No.

ISLAMIC REPUBLIC OF IRAN

THE HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT

REPORT

ON

THE DETAIL DESIGN

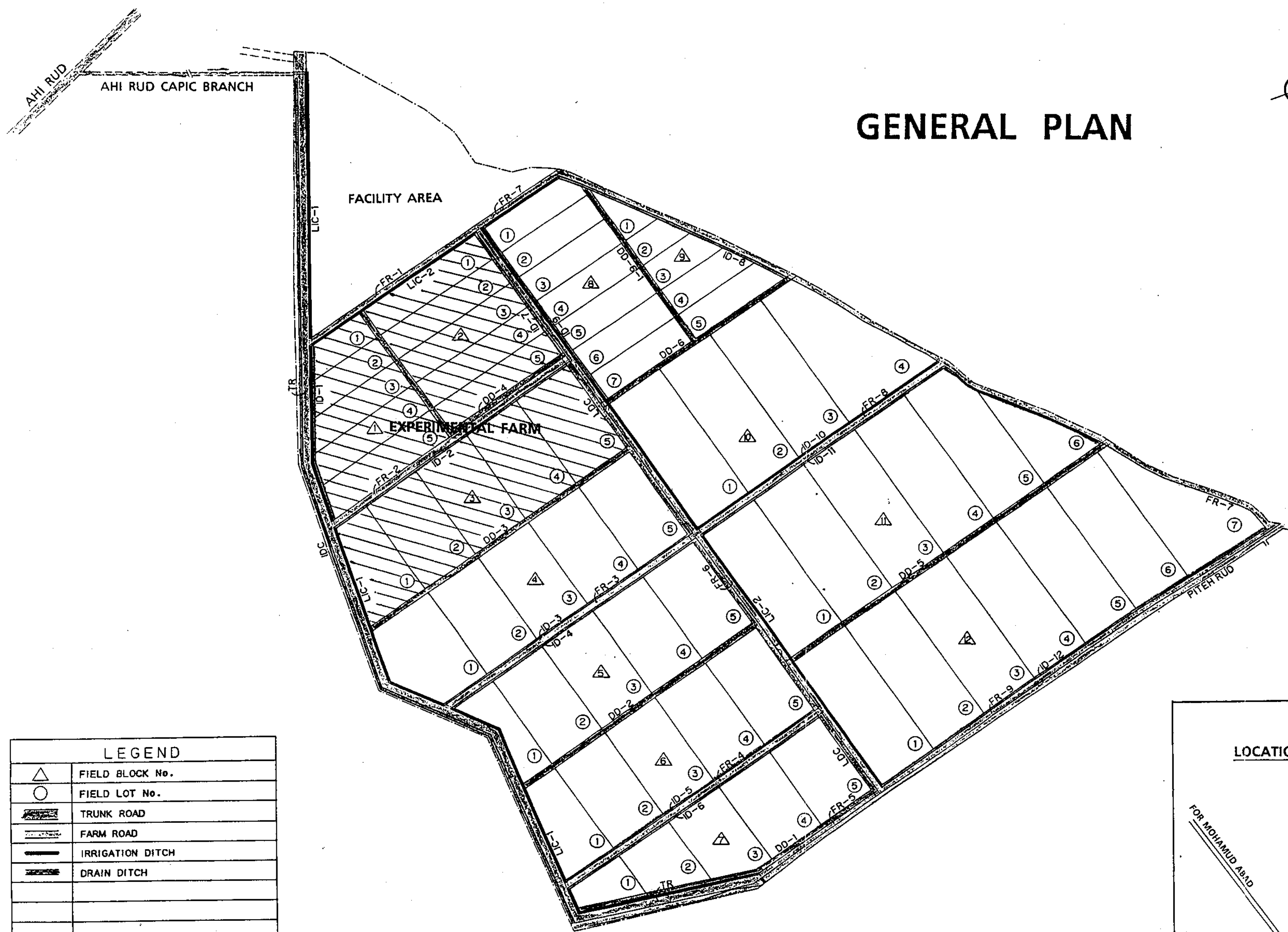
ON

THE CASPIAN SEA COASTAL AREA AGRICULTURAL DEVELOPMENT PROJECT-PILOT IMPLEMENTATION CENTER (CAPIC)

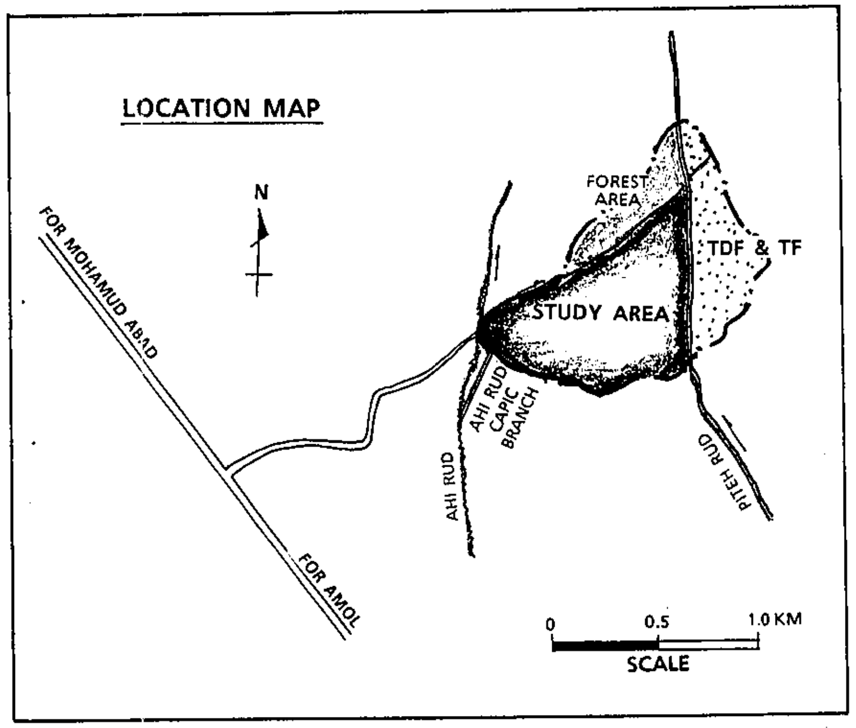
JANUARY, 1991

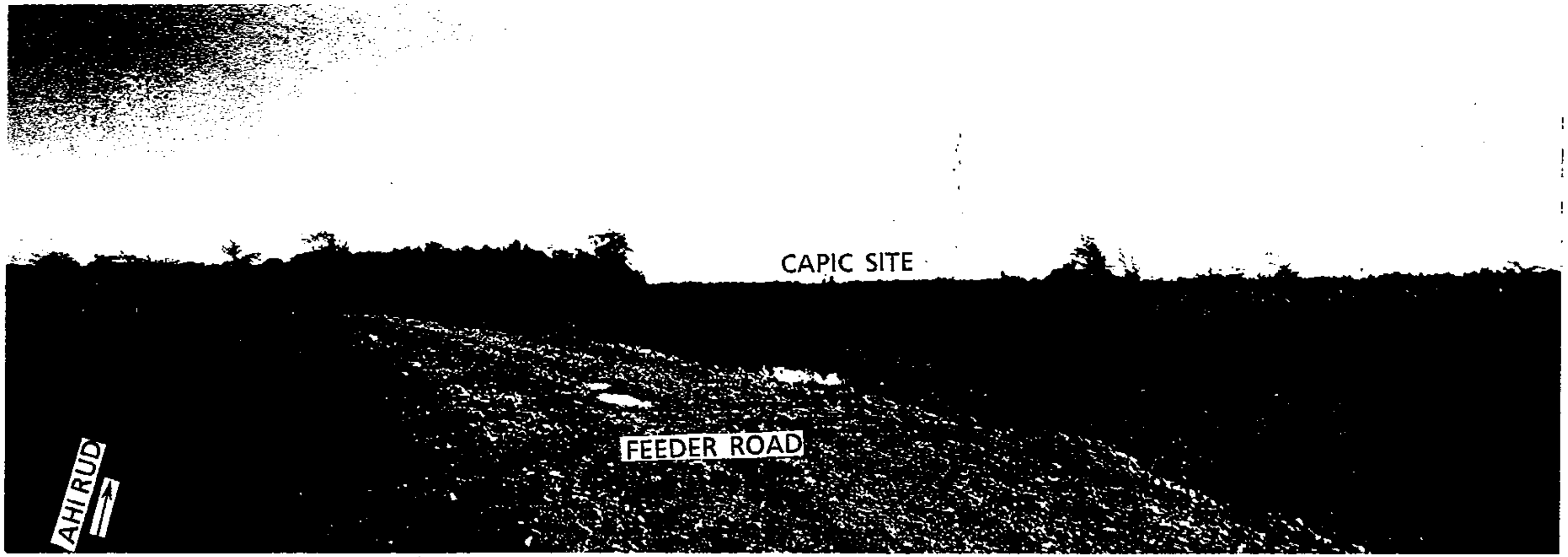
JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL PLAN



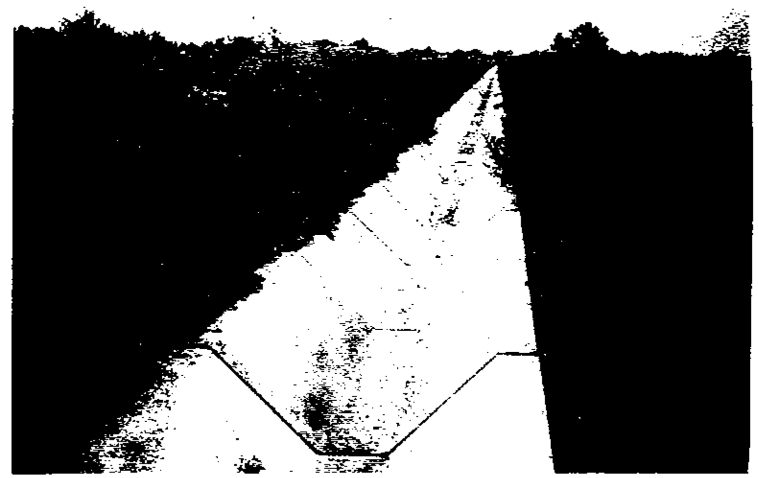
LEGEND	
△	FIELD BLOCK No.
○	FIELD LOT No.
	TRUNK ROAD
	FARM ROAD
	IRRIGATION DITCH
	DRAIN DITCH

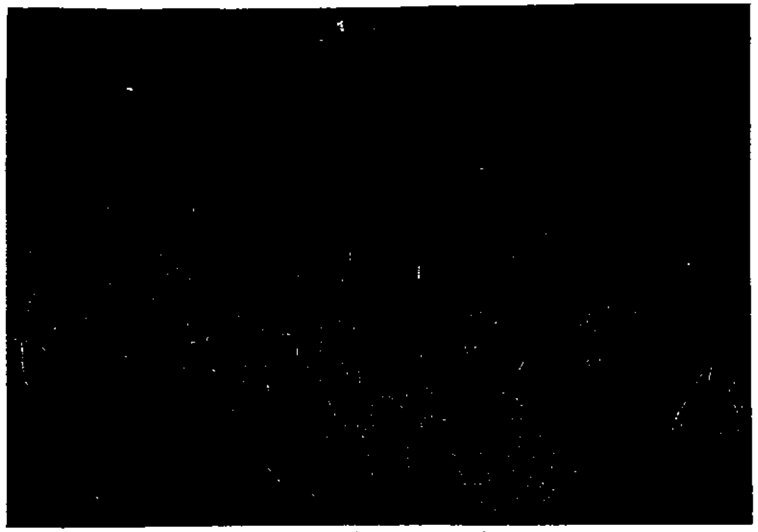




CAPIC SITE


FEEDER ROAD FROM THE NATIONAL ROAD TO THE CAPIC SITE
(Constructed by MOA)


AHI RUD CAPIC BRANCH CANAL
(Constructed by MOA in 1990)



ABANDONED AREA
(Storage of irrigation water)

LOCAL VARIETY OF PADDY
(Growing and Harvested)

THRESHER FOR PADDY
(at a field)

HARVESTED PADDY TRANSPORTED BY POWER TILLER

CONTENTS

CHAPTER 1. INTRODUCTION

CHAPTER 1. INTRODUCTION

The Haraz River basin is one of the richest agricultural regions in Iran. Confined in an alluvium plain surrounded by the Elbrus Mountains to the south and by the Caspian sea to the north, this area has an abundance of water to the fertile soil with gentle contours. Under appropriate climatic conditions, this area has been developed into a major rice growing region of the country.

