	104.1	144.4	146.9	219.6	2,423.5
1972	255.7	304.1	296.9	278.8	-	172.1	223.2	236.8	158.0	184.7	151.8	285.8	2,547.9
1973	330.8	322.4	272.8	242.5	223.0	148.4	175.0	151.7	114.2	103.4	178.9	234.2	2,497.3
1974	259.0	296.2	307.2	344.4	180.1	179.4	225.7	127.0	143.6	243.1	264.0	259.1	2,679.0
1975	270.1	247.3	306.1	307.1	206.4	174.2	230.2	169.4	159.4	137.9	187.9	231.7	2,468.7
1976	281.8	330.4	326.3	192.3	97.2	153.1	212.3	186.9	152.0	124.5	159.0	248.5	2,464.3
Average	290.3	308.2	314.5	282.6	186.9	170.7	200.4	169.4	147.7	159.7	195.3	251.7	2,587.9

Table-H4 POTENTIAL EVAPOTRANSPIRATION AT CHOLUTECA METEO-STATION

A) Christiansen-Hargreaves method

Unit: mm

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total (mm)
1970	269.8	301.5	274.7	274.4	199.3	144.5	145.0	134.3	98.5	122.9	162.3	274.1	2,401.3
1971	305.6	277.3	297.6	269.3	189.3	159.8	232.4	119.3	79.9	100.3	162.0	270.8	2,463.6
1972	301.0	284.7	289.8	280.8	159.0	153.5	272.1	243.6	184.8	168.4	195.8	308.3	2,791.8
1973	328.8	312.6	274.6	258.3	203.1	138.8	177.7	113.9	90.3	88.5	215.6	253.8	2,456.0
1974	269.8	275.3	309.6	352.7	223.7	132.6	239.9	220.8	89.7	169.6	247.9	272.2	2,803.8
1975	276.6	237.5	250.7	269.7	164.9	164.1	164.6	133.3	71.3	97.3	138.2	222.1	2,190.3
Average	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9	2,517.9

B) G. Hargreaves method

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total (mm)
1966	-	-	380.1	368.7	276.9	182.0	246.9	251.2	182.8	196.3	295.7	326.1	-
1967	354.5	322.8	355.2	349.6	382.7	194.1	265.1	278.7	138.4	179.5	255.7	300.9	3,377.2
1968	360.9	309.4	379.1	346.1	199.2	118.8	277.4	288.5	118.7	143.7	186.4	299.9	3,028.1
1969	310.6	310.8	343.6	315.1	210.9	93.9	232.0	120.0	127.5	99.1	203.4	267.4	2,634.3
1970	280.0	302.5	299.5	308.3	199.7	-	145.8	127.3	91.2	115.3	143.0	234.8	-
1971	272.7	267.6	295.9	252.2	184.9	150.3	253.2	111.5	76.6	91.9	154.2	253.8	2,364.8
1972	285.1	259.3	286.2	293.5	170.3	153.0	281.6	251.2	191.1	162.0	204.8	320.9	2,859.0
1973	307.3	299.7	289.0	299.4	225.5	145.4	186.1	105.9	85.2	78.1	212.4	245.3	2,479.3
1974	277.9	270.5	313.4	344.7	49.7	135.3	271.0	257.6	89.8	183.5	258.9	293.0	2,745.3
1975	297.7	260.4	267.5	301.3	187.5	174.4	183.4	146.2	76.6	103.9	148.1	231.7	2,378.6
Average	305.2	290.3	321.0	317.9	208.7	149.7	234.3	193.8	117.8	135.3	206.3	277.0	2,757.3

C) Modified Blaney criddle

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total (mm)
	229.1	209.4	212.0	184.8	147.9	138.3	145.1	135.5	126.6	125.6	116.7	212.7	1,983.7

D) Modified Penman method.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total (mm)
	270.3	265.7	267.8	274.0	211.4	170.1	233.1	195.3	156.3	151.9	204.9	257.6	2.658.4

Table-H5 AVERAGE MONTHLY RAINFALL OF RECORDS AT CHOLUTECA METEO-STATION AND AZUCARERA CHOLUTECA SUGAR CANE FARM (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1967	0	1	27	34	4	378	96	152	289	144	16	20	1,161
1968	0	0	0	27	442	590	105	198	441	377	70	1	2,251
1969	6	0	17	65	187	358	185	425	447	506	69	0	2,265
1970	0	0	0	47	234	222	431	386	500	249	115	1	2,185
1971	1	1	0	1	335	186	112	378	345	408	113	1	1,881
1972	0	0	49	27	326	231	204	131	178	216	48	0	1,410
1973	0	0	2	24	212	272	240	502	580	534	10	22	2,398
1974	0	0	0	0	214	384	39	203	544	138	22	1	1,545
1975	1	0	2	0	243	117	178	280	522	330	287	0	1,708
Average	0.9	0.2	10.8	25	244.1	304.2	176.7	295	427.3	322.4	83.3	5.1	1,867.1
Proportion (%)	0	0	0.2	1.2	13.0	16.2	9.4	15.7	22.8	17.1	4.3	0.1	100

Table-H6 EFFECTIVE RAINFALL CALCULATED BY DAILY WATER BALANCE METHOD BASED ON RECORDS IN CHOLUTECA METEO-STATION (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1967	0	0	38.4	50.4	0	156.3	70.8	139.2	206.2	60	10.4	0	731.7
1968	0	0	0	10.4	324.6	171.0	48.8	87.0	201.3	203.7	27.2	0	1,074
1969	0	0	24.8	54.0	226.0	275.0	122.9	237.3	271.3	187.1	48.8	0	1,447.2
1970	0	0	0	53.6	204.7	0	323.8	225.4	163.4	172.0	16.2	0	1,159.1
1971	0	0	0	0	92.7	148.0	81.6	166.5	207.6	191.6	42.7	0	930.7
1972	0	0	0	18.4	189.3	168.8	97.7	91.1	93.6	200.0	41.6	0	900.5
1973	0	0	0	0	178.3	201.6	107.4	233.2	85.8	188.4	31.2	0	1,025.9
1974	0	0	0	0	127.2	211.3	19.2	117.6	202.5	70.7	25.8	0	774.3
1975	0	0	0	0	248.0	101.6	80.9	134.4	401.5	302.4	153.6	0	1,422.4
Average rainfall	0	0	7	21	177	159	106	159	204	175	44	0	1,052
Proportion (%)	0	0	0.6	2	16.8	15.1	10	15.1	19.4	16.8	4.2	0	100
Probable effective rainfall	0	0	4	15	124	111	74	111	144	124	31	0	738

Table-H7 AVERAGE MONTHLY RAINFALL OF RECORDS AT LOS ENCUENTROS AND CHOLUTECA METEO-STATION (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1967	0	1	47	52	5	303	71	139	284	75	7	3	987
1968	0	0	0	12	463	480	73	100	440	345	37	1	1,951
1969	9	1	29	82	320	364	164	331	368	460	38	5	2,171
1970	0	0	2	49	271	151	333	354	460	235	74	1	1,930
1971	1	1	0	1	297	119	72	293	355	299	77	1	1,516
1972	0	0	49	5	222	236	113	139	83	196	38	0	1,081
1973	0	0	2	1	201	237	185	364	414	463	6	20	1,893
1974	0	0	0	0	298	280	18	140	482	64	22	1	1,305
1975	1	0	11	2	286	89	146	143	537	288	183	0	1,686
Average Rainfall	1	0	16	23	231	251	131	223	380	269	54	4	1,583
Proportion (%)	0	0	1	1.5	14.6	15.9	8.3	14.1	24	17	3.4	0.2	100
Probable Rainfall	0	0	11.5	17.3	168.6	183.6	95.9	162.9	277.2	196.4	39.3	2.3	1,155

Table-H8 AVERAGE MONTHLY MEAN TEMPERATURE, RELATIVE HUMIDITY AND EVAPORATION AT PASO LA CEIBA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
Temperature (°C)	23.1	24.1	26.4	27.6	27.3	25.6	25.1	25.2	25.2	24.4	23.9	22.5	
Relative Hum. (%)	71.8	69.8	65.3	63.0	67.8	75.3	72.0	72.8	73.2	77.0	74.3	75.7	
Evaporation													
A-pan (mm)	110.7	130.6	184.6	189.2	172.5	129.6	125.5	128.8	122.4	111.1	93.0	99.1	1,497.1
Picho Eva. (mm)	121.4	141.8	210.3	218.0	176.0	104.3	105.8	108.7	91.1	84.5	85.0	110.0	1,556.6

Table-H9 MONTHLY MEAN RAINFALL AT PASO LA CEIBA (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
1967	38.1	25.1	38.1	228.6	127.0	431.8	292.1	152.4	533.3	152.4	63.5	76.2	2,158.9
1968	12.7	63.5	0	0	977.9	330.2	248.9	383.5	802.6	419.0	284.4	91.4	3,614.1
1969	4.7	0.5	0.8	1.0	26.3	85.1	89.0	29.7	217.9	267.7	58.4	12.6	793.7
1970	10.5	1.6	0	34.6	178.2	160.4	209.7	102.8	174.1	82.2	30.5	44.1	1,028.7
1971	18.1	5.1	0	3.0	95.3	79.7	95.2	192.3	122.7	171.0	49.1	17.4	848.9
1972	9.7	2.4	0	0.8	134.5	131.6	59.1	91.7	43.8	27.1	26.0	6.4	533.1
1973	9.1	0	0	37.9	158.4	133.9	139.8	121.3	71.2	237.3	18.6	10.8	938.3
1974	11.5	1.5	6.3	6.9	152.0	89.5	69.0	127.9	218.0	145.1	34.7	16.6	879.0
Average	14.3	12.5	5.7	39.1	231.2	180.3	150.4	150.2	273.0	187.7	70.7	34.4	1,349.3

Table-H10 MULTIPLICATION FACTORS TO RELATE MONTHLY EFFECTIVE RAINFALL VALUE OBTAINED FROM TABLE-H11 TO NET DEPTH OF IRRIGATION APPLICATION

d 1/ mm	Factor	d mm	Factor	d mm	Factor
10.00	0.620	31.25	0.818	70.00	0.990
12.50	0.650	32.50	0.826	75.00	1.000
15.00	0.676	35.00	0.842	80.00	1.004
17.50	0.703	37.50	0.860	85.00	1.008
18.75	0.720	40.00	0.876	90.00	1.012
20.00	0.728	45.00	0.905	95.00	1.016
22.50	0.749	50.00	0.930	100.00	1.020
25.00	0.770	55.00	0.947	125.00	1.040
27.50	0.790	60.00	0.963	150.00	1.060
30.00	0.808	65.00	0.977	175.00	1.070

Note: d is net depth of irrigation application.

Table-H11 AVERAGE MONTHLY EFFECTIVE RAINFALL AS RELATED TO MEAN MONTHLY RAINFALL AND MEAN MONTHLY CONSUMPTIVE USE (USDA, SCS)

Monthly mean rainfall (mm)	Mean monthly consumptive use(mm)													
	25	50	75	100	125	150	175	200	225	250	275	300	325	350
	Mean monthly effective rainfall(mm)													
12.5	7.5	8.0	8.7	9.0	9.2	10.0	10.5	11.2	11.7	12.5	12.5	12.5	12.5	12.5
25.0	15.0	16.2	17.5	18.0	18.5	19.7	20.5	22.0	24.5	25.0	25.0	25.0	25.0	25.0
37.5	22.5	24.0	26.2	27.5	28.2	29.2	30.5	33.0	36.2	37.5	37.5	37.5	37.5	37.5
50.0	25	32.2	34.5	35.7	36.7	39.0	40.5	43.7	47.0	50.0	50.0	50.0	50.0	50.0
62.5	at 41.7	39.7	42.5	44.5	46.0	48.5	50.0	53.7	57.5	62.5	62.5	62.5	62.5	62.5
75.0		46.2	49.7	52.7	55.0	57.5	60.2	63.7	67.5	73.7	75.0	75.0	75.0	75.0
87.5		50.0	56.7	60.2	63.7	66.0	69.7	73.7	77.7	84.5	87.5	87.5	87.5	87.5
100.0		at 80.7	63.7	67.7	72.0	74.2	78.7	83.0	87.7	95.0	100	100	100	100
112.5			70.5	75.0	80.2	82.5	87.2	92.7	98.0	105	111	112	112	112
125.0			75.0	81.5	87.7	90.5	95.7	102	108	115	121	125	125	125
137.5			at 122	88.7	95.2	98.7	104	111	118	126	132	137	137	137
150.0				95.2	102	106	112	120	127	136	143	150	150	150
162.5				100	109	113	120	128	135	145	153	160	162	162
175.0				at 160	115	120	127	135	143	154	164	170	175	175
187.5					121	126	134	142	151	161	170	179	185	187
200.0					125	133	140	148	158	168	178	188	196	200
225					at 197	144	151	160	171	182				
250						150	161	170	183	194				
275						at 240	171	181	194	205				
300							175	190	203	215				
325							at 287	198	213	224				
350								200	220	232				
375								at 331	225	240				
400									at 372	247				
425										250				
										at 412				
450	25	50	75	100	125	150	175	200	225	250				

Table-H12 PRESENT IRRIGATION SYSTEM IN CHOLUTECA PLAIN

A) SURFACE WATER

Name	Source	Irrigable Area (ha)	Crops	Methods
1. ACHSA	Choluteca river	990	Sugar cane	Pump-Gravity
2. Experimental farm Lujosa	"	30	Rice sorghum, Beans, etc.	"
3. Oscar Narvaez	"	34	Rice, Beans, etc.	"
4. Abraham Williams		40	Pasture etc.	"
5. Mr Flores		21	Sorghum, Maize etc.	"
6. David Moran		35	Rice etc.	"
7. Abiloo Martinez		100	Rice etc.	"
8. ACENSA	Right bank Left bank	420 360	Cane Cane	" "
Total		2,030		

B) GROUND WATER

Name	No. of Wells	Irrigable Area (ha)	Crops	Methods
1. ACHSA	18	760	Sugar cane	Gravity
2. ACENSA	20	860	"	"
3. Buenavist coop.	9	216	"	"
4. Fuerzas Onidas Coop.	-	42	"	"
5. Herrado Coop.	-	66	"	"
6. Independence Coop	-	74	"	"
7. Cesar Ortega	2	55	Rice	"
8. Andres Lardizabal	4	155	"	"
9. Luis Lardizable	1	34	"	"
10. Roberto Pliva	1	35	"	"
11. Jorge Maradiaga	1	20	Rice Sorghum Cantaloupe	"
12. Carnery Union	-	18	Sugar cane	"
Total		2,335		

Table-H13 OUTLINE OF PRESENT IRRIGATION SYSTEM (OROCUINA AREA)

Name of project	Location	Irrigable Area (ha)	Crops	Irrigation method	Pump capacity m3/min	Water source
1. Las sabilas	Apacilagua	210	Rice, Maize Sorghum sesame	Pump station Gravity	27.75	Choluteca river
2. Asent. Las Sabilas	"	20	Rice Sesame	"	2.86	"
3. Asent. La Trinidad	Orocuina	17	Sorghum Sesame Water melon	"	4.63	"
4. Asent. Son Rafael	Las Basas	18	Sorghum Sesame Melon	"	2.86	"
5. Pre-Coop. El Brasil	Choluteca	45	Rice Sorghum	"	2.18	"
6. Asent. Los Limones	Limon de la cerca	20	Rice Sorghum Sesame	"	4.63	"
Total		330				

Table-H14 PUMP CAPACITY OF EXISTING PUMPINT STATION

Name of Sugar factory	Location	Present condition: Capacity of pump station	Present condition: Estimated operation hour	Present condition: Estimated net irrigable area	In future: Proposed operation hour	In future: Net irrigable area/1
A) ACENSA	El Carera	87.2 m^3/min.	12 hr	420 ha	9 hr	420 ha
	La Sombra	79.6 m^3/min.	12 hr	360 ha	8 hr	360 ha
B) ACHSA	Los Mangles	68.2 m^3/min.	12 hr	990 ha	12 hr	850 ha
		45.5 m^3/min.	12 hr			
					Total	1,630 ha

Note: /1 Diversion water requirement is 1.16 ℓ/sec/ha.

Table-H15 ECONOMIC COMPARISON ON EXISTING PUMPING STATION

Pump irrigation method V.S. Gravity method

Net irrigable area (1,270 ha)
Right bank of the Choluteca river

		Pump Irr. method ($)	Gravity method ($)
A)	*Initial construction cost*		
	Earth works	-	4,300
	Concrete works	-	304,000
	Stand by pump and Mortor	-	-
	Total ($/ha)	- (-)	308,300 (242.8)
B)	*Operation and Maintenance cost*		
	Operation cost	20,300	-
	Maintenance cost	-	2,900
	Total ($/ha/year)	20,300 (18.5)	2.900 (2.7)
C)	Replacement cost		
	Pump and Mortor $/ha/year	14.8	-
D)	Salvage value		
	$/ha/year	1.5	-

Table-H16 COMPARISON OF IRRIGATION METHODS

	Surface irrigation method		Spray irrigation method
	Furrow irrigation method	Border strip irrigation method	Sprinkler irrigation method
A) Advantages	Cheaper installation cost for the soils of slow and moderate permeability rating	Cheaper installation cost for the soils of slow and moderate permeability rating	Applicable to any type of soil of slow to rapidly permeability rating
	Not affected by the wind during the period of irrigation	Not affected by the wind during the period of irrigation	Saves the irrigation water when compared with the surface irrigation method
	Does not flush out the agricultural chemicals sprayed on the crops	Does not flush out the agricultural chemicals sprayed on the crops	Applicable to the steep slope of the ground surface ranging within 0 to 12 %
	No water loss out of farms when compared with the sprinkler irrigation method	No water loss out of farms when compared with the sprinkler irrigation method	Able to spray the agricultural chemicals
	Able to control the alignment of furrow run in the areas with the slope of the ground surface ranging within 0 to 3 %		Protects the ground surface from erosion
			Able to control the irrigation water

	Surface irrigation method		Spray irrigation method
	Furrow irrigation method	*Border strip irrigation method*	Sprinkler irrigation method
B) Disadvantages	Small scale land levelling in the area with the uneven slope is necessary	Land levelling of farm is required	The installation cost tends to increase when compared with the surface irrigation method
	Requires much irrigation water due to poor irrigation efficiency	Requires much irrigation water due to poor irrigation efficiency	Promotes diseases, on the crops
	Tends to cause soil baking, soil crust, and erosion in farm and furrow run	Tends to cause soil baking, soil crust, and erosion in farm and furrow run	Flushes out the agricultural chemicals
	Requires labour for operation and maintenance during the whole period of irrigation	Requires labour for operation and maintenance during the whole period of irrigation	Sprays the water out of farm
			Tends to decrease the irrigation efficiency under the influence of wind

Table-H17 IRRIGATION WATER REQUIREMENT OF WESTERN PLAIN AREA
(PROJECT AREA)

TYPE	AREA (100 ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.		161.3	147.1	137.5	132.8	23.5	0	52.5	0	0	0	76.4	163.5
	51.3	58.2	53.1	49.7	48.0	8.4	0	19.1	0	0	0	27.4	59.0
2.		113.8	19.7	60.4	154.0	106.1	0	0	0	0	0	108.4	210.9
	35	27.8	4.8	14.8	37.6	25.9	0	0	0	0	0	26.5	51.5
3.		113.8	19.7	65.9	165.0	1.8	0	0	0	0	0	108.4	210.9
	8	6.3	1.1	3.7	9.2	0.1	0	0	0	0	0	6.1	11.8
4.		113.8	19.7	54.9	151.5	0	0	0	0	0	0	108.4	210.9
	8	6.3	1.1	3.7	9.2	0	0	0	0	0	0	6.1	11.8
5.		224.8	112.6	19.2	45.9	0	0	0	0	0	0	24.8	184.2
	8	12.5	6.3	1.1	2.6	0	0	0	0	0	0	1.4	10.3
6.		8.0	0	5.5	45.9	0	0	0	0	0	0	44.6	66.7
	4	0.2	0	0.2	1.3	0	0	0	0	0	0	1.2	1.9
7.		140.1	70.4	13.7	45.9	0	0	0	0	0	0	0	98.8
	4	3.9	2.0	0.4	1.3	0	0	0	0	0	0	0	2.8
8.		256.4	207.4	207.0	322.3	166.5	104.1	78.5	0	0	52.4	242.3	365.2
	16	28.6	22.2	23.1	36.0	18.6	11.6	8.8	0	0	5.9	27.1	40.7
9.		329.4	230.8	225.1	220.6	16.8	0	65.1	0	0	0	123.2	218.9
	1.4	2.3	1.6	1.6	1.5	0.1	0	0.5	0	0	0	0.9	1.5
10.		129.9	125.3	122.0	116.5	0	0	2.7	0	0	0	38.7	118.8
	8	7.3	7.0	6.8	6.5	0	0	0.2	0	0	0	2.2	6.6
TOTAL AREA	143.7												
AVERAGE NET IRR. REQ. (mm/month)		153.4	99.2	105.1	153.2	53.1	11.6	28.6	0	0	5.9	98.9	197.9
IRRIGATION EFFICIENCY 52.5 %													
IRRIGATION WATER REQ. (mm/month)		292.2	189.0	200.2	291.8	101.1	22.1	54.5	0	0	11.2	188.4	377.0

Table-H18 IRRIGATION WATER REQUIREMENT OF DIVISION 3

TYPE	AREA (100 ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.		161.3	147.1	137.5	132.8	23.5	0	52.5	0	0	0	76.4	163.5
	0												
2.		113.8	19.7	60.4	154.0	106.1	0	0	0	0	0	108.4	210.9
	13	41.1	7.1	21.8	55.6	38.3	0	0	0	0	0	39.1	76.2
3.		113.8	19.7	65.9	165.0	1.8	0	0	0	0	0	108.4	210.9
	4	12.6	2.2	7.3	18.3	0.2	0	0	0	0	0	12.1	23.4
4.		113.8	19.7	54.9	151.5	0	0	0	0	0	0	108.4	210.9
	4	12.6	2.2	6.1	16.8	0	0	0	0	0	0	12.1	23.4
5.		224.8	112.6	19.2	45.9	0	0	0	0	0	0	24.8	184.2
	4	25.0	12.5	2.1	5.1	0	0	0	0	0	0	2.7	20.5
6.		8.8	0	5.5	45.9	0	0	0	0	0	0	44.6	66.7
	1	0.2	0	0.2	1.3	0	0	0	0	0	0	1.2	1.9
7.		140.1	70.4	13.7	45.9	0	0	0	0	0	0	0	98.8
	1	3.9	2.0	0.4	1.3	0	0	0	0	0	0	0	2.7
8.		256.4	207.4	207.0	322.3	166.5	104.1	78.5	0	0	52.4	242.3	365.2
	7	49.9	40.3	40.2	62.7	32.4	20.2	15.3	0	0	10.2	47.1	71.0
9.		239.4	230.8	225.1	220.6	16.8	0	65.1	0	0	0	123.2	218.9
	0												
10.		129.9	125.3	122.0	116.5	0	0	2.7	0	0	0	38.7	118.8
	2	7.2	7.0	6.8	6.5	0	0	0.1	0	0	0	2.1	6.6
TOTAL AREA	36												
AVERAGE NET IRR. REQ. (mm/month)		152.5	73.3	84.9	167.6	70.9	20.2	15.4	0	0	10.2	116.4	225.7

IRRIGATION EFFICIENCY 52.5 %

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
IRRIGATION WATER REQ. (mm/month)		290.5	139.6	161.7	319.2	135.0	38.5	29.3	0	0	19.4	221.7	429.9

Table-H19 NET IRRIGATION WATER REQUIREMENT OF TYPE 1

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
SEED CANE												2.7
	26.3	56.3	87.8	120.4	0	0	67.4	0	0	0	0	109.4
	73.0	33.8	5.5									
TOTAL	99.3	90.1	93.3	120.4	0	0	67.4	0	0	0	0	112.1
TOTAL x 1.5% (mm/month)	1.5	1.4	1.4	1.8	0	0	1.0	0	0	0	0	1.7
PLANT CANE									0	0	0	77.4
	119.7	152.0	183.9	201.1	141.3	0	64.6	0	0	0	90.3	154.8
	122.6	76.0	35.7	0								
TOTAL (mm/month)	242.3	228.0	219.6	201.1	141.3	0	64.6	0	0	0	90.3	232.2
RATOON-CANE											0	26.7
	55.5	84.5	115.3	148.4	0	0	62.3	0	0	0	92.1	160.1
	125.5	78.8	35.7	0								
TOTAL (mm/month)	181.0	163.3	151.0	148.4	0	0	62.3	0	0	0	92.1	186.8
TOTAL x 4 (mm/month)	724.0	653.2	604.0	593.6	0	0	249.2	0	0	0	368.4	747.2
GRAND TOTAL (mm/month)	967.8	882.6	825.0	796.5	141.3	0	314.8	0	0	0	458.7	981.1
NET. IRR. WATER REQ. (1/6) (mm/month)	161.3	147.1	137.5	132.8	23.5	0	52.5	0	0	0	76.4	163.5

Table-H20 NET IRRIGATION WATER REQUIREMENT OF TYPE 2

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
MAIZE		5.6	60.4	154.0	106.1	0	0					
COTTON	113.8	14.1					0	0	0	0	108.4	210.9
TOTAL NET IRR. WATER REQ. (mm/month)	113.8	19.7	60.4	154.0	106.1	0	0	0	0	0	108.4	210.9

Table-H21 NET IRRIGATION WATER REQUIREMENT OF TYPE 3

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
SORGHUM		5.6	65.9	165.0	1.8	0	0					
COTTON	113.8	14.1					0	0	0	0	108.4	210.9
TOTAL NET IRR. WATER REQ. (mm/month)	113.8	19.7	65.9	165.0	1.8	0	0	0	0	0	108.4	210.9

Table-H22 NET IRRIGATION WATER REQUIREMENT OF TYPE 4

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
BEANS		5.6	54.9	151.5	0	0	0					
COTTON	113.8	14.1					0	0	0	0	108.4	210.9
TOTAL NET IRR. WATER REQ. (mm/month)	113.8	19.7	54.9	151.5	0	0	0	0	0	0	108.4	210.9

Table-H23 NET IRRIGATION WATER REQUIREMENT OF TYPE 5

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
MAIZE			5.5	45.9	0	0	0	0				
SESAME	224.8	112.6	13.7							0	24.8	184.2
TOTAL NET IRR. WATER REQ. (mm/month)	224.8	112.6	19.2	45.9	0	0	0	0	0	0	24.8	184.2

Table-H24 NET IRRIGATION WATER REQUIREMENT OF TYPE 6

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
MAIZE			5.5	45.9	0	0	0	0				
MELON	8.8							0	0	0	44.6	66.7
TOTAL NET IRR. WATER REQ. (mm/month)	8.8	0	5.5	45.9	0	0	0	0	0	0	44.6	66.7

Table-H25 NET IRRIGATION WATER REQUIREMENT OF TYPE 7

NET IRRIGATION WATER REQ.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
MAIZE			5.5	45.9	0	0	0	0				
WATER MELON	140.1	70.4	8.2							0	0	98.8
TOTAL NET IRR. WATER REQ. (mm/month)	140.1	70.4	13.7	45.9	0	0	0	0	0	0	0	98.8

Table-H26 NET IRRIGATION WATER REQUIREMENT OF TYPE 8

NET IRRIGATION WATER REQ.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
RICE		100.9	207.0	322.3	166.5	104.1	78.5					
RICE	256.4	106.5						-	0	52.4	242.3	365.2
TOTAL NET IRR. WATER REQ.	256.4	207.4	207.0	322.3	166.5	104.1	78.5	0	0	52.4	242.3	365.2

(mm/month)

Table-H27 NET IRRIGATION WATER REQUIREMENT OF TYPE 9

NET IRRIGATION WATER REQ.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PASTURE	239.4	230.8	225.1	220.6	16.8	0	65.1	0	0	0	103.2	218.9
TOTAL NET IRR. WATER REQ.	239.4	230.8	225.1	220.6	16.8	0	65.1	0	0	0	103.2	218.9

(mm/month)

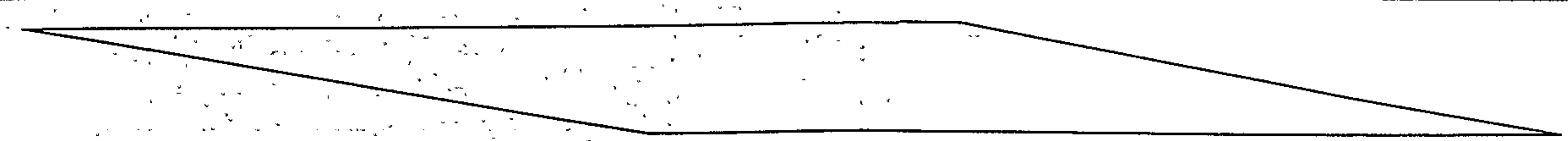
Table-H28 NET IRRIGATION WATER REQUIREMENT OF TYPE 10

NET IRRIGATION WATER REQ.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
VEGETABLE	129.9	125.3	122.0	116.5	0	0	2.7	0	0	0	38.7	118.8
TOTAL NET IRR. WATER REQ.	129.9	125.3	122.0	116.5	0	0	2.7	0	0	0	38.7	118.8

(mm/month)

Table-H29 NET IRRIGATION WATER REQUIREMENT OF SEED CANE

DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR

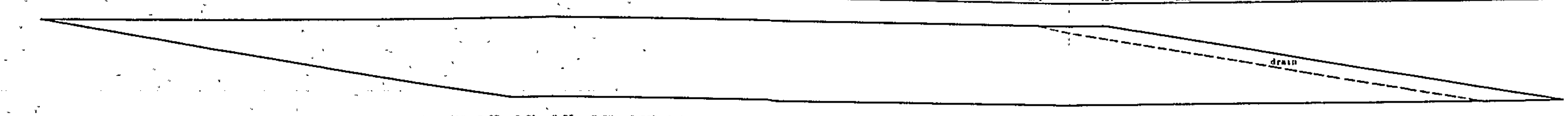


Kc	0.505	0.545	0.595	0.650	0.710	0.765	0.815	0.875	0.915	0.975	0.995	0.99	0.955	0.895	0.835	0.785	0.725	0.620												
Kc x 1/12 Area	0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026											
		0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026										
			0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026									
				0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026								
					0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026							
						0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026						
							0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026					
								0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026				
									0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026			
										0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026		
											0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026	
												0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026
Seasonal Variation of Kc	0.021	0.065	0.113	0.165	0.222	0.284	0.350	0.421	0.496	0.576	0.658	0.711	0.801	0.834	0.858	0.874	0.880	0.874	0.834	0.763	0.688	0.608	0.526	0.443	0.362	0.285	0.213	0.145	0.082	0.026

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Seasonal Variation of Kc	0.01	0.09	0.20	0.32	0.46	0.62	0.78	0.85	0.88	0.86	0.73	0.57	0.41	0.25	0.12	0.02
Potential Evapotranspiration	266.9	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9	291.9	281.5	274.5
Consumptive Use	2.7	26.3	56.3	87.8	130.7	117.7	116.1	174.5	141.6	88.1	90.9	106.6	109.4	73.0	33.8	5.5
Precipitation	1.5	0	0	2.9	17.4	188.8	235.2	136.5	228.0	331.0	218.3	62.4	1.5	0	0	2.9
Effective Rainfall	0	0	0	0	10.3	128.8	128.8	107.1	154.5	103	103	47.4	0	0	0	0
Net Irrigation Water Req.(mm/month)	2.7	26.3	56.3	87.8	120.4	0	0	67.4	0	0	0	0	109.4	73.0	33.8	5.5

Table-H30 NET IRRIGATION WATER REQUIREMENT OF PLANT CANE

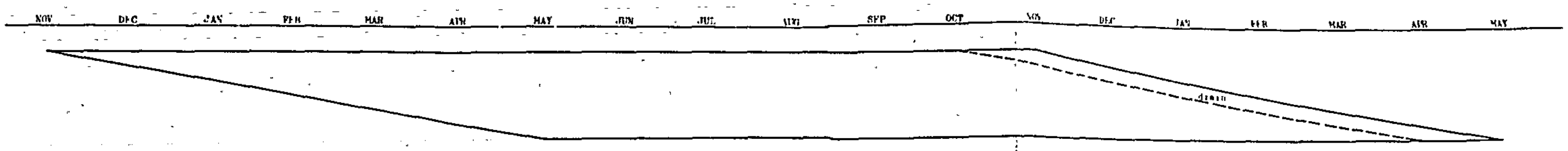
SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY



Kc	0.50	0.525	0.555	0.585	0.615	0.650	0.685	0.120	0.760	0.795	0.830	0.87	0.91	0.95	0.98	0.995	1.000	0.995	0.980	0.955	0.920	0.880	0.840	0.805	0.775	0.735												
Kc x 1/12 Area	0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031											
"		0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031										
"			0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031									
"				0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031								
"					0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031							
"						0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031						
"							0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031					
"								0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031				
"									0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031			
"										0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031		
"											0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031	
"												0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031
Seasonal Variation of Kc	0.021	0.064	0.109	0.157	0.207	0.26	0.316	0.375	0.437	0.502	0.57	0.641	0.694	0.729	0.765	0.799	0.832	0.862	0.898	0.910	0.926	0.936	0.940	0.938	0.930	0.915	0.865	0.783	0.70	0.617	0.535	0.454	0.376	0.301	0.229	0.160	0.094	0.031

