FEASIBILITY REPORT
ON
WAY DJEPARA IRRIGATION PROJECT

REPORT ON IRRIGATION DEVELOPMENT IN INDONESIA

JAN 1972

OVERSEAS TECHNICAL COOPERATION AGENCY

FEASIBILITY REPORT

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CCNTENTS

INTRODUCTION BACKGROUND AND PURPOSE OF SURVEY

1. Background of Survey

The Indonesian government has been vigorously pushing forward its First Five Year Economic Development Plan (1969/1970 - 1973/1974) aiming at the self-sustenance in food, increased production for larger foreign exchange earnings, more employment opportunities for the people and for farmers in particular, and elevation of the nation's living standard. Under this plan, the government has augmented its capital input in the agricultural sector and made successive and strenuous efforts for agricultural modernization with aid provided by various countries of the world. As one of these cooperating countries, Japan also has been promoting aid programmes in the agricultural sector under an agreement concluded with the Indonesian government. These aid programmes of Japan, however, were concentrated in Java island in the past.

To attain the objectives set for the said Five Year Plan, the Indonesian government places much expection on outer areas where there is much room and need for development. Among the many outer areas of the archipelago, Lampung province in the southern part of Sumatra, which embraces a vast wild field area and faces Java island across Sunda channel, is given high development priority and considered geographically suited for resettlement as well. While intensifying its public investment and resettlement policy in the province, the Indonesian government hoped that Japan would assist in the province's development by providing technical cooperation for paddy and upland crop production which constitutes part of technical aid programmes now in progress in Java.

Japan, on its part, has long recognized the need for attaining a higher overall efficiency of its aid programmes and felt it necessary to concentrically implement certain programmes within a particular area so as to make best use of available local capitals and accelerate the pace of regional developm For the desired cooperation in Lampung's development, therefore, the government showed a particularly forward-looking attitude towards integr ed and systematic implementation of an overall agricultural development scheme which is to be pushed forward with account taken of the relationship between respective development projects.

In the climate thus created, the two governments reached an agreement regarding a number of Lamung's development projects which constituted part of the Indonesian request for Japan's aid for 1971. Regional Land Development Plan in Lampung Province, included as Item No. BTA 24 in IGGI List (the list of requests for financial and technical cooperation presented to the governments of cooperating countries), is one of such projects.

The Five Year Plan gives considerable emphasis to the investment in irrigation facilities. Besides the active capital input already made for the rehabilitation and improvement of existing facilities, the Plan also envisages progressive development and infrastructural improvement for those areas whose development potential has not yet been worked out due to the absence of reliable meteorological, hydrological and soil data despite of abundant availability of both water and land area.

BTA 24 mentioned above is aimed at working out such latent development probability and for this purpose, it envisages intensive meteorological and hydrological surveys which would open the way for the planning and execution of a land development project in Lampung.

This plan comprises three irrigation projects intended for the development of the Djepara basin (estimated irrigable area: 7,000 ha), the Umpu basin in the north (7,000 ha), and the Pengubuan basin (5,000 ha). For each of the three basins, improvement of the hydrological and meteorological observation network and pre-feasibility survey of each river are planned. Of these three projects, the largest volume of data is available for Djepara River Project which is given top priority by the Five Year Plan. These data were collected by the surveys conducted under the Five Year Plan as well as by Mr. J. Kitamura, a Colombo Plan expert dispatched to the Water Resource Development of the Indonesian Ministry of Public Works in 1970. Considering, therefore, this accumulation of data which shortens the period required before the project impelementation, the team reached the conclusion that stress should be placed on the feasibility study of Djepara Irrigation Project for the present and that surveys for the other two projects should preferably be carried out some time in future when sufficient data on the two basins are made available by the Indonesian government.

For reasons described above, no actions were taken for dispatching a survey team for Djepara Irrigation Project alone. Instead, it was planned that surveys for this project would be carried out by the team which was assigned to the task of conducting two types of activities, i.e., surveys for aid programmes in Lampung province for which agreement was reached with the Indonesian government and the surveyes for agricultural development project which embraces such aid programmes.

2. Purpose of Survey

In view of the background described in the preceding section, the survey team was required to perform the following activities.

(1) Review of the existing data and related reports and materials, and collection of any additional data required.

(2) Study of the existing pattern of farm management for estimating the future farm management pattern and for judging the need of revising the project.

(3) Economic evaluation of the project, and collection of data needed for mapping out its implementation plan.

All these activities are indispensable for working out a practical plan for materializing agricultural development and increased employment opportunities in Djepara district where the population is rapidly increasing.

CHAPTER I GENERAL DESCRIPTION

1.1 History of Project

Djepara Project was planned for agricultural and irrigation develop-meht from the beginning to promote the resettlement in Djepara district and has therefore maintained close relationship with the government's resettlement policy. The first group of immigrants came to Djepara district in 1935 but they did not settle themselves in the district. After the second group arrived in 1939, surveys were conducted from 1939 to 1941 and an irrigation project was mapped out for the settlers. The project, however, was not brought to materialization by the outbreak of the second World War and the consequent struggle of Indonesians for independence. Surveys for the irrigation project were resumed during the period from 1959 to 1962 for the settlers who came to the district in 1958 and subsequent years, but the political confusion in those years prevented any further progress.

With the establishment of the current administration in 1969 and the formulation of the first Five Year Economic Development Plan, Djepara Irrigation Project was given top priority as part of the government's agricultural development policy which was framed to meet the two major national demands, i. e., acclerated food production through agricultural modernization and export increase of agricultural producis. As a con-sequence, the project plan was prepared by a survey team headed by Prof. Soetodjo of the Institute of Technology, Bandung, and various surveys and design works were also carried out by many experts. It is with such a historical background that the Indonesian government requested Japan's co-operation in this project by including it in its IGGI List for 1971/1972 and received a favourable response of the Japanese government which led to the present feasibility survey.

1.2. Background of Project

The project area, extending around Long. 5°12' S. and Lat. 105°41' E., lies between the Djepara and the Penet and faces the eastern coastline of Lampung province which is in the southern part of Sumatra. With the Sekampung flowing in the south, the Djepara basin is topographically composed of a number of separated hill of El. 250 m or smaller, sloping hilly area extending in the east, and low-lying swamp area spreading along the coastline. These separated hill stretch from the watershed formed by mountains like Gunug, Mirah, and Gunug Periki. The area expected to be benefited by the projected irrigation and drainage work is 5,950 ha ranging in elevation from 2 to 25 m.

Immigrants into this district have settled themselves with an average of 2 ha land allotted per farm household. Due to the poor irrigation condition, however, they have hardly reclaimed new farmland and the shortage of staple food arising from the cultivation of low productive paddy fields along the swamp area is covered by growing maize and cassava. Such being the situation, there is not one settled farmer who does not hope for early materialization of the project to secure sufficient paddy production by improved paddy field cultivation and to cultivate cash crops for the expansion of farm management scale and increase of income.

From the viewpoint of topography, meteorology and geography, the project area is quite favourably conditioned for agricultural development. When the project is put in practice following the irrigation projects which are in the planning stage or in progress at present as part of the Lampung's fully technical irrigation scheme which will create a total of about 100 thousand ha of irrigated farmland in the mid-stream left bank basins of the Sekampung and the Suputih, the first phase irrigation development in Lampung Tengah will be brought to completion and ensued by additional irrigation projects for the Umpu and Pengubuan districts in Lampung Utara.

1.3 Outline of Project

The project aims at the overall land and water development involving irrigation, drainage and farmland improvement and readjustment in the 5,950 ha area extending from the bank of the Djepara so that Djepara district will serve as the base for future agricultural development of the province.

For this purpose, three plans were formulated. One of them is intended to secure the water source by damming up Lake Djepara from which water will be supplied to the 5,070 ha highland area for paddy field irrigation in the wet season and upland field irrigation in the dry season as well as to the 880 ha lowland area for paddy field irrigation in the dry season. The second plan, designed for bringing solution for the problem of constant water logging observed in the downstream area of the Djepara, envisages the construction of a flood way for stabilized paddy production in the low-lying area. The third plan is meant for the creation of a modern field area which is divided into large-sized paddy fields to enhance the modernization of farm management, introduction of farming machines and equipment, and rationalization of water management. Implementation of these three development plans will undoubtedly stabilize the livelihood of farmers and improve their economic footing and at the same time make Djepara district a model district that plays the rôle of a pioneer for less developed parts of the province.

The final basic plan for the project implementation already prepared by Ir. A. Angoedi and the I. T. B team basically conforms to the conclusion reached by the survey team. The team's activity therefore centered on the confirmation of the said three plans and feasibility of the basic implementation plan. In the course of its activity, however, the team made studies on the following six items and changes necessitated by such studies were effected to the implementation plan.

i. Calculation of the benefited area of irrigation and drainage improvement.

ii. Estimation of water requirement of paddy and upland fields.

iii. Kinds of upland crops to be introduced and method of upland field irrigation.

iv. Determination of water use balance in the basin and dam scale.

v. Inclusion of the drainage improvement work for the low-lying swamp area into the implementation plan.

vi. Method of field improvement for modernization of farm management.

(1) Dam

It is planned that a 17 m high front core type earth dam will be constructed on the Djepara to store 19,000 thousand m^3 of water in Lake Djepara. The dam will have a volume of 20,000 m^3, a crest elevation of 39.0 m, and will be capable of maintaining a normal high water level of 36.5m and lowest water level of 26.0m.

The spillway will be an overflow weir type chute spillway to be constructed by excavating the ground approximately 200 m far from the right bank of the dam. The design flood discharge is set at 130 m^3/sec, maximum overflow depth 0.8m, and crest length 90 m.

The intake facility is planned to be composed of an inclined conduit to be installed at a point about 600 m apart from the lake's outflow mouth and a headrace tunnel having a length of 200 m and inside diameter of 2.0m through which water will be led to the first turnout. The maximum design intake volume is 6.0 m^3/sec.

(2) Canal

Water stilled at the outlet of the headrace tunnel will be led into the left bank main canal and right bank main canal at the first turnout. The left bank main canal will have a total length of about 38 km and pass water at a rate of 5.1 m^3/sec, whereas the right bank main canal will have a total length of about 12 km and allows water to flow at a rate of 0.9 m^3/sec. On the course of the headrace, various facilities such as turnouts, drops, spillways, outlets, etc. will be constructed, and in addition, a regulating ponds will also be provided for dry season upland crop cultivation which calls for satisfactory control of water supply and alleviation of water loss incidental to water management. Further, a 5 m wide maintenance road will be constructed along the headrace tunnel.

(3) Drainage Facilities

To improve the drainage condition and introduce dry season paddy cultivation in the low-lying swamp area along the Djepara, it is planned that a new flood way having a bottom width of 80 m and total distance of about 7.1 km will be constructed from the junction of the Djepara and the Tjurup. The design drainage volume is 124 m^3/sec. Main drainage canals in the project area will be linked with this flood way and also dredged and widened to reclaim all the land area having an elevation of 2.0 m or more. It is estimated that the total volume of soil excavated in the main canals by a dredger will amount to somewhere close to 2,000 thousand m^3.

(4) Improvement of Field

In order to be able to cope with the future introduction of large type agricultural machines and equipments, reclamation of farmland composed of enlarged blocks is planned. It is planned that each block will cover an area of 12 ha (200 m x 600 m) and will be composed 30 to 60 plots each occupying an area of 20 - 40 a. In other words, each plot will measure 100 x 20 - 40 m. This plan was so prepared that each plot may have a size and configuration that impose no undue workload on farmers using manual labour and draught-animals in farming work, and that irrigation and drainage of each block may be controlled independently from other blocks.

It is also planned that a 5 m wide farm road stretching along each main canal and a 3 m wide farm road branching from the said road will be constructed for easier passage to and from respective plots.

Note: The term 'block used here indicates a farmland area delineated by permanent structures for irrigation and drainage, and "plot" denotes a farmland area surrounded by the field partition as the unit area for mechanized agriculture. In general, a group of plots constitutes a block.

(5) Construction Period

It is envisaged that the project will be completed in about four years after the construction work is started.

(6) Construction Cost

The project is estimated to require a total cost of US$ 4,524 thousand of which US$2,915 thousand is to be covered by local funds, and foreign loan is estimated at US$2,171 thousand.

As regards US$1,520 thousand required for the purchase of machines and equipments, the depreciated value only was included in the project cost, assuming that the remainder can be covered by irrigation projects planned for other parts of the province.

Breakdown of Total Project Cost

(Unit US$)

Item	Local Currency Portion	Foreign Currency Portion	Total	Remarks
Construction Cost	2,915,000	651,000	3,566,000	The foreign currency includes $453,000 required for the construction design and construction management
Cost of Machines and Equipments	-	743,000 (1,520,000)	743,000	Figure indicates the value depreciated by the project
Cost of Land Consolidation	215,000	-	215,000	Cost of labour offered by farmers
Total	3,130,000	1,394,000 (2,171,000)	4,524,000	

Note : Calculation worked out at a conversion rate of US$1=Rp415=308 Yen

(7) Economic Evaluation

When the facilities planned under the project are completed and farmers are provided with sufficient technical guidance, it will be possible to increase the net agricultural income in the district by about Rp 400 million. This increase is naturally estimated on the basis of the improvement of the processing and distribution mechanism which will be required for animated commodity flow. The increase is also considered to bring about population increase, increased employment opportunities, expansion of external economy and other effects. Benefit derivable from the project is not therefore limited to the direct promotional effect on agricultural production and farmers' income.

The direct effect alone taken into consideration, the project's payability against the total capital input of US$4,524 thousand can be fully justified. A comparative study of the total capital input and the net income increment during the fifty year durable period of the project discloses that the project promises a benefit-cost ratio of 1.46 and an internal rate of return of 15.6%. It may be safely said that the project feasibility is sufficiently demonstrated by these figures.

1.4. Conclusions and Recommendations

This report is a feasibility report prepared on the basis of data and reports made available by the Indonesian government as well as the team's findings. The team incorporated the dry season upland field irrigation for second cropping in the highland paddy field area and the drainage improvement work in the lowland area into the original Indonesian plan. By so doing, the project gained higher economic and social value and its feasibility was confirmed. It is earnestly hoped that the governments of Indonesia and Japan will unite their efforts for early materialization of this project which will have an immense effect not only on the livelihood stabilization of farmers who have long suffered water shortage but also on the expanded export of agricultural products from Lampung.

The team considers that in the stage of implementation design, detailed field survey will have to be made on the following items.

i. Delineation of the benefited area of drainage improvement work and route selection of the headrace tunnel.

ii. On-the-spot measurements for determination of water requirement for upland and paddy field irrigation.

iii. Installation of automatic observation instrument for recording the inflow, outflow and rainfall of Lake Djepara.

iv. Geological and leakage survey in the vicinity of Lake Djepara.

v. Studies for establishing standard cultivation techniques of respective crops which will be necessitated by the project implementation.

These activities will serve for the review of water use balance and affirmation of the land drying effect of flood way construction through the low-lying swamp area. If, as a result of such activities, the swamp area extending in the right side downstream basin of the Djepara can be included in the benefited area, the project will have an augmented value.

The project envisages a great diversity of improvements such as the introduction of dry season upland crop cultivation, development of coastal low-lying area, creation of large-sized blocks of field, etc. which will provide guiding principles for future agricultural development of the province.
It will therefore serve as a model project for future development of Sumatra and Kalimantan as well.

CHAPTER II EXISTING STATE OF PROJECT AREA

2.1 Location

The project area is in the eastern part of Lampung Tengah of Lampung province, the southernmost province of Sumatra. To be precise, it is situated about 60 km to the east-north-east of Telukbetung. Tandjung Karang, the capital city of the province, and extends around Lat. 5°12' S. and Long. 105°41' E. (See Annex Fig. 1).

Java island covers only 7% of total land area of the archipelago and yet bears 65% of the nation's total population, and consequently suffers the excessive population convergence and food problem. Sumatra, and particularly Lampung province, which faces Java across Sunda channel is blessed with favourable natural conditions and embraces many areas suited for development. Not only as the food supplying area but also as the most important resettlement area, the Indonesian government places much expectation on the province's development. During the period from 1956 to 1963, a total of 16,491 farmers (3,992 farm households) left their home in Central Java or Bali and started new life in Djepara district. It is estimated that settlers in this district will shortly reach 25,000 persons or 5,000 farm households.

2.2 Natural Conditions

2.2.1 Topography

The project area is delineated by the Penet in the north, the Djepara in the south and the Tjurup in the east, and has an elevation of less than 25 m. It is composed of rich undulations of hills and coastal low-lying swamp area.

The Djepara flowing in the south is a medium scale river rising in the Habar swamp area which has a 3 km east-west extension and a 5 km south-north extension. In the upper reaches, it water flows into Lake Djepara through the Habar. Being a crater lake, Lake Djepara is nearly round and has a diameter of about 1.8 km and a maximum water depth of 26 m. The Djepara flows out of this lake with a gentle graident at its southeastern tip, declines in stage by ten and odd meters as it branches into a number of torrents at a point about 400 m downstream of the planned dam site, flowing into the swamp area near Desa Djepara. Through the swamp area, the river follows a meandering course heading eastwards or southwards, and turns its course to the north after it joins the Tjurup. After it joins the Penet, it flows eastwards to empty into Sea of Java. The project area embraces the hills extending from its either bank and the low-lying swamps interposing between these hills. (See Annex Fig. 2)

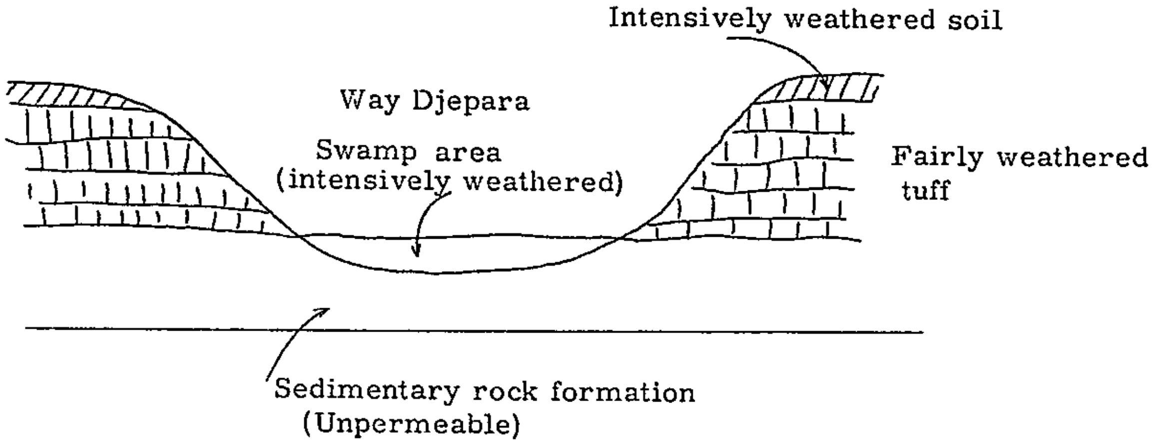
2.2.2 Geology and Soil

A fairly accurate geological map covering Lampung province was prepared during the Dutch colonial days.

Along the coast facing the Indian Ocean stretches the Barisang Mountains in the south-north direction. This mountain range is composed chiefly of igneous rocks, basalt and tuff. The project area is therefore covered with soils produced by the weathering of these rocks. Since the project area is in the tropical zone with abundant rainfall, the soils are acidified by the eluviation of basic matters invited by rainfall, and transformation into lateritic and podzolic soil is observed. The coastal area is covered by alluvial soils.

In the vicinity of Lake Djepara, the bedrock is composed of sedimentary rock of the lower Palembang formation spreading almost horizontally or dipping in the northeast direction. This bedrock is overlain by the plateau formed by the diffusive rock produced when Lake Djepara was created. The diffusive rock, which is sandy tuff, is already weathered to some extent, and flowing water rising through this formation is observed at some places.

Fig. 1 - Geological Section in the Vicinity of Lake Djepara



According to the 'Report on Agricultural Survey of Way Djepara Irrigation Project', the soils of the project area are classified into three groups.