However, it is correct to say that a lot of constraints have still to be overcome if future prosperity is to be assumed. Through utilizing the advantageous natural conditions as well as available human resources to the fullest extent this area can be effectively revitalized.

Aiming to significantly raise agricultural output and improve living standards in the area, in 1988 the Ministry of Agriculture (MOA) established the Caspian Sea Coastal Area Agricultural Development Project-Pilot Implementation Center (CAPIC) occupying some 140 hectares of land located in the center of the area.

Subsequently, CAPIC has been assigned a wide range of tasks; from demonstration of suitable land consolidation and advanced farming methods to training and extension program in the areas covering the Haraz River basin and adjacent areas having similar conditions. From the view point of these wide ranging tasks, the number of the staff members in CAPIC is expected to reach 85 by the mature stage.

The Japanese government began project-type technical cooperation in April 1990 called, "The Haraz River Basin Agricultural Development Project". Within the framework of this cooperation project, Japan International Cooperation Agency (JICA) sent a detail design study team to the project area for two months (September 2nd to October 31st, 1990) for the purpose of executing detail design work on the CAPIC field land reclamation. The design work began in mid-September following the establishment of a Tentative Implementation Schedule (TIS) for the Project.

The detail design covered 43 hectares of land (39 hectares for paddy and four (4) hectares for a facility site) to be reclaimed from virgin land. Irrigation canals, drainage canals, farm roads, and infrastructure related to the land reclamation were included. A topographical map with a scale of 1 to 1,000 was provided for use as a base map and several kinds of surveys such as soil, groundwater table, water sources and a drain to divert excess water away from the Project area were carried out and included in the design. During the course of design work, several meetings and frequent individual discussions were held.

The design was drawn up taking into consideration the following items in accordance with the tasks given to the Project as mentioned above.

- to make several irrigation and drainage systems/trials available,
- to facilitate exact and timely water management,
- to make easy transportation in the field and access to all farm plots feasible,
- to make field plot sizes flexible,
- to make a second crop cultivable, and
- to reduce land designated for facilities as much as possible in order to maximize cultivated areas.

Economic considerations are also given togather with durability of facilities, and the necessary safety measures for farming practices.

There is no doubt that when the CAPIC Project has been completed it will be able to fulfill its aims to the fullest extent.

Acknowledgment for completion of the detail design should be extended firstly to Mr. Jalal Resoulof, Deputy Minister of the Ministry of Agriculture, who has consistently supported the Project from the governmental level and Mr. J. Alizadeh, the general manager of the Project, who has coordinated schedules accurately and provided all necessary services. Secondly, the excellent technical contributions given by Mr. Nabavi and other members of the advisory group to and engineers of the Project deserve to be recorded. Finally, it should be mentioned that this design could not have reached the current level had not been for the generous cooperation and assistance given by all other staff members of the Project.

CHAPTER 2. PRESENT CONDITIONS OF THE STUDY AREA

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2.1. Location, Area, and Topography

The Project area is located about 10 kilometers(km) north of Amol town in Mazandaran Province. A national road runs about 2 km from the Project area, and an access road with gravel surface was constructed by MOA, links the Project area with the national road.

The total acreage allocated to the CAPIC is about 140 ha, of which 78.04 ha was surveyed by MOA. The surveyd area is consisting of four (4) sub-areas, namely, the Main Field (MF), the Facility Area (FA), the Traditional Demonstration Field and Trail Field (TDF & TF), and Others, such as the forest area and canal areas. The area of CAPIC is summarized as follows:

Item	Gross (ha)	Net (ha)
Main Field	39.03	35.09
Facility Area	3.75	3.37
TDF & TF	22.87	21.73
Others	12.39	(including Piteh Rud and existing forest areas)
Total	78.04	

The object areas for the Detail Design study are the MF and FA, which together amount to 42.78 ha. The study area of the MF and FA is bordered in the south by of the CAPIC area's boundary, the Piteh Rud in the east and Ahi Rud in the northwest. The only earth moving plan in the FA, however, is designed.

The study area inclines from south to north with a land slope of between 1/150 and 1/200, and also to the Piteh Rud. The elevation of the study area ranges between -5 to 0 meters (m) based on the National Cartography Center Bench Mark (NCC BM) (about 95 to 100 m based on the temporary benchmark). The southern part is the highest and the northern part is the lowest. Small rolling portions are also observed.

2.2. Soil and Groundwater

The soil in the MF is categorized in Silty Loam and Loamy Clay based on the field investigation during the study period. In the southern part of the MF, a sandy soil layer of about 40 to 80 centimeters (cm) below the ground surface is observed. In the other areas, a sand layer is also found, however, the depth is more than 1.5 m below the ground surface. The soil analysis data produced by the soil institute, MOA, shows no obstruction, apart from the sandy layer in CAPIC, for and consolidation work.

The groundwater is lower than 1.5 m on average in September, 1990 due to less amount of rainfall and no irrigation. However, the former observation by MOA indicates a higher groundwater table within approximately 1.0 m below the ground surface in CAPIC.

2.3. Meteorological and Hydrological Conditions

The annual rainfall is about 800 mili-meters(mm), the mean temperature is 16.3 centigrade degree(°C), the mean relative humidity is 83 percents(%), and the average number of rainy days is 106 as observed at the Babol Sar observatory. The monthly mean values are shown below.

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Tempt. (°C)	7.4	7.2	9.6	14.0	19.2	23.4	25.1	25.7	22.9	18.3	13.2	9.3	16.3
Humidity (%)	84	84	85	82	81	78	80	82	83	83	84	85	83
Rainfall(mm)	82	73	66	46	26	28	30	47	77	112	95	111	793
No. of R. Day	11	9	13	10	6	5	6	7	10	9	10	10	106
ET	31	40	62	93	136	165	164	146	105	74	42	28	1,086

Note: ET (evapo-transpiration) is calculated by the modified Penman method. All figures are referred to the Master Plan Report.

The study area is not under cultivation at present. The Ahi Rud is the main water source for irrigation in the CAPIC area and the Piteh Rud is the main drainage canal for the area. Both canals are unlined. The meandering Piteh Rud was straightened by MOA in 1989. The capacity of the Piteh Rud of 4 cubic meters per second(cu.m/sec) is calculated based on the improved canal section at the bridge point which was newly constructed in 1990.

Unexpected rainfall at the beginning of September or during the period of harvesting entailed the poor quality and quantity of rice. Under such circumstance, the manual harvesting limits quality control. During this period, the hired labor costs are increased by 1.5 to 2 times that of normal labor costs. The higher hired labor costs depressed farm income from the paddy cultivation at present.

2.4. Irrigation Condition

There are no paddy fields in the CAPIC area. Based on the surrounding paddy field conditions, the irrigation water is insufficient for paddy growing because farmers in the surrounding areas are cultivating by using and storing excess water or return flows at abandon areas which have between 10 and 20 ha of pond acreage. Since the lowest elevation of Ahi Rud along the CAPIC area is about 1 to 1.5 m below both banks, the irrigation water cannot be taken from the adjacent canal. The Ahi Rud CAPIC branch canal, which has an intake gate, was constructed by MOA in 1990. It is now easy to supply irrigation water for CAPIC.

2.5. Drainage Condition

In the CAPIC area there are no drainage canals. The Piteh Rud is the only drainage canal. When heavy rains occurred, the lower parts of the MF, which are located at along the Piteh Rud, are inundated. The inundation time is not long; from 1 to 2 days depending on the amounts of rainfall. The maximum inundation water depth is about 50 cm. Most of the MF are has no drainage problem because of a higher ground elevation.

2.6. Road Conditions

In the Haraz River basin, the main roads, such as national and provincial roads, are asphalt paved, however, farm roads are gravel paved. The road width is only about 1.5 to 2 m. It is rather difficult to pass farm machinery on the these narrow roads.

Within the MF and FA areas, there is no road as the land in virgin. As mentioned in the previous section, the access road from the national road to the CAPIC area had already been constructed.

2.7. Agricultural Mechanization

There are many power tillers and tractors in the farmlands of the Haraz River basin. The main farming machinery is the power tiller. During the harvesting season, large-scale threshers for barley harvesting were observed along the roads. The main objective of machiney in rice cultivation is for shattering. The farmland is poorly served by roads at present, therefore, the transplanting and harvesting work is carried out manually.

2.8. Conditions of Farmland

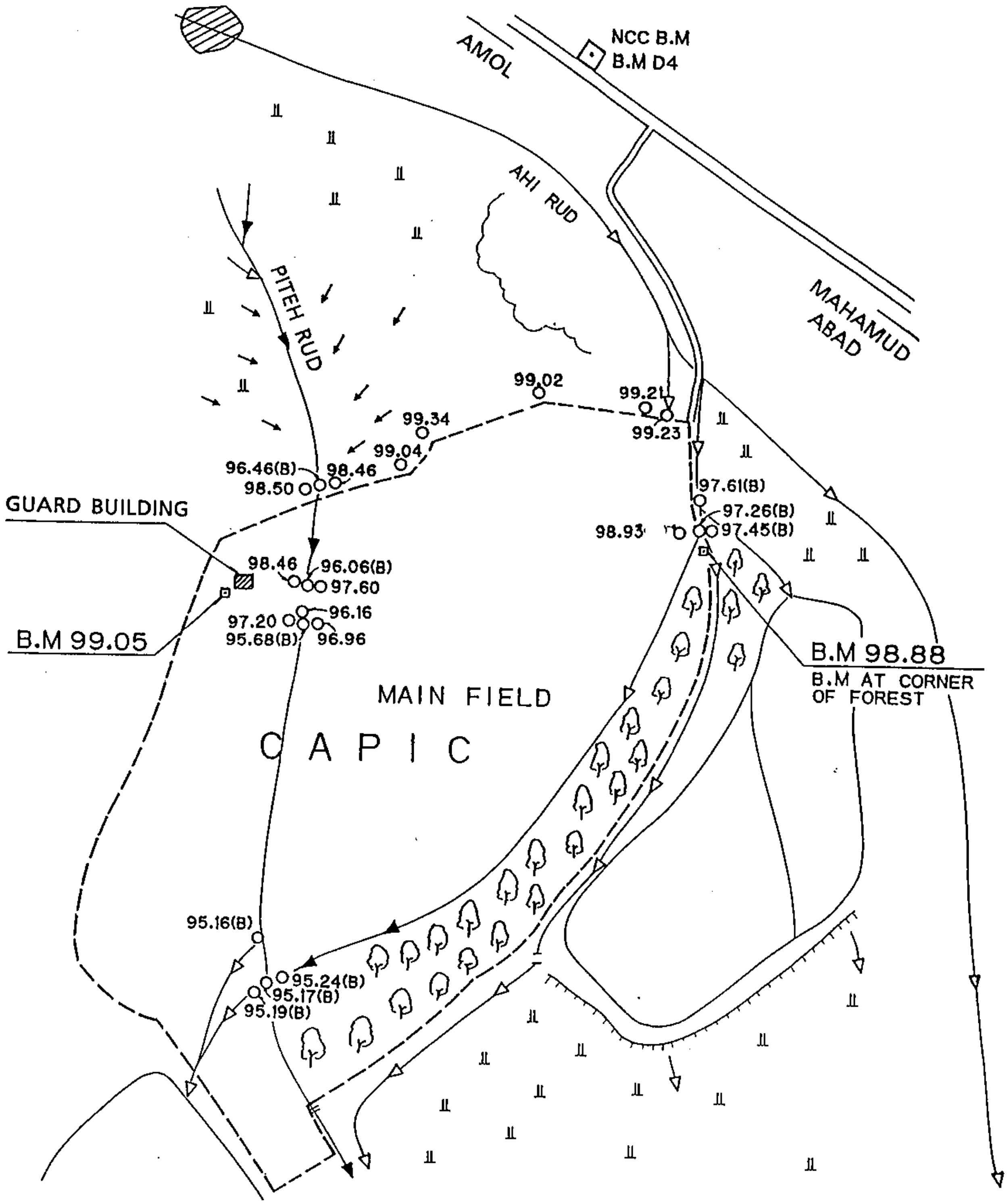
Since the CAPIC area is on reclaimed land, there is no cultivation. The surrounding areas are paddy fields. There is only one growing season annually due to low temperatures for paddy planting. During the winter season, some areas are cultivated as upland crop fields, however, the acreage is too small because of poor drainage conditions and low temperatures. Many tracks, loaded with feed for animals, are observed at the end of the harvest season.