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Seasonal Variation of Kc	0.01	0.09	0.19	0.29	0.41	0.54	0.67	0.75	0.82	0.88	0.92	0.94	0.94	0.89	0.75	0.58	0.42	0.27	0.13	0.02	
Potential Evapotranspiration	102.4	124.5	187.0	266.9	291.9	281.5	274.5	264.2	189.9	118.9	205.3	160.9	102.4	124.5	187.0	266.9	291.9	281.5	274.5	284.2	
Consumptive Use	1.0	11.2	35.5	77.4	119.7	152.0	183.9	213.2	155.7	131.0	188.9	151.3	96.3	110.8	140.3	154.8	122.6	76.0	35.7	5.7	
Precipitation	331.0	248.3	62.4	1.5	0	0	2.9	17.4	188.8	235.2	136.5	228.0	331.0	218.3	62.4	1.5	0	0	2.9	17.4	
Effective Rainfall	25.8	25.8	40.9	0	0	0	0	12.1	14.4	154.5	114.3	165.8	103	128.8	50.0	0	0	0	0	15.5	
Net Irrigation Water Req. (mm/month)	0	0	0	77.4	119.7	152.0	183.9	201.1	141.3	0	64.6	0	0	0	90.3	154.8	122.6	76.0	35.7	0	

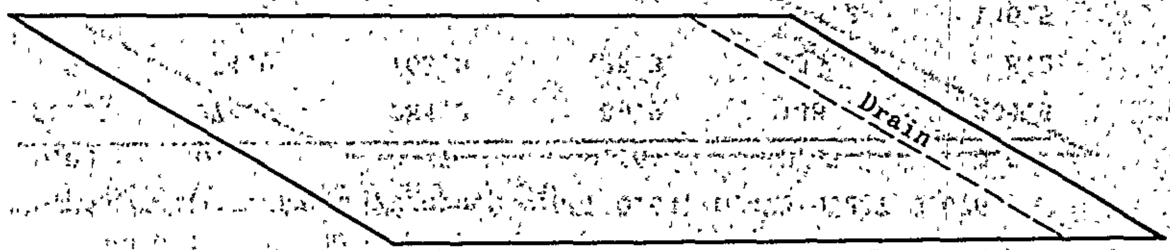
Table-II31 NET IRRIGATION WATER REQUIREMENT OF RATOON CASE



	NOV	DEC		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR		APR
kc	0.505	0.515	0.565	0.600	0.640	0.685	0.730	0.775	0.815	0.855	0.90	0.945	0.980	0.995	1.000	0.990	0.965	0.925	0.875	0.835	0.795	0.750												
kc x 1/12 Area	0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031											
"		0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031										
"			0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031									
"				0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031								
"					0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031							
"						0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031						
"							0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031					
"								0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031				
"									0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031			
"										0.021	0.043	0.046	0.049	0.052	0.055	0.059		0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031		
"											0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031	
"												0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031
Seasonal Variation of kc	0.021	0.084	0.110	0.159	0.211	0.266	0.325	0.388	0.454	0.524	0.597	0.674	0.733	0.772	0.809	0.843	0.873	0.897	0.913	0.922	0.924	0.918	0.876	0.779	0.719	0.637	0.554	0.471	0.389	0.310	0.235	0.163	0.095	0.031

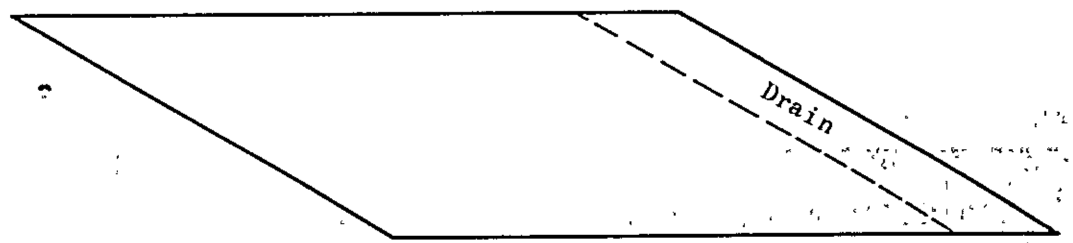
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Seasonal Variation of kc	0.01	0.10	0.19	0.30	0.42	0.56	0.71	0.79	0.86	0.91	0.93	0.90	0.76	0.60	0.43	0.28	0.13	0.02	
Potential Evapotranspiration	187.0	266.9	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9	291.9	281.5	274.5	284.2	
Consumptive Use	1.9	26.7	55.5	84.5	115.3	159.2	134.8	117.6	176.6	146.4	95.2	112.1	142.1	160.1	125.5	78.8	35.7	5.7	
Precipitation	62.4	1.5	0	0	2.9	17.4	188.8	215.2	136.5	228.0	3[illegible]1.0	248.3	62.4	1.5	0	0	2.9	17.4	
Effective Rainfall	25.8	0	0	0	0	10.8	137.0	128.8	114.3	154.5	103	128.8	50	0	0	0	0	15.5	
Net Irrigation Water Req. (mm/month)	0	26.7	55.5	84.5	115.3	148.4	0	0	62.3	0	0	0	92.1	160.1	125.5	78.8	35.7	0	

Table-H32 NET IRRIGATION WATER REQUIREMENT OF SESAME



	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
Kc	0.275	0.455	0.630	0.830	0.895	0.845	0.715					
Kc x 1/4 Area	0.034	0.091	0.136	0.183	0.216	0.218	0.195	0.089				
Kc x 1/4 Area		0.034	0.091	0.136	0.183	0.216	0.218	0.195	0.089			
Kc x 1/4 Area			0.034	0.091	0.136	0.183	0.216	0.218	0.195	0.089		
Kc x 1/4 Area				0.034	0.091	0.136	0.183	0.216	0.218	0.195	0.089	
Seasonal Variation of Kc	0.034	0.125	0.261	0.444	0.626	0.753	0.812	0.718	0.502	0.284	0.089	
	0.08		0.36		0.69		0.77		0.40		0.05	
Potential Evapotranspiration	124.5		187.0		266.9		291.9		281.5		274.5	
Consumptive Use	10.0		67.3		184.2		224.8		112.6		13.7	
Precipitation	248.3		62.4		1.5		0		0		2.9	
Effective Rainfall	25		42.5		0		0		0		0	
Net Irrigation Req. (mm/month)	0		24.8		184.2		224.8		112.6		13.7	

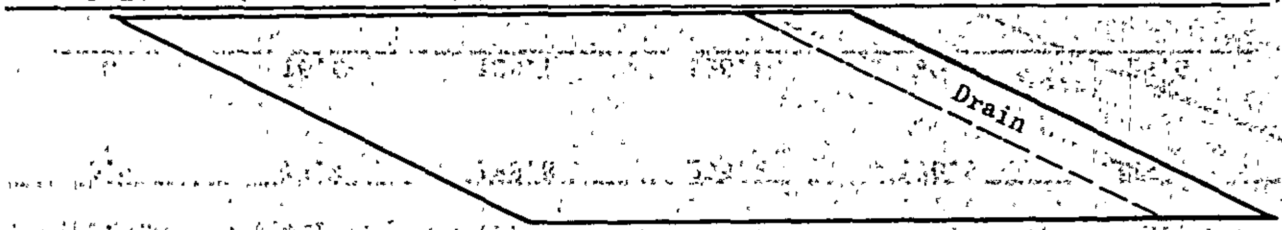
Table-H33 NET IRRIGATION WATER REQUIREMENT OF BEANS



Kc	0.260	0.465	0.745	0.890	0.835	0.610				
Kc x 1/4 Area	0.033	0.091	0.151	0.204	0.216	0.181	0.076			
Kc x 1/4 Area		0.033	0.091	0.151	0.204	0.216	0.181	0.076		
Kc x 1/4 Area			0.033	0.091	0.151	0.204	0.216	0.181	0.076	
Kc x 1/4 Area				0.033	0.091	0.151	0.204	0.216	0.181	0.076
Seasonal Variation of Kc	0.033	0.124	0.275	0.479	0.662	0.657	0.647	0.473	0.257	0.076

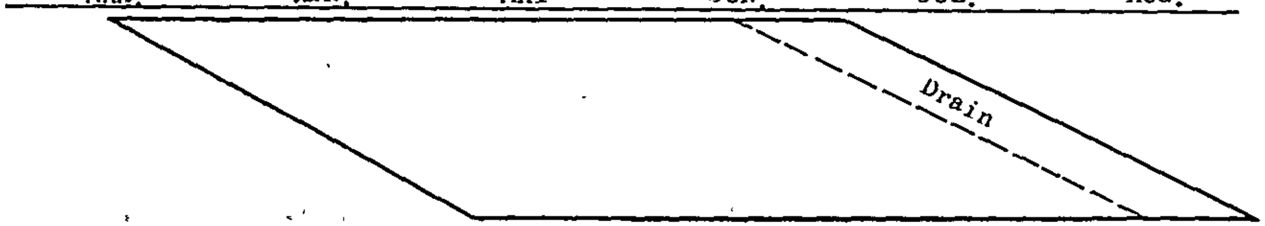
	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Seasonal Variation of Kc	0.02	0.20	0.57	0.66	0.37	0.04
Potential Evapotranspiration	281.5	274.5	284.2	189.9	148.9	205.3
Consumptive Use	5.6	54.9	162.0	125.3	55.1	8.2
Precipitation	0	2.9	17.4	188.8	235.2	136.5
Effective Rainfall	0	0	10.5	133	75	25
Net Irrigation Req. (mm/month)	5.6	54.9	151.5	0	0	0

Table-H34 NET IRRIGATION WATER REQUIREMENT OF MAIZE (CASE-1)



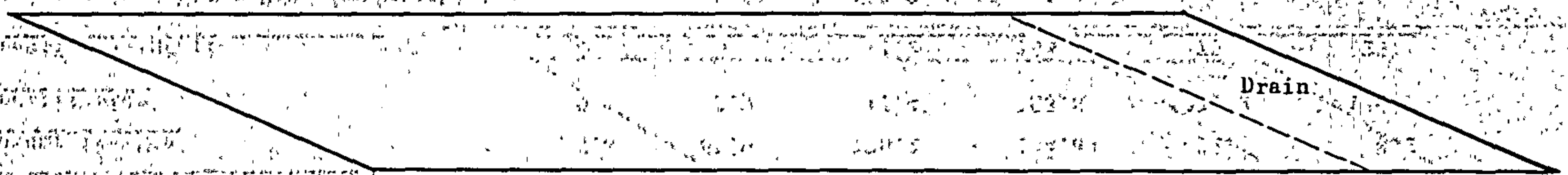
	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Kc	0.29	0.505 0.73	0.865 0.865	0.750		
Kc x 1/4 Area	0.036	0.099 0.154	0.199 0.216	0.202 0.094		
Kc x 1/4 Area		0.036 0.099	0.154 0.199	0.216 0.202	0.094	
Kc x 1/4 Area		0.036	0.099 0.154	0.199 0.216	0.202 0.094	
Kc x 1/4 Area			0.036 0.099	0.154 0.199	0.216 0.202	0.094
Seasonal Variation of Kc	0.036 0.02	0.135 0.289 0.22	0.488 0.668 0.58	0.771 0.711 0.75	0.512 0.296 0.41	0.094 0.05
Potential Evapotranspiration	281.5	274.5	284.2	189.9	148.9	205.3
Consumptive Use	5.6	60.4	164.8	142.4	61.1	10.3
Precipitation	0	2.9	17.4	188.8	235.2	136.5
Effective Rainfall	0	0	10.8	136.3	76.9	25.6
Net Irrigation Water Req. (mm/month)	5.6	60.4	154.0	106.1	0	0

Table-H35 NET IRRIGATION WATER REQUIREMENT OF MAIZE (CASE-2)



	MAR.	APR.		MAY		JUN.		JUL.		AUG.
Kc	0.29	0.505	0.73	0.865	0.865	0.750				
Kc x 1/4 Area	0.036	0.099	0.154	0.199	0.216	0.202	0.094			
Kc x 1/4 Area		0.036	0.099	0.154	0.199	0.216	0.202	0.094		
Kc x 1/4 Area			0.036	0.099	0.154	0.199	0.216	0.202	0.094	
Kc x 1/4 Area				0.036	0.099	0.154	0.199	0.216	0.202	0.094
	0.036	0.135	0.289	0.488	0.668	0.771	0.711	0.512	0.296	0.094
Seasonal Variation of Kc	0.02	0.22		0.59		0.75		0.41		0.05
Potential Evapotranspiration	274.5	284.2		189.9		148.9		205.3		160.9
Consumptive Use	5.5	62.5		112.0		111.7		84.2		8.1
Precipitation	2.9	17.4		188.8		235.2		136.5		228.0
Effective Rainfall	0	16.6		128.1		128.1		90.9		25.6
Net Irrigation Water Req. (mm/month)	5.5	45.9		0		0		0		0

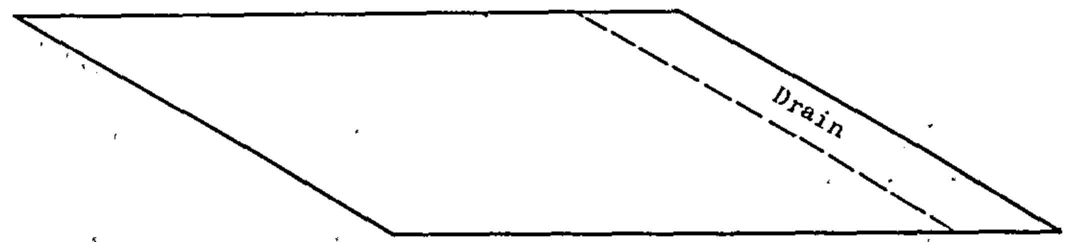
Table-H36 NET IRRIGATION WATER REQUIREMENT OF COTTON



	JUL.		AUG.		SEP.		OCT.		NOV		DEC.		JAN.		FEB.		MAR.
Kc	0.135	0.235	0.375	0.52	0.665	0.80	0.885	0.905	0.875	0.815	0.725						
Kcx1/4 Area	0.017	0.046	0.076	0.112	0.148	0.183	0.211	0.224	0.223	0.211	0.193	0.091					
Kcx1/4 Area		0.017	0.046	0.076	0.112	0.148	0.183	0.211	0.224	0.223	0.211	0.193	0.091				
Kcx1/4 Area			0.017	0.046	0.076	0.112	0.148	0.183	0.211	0.224	0.223	0.211	0.193	0.091			
Kcx1/4 Area				0.017	0.046	0.076	0.112	0.148	0.183	0.211	0.224	0.223	0.211	0.193	0.091		
Seasonal Variation of Kc	0.017	0.063	0.139	0.251	0.382	0.519	0.654	0.766	0.841	0.869	0.851	0.718	0.495	0.284	0.091		
	0.04		0.20		0.45		0.71		0.86		0.79		0.39		0.05		
Potential Evapotrans-piration	205.3		160.9		102.4		124.5		187.0		266.9		291.9		281.5		
Consumptive Use	8.2		32.2		46.1		88.4		160.8		210.9		113.8		14.1		
Precipitation	136.5		228.0		331.0		248.3		62.4		1.5		0		0		
Effective Rainfall	25.9		51.9		51.9		103.7		52.4		0		0		0		
Net Irrigation Water Req. (mm/month)	0		0		0		0		108.4		210.9		113.8		14.1		

Table-H37 NET IRRIGATION WATER REQUIREMENT OF SORGHUM

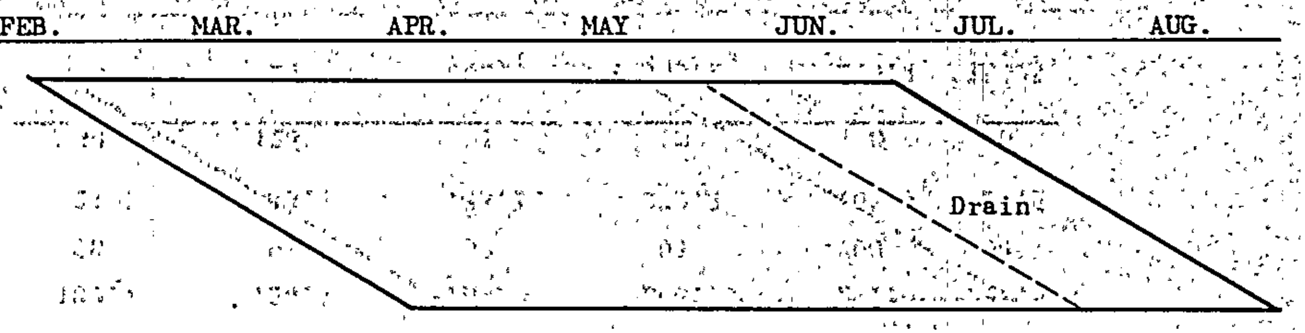
	FEB.	MAR.	APR.	MAY	JUN.	JUL.



Kc	0.315	0.575	0.795	0.870	0.775	0.580				
Kc x 1/4 Area	0.039	0.111	0.171	0.208	0.206	0.169	0.073			
Kc x 1/4 Area		0.039	0.111	0.171	0.208	0.206	0.169	0.073		
Kc x 1/4 Area			0.039	0.111	0.171	0.208	0.206	0.169	0.073	
Kc x 1/4 Area				0.039	0.111	0.171	0.208	0.206	0.169	0.073
Seasonal Variation of Kc	0.039	0.15	0.321	0.529	0.696	0.754	0.656	0.448	0.242	0.073

	FEB.	MAR.	APR.	MAY	JUN.	JUL.
	0.02	0.24	0.62	0.71	0.35	0.04
Potential Evapotranspiration	281.5	274.5	284.2	189.9	148.9	205.3
Consumptive Use	5.6	65.9	176.2	134.8	52.1	8.2
Precipitation	0	2.9	17.4	188.8	235.2	136.5
Effective Rainfall	0	0	11.2	133	75	25
Net Irrigation Water Req. (mm/month)	5.6	65.9	165.0	1.8	0	0

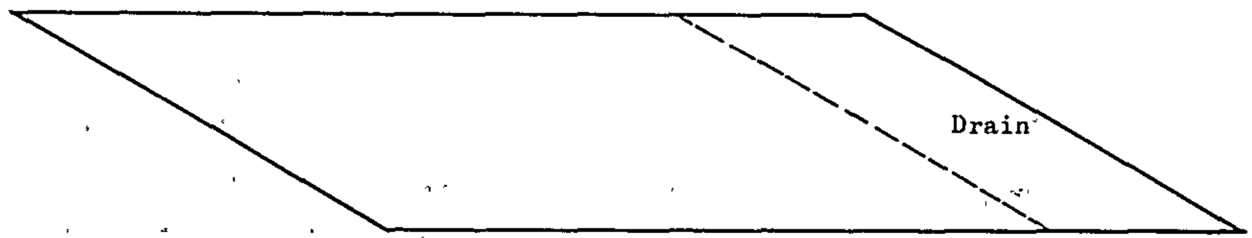
Table-H38 NET IRRIGATION WATER REQUIREMENT OF RICE (CASE-1)



Kc	0.825	0.880	0.945	1.01	1.075	1.13	1.14				
Kc x 1/4 Area	0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143			
Kc x 1/4 Area		0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143		
Kc x 1/4 Area			0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143	
Kc x 1/4 Area				0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143
Seasonal Variation of Kc	0.103	0.316	0.544	0.788	0.946	1.009	1.065	0.964	0.703	0.427	0.143

	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Seasonal Variation of Kc	0.06	0.43	0.87	1.04	0.84	0.29
Potential Evapotranspiration	281.5	274.5	284.2	189.9	148.9	205.3
Consumptive Use	16.9	118.0	247.3	197.5	125.1	59.5
Percoration	84.0	93.0	90.0	93.0	90.0	93.0
Effective Rainfall	0	4	15	124	111	74
Net Irrigation Water Req. (mm/month)	100.9	207.0	322.3	166.5	104.1	78.5

Table-H39 NET IRRIGATION WATER REQUIREMENT OF RICE (CASE-2)



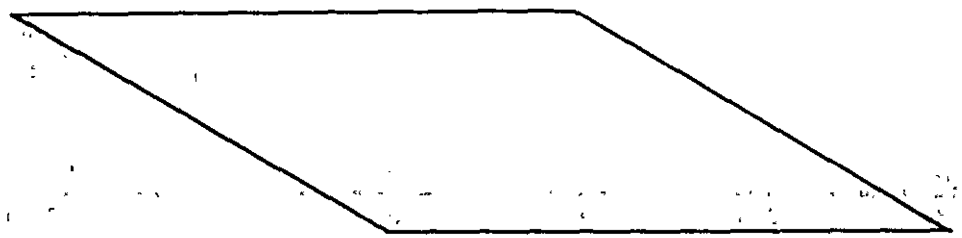
	SET.		OCT.		NOV.		DEC.		JAN.		FEB.	MAR.
Kc	0.825	0.880	0.945	1.01	1.075	1.13	1.145					
Kc x 1/4 Area	0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143				
Kc x 1/4 Area		0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143			
Kc x 1/4 Area			0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143		
Kc x 1/4 Area				0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143	
Seasonal Variation of	0.103	0.316	0.544	0.788	0.946	1.009	1.065	0.964	0.703	0.427	0.143	
Kc	0.21		0.67		0.98		1.02		0.57		0.08	

	SET.	OCT.	NOV.	DEC.	JAN.	FEB.
Potential Evapotranspiration	102.4	124.5	187.0	266.90	291.9	281.5
Percoration	90	93	90	93	90	84
Consumptive Use	21.5	83.4	183.3	272.2	166.4	22.5
Effective Rainfall	144	124	31	0	0	0
Net Irrigation Water Req. (mm/month)	0	524	242.3	365.2	256.4	106.5

Table-H40 NET IRRIGATION WATER REQUIREMENT OF MELON

	AUG.		SEP.		OCT.		NOV.		DEC.		JAN.	
Kc	0.17	0.29	0.46	0.58	0.57	0.425						
Kc x 1/4 Area	0.021	0.058	0.094	0.13	0.144	0.124	0.053					
Kc x 1/4 Area		0.021	0.058	0.094	0.13	0.144	0.124	0.053				
Kc x 1/4 Area			0.021	0.058	0.094	0.130	0.144	0.124	0.053			
Kc x 1/4 Area				0.021	0.058	0.094	0.130	0.144	0.124	0.053		
Seasonal Variation of Kc	0.021	0.079	0.173	0.303	0.426	0.492	0.451	0.321	0.177	0.053		
	0.01		0.13		0.37		0.48		0.25		0.03	
Potential Evapotranspiration	160.9		102.4		124.5		187.0		266.9		291.9	
Consumptive Use	1.6		13.3		46.1		89.8		66.7		8.8	
Precipitation	228.0		331.0		248.3		62.4		1.5		0	
Effective Rainfall	25.4		25.4		50.8		45.2		0		0	
Net Irrigation Water Req. (mm/month)	0		0		0		44.6		66.7		8.8	

Table-H41 NET IRRIGATION WATER REQUIREMENT OF WATER MELON



	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
Kc	0.17	0.29	0.46	0.58	0.57	0.425						
Kc x 1/4 Area	0.021	0.058	0.094	0.13	0.144	0.124	0.053					
Kc x 1/4 Area		0.021	0.058	0.094	0.13	0.144	0.124	0.053				
Kc x 1/4 Area			0.021	0.058	0.094	0.13	0.144	0.124	0.053			
Kc x 1/4 Area				0.021	0.058	0.094	0.13	0.144	0.124	0.053		
Seasonal Variation of Kc	0.021	0.079	0.173	0.303	0.426	0.492	0.451	0.321	0.177	0.053		
	0.01		0.13		0.37		0.48		0.25		0.03	
Potential Evapotranspiration	124.5		187.0		266.9		291.9		281.5		274.5	
Consumptive Use	1.2		24.3		98.8		140.1		70.4		8.2	
Precipitation	248.3		62.4		1.5		0		0		2.9	
Effective Rainfall	25.4		25.4		0		0		0		0	
Net Irrigation Water Req. (mm/month)	0		0		98.8		140.1		70.4		8.2	

Table-H42 NET IRRIGATION WATER REQUIREMENT OF PASTURE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Kc	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Potential Evapotranspiration	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9
Consumptive Use	239.4	230.8	225.1	233.0	155.7	122.1	168.3	131.9	84.0	102.1	153.3	218.9
Precipitation	0	0	2.9	17.4	188.8	235.2	136.5	228.0	331.0	248.3	62.4	1.5
Effective Rainfall	0	0	0	12.4	138.9	124	103.2	148.8	99.2	124	50.1	0
Net Irrigation Water Req. (mm/month)	239.4	230.8	225.1	220.6	16.8	0	65.1	0	0	0	103.2	218.9

Table-H43 NET IRRIGATION WATER REQUIREMENT OF VEGETABLE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Kc	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445
Potential Evapotranspiration	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9
Consumptive Use	129.9	125.3	122.0	126.5	84.5	66.3	91.4	71.6	45.6	55.4	83.2	118.8
Precipitation	0	0	2.9	17.4	188.8	235.2	136.5	228.0	331.0	248.3	62.4	1.5
Effective Rainfall	0	0	0	10	100	75	88.7	75	50	75	44.5	0
Net Irrigation Water Req. (mm/month)	129.9	125.3	122.0	116.5	0	0	2.7	0	0	0	38.7	118.8

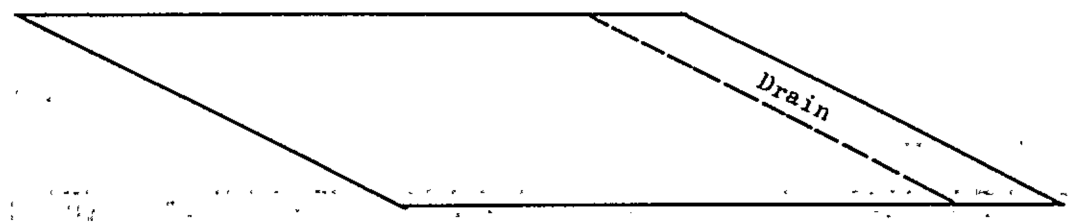
Table-H44 IRRIGATION WATER REQUIREMENT (MIDDLE REACH VALLEYS)

TYPE	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
RICE 1		100.9	207.0	322.3	166.5	104.1	78.5			52.4	242.3	365.2
RICE 2	259.4	106.5						0	0			
TOTAL	259.4	207.4	207.0	322.3	166.5	104.1	78.5	0	0	52.4	242.3	365.2
x 0.5	129.7	53.3	103.5	161.2	83.3	52.1	39.3	0	0	26.2	121.2	182.6
BEANS	23.4	107.0	170.0	148.7	0							
MAIZE						0	0	0	0	0	0	
TOTAL	23.4	107.0	170.0	148.7	0	0	0	0	0	0	0	0
x 0.45	10.5	48.2	76.5	66.9	0	0	0	0	0	0	0	0
VEGETABLE	130.0	125.3	113.0	116.0	0	0	23.7	0	0	0	47.5	118.8
x 0.05	6.5	6.3	5.7	5.8	0	0	1.2	0	0	0	2.4	5.9
NET IRR. WATER REQ. (mm/month)	146.7	108.3	185.7	233.9	83.3	52.1	40.5	0	0	26.2	123.6	182.6

IRRIGATION EFFICIENCY 52.5 %

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
IRRIGATION WATER REQ. (mm/month)	279.4	206.3	353.7	445.5	158.7	99.2	77.1	0	0	49.9	235.4	347.8

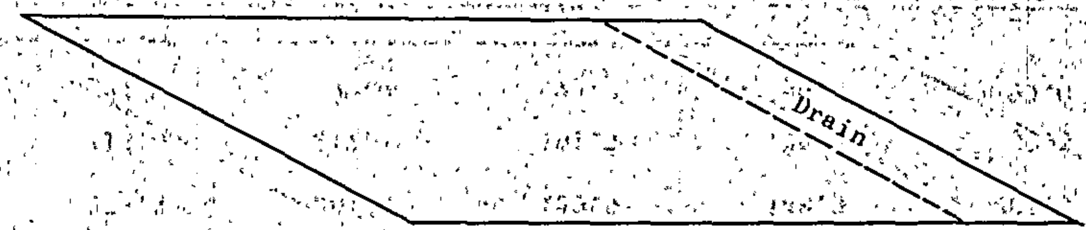
Table-H45 NET IRRIGATION WATER REQUIREMENT OF BEANS (MIDDLE REACH VALLEYS)



	JAN.		FEB.		MAR.		APR.		MAY		JUN.	
Kc	0.26	0.465	0.745	0.89	0.835	0.610						
Kc x 1/4 Area	0.033	0.091	0.151	0.204	0.216	0.181	0.076					
"		0.033	0.091	0.151	0.204	0.216	0.181	0.076				
"			0.033	0.091	0.151	0.204	0.216	0.181	0.076			
"				0.033	0.091	0.151	0.204	0.216	0.181	0.076		
Seasonal Variation of	0.033	0.124	0.275	0.479	0.662	0.657	0.647	0.473	0.257	0.076		
Kc	0.08		0.38		0.66		0.56		0.17			
Potential Evapotranspiration	291.9		281.5		274.5		284.2		189.9			
Consumptive Use	23.4		107.0		181.2		159.2		32.3			
Precipitation	0		0		11.5		17.3		168.6			
Effective Rainfall	0		0		11.2		10.5		50			
Net Irrigation Water Req. (mm/month)	23.4		107.0		170.0		148.7		0			

Table-H46 NET IRRIGATION WATER REQUIREMENT OF MAIZE (MIDDLE REACH VALLEYS)

	JUN.		JUL.		AUG.		SEP.		OCT.	NOV.

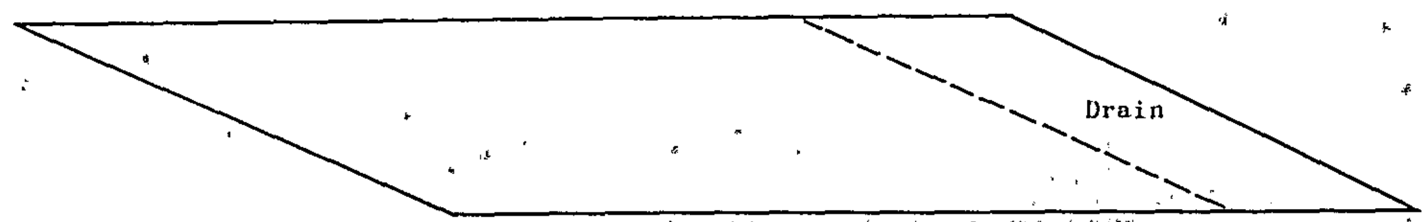


Kc	0.29	0.505	0.73	0.865	0.865	0.750				
Kc x 1/4 Area	0.036	0.099	0.154	0.199	0.216	0.202	0.094			
Kc x 1/4 Area		0.036	0.099	0.154	0.199	0.216	0.202	0.094		
Kc x 1/4 Area			0.036	0.099	0.154	0.199	0.216	0.202	0.094	
Kc x 1/4 Area				0.036	0.099	0.154	0.199	0.216	0.202	0.094
Seasonal Variation of Kc	0.036	0.135	0.289	0.488	0.668	0.771	0.711	0.512	0.296	0.094

	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.
Kc	0.02	0.22	0.58	0.75	0.41	0.05
Potential Evapotranspitation	148.9	205.3	160.9	102.4	124.5	187.0
Consumptive Use	3.0	45.2	93.3	76.8	51.0	9.4
Precipitation	183.6	95.9	162.9	277.2	196.4	39.3
Effective Rainfall	25.6	51.3	102.5	102.5	76.9	25.6
Net Irrigation Water Req. (mm/month)	0	0	0	0	0	0

Table-H47 NET IRRIGATION WATER REQUIREMENT OF RICE (CASE-1)
(MIDDLE REACH VALLEYS)

	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AVG.