1. Soils of the East Lampung peneplain: The soils were derived from acid tuff materials and formed through acid weathering

process. The soils are podosolic being characterized by the presence of a horizon of illuviation of clay accumulation and a horizon of eluviation pale in color and coarser in texture. The most part of the project area belongs to these podosolic soils.

2. Soils of the alluvial basin: The soils are found in the area of low elevation which are flooded every year or often influenced by flooding.

3. Soils of Sukadana basalt: The soils were derived from basaltic rocks of old volcanic activity products. The soils are of fine texture and of red color throughout the profile without horizon development. Thus the soils are characterized as latosolic. The latosols are found only in narrow part of the southern district of the project area.

As for the soil fertility of the area, (1) nitrogen, phosphorus and potassium contents are generally low, (2) soil reaction is acid to slightly acid, (3) content of available calcium is medium to high, (4) organic matter content based on C/N ratio is rather high, and (5) cation exchange capacity can be classified as low to medium.

Calcium fertilizer should be applied for increasing agricultural production along with the implementation of the Irrigation Project.

In detail, refer to the said Report.

2.2.3. Meteorology

The annual rainfall of the project area averages 2,000 mm of which more than 70% is recorded in the wet season lasting from November to April. However, the dry season in the project area is not so distinct as observed in Java. Though dry weather occasionally continues for about two weeks in the dry season (June - August), cultivation of dry season crops will not be subjected to so exacting a condition as expected in Java if irrigation facilities are improved to some degree.

The monthly average temperature stands at about 27°C throughout the year, with virtually no difference noticeable between seasons. The relative humidity averages 85%. Thus, both temperature and humidity are very high and provide a favourable condition for the growth of crops. What is more, the project area is completely free from typhoons or any other strong winds though seasonal winds blow as a characteristic of the tropical zone.

Table 1 shows the names of rain-gauge stations established near the Djepara river. As will be clear in the table, however, the values for the Djepara were recorded quite some time ago during a short observation period. To cover this shortcoming, Table 2 is shown below because this table gives recent and well consolidated rainfall values in Metro which is close to the project area.

It is planned that irrigation improvement will be based on the rainfall values at Sukadana, Labuhan, Maringgai and Bergen which are adopted in the report of the Institute of Technology, Bandung (here-after called the 'I.T.B. Report'). In the stage of construction design, however, it is desirable that the rainfall correlation between Metro and Djepara be studied so that the probable rainfall values in Djepara district will be used as basic data.

Table 1 - Names of Rain-Gauge Stations Near Djepara River

Name of Station	Period of Observation	Number of Years Covered by Rain-fall Data
Sukadana	1914 - 1953	27 Years
Labuhan Marringai	1914 - 1953	18 Years
Bergen	1926 - 1952	15 Years
Way Djepara	1936 - 1941	5 Years

Table 2 - Record of Rainfall in Metro District

Month / Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Monthly Average Rainfall (mm)	349	238	243	167	115	95	91	73	76	98	199	229	1,973
Monthly Rainfall Ratio in (%)	(17.7)	(12.1)	(12.3)	(8.5)	(5.8)	(4.8)	(4.6)	(3.7)	(3.8)	(5.0)	(10.1)	(11.6)	(100.0)
Average Number of Monthly Rainy Day	16.6	13.6	14.8	10.9	9.3	6.2	5.6	5.0	5.1	6.9	13.3	14.3	121.6

Period of Observation : 1950 - 1967, 18 Years

Elevation of Station : ± 57 m

2.2.4. Hydrology

The discharge of the Djepara was observed at the proposed dam site during the period from 1938 to 1940 and then from July 1958 to February 1959. Values obtained during these periods, however, are not suited for irrigation planning because neither of the two observation periods was long enough for the purpose and there exists a large gap between the values recorded by these two series of observation. It is therefore planned that the design inflow into the reservoir will be estimated on the basis of a comparative study of the values recorded at various places of Lampung during the 1937 - 1940 period (See Annex Table 3) according to the method described in Chapter III.

Table 3 - Monthly Average Discharge of Djepara River

Catchment Area : 130 km^3
Unit : m^3/sec

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1930							2.55	2.00	1.48	1.37	2.08	3.38	-
39	4.05	6.32	7.41	3.68	2.93	2.90	3.18	2.52	1.52	1.44	1.45	5.35	3.63
40	7.49	5.70	5.54	7.39	6.30	5.38	3.09	2.57	1.55	1.09	0.98	2.01	4.09
Average	6.17	6.01	6.48	5.54	4.62	4.14	2.94	2.36	1.52	1.30	1.50	3.58	3.85
1950						0.95	0.88	-	0.96	0.77	-	8.58	-
59	7.13	8.90											

2.3 Irrigation Condition

Hardly unable to wait for the project implementation, four thousand farm households or about 16 thousand persons have already settled themselves in

Djepara district. These people are now cultivating farmland created by opening jungles and reclaiming alang-alang fields. There are at present practically no irrigation facilities in the district, except that rain-fed or well irrigation conducted in the low-lying area makes it possible to cultivate paddy on a small scale in the dry season around the swamps. In some parts of the highland area, farmers cultivate maize and cassava as their staple food. Hence, the settlers in this district expect much of the project and are hoping that it will be put into practice as soon as possible.

Rivers in the district are all natural rivers, and there is not a trace of river improvement. Due to the lack of flood preventive capacity, the entire lowland area is inundated in the wet season so that all the land area with an elevation of 3 m or smaller is never used for agricultural production.

2.4 Roads and Transportation

There is a road that connects Telukbetung. Tandjung Karang, the capital of the province, and Djepara via Metro which is the centre of Lampung Tengah. The Telekbuteng..Tandjung Karang - Metro section is an excellent four-lane paved road, but from Metro on, the road width narrows to a two-lane paved road which is not given good maintenance care. The 100 km distance between Tandjung Karang and Djepara which is now covered by the said road via Metro will be reduced to as small as 60 km when the planned maize road is completed.

Access to the dam site from Desa Djepara must resort to a 2 km farm road having a width of less than 3 m and then to a 1 km walk. However, the flat topography in this vicinity will make it easy to provide a construction road.

Roads in the project area are systematically laid out for connection between respective village areas. The road surface, however, is given an extremely poor maintenance care and there are many sections that prevent smooth automobile passage. It is rarely the case that farm roads are constructed in any block of farmland area, not to mention the unreclaimed area.

2.5 Regional Agriculture

2.5.1 Agricultural condition of the project area

The lands of the area are roughly grouped as follows: Swamp, upland and alang-alang grass land.

(1) Swamp

The swamp in the project area are generally lower than 3 meters in elevation though some swamp on the left bank of Way Djepara is higher than 3 meters. Some part of the swamp is planted to rice in dry season while the most part is always left blooded without any crop.

(2) Upland

This land is generally flat in topography and higher than 3 meters in elevation. As for the acreage planted to various crops, upland rice and cassava occupy the largest, being followed by maize, soy bean and a few acreage of pea-nuts.

The yields of those crops are generally low. Pepper, coffee, coconut and some fruit trees are grown in the fields near the lake Djepara and near the settlements, but the acreage planted to these perannial crops is still small.

(3) Alang-alang grass land

This grass land which is left as it is, occupies nearly a half of the land higher than 5 meters in elevation. Though shifting agriculture is practiced in some part of the land, such reclaimed land is abandoned in two or thre years owing to the decreasing soil fertility and gets again occupied by alang-alang.

The average acreage of arable land per household is approximately one hectare, and its agricultural products is mostly allocated to home consumption.

2.5.2 Growing method of crops

According to the Report on Agricultural Survey of Way Djepara Irrigation Project (1971), the growing method of each crop is as follows:

(1) Swamp rice

Swamp rice is grown in dry season in the swamp area with comparatively shallow standing water, where irrigation is not necessary but drainage is a serious problem. Sometimes rice is harvested by using canoe when water is deep.

Variety : 'Gembira is most prevailing. Recommended varieties such as 'PB5 and 'Bengawan is on trial.

Growing practice:

Preparation of nursery and cultivation of field : May to June.

Transplanting in field (by using 30 to 40 day seedlings) : June to July.

Harvesting
- local varieties : 120 to 150 days after transplanting.
- PB5 : 105 days after transplanting.

Spacing : 25 cm x 25 cm or 30 cm x 30 cm, 3 to 5 seedlings per hill.

Disease and pest control : Seldom practiced. 0. 5 l/ha of endrine is sprayed at most.

Yield : 0. 9 t of gabah per hectare.

(2) Upland rice

Variety : Gembira, Kretak and Djapah darat.

Growing practice :

Preparation of land : August

Land is hoed once or twice. In case of grassland, alang-alang is reaped and burnt before hoeing.

Seeding : November

Weeding : December to January

Harvesting : March to April (130 to 150 days after seeding)

Amount of seed sown : 20 to 35 Kg/ha

Spacing : 25cm x 25cm or 20cm x 30cm (hill seeding)

Yield : 0. 25 t to 0. 8 t of gabah per hectare (0. 6 t/ha in average)

(3) Maize

In most cases maize is grown in mixed cropping system with upland rice and soy bean.

Variety : Yellow Metro (growth period : 90 to 100 days)

Growing practice:

First crop : December (seeding) to March (harvesting)

Second crop : March to June

Some times second crop maize is inter-planted in first crop under the following pattern.

First crop : October to January

Second crop : December to February

When maize is planted in grassland, land preparation is made by reaping and burning of alang-alang, and hoeing. However, land is not hoed when maize is seeded as the succeeding crop of upland rice.

Amount of seed sown : 15 to 17 Kg/ha

Spacing : Single cropping : 30cm x 30cm

Mixed cropping jwith upland rice or soy bean: 100 cm x 300 cm

Yield : Single cropping : 1.1 t/ha

Mixed cropping : 0.9 t/ha

(4) Soy bean

Soy bean is grown in mixed cropping system with maize; that is, soy bean is planted between rows of maize which are 3 meters apart.

Variety : 2 local varieties

Growing practice :

Seeding : November to December

Harvesting: February to March (90 days after seeding)

Amount of seed sown : 20 to 30 Kg/ha

Spacing : 25 cm x 25 cm

Yield : 0.24 - 0.4 t/ha (0.3 t/ha in average)

(5) Cassava

Cassava is grown in the both system of single cropping and mixed cropping with upland rice or maize.

Growing practice:

Planting of seeding : Mostly in August

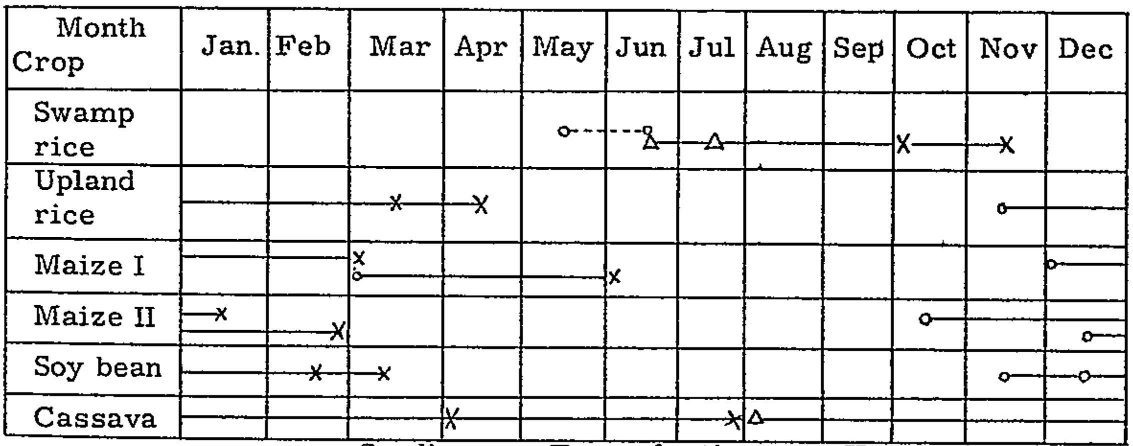
Harvesting : 8 to 12 months after planting

Spacing : Single cropping : 100cm x 100cm

Mixed cropping : 100cm x 300cm

Yield : Single cropping : 12.5 t/ha
Mixed cropping : 6 t/ha

The cropping pattern of these annual crops is summarized as follows:



o Seeding Δ Transplanting x Harvesting

These crops are grown in primitive methods as mentioned above without any fertilizer application. Thus the extension of modern growing techniques of various crops is badly needed, in parallel with the construction of the facilities of this Irrigation Project.

2.6 Historical Background of Project

The Djepara Irrigation Project has a history of 30 years which can be broadly divided into the following three stages.

1st Stage (1939 - 1941, survey conducted by Dr. Ir. W. H. Hetzel)

2nd Stage (1959 - 1962, survey conducted by Ir. A. Angoedi)

3rd Stage (1969 and onward, survey conducted by Ir. Prof. Soetedjo)

It goes back to as early as 1935 that resettlement in Djepara district was initiated by the government, and this was ensued by the arrival of the second wave of settlers in 1939. (The 700 farm households or 3,000 persons sent in 1958 were the first group of farmers who settled themselves in the district, and this was followed by successive resettlement up to 1964) For these early settlers, surveys were carried out in 1940 in Djepara district by Dr. Ir. W.H. Hetzel, Ir. J.A. Buedering and other experts who formulated an irrigation plan of the district. This plan envisaged the construction of a 20m high earth dam across the outlet of Lake Djepara and an auxiliary dam on the Habar that flows into the lake. In 1941, a drainage improvement plan was also prepared by Ir. A. Segond Von Banchet.

This initial stage was ensued by a blank period of about 20 years caused by the outbreak of the World War II and the subsequent independence war.

In 1959, the irrigation project was again taken up by Ir. Abdoellah Angoedi who proposed the construction of an earth dam having a crest length of about 60 m and other structures for irrigation coverage of a 7,120 ha area; and in 1962, the dam site geology was investigated by Dr. M. M. Poerbohadiwidjojo

During the subsequent several years, survey activities were interrupted by political confusion of the country.

In 1969, however, Djepara Irrigation Project was selected as one of top urgent programmes under the first Five Year Plan, whereby a survey team led by Prof. Ir. Soetedjo of I. T. B. was sent to the district. This team prepared a project implementation plan using the data contained in the many reports so far published, and presented it to the government. In this plan, it is envisaged that a 10.5 m high earth dam will be constructed to store 12,000 thousand m^3 of water for paddy field irrigation in a total of 6,560 ha comprising 4,170 ha of highland area and 2,390 ha of low-lying swamp area.

A further step forward was made in 1970 when the Institute of Hydraulic Engineering in Bandung carried out a geological survey for the headrace construction. In 1971, too, a soil survey was conducted in the project area by Prof. S. Arsjad of Bogor Agricultural University (I. P. B.) and a land survey by Ir. Sjahamardan and other experts of the Land Use Department of the Ministry of Home Affairs.

It was with such historical background that the project was included in the IGGI List for 1971/1972 by the Indonesian government as a top priority project. The Japanese government showed a favourable response to the request for cooperation in this project, which eventually led to the present feasibility survey.

It may as well be added that Mr. Junichi Kitamura (overseas technical cooperation officer, Agricultural Economic Bureau, Ministry of Agriculture and Forestry), who was dispatched by the Overseas Technical Cooperation Agency to the Irrigation Development Department of Indonesian Ministry of

Public Works in 1970 as a Colombo Plan expert, made a series of very energetic field surveys during the period from March to September 1971 and collected virtually all the data then available.

Abundance of information and data required for the preparation of this feasibility report must be credited to the aforementioned past survey activities since the time allowed for the team's survey activity was very limited.

CHAPTER III PROJECT IMPLEMENTATION PLAN

3.1 Acreage of Project Area

By reason of its topographic feature, the project area is divided into the highland area and the lowland area. The former is a hilly area stretching in undulation and sloping from west to south, and ranges from +5 m to +25 m in elevation, whereas the latter is a constantly logging area where the elevation does not exceeds +5 m. These two areas combined, the project area has a total acreage of 10,600 ha.

The planned irrigation area in the highland area is 4,170 ha. This value was obtained by 1) assuming, from the experience gained by the project in the mid-stream left bank basin of the Sekampung, that 30% of the total acreage of 7,360 ha of the highland area must be excluded as being unsuited for irrigation development either by the existence of village areas and surrounding orchards or by reason of topography or elevation, and by 2) deducting 20% from the remaining area of 5,100 ha as being required for road and canal construction.

The planned irrigation area in the lowland area of 3,240 ha, on the other hand, is set at 900 ha for the land ranging from +3 to +5 m in elevation and covering an area of 1,250 ha, and at 880 ha for the land ranging from +2 to +3 m in elevation and covering an area of 1,420 ha. The former value was obtained by deducting 10% by reason of local soil and topographic conditions and 20% as being required for road and canal construction, and the latter value by excluding 200 ha of swamp area along the Penet and deducting 10%

and 20% from the remaining area of 1, 220 ha for the same reasons.

Table 4 shows the results of this calculation.

Table 4 - Estimated Irrigation Area

Unit : ha

Division of Area	Elevation	Total Area	Area Excluded as unsuited for Irrigation	Total area incl. Roads and Canals	Planned Irrigation Area
Highland Area	+5 - +25^{m}	7, 360	2, 200	5,160	4,170
Lowland Area	+3 - +5	1, 250	120	1,130	900
	+2 - +3	1,420 (1, 220)	320 (120)	1,100	880
	Under +2	570	570	0	0
Total		10, 600	3, 210	7, 390	5, 950

Note: Figures in parentheses are for the case where the swamp on the right Bank of the Penet is excluded.

3. 2 Farm Management Plan

3. 2. 1 Production Target

Farmers in the project area settled themselves in poorly irrigated districts where they have hardly reclaimed any farmland and have also been forced to continue not in the least productive agriculture. The project is intended to offer the real promise for these settlers of providing modern and improved farmland, assuring supply of rice for food, increasing the commodity production and stabilizing their livelihood through effective use of irrigation water which will become available by augmenting the storage capacity of Lake Djepara and through draining and reclaiming the constantly logged area spreading in the lower basin of the Djepara.

Therefore, if sufficient safety is to be assured for the project by taking full account of such factors as the storage capacity of the lake, effective rainfall and the 10 year recurrence probability of droughty year, etc., then the only rational cropping patterns would be the ones shown in the table of this section. If such consideration and cropping patterns lead to the intensive land use and extension of advanced techniques, and ultimately result in production increase, the project may be considered to have attained its target.

For this reason, it is planned that wet season paddy field irrigation and dry season upland field irrigation will be introduced in the highland fields which are currently used for upland paddy and cassava production as well as in the 5,070 ha area of alang-alang fields for cultivation of cash crops such as maize, soybeans and groundnuts. For the 880 ha lowland area, on the other hand, drainage improvement and land drying works will be carried out for paddy field irrigation in the dry season. Thus, the project envisages expansion of farmland area and intensive land use and further aims at the improvement of land productivity through creation of modern paddy fields and extension of advanced cultivation techniques. While the improvement of land productivity can be promised by the shifting from upland paddy cultivation to paddy cultivation, it is expected that a higher yield level will be achieved by the introduction of improved varieties, application of fertilizers and agrochemicals and introduction of other advanced cultivation techniques. Considering, however, the fact that farmers generally have strong preference of local varieties over improved ones, the yield level is set at an average of 4 tons/ha (in stalk paddy) or 3 tons/ha (in coarse paddy grains) assuming that half of varieties will be composed of local ones and another half improved varieties such as PB-5. Accordingly, a dossage of 200 kg of urea fertilizers and 75 kg of double superphosphate of lime is assumed for improved varieties, whereas an average dosage of 100 kg of urea and 50 kg of double superphosephate of lime is considered for local varieties.

As regards dry seacon upland crops, increased and stabilized yield is hoped to be attained by irrigation and fertilizer application. The yield level is set at about three times the present level, i.e., 3 tons/ha for maize and 1 ton/ha for both soybeans and groundnuts. Dosage of fertilizer application is planned to be 100 kg/ha of urea and 50 kg/ha of double superphosphate of lime for maize; and for soybeans and groundnuts, a per ha dosage of 50 kg of urea, 100 kg of superphosphate of lime and 300 kg of slaked lime is envisaged.