2.9. Benchmarks

The topographic map and other survey materials used elevation based on the temporary benchmark(TBM). The NCC BM (National Cartography Center Bench Mark) with an elevation of +4.991 m is located on the national road from Amol to Mahamud Abad, baside the Post Office on the national road. The TBM is connected to the NCC BM, which is located in the southern part of the TDF & TF areas.(refer to Figure 2-9-1 and -2)

The elevation of the top of the nail on the TBM is -0.974 m and the top of the concrete post is -0.969 m based on the NCC BM. The elevation of the TBM is 99.05 m. Therefore, the difference of elevation between the TBM and the NCC BM is 100.024 m (= 99.05 + 0.974). Another BM was established during the study period in 1990. The TBM with an elevation of 98.88 m based on the TBM is located at the southern most of the forest area in the CAPIC area. (refer to Figure 2-9-1 and -2)

All elevations indicated on the topographic map with a scale of 1:1000 surveyed by MOA, are based on the TBM located near the existing guard building in the TDF & TF areas. During all studies in this report, elevations are based on this TBM.



Note: All elevation indicated in this figure are based on the temporary Bench Mark.
(B) Bottom elevation

FIGURE 2-9-1 LOCATION MAP OF TEMPORARY BENCH MARK AN D SURVEYED ELEVATIONS

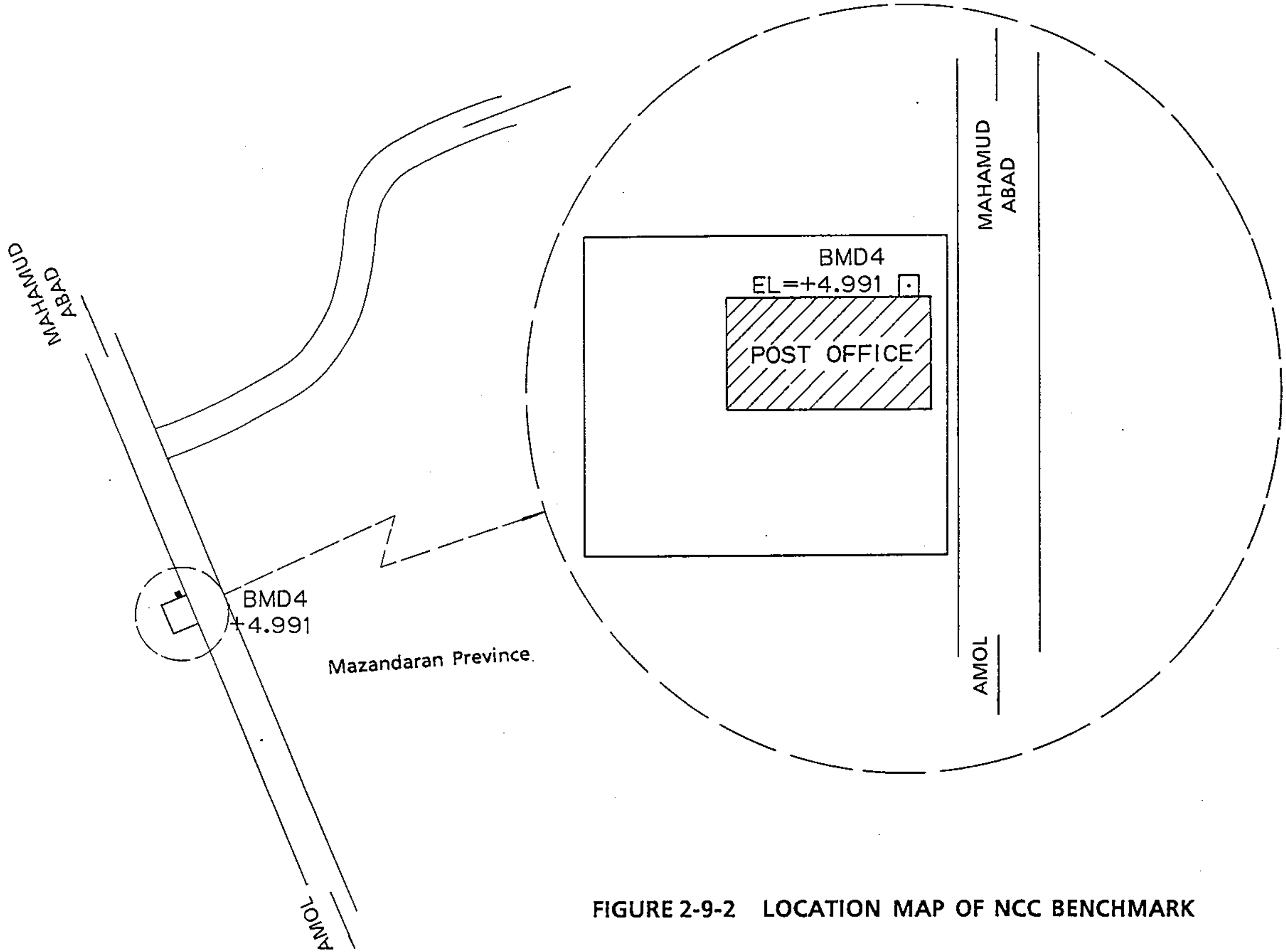


FIGURE 2-9-2 LOCATION MAP OF NCC BENCHMARK

CHAPTER 3. DETAIL DESIGN OF LAND CONSOLIDATION

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3.1. General

The CAPIC farm will play a role as a demonstration of land consolidation for the Haraz River basin area as a whole, and in parallel as an experimental farm for rice cultivation, rice mechanization, post-harvest, and livestock.

Considering the above role, the objective of this Project is to design the necessary facilities to demonstrate mechanized farming and various water management methods to farmers in the Haraz River basin area. To achieve this purpose, various facilities are proposed in the Study area. This Study covers the detailed design works for proposed facilities including proposed field construction in the MF of the CAPIC area and land leveling work in the adjacent FA. The MF, including the FA, is bounded by the Ahi Rud and Piteh Rud and the southern boundary of the CAPIC area. (refer to General Plan)

The experimental field, which has about 6 ha of consolidated fields near the FA, is also designed with necessary infrastructure such as farm ditches, farm drains and roads for various activities on agronomic, mechanization field and extension fields.

The irrigation water for the Study area is provided from the Ahi Rud CAPIC Branch which was well constructed by the Iranian Government in 1990. In the Study, the proposed irrigation canals should be connected with this Branch and convey irrigation water to the reclaimed land with land consolidation, the TDF and TF. The proposed irrigation canal has sufficient capacity to transport the necessary amount of irrigation water not only for the MF but also for the TDF and TF.

The proposed road in the MF should connect to an existing gravel paved feeder road from the National Road to the CAPIC area, which was constructed by the MOA. The proposed road should also connect with the existing bridge over the Piteh Rud, which connects with the MF and/or the FA and TDF & TF.

The main drainage canal for the CAPIC area is the Piteh Rud. In the Study, however, considering the present water shortages during the paddy growing season, the idea of re-use of water is also inclusive.

The components of the facilities consist of construction of field lots, irrigation canals, drainage canals, and farm roads. The following sections describe design ideas on each component.

3.2. Determination of Field Lots

3.2.1. Field Lot Design

(1) Shape and Size of Field Lot

The shape and size of a field lot to be land-consolidated are determined by taking into consideration various conditions such as land slope, irrigation and drainage, water management, farm size, workability of agricultural machinery to be introduced.

a) Alignment of Field Lots

The longer side of a field lot should be aligned in parallel with the counter line in order to minimize earth moving costs as far as possible. The shorter side of the field lot will, therefore, cross the counter line. (refer to Figure 3-2-1)

b) Shape of Field Lots

The proposed shape of each field lot to be land-consolidated is rectangular in principle taking into consideration the workability of farm machinery and reducing the abandoned area after completing land consolidation. Acute-angled corners in field lots should be avoided as far as possible due to difficulty of utilizing farm machinery. However, a corner with an obtuse angle could be applied when a rectangular shape with right angle is not possible. (refer to Figure 3-2-1)

c) Size

The following conditions should be taken into consideration.

- Topographic conditions

The deference of height between elevations of an upper field and the adjacent lower field should be 50 cm or less in order to facilitate farm machinery moving smoothly between them. (refer to Figure 3-2-2)

The size of the field lot should be determined taking the following items into consideration.

- Reduction of land allocated to farm roads, canals, drains, and paddy dikes
- Construction costs
- Farming practices and water management

Generally, it is said that if the volume of earthwork comes to more than 3,000 cu.m/ha, the size of the field lot should be realigned or reconsidered. Since the MF in the CAPIC has a gentle slope of 1/150 to 1/200, the earthwork volume will not exceed this figure.

The sandy soil layer can be observed at 40 to 80 cm below the natural ground surface in the southern part of the MF. When the topsoil treatment (surface soil handling) is carried out, this sandy soil layer will not limit the size of the field lot. In this case, the construction costs will be increased due to additional topsoil treatment. Without topsoil treatment, a thickness of 20 to 30 cm of surface soil will remain on the sandy soil layer. The length of the shorter side of the field lot will be limited to a maximum of 20 to 40 m.

Topsoil treatment will usually increase construction costs. The thickness of topsoil treatment is 15 cm in principle taking into consideration the length of plant roots. The standard earthwork volume of the topsoil treatment is, therefore, about 1,500 cu.m/ha. The hauling distance depends on the hauling method and the size of the field lot. In order to minimize construction costs, it is better that topsoil treatment is avoided as far as possible.

- Workability of farm machinery

The length of a longer side of a field lot is not limited regarding the workability of machinery in principle, so long as the machinery is operated in the straight lines.