Kc	0.825	0.880	0.945	1.01	1.075	1.13	1.14				
Kc x 1/4 Area	0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143			
Kc x 1/4 Area		0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143		
Kc x 1/4 Area			0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143	
Kc x 1/4 Area				0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143
Seasonal Variation of Kc	0.103	0.316	0.544	0.788	0.946	1.009	1.065	0.964	0.703	0.427	0.143

	FEB.	MAR.	APR.	MAY	JUN.	JUL.
(Seasonal Kc, monthly)	0.06	0.43	0.87	1.04	0.84	0.29
Potential Evapotranspiration	281.5	274.5	284.2	189.9	148.9	205.3
Consumptive Use	16.9	118.0	247.3	197.5	125.1	59.5
Percoration	84.0	93.0	90.0	93.0	90.0	93.0
Effective Rainfall	0	4	15	124	111	74
Net Irrigations Water Req. (mm/month)	100.9	207.0	322.3	166.5	104.1	78.5

Table-H48 NET IRRIGATION WATER REQUIREMENT OF RICE (CASE-2)
(MIDDLE REACH VALLEYS)

	SEP.		OCT.		NOV.		DEC.		JAN.		FEB.		MAR.
Kc	0.825	0.880	0.945	1.01	1.075	1.13	1.145						
Kc x 1/4 Area	0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143					
Kc x 1/4 Area		0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143				
Kc x 1/4 Area			0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143			
Kc x 1/4 Area				0.103	0.213	0.228	0.244	0.261	0.276	0.284	0.143		
Seasonal Variation of	0.103	0.316	0.504	0.788	0.946	1.009	1.065	0.964	0.703	0.427	0.143		
Kc	0.21		0.67		0.98		1.02		0.57		0.08		
Potential Evapotranspiration	102.4		124.5		187.0		266.9		291.9		281.5		
Percoration	90		93		90		93		93		84		
Consumptive Use	21.5		83.4		183.3		272.2		166.4		22.5		
Effective Rainfall	144		124		31		0		0		0		
Net Irrigation Water Req. (mm/month)	0		52.4		242.3		365.2		259.4		106.5		

Table-H49 NET IRRIGATION WATER REQUIREMENT OF VEGETABLE
(MIDDLE REACH VALLEYS)

	JAN.	FEB.	MAR	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Kc	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445
Potential Evapotranspitation	291.9	281.5	274.5	284.2	189.9	148.9	205.3	160.9	102.4	124.5	187.0	266.9
Consumptive Use	130.0	125.3	122.2	126.5	84.5	66.3	91.4	71.6	45.6	55.4	83.2	118.8
Precipitation	0	0	11.5	17.3	168.6	183.6	95.9	162.9	277.2	196.4	39.3	2.3
Effective Rainfall	0	0	9.2	10	100	75	67.7	75	50	75	35.7	0
Net Irrigation Water Req. (mm/month)	130.0	125.3	113.0	116.5	0	0	23.7	0	0	0	47.5	118.8

Table-H50 IRRIGATION WATER REQUIREMENT
(SAN JUAN DE FLORES AREA)

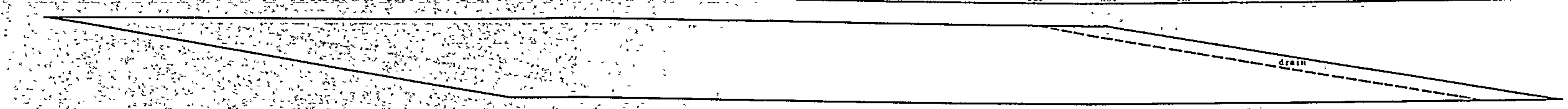
NET IRRIGATION WATER REQ.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SEED CANE												1.0
	2.3	26.1	59.1	87.0	8.9	3.0	59.3	39.1	67.5	62.6	35.0	40.6
	18.8	15.7	3.7									
TOTAL	21.1	41.8	62.8	87.0	8.9	3.0	59.3	39.1	67.5	62.6	35.0	41.6
TOTAL x 1.5 % (mm/month)	0.3	0.6	0.9	1.2	0.1	0.04	0.8	0.5	0.9	0.9	0.5	0.6
PLANT CANE									0	0	0	28.7
	37.2	70.5	123.7	141.9	131.2	15.9	68.1	46.9	77.3	80.4	51.8	57.5
	38.3	35.3	24.0	3.8								
TOTAL (mm/month)	75.5	105.8	147.7	145.7	131.2	15.9	68.1	46.9	77.3	80.4	51.8	86.2
RATOON CANE											0	9.9
	13.3	39.2	77.5	106.0	24.4	4.3	60.5	43.0	76.0	81.5	52.7	59.5
	39.4	36.6	24.0	3.8								
TOTAL (mm month)	52.7	75.8	101.5	109.8	24.4	4.3	60.5	43.0	76.0	81.5	52.7	69.4
TOTAL x 4 (mm/month)	210.8	303.2	406.0	439.2	97.6	17.2	242.0	172.0	304.0	326.0	210.8	277.6
G. TOTAL	286.6	409.6	554.6	386.1	228.9	33.1	310.9	219.4	382.2	407.3	263.1	364.4
NET IRR. WATER REQ. G. TOTAL x 1/6 (mm/month)	47.8	68.3	92.4	97.7	38.2	5.5	51.8	36.6	63.7	67.9	43.9	60.7
IRRIGATION EFFICIENCY 52.5 %												
IRRIGATION WATER REQ. (mm/month)	91.0	130.1	176.0	186.1	72.8	10.5	98.7	69.7	121.3	129.3	83.6	115.6

Table-H51 NET IRRIGATION WATER REQUIREMENT OF SEED CANE (SAN JUAN DE FLORES AREA)

	DEC	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR
Kc	0.505	0.545	0.595	0.650	0.710	0.765	0.815	0.875	0.935	0.975	0.995	0.990	0.955	0.895	0.835	0.785	0.725	0.620												
Kc x 1/12 Area	0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026											
"		0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026										
"			0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.077	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026									
"				0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026								
"					0.021	0.014	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026							
"						0.021	0.044	0.045	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.081	0.081	0.077	0.072	0.068	0.063	0.056	0.026						
"							0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026					
"								0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026				
"									0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026			
"										0.021	0.044	0.018	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026		
"											0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026	
"												0.021	0.044	0.048	0.052	0.057	0.062	0.066	0.071	0.075	0.080	0.082	0.083	0.081	0.077	0.072	0.068	0.063	0.056	0.026
Seasonal Variation of Kc	0.021	0.065	0.113	0.165	0.222	0.284	0.350	0.421	0.496	0.576	0.658	0.741	0.801	0.834	0.858	0.814	0.880	0.874	0.834	0.763	0.688	0.608	0.526	0.443	0.362	0.285	0.213	0.145	0.082	0.026

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Seasonal Variation of Kc	0.01	0.09	0.20	0.32	0.46	0.62	0.78	0.85	0.88	0.86	0.73	0.57	0.41	0.25	0.12	0.02
Potential Evapotranspiration	99.1	110.7	130.6	154.6	149.2	172.5	129.6	125.5	128.8	122.4	111.1	93.0	99.1	110.7	130.6	181.6
Consumptive Use	1.0	10.0	26.1	59.1	87.0	107.0	101.1	106.7	113.3	105.3	81.1	53.0	40.6	27.7	15.7	3.7
Precipitation	6.4	9.7	2.4	0	0.8	134.5	131.6	59.1	91.7	43.8	27.1	26.0	6.4	9.7	2.4	0
Effective Rainfall	0	7.7	0	0	0	98.1	98.1	47.4	74.2	37.8	18.5	18.0	0	8.9	0	0
Net Irrigation water Req. (mm/month)	1.0	2.3	26.1	59.1	87.0	8.9	3.0	59.3	39.1	67.5	62.6	35.0	40.6	18.8	15.7	3.7

Table-H52 NET IRRIGATION WATER REQUIREMENT OF PLANT CANE
(SAN JUAN DE FLORES AREA)

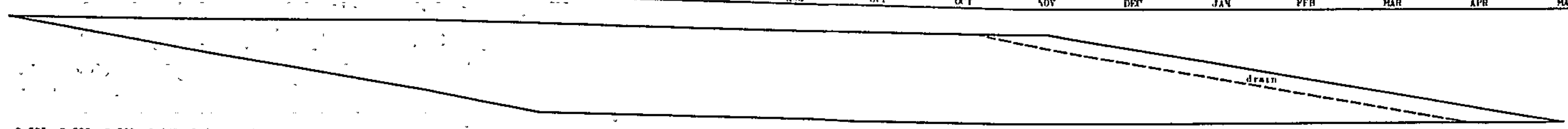


	SEP	OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUN	
Kc	0.50	0.525	0.555	0.585	0.615	0.650	0.685	0.720	0.760	0.795	0.830	0.87	0.91	0.95	0.98	0.995	1.000	0.995	0.980
Kc x 1/12 Area	0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082
"		0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083
"			0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083
"				0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082
"					0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078	0.081
"						0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074	0.078
"							0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071	0.074
"								0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068	0.071
"									0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065	0.068
"										0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062	0.065
"											0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059	0.062
"												0.021	0.043	0.045	0.048	0.050	0.053	0.056	0.059
Seasonal Variation of Kc	0.021	0.064	0.109	0.157	0.207	0.26	0.316	0.375	0.437	0.502	0.570	0.641	0.694	0.729	0.765	0.799	0.832	0.862	0.888

	JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR		APR
Kc	0.955	0.900	0.880	0.840	0.805	0.775	0.735												
Kc x 1/12 Area	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031											
"	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031										
"	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031									
"	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031								
"	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031							
"	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031						
"	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031					
"	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031				
"	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031			
"	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	01082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031		
"	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031	
"	0.062	0.065	0.068	0.071	0.074	0.078	0.081	0.082	0.083	0.083	0.082	0.081	0.078	0.075	0.072	0.069	0.066	0.063	0.031
Seasonal Variation of Kc	0.910	0.926	0.936	0.940	0.938	0.930	0.915	0.865	0.783	0.70	0.617	0.535	0.454	0.376	0.301	0.229	0.160	0.094	0.031

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Seasonal Variation of Kc	0.01	0.09	0.19	0.29	0.41	0.54	0.67	0.75	0.82	0.88	0.92	0.94	0.94	0.89	0.75	0.58	0.42	0.27	0.13	0.02	
Potential Evapotranspiration	122.4	111.1	93.0	99.1	110.7	130.6	184.6	189.2	172.5	129.6	125.5	128.8	122.4	111.1	93.0	99.1	110.7	130.6	184.6	189.2	
Consumptive Use	1.2	10.0	17.7	28.7	45.4	70.5	123.7	141.9	141.5	114.0	115.5	121.1	115.1	98.9	69.8	57.5	46.5	35.3	21.0	3.8	
Precipitation	438.0	27.1	26.0	6.4	9.7	2.4	0	0.8	13.45	131.6	59.1	91.7	43.8	27.1	26.0	6.4	9.7	2.4	0	0.8	
Effective Rainfall	25.8	23.2	23.2	0	8.2	0	0	0	10.3	98.1	17.4	74.2	37.8	18.5	18.0	0	8.2	0	0	0	
Net Irrigation Water Req. (mm/month)	0	0	0	28.7	37.2	70.5	123.7	141.9	131.2	15.9	68.1	46.9	77.3	80.4	51.8	57.5	38.3	35.3	24.0	3.8	

Table-II53 NET IRRIGATION WATER REQUIREMENT OF RATOON CANE
(SAN JUAN DE FLORES AREA)



	NOV	DIC		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR		APR	MAY
Kc	0.505	0.535	0.565	0.600	0.640	0.685	0.730	0.775	0.815	0.855	0.90	0.945	0.980	0.955	1.000	0.990	0.965	0.925	0.875	0.835	0.795	0.750													
Kc x 1/12 Area	0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031												
		0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031											
			0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031										
				0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031									
					0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031								
						0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031							
							0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031						
								0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031					
									0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031				
										0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031			
											0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031		
												0.021	0.043	0.046	0.049	0.052	0.055	0.059	0.063	0.066	0.070	0.073	0.077	0.080	0.082	0.083	0.083	0.082	0.079	0.075	0.072	0.068	0.064	0.031	
Seasonal Variation of Kc	0.021	0.084	0.110	0.159	0.211	0.266	0.325	0.388	0.454	0.524	0.597	0.674	0.733	0.772	0.809	0.843	0.873	0.897	0.913	0.922	0.924	0.918	0.876	0.799	0.719	0.637	0.554	0.471	0.389	0.310	0.235	0.163	0.095	0.031	

	NOV	DIC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Kc	0.01	0.10	0.19	0.30	0.42	0.56	0.71	0.79	0.86	0.91	0.93	0.90	0.76	0.60	0.43	0.28	0.13	0.02	
Potential Evapotranspiration	93.0	99.1	110.7	130.6	184.6	189.2	172.5	129.6	125.5	128.8	122.4	111.1	93.0	99.1	110.7	130.6	184.6	189.2	
Consumptive Use	0.9	9.9	21.0	39.2	77.5	106.0	122.5	102.4	107.9	117.2	113.8	100.0	70.7	59.5	47.6	36.6	24.0	3.8	
Precipitation	26.0	6.4	9.7	2.4	0	0.8	134.5	131.6	59.1	91.7	43.8	27.1	26.0	6.4	9.7	2.4	0	0	
Effective Rainfall	15.5	0	7.7	0	0	0	98.1	98.1	47.4	74.2	37.8	18.5	18.0	0	8.2	0	0	0	
Net Irrigation Water Req. (mm/month)	0	9.9	13.3	39.2	77.5	106.0	24.4	4.3	60.5	43.0	76.0	81.5	52.7	59.5	39.4	36.6	24.0	3.8	

Table-H54 SUMMARY OF CALCULATING IRRIGATION WATER REQUIREMENT (1)

	Consumptive Use/1 (mm/month)	Effective Rainfall (mm/month)	Net Irrigation Water Requirement (mm/month)	Farm Irrigation Water Requirement (mm/month)	Diversion Water Requirement (mm/month)	Irrigable Area (ha)	Demanded Discharge $x10^6 m^3$/month
(WESTERN PLAIN AREA)							
JAN	153.4	0	153.4	236.0	292.2	14,370	41.99
FEB	99.2	0	99.2	152.6	189.0	14,370	27.16
MAR	105.1	0	105.1	161.7	200.2	14,370	28.77
APR	165.0	11.8	153.2	235.7	291.8	14,370	41.93
MAY	153.1	100.0	53.1	81.7	101.1	14,370	14.52
JUN	97.9	86.3	11.6	17.8	22.1	14,370	3.17
JUL	92.7	64.1	28.6	44.0	54.5	14,370	7.83
AUG	61.5	83.2	0	0	0	14,370	0
SEP	49.1	75.7	0	0	0	14,370	0
OCT	90.9	85.0	5.9	9.1	11.2	14,370	1.61
NOV	145.5	46.6	98.9	152.2	188.4	14,370	27.07
DEC	197.9	0	197.9	304.5	377.0	14,370	54.17
Total	1,411.3	552.7	906.9	1,395.3	1,727.5	-	248.22
(EASTERN PLAIN AREA)							
JAN	167.1	0	167.1	257.1	318.3	9,600	30.56
FEB	104.8	0	104.8	161.2	199.6	9,600	19.16
MAR	119.0	0.4	118.6	182.4	225.9	9,600	21.69
APR	191.1	11.5	179.6	276.3	342.1	9,600	32.84
MAY	155.2	90.3	64.9	99.8	123.6	9,600	11.87
JUN	96.8	86.0	10.8	16.6	20.6	9,600	1.98
JUL	80.1	54.8	25.3	38.9	48.2	9,600	4.63
AUG	55.1	55.1	0	0	0	9,600	0
SEP	59.5	59.5	0	0	0	9,600	0
OCT	94.0	88.5	5.5	8.5	10.5	9,600	1.01
NOV	159.5	48.4	111.1	170.9	211.6	9,600	20.31
DEC	220.2	0	220.2	338.8	419.4	9,600	40.26
Total	1,502.4	494.5	1,007.9	1,550.5	1,919.8	-	184.31

Note: /1 Percolation loss in the paddy field is included.

Table-II54 SUMMARY OF CALCULATING IRRIGATION WATER REQUIREMENT (2)

	Consumptive Use (mm/month)	Effective Rainfall (mm/month)	Net Irrigation Water Requirement (mm/month)	Farm Irrigation Water Requirement (mm/month)	Diversion Water Requirement (mm/month)	Irrigable Area (ha)	Demanded Discharge $x10^6$ m^3/month
(SUGARCANE FARM IN CHOLUTECA COASTAL PLAIN)							
JAN	161.3	0	161.3	248.2	307.2	1,630	5.01
FEB	147.1	0	147.1	226.3	280.2	1,630	4.57
MAR	137.5	0	137.5	211.5	261.9	1,630	4.27
APR	146.8	10.3	136.5	210.0	260.0	1,630	4.24
MAY	117.1	128.8	0	0	0	1,630	0
JUN	100.5	128.8	0	0	0	1,630	0
JUL	149.7	107.1	42.6	65.5	81.1	1,630	1.32
AUG	123.2	154.5	0	0	0	1,630	0
SEP	46.6	103.0	0	0	0	1,630	0
OCT	95.3	103.0	0	0	0	1,630	0
NOV	125.6	47.4	78.2	120.3	148.9	1,630	2.43
DEC	163.5	0	163.5	251.5	311.4	1,630	5.08
Total	1,514.2	782.9	705.4	1,333.3	1,650.7	-	26.92
(MIDDLE REACH VALLEYS, OROPOLI-MOROLICA-OROCUINA AREAS)							
JAN	146.7 /1	0	146.7	225.7	279.4	1,850	5.17
FEB	108.3	0	108.3	166.6	206.3	1,850	3.82
MAR	193.2	7.5	185.7	285.7	353.7	1,850	6.54
APR	246.4	12.5	233.9	359.8	445.5	1,850	8.24
MAY	172.8	89.5	83.3	128.2	158.7	1,850	2.94
JUN	122.9	70.8	52.1	80.2	99.2	1,850	1.84
JUL	104.0	63.5	40.5	62.3	77.1	1,850	1.43
AUG	0	49.9	0	0	0	1,850	0
SEP	92.7	120.6	0	0	0	1,850	0
OCT	126.6	100.4	26.2	40.3	49.9	1,850	0.92
NOV	152.7	29.1	123.6	190.2	235.4	1,850	4.35
DEC	182.6	0	182.6	280.9	347.8	1,850	6.43
Total	1,648.9	543.8	1,182.9	1,819.9	2,253.0	-	41.68

Table-II54 SUMMARY OF CALCULATING IRRIGATION WATER REQUIREMENT (3)

	Consumptive Use (mm/month)	Effective Rainfall (mm/month)	Net Irrigation Water Requirement (mm/month)	Farm Irrigation Water Requirement (mm/month)	Diversion Water Requirement (mm/month)	Irrigable Area (ha)	Demanded Discharge x10^6 m^3/month
			(SAN JUAN DE FLORES AREA)				
JAN	61.2	13.4	47.8	73.5	91.0	340	0.31
FEB	68.3	0	68.3	105.1	130.1	340	0.44
MAR	92.4	0	92.4	142.2	176.0	340	0.60
APR	97.7	0	97.4	150.3	186.1	340	0.63
MAY	105.5	67.3	38.2	58.8	72.8	340	0.25
JUN	87.5	82.0	5.5	8.5	10.5	340	0.04
JUL	91.5	39.7	51.8	79.7	98.7	340	0.03
AUG	98.6	62.0	36.6	56.3	69.1	340	0.02
SEP	95.5	31.8	63.7	98.0	121.3	340	0.40
OCT	85.0	17.1	67.9	104.5	129.3	340	0.44
NOV	62.5	18.1	43.9	67.5	83.6	340	0.29
DEC	60.7	0	60.7	93.4	115.6	340	0.39
Total	1,006.4	331.4	674.5	1,037.8	1,284.7	-	3.84

Table-H55 PEAK CROP CONSUMPTIVE USE

A) Choluteca Coastal Plain Irrigation Area (Project Area)

Crops	Peak Amount mm/month	mm/day	Month
1. Sugar cane			
(1) Sheed cane	130.7	4.3	April
(2) Plant cane	213.2	7.1	April
(3) Ratoon cane	176.6	5.7	July
2. Maize	164.8	5.5	April
3. Cotton	210.9	6.8	December
4. Sorghum	176.2	5.9	April
5. Beans	162.0	5.4	April
6. Sesame	224.8	7.3	January
7. Melon	89.8	3.0	November
8. Water melon	140.1	4.5	January
9. Rice	247.3	8.2	April
10. Vegetables	126.5	4.2	April
11. Pasture	239.4	7.7	January

B) Middle Reach Valleys

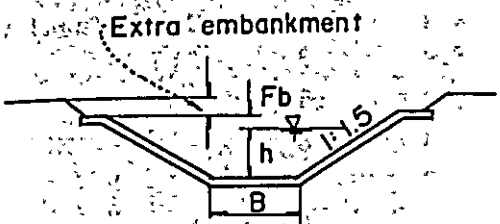
Crops	Peak mm/month	Amount mm/day	Month
1. Rice	247.5	8.3	April
2. Beans	181.2	5.8	March
3. Maize	93.3	3.0	August
4. Vegetables	130.0	4.2	January

C) San Juan de Flores Area

Crops	Peak mm/month	Amount mm/day	Month
Sugar cane			
(1) Seed cane	113.3	3.7	August
(2) Plant cane	141.9	4.7	April
(3) Ratoon cane	122.5	4.0	May

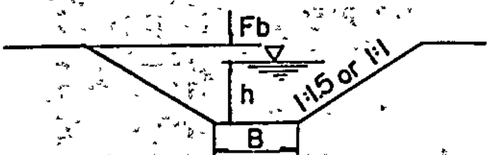
Table-H56 CANAL BOTTOM WIDTH (B)/WATER DEPTH (h) RATIO

B/h ratio



Concrete Lined Canal

Discharge (m^3/sec)	Range of B/h	Representative B/h
Q > 36	1.0-1.5	1.5
36 ≧ Q > 10	1.0-1.2	1.2
10 ≧ Q	1.1-1.5	1.5



Earth Lined Canal & Earth Canal

Discharge (m^3/sec)	Range of B/h	Representative B/h
Q > 25	2.5-5.0	4
25 ≧ Q > 10	2.0-4.5	3
10 ≧ Q > 5	2.0-3.0	2.5
5 ≧ Q > 2	2.0-2.5	2
2 ≧ Q	1.0-2.0	1.5

Free board (Fb)

(i) Head reach, main canal, branch canals, and secondary canals

Water depth (m)	Free board (Fb) (m)	Extraembankment (m)
Less than 0.75	0.20	0.35
0.75 - 1.00	0.25	0.40
1.00 - 1.50	0.30	0.45
1.50 - 1.75	0.35	0.50
1.75 - 2.00	0.40	0.55
More than 2.0	0.45	0.60

(ii) Tertiary and Distribution canal

Free board for Tertiary and Distribution canals is 0.15 m.

Addingly, the extra embankments on the concrete lined canal are designed.

Table-H57 OUTLINE OF PUMPING STATION

A) Choluteca Middle Reach Valleys

Name of sub-area		Net irrigable area (ha)	Design discharge (m^3/min)	Total head (m)	Capacity of pump (m^3/min)	Number of pumps	Type of pumps
Morolica	C	210	41.58	17	8.3	6	Centrifugal pump
Morolica	D	90	17.82	23	8.9	3	"
Orocuina	E	150	30.90	23	7.7	5	"
"	F	250	51.50	10	10.3	6	"
"	G	100	20.60	15	10.3	3	"
"	H	540	111.24	15	22.3	6	"

Name of sub-area		Dia. of Delivery pipe (mm)	Length of Delivery pipe (m)	Type of Delivery pipe	Capacity of Motor (kW)
Morolica	C	800	50	Reinforced concrete pipe	37
Morolica	D	600	100	"	55
Orocuina	E	700	100	"	55
"	F	1,000	50	"	30
"	G	600	150	"	45
"	H	1,350	100	Steel pipe	90

B) San Juan de Flores Area

Name of sub-area	Net irrigable area (ha)	Design discharge (m^3/min)	Total head (m)	Capacity or pump (m^3/min)	Number of pumps	Type of pump
A	230	19.86	40	6.4	4	Centrifugal pump
B	110	9.48	31	9.4	2	"

Name of sub-area	Dia. of Delivery pipe (mm)	Length of Delivery pipe (m)	Type of Delivery pipe	Capacity of Motor (kW)
A	600	100	Reinforced concrete pipe	75
B	450	150	"	75

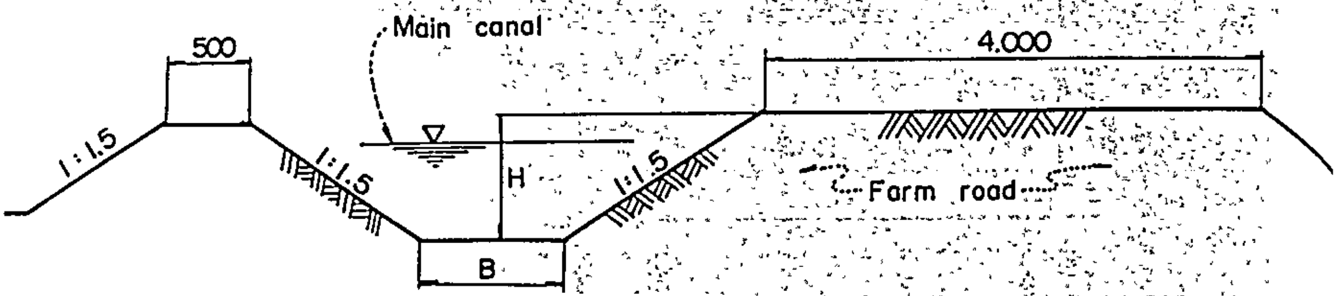
Table-H58 SAMPLE CALCULATION ON APPLICABILITY OF

PUMPINT STATION - Orocuina (F) in Middle Reach Valleys

Month	(1) Number of Day	(2) Design Discharge m^3/min/ha	(3) Irrigable Area 250 ha	(4) DV (1)x(3)	(5) 3 Pumps Unit Capacity 17.2m^3/min	(6) ai (3)/(5)	DVai (4)x(6)	(7) 4 Pumps Unit Capacity 12.9m^3/min	(8) ai (3)/(7)	DVai (4)x(8)	(9) 5 Pumps Unit Capacity 10.3m^3/min	(10) ai (3)/(9)	DVai (4)/(10)
JAN	31	0.124	31.0	961.0	34.4	0.90	864.9	38.7	0.80	768.8	41.2	0.75	720.8
FEB	28	0.102	25.5	714.0	34.4	0.74	528.4	25.8	0.99	706.9	30.9	0.83	592.6
MAR	31	0.158	39.5	1,224.5	51.6	0.77	942.9	51.6	0.77	942.9	41.2	0.96	1,175.5
APR	30	0.206	51.5	1,545.0	51.6	1.00	1,545.0	51.6	1.00	1,545.0	51.5	1.00	1,545.0
MAY	31	0.070	17.5	542.5	34.4	0.51	276.7	25.8	0.68	368.9	20.6	0.85	461.1
JUN	30	0.046	11.5	345.0	17.2	0.67	231.2	12.9	0.89	307.1	20.6	0.56	193.2
JUL	31	0.034	8.5	263.5	17.2	0.49	129.1	12.9	0.66	173.9	10.3	0.83	218.7
AUG	31	0	0	0	-	-	-	-	-	-	-	-	-
SEP	30	0	0	0	-	-	-	-	-	-	-	-	-
OCT	31	0.022	5.5	170.5	17.2	0.32	54.6	12.9	0.43	73.3	10.3	0.53	90.4
NOV	30	0.110	27.5	825.0	34.4	0.80	660.0	38.7	0.71	585.8	30.9	0.89	734.3
DEC	31	0.156	39.0	1,209.0	51.6	0.76	918.8	51.6	0.76	918.8	41.2	0.95	1,148.5
				ΣDV (7,800.0)			ΣDVai (6,151.6)			ΣDVai (6,391.4)			ΣDVai (6,880.1)

$a = \frac{\Sigma DVai}{\Sigma DV} = 0.789$ $a = \frac{\Sigma DVai}{\Sigma DV} = 0.819$ $a = \frac{\Sigma DVai}{\Sigma DV} = 0.882$

Table-H59 TYPICAL CROSS SECTION OF MAIN CANAL



A) Middle Reach Valleys

Name of Sub-area	Name of Canal	Net Irrigable Area (ha)	Design Discharge (m^3/sec)	B (m)	H (m)
Morolica C	No.1	210	0.693	1.00	0.80
Orocuina E	No.1	150	0.515	1.00	0.80
Orocuina F	No.1	250	0.858	1.00	0.80
Orocuina H	No.1	540	1.854	1.50	1.50

B) San Juan de Flores Area

Name of Sub-area	Net Irrigable Area (ha)	Design Discharge (m^3/sec)	B (m)	H (m)
A	230	0.331	0.50	0.65
B	110	0.158	-	-

Table-H60 RESULT OF WATER QUALITY ANALYSES

A) Choluteca Coastal Plain Irrigation Area (Project Area)

Site Number	Location	PH	Electric Conductivity (v/cm)	NaCl (ppm)
No. 1	Marcovia	7.6	280	130
No. 2	La piletas	7.6	288	138
No. 3	El palenque	7.6	290	140
No. 4	El Botadero	7.9	1,100	520
No. 5	Zapote	7.4	440	210
No. 6	Buena vista	7.5	840	420
No. 7	Paroseco	6.4	2,000	1.000
No. 8	Loma	7.35	180	220
No. 9	Cortijo	7.4	400	180
No. 10	San jose	7.4	700	320
No. 11	Santa julia	7.5	372	170
No. 12		7.6	680	320
No. 13		8.2	15.000	8,800
No. 14		7.4	860	420
No. 15		7.1	570	270
No. 16		7.4	2.400	1.200
No. 17		7.2	360	180
No. 18		7.0	2.100	1.000
No. 19		7.2	970	490
No. 20	Sampile	7.2	180	84
No. 21	Gervaceas	6.4	110	50
No. 22	Sampile	6.4	60	28
No. 23		6.4	105	49
No. 24		6.2	58	26
No. 25	El carrizo	7.8	480	230
No. 26	Gervaceas	6.8	420	200
No. 27	Monjaras	7.0	360	160
		7.5	345	140
No. 28		6.7	300	140
No. 29		7.4	2.200	1.050
No. 30		7.2	460	215
No. 31		7.6	2,450	1.200
No. 32		6.8	340	165
No. 33		7.2	580	270
No. 34		6.4	165	74
No. 35		7.1	700	320
No. 36		7.5	240	110
No. 37		6.9	140	62
No. 38		7.7	280	140

Note: The locations are shown in Fig.-H30.

B) San Juan de Flores Area

Site Number	Location	PH	Electric Conductivity (v/cm)	NaCl (ppm)
No. 1	*	7.8	310	155
No. 2	*	8.7	350	175
No. 3	*	7.2	280	143
No. 4	*	8.4	295	150
No. 5	Hacienda La Concordia	7.6	310	155
No. 6	Bridge Paso La Ceiba	7.5	290	140

Note; * The locations are shown in Fig.-H31.

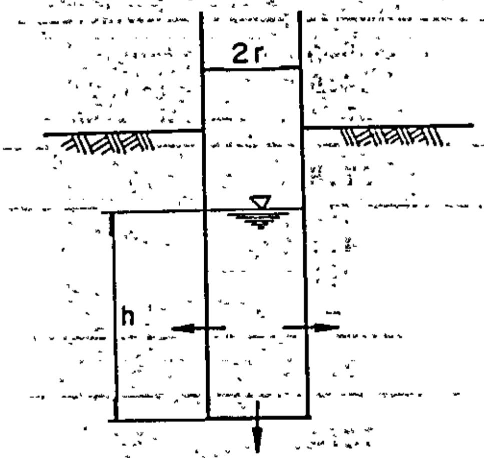
Table-H61 COEFFICIENT OF PERMEABILITY

(1) Formula

The coefficient of permeability is estimated by following formula.

$$k_{20} = \frac{Q}{2\pi h^2}\left[2.3 \log 10\left\{\frac{h}{r} + \sqrt{1 + \left(\frac{h}{r}\right)^2}\right\} \quad 1\right] \times \frac{\eta T}{\eta 20}$$

where,



k_{20}: Coefficient of permeability in cm/sec. 20°C

h : Water depth in test hole in cm

r : Radius of the test hole in cm

Q : Discharge in cm^3/sec.

ηT : Coefficient of viscosity of water 7°C

$\eta 20$: " 20°C

Coefficient of permeability

Site Number	Location	K_{20} (cm/sec.)
No.1	El Papalon	1.3×10^{-4}
No.2	Las Basas	2.0×10^{-4}
No.3	Coop. Nueva Consepcion	1.0×10^{-4}
No.4	Laguna Palo Seco	4.7×10^{-5}
No.5	Cerro Butus	1.5×10^{-4}
No.6	El Palenque	2.4×10^{-4}
No.7	Hacienda Santa INE's	1.5×10^{-4}

Note: The locations are shown in Fig.-H30.