Program for farm management and estimation of benefit.

(1) Land utilization at present

Elevation	Swamp			Grass-land	Upland				
	Benefit area	Actual acreage	Swamp rice	Alang-alang	Actual acreage	Upland rice	Cassava	Maize	Soy bean
	ha	ha	ha	ha	ha	ha	ha	ha	ha
$+5^m$-$+25^m$	4,170	-	-	2,000	2,170	(0.7) 1,519	(0.5) 1,085	(0.2) 434	(0.1) 217
$+3^m$- $+5^m$	900	550	(0.4) 220		350	(0.7) 245	(0.5) 175	(0.2) 70	(0.1) 35
$+2^m$- $+3^m$	880	880	(0.2) 176	-	-	-	-	-	-
Total	5,950	1,430	396	2,000	2,520	1,764	1,260	504	252

Number in parenthesis means the planted ratio of each crop to the actual acreage of land.

(2) Proposed land utilization after the implementation of the Irrigation Project

Elevation	Benefit area	Crop				
		Lowland rice	Maize	Peanut	Soy bean	Total acreage
	ha	ha	ha	ha	ha	ha
$+3^m$- $+25^m$	5,070	(1.0) 5,070	(0.6) 3,042	(0.2) 1,014	(0.2) 1,014	10,140
$+2^m$- $+3^m$	800	*(1.0) 880	-	-	-	880
Total	5,950	5,950	3,042	1,014	1,014	11,020

* Double cropping of rice might be possible in this area, but only the benefit of dry season crop is estimated here.

(3) Yield of crops before and after the implementation of the Irrigation Project

Crop	At present	After the Project
	t/ha	t/ha
Swamp rice	1	3
Upland rice	0.6	
Cassava	9	
Maize	1	3
Soy bean	0.3	1
Peanut		1

(4) Proposed fertilizer application after the implementation of the Irrigation Project

Crop	Urea	TSp	Calcium carbonate
	kg/ha	kg/ha	kg/ha
Rice	100	50	
Maize	100	50	
Soy bean	50	100	300
Peanut	50	100	300

(5) Production of crops before and after the implementation of Irrigation Project

Crop	At present			After the Project		
	Acreage planted	Yield/ha	Production	Acreage planted	Yield/ha	Production
	ha	t	t	ha	t	t
Rice	396	1	396	5,950	3	17,850
Upland rice	1,764	0.6	1,058			
Cassava	1,260	9	11,340			
Maize	504	1	504	3,042	3	9,126
Soy bean	252	0.3	76	1,014	1	1,014
Peanut	-	-	-	1,014	1	1,014

Yield of rice is indicated in term of gabah.

3.2.2 Balance Sheet Estimates

The crop-wise per ha production cost and net income before and after completion of the construction work will be as shown in the following table. The balance sheet condition before the construction was obtained by the method adopted by the Ministry of Public Works[1] and that after the construction is based on the consumption of fertilizers and increase in harvesting labour.

Income per Ha by Crop and Net Agricultural Income in Project Area

Crop	Yield (tons)	Gross Income (Rp)	Production Cost (Rp)	Net Income (Rp)	Planted Area in Project Area (ha)	Net Agricultural Income in Project Area (Rp 1,000)
Before Construction:						
Paddy (Stalk)	1.3	19,500	1,795	17,705	396	7,011
Upland Paddy (Stalk)	0.8	8,800	769	8,031	1,764	14,167
Maize	1.0	12,000	266	11,734	504	5,914
Cassava	9.0	13,500	1,400	12,100	1,260	15,246
Soy-beans	0.3	9,000	991	8,009	252	2,018
Total						44,356
After Construction:						
Paddy	3.9	58,500	8,850	49,650	5,950	294,418
Maize	3.0	36,000	5,310	30,690	3,042	93,359
Soy-beans	1.0	30,000	7,110	22,890	1,014	23,210
Ground-nuts	1.0	75,000	7,480	67,520	1,014	68,465
Total						480,452

1) Ministry of Public Works and Electric Power : Report on Agricultural Survey of Way Djepara Irrigation Project, July 1971.

The above table indicates that when the project is set afoot, there will be brought about an increase of approximately Rp 4 million to the net agricultural income in the project area. Needless to say, it is not that all this increment will go to farmers but a portion of it will be collected as taxes and public dues with the increased assessed value of land, etc. and go to national treasury and local governments. Nevertheless, it leaves no doubt that the project gives a direct and extremely effectual promotional effect on agricultural production.

It may be added that such cash crops as coffee and pepper were disregarded because they are cultivated on a small scale and are likely to be little benefited by the project.

3. 3 Irrigation Plan

3. 3. 1 Water Requirement

(1) Unit Water Requirement

It is planned that crops to be cultivated in the planned irrigation area will be chiefly paddy in the wet season and cash crops such as groundnuts, maize and soybeans in the dry season.

Water requirement in depth should in principle be determined on the basis of actual measurements. In the absence of data of such measurements in the project area, however, observation records in Cambodia and Malaysia (See Annex Table 5) were utilized to arrive at the following values.

For paddy cultivation, water requirement is set at 150 mm for puddling season while a daily evapo-transpiration of 7 mm and a percolation of 5 mm, totalling 10 mm/day, is planned uniformly for the ordinary irrigation period. For the low-lying area where the groundwater level is high, however, it is planned that the water requirement for puddling will be 120 mm and a total of 8 mm/day comprising 7 mm/day of evapo-transpiration and 1 mm/day of percolation will be required during the ordinary irrigation period.

For upland crop cultivation, daily water requirement is set at 7 mm by assuming that the irrigation efficiency in the field is 0.70 against the water consumption of crops of 5 mm/day. Since water is to be supplied to upland crops often grown by drill sowing in paddy fields after harvesting paddy, the 35 mm 5-day intermittent irrigation is planned to be carried out either by furrow irrigation or basin irrigation.

(2) Time and Period of Irrigation

As shown in Table 8, time and period of irrigation are planned on the basis of the local practice of planting in the beginning of the wet season and harvesting towards the end of it. As the period irrigation, a total of 135 days is considered necessary, i.e., one month from the puddling to transplanting and 3.5 months for ordinary irrigation after transplanting. No irrigation is planned for the one-month harvesting season, nor is water supply to nursery beds considered in the calculation of the irrigation period since it is as small as one-twentieth of usual irrigation requirement.

(3) Effective Rainfall

The design rainfall given inI. T. B.'s report (See Ref. No. 1) was adopted in the calculation for irrigation plan. In other words, a dry year rainfall of 1,750 mm having an occurrence frequency of once in five years (probability of non-exceedence: 1/5) was adopted and the monthly rainfall distribution is based on the Table 9 shown in the said I. T. B. report.

Due to the lack of daily rainfall record, the monthly rainfall had to be resorted to in assuming the effective rainfall ratio in paddy and upland fields. For both paddy and upland fields, it is assumed that the ratio stands at 80% if the monthly rainfall is smaller than 150 mm, 70% for a monthly rainfall of 150 to 200 mm, and 60% for a monthly rainfall of more than 200 mm. (See Ref. No. 2).

Reference

1. In I. T. B. report, the said value of 1,750 mm is obtained, as shown by the following equation, from the average of observed values at Sukadana, Labuhan and Marringgai and from the arithmetical mean of the dry year rainfall with an occurrence probability of 1/5 (80% dry year) observed at Bergen.

$$\frac{2 \times 1,640 + 1,980}{3} \fallingdotseq 1,750 \text{ mm}$$

The rainfall distribution by month given in the said report is obtained from the monthly average rainfall at the abovementioned three places.

2. In Japan, the ratio of effective rainfall is set at 80% for paddy fields if the daily rainfall ranges from 5 to 80 mm. For upland fields, too, the ratio is set at 80% if the daily rainfall exceeds 5 mm, but if it is less than 5 mm, it is considered ineffective. The upper limit is set at the T.R.A.M. value (total readily available moisture).

(4) Volume of Inflow into Reservoir

Due to the lack of sufficient discharge data of the project area, conversion from the monthly rainfall is the only means to calculate the inflow volume, and this in turn demands that the monthly discharge coefficient be clarified.

For this reason, the runoff ratio by month (See Table 5) had to be obtained from the monthly average discharge of the four rivers in Lampung shown in Annex Table 3. In this case, however, the Batanghari and the Raman were left out of consideration since these two rivers are drainage rivers whose catchment area is the low-lying paddy field area extending on the mid-stream left bank side of the Sekampung and their discharge data do not fit in the condition in the project area. Then, Hazen's probability paper was used for probability calculation based on the values shown in Annex Table 4 so as to obtain the specific discharge against the recurrence probability of every five years of droughty year (See Table 6). The annual average specific discharge of the four rivers per 100 km^2 is 3.5 m^3/sec, whereas the annual average droughty-water discharge against the said recurrence probability is 3.0 m^3/sec as calculated below provided that the 1937 - 1940 period is assumed to have recorded mean values for the convenience of calculation.

$$3.5 \times 130/100 \times 0.69 = 3.1 \fallingdotseq 3.0\ m^3/sec$$

As a precondition to the above calculation, it is also assumed that the annual average rainfall in the four river basins shows a fair conformity to that of the river basins in the project area. The team considers that any further study into the inflow volume would matter little to the Project planning because of the lack of data.

Table 5 - Specific Discharge and Monthly Runoff Ratio of Four Rivers in Lampung

Period of Observation: 1937 - 1940

Unit : m^3/sec

Name of River		Jan.	Feb.	Mar.	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Way Sekampung	Average Discharge	123	94	85	105	64	62	40	31	25	28	24	64	62
(Argoguruh)	Ditto Specific Discharge per 100 km^2	5.7	4.3	3.9	4.9	3.0	2.9	1.9	1.4	1.2	1.3	1.1	2.9	2.9
CA=2,155 km^2	Runoff Ratio(%)	16.4	12.5	11.4	14.0	8.6	8.4	5.4	4.2	3.4	3.8	3.3	8.6	-
Way Suputih	Average Discharge	38	34	27	25	20	16	13	7	6	5	5	17	18
CA=500 km^2	Ditto Specific Discharge per 100 km^2	7.5	6.9	5.3	5.0	4.0	3.2	2.6	1.4	1.1	1.0	1.1	3.3	3.5
	Runoff Ratio (%)	17.8	16.0	12.7	11.7	9.4	7.5	6.1	3.3	2.8	2.3	2.4	8.0	-
Way Pengubuan	Average Discharge	18	16	12	12	9	8	7	4	2	2	2	8	8
CA=180 km^2	Ditto Specific Discharge per 100 km^2	10.0	9.2	6.8	6.9	5.0	4.5	3.8	1.9	1.1	1.2	1.1	3.3	4.7
	Runoff Ratio (%)	18.0	16.0	12.0	12.0	9.0	8.0	7.0	4.0	2.0	2.0	2.0	8.0	-
Way Djepara *	Average Discharge	6	6	6	5	5	4	3	2	2	1	2	4	5
CA=130 km^2	Ditto Specific Discharge per 100 km^2	4.8	4.6	5.0	4.3	3.5	3.2	2.3	1.8	1.2	1.0	1.2	2.8	3.0
	Runoff Ratio (%)	13.0	13.0	12.9	10.9	10.9	8.7	6.5	4.4	4.4	2.2	4.4	8.7	-
Average of 4 rivers	Specific Discharge per 100	7.0	6.3	5.3	5.3	4.1	3.5	2.6	1.6	1.2	1.1	1.1	4.1	3.5
	Runoff Ratio(%)	16.3	14.4	12.3	12.1	9.5	8.2	6.3	3.9	3.2	2.6	3.0	8.3	-

Note : Values for the Djepara are the averages in the 1938 - 1940 period.

Table 6 - Monthly Average Discharge and Probability Droughty-Water Discharge of the Sekampung

Unit : $m^3/sec.$

Probability of Non-exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1/2 ①	200	229	196	173	116	90	64	62	49	52	72	133	119
1/5 ②	135	173	152	122	89	58	38	44	32	32	50	90	111
1/10 ③	115	154	141	107	80	48	30	40	27	27	42	76	108
1/20	101	138	129	94	72	41	25	36	22	23	36	62	103
② / ①	0.67	0.76	0.77	0.70	0.77	0.64	0.59	0.71	0.65	0.62	0.69	0.69	0.69 (0.93)
③ / ①	0.57	0.67	0.72	0.62	0.69	0.53	0.43	0.65	0.55	0.52	0.58	0.57	0.59 (0.91)

Notes: 1) Observation Point - Waduk Kemantana (CA = 2,150 km^2).

2) Observation Period - 25 years from 1917 to 1941.

3) Hazen's probability paper employed for approximate probability calculation.

The above calculation provided the basis for estimating the runoff coefficient by month to be adopted for the project planning.

The coefficient thus obtained in subject to large monthly fluctuation, which is assignable to the lack of conformity between rainfall and discharge in any month in view. If a time-lag of one month is provided to discharge, however, uniformity can be attained as shown in Table 7.

Table 7 - Runoff Coefficient by Month Adopted for Project Planning

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall Ratio(%)	13.9	12.4	12.2	9.6	8.4	6.6	4.1	4.5	4.0	5.0	7.5	11.8	100.0
Monthly Rainfall(mm)	243	217	213	166	147	116	72	50	70	87	131	206	1,750
Monthly Rainfall Converted into Discharge(m^3/sec) ①	11.5	11.3	10.0	8.2	6.9	5.7	3.4	2.8	3.4	4.1	6.4	9.8	
Runoff Ratio (%)	16.3	14.4	12.3	12.1	9.5	8.2	6.3	3.9	3.2	2.6	3.0	8.3	100.0
Monthly Discharge(m^3/sec) ②	5.9	5.2	4.4	4.4	3.4	3.0	2.3	1.4	1.2	0.9	1.1	3.0	36.0
Runoff Coefficient ②/①(%)	51	46	44	55	49	53	68	50	35	22	17	31	42
Runoff Coefficient Adopted for Project Planning(%)	50	45	45	55	50	55	55	50	35	20	20	20	30
Runoff Coefficient Modified by Provision of One-Month Time Lag	45	40	44	42	43	40	41	41	29	27	51	60	

Notes: 1) The runoff coefficient adopted for project planning was obtained by arranging the calculated value, i.e., by counting as one fractions more than 0.5 inclusive and cutting away the rest. The upper limit in this case was set at 50% and the lower limit at 20%.

2) The modified runoff coefficient indicates the coefficient obtained by dividing the discharge of a certain month by the rainfall of the preceding month.

(5) Gross Water

From the explanation given in the preceding item, the gross water requirement in the entire project area to be supplied from the reservoir can be expressed by the following equation.

Gross water requirement in the project area = (net water requirement - effective rainfall)/(1 - conveyance loss)

The conveyance loss, incurred in the course of both water supply and water distribution, is set at 20% in this case. Tables 8 to 11 show the outcome of calculation worked out to obtain the water requirement.

Table 8 - Net Water Requirement in Planned Irrigation Area

Item / Month	Paddy Cultivation I			Paddy Cultivation II			Paddy Cultivation III			Upland Crop Cultivation I			Upland Crop Cultivation II			Upland Crop Cultivation III	
	Area	Unit Water Req't	Total Water Req't	Area	Unit Water Req't	Total Water Req't	Area	Unit Water Req't	Total Water Req't	Area	Unit Water Req't	Total Req't	Area	Unit Water Req't	Total Req't	Area	Total Req't
	ha	mm	m^3 x1000	ha	mm	m^3 x1000	ha	mm	m^3 x1000	ha	mm	m^3 x1000	ha	mm	m^3 x1000	ha	m^3 x 1000
1	2,570	300	7,710	2,500	300	7,500										5,070	15,210
2	2,570	300	7,710	2,500	300	7,500										5,070	15,210
3	2,570	150	3,855	2,500	300	7,500										(3,785) 5,070	11,355
4				2,500	300	3,750										(1,250) 2,500	3,750
5							880	280	2,404	2,570	210	5,397				3,450	7,861
6							880	240	2,112	2,570	210	5,397				3,450	7,509
7							880	240	2,112	2,570	210	5,397				3,450	7,509
8							880	240	2,112				2,100	210	5,250	3,380	7,362
9							880	120	1,056				2,500	210	5,250	(2,940) 3,380	6,306
10													2,500	210	5,250	2,500	5,250
11	2,570	350	8,995													2,570	8,995
12	2,570	300	7,710	2,500	350	8,750										5,070	16,460
Total	2,570	1,400		2,500	1,400		880			2,570	630	16,191	2,500	630	15,750	5,950	112,777

Notes: 1) In the initial month of paddy cultivation, the puddling period is assumed to cover the first 20 days and ordinary unit water requirement is planned for the remaining 10 days.

2) For the fifth month of paddy cultivation, half the normal monthly requirement is considered. Hence, half the irrigation area is shown between parentheses.

Table 9 - Effective Rainfall in Planned Irrigation Area

Month	Monthly Rainfall Distribution	Design Rainfall	Ratio of Effective Rainfall	Effective Rainfall	Irrigation Area	Total Effective Rainfall
	%	mm	%	mm	ha	x1000 m^3
1	13.9	243	60	146	5,070	7,098
2	12.4	217	60	130	5,070	6,591
3	12.2	213	60	128	3,785	4,845
4	9.6	168	70	118	1,250	1,475
5	8.4	147	80	118	3,450	4,071
6	6.6	116	80	93	3,450	3,209
7	4.1	72	80	58	3,450	2,001
8	4.5	80	80	64	3,380	2,163
9	4.0	70	80	56	2,940	1,646
10	5.0	87	80	70	2,500	1,750
11	7.5	131	70	92	2,870	2,364
12	11.8	206	60	124	5,070	6,292
Total	100.0	1,750		1,197	-	43,505

Table 10 - Inflow into Lake Djepara

Month	Design Rainfall	Runoff Coefficient	Rainfall Converted into Runoff	Inflow into Lake Djepara	Average Discharge Converted from Inflow
	mm	%	mm	x1000m^3	m^3/sec
1	243	50	122	15,372	5.75
2	217	45	98	12,348	5.08
3	213	45	96	12,098	4.50
4	168	55	92	11,592	4.51
5	147	50	74	9,324	3.45
6	116	55	04	8,064	3.13
7	72	55	40	5,040	1.87
8	80	50	40	5,040	1.87
9	70	35	25	3,150	1.19
10	87	20	17	2,142	0.82
11	131	20	26	3,276	1.28
12	206	30	62	7,812	2.94
Total	1,750	43	756	95,258	

Notes: 1) The dam has a catchment area of 126 km^2.

2) See Table 7 for the calculation basis of the runoff coefficient.