However, the workability of farm machinery is actually affected by various limitations such as the volume of a container for fertilizer, insecticide, and pesticide. The maximum length of the field lot side is about 250 m at present. And a modern power sprayer can spread chemical inputs about 100 m under calm conditions. When more technical development and/or improvement on farm machinery is achieved, this limitation will be altered.

According to the experimental data for workability of various farm machinery on rotary tilling work, the following sizes of a field lot show a workability of more than 70%.

Small-scaled power tiller	:	0.05 ha or more
Medium-scaled tractor (15-25 ps)	:	0.15 ha or more
Larger-scaled tractor (30 ps)	:	0.30 ha or more

The data also shown the workability by ratio of various lengths of the longer and shorter sides of field lots. There are no remarkable difference between ratio of 1:10 and 1:1. However, for rotary tilling in fields with areas less than 0.2 ha, the workability is reduced. Consequently, workability of agricultural machinery is favorable in a ratio of more than four (4) for the tilling work by rotary and in more than six (6) by plow.

Based on the above study, in the cases where the length of the shorter side is more than 20 m and the area of the lot is more than 0.3 ha, the workability is higher.

From the point of view farm mechanization, it is recommended that the field lot size is more than 0.3 ha and the lengths of the shorter and longer sides of the field lot are more than 20 m and 100 to 150 m, respectively.

- Irrigation, drainage and water management

From the point of view of water management, the maximum length of the longer side of the field lot is favorable up to 150 m. In the fields having a longer side of more than 150 m, timely water management is more difficult.

It is desirable for irrigation work in a given field lot to be finished within several hours in order to achieve a high workability of farming machinery as well as to save irrigation water. In these cases, the area of a field lot is limited to approximately 0.5 ha. It is desirable that the size of a field block is between 5 and 6 ha, to facilitate greater efficiency in the use of farming machinery and water management by an irrigation unit by a single farm ditch.

The increased workability of farm machinery will require a low groundwater table more than 50 cm below the field surface. After halting irrigation during the harvest period, a groundwater table of about 20 to 30 cm below the field surface is required for better operation of farm machinery on the field. This fact limits the length of the longer side of a field lot, however, it depends on the soil. If a tile drainage system is introduced, this limiting factor is not applied in determining the length of the sides of the field lot.

- Farm size

The farm size in the Project area is one for the limiting factors determing the size of a field lot. A size which is above the average farm size for the area is not recommended for individual farm management. However, cooperative farm management will require larger sizes of a field lot in the future.

- Size applied for the MF in the CAPIC

Various lot sizes are proposed for experimentation and demonstration of farm mechanization and water management for the MF in the CAPIC. The 0.2 ha lot size is also proposed for farm mechanization using small-scaled machinery such as the power tiller.

Taking account of the above conditions and limitations, the length of the longer and shorter sides of field lots are recommended as follows:

Length of longer side of a field lot : 100 to 150 m
Length of shorter side of a field lot : 60 m maximum

(2) Size of Field Block

A field block consists of several field lots. A field block is the land unit for water management on separate irrigation and drainage systems. The size of a field block affects the acreage of land for infrastructure such as farm roads, irrigation and drainage canals.

Greater space between farm roads, irrigation and drainage canals can decrease the acreage of lands for facilities due to low density of canals. However, too wide space of the facilities is not convenient for farming. The following figure in Figure 3-2-3 shows the ratio of land to infrastructure in the farmland area. According to the results of the study, types III and IV are suitable for land consolidation, taking into consideration the size of field lots mentioned above. (refer to Figure 3-2-3)

(3) Direction and Size of Field Lot in the MF

As is well known, in land consolidation work, the direction of the longer size of a field lot matched with the direction of a contour line can minimize land leveling costs. In the MF of the CAPIC, two directions of contour lines can be observed on the topographic map with a scale of 1:1000 as surveyed by the MOA. The main direction is east to west, and in the southwestern part, the direction of the contour line runs from north to south.

To determine the frame of the road and canal networks topographic conditions should be considered. The five (5) cases of the frame of the field are studied. (refer to Figures 3-2-4)

Case-A and D are located in the upper portion of the MF which includes the area with differing direction of contour lines. The direction of the longer side of the field lot in Case-A is across the contour line. The direction of the longer side of the field lot in Case-D is the same direction as the contour line. The length of the longer side is fixed at 100 m. Under these conditions, the length of the shorter side varies between 30 m in Case A1 and D1 ; 60 m in Cases A2 and D2; and 90 m in Cases A3 and D3. (refer to Figures 3-2-5 to -9)

Case-B, -C and -E are selected for the lower part of the MF. The length of the longer side of the field lot is fixed at 150 m. Cases-B and -D are placed in the same direction as Case-A in the upper portion of the MF. Case-E is also in the same direction as Case-D. The difference between Cases-B and -C is the location of the drainage canal. In Case-C, a drainage canal is located in the lower portion of the MF of the CAPIC. The length of the shorter side of the field lot is the same as Cases-A and -D, that is, B1, C1 and E1 with 30 m-length, B2, C2 and E2 with 60m-length, and B3, C3 and E3 with 90m-length.

For approximately calculating earth moving volume and hauling distances, a theoretical equation is applied. This equation needs only the length of both sides of a field lot, the maximum cutting depth, the angle between a contour line and the longer side of the lot. (refer to Figures 3-2-10 and -11)

According to the results of the study, the earth moving volume increases in accordance with the length of the shorter side. Cases-B2 and -C2 which have a shorter side of 60 m require the least volume of earth moving due to the imperfect match between direction of contour line and that of the longer side of the lot. As a general trend, the shorter length requires less volume of earth moving. The difference between cases of 30 m sides and 60 m sides is less than for cases of 90 m sides. (refer to Table 3-2-1)

The hauling distances required for Cases-A and -D are remarkably different, however, in a lower portion area, the hauling distances are not big difference. In the results of the study Case-D required the shorter hauling distance. (refer to Table 3-2-1)

The construction costs of leveling work are related not only to earthwork volume but also to hauling distances. As the results of the study on working times per ha, the Case-D gives the least working time for the shorter length of 30 to 60 m among cases. In the lower portion, the work time for equipment shows only slight differences between each Case. Consequently, in the upper portion, Case-D is applied and in the lower portion, Case-E is applied. (refer to Tables 3-2-1)

3.2.2. Calculation Method for Earth Moving Works

(1) Calculation Method

To calculate the volume of earthworks needed for land leveling in land consolidation work, the following calculation methods are employed. In these calculations, the hauling distance for earth moving is also important.

- Ordinary Method — This method gives the most accurate result. However, its needs not only rather complicated computation of hauling distance but much data processing work.

- Simple theoretical method — The required time for calculation including data processing is the smallest compared to other methods. In areas with rolling topographic conditions, the reliability would be low in such areas. The earthwork volume and hauling distance can be easily calculated by the theoretical equation. The necessary data are mentioned in a previous section.

- Mesh method — There are several names of calculation due to different calculation procedures. This method employs several meshes instead for the acreage of existing fields, with a certain size of mesh in a field lot. The coordinates on X- and Y-axes and the mean elevation of each mesh are necessary. Based on the calculated center of gravity of cut and fill portions, the hauling distance can be calculated. By changing the size of meshes, the accuracy and calculation time can be varied.

The cost of earth moving in land consolidation work varies depending not only on quantity of earthwork but also on hauling distance, especially in larger size field lots. When using the calculation method for earth moving volume, this should be considered. There are various methods to calculate the volume of earthworks. Taking into consideration the above mentioned features, for the detailed design of the MF of the CAPIC, the mesh method was employed for the calculation of earth moving volume.

(2) Earth Moving Works

The following data and procedures were used to calculate earth moving volume. (refer to Table 3-2-2 and Figure 3-2-12)

Input data : Mesh size, elevation (EL) and coordination
Proposed acreage of the field lot

$$\text{Proposed elevation of a field lot (ELprop)} = \frac{\text{Sum of present elevation of meshes}}{\text{Effective number of mesh within the lot}}$$

$$\text{Average mesh area (AMA)} = \frac{\text{Proposed acreage of the field lot}}{\text{Effective number of mesh within the lot}}$$

Cut depth = Positive value of (EL - ELprop)

Fill depth = Negative value of (EL - ELprop)

Earth moving volume = Sum of cut depth × AMA

Coordination of the center of gravity of cut on X-axis (Xhc)
= {Sum of (cut depth × cut coordination of X-axis)} ÷ Sum of cut depth

Coordination of the center of gravity of cut on Y-axis (Yhc)
= {Sum of (cut depth × cut coordination of Y-axis)} ÷ Sum of cut depth

Coordination of the center of gravity of fill on X-axis (Xhe)
= Sum of (fill depth × fill coordination of X-axis)}÷ Sum of fill depth

Coordination of the center of gravity of fill on Y-axis (Yhe)
= Sum of (cut depth × fill coordination of Y-axis)}÷ Sum of fill depth

$$\text{Hauling distance} = \sqrt{(Xhc-Xhe)^2 + (Yhc-Yhe)^2}$$

3.2.3. Earth Moving Plan

(1) Earth Moving

The proposed elevation would be finalized by considering the necessary volume of earth for roads, irrigation canals, paddy dikes, and surplus of earth from drainage excavation.

Major revised points on land leveling are as follows;

- At the portion along the southern boundary of the CAPIC area, the elevation is higher than that of other areas. Therefore, the LIC-1 shall be designed as a gentle gradient to convey irrigation water to the TDF & TF.
- The proposed field lots with higher elevations under irrigation by ID-7, -8 and -9 branched off from LIC-2, can not be irrigated. The proposed elevations of those lots are less than EL 99.00 based on the temporary benchmark. The surplus earth would be hauled to the lower field lots within a field block.
- The elevations of Nos. 4 to 6 field lots in the field block of No.11 are adjusted by embanking a volume of surplus earth from the higher field lots within a field block and the elevation of No.6 is thereby lowered by 20 cm due to the lower lot's elevation becoming higher than that of the upper lot's elevation.
- In addition to the above results, the final designed elevation of each lot is determined by taking into account the adjustments from other necessary volume of earth such as farm roads, irrigation and drainage canals, and paddy dikes to be constructed in the MF. (refer to Tables 4-1-1 to -2 and Figure 4-1-1 in Chapter 4)

The results of earthworks in the MF are shown as follows;

Item	Volume	Hauling Distance	Necessary H. Equipment
Within a field lot	27,600 cu.m	57.0 m	Bulldozer
Within a field block	6,240 cu.m	82.2 m	Bulldozer
Total	33,840 cu.m	61.6 m	

Note : The further detail data are attached in Chapter 4-1.

The vectors of earth movement in the CAPIC are schematically presented the attached Drawings.

(2) Topsoil Treatment

The top soil treatment area is 3.43 ha in the MF based on the depth of the layer of sandy soil and the cutting depth of earth. A hauling distance of 22.7 m is calculated based on the earth moving plan whereby the topsoil is moved on both sides of the field lot. The same amount of top soil is replaced in the field lot after land leveling. The major portion of the top soil treatment area is located in the southern part of the MF, which consists of field block numbers 1, 8 and 9. The proposed thickness of top soil for treatment is 15 cm. (refer to Table 4-1-3 and Figure 4-1-1 in Chapter 4)

(3) Plot Dike

A plot dike between field lots is proposed in order to store water for paddy growing. The plot dike belongs to the upper field lot. The side slope of 1:1, the height of 30 cm and a berm width of 30 cm are planned. At road and canal sides, plot dikes will not be planned because both of these types of infrastructure have heights of more than 30 cm.