Table-H62 BASIC INTAKE RATE

A) Choluteca Coastal Plain Irrigation Area (Project Area)

Number of Spot		Accumulated Discharge (mm)	Intake Rate (mm/hr)	Basic Intake Rate (mm/hr)	Remarks
No.2	1	$15.0T^{0.30}$	$270.0T^{-0.70}$	3.9	Omit
	2	$10.2T^{0.39}$	$449.3T^{-0.61}$	12.3	
	3	$22.1T^{0.38}$	$503.9T^{-0.62}$	12.8	
Average		$20.8T^{0.38}$	$474.2T^{-0.62}$	12.1	
No.3	1	$38.0T^{0.29}$	$661.2T^{-0.71}$	9.0	
	2	$14.3T^{0.54}$	$463.3T^{-0.46}$	34.9	
	3	$38.9T^{0.46}$	$1,073.6T^{-0.54}$	47.3	
Average		$30.0T^{0.43}$	$774.0T^{-0.57}$	27.8	
No.4	1	$22.6T^{0.27}$	$366.1T^{-0.73}$	4.3	
	2	$25.0T^{0.22}$	$330.0T^{-0.78}$	2.7	
	3	-	-	-	
Average		$24.6T^{0.24}$	$354.2T^{-0.76}$	3.4	
No.5	1	$5.9T^{0.52}$	$184.1T^{-0.48}$	12.2	
	2	$8.6T^{0.55}$	$283.8T^{-0.45}$	22.9	
	3	$15.4T^{0.44}$	$406.6T^{-0.56}$	15.6	
Average		$9.9T^{0.49}$	$291.1T^{-0.51}$	15.7	
No.7	1	$12.2T^{0.32}$	$234.2T^{-0.68}$	3.9	Omit
	2	$12.0T^{0.42}$	$302.4T^{-0.58}$	10.2	
	3	$11.2T^{0.46}$	$309.1T^{-0.54}$	13.6	
Average		$12.3T^{0.43}$	$317.3T^{-0.57}$	11.4	
No.8	1	$36.3T^{0.49}$	$1,067.2T^{-0.51}$	57.6	
	2	$32.2T^{0.40}$	$772.8T^{-0.50}$	22.6	
	3	$30.6T^{0.33}$	$605.9T^{-0.67}$	10.9	
Average		$31.9T^{0.42}$	$803.9T^{-0.58}$	30.3	
No.9	1	$12.1T^{0.40}$	$290.4T^{-0.60}$	8.5	Omit
	2	$30.9T^{0.37}$	$686.0T^{-0.63}$	16.3	
	3	$10.0T^{0.42}$	$252.0T^{-0.58}$	8.5	
Average		$11.4T^{0.40}$	$273.6T^{-0.60}$	8.5	
No.10	1	$25.6T^{0.34}$	$522.2T^{-0.66}$	10.1	Omit
	2	$9.8T^{0.58}$	$341.0T^{-0.42}$	33.4	
	3	$9.1T^{0.50}$	$273.0T^{-0.50}$	15.8	
Average		$11.2T^{0.56}$	$376.3T^{-0.44}$	13.0	

B) San Juan de Flores Area

Number of Spot		Accumulated Discharge (mm)	Intake Rate (mm/hr)	Basic Intake Rate (mm/hr)	Remarks
No.11	1	$10.2T^{0.31}$	$189.7T^{-0.69}$	3.2	
	2	$4.3T^{0.29}$	$79.8T^{-0.71}$	1.1	
	3	$6.1T^{0.51}$	$186.7T^{-0.49}$	11.5	Omit
Average		$6.1T^{0.37}$	$135.4T^{-0.63}$	3.2	
No.12	1	$6.5T^{0.46}$	$179.4T^{-0.54}$	7.9	
	2	-	-	-	No Data
	3	$7.9T^{0.26}$	$123.2T^{-0.74}$	1.4	
Average		$7.4T^{0.36}$	$159.8T^{-0.64}$	3.5	

Table-II-3 FIELD CAPACITY, WATER CONTENT AND AVAILABLE MOISTURE OF SOILS

Sample Number		Weight of wet soil (g) F.C.	Weight of wet soil (g) PF.3	Weight of dry soil (g)	Weight of water (g) F.C.	Weight of water (g) PF.3	Water content (%) F.C.	Water content (%) PF.3	Apparent specify gravity	Wilting point (%) (PF.3/1.84)	F.C. - W.P. (%)	Available (%) Moisture/10 cm
No.1	1	161.71	161.16	115.96	45.75	45.20	39.45	38.98	1.16	21.18	18.27	21.19
	2	158.07	157.52	116.32	41.75	41.20	35.89	35.42	1.16	19.25	16.64	19.30
	3	147.87	147.20	104.46	43.41	42.74	41.56	40.92	1.04	22.24	19.32	20.09
	4	123.93	123.66	87.98	35.95	35.68	40.86	40.55	0.88	22.04	18.82	20.33
No.2 (a)	1	169.60	164.22	130.83	38.77	33.39	29.63	25.52	1.31	13.87	15.76	20.65
	2	157.46	151.30	116.00	41.46	35.30	35.74	30.43	1.16	16.54	19.20	19.20
	3	172.24	165.03	129.00	43.24	36.03	33.52	27.93	1.29	15.18	18.34	22.27
	4	158.58	152.52	125.66	32.92	26.86	26.20	21.38	1.26	11.62	14.58	18.37
No.2 (b)	1	165.20	159.87	128.50	36.70	31.37	28.56	24.41	1.29	13.27	15.29	19.72
	2	173.36	166.92	130.47	42.89	36.45	32.87	27.94	1.30	15.18	17.69	23.00
	3	164.14	157.70	123.51	40.63	34.19	32.90	27.68	1.24	15.04	17.86	22.15
	4	165.72	159.69	127.64	38.08	32.05	29.83	25.11	1.28	13.65	16.18	20.71
No.3 (a)	1	166.08	162.39	123.10	42.98	39.29	34.91	31.92	1.23	17.35	17.56	21.60
	2	174.43	170.85	126.14	48.29	44.71	38.28	35.44	1.26	19.26	19.02	23.96
	3	174.19	170.84	126.83	47.36	44.01	37.34	34.70	1.27	18.86	21.22	26.95
	4	174.87	171.45	123.58	51.29	47.87	41.50	38.74	1.24	21.05	20.45	25.36
No.3 (b)	1	155.57	151.74	119.87	35.70	31.87	29.78	26.59	1.20	14.45	15.33	18.40
	2	175.59	172.10	129.66	45.93	42.44	35.42	32.73	1.30	17.79	17.63	22.92
	3	173.06	169.73	127.32	45.74	42.41	35.93	33.31	1.27	18.10	17.83	22.64
	4	166.72	163.33	116.78	49.94	46.55	42.76	39.86	1.17	21.66	21.10	24.69
No.4	1	153.37	152.88	110.08	43.29	42.80	39.33	38.88	1.10	21.13	18.20	20.02
	2	162.72	162.48	123.38	39.44	39.10	31.89	31.69	1.23	17.22	14.67	18.04
	3	149.59	149.41	111.45	38.14	37.96	34.22	34.06	1.11	18.51	15.71	17.44
	4	163.46	163.16	133.21	30.25	29.95	22.71	22.48	1.33	12.22	10.49	13.95
No.5	1	169.54	162.50	133.30	36.24	29.20	27.19	21.91	1.33	11.91	15.28	20.32
	2	171.43	164.59	129.53	41.90	35.06	32.35	27.07	1.30	14.71	17.64	22.93
	3	143.47	136.78	107.13	36.34	29.65	33.92	27.68	1.07	15.04	18.88	20.20
	4	137.65	130.51	106.39	31.26	24.12	29.38	22.67	1.06	12.32	17.06	18.08
No.6	1	150.93	147.01	115.91	35.02	31.10	30.21	26.83	1.16	14.58	15.63	18.13
	2	138.93	135.67	109.33	29.60	26.34	27.07	24.09	1.09	13.09	13.98	15.24
	3	141.42	138.10	107.80	33.52	30.20	31.09	28.01	1.08	15.22	15.81	17.14
	4	143.96	139.51	107.48	36.48	32.03	33.94	29.80	1.07	16.20	17.74	18.98
No.11	1	167.52	157.59	137.66	29.86	19.93	21.69	14.48	1.38	7.87	13.82	19.07
	2	174.38	163.60	137.88	36.50	25.72	26.47	18.65	1.38	10.14	16.33	22.54
	3	150.11	142.77	121.04	29.07	21.73	24.02	17.95	1.21	9.76	14.26	17.25
	4	199.10	190.07	155.98	43.12	34.09	27.64	21.86	1.56	11.88	15.76	24.59
No.12	1	179.18	176.74	139.86	39.32	36.88	28.11	26.37	1.40	14.33	13.78	19.29
	2	164.68	160.28	130.82	33.86	29.46	25.88	22.52	1.31	12.24	13.64	17.55
	3	172.13	168.84	126.44	46.05	42.76	36.42	33.82	1.26	18.38	18.04	22.73
	4	169.15	166.36	130.10	39.05	36.26	30.02	27.87	1.30	15.15	14.87	19.23

Table-H64 TOTAL READILY AVAILABLE MOISTURE (mm)

Soil Type	Land Capacity	Spot Number	Crops							
			Pasture	Sugarcane	Beans	Maize	Sesame	Cotton	Water Melon Melon	Sorghum
Mollisol	1st class	No. 1	72	119	79	113	113	124	81	85
"	"	No. 3	-	113	74	107	107	125	-	80
		Range	72	113-119	74-79	107-113	107-113	124-125	81	80-85
Mollisol	2nd class	No. 4	71	113	75	107	107	117	76	80
"	"	No. 5	74	114	76	109	109	126	77	81
		Range	71-74	113-114	75-76	107-109	107-109	117-126	76-77	80-81
Entisol	2nd class	No. 2	72	114	76	108	108	123	77	81
Entisol	3rd class	No. 6	64	102	68	97	97	104	69	73

Table-H65 MINIMUM IRRIGATION INTERVAL

Soil Type & Land Capacity	Crops	Pasture	Sugarcane	Beans	Maize	Sesame	Cotton	Melon & Water Melon	Sorghum
	Max. Consumptive use (mm/day)	7.7	7.1	5.4	5.5	5.5	6.8	3.0	5.5
Mollisol (1st class)	TRAM (mm)	72	113-119	74-79	107-113	107-113	124-125	81	80-85
	Irr. Interval (days)	9	15-16	13-14	19-20	19-20	18	27	14-15
Millisol (2nd class)	TRAM (mm)	71-74	113-114	75-76	107-109	107-109	117-126	76-77	80-81
	Irr. Interval (days)	9	15-16	13-14	19	19	17-18	25	14
Entisol (2nd class)	TRAM (mm)	72	114	76	108	108	123	77	81
	Irr. Interval (days)	9	16	14	19	19	18	25	14
Entisol (3rd class)	TRAM (mm)	64	102	68	97	97	104	69	73
	Irr. Interval (days)	8	14	12	17	17	15	23	13

Table-H66 WORKABLE DAYS

	JAN	FAB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1963	-	-	-	-	-	-	-	18	17	20	21	27
1964	26	25	27	24	23	15	16	20	15	21	26	26
1965	27	24	27	26	21	15	22	-	15	-	-	-
1966	-	24	27	24	19	12	19	24	15	17	26	27
1967	26	24	25	22	27	14	24	22	16	22	25	26
1968	27	25	26	25	16	7	26	23	12	14	24	26
1969	27	24	25	23	19	16	20	14	15	16	23	27
1970	27	24	26	25	18	-	17	14	12	20	23	27
1971	26	24	27	26	20	21	25	15	13	16	24	27
1972	26	25	27	24	17	18	21	22	21	16	24	27
1973	26	24	27	25	20	18	20	18	17	16	26	26
1974	26	24	27	26	19	18	27	21	16	22	25	27
1975	26	24	27	26	19	21	20	21	12	20	20	27
1976	-	-	-	-	23	16	25	-	-	-	-	27
Average	26	24	27	25	20	16	22	19	15	18	24	27

Table-H67 LENGTH OF MAIN, BRANCH AND SECONDARY CANALS IN WESTERN PLAIN (PROJECT AREA)

Unit: km

	Main	Branch	Secondary
Upper Main Canal	12.8		
Secondary canal R-0-1			5.0
Secondary canal R-0-2			9.5
Secondary canal R-0-3			8.0
Secondary canal R-0-4			8.0
Left Main Canal LM-1	8.6		
Secondary canal R-0-7			2.3
Left Branch Canal LB-1		9.0	
Secondary canal L-1-1			4.5
Secondary canal L-1-2			2.0
Secondary canal L-1-3			2.0
Secondary canal L-1-4			1.0
Secondary canal L-1-5			0.5
Left Branch Canal LB-1a		2.5	
Secondary canal L-1a-1			1.5
Secondary canal L-1a-2			2.5
Secondary canal L-1a-3			1.5
Right Branch Canal RB-1		7.0	
Secondary canal R-1-1			2.8
Secondary canal R-1-1a			4.5
Secondary canal R-1-1b			4.0
Secondary canal R-1-2			5.0
Right Main Canal	4.9		
Secondary canal R-0-5			3.6
Right Branch Canal RB-2		11.8	
Secondary canal R-2-1			3.7
Secondary canal R-2-2			2.2
Secondary canal R-2-3			1.5
Secondary canal R-2-4			2.8
Right Branch Canal RB-3		9.0	
Secondary canal R-3-1			2.4
Right Branch Canal RB-4		7.2	
Secondary canal R-4-1			2.2
Secondary canal R-4-2			1.8
Total	26.3	46.5	84.8

Table-H68 LENGTH OF MAIN AND SECONDARY DRAIN IN WESTERN PLAIN (PROJECT AREA)

Unit: km

	Main Drain	Secondary Drain
Right Main Drain RMD-1	15.0	
Secondary Drain RD-1-1		1.5
Right Main Drain RMD-2	21.3	
Secondary Drain RD-2-1		2.5
Secondary Drain RD-2-2		1.2
Right Main Drain RMD-3	7.5	
Secondary Drain RD-3-1		3.5
Secondary Drain RD-3-2		0.5
Secondary Drain RD-3-3		2.5
Secondary Drain RD-3-3a		3.2
Right Main Drain RMD-3a	1.9	
Right Main Drain RMD-4	14.0	
Secondary Drain RD-4-1		1.6
Secondary Drain RD-4-2		1.0
Right Main Drain RMD-5	9.4	
Right Main Drain RMD-6	8.1	
Right Main Drain RMD-7	6.5	
Right Main Drain RMD-7a	3.9	
Right Main Drain RMD-8	1.2	
Right Main Drain RMD-9	3.1	
Left Main Drain RMD-7	2.0	
Left Main Drain RMD-7b	3.5	
Secondary Drain LD-7b-1		4.0
Secondary Drain LD-7b-1a		1.0
Left Main Drain LMD-14	3.3	
Left Main Drain LMD-15	6.0	
Left Main Drain LMD-16	1.5	
Left Main Drain LMD-17	1.5	
Left Main Drain LMD-18	5.0	
Left Main Drain LMD-19	2.0	
Left Main Drain LMD-20	1.5	
Total	121.9	22.5

Table-H69 : NUMBER OF RELATED STRUCTURES ON THE WESTERN PLAIN AREA (PROJECT AREA)

Name of Related Structures	Structures related to Irrigation Canal (Nos)	Structures related to Drainage Canal (Nos)	Related structures on Farm (Nos)
1. Intake Weir	1	-	-
2. Desilting Basin	1	-	-
3. Bifurcation Structure	1	-	-
4. Turnout	287	-	1,150
5. Cross Regulator	78	-	-
6. Drop	51	11	-
7. Colvert	36	-	-
8. Spillway	28	-	-
9. Syphon	1	-	-
10. Drainage Culvert	-	22	-
11. Bridge	-	3	-
12. Cause Way	-	1	-
13. Booster Pump Station	1	-	-
14. Division Box	-	-	5,800
Total	484	37	6,950

Table-H70 WORK QUANTITY AND CONSTRUCTION MATERIALS (WESTERN PLAIN AREA)

Description	Unit	Quantity
1. Head Works (El Papalón Intake Weir)		
Excavation	m^3	29.500
Backfill	m^3	6.600
Concrete	m^3	15.300
Reinforcement bar	ton	240
2. Irrigation Canal		
Excavation	m^3	133.800
Embankment	m^3	1,153,900
Stripping	m^3	153,000
Concrete lining	m^3	27.600
3. Drainage Canal		
Excavation	m^3	970,000
4. Link Road & Farm Road		
Embankment	m^3	153.000
Stripping	m^3	86.000
Gravel metalling	m^3	42.000
5. Related Structures		
Excavation	m^3	31.500
Embankment	m^3	2.400
Backfill	m^3	9.800
Concrete	m^3	12,300
Reinforcement bar	ton	570

Table-II71 STAFFING

	Staff
I) Staff Required During Construction	
Resident Manager	1
Progress Control	
Construction engineer	1
Secretary	1
Construction	
Chief	1
Architects	1
Civil engineer	1
Assistant civil engineer	2
Irrigation engineer	8
Assistant irrigation engineer	16
Secretary	2
Inspector	12
Mechanical and Electrical	
Chief	1
Electrical engineer	1
Mechanical engineer	2
Assistant mechanical engineer	4
Skilled labor	4
Secretary	1
Laboratory	
Material engineer	1
Assistant material engineer	2
II) Staff Required of Operation and Management	
Resident Manager	1
Operation and Maintenance	
Chief	1
Sub-director	1
Civil engineer	1
Assistant civil engineer	2
Irrigation engineer	8
Assistant irrigation engineer	16
Electrical engineer	1
Driver	7
Forman	12
Secretary	2
Repair Shop and Motor Pool	
Chief	1
Mechanical engineer	1
Assistant mechanical engineer	4
Driver	2
Secretary	1

Table-H72 LIST OF CONSTRUCTION MACHINERY

Construction Machinery		Required Number
A) Earth Moving Machinery		
1. Bulldozer	21 ton	9
2. Bulldozer	15 ton	5
3. Rake dozer	21 ton	8
4. Dragline	0.8 m^3	3
5. Backhoe	0.6 m^3	5
6. Mortor grader	9 ton	8
7. Mortor scraper	11 m^3	4
8. Tractor shovel	0.6 m^3	16
9. Tractor shovel	1.0 m^3	32
10. Dump truck	8 ton	13
11. Tamper	80 kg 4 ps	6
12. Tyre roller	8 ton	8
13. Tractor	6 ton	2
B) Concrete Machinery		
1. Slop form	(0.3 m^2 x 2 Nos.)	5
2. Truck mixer	3 m^3	9
3. Portable butcher	0.6 m^3	4
4. Concrete mixer	3 m^3	2
5. Vibrator	10,000 rpm 0.5 ps	32
6. Compressor	12 m^3/hr	26
C) Others		
1. Truck crane	10 ton	4
2. Truck crawler crane	30 ton	1
3. Belt Conveyer	(35m - 10m)	10
4. Submergible pump	(80 mm) (4 ps)	20

CONSTRUCTION MACHINERY (Continued)		Required Number
5. Diesel hummer	2.5 ton	3
6. Ordinary truck	6 ton	8
7. Jeep		5
8. Mortor bicycle		20
9. Diesel generator		20
10. Pick hammer		5
11. Bush cleaner	2.5 ps	40
12. Rotary grass cutter	50 ps	2

Table-H73 OPERATION AND MAINTENANCE COST

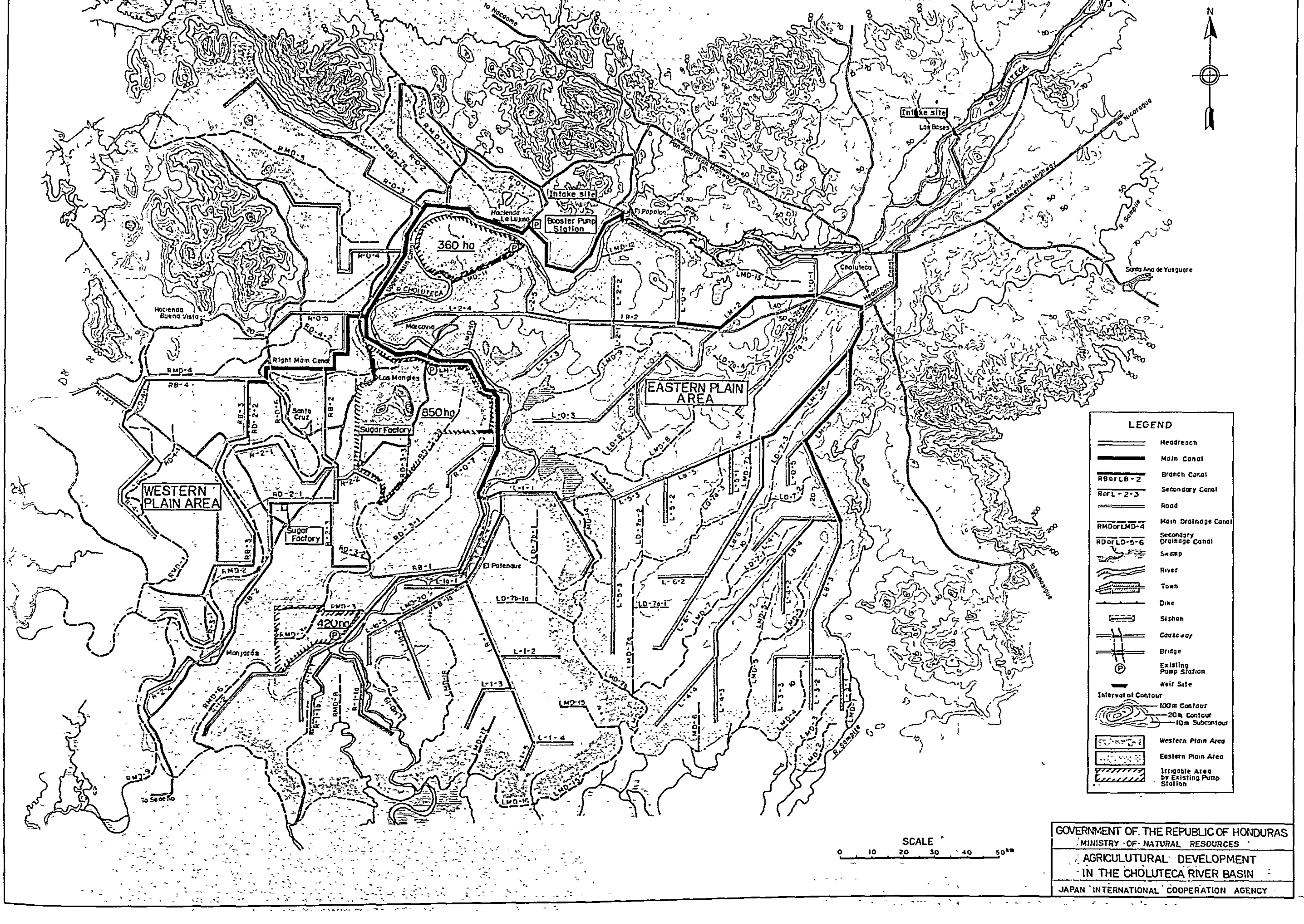
Construction	Machinery	Operation hour per year		Nos.	Cost/* per hour	Cost per year
A) Easth Moring Machinery		day x hours				
1. Bulldozer	21 ton	150	6	2	28.22	50,800
2. Bulldozer	15 ton	150	6	1	21.38	19.250
3. Rake dozer	21 ton	150	6	2	28.35	51.030
4. Dragline	0.8 m^3	150	6	1	17.53	15.780
5. Back hoe	0.6 m^3	150	6	1	10.67	9.610
6. Mortor grader	9 ton	150	6	2	13.50	24,300
7. Mortor scraper	11 m^3	150	6	1	44.91	40.420
8. Tractor shovel	0.6 m^3	150	6	4	5.97	21.500
9. Tractor shovel	1.0 m^3	150	6	7	8.47	53.370
10. Dump truck	8 ton	180	6	2	5.72	18,540
11. Tamper	80 kg 4ps	150	6	2	0.89	1.610
12. Tyre roller	8 ton	150	6	2	8.72	15.700
13. Tractor	6 ton	230	6	1	6.22	8,590
Sub-total (1)						330.500
B) Concrete Machinery						
1. Truck mixer	3 m^3	130	6	2	8.16	13,670
2. Portable butcher	0.6 m^3	130	6	1	3.66	2,860
3. Concrete mixer	3 m^3	130	6	1	14.45	11.280
4. Vibrator	10,000 vpm 0.5 ps	130	6	7	0.61	3.340
Sub-total (2)						31.150
C) Others						
1. Truck crane	10 ton	100	6	1	11.67	7.010
2. Belt conveyer	(35cm-10m)	150	6	2	0.87	1.570
3. Submersible pump	(80 mm 4 ps)	110	6	4	1.48	3.910
4. Diesel hummer	2.5 ton	100	6	1	9.91	5.950
5. Ordinary truck	6 ton	300	4	2	1.32	3.170
6. Jeep		300	4	13	2.12	33.080

Construction	Machinery	Operation hour per year		Nos.	Cost/1 per hour	Cost per year
7. Mortor bicycle		300	4	26	0.45	14,040
8. Bush cleaner 2.5ps		230	6	8	0.12	1,330
9. Pump and morter						
Contrifugal type	44 m^3/min	1,100	2	2	3.74	8,230
"	45 "	1,260		2	3.74	9,430
"	70 "	920		2	4.74	8,730
"	85 "	1,130		2	6.33	14,310
Electric charge				LS		17,250
Sub-total (3)						128,010
Total	Sub-total (1) - (3)					489,660
Miscellaneous 10%						48,970
Grand total						538,630

O & M cost 538,630($) ÷ 15,600(ha) = 34.5 $/ha

/1 : Operation cost includes the replacement cost of machineries.

Fig.-H1 SCHEMATIC CANAL LAYOUT OF CHOLUTECA COASTAL PLAIN AREA



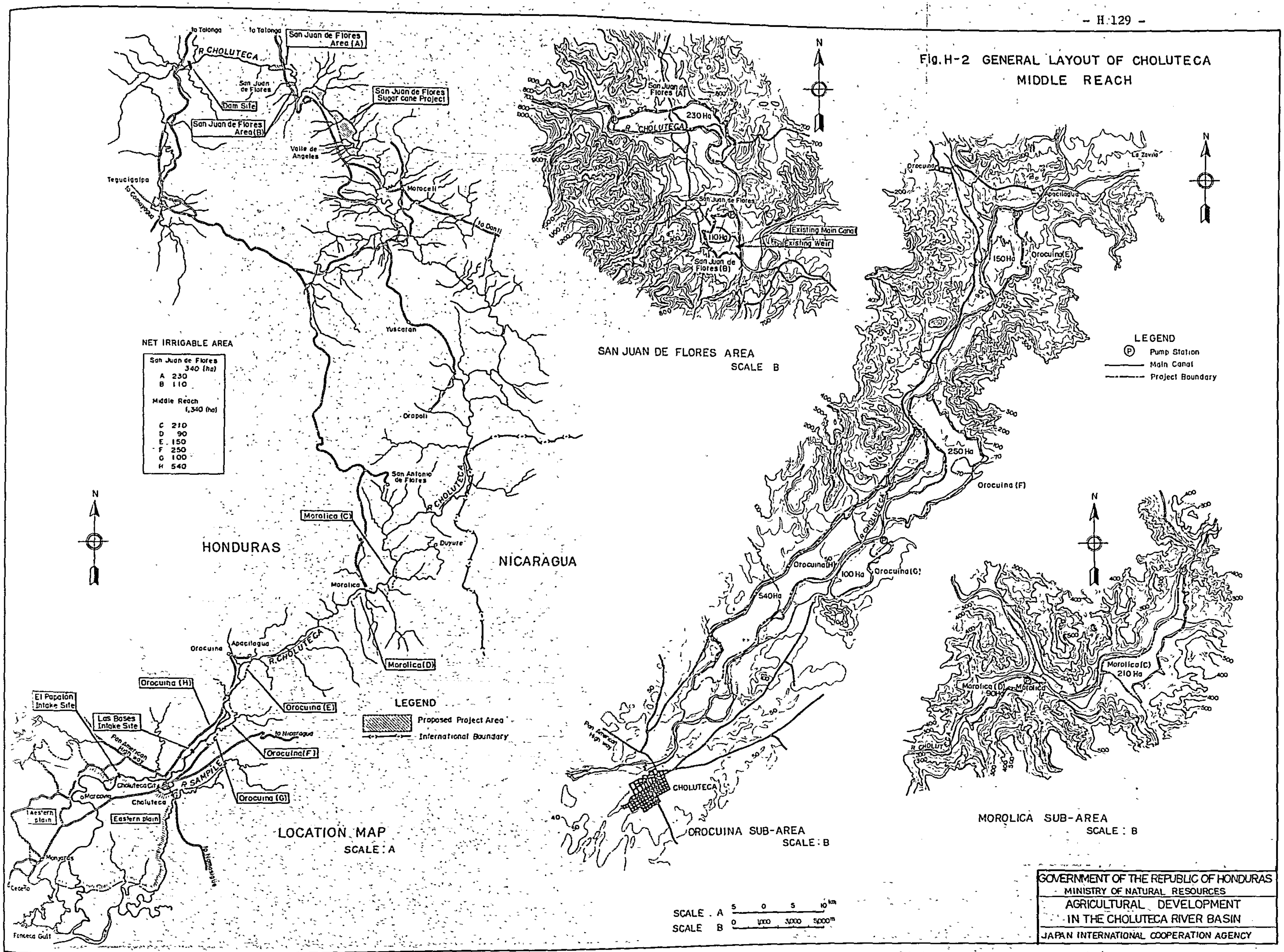


Fig. H-2 GENERAL LAYOUT OF CHOLUTECA MIDDLE REACH
to Talanga
San Juan de Flores Area (A)
R. CHOLUTECA
San Juan de Flores
Dam Site
San Juan de Flores Area (B)
San Juan de Flores Sugar cane Project
Valle de Angeles
Tegucigalpa
to Comayagua
Morocelí
to Danlí
Yuscaran
Oropoli
San Antonio de Flores
Morolica (C)
Duyure
Morolica
Morolica (D)
HONDURAS
NICARAGUA
Orocuina
Apacilagua
Orocuina (H)
Orocuina (E)
Orocuina (F)
Orocuina (G)
El Papalon Intake Site
Las Bases Intake Site
Pan American High way
Choluteca City
R. SAMPILE
Choluteca
to Nicaragua
Eastern plain
Monjaras
Fonseca Gulf
LEGEND
Proposed Project Area
International Boundary
LOCATION MAP
SCALE : A
NET IRRIGABLE AREA
San Juan de Flores 340 (ha)
A 230
B 110
Middle Reach 1,340 (ha)
C 210
D 90
E 150
F 250
G 100
H 540
SAN JUAN DE FLORES AREA
SCALE B
230 Ha
110 Ha
Existing Main Canal
Existing Weir
San Juan de Flores (B)
LEGEND
Pump Station
Main Canal
Project Boundary
La Zavila
150 Ha
250 Ha
100 Ha
540 Ha
CHOLUTECA
OROCUINA SUB-AREA
SCALE : B
Morolica (C) 210 Ha
Morolica (D) 90 Ha
MOROLICA SUB-AREA
SCALE : B
SCALE . A 5 0 5 10km
SCALE B 0 1000 3000 5000m
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Fig.-H 3 CONSTRUCTION DIVISION OF IRRIGATION AREA