Table 11 - Values Calculated for Reservoir Scale Determination

Unit : 1,000 m^3

Month	Net Water Requirement	Effective Rainfall	Field Water Requirement	Gross Water Requirement from Reservoir ①	Average Intake Rate from Reservoir	Inflow into Reservoir ②	Average Inflow into Reservoir	Balance ②-①	Cumulative Value	Reservoir Water Level at the End of Month
					m^3/sec		m^3/sec			m
1	15,210	7,098	8,112	10,140	3.79	15,372	5.75	+5,232	-12,891	EL. 30.30
2	15,210	6,591	8,619	10,774	4.45	12,348	5.08	+1,574	-11,317	31.40
3	11,355	4,845	6,510	8,138	3.04	12,098	4.50	+3,900	- 7,357	33.40
4	3,750	1,475	2,275	2,844	1.10	11,592	4.51	+8,748	+ 1,391	36.50
5	7,861	4,071	3,790	4,738	1.77	9,324	3.45	+4,586	+ 5,977	36.50
6	7,509	3,209	4,300	5,375	2.07	8,064	3.13	+2,689	+ 8,666	36.50
7	7,509	2,001	5,508	6,885	2.57	5,040	1.87	-1,845	- 1,845	35.80
8	7,362	2,163	5,199	6,499	2.43	5,040	1.87	-1,459	- 3,304	35.00
9	6,306	1,646	4,660	5,825	2.25	3,150	1.19	-2,675	- 5,979	34.00
10	5,250	1,750	3,500	4,375	1.63	2,142	0.82	-2,233	- 8,212	33.00
11	8,995	2,364	6,632	8,289	3.20	3,276	1.28	-5,013	-13,225	30.20
12	16,460	6,292	10,168	12,710	4.75	7,812	2.94	-4,898	-18,123	26.80
Total	112,777	43,505	69,273	86,592	2.75	95,258	3.00	-	-	

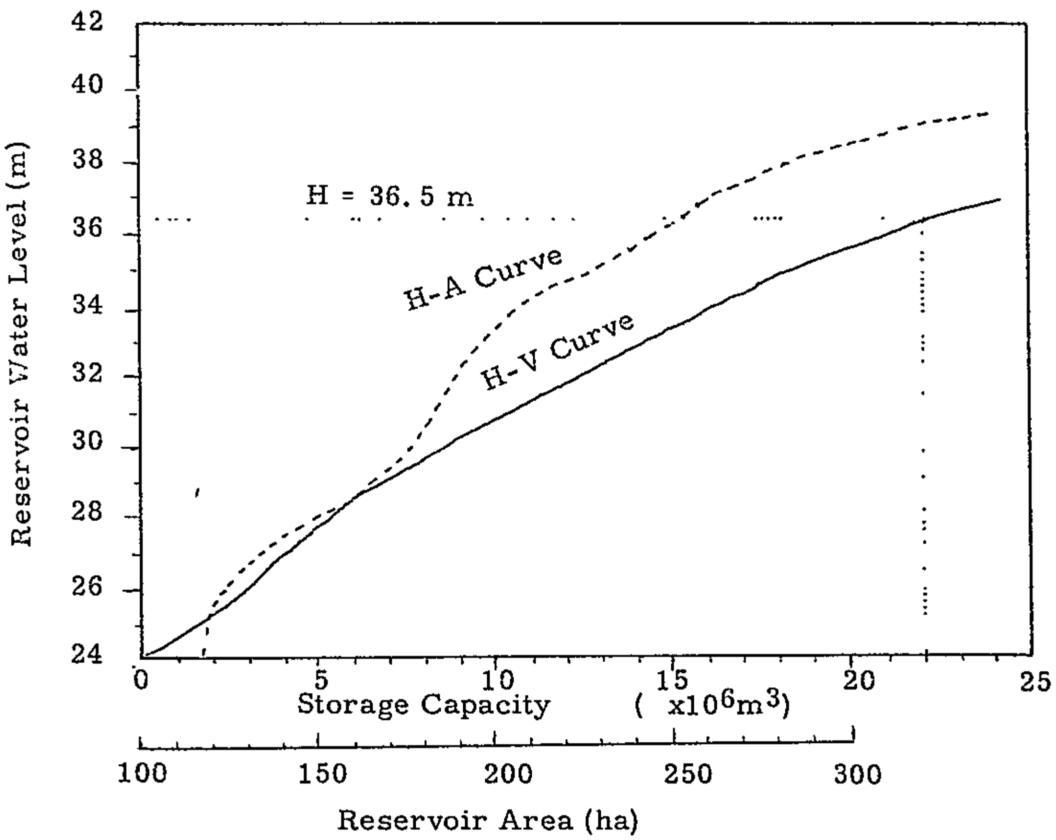
Note : The gross water requirement includes the 20% loss incurred by water supply and distribution.

Table 11 indicates that the annual net water requirement is 112,800,000 m^3, and that the effective rainfall and gross water requirement in the fields are 43,500,000 m^3 and 86,600,000 m^3 respectively in the basic year of project. The inflow into the reservoir in the same year, on the other hand, is 95,300,000 m^3. These facts point to the possibility of securing sufficient water supply by the regulating function of the reservoir.

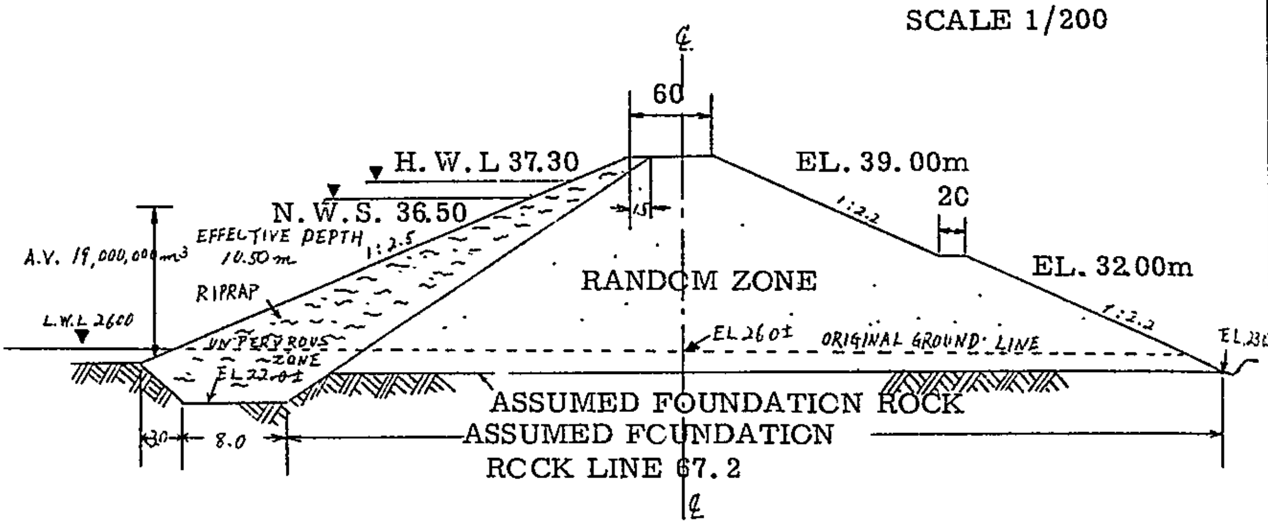
3.3.2 Scale of Reservoir

The storage capacity of a reservoir can be obtained from the maximum cumulative total of monthly differences between the gross water requirement and the inflow into the reservoir. In the case of this project, the said cumulative total is 18,100,000 m^3. Assuming a 5% loss due to percolation and leakage, the reservoir should be provided with a storage capacity of 19,000,000 m^3. From the storage capacity curve shown in Fig. 2 below, the design normal high water level turns out to be El. +36.5 m. With a 25 m free board added to this value, the design crown height is set at El. +39.0 m.

Fig. 2 - Water Level - Reservoir Area and Capacity Curves



STANDARD CROSS SECTION OF DJEPARA DAM



FRONT VIEW OF DJEPARA DAM

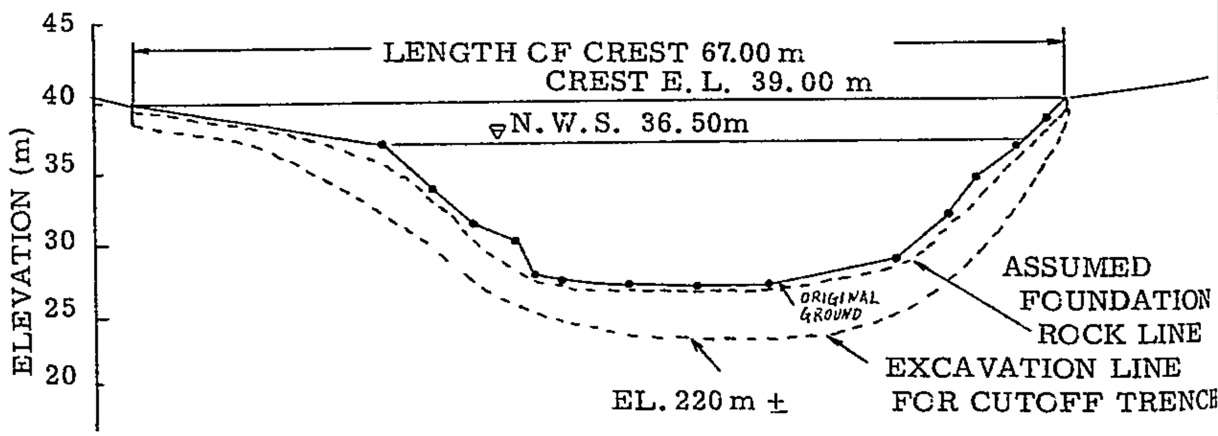


Fig. 3 - CROSS SECTION OF DJEPARA DAM

The lowest water level in this case is +26.0 m. Since the lowest elevation of the cut-off trench is +22.0 m, the dam should have a height of 17 m (the height above the river bed elevation of +26.0 m is 13 m).

In determining the reservoir size, two problems were taken into consideration. One of them is when to start supplying irrigation water to the low-lying 880 ha paddy field area, and the other is what the dame scale should be if a droughty year recurrence probability of 10 years is assumed for the basic year of project.

For the first problem, calculations were made for irrigation commencement in January, March and May (See Annex Table 6). If irrigation is to be started in January and March, then the reservoir will be required to have a storage capacity of 14,500,000 m^3, whereby the crest elevation can be reduced to +37 m (normal high water level : +34.5 m) and the dam height can also be reduced by about 2 m. In this project, however, there is no choice but to adopt the May-September period (dry season) as the irrigation period for a number of reasons such as 1) heavy demand for irrigation water is expected to continue in the project area, 2) additional construction cost required for this plan is quite small, 3) the short-cut plan of the Djepara and the Tjurup described later promises not much head so that the wet season logging in the low-lying swamp area is liable to continue even after the completion of the drainage construction work. This plans demands the largest storage capacity which is quite sufficient for the first two plans for starting water supply in January and March.

To cope with the second problem, the reservoir should have a capacity of 25,800,000 m^3 as shown in Annex Table 7 and this calls for a crest elevation of more than +42.0 m. Construction of a reservoir of this size is not feasible due to topographical conditions at and around the dam site. If the abovementioned low-lying paddy field cultivation is left out of consideration, the design normal high water level of +36.5 m will suffice for the 10 yen recurrence probability. However, there is no need to seek a higher safety level than can be expected from the said design normal high water level because it scarcely happens that both the wet and the dry seasons are involved in the probability drought.

The dam site is already selected by the Ministry of Public Works, and there is no need to find a new site at any other place. At this site, the river has the smallest width and hills of El. 40 m or little higher extend on its either bank. For the construction of a dam with a crest elevation of +39.0 m, the site provides a near-ideal condition for selection of the spillway location and supply of dam materials. In view of the topography, foundation, material availability and convenience of construction work at the site, construction of an earth dam is recommended as most suitable.

3.3.3 Irrigation Facilities Plan

(1) Canals

Water taken from the reservoir by the inclined conduit is led through the headrace tunnel having a length of about 200 m, and then distributed to respective benefited areas through the main irrigation canal leading out from its either bank. As for the route of the main and lateral canals, the preliminary planning stage is already completed and the final plan is shown in I.T.B. report.

In the said final plan, it is envisaged that canals will, in principle, be earth canals to cut down both the cost and period of construction. The canal base is covered with relatively small particles of soil produced by intensive weathering of volcanic rocks. Therefore, the velocity of water flow in the canals is set at 0.4 to 0.5/sec in prevention of the scouring and silt depositing.

Intake is expected to increase in December when a total monthly flow of 12,700,000 m^3 and an average flow velocity of 4.75 m^3/sec will be required. This average flow velocity was obtained with account taken of the effective rainfall and will be increased if detailed calculation is worked out. Hence, it is planned that the canal design section will be expanded by 20% to attain a maximum velocity of 6 m^3/sec.

This maximum velocity of 6 m^3/sec, if apportioned by the irrigation area on the left and right bank sides, will be reduced as follows.

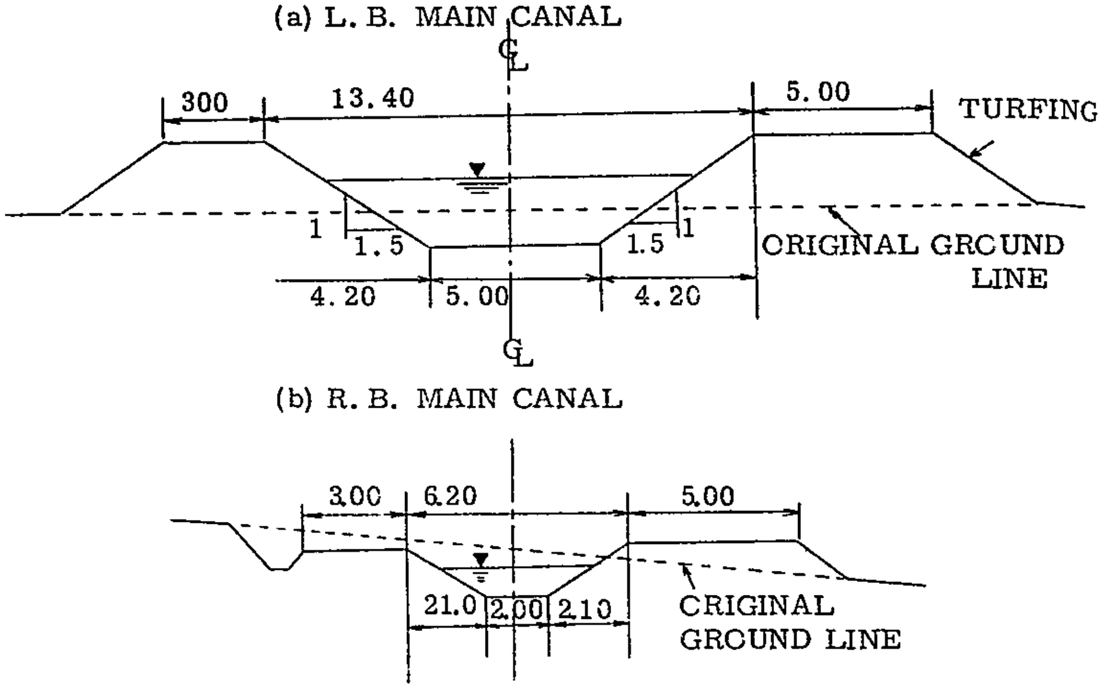
Left bank main canal : 5.1 m^3/sec

Right bank main canal : 0.9 m^3/sec

Fig. 4 shows the standard cross section of the main canals.

Fig. 4 - STANDARD CROSS SECTION OF MAIN CANAL

SCALE 1:200



(2) Maintenance Road

Embankment or cutting work is planned to be carried on the left bank of the main canal to construct a 5 m wide road which will be used for canal construction and for canal maintenance afterwards.

(3) Turnout

It is planned that either concrete work or cobble stone masonry will be carried out for turnout construction. For diversion from the turnout, installation of "Romjn Gate" which is widely used in Indonesia is recommended for the sake of simple and accurate diversion. A drawback of this gate is that it incurs a large head loss at the turnout. If the necessary head is not obtained in the downstream section, it is recommended that a slide gate be used and a triangular measuring weir be installed. All the turnouts should have a construction which allows for easy water gauging.

(4) Appurtenant Facilities

Spillways and outlets should be constructed at intervals of approximately 10 km along the entire extension of the canal so as to facilitate the operation and maintenance of canal.

Further, drops built by concrete work or cobble stone masonry should also be provided if need arises. These should be of the over-flow type construction and designed to make the water surface dammed up at a point upstream of the overflow section.

In addition, bridges should be constructed at intervals of less than 2 km with due account taken of the farmland reclamation plan and layout of farm roads.

3.3.4 Upland Field Irrigation Facilities

It is planned that cash crops will be grown in paddy fields in the highland area during the dry season after harvesting paddy. For this purpose, furrow or basin irrigation is to be carried out with water drawn from the canals which are intended primarily for wet season paddy cultivation in the project area. If need arises in future, it may be advisable to employ sprinklers for paddy production in the highland area.

For efficient operation and maintenance of irrigation facilities during the dry season, regulating ponds should be provided along the canal route so that water stored in the nighttime may be supplied for irrigation in the daytime. It is considered that a total of at least three regulating ponds, one along the right bank main canal and two along the left bank main canal, will be required. Locations of these regulating ponds can be selected in the course of implementation design.

3.4 Drainage Plan

3.4.1 Catch Basin

The drainage plan for the project area is intended for reduction of logging water level in the lowland area as well as for introduction and stabilized production of upland paddy in part of the existing swamp area. The plan is expected to eliminate the constantly logged area and improve the living standard of the inhabitants in the lowland area.

Ir. A.S. Banchet states in his report that the highest logged water level observed in the swamp area is +2. 8 m. It appears to entail little difficulty to reduce this water level to +2. 0 m if a new flood way is constructed to let water directly flow into the sea from the Djepara and the Tjurup.

Construction of a flood way connected to the Penet is not advisable because it will be costly relative to the small catch area of the river. Therefore, the planned drainage improvement work will cover a 2, 470 ha area within the 3, 240 ha land ranging from +2. 0 m to +5. 0 m in elevation.

As an immediate benefit of this plan, transformation of the approximately 900 ha constantly logged area into dry land can be expected. If this drainage improvement work is accompanied by the construction of new main and lateral drainage canals connected with the flood way and by the farmland reclamation work, it will serve to decrease the field groundwater level in about 1,000ha low-lying area extending with an elevation of +3.0 m or more on either side of the Djepara. Construction of the flood way thus brings about an immense promotional effect.

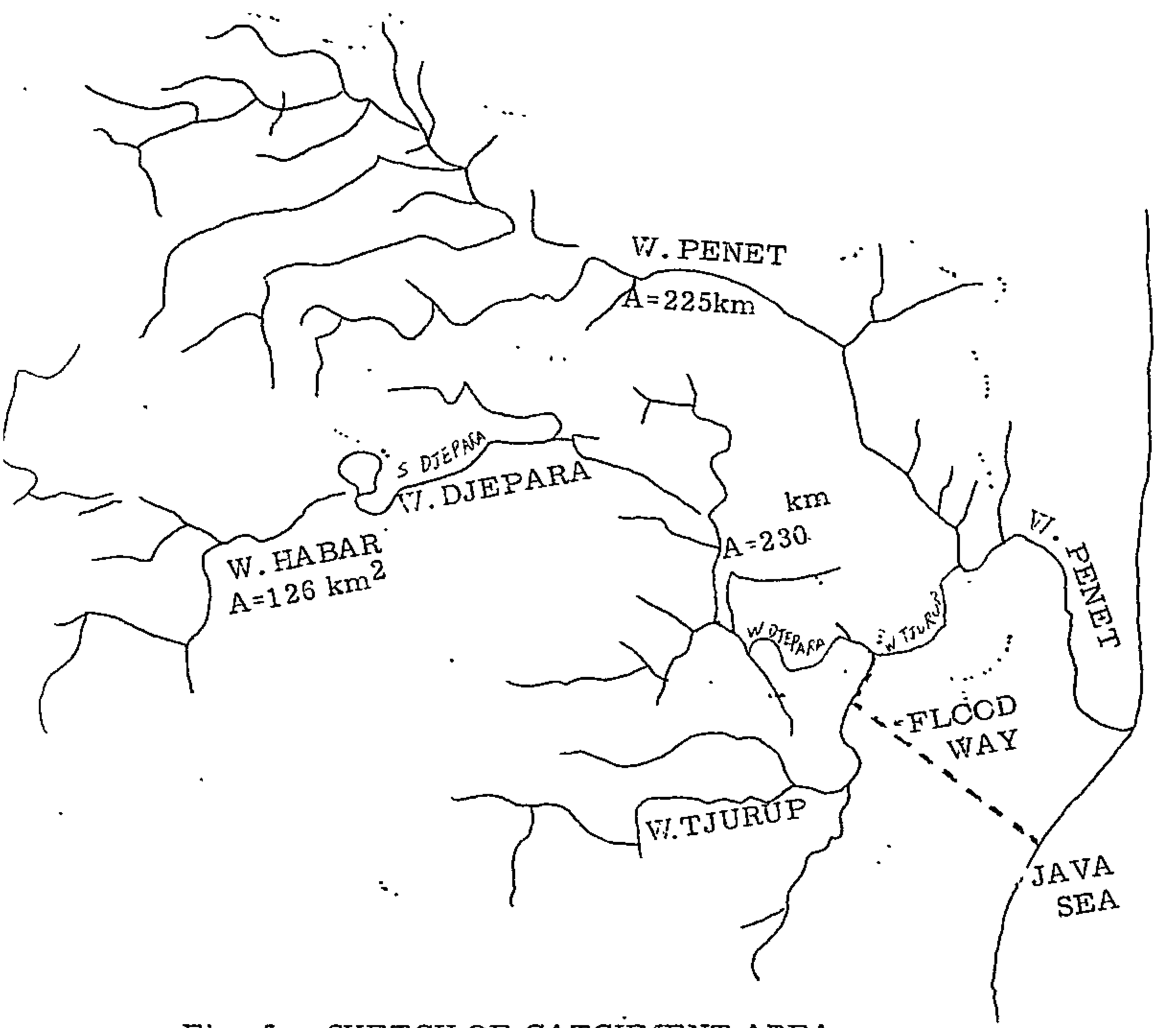


Fig. 5 - SKETCH CF CATCHMENT AREA

1 : 20,000

3.4.2 Drainage Canal Plan

Both the Djepara and Tjurup join the Penet before empyting in Sea of Java. If a flood way to the sea is to be constructed from a point near the confluence of the Djepara and the Tjurup, the river section would have a length of about 7.1 km. A number of different routes may be conceived of for the flood way depending on the topographic and soil conditions which, however, cannot be clarified at present because the existing condition of the swamp area does not allow for any reconnaissances. Actual route selection will therefore have to be made at the stage of implementation design.