(4) Slope Tamping

Slope tamping work is proposed in order to protect the side slopes between the upper field lot ad the adjacent lower field lot from erosion, where differences in height of more than 10 cm occur.

TABLE 3-2-1 RESULTS OF EARTH WORK VOLUME ON LEVELING WORKS BY LOT SIZE

Case	Field Lot Size (m)	Total Area (sq.m)	Earth Work Volume			Hauling Distance		Working Time		
			Volume (cu.m)	Per ha (cu.m/ha)	Rate (%)	Distance (m)	Rate (%)	Workablt'y (cu.m/ha)	Time (hr)	Rate (%)
(Upper Portion of the Main Field)										
A1	100 × 30	121,086	7,482	618	100	64.0	100	34.2	18.1	100
A2	100 × 60	121,086	8,053	665	108	64.2	100	34.1	19.5	108
A3	100 × 90	121,086	9,196	759	123	65.6	103	33.4	22.7	125
D1	100 × 30	109,801	5,901	537	100	48.0	100	45.4	11.8	100
D2	100 × 60	109,801	7,350	669	125	47.2	98	46.2	14.5	123
D3	100 × 90	109,801	10,150	924	172	56.7	118	38.5	24.0	203
(Lower Portion of the Main Field)										
B1	150 × 30	108,412	8,009	739	100	82.4	100	26.6	27.7	100
B2	150 × 60	108,412	7,530	695	94	81.0	98	27.1	25.6	92
B3	150 × 90	108,412	12,139	1,120	152	83.3	101	26.3	42.6	154
C1	150 × 30	107,774	9,291	862	100	73.0	100	30.0	28.7	100
C2	150 × 60	107,774	8,791	816	95	76.6	105	28.6	28.5	99
C3	150 × 90	107,774	11,678	1,084	126	79.7	109	27.5	39.4	137
E1	150 × 30	122,062	9,279	760	100	75.8	100	28.9	26.3	100
E2	150 × 60	122,062	11,152	913	120	69.4	92	31.6	28.9	110
E3	150 × 90	122,062	11,851	971	128	78.0	103	28.1	34.6	132

Note: Workability $Q = 60 \times q \times f \times E / (0.034 \times D + 0.025)$: q = hauling volume of swamp bulldozer (16 ton class) per one cycle = 2.09 cu.m/cm
f = Soil conversion factor = 1.00 : E = Workability = 0.60 : D = Hauling distance (m)
Therefore, $Q = 60 \times 2.09 \times 1.00 \times 0.6 / (0.034 \times D + 0.025)$

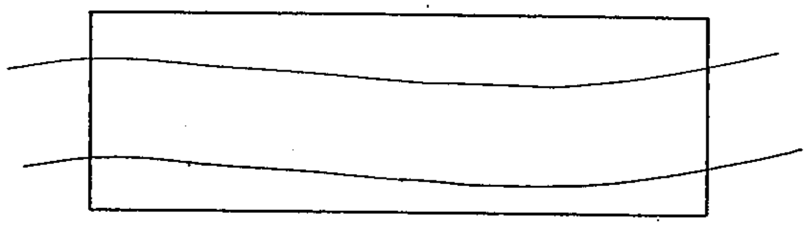
TABLE 3-2-2 SAMPLE FORM OF EARTH MOVING

No.	X	Y	EL	Height (cm)		Cut		Fill		
				Cut (Hc)	Fill (He)	H·Hc	Y·Hc	X·He	Y·He	
1-1	5	5	99.11		39			195	195	
1-2	15	5	99.22		28			420	140	
1-3	25	5	99.38		12			300	60	
1-4	35	5	99.40		10			350	50	
1-5	45	5	99.46		4			180	20	
1-6	55	5	99.47		3			165	15	
1-7	65	5	99.53		7			455	35	
....								...	...	
....								...	...	
....								...	...	
3-6	55	25	99.59	9		...	...			
3-7	65	25	99.63	13		1,375	225			
3-8	75	25	99.67	17		845	325			
3-9	85	25	99.69	19		1,275	425			
3-10	95	25	99.71	21		1,615	475			
Average			99.50			85.1	22.9	24.5	5.3	
Total				214	232	18,204	4,908	5,684	1,230	

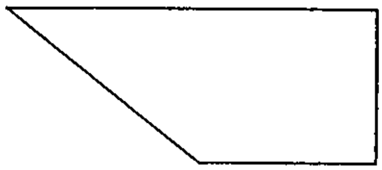
Earth Moving Volume : $V = \Sigma Hc \times 100 =$ 100×2.14 m = 214 m^3

Hauling Distance = : $\sqrt{\{(\Sigma X{\cdot}Hc - \Sigma X{\cdot}He)^2 + (\Sigma Y{\cdot}Hc - \Sigma Y{\cdot}He)^2\}} =$ 63.1 m

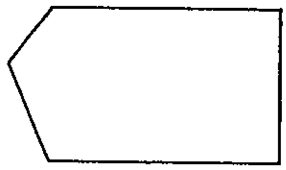
No. of Effective Mesh :n = 30 | Average Mesh Area : = Field lot area / n = 100 m^2



ALIGNMENT OF FIELD LOT



FIELD LOT WITH
ACUT ANGLE CORNER



FIELD LOT WITH
OBTUSE ANGEL CORNER

FIGURE 3-2-1 VARIOUS SHAPES OF FIELD LOT

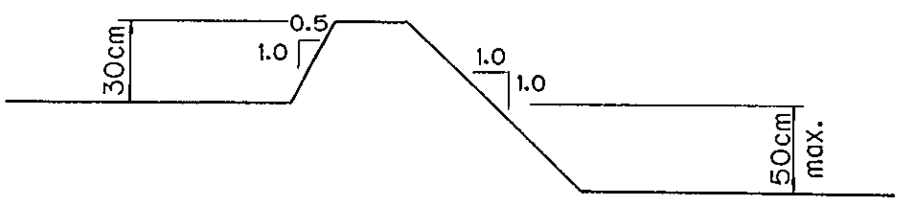
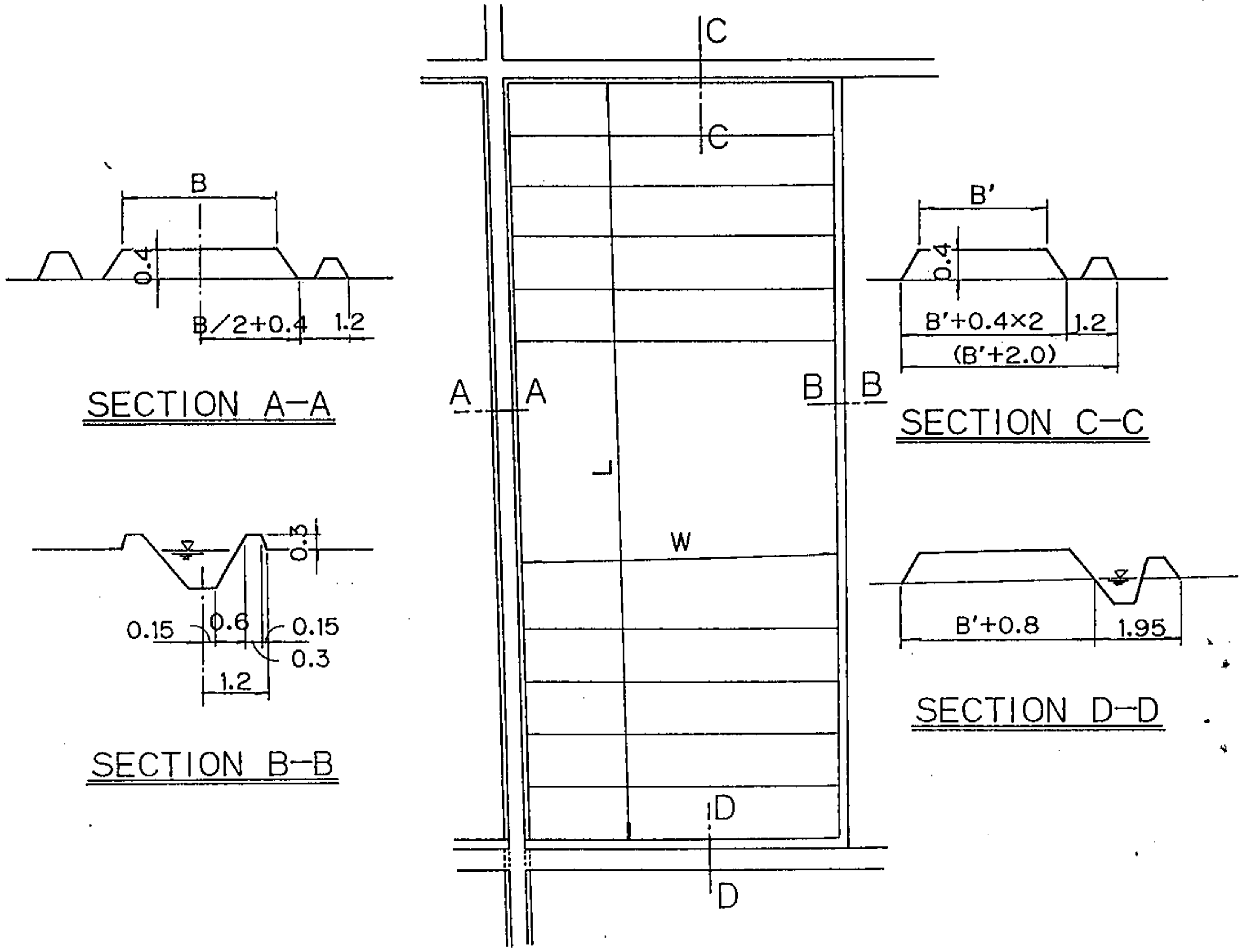


FIGURE 3-2-2 MAX. DIFFERENT HEIGHT BETWEEN BOTH FIELD LOT

FIGURE 3-2-3 RATE OF AREA FOR PROPOSED INFRASTRUCTURE



Type	L	W	B	B'	Area of Field Block	Land for facilities	Rate
I	m 300	m 100	(2.5) 3.5	3.5	ha 3.0	(1803) m^2 1953	(6.0) % 6.5
II	600	100	(2.5) 3.5	3.5	6.0	(3018) 3318	(5.0) 5.5
III	300	150	(2.5) 3.5	3.5	4.5	(2096) 2246	(4.7) 5.0
IV	600	150	(2.5) 3.5	3.5	9.0	(3311) 3611	(3.7) 4.0
V	600	200	(2.5) 3.5	3.5	12.0	(3605) 3905	(3.0) 3.3