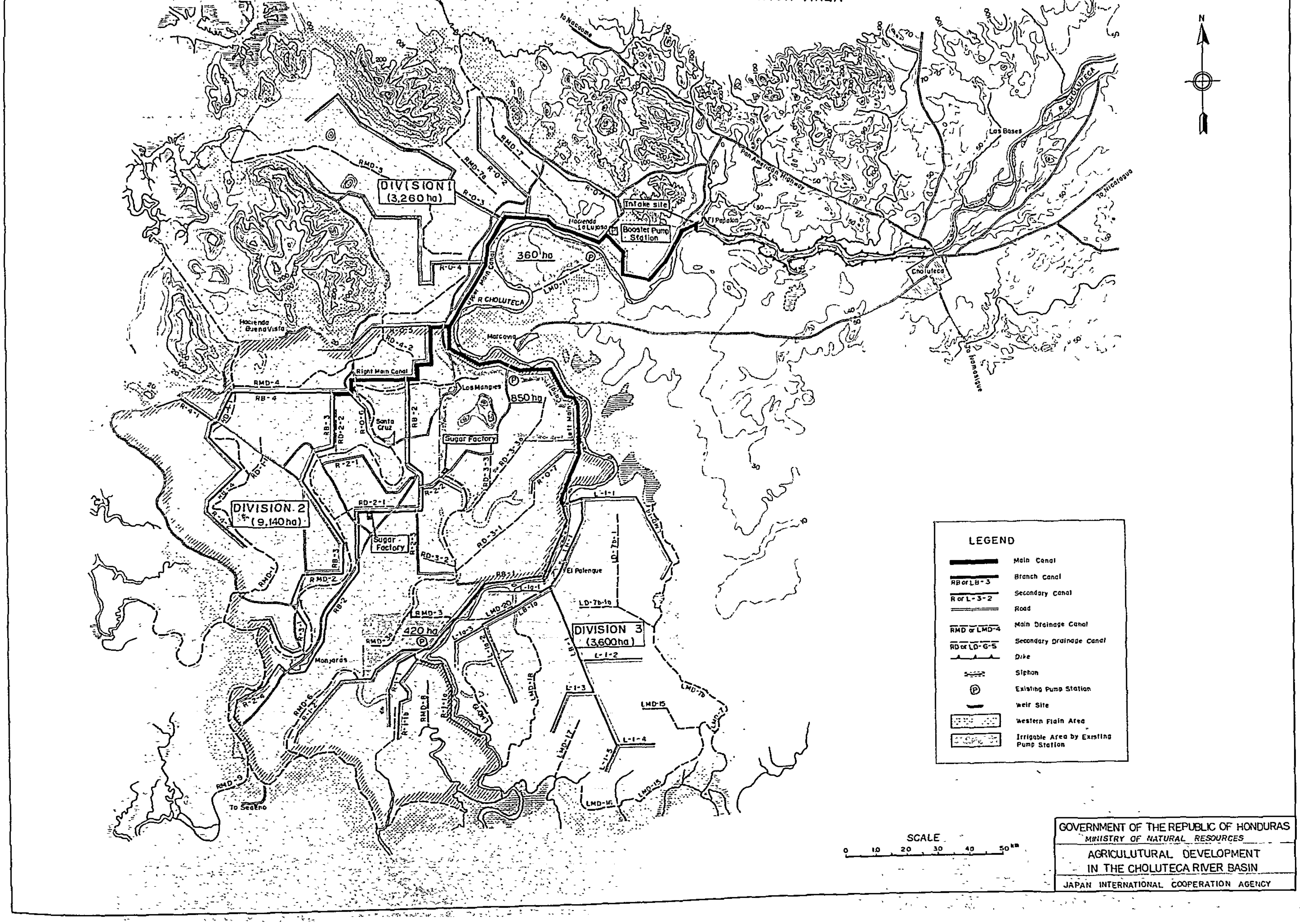
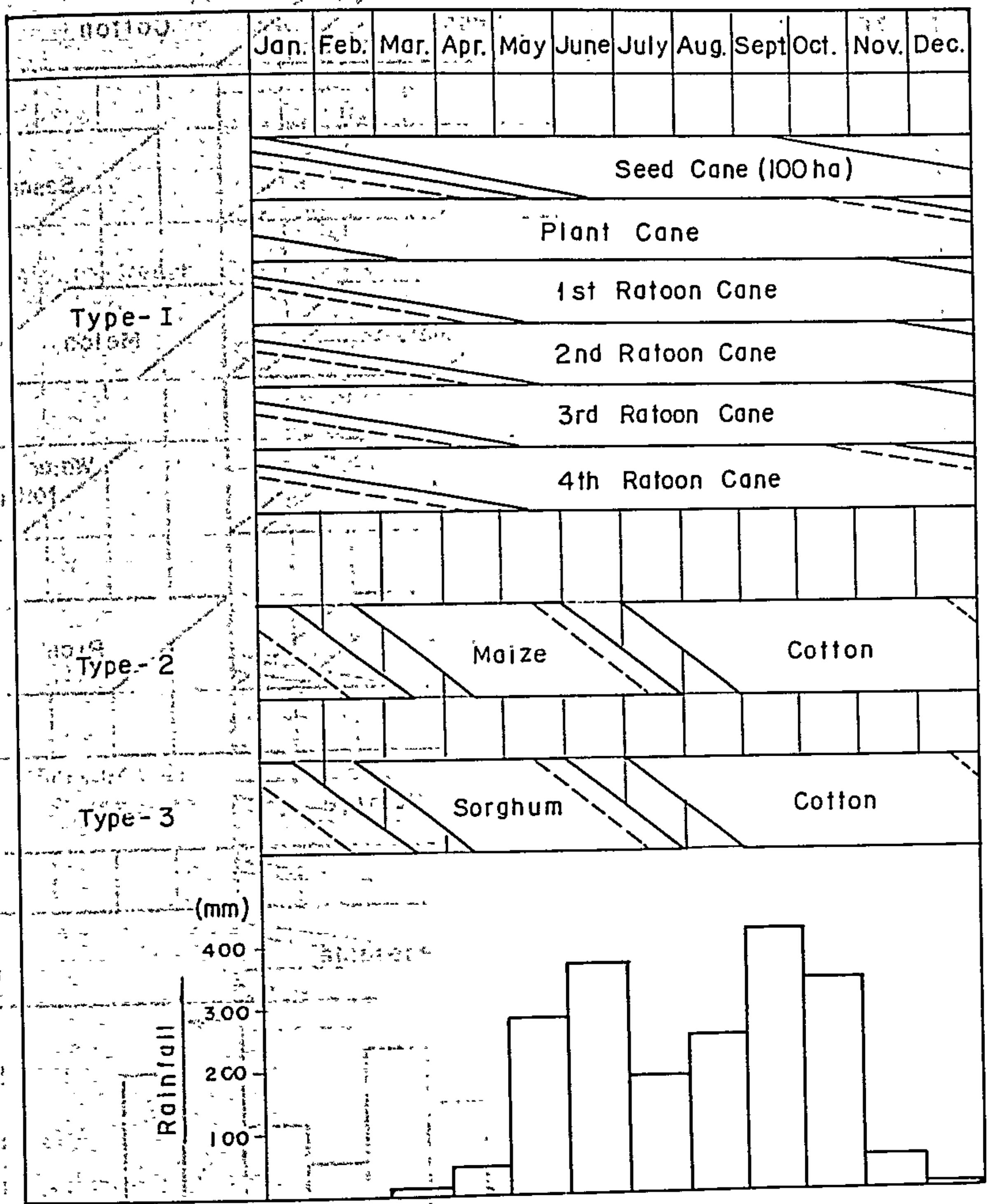


Fig.-H4 PROPOSED CROPPING PATTERN
(Choluteca Coastal Plain)



- to be continude -

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Fig.-H5 PROPOSED CROPPING PATTERN (Continued)
(Choluteca Coastal Plain)

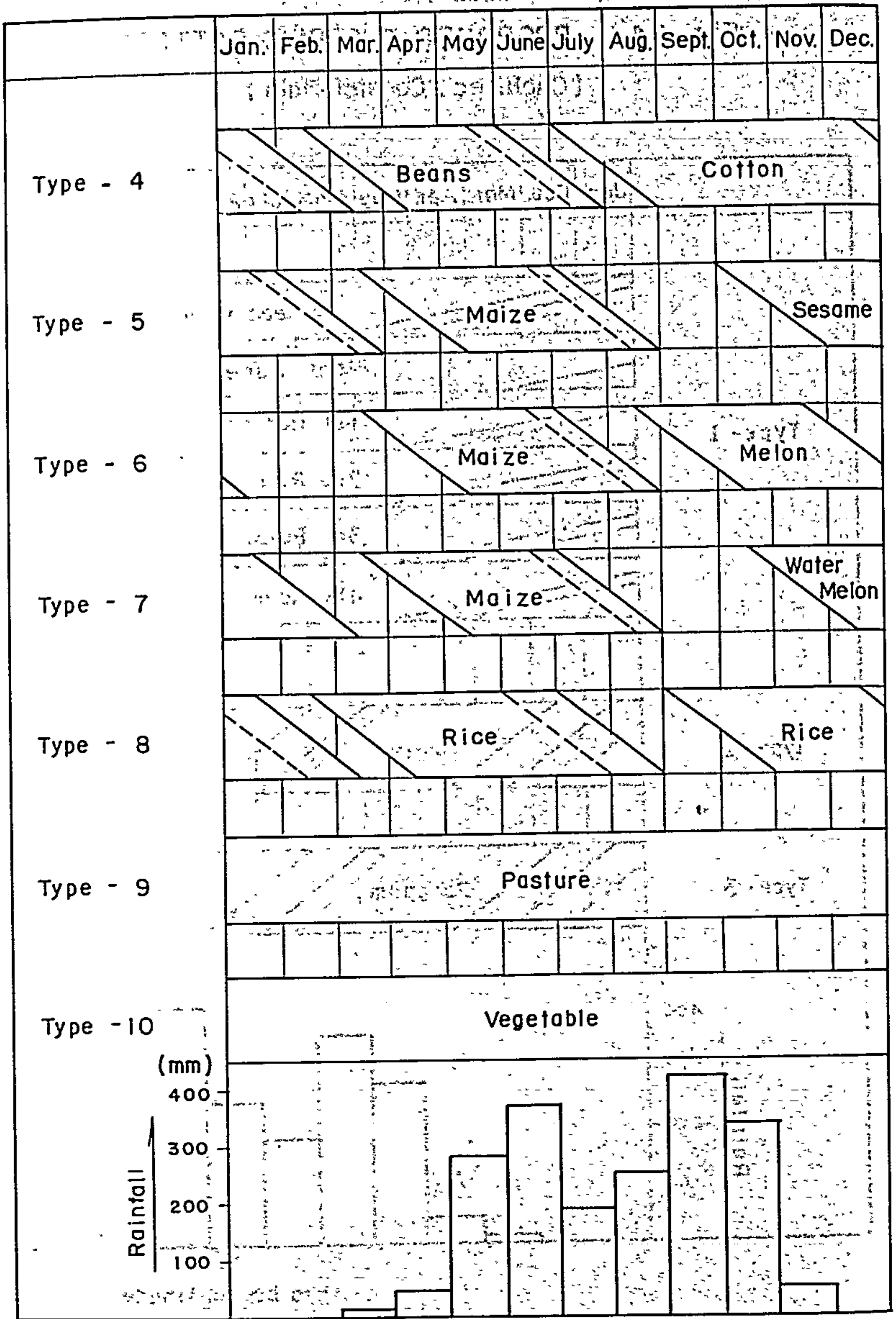

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Fig.-H6 PROPOSED CROPPING PATTERN
(Middle-Reach and San Juan de Flores Area)

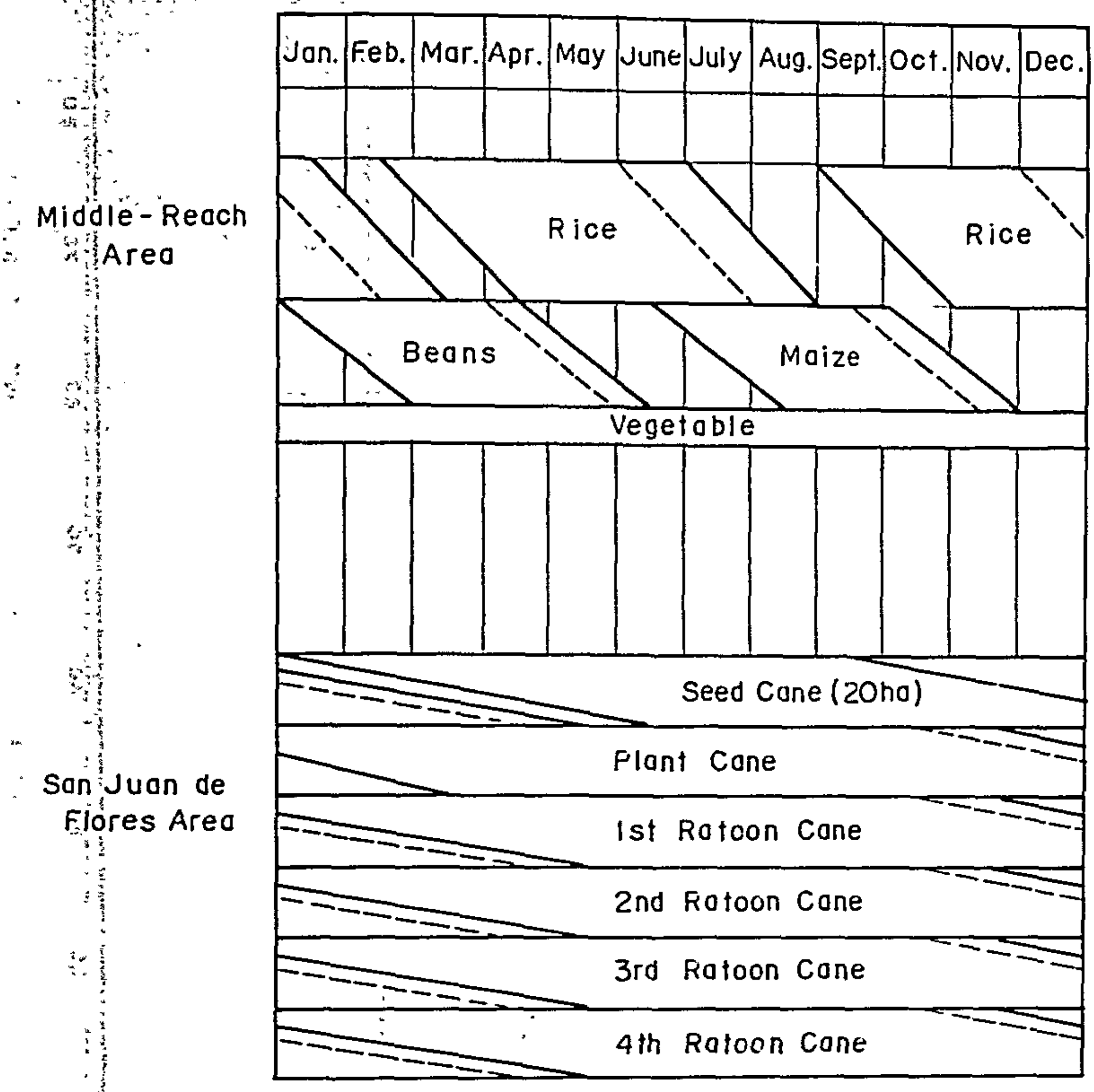

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Fig.-H7 CROP GROWTH STAGE COEFFICIENT FOR SUGAR CANE

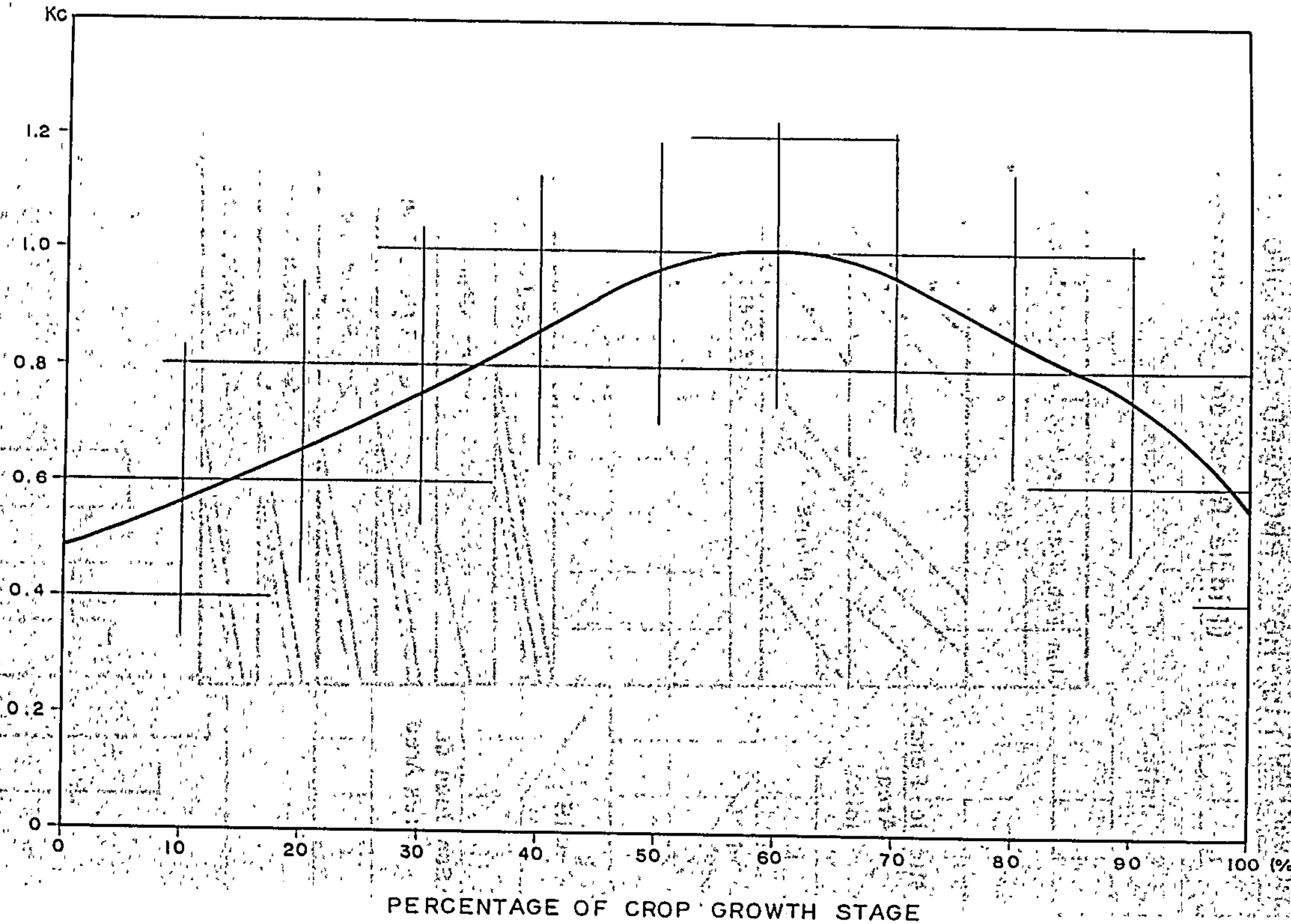

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Fig.-H8 CROP GROWTH STAGE COEFFICIENT FOR COTTON

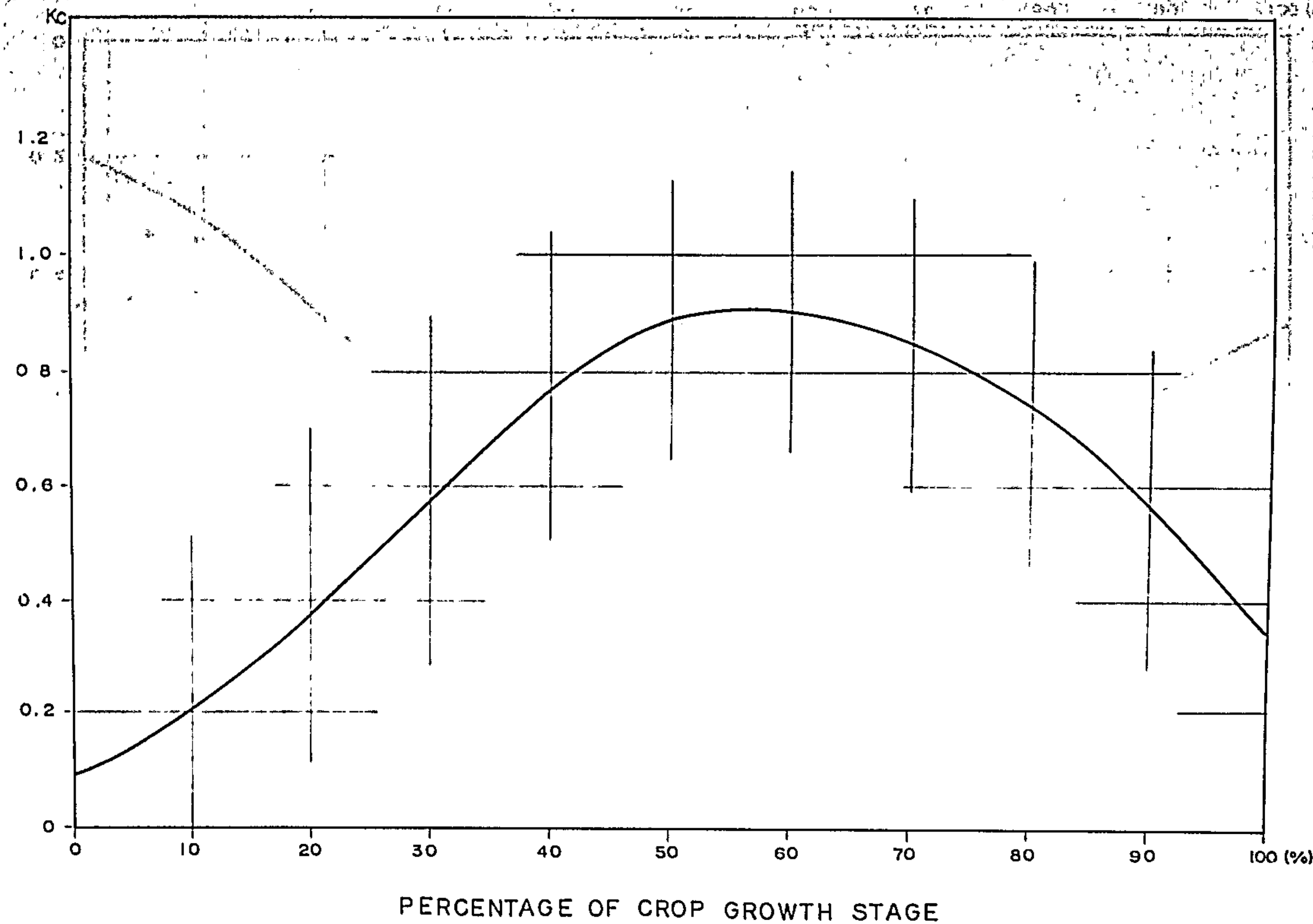

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Fig.-H9 CROP GROWTH STAGE COEFFICIENT FOR MAIZE & SESAME

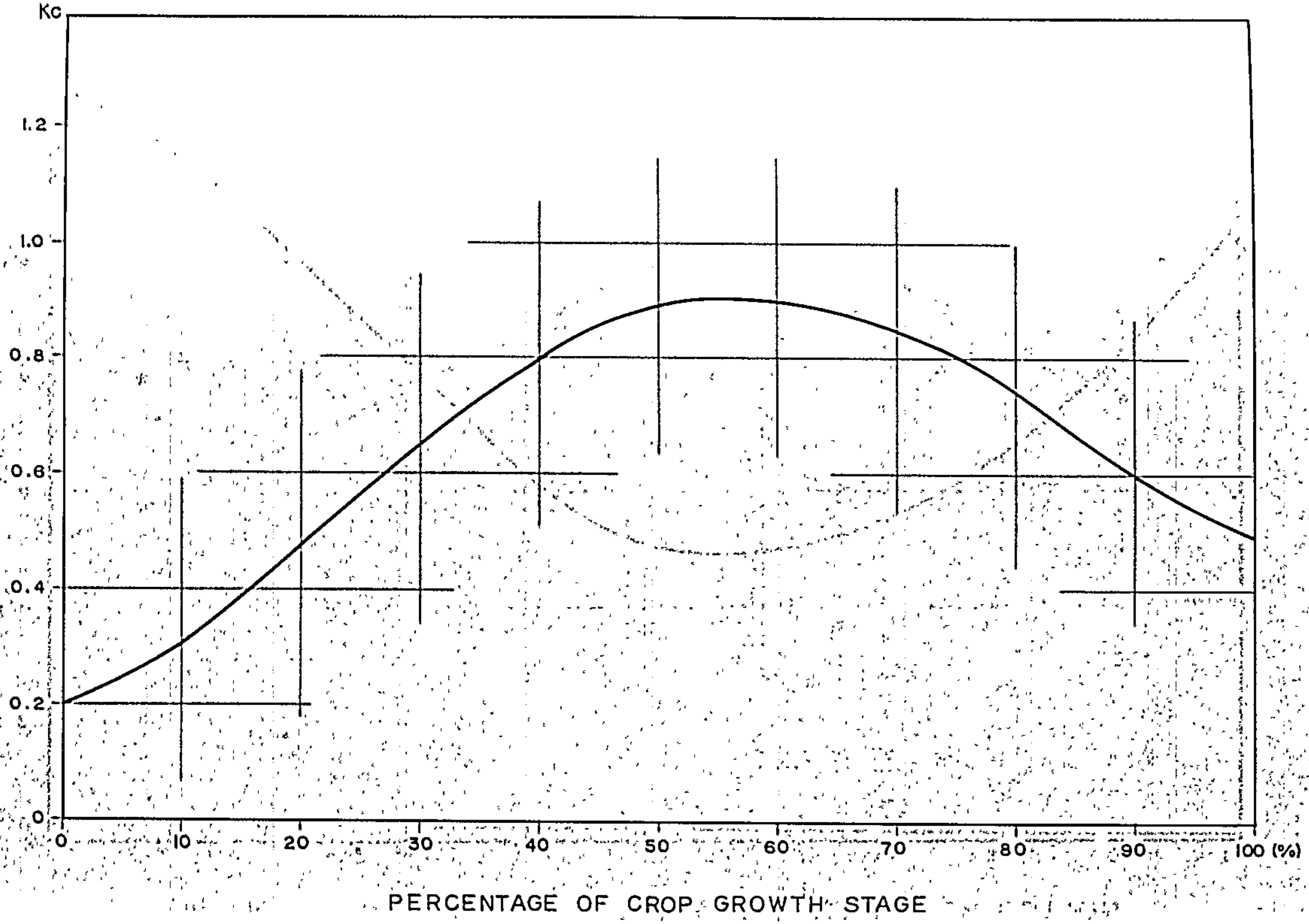

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Fig.-HIO CROP GROWTH STAGE COEFFICIENT FOR SORGHUM

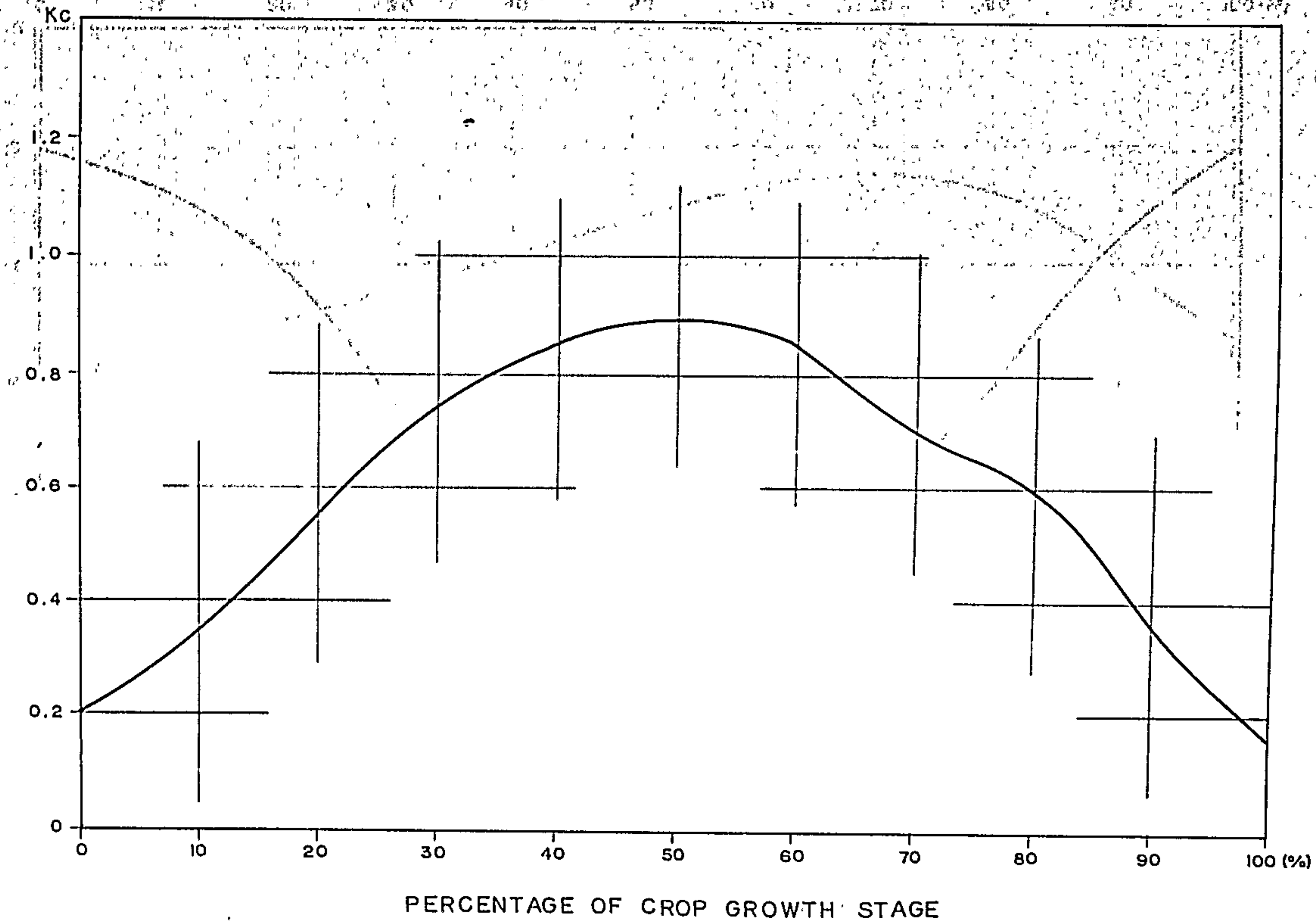

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Fig.-HII CROP GROWTH STAGE COEFFICIENT FOR BEANS

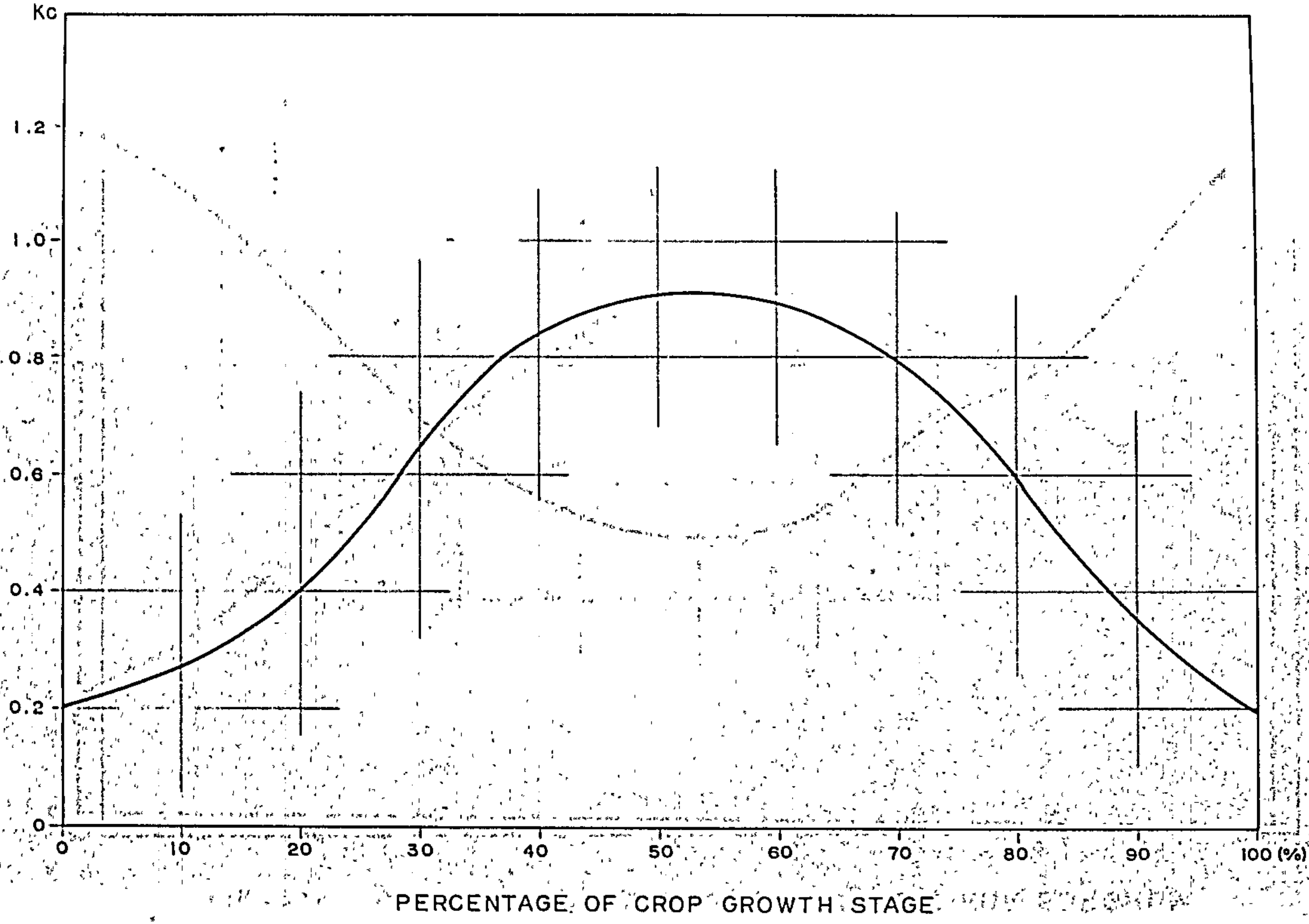

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Fig.-H12 CROP GROWTH STAGE COEFFICIENT FOR RICE