While the catchment area around the confluence of the two rivers is 356 km^2, the design drainage discharge will be as described below.

The two-day rainfall (48-hour rainfall) at a probability of 1/20 exceedence observed during the 26 years from 1914 to 1939 at the three stations in Sukadana, Labuhan Maringgai and Dejpara is 150 mm (source: Report by Ir. A.S. Benchet). Accordingly, the design drain discharge in terms of a discharge corresponding to continuous rainfall in 2 days - drainage in 2 days will be as expressed by the following equation.

$$\frac{f.R.A.}{T} = \frac{0.4 \times 150 \times 10^{-3} \times 356 \times 10^{6}}{86,400 \times 2} \doteq 124 \ m^3/sec$$

In the above calculation, the runoff ratio for two days at time of peak discharge is assumed to be 0.4, and the drainage in 2 days is considered since flooding for two days in generally allowable in normal paddy cultivation.

It is expected that the peak discharge will be reduced and distributed uniformly by the existence of Bahar swamp area upstream of Lake Djepara and by the regulating function of the reservoir. It is also expected that the discharge will be cut down to some extent because in the wet season, the reservoir will often maintain a water level lower than the high water.

Since the peak flood discharge in the dry season when paddy production will be carried out in the lowland area will be much smaller than in the wet season, it is considered possible to reclaim all the land having an elevation of 2 m or more by river alignment and deviation work. Further, if prime consideration is given to the flood way in the systematic improvement of main and lateral canals in the benefited area, it would result in the creation of good drainage conditions that ensure stabilized and increased paddy production.

3.4.3 Cross Section of Flood Way

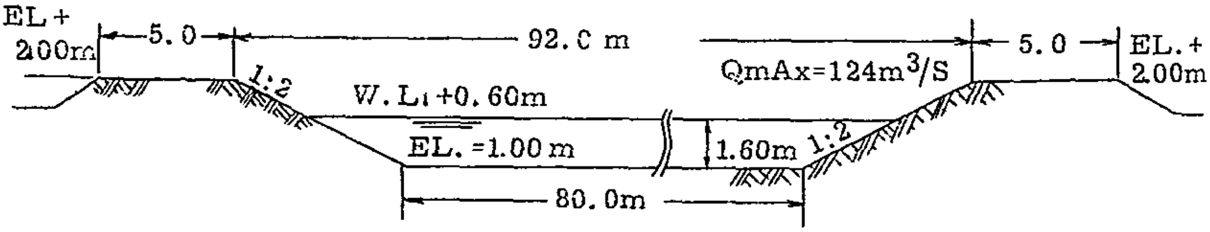
Though the tidal range in and around Labuhan Marignggai is reported to be as shown in Table 13 (source: Ir. A.S. Banchet), not much is known about the tidal range of rivers in the planned drainage improvement area. Since the drainage plan in the lowland area is largely affected by the tidal range assumed, collection of data on tidal range is one of the prerequisite to the implementation design.

Table 13 - Tidal Level in and around Labuhan Maringgai

Item	Tidal Level
Average High Water Level at Conjunction and Opposition	+0.60 m
Average High Water Level at First and Last Quarters	+0.30 m
Average Tidal Level	±0.00 m
Average Low Water Level at First and Last Quarters	-0.30 m
Average Low Water Level at Conjunction and Opposition	-0.60 m

Assuming that the design water level is +0.60 m at the estuary and +20 m at the confluence, the design gradient of water surface will be 1/5070 and the flood way will be required to have a cross section shown in Fig. 6 to dispose with the design drainage discharge of 124 m^3/sec. In this case, the average flow velocity will be 0.93 m/sec and the channel base width will be 80 m.

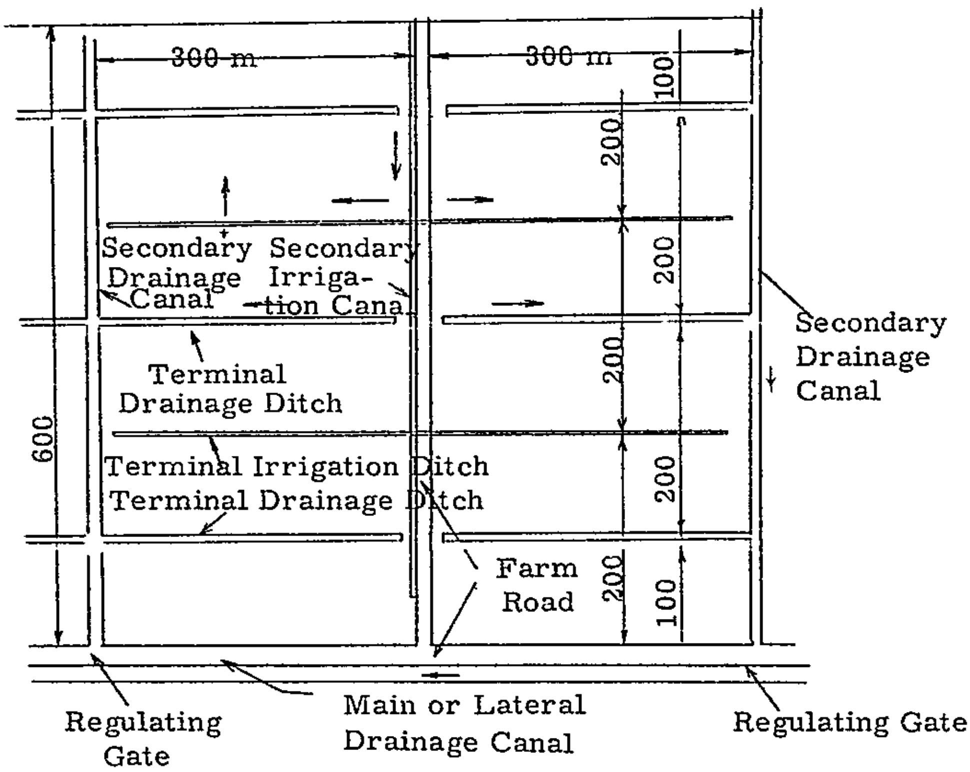
Fig. 6 STANDARD CROSS SECTION OF FLOOD WAY (RIVER MOUTH PORTION) SCALE 1/200



3.4.4 Drainage Facilities Plan

Since the swamp area is naturally expected to have a high groundwater level, it will be necessary to excavate main and lateral drainage canals through the lowland area which will be connected to secondary drainage canals and terminal drainage ditches. All these canals should be so designed that they can also be used as irrigation canals if necessary. To meet this purpose, a flash board or a gate should be installed at the joint of the main/lateral drainage canal and the secondary drainage canals as shown in Fig. 7. The gate is to be closed to store irrigation water in the drainage canals if dry weather continues, and opened if it rains so as to allow the canals to perform the drainage function.

Fig. 7 - Typical Layout of Drainage Facilities in Lowland Area



3.5 Farmland Consolidation Plan

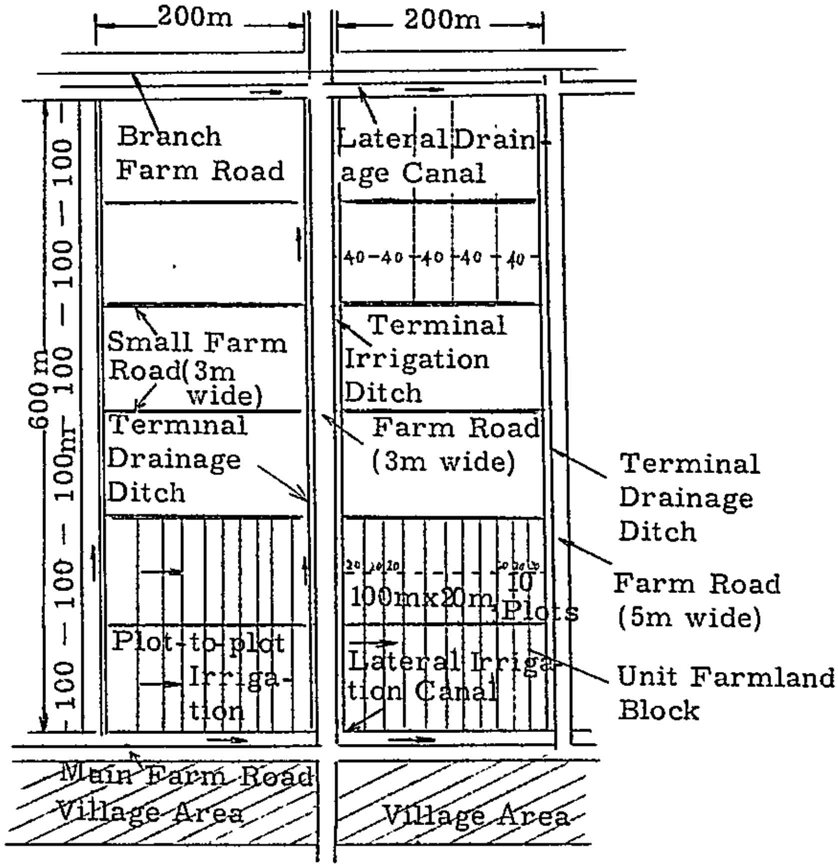
The farmland reclamation should be so planned that large type farming machines and equipments can be readily introduced in future. For this purpose, the newly created farmland should be divided into areas each measuring 200m x 600m and divided into six blocks. Each block will therefore measure 100m x 200m (2 ha), and this will be adopted as the unit area.

Since an average of 2 ha farmland is owned by each farm household, several paddy field plots measuring 100 m x (20 - 40 m) should be created per ha (100 m x 200 m) of wild land. It is advisable that paddy fields be stepped with a level difference of less than 50 cm, and that irrigation be conducted by the plot-to-plot method by each farm household. A plot of paddy field measuring 100 m on its two sides is suited for both the conventional farming method and the introduction of a mechanized cultivation system in future. For actual demarcation of paddy field, a plan on a scale of 1/5,000 should be prepared in the implementation design stage so that a detailed plan will be worked out after route selection of the main canal and main road.

For second cropping in paddy fields, it is planned that maize, soybeans and groundnuts will be cultivated by drying paddy fields in the dry season. Since the second cropping will be carried out in the highland area, it will entail little drainage problem. Irrigation water will be let down through the irrigation canals and distributed to the fields in which ridges are formed.

Fig. 8 - Standard Block Formation for Farmland Improvement

(For Highland Area)



CHAPTER IV CONSTRUCTION PLAN

4.1 Reservoir Construction

4.1.1 Dam

By damming up Lake Dejpara to a height of about 10.5 m, a storage capacity needed for irrigation can be readily obtained. For this purpose, it is planned that a 17 m earth dam will constructed at a point about 1200 m downstream of the lake's outlet.

At the dam site, the Djepara has a width of about 25 m across the river-bed and about 60 m near the crest, and the bed-rock exposes itself when the surface soil is excavated to a depth of about 1 m. The dam material can be obtained from the plateau on the left bank of the dam and also from the right bank side where the soil will be excavated for spillway construction. The topography, geology, material availability and construction convenience at the dam site all point to the suitability of an earth dam. Hence, it is planned that a zoned embankment type front core earth dam illustrated in Fig. 3 will be constructed. The gradient of slope will be 1:2.5 on the upstream face and 1:2.2 on the downstream face. As slope protection works, stone pitching will be carried out on the upstream side and sodding on the downstream side. Table 14 shows basic engineering data of the dam and its appurtenant facilities.

Table 14 - Outline of Djepara Dam

Item		Data
Dam	Type	Front core type earth dam
	Dam Height	17 m
	Crest Height	67 m
	Crest Width	6 m
	Dam Volume	20,000 m^3
	Crest Elevation	EL. 39.0 m
Reservoir	Design Normal High Water Level	EL. 36.5 m
	Design Lowest Water Level	EL. 26.0 m
	Available Draw-down	10.5 m
	Effective Storage Capacity	19,000,000 m^3
	Full Water Area	252 ha
Spillway	Type	Overflow Weir Type Chute Spillway
	Design Highest Water Level	EL. 37.3 m
	Design Flood Discharge	130 m^3/sec.
Intake Facilities	Type	Inclined Conduit
	Design Intake	6.0 m^3/sec

4.1.2 Spillway

An overflow weir type chute spillway will be constructed by excavation work to be carried out at a point having an elevation of about 42 m and approximately 200 m apart from the dam right bank. Water from the segmentally arranged approach channel will overflow the concrete or boulder concrete crest, and flows through the approximately 50 m long regulating section into the chute. The chute will be concrete lined on all its three sides, and designed to discharge water towards the stream line of the Djepara. The horizontal stilling basin will be provided with a baffle pier and an end sill to make the horizontal distance as short as possible. Assuming that the design flood discharge over the spillway is 130 m^3/sec according to the data shown in Kitamura's report (5) and that the overflow depth on the crest is 0.8 m, 90 m suffices as the length of the overflow weir.

4.1.3 Construction Sequence

Construction work should be started with the provision of a construction road to the dam site, which is to be ensued by the excavation of the headrace tunnel.

Since the headrace tunnel will be used as a temporary drainage canal during construction, a temporary cofferdam will have to constructed immediately upstream of the dam site after its completion. Construction of this cofferdam, which will be an earth dam having an elevation of 28 m, can be readily carried out by means of a bulldozer which will be used to move the earth material on either bank to dam up the Djepara.

Completion of the coffering work will be followed by the excavation of surface soil at the dam site for preparation of the foundation, then by the embankment work of the 20,000 m^3 dam. To cover this 20,000 m^3 earth requirement, about 10,000 m^3 of earth excavated for spillway construction and another 10,000 m^3 from the pit site on the left bank will be used. Special attentibn should be given to the 6,000 m^3 material for the front core portion so as to assure that the dam will have a sufficient watertightness. Main machines required for the construction work will be the scraper, dozer shovel and damp truck which will be used for transportation; bulldozer for spraying and spreading; and sheep's foot roller for compacting work. Upon completion of the embankment work, riprup work will be conducted on the upstream face, sodding on the downstream face and ballast spreading on the crest.

In parallel with the dam construction work, construction of the spillway and inclined conduit is to be carried out.

4.2 Intake Facilities

4.2.1 Inclined Conduit

For intake of water, an inclined conduit is most advisable since the slope facing the reservoir has an average gradient of 1:1.2 and the foundation condition is excellent. A steel gate measuring 1 m x 2 m will be installed at a height of 4 m and 8 m from the normal high water level, with a slide gate measuring 1.8 m x 2 m fitted at the bottom (El. 24 m) which will concurrently serve as a sand waste. Operation of all these gates will be controlled in the control room to be constructed on the top of the inclined conduit.

The front part of the conduit should be equipped with a screen to prevent the intrusion of floating leaves, drifting wood pieces and other foreing objects into the intake port.

4.2.2 Headrace Tunnel

The headrace tunnel will have a diameter of 2.0 m and the standard horseshoe section. It will be used as the temporary drainage canal required in the initial construction stage, and will exhibit its water conveyance function upon completion of the dam.

Though its route is favourably conditioned by the prevalance of sandy tuff which is fairly compact, application of steel timberings will be necessary during the construction work. Since the tunnel will be a pressure tunnel both before and after the dam construction, it should be provided with at least 30 cm concrete lining, and high and low pressure grouting should also be conducted.

Further, a horrow jet valve or Howell-Bunger valve with a diameter of about 1,500 mm should be fitted to the outlet port of the tunnel for the purpose of stilling water conducted through the tunnel.

4.3 First Turnout

4.3.1 Turnout Facilities

The first turnout to be constfucted near the outlet port of the headrace tunnel is intended for diverting water into the main canal on either side of the tunnel. The turnout will be of the concrete construction and equipped with a gate which will be linked with the horrow jet valve for automatic control of water supply into the main canal. Operation of these gates will be remote-controlled with account taken of the reservoir water level and intake in the control room built on the top of the inclined conduit.

The first turnout will also be equipped with an outlet and a spillway. The outlet is to be connected to the diversion channel which will have a gradient of 1/1,000 and a height of 1 m and will also be concrete-lined on all its three sides for diversion of the total design intake of 6.0 m^3/sec. The spillway, on the other hand, will be of the overflow type and designed to allow water to overflow into the outlet and the diversion channel which will have a length of 145 m.

4.3.2 Aqueduct Bridge

The right bank main canal crosses the Djepara at a point downstream of the first turnout. As the cross-the-river structure of this nature, an aqueduct is considered most adequate and therefore, a 70 cm diameter steel pipe reinforced on its either side by steel truss will be built across the river with a single span of 75 m.

4.4 Canals

4.4.1 Main Canal

There is no need of effecting any change to the canal route shown in I.T.B. report. The main canals, which are all designed to be earth canal, are expected to have a total length of 50 km, i.e., 29 km for main canals (18 km on the left bank side and 11 km on the right bank side) and 21 km for secondary main canals (20 km on the left bank side and 1 km on the right bank side).

Construction of the right bank canal is considered to entail some difficulty because the greater part of its route passes through the mountainous district having many undulations. Construction of the left bank canal, on the other hand, will be easy because its route is so selected as will pass along the roof of plateau excepting the upstream 5.5 km section which runs through the mountainous district.

Approximate volume of work required for the construction of these canals is as shown in Table 15.

Table 15 - Approximate Volume of Work for Canal Construction

Canal	Excavation	Embankment	Sodding
Main Canal (Left Bank)	139,000 m^3	353,000 m^3	218,000 m^3
Secondary Canal (Left Bank)	76,000	210,000	110,000
Main Canal (Right Bank)	101,000	46,000	77,000
Secondary Canal (Right Bank)	3,000	1,000	2,000
Total	319,000	610,000	407,000

Excavated earth will be used for embankment work, and if any shortage of earth material occurs, excavation will be carried out in the neighbouring hilly area. The surface soil need not be excavated except that plant roots should be pulled out. For transportation of earth material and embankment work, it will be effective to employ power shovels and damp trucks on the right bank, and scrapers, dozer shovels and damp trucks on the left bank. If the embankment in any section is required to have a larger height than in other parts of the route, compacting work should be carried out by means of a sheep's foot roller.

4.4.2 Facilities Appurtenant to Canals

A total of 29 turnouts (16 on the left bank side and 13 on the right bank side) are required for secondary main canals branching off from the main canals, and 16 turnout (13 on the left bank side and 3 on the right bank side) for lateral canals branching off from secondary main canals. Thus, a total of 45 turnouts should be constructed.

Number of drops is not definite because the profile levelling of the canals has not yet been conducted. It is estimated, however, that about 10 will be required on the main canals (6 on the left bank side and 4 on the right bank side) and about 7 on the secondary main canals.

Spillways will have to be constructed at about 7 places if they are to be built immediately upstream of major canal structures as well as on the canal route at intervals of about 10 km. An outlet will also have to be constructed at the end of these canals.