Note : ( ) In case of a road width of 2.5 m

FIGURE 3-2-4 LOCATION MAP OF SAMPLE AREAS

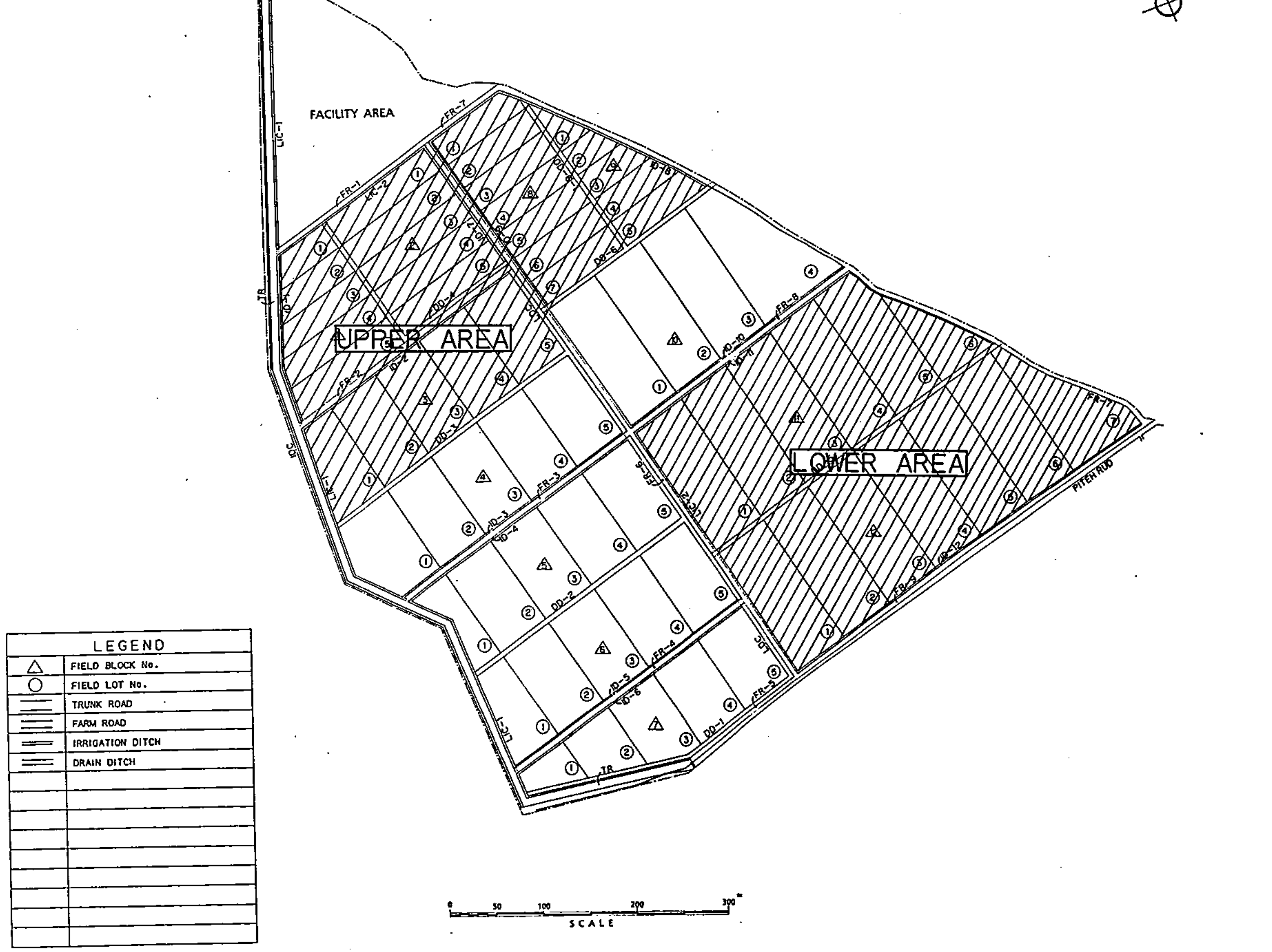


FIGURE 3-2-5 ALTERNATIVE LOT ALIGNMENT (CASE - A)

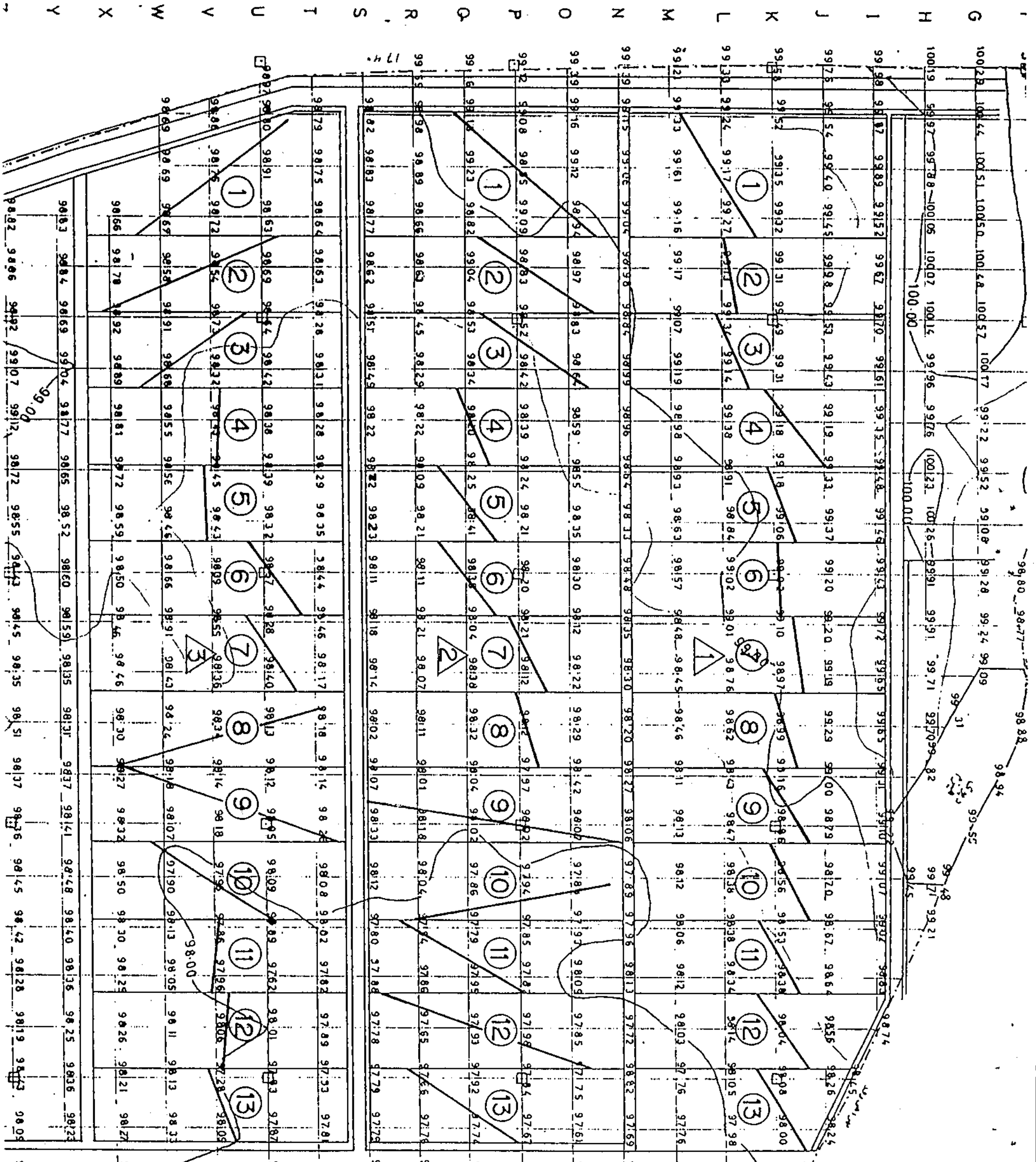


FIGURE 3-2-6 ALTERNATIVE LOT ALIGNMENT
(CASE - B)

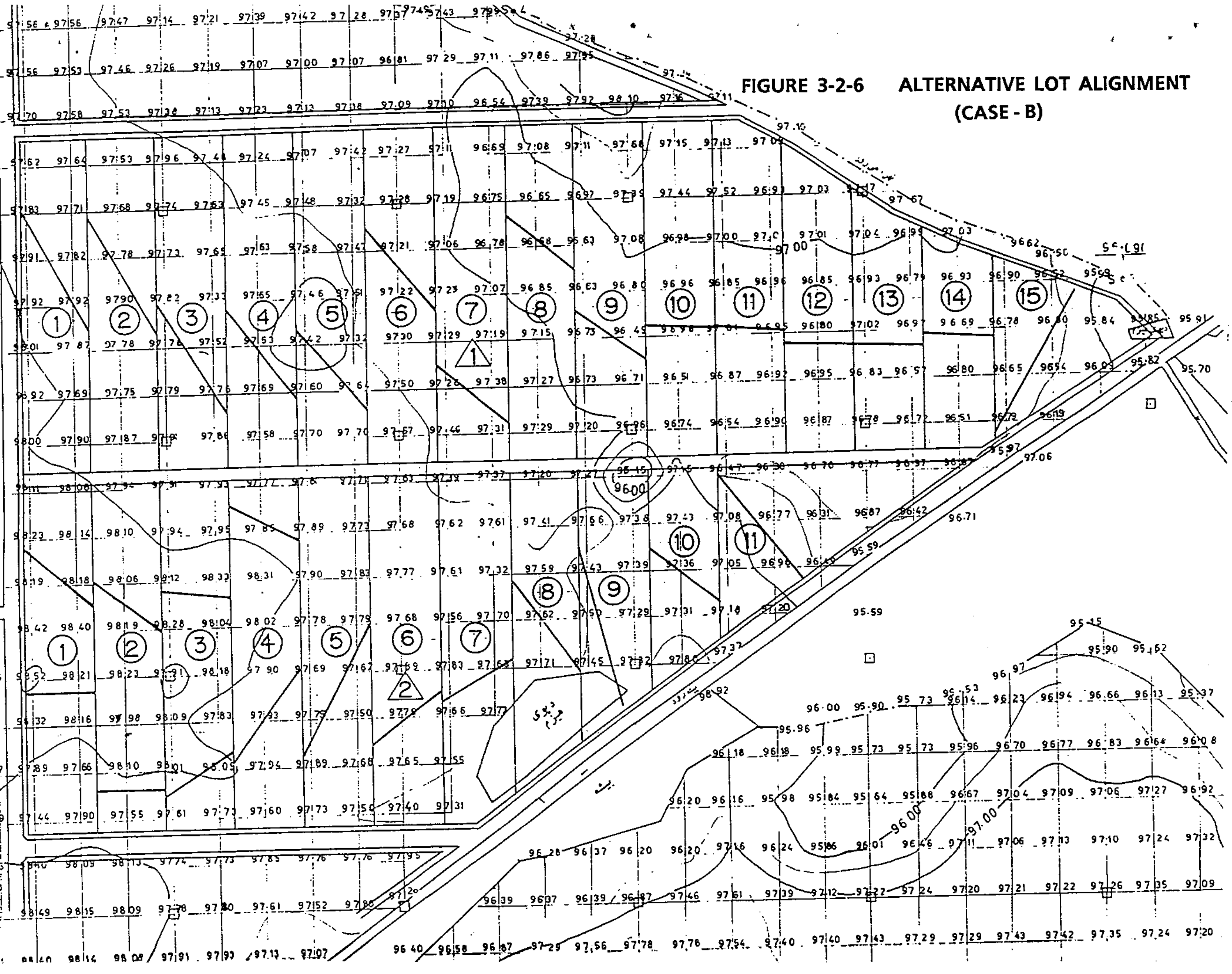
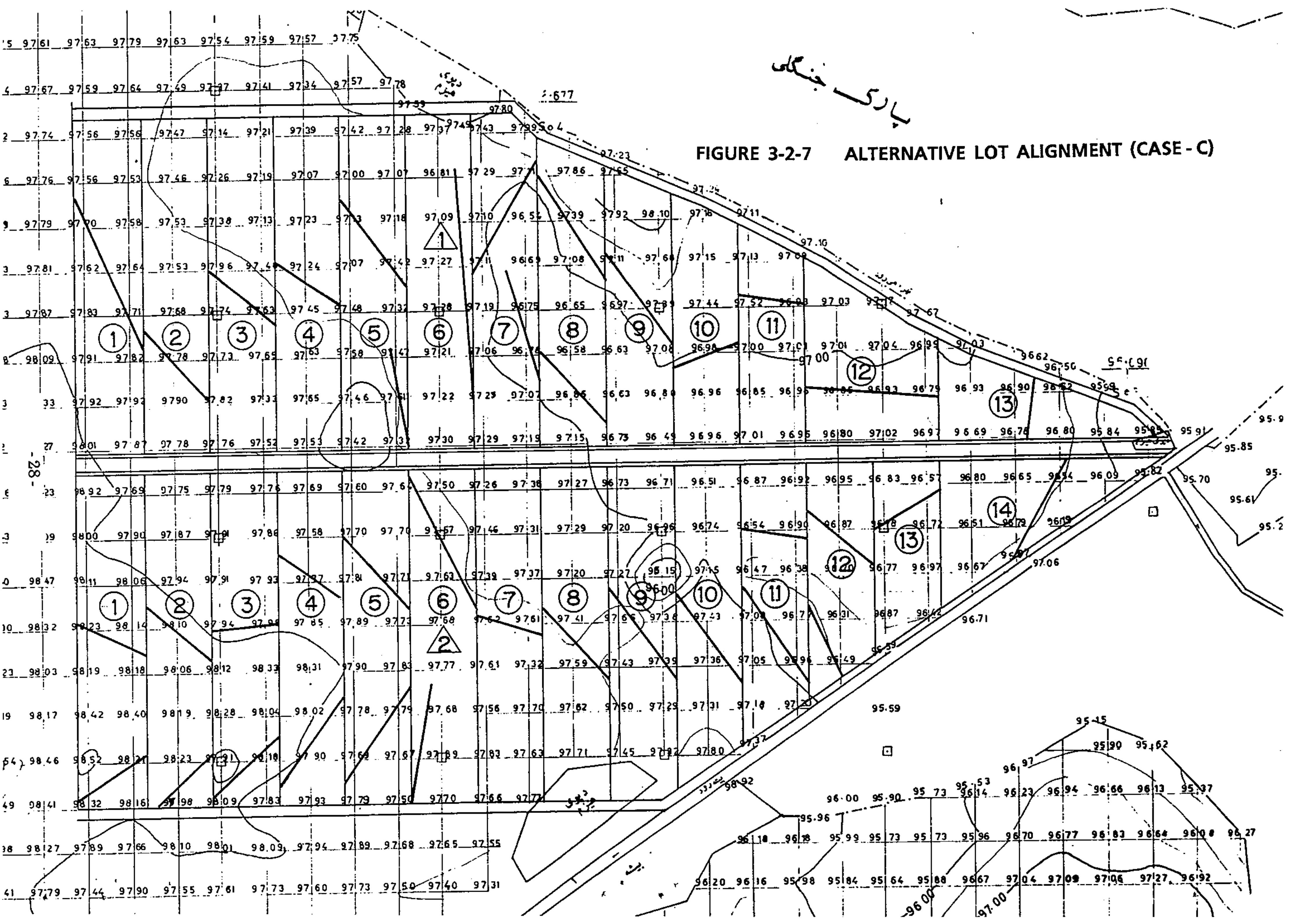