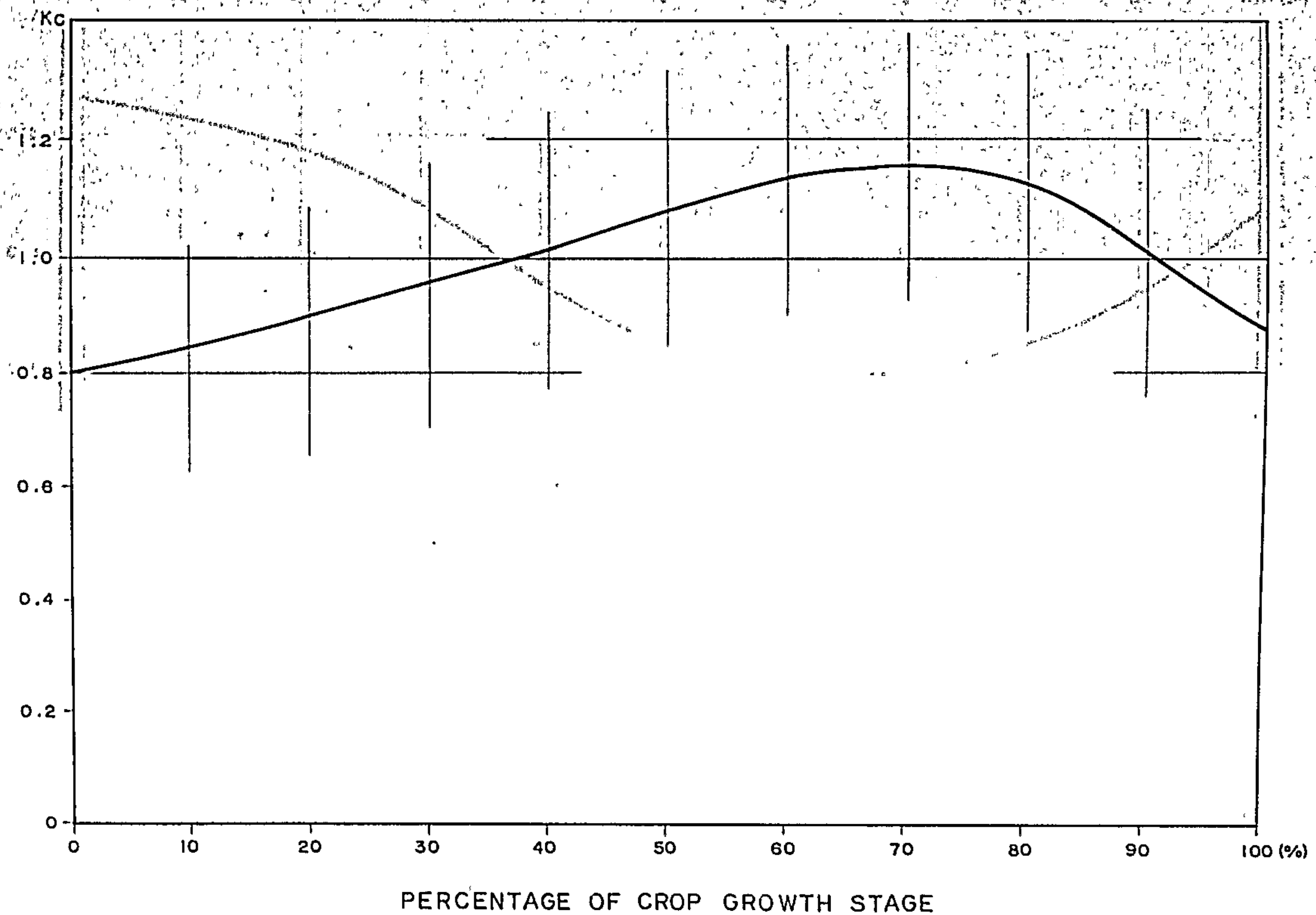

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Fig.-H13 CROP GROWTH STAGE COEFFICIENT FOR MELON

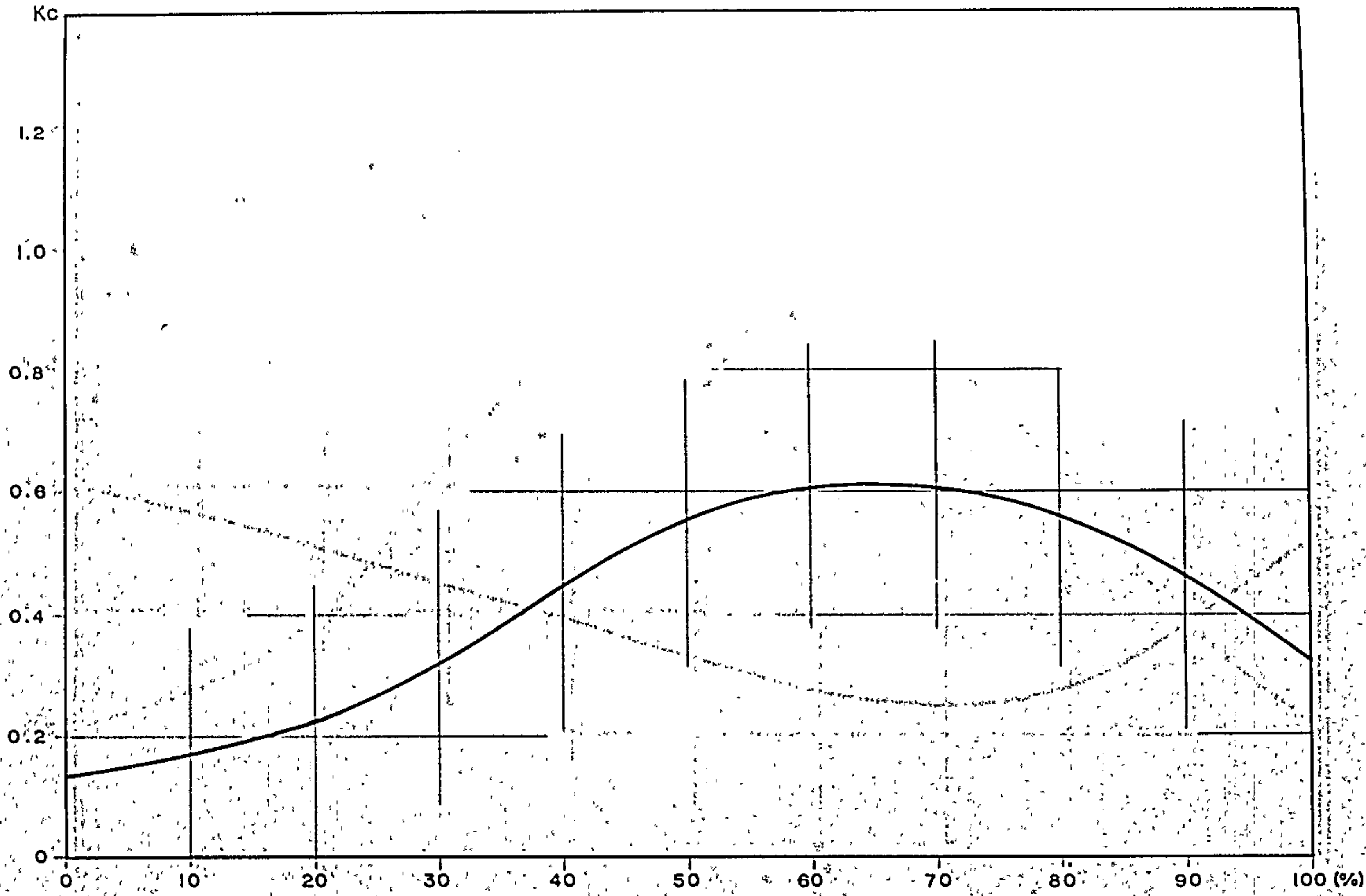

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Fig.-H14 CROP GROWTH STAGE COEFFICIENT FOR VEGETABLE

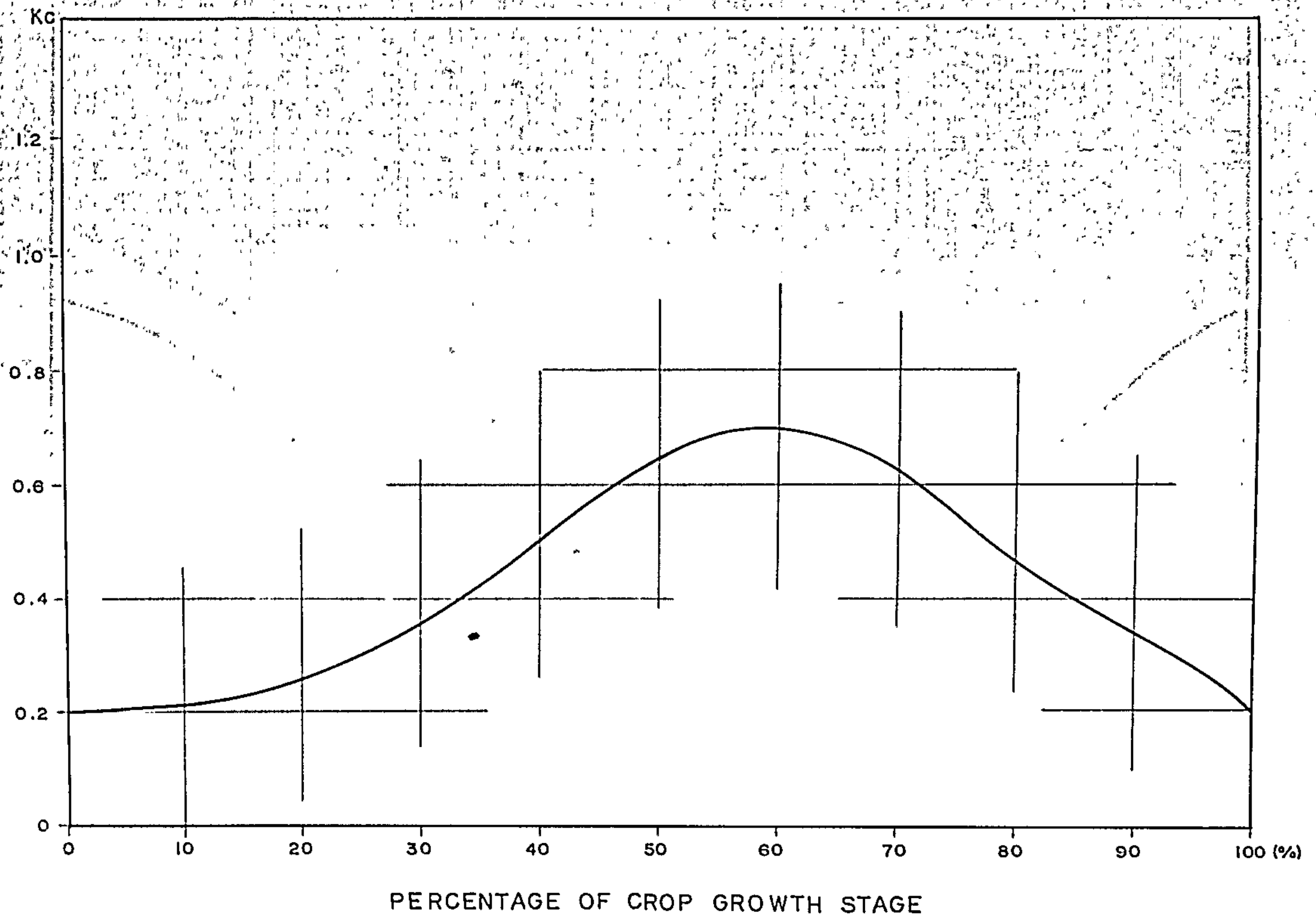

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Fig.-H15 CROP GROWTH STAGE COEFFICIENT FOR PASTURE (GRASS)

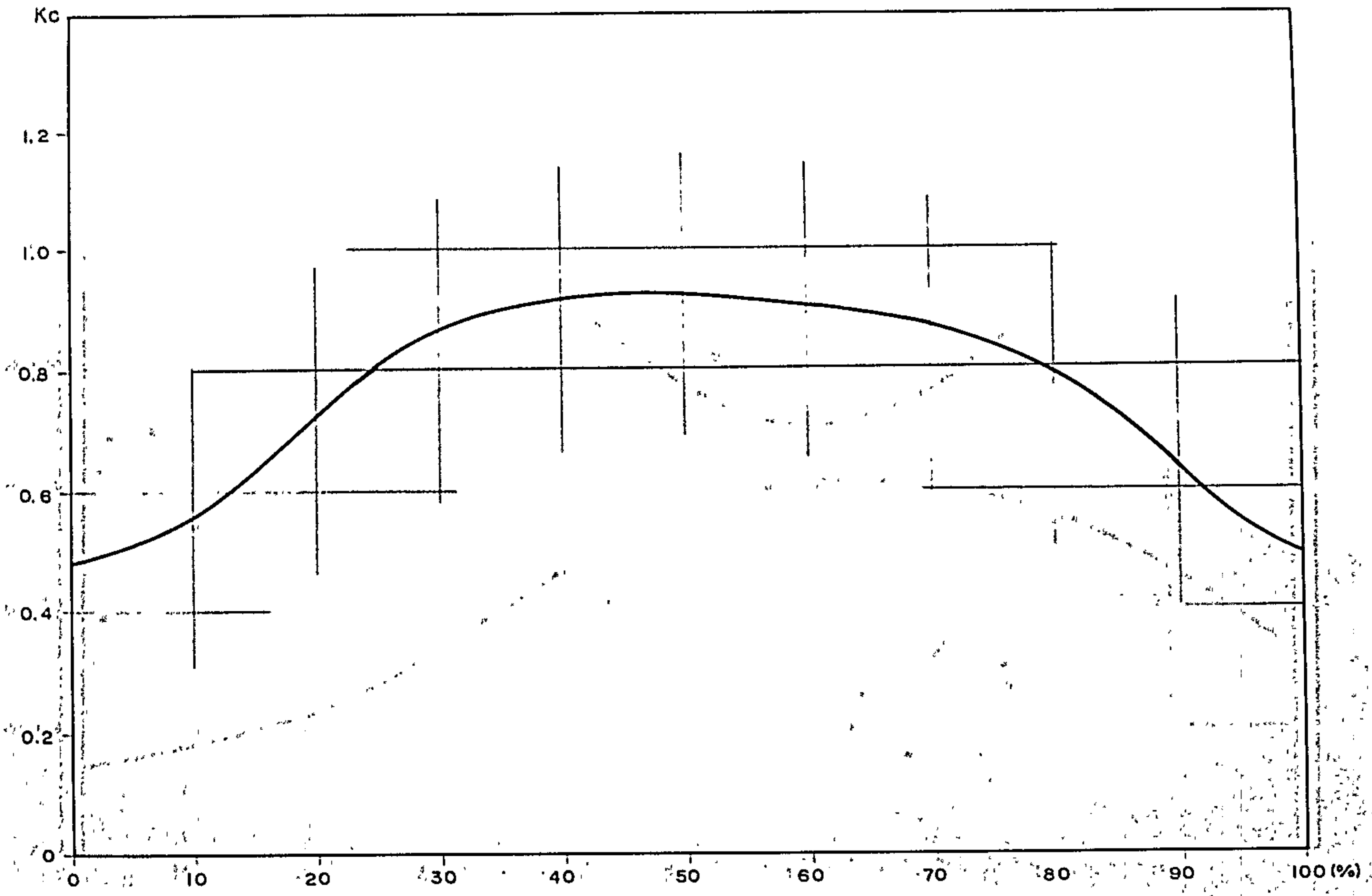

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Fig.-H16 PROBABLE MAXIMUM DAILY RAINFALL AT CHOLUTECA METEO-STATION

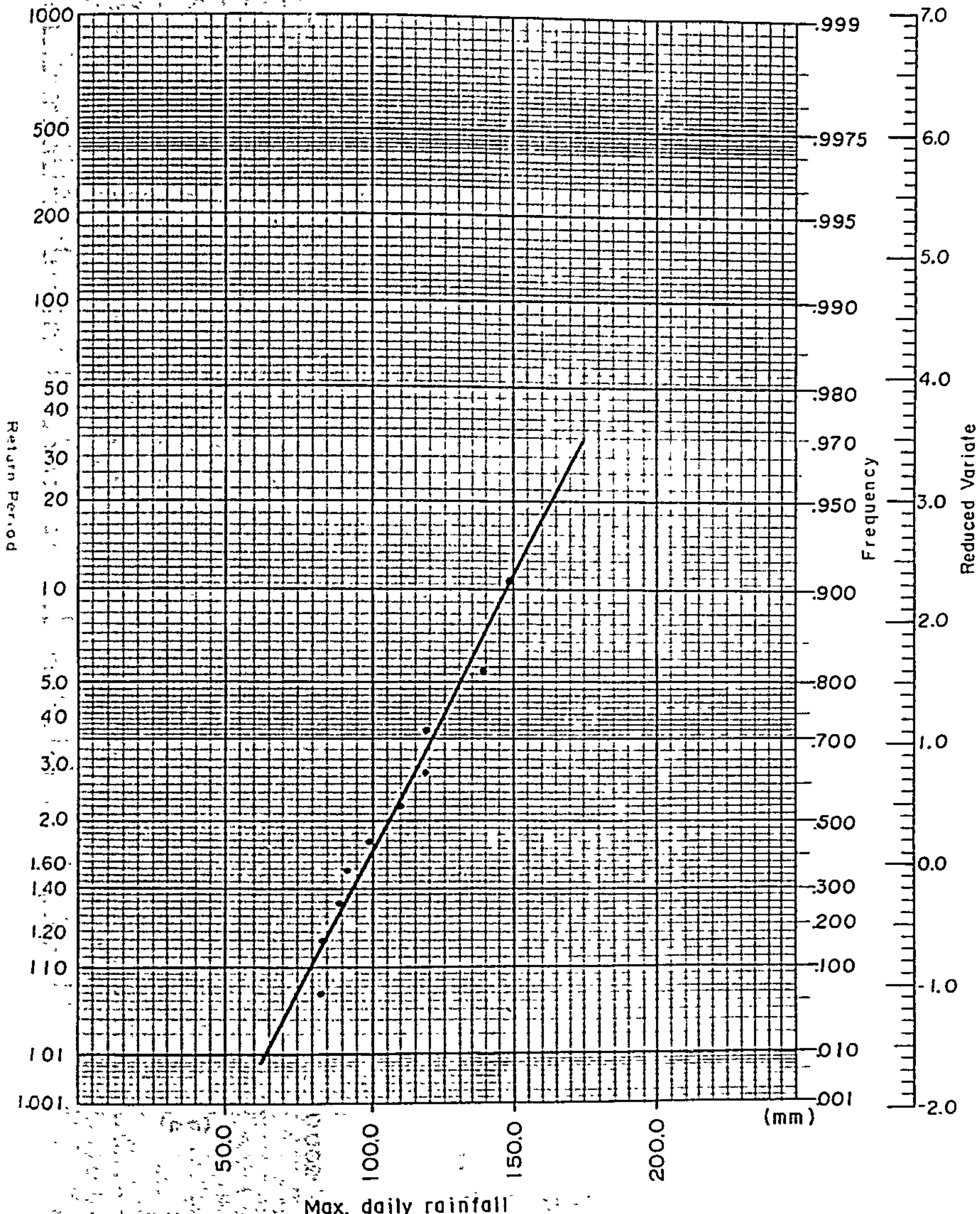


Fig.-H17 PROBABLE MAXIMUM DAILY RAINFALL AT LOS ENCUENTROS

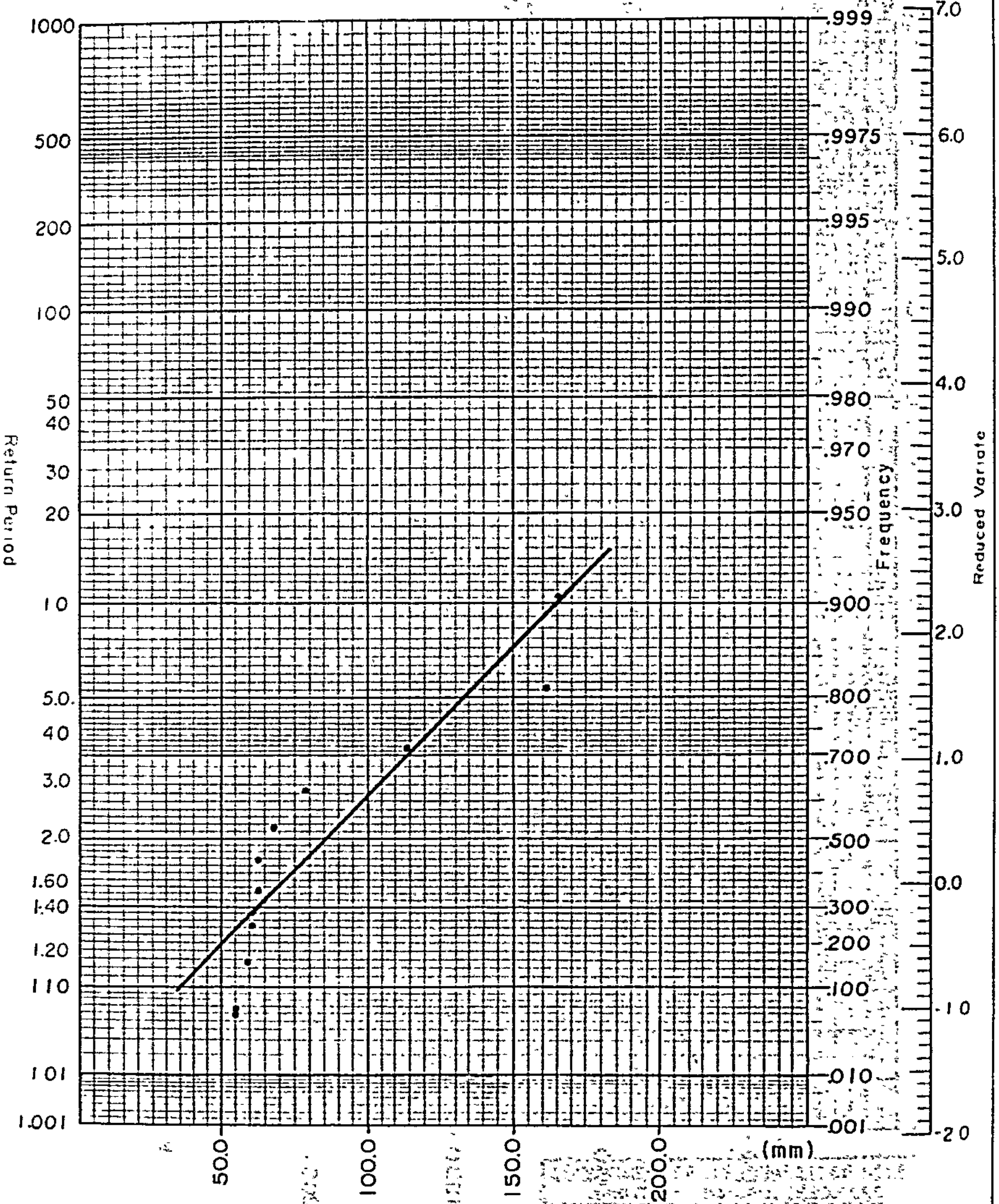


Fig. H18 INTAKE RATE OF SPOT NO. 2
(Choluteca Coastal Plain)

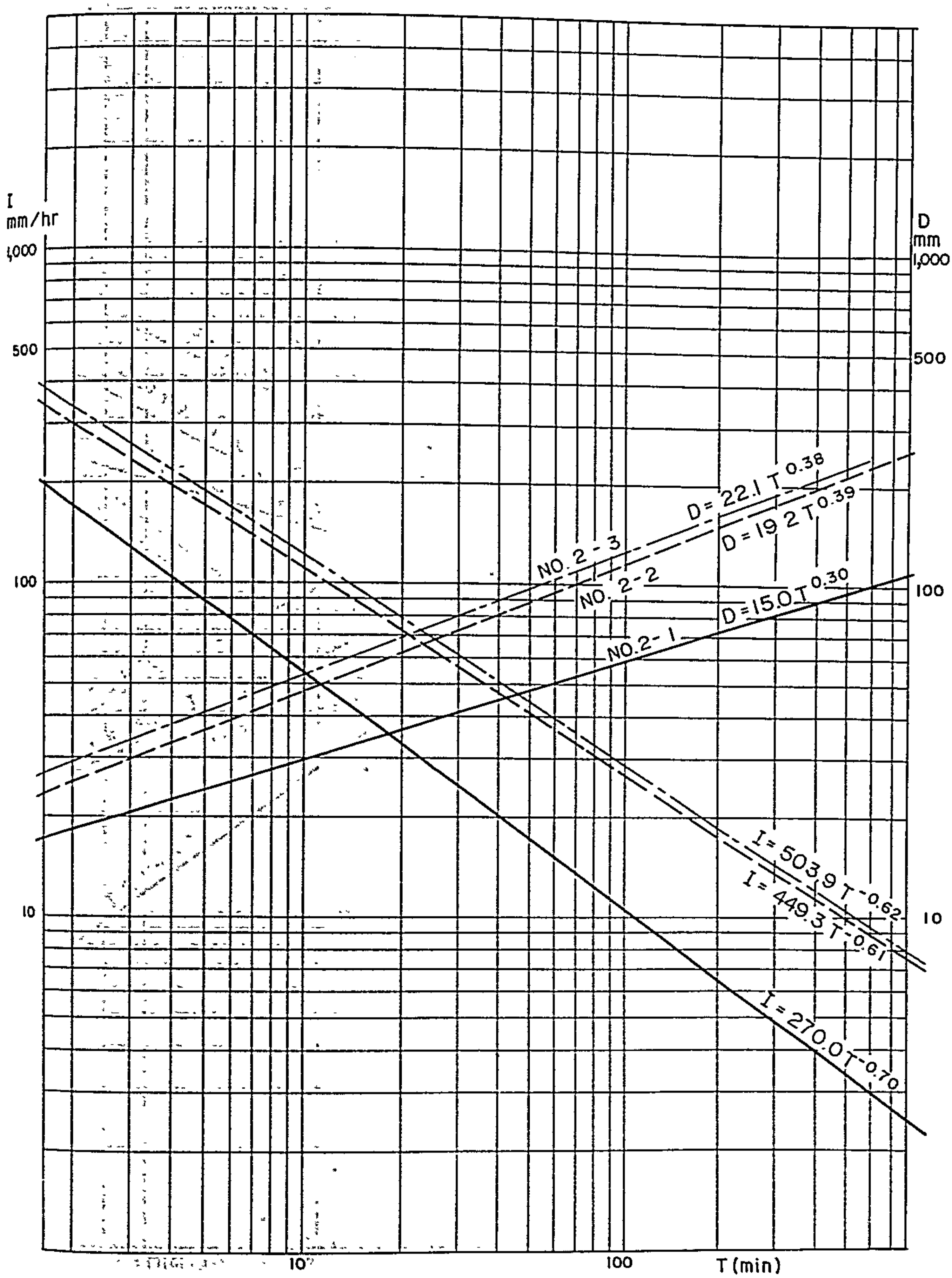


Fig. -H19 INTAKE RATE OF SPOT NO. 3
(Choluteca Coastal Plain)

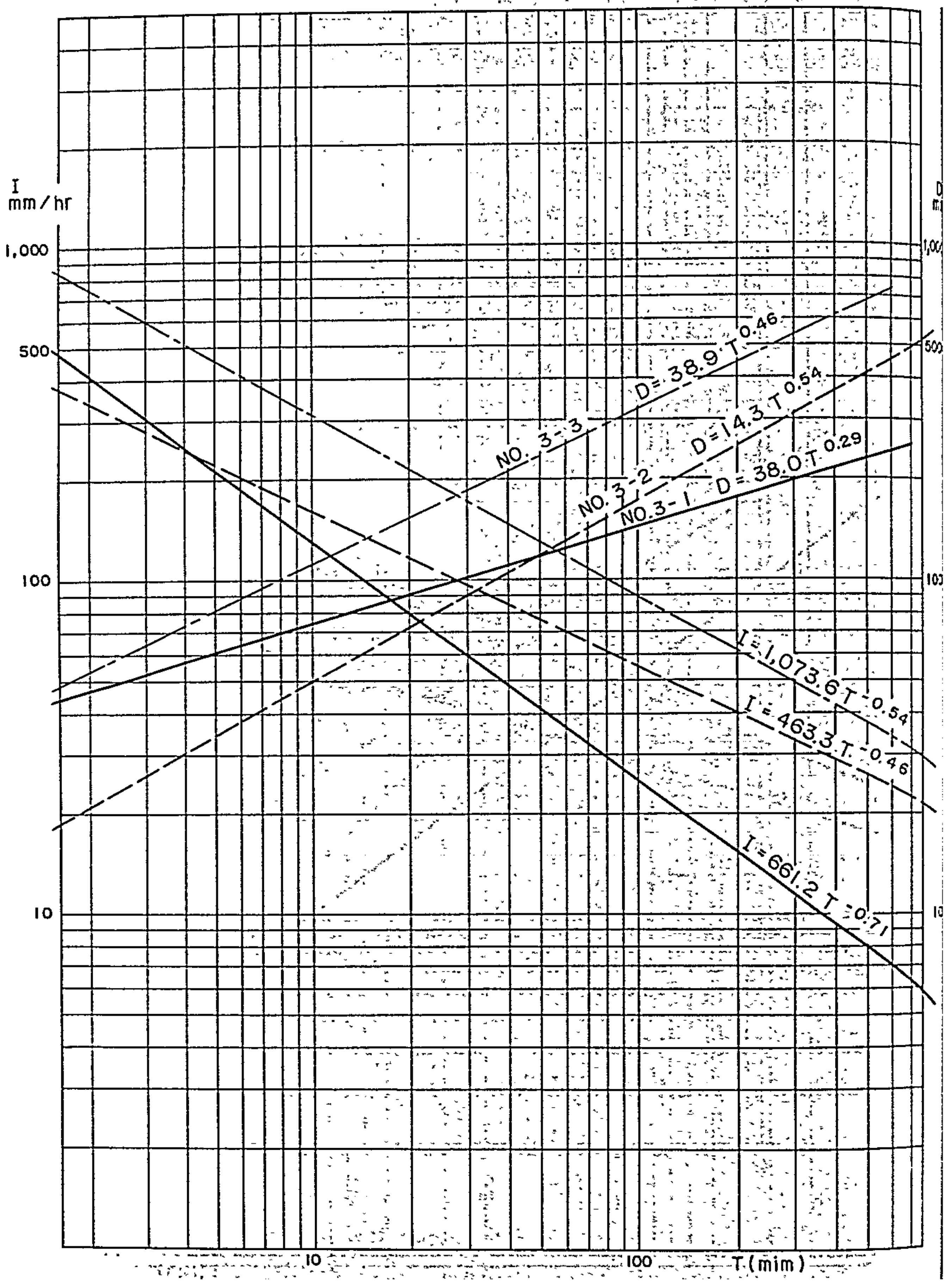


Fig. -H20 INTAKE RATE OF SPOT NO. 4
(Choluteca Coastal Plain)

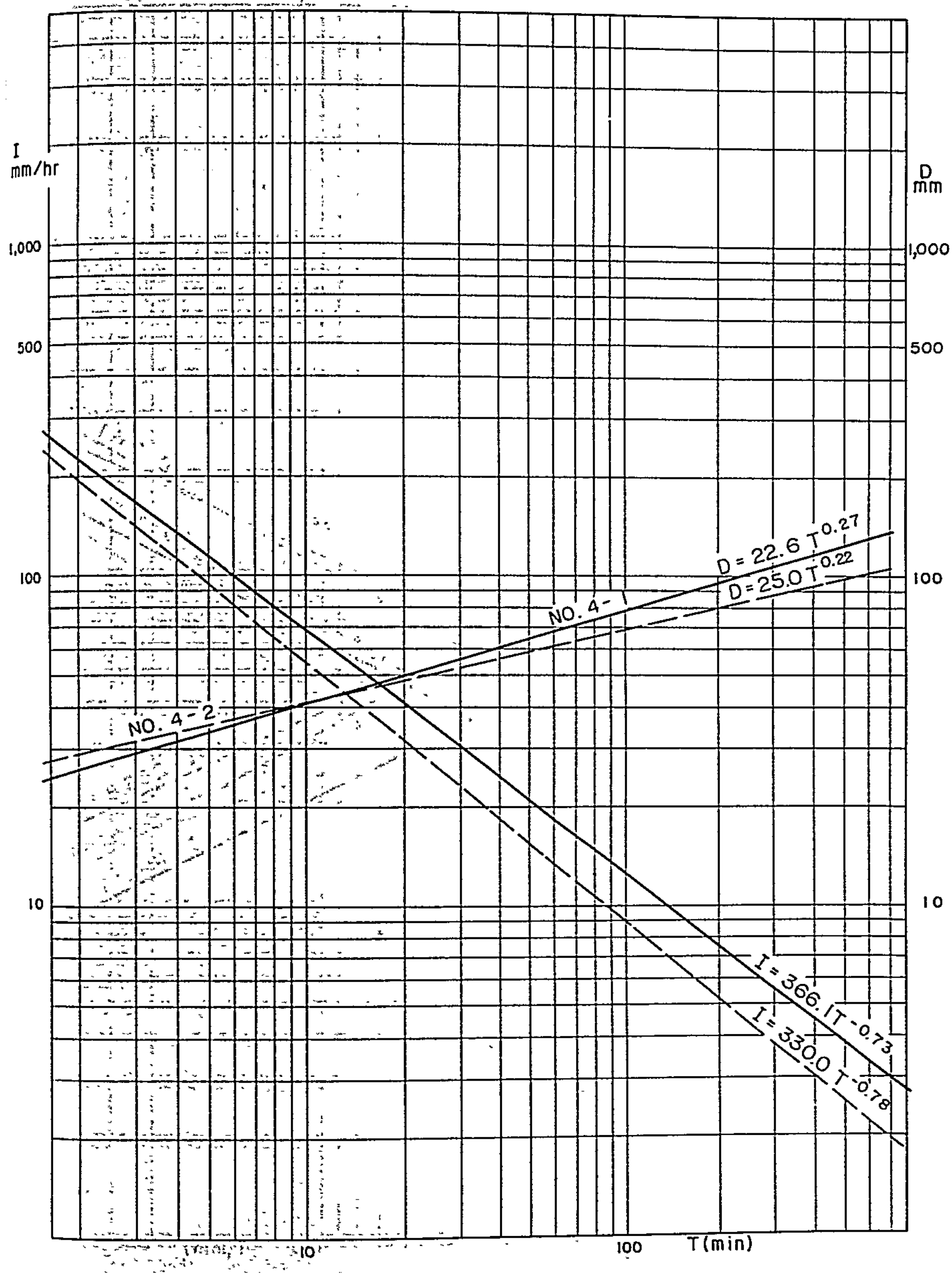


Fig.- H21 INTAKE RATE OF SPOT NO.5
(Choluteca Coastal Plain)