The irrigation canals intersect many roads and drainage waterways (including natural drainage waterways such as small brooks in depressions). It is considered that road bridges crossing the arterial road will have to be constructed at two places and those crossing farm roads at about 50 places. Further, it is estimated that about 7 large aqueducts and about 40 small ones will have to constructed for intersecting drainage ditches. All these appurtenant structures will have the concrete or boulder concrete structure, and the maintenance road to be built along the canals will be used for transport of materials required for their construction. A concrete mixer will be used for mixing concrete materials.

4.5 Drainage Improvement Work

Since the low-lying swamp area is constantly submerged, pump dredgers should be employed to excavate drainage canals in this area. It is estimated that the excavated earth, including that produced from the main drainage canals in the lowland area, will amount to somewhere close to 2,000,000 m^3. If one dredger has an hourly excavating capacity of about 100 m^3, it would be able to excavate 200,000 m^3 of earth per year. This means that five dredgers will be required if the abovementioned exavation work is to be completed in two years. Two of the five dredgers will have to be kept for maintenance service because the canal must be frequently dredged even after the completion of construction work.

Excavated earth will be used for reclaiming the lowland area on either side of drainage canals so as to raise the land elevation as much as possible. A clamshell will have to be used instead of the dredger boom because the performance of pump dredgers is liable to be impaired by old wood pieces and other foreign objects in the ground.

Excavation of lateral drainage canals is to be carried out after completion of the main drainage canal using small type dredgers and draglines or manual labour in time with the farmland reclamation work.

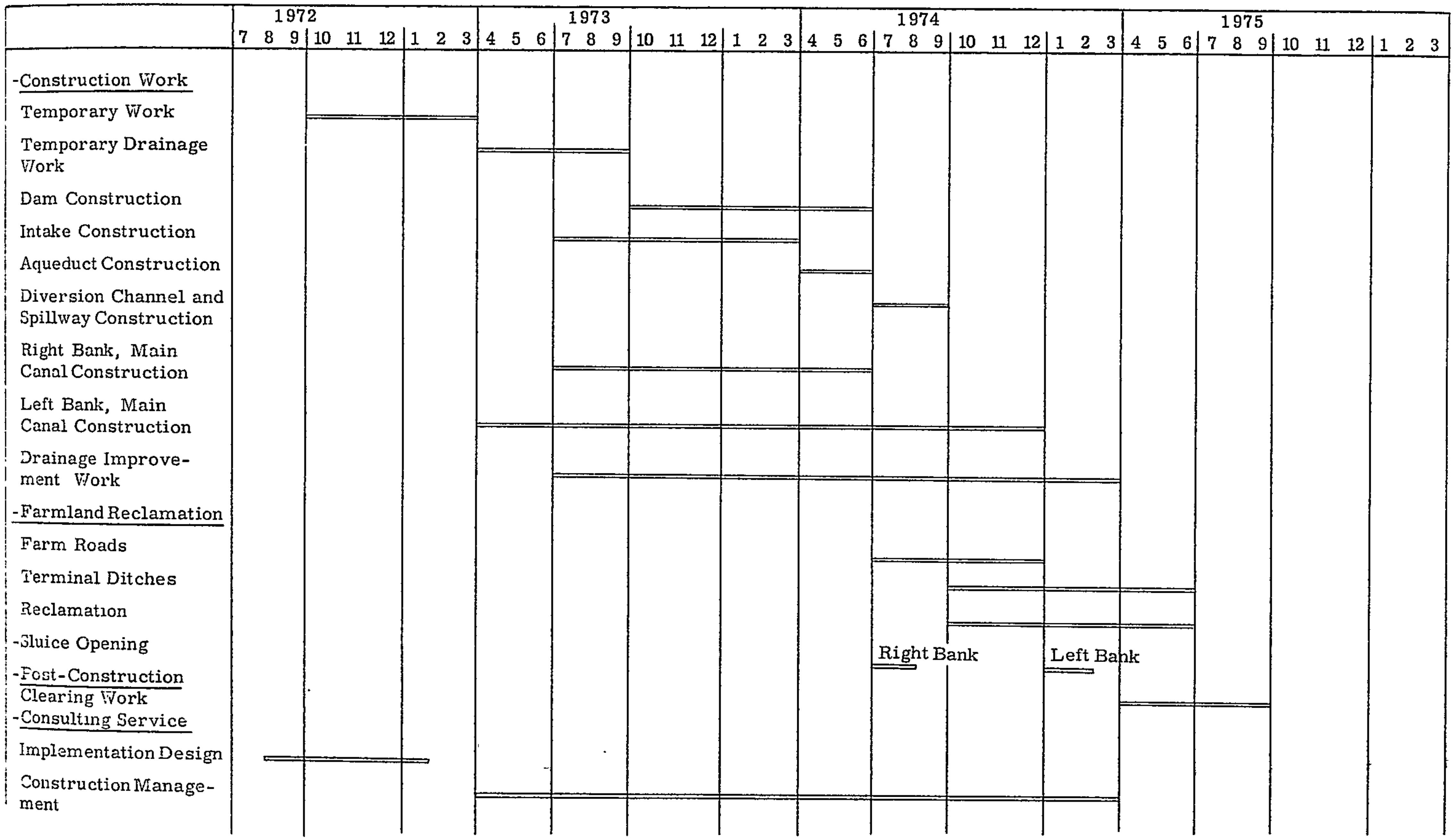
4.6 Farmland Reclamation Work

The farmland reclamation work will be accompanied by the construction of farm roads and terminal drainage ditches which will be carried out by farmers' organizations under the Farmland Consolidation Plan. This means that the construction will resort to manual labour almost entirely. To derive benefit from the project at an early date, therefore, the pace of construction should be accelerated by using bulldozers, dozer shovels and damp trucks which will become available upon completion of the irrigation canal embankment work.

4.7 Construction Schedule

Fig. 9 shows the construction schedule prepared on the assumption that the entire construction work carried out according to the methods described in the foregoing pages can be completed in four years.

Fig. 9 Construction Schedule



CHAPTER V PROJECT COST

The project cost is the sum total of all costs incurred by the project impelementation and is based on the average unit cost of labour and materials in the first half of 1971. Its foreign currency portion is subject to minor change by the dollor rate fluctuation. It is divided into the local currency portion and foreign currency portion, with the latter assumed to be appropriated for procurement of machines and construction administration.

5.1 Construction Cost. (See Table 16)

Table 16 - Construction Cost

Item	Local currency Portion	Foreign Currency Portion
	Rupiah	Yen
Construction Cost		
a) Temporary Works	31,300,000	0
Improvement and New Construction of Road	9,950,000	0
Temporary Structure	17,750,000	0
Survey Cost	3,600,000	0
b) Dam Construction	59,430,000	0
Temporary Coffering	1,320,000	0
Dam Body	11,210,000	0
Excavation and Transport of Earth Material	10,800,000	0
Spillway	36,100,000	0
c) Intake Facilities Construction	55,010,000	35,500,000
Headrace Tunnel	41,610,000	0
Inclined Conduit	11,200,000	0
Gates and Instruments	2,200,000	35,500,000

Item	Local Currency Portion Rupiah	Foreign Currency Portion Yen
Construction Cost (Cont'd)		
d) Aqueducts and Spillway	7,940,000	15,800,000
Aqueducts	2,240,000	15,000,000
Spillway	5,700,000	800,000
e) Right Bank Canal	73,581,000	0
Earth Work	50,900,000	0
Turnouts	19,000,000	0
Secondary Main Canal	3,681,000	0
f) Left Bank Canal	334,842,000	0
Earth Work	184,728,000	0
Turnouts	31,750,000	0
Secondary Main Canal	118,364,000	0
g) Structures Appurtenant to Canal	64,000,000	9,500,000
Drops	5,800,000	0
Spillways	6,800,000	0
Bridges	20,500,000	0
Aqueducts	17,000,000	
Cross Drainage Canal	14,500,000	9,500,000
h) Drainage Improvement Work	195,000,000	0
Excavation Work	180,000,000	0
Ancilliary Work	15,000,000	0
Total	821,703,000	60,800,000
Overhead Cost and Taxes	163,573,000	0
Land Acquisition Cost	20,000,000	0
Cost for Construction Management	100,000,000	139,600,000 *
Contingencies (approx. 10%)	104,724,000	0
Grand Total	1,210,000,000(Rupiah) ÷ 2,915,000(US$)	200,400 (yen) ÷ 650,600 (US$)

Notes : 1) Calculation based on the conversion rate of Rp 415 = US$1.00 = 308 Yen.

2) See Section 5.5 for foreign currency portion of the construction management cost amounting to 139,600,000 yen.

5.2 Cost of Machines and Equipment

Table 17 - Cost of Machines and Equipment

Kind of Machine		Quantity	Cost in Foreign Currency
			Yen
a) Earth-Moving Machine			220,700,000
Power Shovel	0.6 m^3	2 units	
Bulldozer	21 T	2 units	
Scraper	9 m^3	1 unit	
Ripper Dozer	21 T	1 unit	
Pushdozer	21 T	2 units	
Dozer Shovel	1.3 m^3	2 units	
Bulldozer	11 T	2 units	
Back Hoe	0.6 m^3	3 units	
Motorized Grader	W=3.7 m	1 unit	
Damp Truck	5	20 units	
Hand Roller	100 kg	10 units	
Sheep's Foot Roller	3 T	1 unit	
b) Tunnel Excavation Machines			35,000,000
Batcher Plant	21 x 2	1 unit	
Generator	30 KVA	4 units	
Concrete Pump	15 m^3/hr	1 unit	
Compressor	75 kw	2 units	
Boring and Grouting Machines		1 set	
c) Common Machines			30,000,000
Fuel Tanker	5000 ℓ	1 unit	

because of their long durable period. Assuming further that 80% of spare parts will be used for the project, total cost of machines and equipment required will be as calculated below.

285,000,000 x 50% = 142,850,000

140,000,000 x 30% = 52,000,000

42,300,000 x 80% = 33,840,000

		US$
Total	228,690,000 =	743,000 (US$1.00 = 308 Yen)

5.3 Cost of Labour Offered by Farmers

The Ministry of Public Works undertakes the construction work required for the 50 m section between the turnout of secondary main irrigation canal and the fitting part of the tertiary canal. Labour service of local farmers must therefore be resorted to in the construction of almost all terminal facilities such as terminal irrigation ditches, paddy field intake facilities, farmland reclamation, farm roads and terminal drainage canals.

The volume of such terminal construction work for a unit area of 24 ha (12 farmhouseholds) will be as follows.

Irrigation Canals	1,600 m
Drainage Canals	1,600 m
5 m Wide Farm Roads	1,600 m
3 m Wide Farm Roads	2,000 m
Farmland Improvement	24 ha

Though bulldozers, dozer shovels and damp trucks may be used for part of 5 m farm road construction and farmland improvement, a total of Rp150,000 would be required per ha if all the work is to be carried out by farmers' labour service alone. Hence, the total cost for the 5,950 ha area turns out to be US$ 215,000.

5.4 Cost of Construction Design and Construction Management

Implementation of the project must be preceded by the collection of all the lacking data, surveys, and checks on fundamental data and figures, which are all required for the preparation of the final operation plan.

Particularly important among these pre-implementation activities are the definite delineation of the irrigation area, survey on the paddy field water requirement in depth, hydrological survey of Lake Djepara and selection of a new river course for drainage improvement. It is equally very important to study and devise a farmland improvement system that can readily introduce the future mechanized agriculture and to select suitable upland cash crops and design an upland field irrigation method suited for such cash crops.

The construction design should therefore be entrusted to a qualified consultants company capable of carrying out all these surveys and controlling the construction work as well. The following services should be offered by such consultants company.

(1) Design of dam and reservoir and aforementioned surveys, design of intake facilities, route selection and design of main and secondary irrigation canals, design of drainage canals in the drainage improvement area, provision of technical guidance to Indonesian engineers respecting all these surveys and designs,

and management and supervision of construction work;

(2) Establishment of a farm management plan and a cropping plan which will provide guiding principles for farmers' future farm management; and

(3) Establishment of the irrigation facilities management and maintenance system and the water charge collection plan before completion of construction.

Table 18 shows the formation of consultants and the duration of their stay in Indonesia. Fees for consulting service as calculated from this table will be as follows.

Total man-months will be 98 man-months (= 35 man-months + 63 man-months) and the average fees per man-month will US$4, 200.

98 man-months x US$4, 200 =	US$411, 600
Contingencies (approx. 10%)	41, 400
Total	US$453, 000

Table 18 - Formation of Consultants and Period of Their Stay

Assignment	Duaration of Stay
a) Design and Survey Activities	
Leader, Agricultural Engineer	6 months
Engineer (Design of Demand Canals)	6 months
Engineer (Design of Drainage and Reclamation)	3 months

Assignment	Duaration of Stay
a) Design and Survey Activities(Cont'd)	
Hydrologist	3 months
Geologist	3 months
Agronomist (Lowland Paddy and Upland Crop)	2 months
Agricultural Economist	3 months
Engineer (Construction Machines)	3 months
Coordinator	6 months
Total	35 man-months
b) Construction Management	
Leader, Agri-Engineer	24 months
Administrator (Design and Construction)	18 months
Engineer (Construction Machines)	18 months
Agricultural Economist	3 months
Total	63 man-months
Grand Total	98 man-months

5.5 Total Project Cost

Total project cost obtained by summing up the costs estimates described in the preceding sections of this chapter will be as follows.

Construction Cost	Local currency portion	US$2,915,000
	Foreign currency portion	651,000

Depreciation Expense of Machines and Equipment in Foreign Currency	US$	743,000
Cost of Labour Service Offered by Local Farmers		215,000
Total		4,524,000

In the total project cost of US$4,524,000, US$2,915,000 will have to be covered by local funds and US$2,171,000 (1,520,000 + 651,000) by foreign loans.

CHAPTER VI ECONOMIC EVALUATION

6.1 Study on Total Project Cost

6.1.1 Project Cost

As detailed in the preceding chapter, the project cost amounts to a total of US$4,524,000.

Construction Cost	Local currency portion	US$2,915,000
	Foreign currency portion	651,000
Cost of Machines and Equipment (cost to be depreciated by the project only)	Foreign currency	743,000
Cost of Labour Offered by Local Farmers	Local currency	215,000
Total		US$4,524,000

This total cost includes the cost of design and construction management as well as about 10% contingencies. It also includes the interest during construction payable on US$2,171,000 in foreign currency which will be appropriated to the initial stage procurement of machines, equipment, and construction materials and other necessary loans.

6.1.2 Cost of Maintenance and Management

The cost of yearly maintenance and management service and partial replacement of machines and equipment will naturally vary in the rate to initial capital input depending on the type of respective facilities.

For the sake of simplicity, however, 5% of the total project cost will be appropriated for maintenance and management as a necessary yearly expenditure after completion of construction work.

Expenses for introduction and extension of advanced techniques cannot be dispensed with for production increase, and the capital input in extension service is to be considered to promote the income increase derivable from the project. For this project, however, this factor is excluded from economic evaluation.

6.2 Benefit of Project

As described in Chapter 3, Djepara Irrigation Project is expected to produce a direct and far-reaching benefit in the project area, but it is to be noted that this benefit cannot be fully enjoyed until the fifth and subsequent years of the project. It is possible, however, to expect half the said benefit will be brought about in the fourth year because more than half of the planned farmland area will be created in the third year of construction as can be seen in the construction schedule (See Fig. 9).

Judging from the magnitude of its direct benefit, the project is expected to yield a substantial spill out effect such as increased employmant opportunities ensued from the expansion of rice milling facilities and commodity flow as well as increased effective demand for consumer goods in the project area arising from increased income and employment opportunities. Therefore, the project not only serves to elevate the level of agricultural production and farmers' income, but could also encourage the economic development of the area.

6.3 Economic Evaluation of Project

6.3.1 Project Period

To judge the economic justifiability of the project, comparison must be made between the aforementioned direct effect and the capital input required. In this report, comparison is made between the amount of direct capital investment and the direct effect derivable therefrom. If the construction period is assumed to be four years and the facilities constructed by the project have a durable period of 50 years, the yearly amount of capital to be invested according to the construction schedule and the direct effect attainable over the 50 year project period should both be measured against the yardstick of their present value.

6.3.2 Benefit-Cost Ratio

The discount rate to be adopted for calculation of the present value of the investment cost and benefit is set at 10% in view of the conditions for yen credit and the interest on loans to be advanced for development, though this method may be considered rather arbitarary. The following equation is to be applied to obtain the discount rate.

$A = V/u$

where, A : Benefit-cost ratio

V : Present value of aggregate benefit

$V = \Sigma Q_t/(1 + i)^t$ Q_t : Benefit in the t-th year (t = 1, 2, 3 ....n) u : Present value of total capital input

$u = \Sigma\, C_t/(1+i)^t$ C_t : Investment in the t-th year (t = 1, 2, 3 .... n)

Benefit-Cost Ratio

Unit: US$1,000

Year	Investment Cost: Invested Amount	Investment Cost: Maintenance & Management Cost	Investment Cost: Total	Net Benefit	Calculation Coefficient (Discount rate: 10%)	Present Value: Invested Amount	Present Value: Net Benefit
1st	145	-	145	-	0.909	132	-
2nd	2,289	-	2,289	-	0.826	1,891	-
3rd	1,954	-	1,954	-	0.751	1,467	-
4th	136	-	136	525	0.683	93	359
5th	-	226	226	1,050			
6th	-	226	226	1,050	6.745	1,524	7,082
.							
.							
.							
50th	-	226	226	1,050			
Total	4,524	10,396	14,920	48,825		5,107	7,441

The benefit-cost ratio obtained by the above calculation is 1.46.

6.3.3 Internal Rate of Return

The internal rate of return is a discount rate by which both the present value of investment cost and that of net benefit during the durable years of the project can be brought to an equivalence. Hence, it served to judge how a project can be brought to a success as an enterprise with funds provided from a specific source at a specific interest rate.

Assuming that the total capital input and aggregate benefit are as described in the preceding section, the internal rate of return (i) can be obtained by the application of the following equation.

$$I = \Sigma C_t (1 + i)^{-t} = \Sigma Q_t (1 + i)^{-t} = R$$

If i = 14%,

I = 4.240 R = 4.741 R/I = 1.118

If, again, i = 16%,

I = 3.933 R = 3.914 R/I = 0.995

Therefore, to make R/I = 1, the internal rate return is 15.6%.