FIGURE 3-2-7 ALTERNATIVE LOT ALIGNMENT (CASE - C)



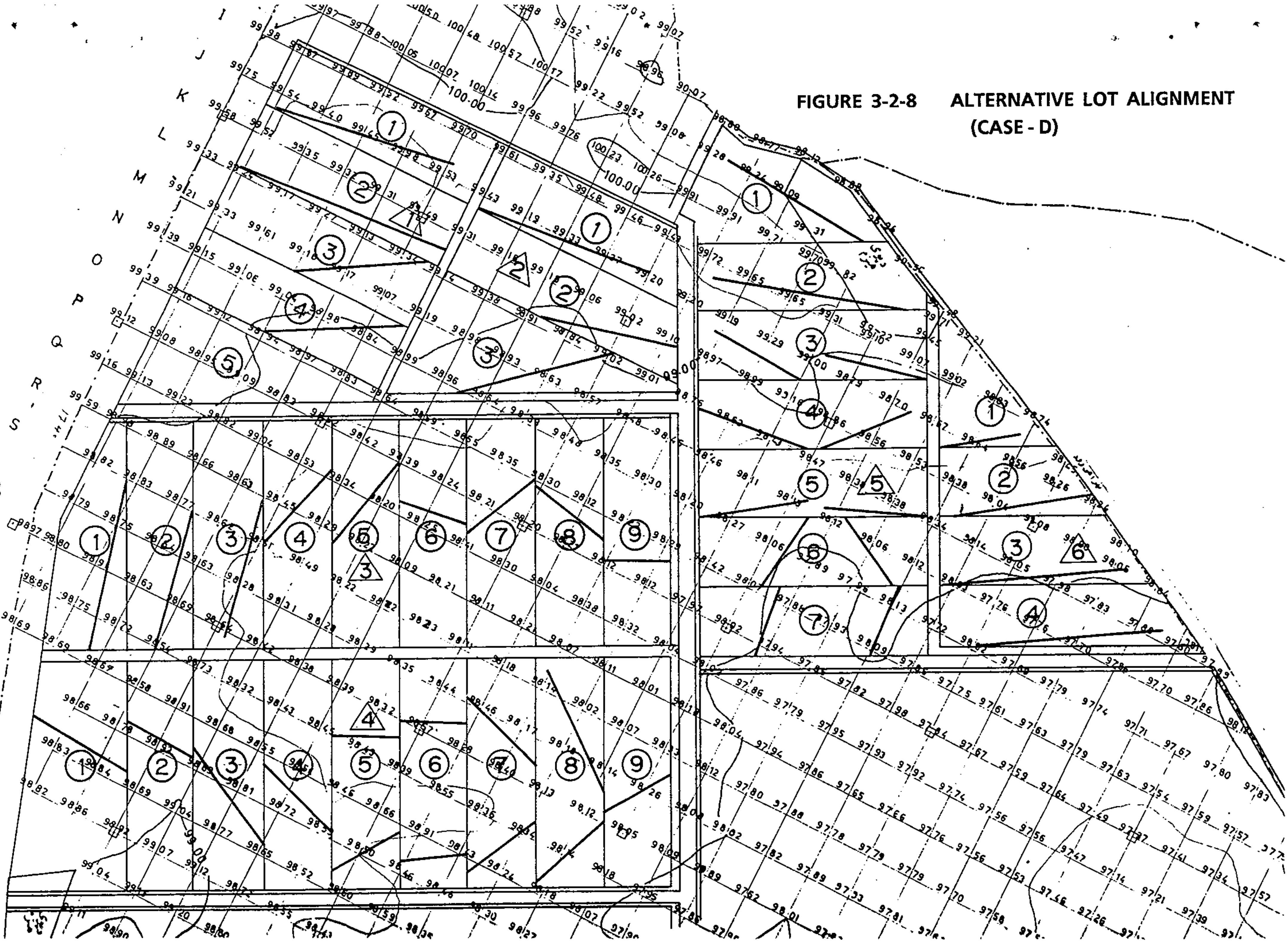


FIGURE 3-2-8 ALTERNATIVE LOT ALIGNMENT (CASE - D)

FIGURE 3-2-9 ALTERNATIVE LOT ALIGNMENT (CASE - E)

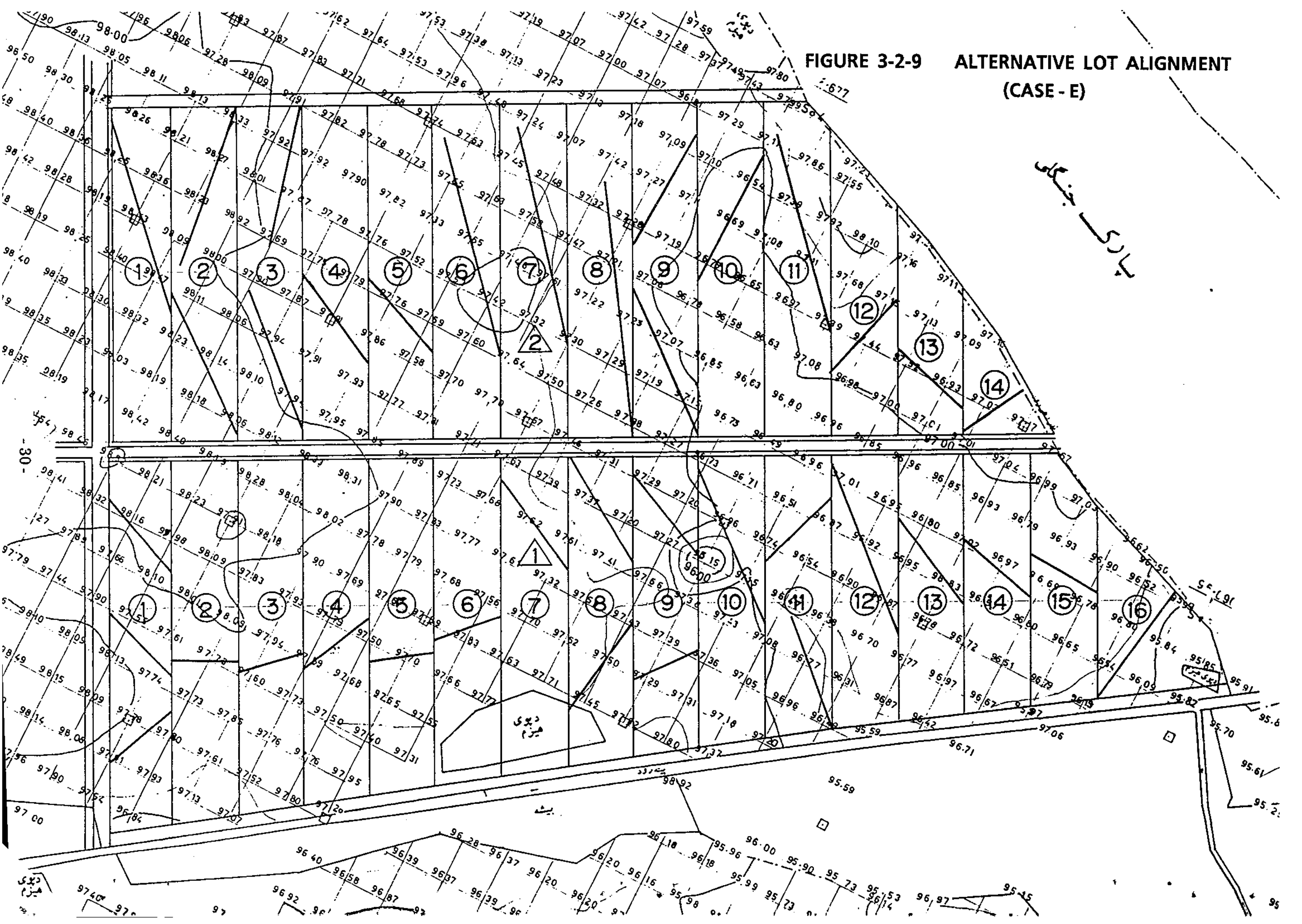
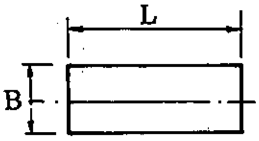
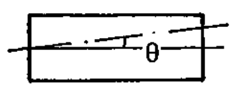
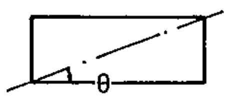
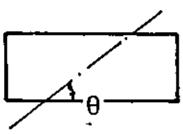
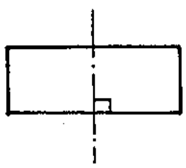


FIGURE 3-2-10 EQUATION TO CALCULATE EARTH WORK VOLUME

Case No.	Figure	Range	Equation to be Applied	
			Volume (cu.m)	Hauling Distance (m)
I		θ=0°	$\frac{L\times B\times hmax}{4}$	$\frac{2\times B}{3}$
II		0°〈θ〈T-ANG	(I×k×B3×(k× SIN2+3×COS2)) ÷ (24×COS)	(2×B×COS×k1) ÷(k2×SIN2+3 ×COS2)
III		θ=T-ANG	$\frac{L\times B\times hmax}{6}$	$\frac{\sqrt{(B2+L2)}}{2}$
IV		T-ANG〈θ〈90°	I×B3(3×K2× SIN2+COS2)÷(24 ×SIN)	(2×k×B×SIN ×k1)÷(3×k2× SIN2+COS2)
V		θ=90°	$\frac{L\times B\times hmax}{4}$	$\frac{2\times L}{3}$

Note: k = L/B, T-ANG=tan-1 (1/k), B3 = B^3, I = tan i = 2×hmax÷(B×COS+L×SIN) COS=cos θ, COS2=$\cos^2\theta$, k2=k^2, k4=k^4, SIN=sin θ, SIN2=$\sin^2\theta$,L2=L^2, i=Ground slope, k1=√(k4×SIN2+COS2), hmax=the max. cutting depth within a field lot

FIGURE 3-2-11 CALUCULATION OF EARTH MOVING VOLUME BY THEORETICAL METHOD (CASE-)

(SHEET NO. OF)

FBN	FLN	AREA (sq.m)	B (m)	L (m)	ELEVATION (m)		h (m)	θ (°)	θo (°)	EA	V (cu.m)	D (m)
					Max.	Min.						