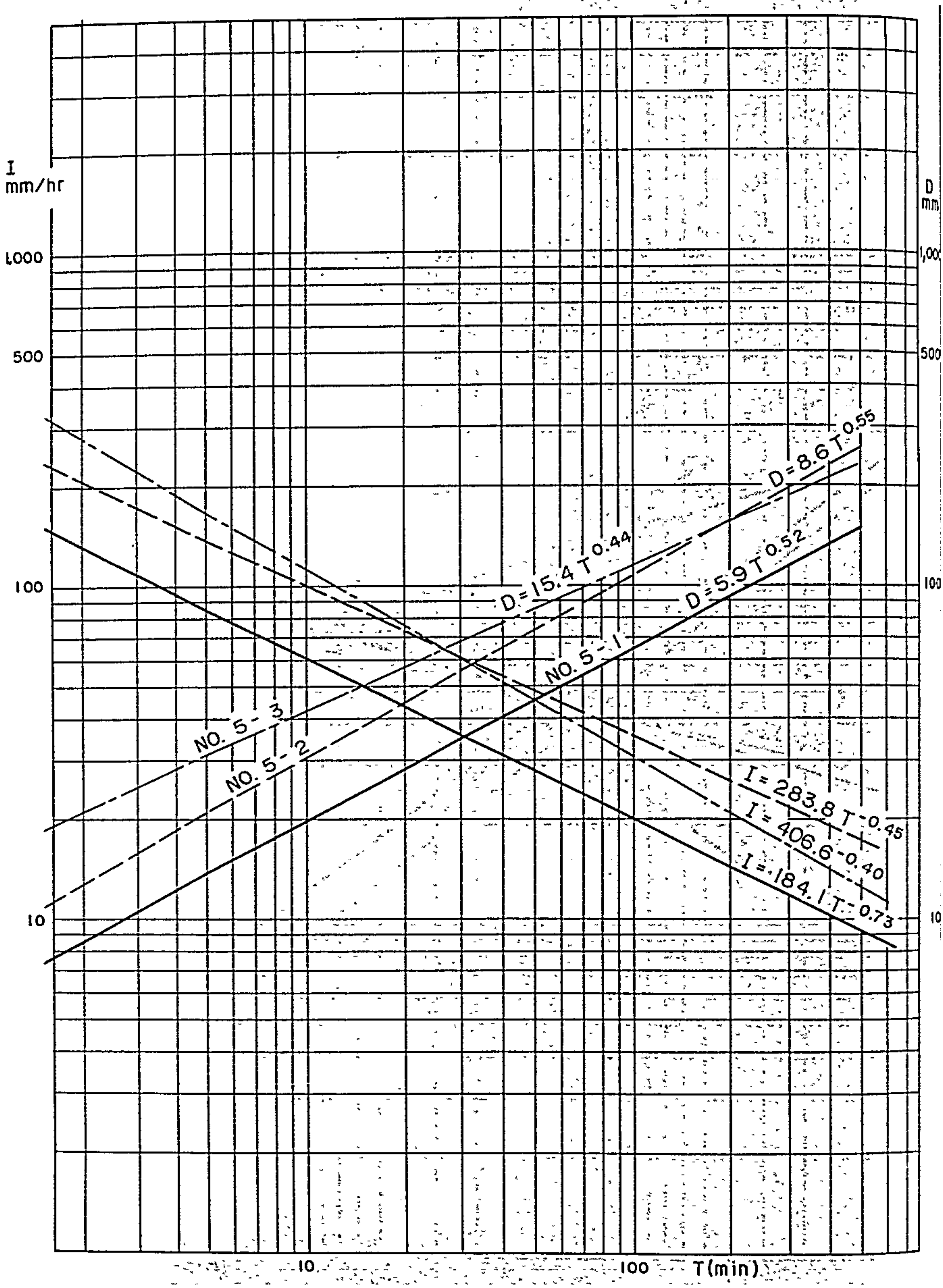


Fig. - H22 INTAKE RATE OF SOST NO.7
(Choluteca Coastal Plain)

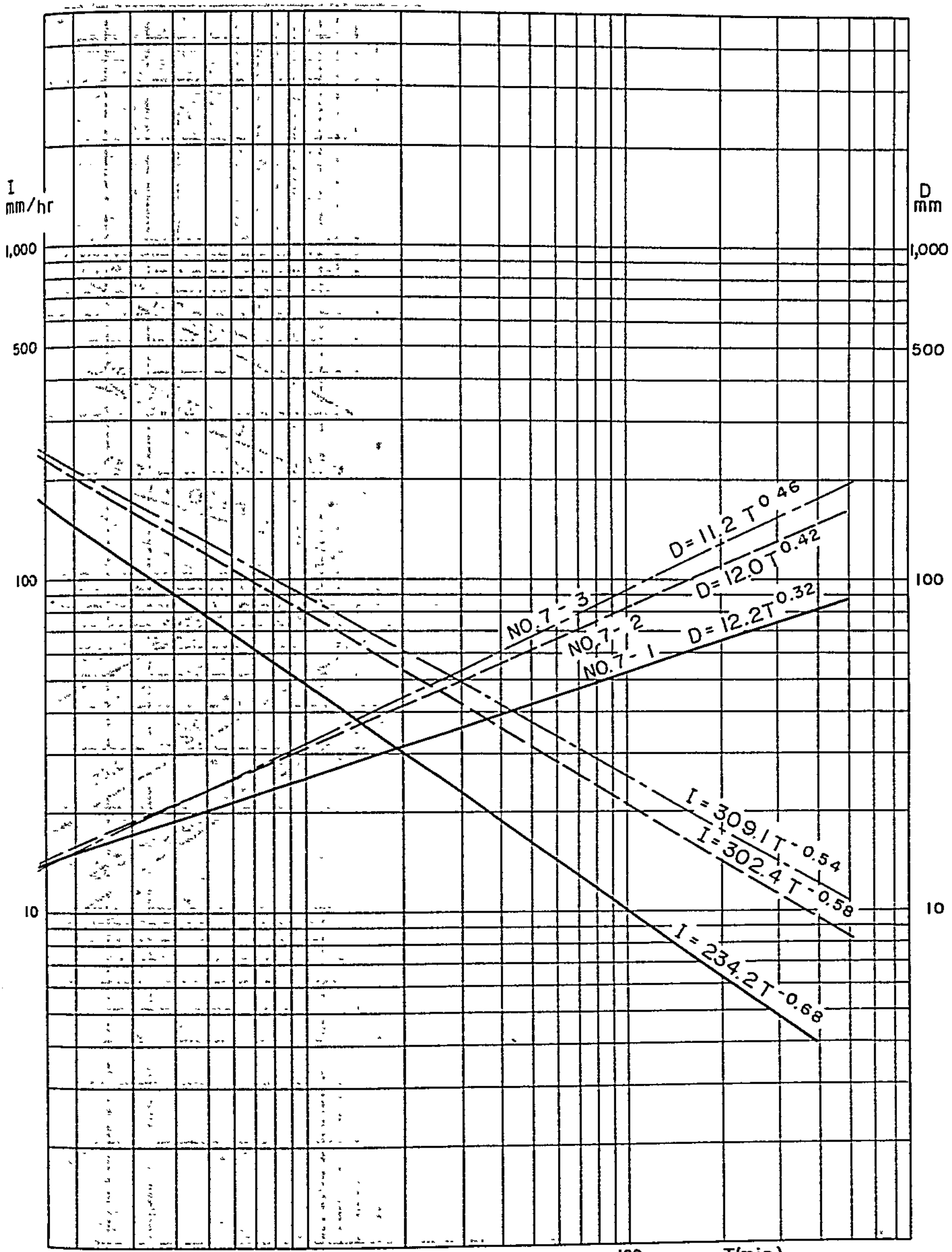


Fig. - H23 INTAKE RATE OF SPOT NO. 8
(Choluteca Coastal Plain)

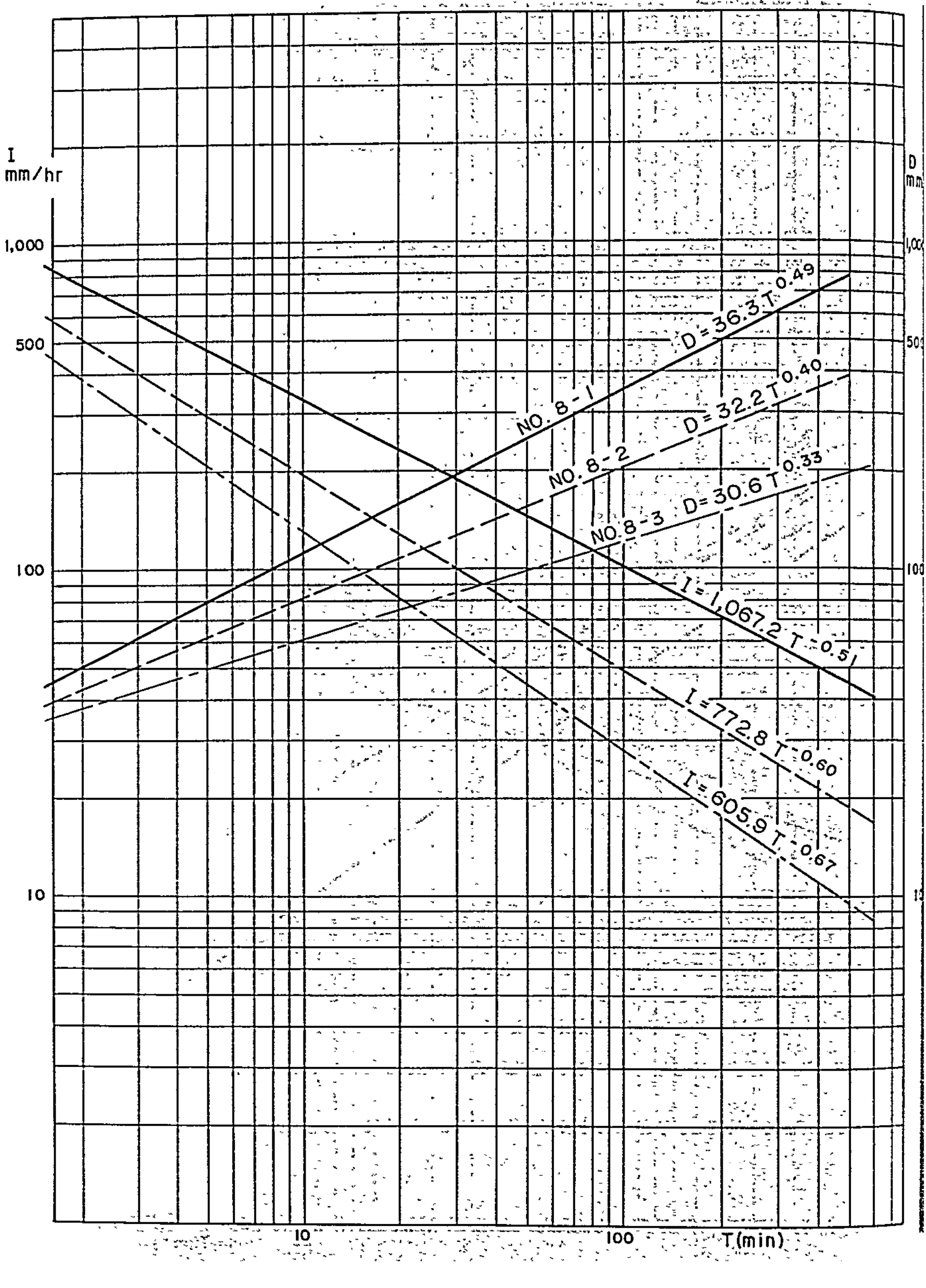


Fig. H24 INTAKE RATE OF SPOT NO.9
(Choluteca Coastal Plain)

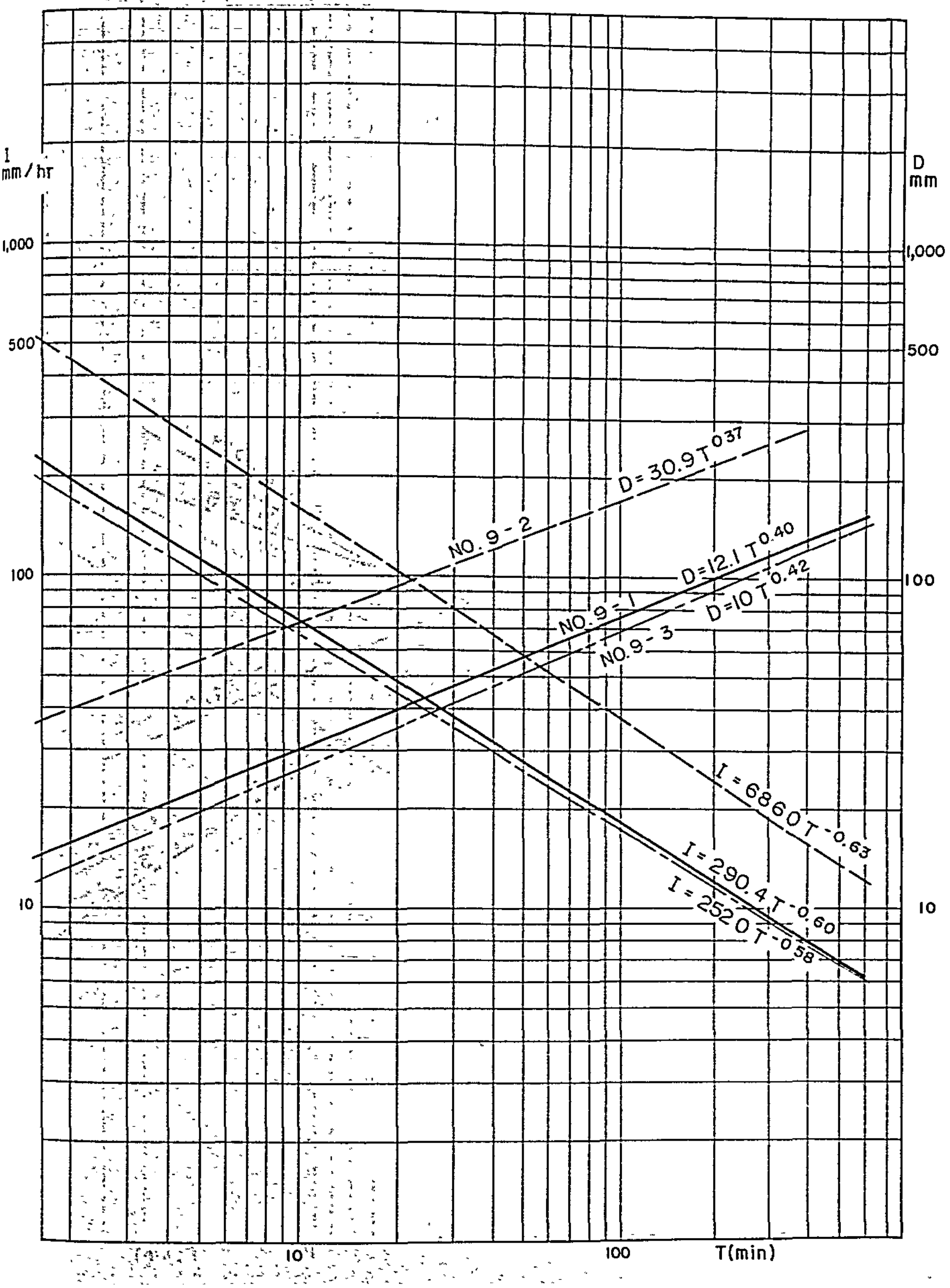


Fig.-H25 INTAKE RATE OF SPOT NO.10
(Choluteca Coastal Plain)

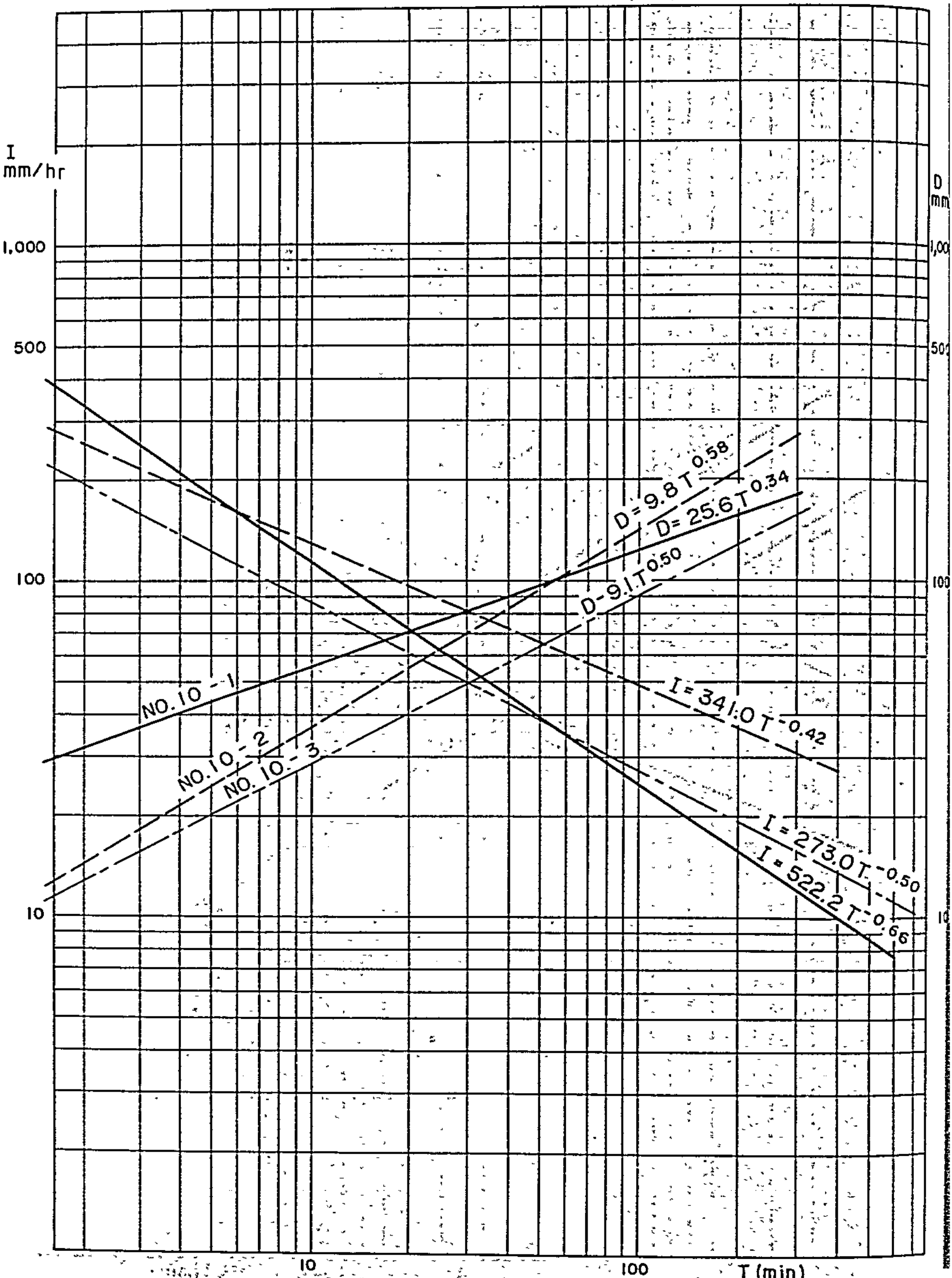


Fig.-H26 INTAKE RATE OF SPOT NO.11 (San Juan de Flores)

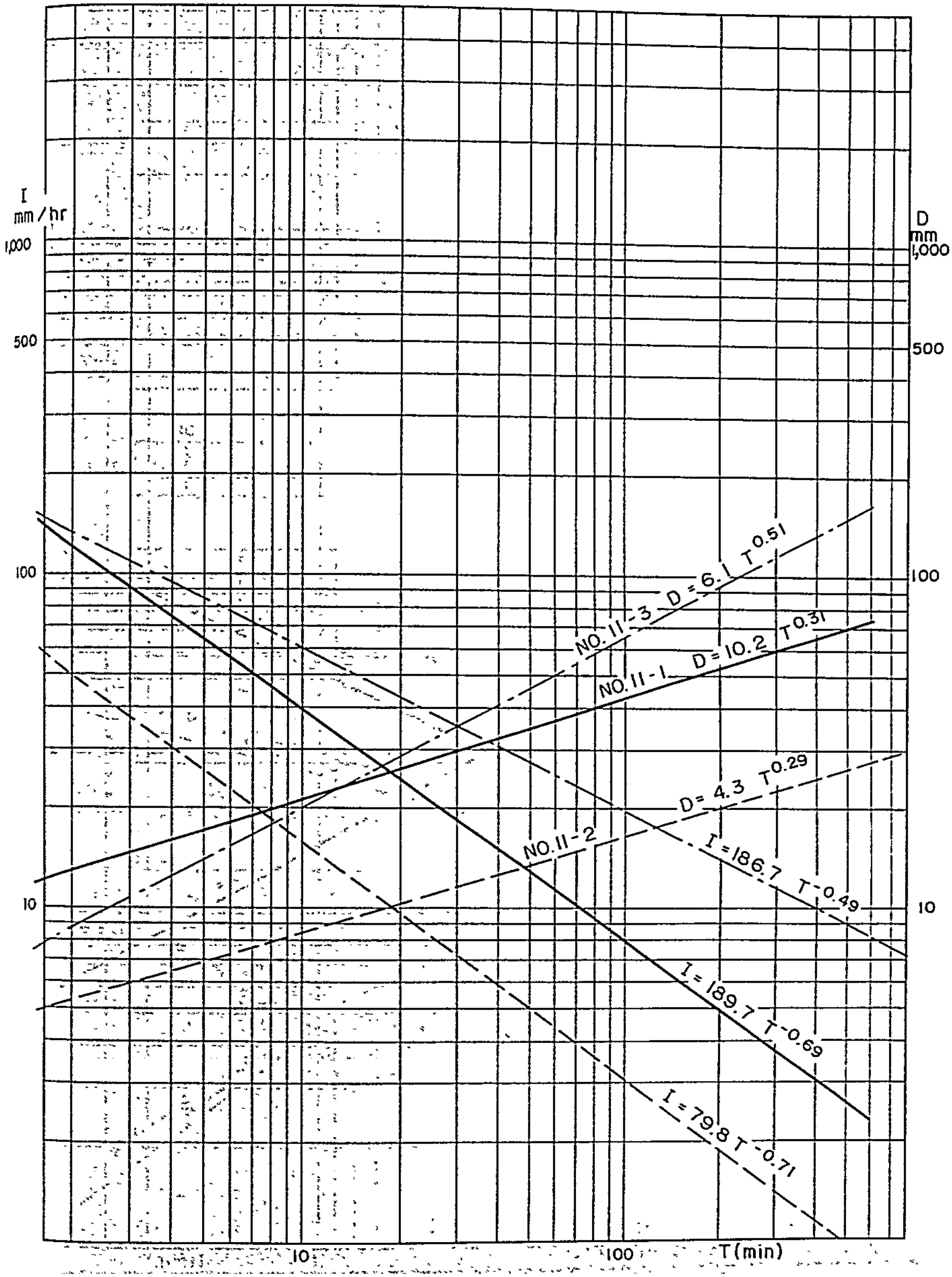


Fig. - H27 INTAKE RATE OF SPOT NO. 12
(San Juan de Flores)

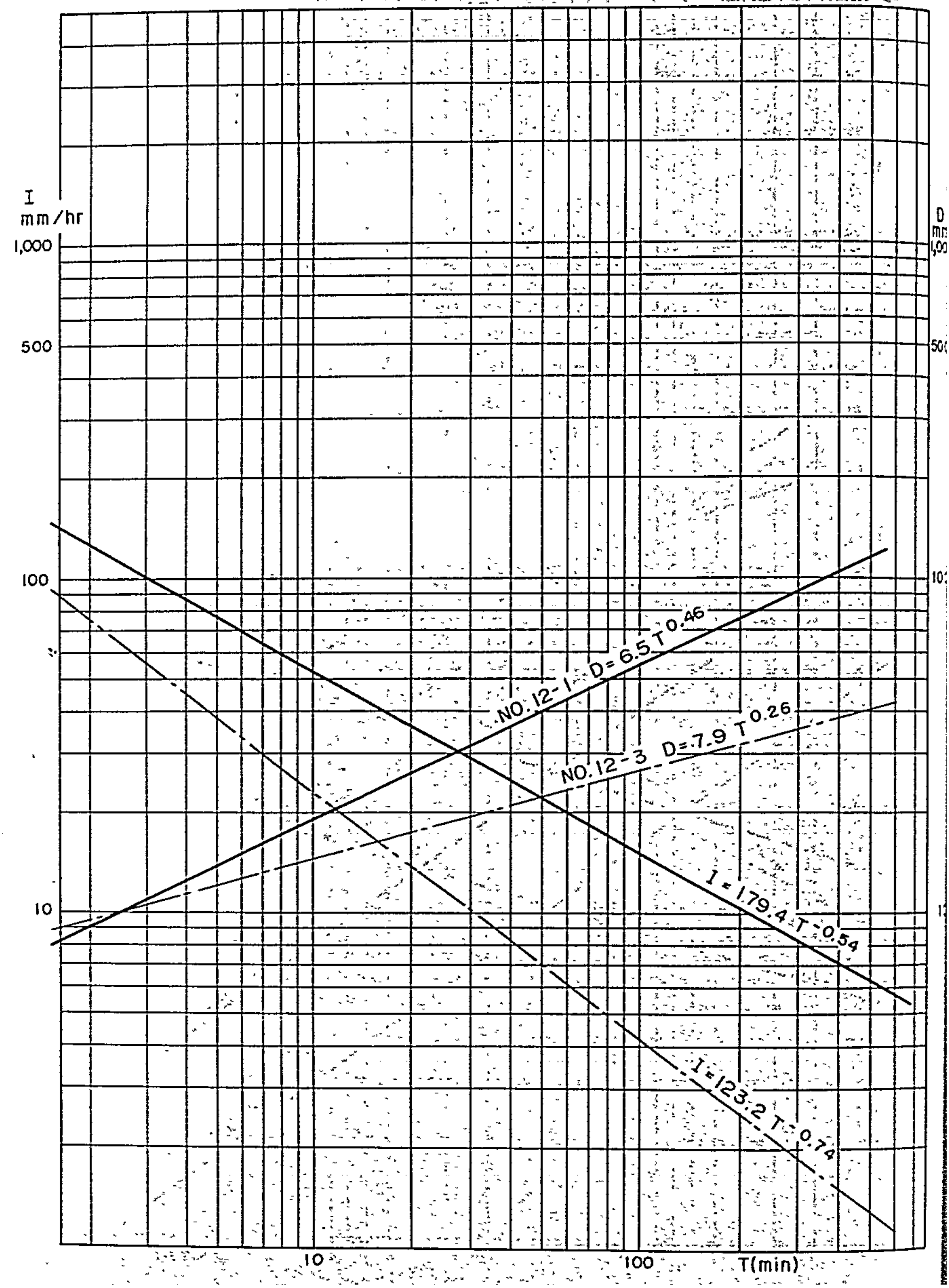
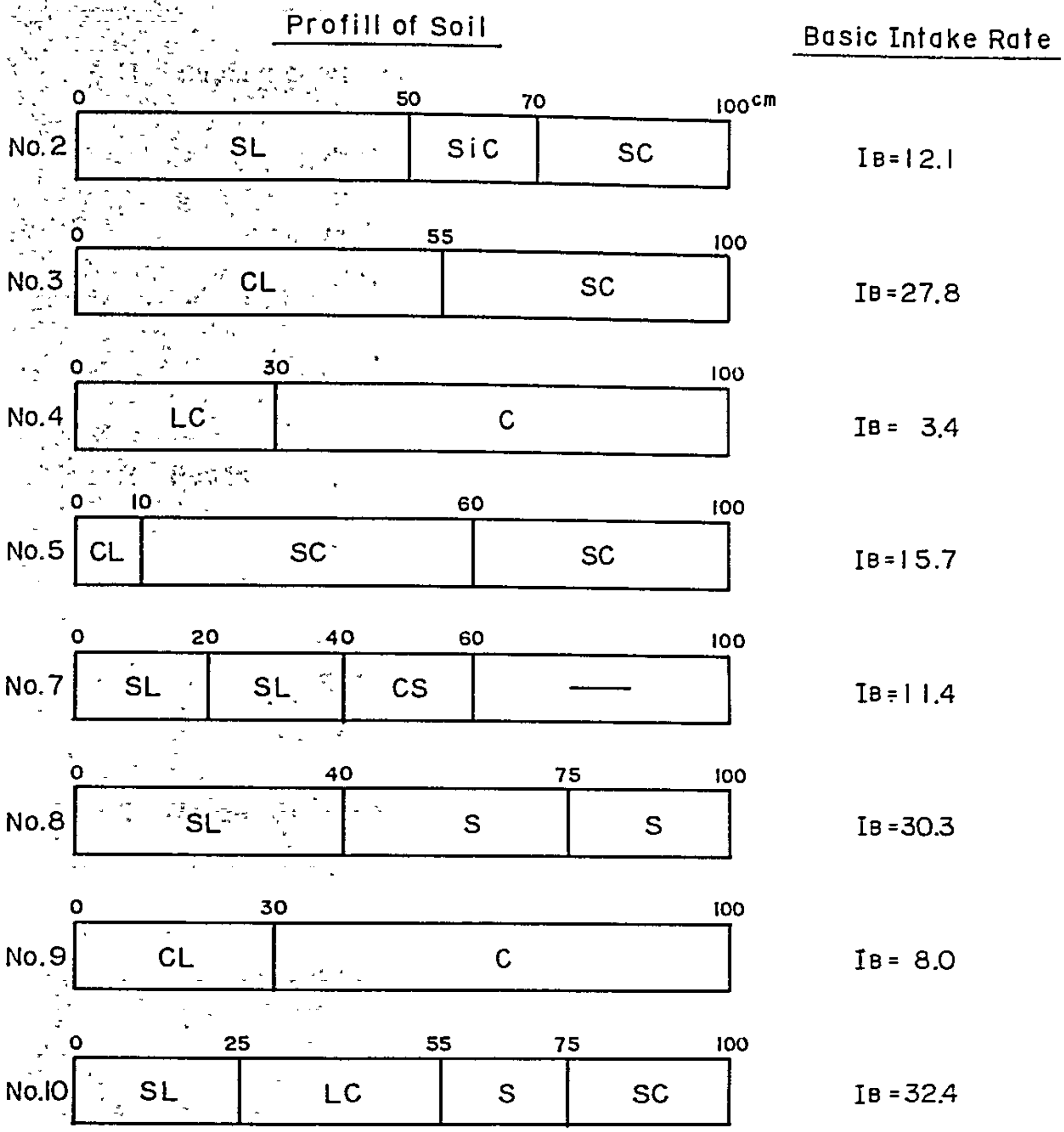


Fig.-H28 PROFILE OF SOIL AND BASIC INTAKE RATE



Note

SL : Sandy Loam
SiC : Silty Clay
SC : Sandy Clay
CL : Clay Loam
S : Sand
LC : Loamy Clay
C : Clay
SL : Sandy Loam

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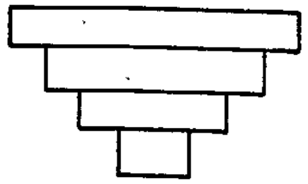
Fig.- H29 SOIL MOISTURE EXTRACTION PATTERN

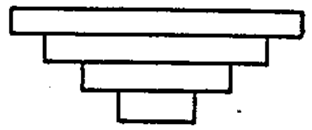
1. Sugar Cane — Root Depth 0.6 - 0.90 m

0.225 m	40 %
0.45 m	30 %
0.675 m	20 %
0.90 m	10 %



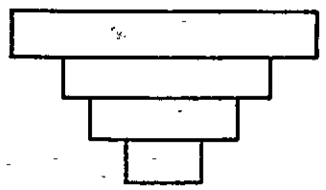
2. Beans — Root Depth 0.60 m

0.15 m	40 %
0.30 m	30 %
0.45 m	20 %
0.60 m	10 %



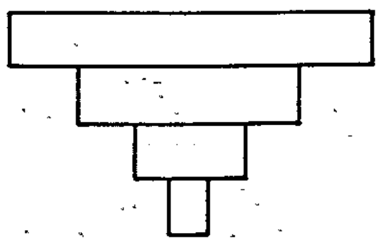
3. Maize, Sesame — Root Depth 0.60 - 0.90 m

0.225 m	42.1 %
0.45 m	28.2 %
0.675 m	19.1 %
0.90 m	10.6 %



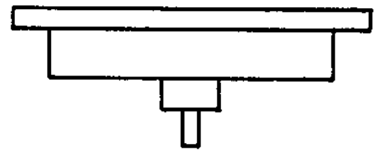
4. Cotton — Root Depth 0.9 - 1.20 m

0.30 m	50 %
0.60 m	30 %
0.90 m	15 %
1.20 m	5 %



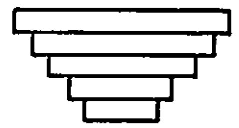
5. Melon, Water Melon — Root Depth 0.60 - 0.75 m