ANNEX

Annex Table 1 - Monthly Rainfall in Metro

No. of Rain-Gauge Station : 228C
Elevation : +57m
Unit : mm

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1950	227	229	173	98	139	231	202	140	167	239	432	221	2,498
51	379	239	161	34	86	111	115	122	78	104	71	185	1,685
52	408	274	350	176	157	120	65	154	161	131	395	448	2,839
53	282	308	198	106	282	56	105	21	28	19	202	47	1,654
54	139	243	267	364	304	161	-	66	61	152	-	-	-
55	507	287	213	182	70	114	216	47	96	50	208	371	2,361
56	314	266	294	78	51	112	100	255	232	105	211	252	2,270
57	379	163	365	169	70	85	142	63	35	56	196	89	1,812
58	430	255	204	114	53	33	142	62	70	89	248	303	2,003
59	347	348	382	51	192	106	117	4	43	73	156	185	2,004
60	558	254	210	83	127	108	86	246	130	76	126	324	2,328
61	381	295	102	302	200	132	13	0	0	0	65	130	1,620
62	301	125	316	189	59	127	76	49	141	140	188	293	2,004
63	389	342	235	132	132	33	0	7	0	20	122	196	1,608
64	300	181	492	325	62	92	67	77	83	361	235	237	2,512
65	356	164	235	109	36	8	35	3	7	4	185	247	1,389
66	319	79	139	199	12	26	32	.1	28	39	149	131	1,154
67	261	233	139	132	41	0	38	0	0	17	-	-	-
Average	349	238	243	167	115	95	91	73	76	98	199	229	1,973

Annex Table 2 - Number of Monthly Rainy Days in Metro

No. of Rain-Gauge Station: 228C
Elevation : +57 m
Unit : days

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1950	17	16	12	7	7	10	9	9	6	9	10	16	134
51	15	13	12	2	6	5	5	5	6	6	11	11	100
52	17	19	17	12	10	4	12	11	12	10	18	18	160
53	20	14	17	10	17	7	5	2	6	3	6	6	113
54	15	13	13	14	12	14	-	7	7	11	-	-	-
55	18	15	13	15	4	5	9	7	8	7	18	18	137
56	17	18	15	7	4	7	5	7	-	9	12	12	-
57	14	7	18	10	9	4	11	8	-	6	7	7	-
58	11	14	16	9	8	3	5	10	4	6	18	18	122
59	14	14	13	6	12	9	6	1	4	7	19	18	123
60	-	19	12	9	10	6	5	10	9	4	9	19	-
61	14	13	11	18	16	8	2	0	0	0	11	9	102
62	18	12	16	11	9	-	8	-	3	11	16	16	-
63	18	14	18	17	15	5	0	1	0	4	14	16	122
64	19	15	19	16	9	8	8	4	11	14	19	14	156
65	18	9	18	7	9	4	1	2	2	4	9	19	102
66	20	9	14	15	4	7	4	1	4	6	10	9	103
67	17	11	12	11	6	0	1	0	0	1	-	-	-
Average	16.6	13.6	14.8	10.9	9.3	6.2	5.6	5.0	5.1	6.9	13.3	14.3	121.6

Annex Table 3 - Average Monthly Discharge of Rivers in Lampung

Unit : m^3/sec

Name of River	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Way Sekampung (Argoguruh) CA=2,155km^2	1937				151.5	107.0	108.0	52.3	41.5	37.5	55.2	36.8	69.8	-
	38	131.0	106.0	90.6	76.8	50.8	62.6	33.4	27.5	20.8	15.6	26.9	47.4	57.4
	39	111.0	98.1	80.8	70.1	43.7	28.1	35.2	30.3	25.4	28.2	26.1	86.6	55.2
	40	125.0	(76.9)	82.8	124.0	56.0	50.2	38.7	24.5	17.4	14.3	7.5	50.0	55.6
	Average	122.3	93.7	84.7	105.6	64.4	62.2	39.9	31.0	25.3	28.3	24.3	63.5	56.1
	1966							20.0	15.2	18.2	20.8	28.8	40.7	-
	67	-	111.9	66.1	76.6	73.2	27.8	20.8	13.3	10.7	9.1	-	-	-
	68	131.5	62.4	80.8	-	-	41.6	52.9	65.7	-	75.6	104.0	133.7	--
	69	128.5	139.9	133.9	153.5	93.6	85.9	72.3	25.3	56.9	29.2	48.2	72.3	86.6
	70	138.1	248.2	200.7	158.8	122.6	80.3	(40.8)	(38.0)	39.5	35.9	27.0	84.2	101.2
	71	194.5	85.0	95.1	110.0	55.6	51.6	29.0	21.5					
	Average	148.2	129.5	115.3	124.7	86.3	57.4	39.3	29.8	31.3	34.1	52.0	82.7	93.9
Way Pengubuan (Trimodadi) CA=180km^2	1937										2.9	1.4	7.5	-
	38	16.5	16.3	10.3	10.9	8.8	8.8	2.8	2.3	1.3	0.9	2.6	6.8	7.4
	39	21.6	16.8	10.8	11.9	9.3	7.2	6.8	4.9	2.5	3.0	3.8	9.4	9.0
	40	16.1	16.6	15.6	14.6	9.1	8.4	10.8	3.4	2.0	1.5	2.0	6.8	8.8
	Average	18.1	16.6	12.2	12.5	9.1	8.1	6.8	3.5	1.9	2.1	2.5	7.6	8.4

Table 3 (Cont'd)

Unit : m^3/sec

Name of River	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Way Suputih $CA=500km^2$	1937									10.3	10.2	5.2	20.7	-
	38	45.1	37.8	27.1	25.6	17.6	17.8	8.2	4.9	3.4	2.2	5.2	15.1	17.5
	39	40.5	38.2	29.2	22.4	16.6	12.9	11.3	9.0	5.4	6.3	7.1	16.5	17.9
	40	28.2	27.4	24.0	27.4	25.5	16.8	19.8	7.2	3.3	2.2	3.7	14.6	16.7
	Average	37.9	34.5	26.8	25.1	19.9	15.8	13.1	7.0	5.6	5.2	5.3	16.7	17.4
Way Batanghari $CA=110km^2$	1939	9.7	6.1	5.6	8.0	4.2	3.2	4.6	0.7	0.4	0.5	1.5	8.0	4.4
	40	14.0	9.9	11.0	10.9	2.7	5.2	2.0	0.6	0.4	0.3	2.4	15.0	6.2
	Average	11.9	8.0	8.3	9.5	3.5	4.2	3.3	0.7	0.4	0.4	2.0	11.5	5.3
Way Raman $CA=45\ km^2$	1939	6.7	3.6	1.4	3.2	1.6	0.2	1.3	0.4	0.1	0.4	3.3	10.2	2.7
	40	17.3	6.2	7.6	6.2	0.8	0.6	0.3	0.1	0.1	0.2	5.6	14.9	5.0
	Average	12.0	4.9	4.5	4.7	1.2	0.4	0.8	0.3	0.1	0.3	4.5	12.6	3.9
Way Djepara $CA=130km^2$	1938							2.6	2.0	1.5	1.4	2.1	3.4	-
	39	4.9	6.3	7.4	3.7	2.9	2.9	3.2	2.5	1.5	1.4	1.4	5.4	3.7
	40	(7.5)	5.7	5.5	7.4	6.3	5.4	(3.1)	2.6	(1.6)	1.1	(1.0)	2.0	4.1
	Average	6.2	6.0	6.5	5.6	4.6	4.2	3.0	2.4	1.5	1.3	1.5	3.6	3.9

Annex Table 4 - Average Monthly Discharge of the Sekampung

Observation Point : Waduk Kementara
Catchment Area : 2,150 km^2
Unit : m^3/sec

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1917	286	333	147	140	105	68	99	129	83	56	77	164	141
18	189	229	230	112	143	88	63	74	36	33	55	155	117
19	264	346	151	143	118	100	64	56	43	41	78	116	127
20	262	190	211	141	106	76	21	120	105	42	66	71	118
21	159	215	232	113	78	59	117	51	57	43	69	185	115
22	149	191	172	165	76	121	95	58	42	73	94	114	113
23	128	211	146	135	76	141	104	46	23	30	83	172	108
24	248	205	144	187	125	93	39	32	47	78	56	150	117
25	164	226	100	59	88	18	32	58	29	35	47	115	81
26	228	212	332	163	105	74	52	56	56	55	87	162	132
27	129	128	165	147	153	46	48	80	60	73	98	209	111
28	307	237	212	200	107	153	93	166	41	38	80	162	150
29	181	274	304	201	103	63	39	29	25	21	35	109	115
30	163	222	316	417	206	91	66	43	43	70	82	65	154
31	99	284	270	175	42	49	74	59	91	85	63	172	122
32	238	134	171	163	114	106	81	45	46	64	103	107	114
33	150	230	146	145	126	79	69	54	71	59	103	193	119

Annex Table 4 (Cont'd)

Month / Year	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1934	164	145	141	108	79	46	37	31	24	25	89	46	78
35	80	234	193	222	93	102	18	21	22	42	52	83	97
36	188	372	162	125	138	76	32	48	50	65	91	140	124
37	236	328	217	299	214	216	105	83	75	109	74	138	175
38	259	212	182	154	102	125	67	55	42	31	54	94	115
39	222	196	162	143	88	56	71	61	51	56	52	169	111
40	308	189	182	249	112	101	78	49	35	29	30	133	124
41	192	173	209	221	155	105	38	48	33	44	72	105	116
Average	200	229	196	173	116	90	64	62	49	52	72	133	119

Annex Table 5 - Observation Data of Water Requirement (Evapo-transpiration) for Paddy Cultivation inCambodia and Malaysia

Cambodia (Dry Season of 1966) [1]			Malaysia (Off season of 1968) [2]				
Observation Period	Days(prior to heading)	Evapo-tran-spiration	Observation Period	Days (prior to 50% Flowering)	Evapo-ration	Tran-spiration	Evapo-tran-spiration
	ET	mm/day			mm/day	mm/day	mm/day
Dec 25 - 31	56 - 51	5.1	May 14-23 *	82 - 73	4.9	1.0	5.9
Jan 1 - 5	50 - 46	4.4	24 - Jun. 2	72 - 63	4.3	1.2	5.5
6 - 10	45 - 41	4.4	3 - 12	62 - 53	3.4	2.8	6.2
11 - 15	40 - 36	4.2	13 - 22	52 - 43	4.4	3.0	7.4
16 - 20	35 - 31	5.2	23 - Jul. 2	42 - 33	3.0	3.6	6.6
21 - 25	30 - 26	7.4	3 - 12	32 - 23	2.6	3.2	5.8
26 - 31	25 - 20	8.0	13 - 22	22 - 13	3.1	3.2	6.3
Feb 1 - 5	19 - 15	6.0	23 - Aug. 1	12 - 3	2.7	4.1	6.8
6 - 10	14 - 10	6.6	2 - 11	3 - -7	2.4	4.4	6.8
11 - 15	9 - 5	7.6	12 - 21	-8 - -17	2.6	5.4	8.1
16 - 20	4 - 0	7.0	23 - 31	-18 - -27	2.1	3.8	5.9
21 - 25	-1 - -5	6.2	Sep. 1 - 6 **	-28 - -33	9	1.5	2.4
26 - 28	-6 - -8	7.0					
Mar 1 - 5	-9 - -13	5.8					
6 - 10	-14 - -18	6.4					
11 - 15	-19 - -23	9.4					
16 - 20	-24 - -28	8.2					

Annex Table 5 (Cont'd)

Cambodia(Dry Season of 1966) [1]			Malaysia (Off season of 1968) [2]				
Observation Period	Days(prior to Heading	Evapo-tran-spiration	Observation Period	Days (prior to 50% Flowering)	Evapo-ration	Tran-spiration	Evapo-tran-spiration
	ET	mm/day			mm/day	mm/day	mm/day
Mar 21 - 25	-29 - -33	9.8					
26 - 31	-34 - -39	7.7					
Apr 1 - 5	-40 - -44	6.6					
Average		6.7			3.1	3.2	6.3

Notes : 1) 1 and 2 Observation conducted by Sadao Hatta in Cambodia and Haruo Sugimoto in Malaysia.

2) * indicates that May 14th was the 23rd day after sowing and ** indicates that September 16 was the 138th day after sowing (115th day after transplanting).

Annex Table 6-(1) - Storage Capacity for January-May Irrigation of Paddy Fields in Low-lying Swamp Area

Month	Net Water Requirement	Effective Rainfall	Water Requirement of Paddy Field	Gross Water Requirement in Reservoir ①	Inflow into Reservoir ②	Balance ②-①	Cumulative Total
1	17,674	8,383	9,291	11,614	15,372	+3,758	-10,049
2	17,322	7,735	9,587	11,984	12,348	+ 364	-9,685
3	13,467	5,971	7,491	9,370	12,098	+2,728	-6,957
4	5,862	2,513	3,348	4,186	11,592	+7,406	+449
5	6,453	3,552	2,901	3,626	9,324	+5,698	+6,146
6	5,397	2,390	3,007	3,759	4,064	+4,305	+10,451
7	5,397	1,491	3,906	4,883	5,040	+ 157	+11,085
8	5,250	1,000	3,650	4,563	5,040	+ 477	+11,608
9	5,250	1,400	3,850	4,813	3,150	-1,663	-1,663
10	5,250	1,750	3,500	4,375	2,142	-2,233	-3,896
11	8,995	2,364	6,631	8,289	3,276	-5,013	-8,909
12	16,460	6,292	10,168	12,710	7,812	-4,898	-13,807
Total	112,777	44,841	67,336	84,172	95,258	-	-

Note : Storage Capacity - 13,807,000 1.05 ÷ 14,500,000 m^3

Annex Table 6-(2) - Storage Capacity for March-July Irrigation of Paddy Fields in Low-lying Swamp Area

Unit : 1,000 m^3

Month	Net Water Requirement	Effective Rainfall	Water Requirement of Paddy Field	Cross Water requirement in Reservoir	Inflow into Reservoir	Balance 2 - 1	Cumulative Total
1	15,210	7,098	8,112	10,140	15,372	+5,232	-8,575
2	15,210	6,591	8,619	10,774	12,348	+1,574	-7,001
3	13,819	5,971	7,848	9,810	12,098	+2,288	-4,713
4	5,862	2,513	3,349	4,186	11,592	+7,406	+2,693
5	7,509	4,071	3,438	4,298	9,324	+5,026	+7,719
6	7,509	3,208	4,301	5,376	8,064	+2,688	+10,407
7	6,453	1,746	4,707	5,884	5,040	-844	+9,564
8	5,250	1,600	3,050	4,563	5,040	+477	+10,040
9	5,250	1,400	3,850	4,813	3,150	-1,663	-1,663
10	5,250	1,750	3,500	4,375	2,142	-2,233	-3,896
11	8,995	2,364	6,631	8,289	7,276	-5,013	-8,909
12	16,460	6,292	10,168	12,710	7,812	-4,898	-13,807
Total	112,777	44,604	68,173	85,218	95,258	-	-

Note : Storage Capacity - 13,807,000 x 1.05 ≑ 14,500,000 m^3

Annex Table 7-(1) Reservoir Scale for 10 Year Recurrence Probability of Droughty Year

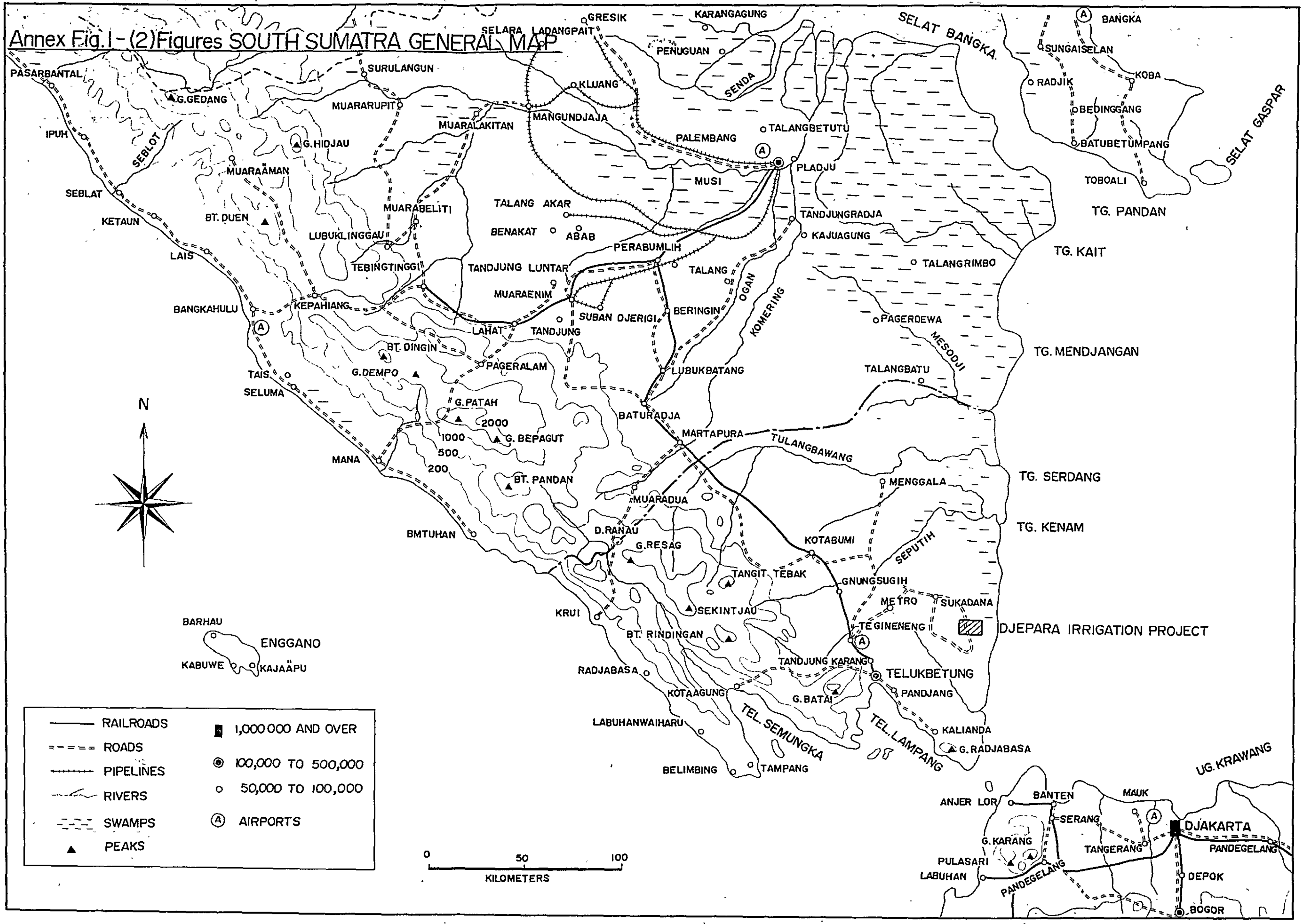
Month	Design Rainfall	Ratio of Effective Rainfall	Effective Rainfall	Irrigation Area with Paddy Cropping III considered	Total Effective Rainfall in Irrigation Area	Irrigation Area with Paddy Cropping III not considered	Total Effective Rainfall in Irrigation Area	Runoff Coefficient	Inflow into Seservoir	Average Inflow in Reservoir
	mm	%	mm	ha	x1000 m^3	ha	x1000 m^3	%	x 1000 m^3	m^3/sec
1	203	60	122	5,070	6,185	5,070	6,185	50	12,810	4.79
2	181	70	127	5,070	6,439	5,070	6,439	40	10,290	4.23
3	178	70	125	3,785 (5,070)	4,731	3,785 (5,070)	4,731	45	10,082	3.75
4	140	80	112	1,250 (2,500)	1,400	1,250 (2,500)	1,400	55	9,660	3.76
5	123	80	98	3,450	3,381	2,570	2,519	50	7,770	2.87
6	96	80	77	3,450	2,657	2,570	1,979	55	6,720	2.61
7	60	80	48	3,450	1,656	2,570	1,233	55	4,200	1.56
8	66	80	53	3,380	1,791	2,500	1,325	50	4,200	1.56
9	58	80	46	2,940 (3,380)	1,351	2,500	1,150	35	2,625	0.99
10	73	80	58	2,500	1,450	2,500	1,450	20	1,785	0.68
11	110	80	88	2,570	2,262	2,570	2,262	20	2,730	1.07
12	172	70	120	5,070	6,084	5,070	6,084	30	6,510	2.45
Total	1,460	74	1,074	-	39,387	-	36,757	43	79,382	2.50