0.119 m	50 %
0.38 m	40 %
0.56 m	8 %
0.75 m	2 %



6. Sorghum — Root Depth 0.60 m

0.12 m	30 %
0.24 m	25 %
0.36 m	20 %
0.48 m	15 %
0.60 m	10 %



7. Pasture — Root Depth 0.45 - 0.75 m

0.25 m	70 %
0.50 m	20 %
0.75 m	10 %

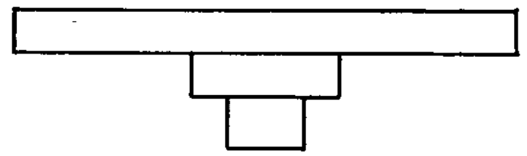


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Fig.-H30 LOCATION AND RESULT OF FIELD SURVEY (1)
CHOLUTECA COASTAL PLAIN AREA

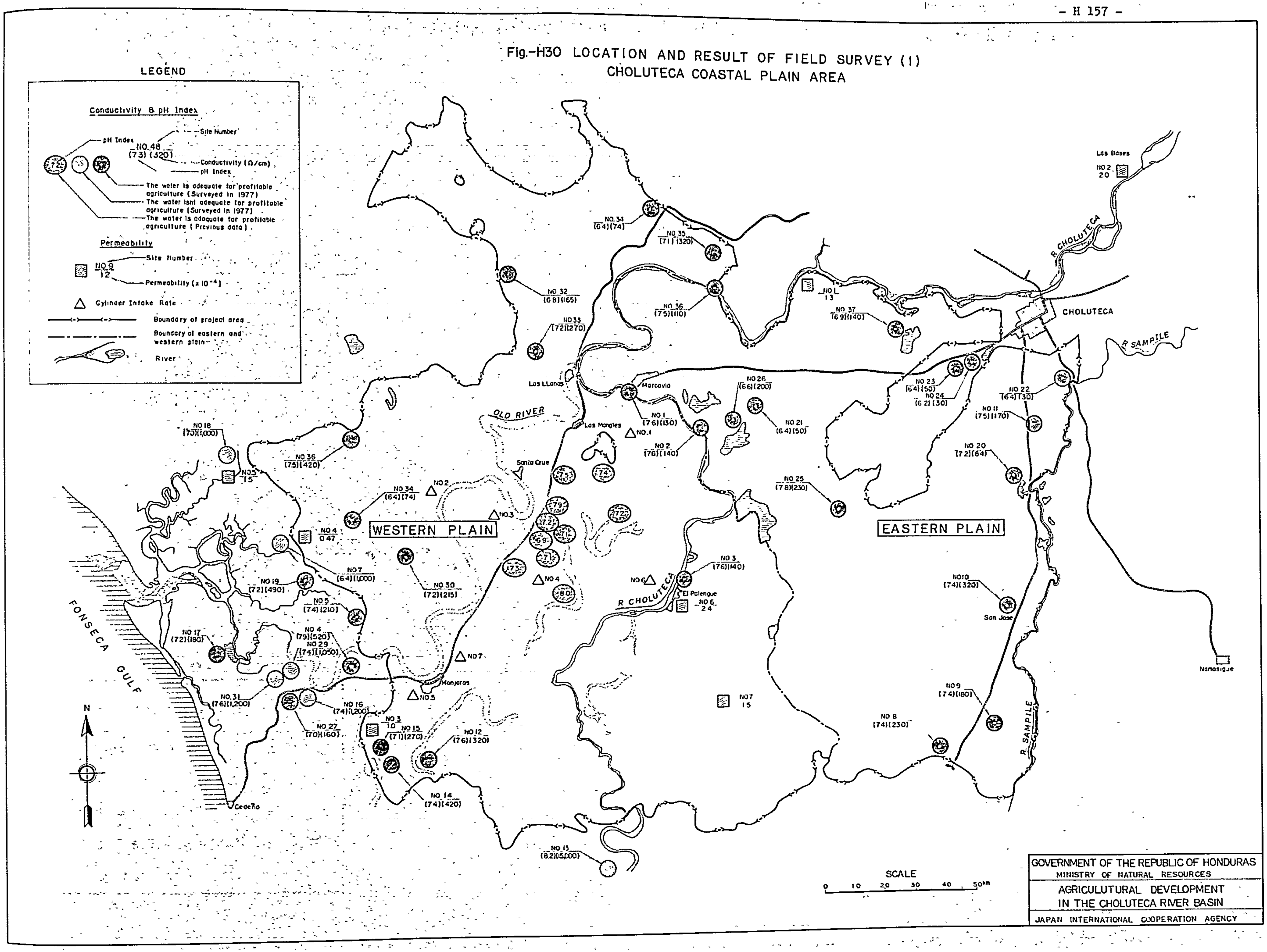


Fig.-H31 LOCATION AND RESULT OF FIELD SURVEY (2)
SAN JUAN DE FLORES AREA

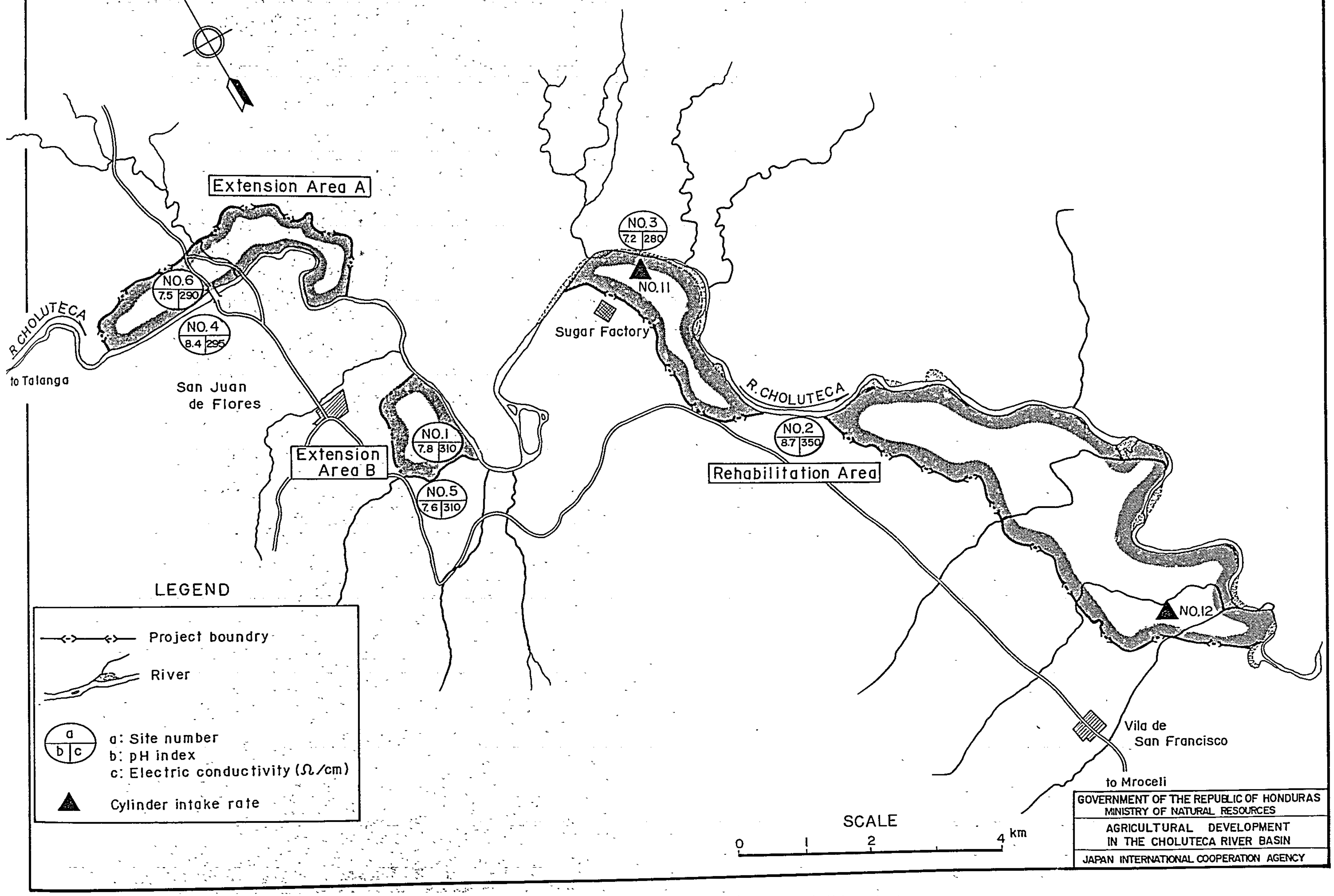
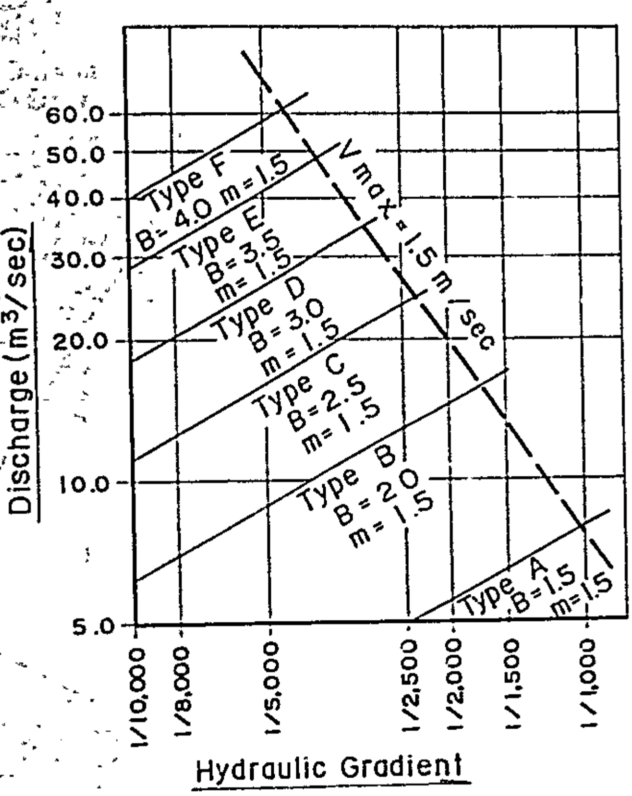


Fig.-H32 DETERMINATION OF CANAL TYPE ON CONCRETE LINED CANAL



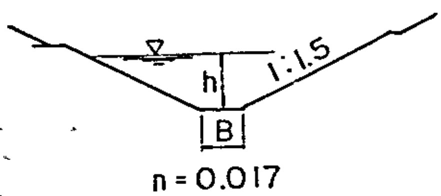


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Fig.-H33 DETERMINATION OF CANAL TYPE ON EARTHEN LINED CANAL

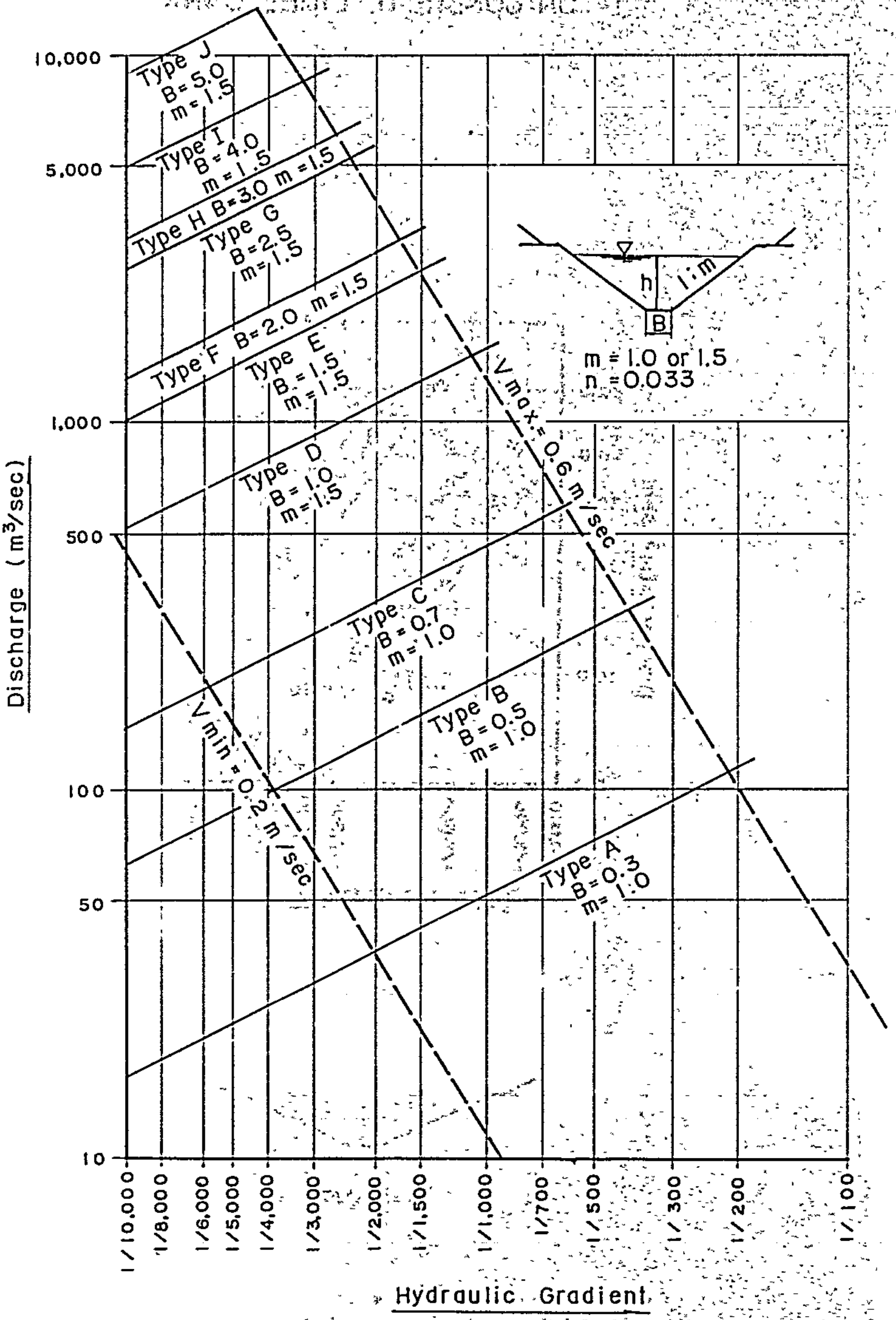

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Fig.-H34 DETERMINATION OF CANAL TYPE ON DRAINAGE CANAL

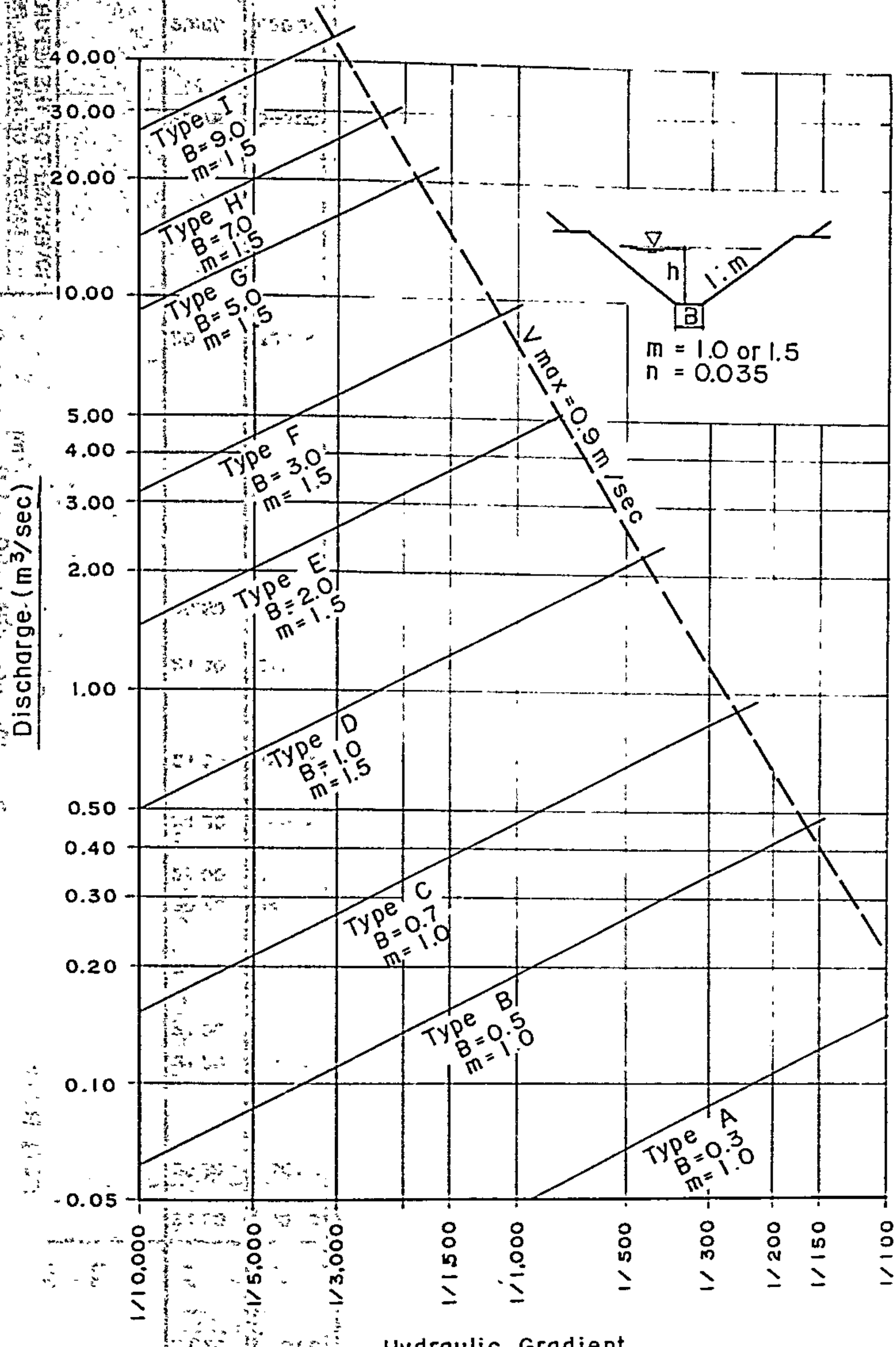

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Fig.-H35 PROFILE OF CHOLUTECA RIVER AT EL PAPALÓN WEIR SITE

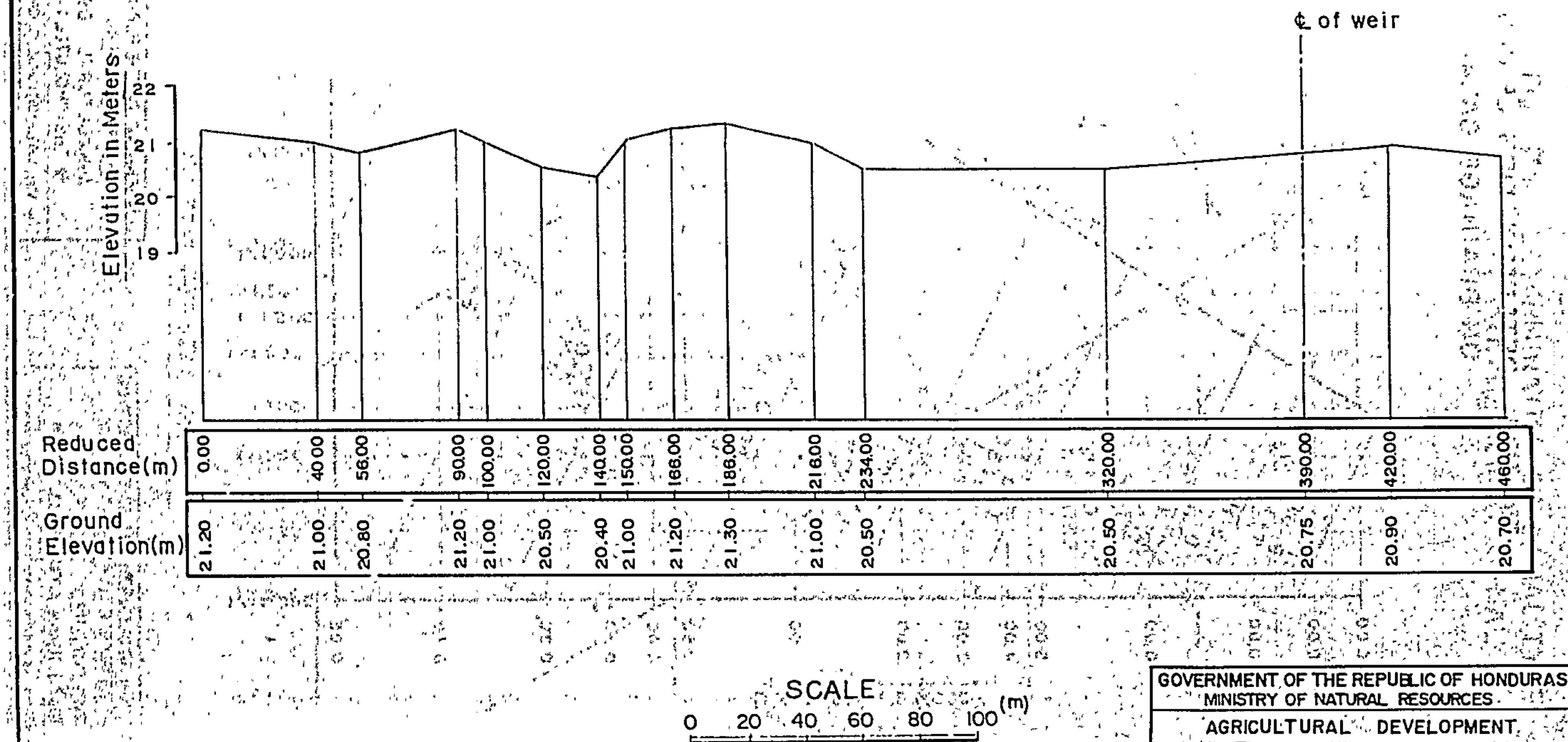

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Fig.-H36 CROSS SECTION OF CHOLUTECA RIVER AT EL PAPALÓN WEIR SITE

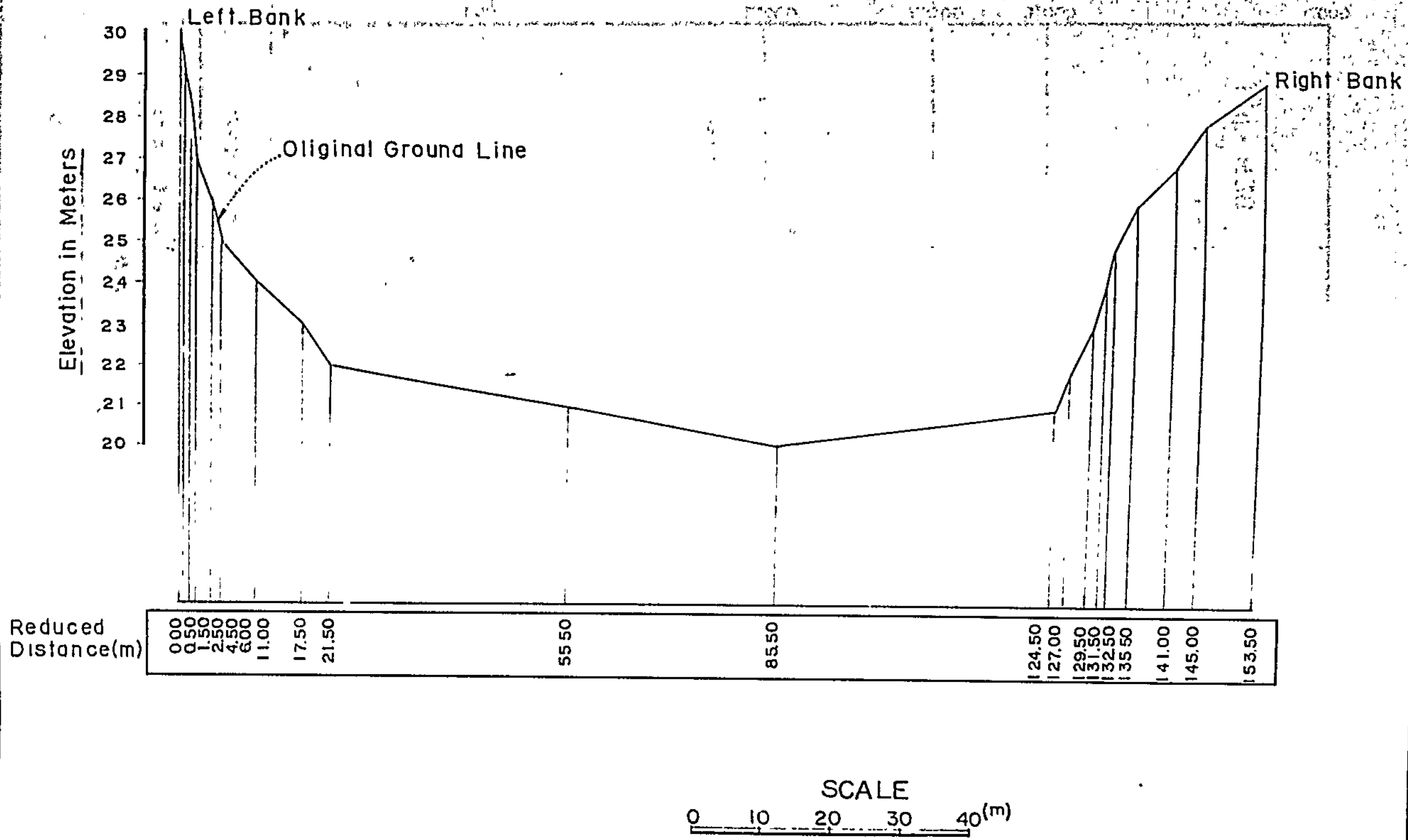

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Fig.-H37 H- Q CURVE (EL PAPALÓN)

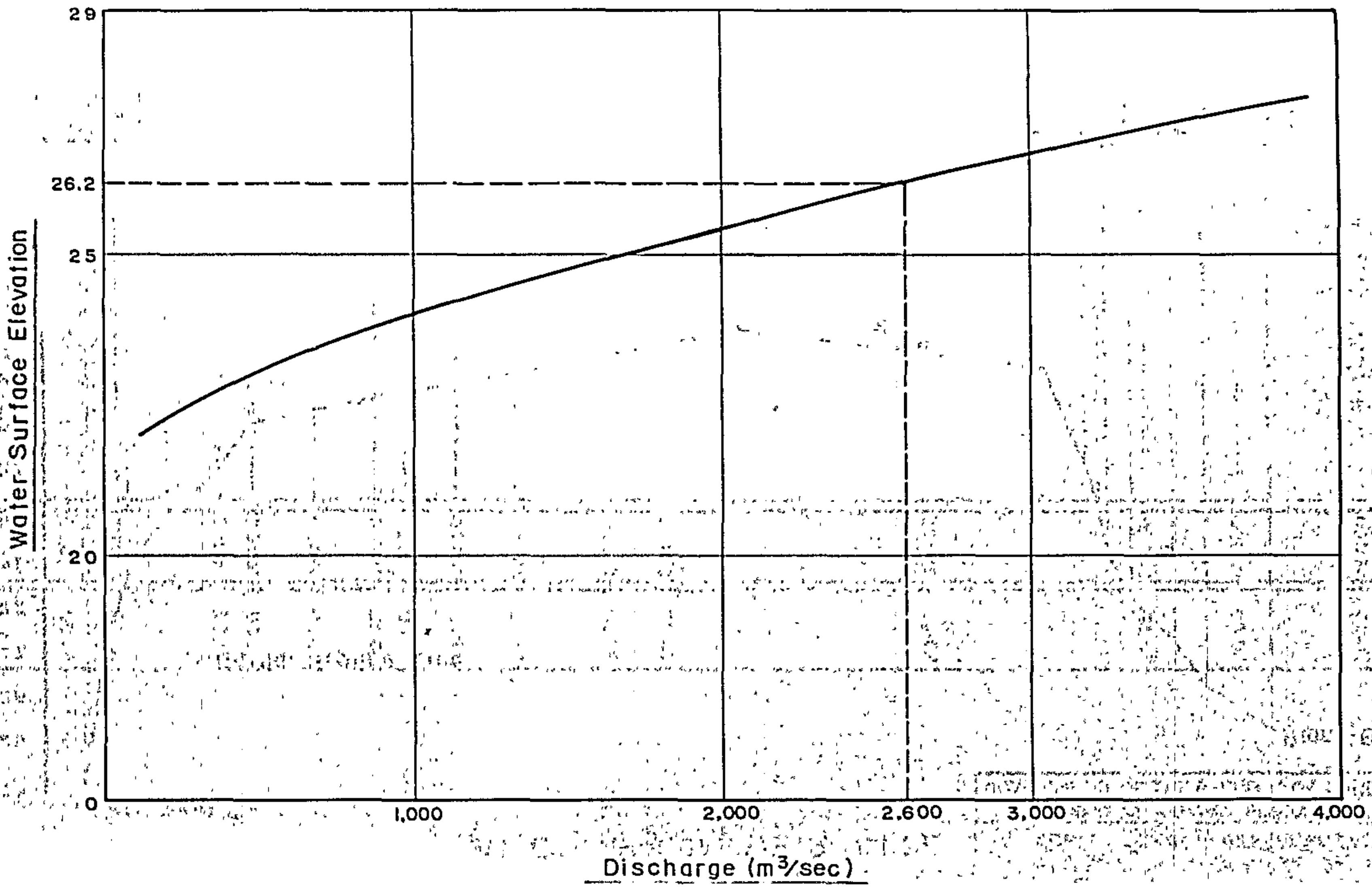

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Fig.- H38 COMPARISON ON NUMBERS AND CAPACITY OF PUMPS

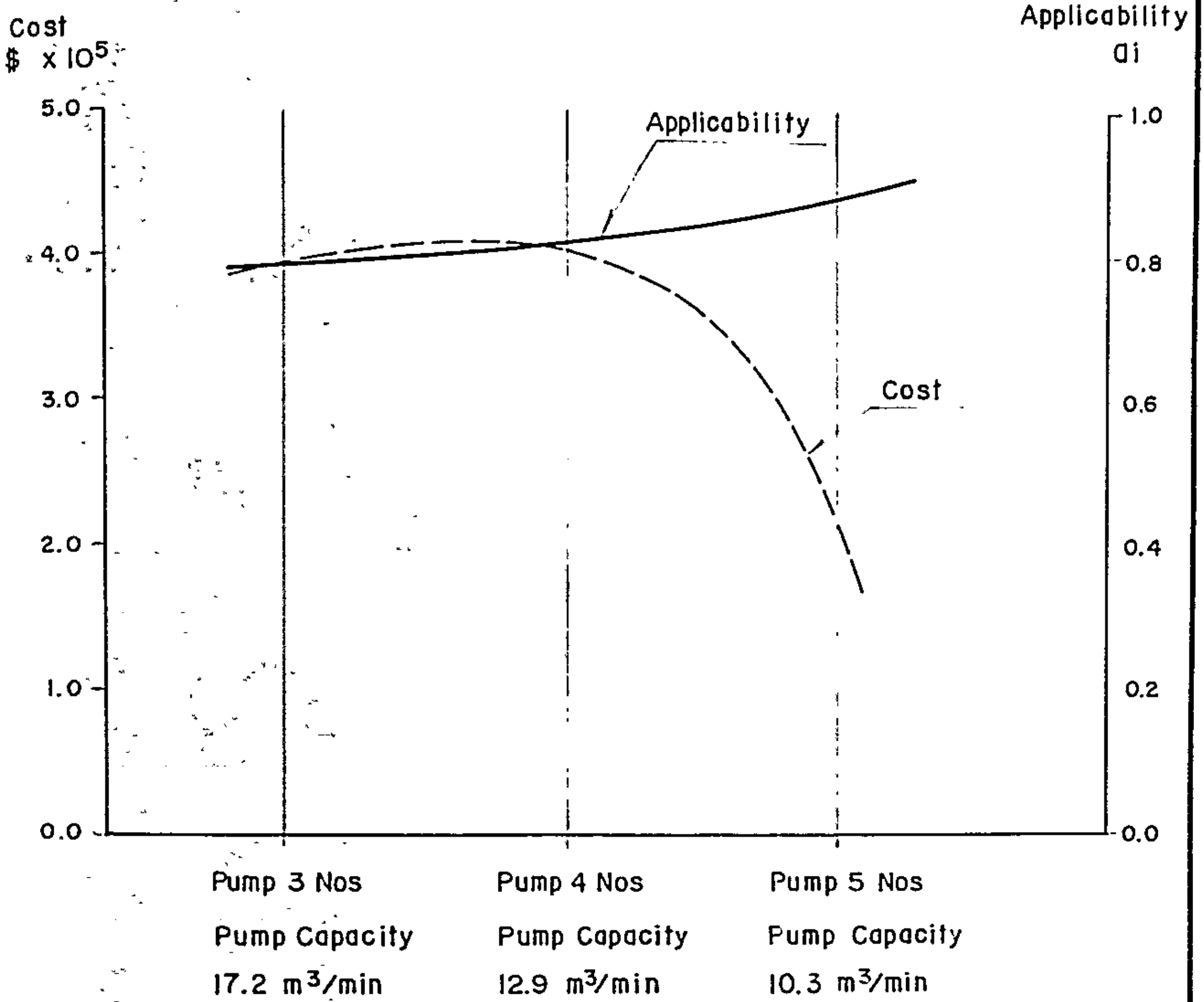

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Fig.-H39 GENERAL LAYOUT OF PROPOSED PROJECT AREA