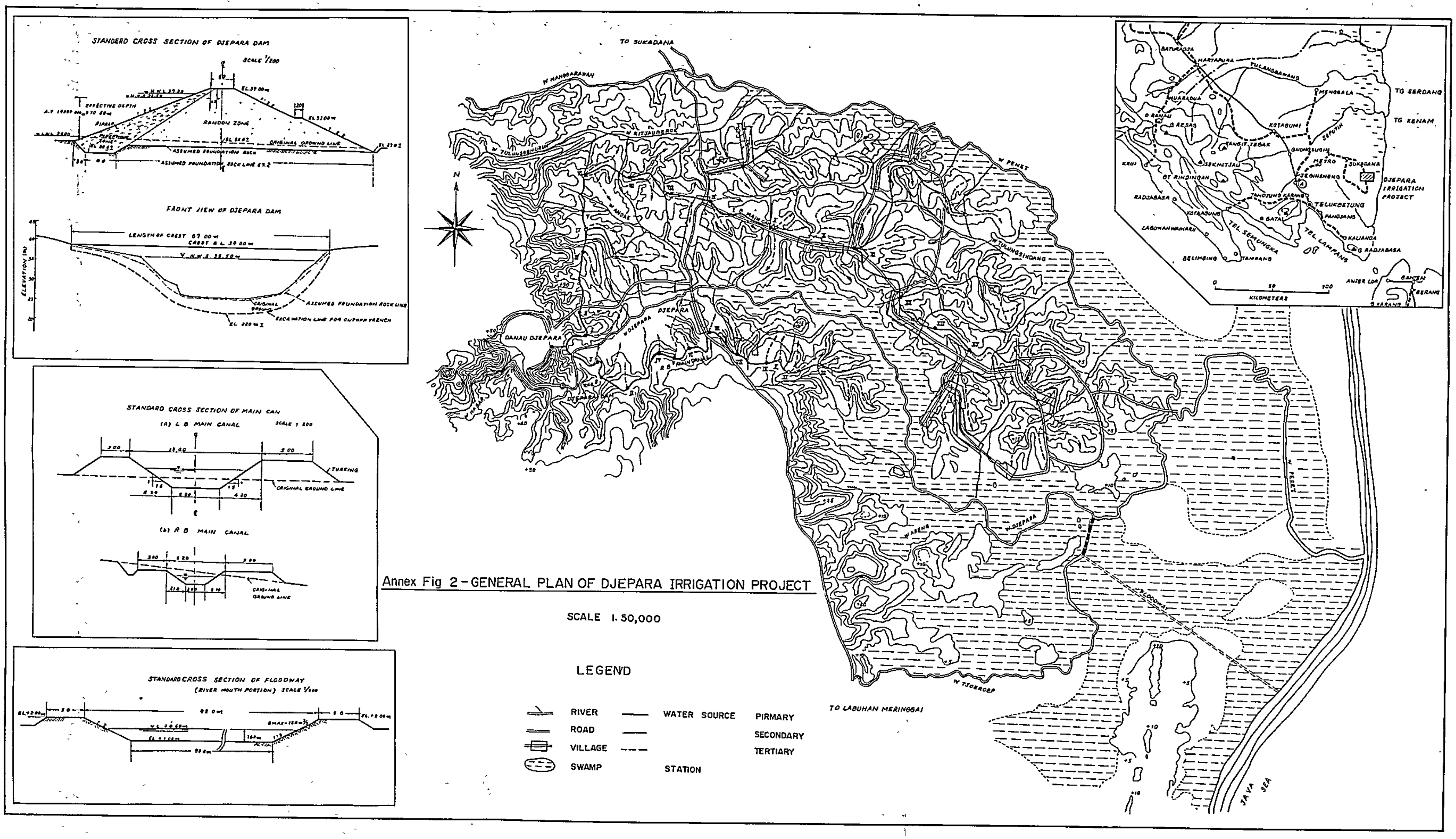
From Table 6 shown in Section 3.4.1, it can be concluded that Specific discharge for 10 year recurrence probability of droughty year
= Specific discharge for 5 year recurrence probability of droughty year x 0.59/0.69
= 3.0 m^3/sec x 0.85 ≑ 2.5 m^3/sec

Therefore,

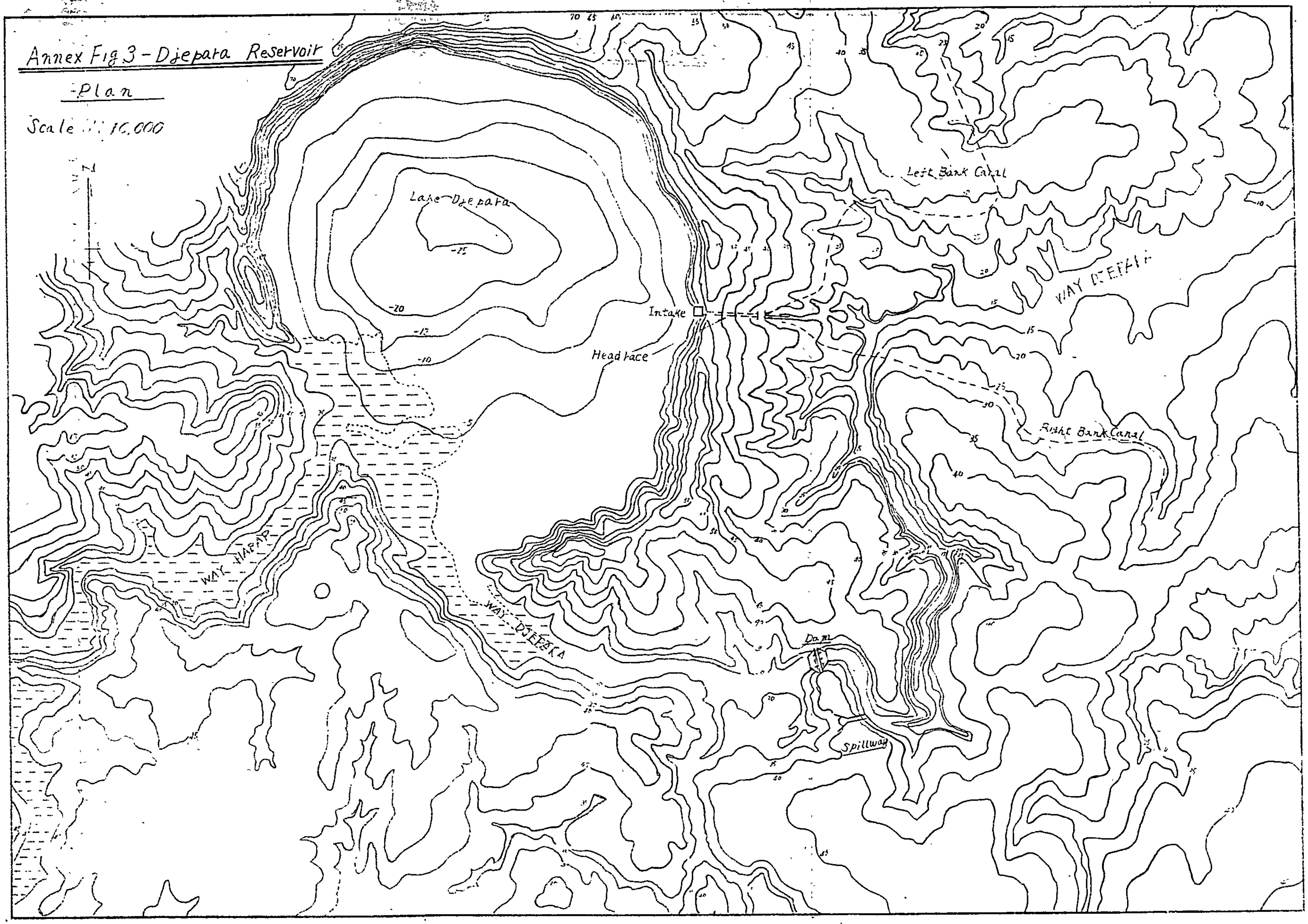
Annual rainfall for 10 year recurrence probability of droughty year = 1,750 mm x 2.5/3.0 = 1,460 mm

Annex Fig.1 - (2) Figures SOUTH SUMATRA GENERAL MAP

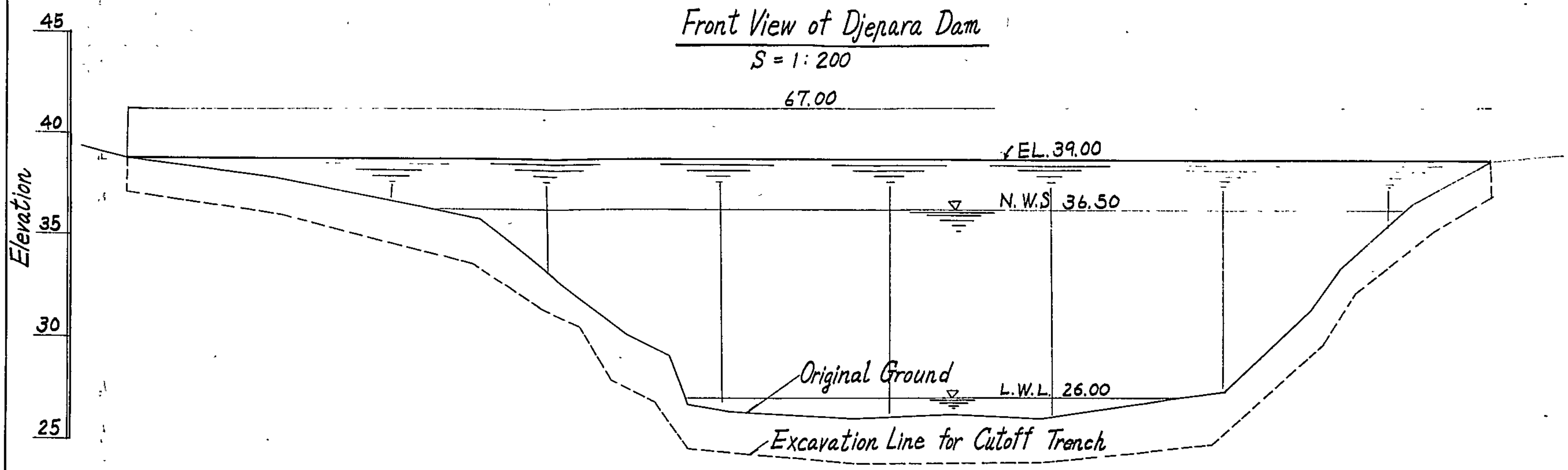


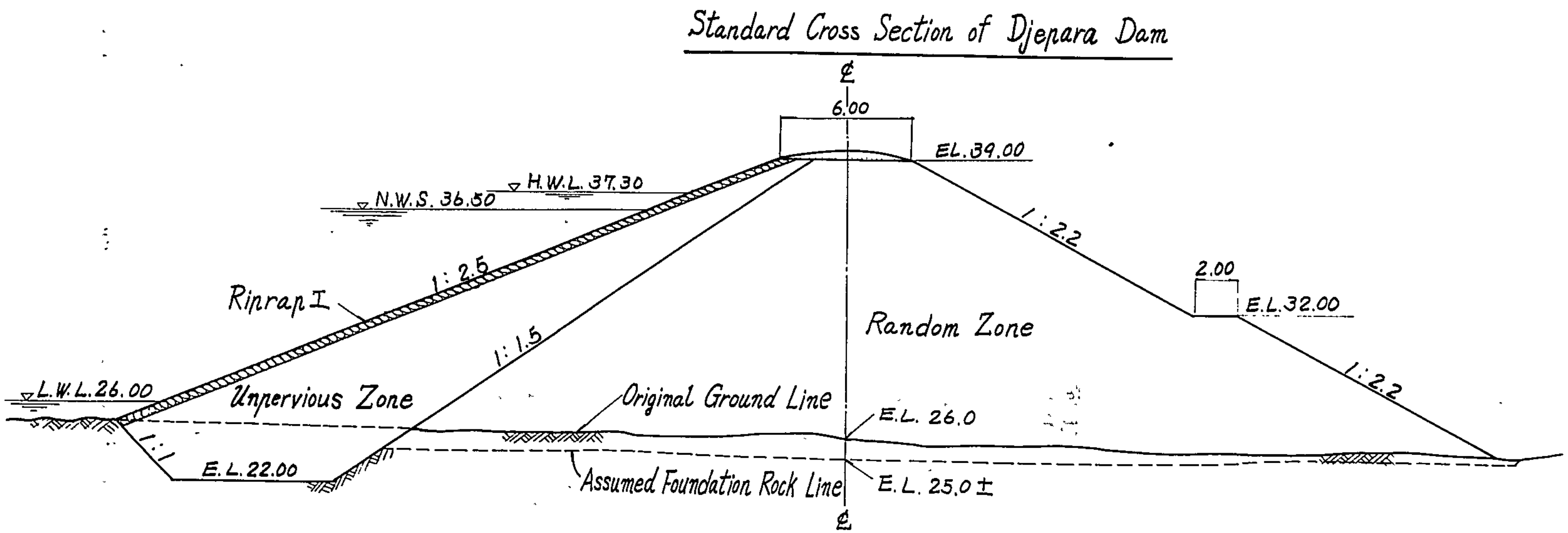


Annex Fig 2 - GENERAL PLAN OF DJEPARA IRRIGATION PROJECT

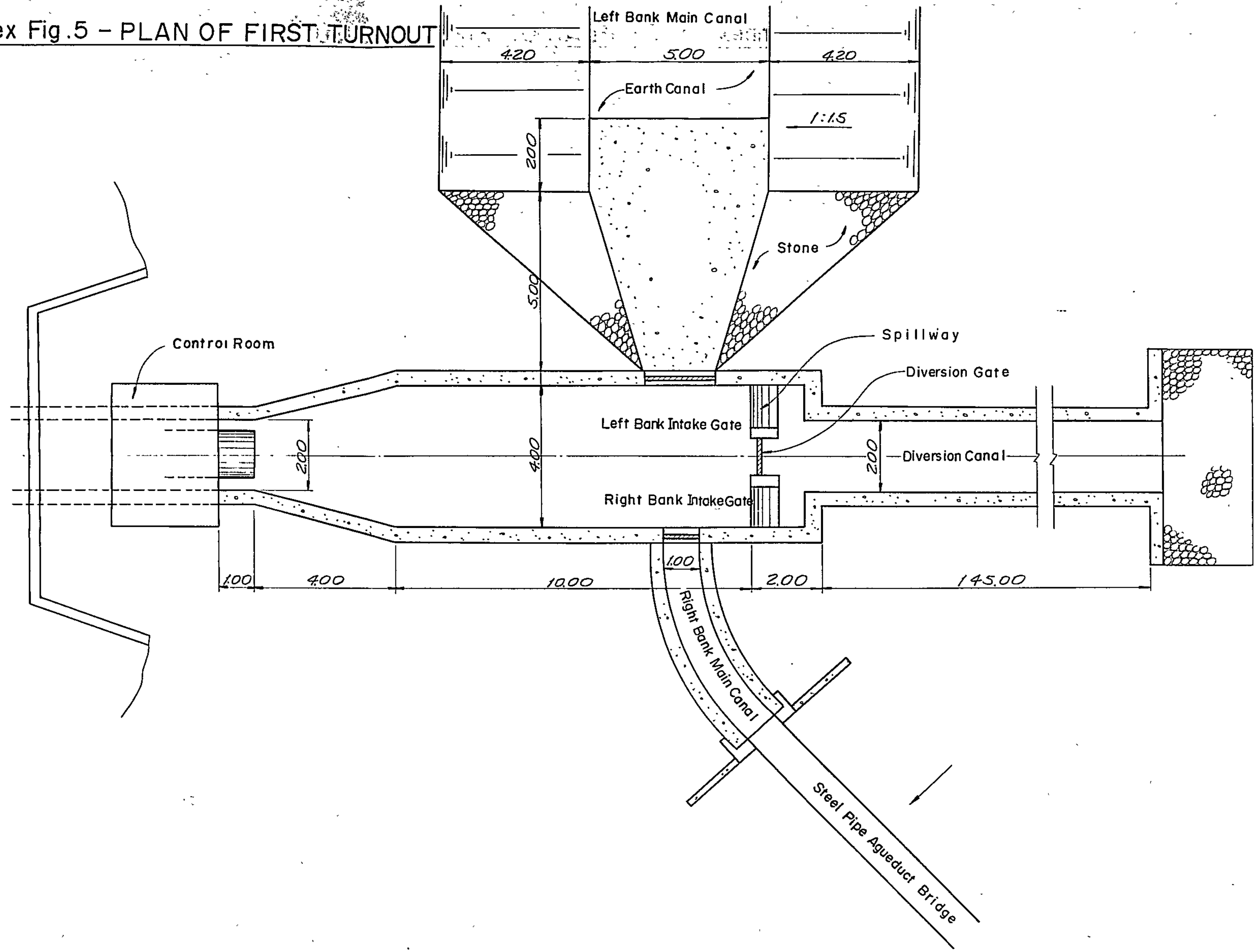

Annex Fig 3 - Djepara Reservoir
-Plan
Scale 1:10,000
N
Lake Djepara
Intake
Head race
Left Bank Canal
Right Bank Canal
WAY DJEPARA
WAY HABAR
Dam
Spillway

Annex Fig.4 – Cross Section of Djepara Dam

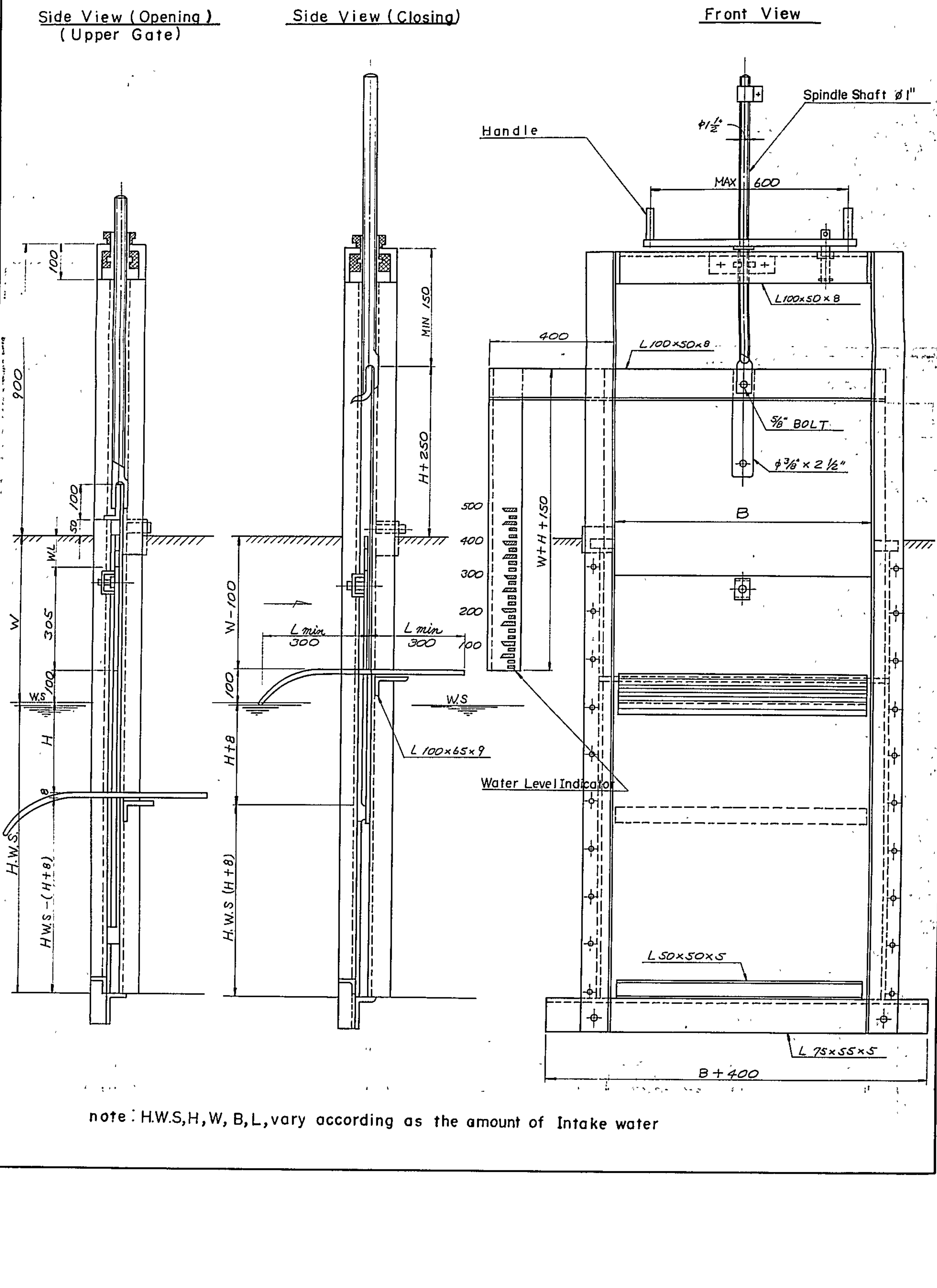




Annex Fig.5 – PLAN OF FIRST TURNOUT



Annex Fig.6 - DETAILED PLAN OF ROMYN GATE   Unit mm or inch



note: H.W.S, H, W, B, L, vary according as the amount of Intake water

Annex (3)

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