Note;FBN = Field Block, FLN = Field Number, B = Length of Shorter Side of the Field Lot, L = Length of Longer Side of the Field Lot, h = ELmax-Elmin, θ = Angle between Counter Line and Longer Side of the Field Lot, θo = θ in Tan θ = B/L, EA = Eqation applied, V = Cutting Volume, D = Hauling Distance

Figure 3-2-12 TYPICAL MESHES ALIGNMENT

In Case of Regular Size of Filed Lot with 100 × 30 m

3 (25m)	• 99.43	• 99.46	• 99.51	• 99.54	• 99.55	• 99.59	• 99.63	• 99.67	• 99.69	• 99.71
2 (15m)	• 99.29	• 99.31	• 99.41	• 99.43	• 99.48	• 99.49	• 99.54	• 99.58	• 99.61	• 99.64
1 (Y=5m) (0 m)	• 99.11	• 99.22	• 99.38	• 99.40	• 99.46	• 99.47	• 99.53	• 99.55	• 99.59	• 99.61
	(0m) 1 (X=5m)	2 (15)	3 (25)	4 (35)	5 (45)	6 (55)	7 (65)	8 (75)	9 (85)	10 (95)

Note :

•	The center of a mesh
99.11	Representative EL of the mesh
1, 2	No. of mesh on X or Y axis
X=5m	Distance in m from the original point to the center of the mesh on X-axis
Y=5m	Distance in m from the original point to the center of the mesh on Y-axis

In Case of Irregular Size of Field Lot

3 (25m)	• 99.43	• 99.46	• 99.51	• 99.54	• 99.55	*	*	*	*	*
2 (15m)	• 99.29	• 99.31	• 99.41	• 99.43	• 99.48	• 99.49	*	*	*	*
1 (Y=5m) (0 m)	• 99.11	• 99.22	• 99.38	• 99.40	• 99.46	• 99.47	• 99.53	*	*	*
	(0m) 1 (X=5m)	2 (15)	3 (25)	4 (35)	5 (45)	6 (55)	7 (65)	8	9	10

Note :

•	The center of effective meshes
*	Non-effective meshes
99.11	Representative El of the mesh
1, 2	No. of mesh on X or Y axis
X=5m	Distance in m from the original point to the center of the mesh on X-axis
Y=5m	Distance in m from the original point to the center of the mesh on Y-axis

3.3. Irrigation Facilities Plan

3.3.1. Irrigation Planning

(1) Irrigation Area

The irrigation areas of the CAPIC are measured on the topographic map with a scale of 1:1,000. The net irrigation area is calculated by excluding areas for infrastructure such as irrigation canals, drainage canals, and farm roads. Net areas of the TDF and TF are calculated by an assumption of the non-cultivated area ratio of 5% to the total area. Proposed irrigation areas of the CAPIC are aso follows:

Irrigation Area

Field	Gross	Net	Non-Cultivated Area
Main Field	39.03	35.09	3.94
TDF	10.00	9.50	0.50
TF	12.87	12.23	0.64
Total	61.90	56.82	5.08

(2) Water Right for the CAPIC Area

The water right of the CAPIC filed is authorized by the Mazandaran Regional Water Board. Irrigation water during an irrigation period amounts within 946,080 cu.m, equivalent to 30 lit/sec/ha a year.

(3) Water Source for the CAPIC Area

Irrigation water for the CAPIC area is diverted from the Ahi Rud CAPIC Branch which was constructed by the MOA in 1990. A tubewell which locates nearby the CAPIC field has not been considered due to less yield (6.25 lit/sec at 950 rpm of a motor rotation) by a pumping test than that of water right for the CAPIC field.

The Ahi Rud CAPIC Branch is a concrete lined canal. the Branch was designed with a canal gradient of 1:1,000 and having a design capacity of 183 lit/sec. The bottom elevation at the tail end is EL 99.23 based on the temporary bench mark. (refer to Figure 3-3-3)

(4) Practices on Water Management

Following tests and demonstrations will be able to execute, after introducing land-consolidation fields in the MF.

a) Irrigation System

- Separate irrigation system
- Irrigation-cum-drainage system (dual purpose irrigation system)
- Plot-to-plot irrigation system

b) Drainage System

- Free drainage system
- Controlled drainage system

c) Water application

- Mid-summer drying
- Intermittent (rotational) irrigation system

(5) Basic Dimensions of Irrigation Plan for the CAPIC

a) Duration of Puddling (Nd or nd)

- Whole CAPIC field

  Nd = 16 days (proposed from the aspect of farming activities in CAPIC)

- for one field lot

  nd = 2 days

  First day : Filling puddling water
  Second day : Puddling and transplanting

b) Puddling Acreage per Day (Ao or ao)

$$Ao = A/Nd \text{ (ha/day)}$$

If fields under plot-to-plot irrigation system are puddled before starting an irrigation period, following equation will be applied.

$ao = (A - Ap)/Nd$ or As/Nd (ha/day)

where : A - Whole net irrigation area (ha)

As - Net irrigation area of separate irrigation system (ha)

Ap - Net irrigation area of plot-to-plot irrigation (ha)

c) Irrigation Efficiency (E)

$$E = Ea * Ef = 0.85 \times 0.90 = 0.765$$

where : Ea - Field application efficiency = 0.85

Ef - Conveyance efficiency of a tertiary canal = 0.90 (The above figures are based on the Master Plan report)

d) Crop Water Requirement

- Transplanted plot

ETcrop = ETo * Kc = 4.4 mm/day * 1.1 = 4.84 mm/day

where : ETo : reference crop evapotranspiration in May = 4.4 mm/day (refer to the Master Plan report)

Kc : Crop coefficient = 1.1 (evapotraspiration from transplanted plot)

- Puddling plot

ETcrop = ETo * Kc = 4.4 mm/day * 1.0 = 4.4 mm/day

where : Kc = 1.0 (evaporation from free water surface)

e) Puddling Water (hl)

$$hl = (212 * As + 189 * Ap) / A$$

In case of separate irrigation system : hls = 161.8 mm/E = 212 mm

In case of plot-to-plot irrigation system : hls = 144.8 mm/E
= 189 mm

Breakdown of puddling water are as follows :

Item	Separate Irr. System		Plot-to-plot Irri. System
Water to saturate soil of 30cm thickness	75 mm		75 mm
Standing water depth	50		50
Percolation during puddling (2 days)	28	(14.0*2)	11 (5.5*2)
Free water surface evaponation (2 days)	8.8	(4.4*2)	8.8(4.4*2)
Total	161.8		144.8

f) Percolation Rate (P)

(varying on type of fields and stages)

Type of Irrigation System	Land Preparation Stage (mm/day)	Growing Stage (mm/day)
Separate irrigation system (As)	14.0	7.3
Plot-to-plot irrigation system (Ap)	5.5	3.0
Total/average	$\frac{14.0*As+5.5*Ap}{A}$	$\frac{7.0*As+3.0*Ap}{A}$

Note : Percolation rate is presumed taking drainage improvement into consideration

g) Consumptive Depth in Transplanted plots (h2)

h2 = (15.5 * As + 10.2 * Ap) /A

Type of Irrigation System	Area (ha)	ETcrop (mm/day)	Percolation (mm/day)	Total (mm/day)	Depth
Separate irrigation system	As	4.84	7.0	11.84	15.5
Plot-to-plot irrigation system	Ap	4.84	3.0	7.84	10.2
Total/average	A				h2

Note : Depth = Total / E

(6) Peak Water Requirement

Water requirement of following three (3) cases were studied.

a) Case-1

Whole irrigation area is puddled in 16 days and the MF of 35.09 ha is under separate irrigation system. the TDF and TF areas of 21.73 ha are under plot-to-plot irrigation system.

Q1 = 10 * (a0 * h1 + a0 (Nd - 1) * h2) / 86.400

Q1 = 10 * (3.55 * 203 + 3.55 * (16-1) * 13.5) / 86,400
= 167 lit/sec

where : a0 = A/Nd = 56.82/16 = 3.55 ha/day
h1 = (212 * As + 189 * Ap) / A = 203 mm
h2 = (15.5 * 35.09 + 10.2 * 21.73)/56.82 = 13.5 mm/day
A = 56.82 ha
As = 35.09 ha
Ap = 21.73 ha

b) Case-2

In case of puddling under plot-to-plot irrigation system before an irrigation period (acreage and irrigation system are the same as above)

Q2 = 10 * (a0 * h1 + (Ap + a0 (Nd - 1) * h2 / 86,400

Q2 = 10 * (3.55 * 212 + (21.73+2.19 * (16-1) × 13.5) / 86,400
= 139 lit/sec

where : a0 = (A - Ap)/Nd = 35.09/16 = 2.19 (ha/day)
h1 = 212 mm
h2 = 13.5 mm/day
A = 56.82 ha
As = 35.09 ha
Ap = 21.73 ha

c) Case-3

In case of whole irrigation area under separate irrigation system.

Q3 = 10 * (a0 * h1 + (a0 (Nd - 1) * h2 / 86,400
   = 10 * (3.55 * 212 + 3.55 * (16 - 1) * 15.5) /86,400
   = 183 lit/sec

where : a0 = A/Nd = 56.82/16 = 3.55 ha/day
h1 = 212 * As + 189 * Ap) / A
   = (212 * 56.82 + 189 * 0) / 56.82
   = 212 mm
h2 = (15.5 * 56.82 + 10.2 * 0) / 56.82
   = 15.5 mm/day
A = 56.82 ha
As = 56.82 ha
Ap = 0

Since Case-3 shows the maximum water requirement, 183 lit/sec is applied as the design water requirement for the CAPIC area.

(7) Water Requirement by Growing Stage

The peak water requirement of 183 lit/sec appears at the last day of the puddling period.(refer to Figure 3-3-1)

a) Ordinary Maximum Irrigation Water Requirement

2.05 lit/sec/ha × 56.82 = 116 lit/sec (late July)

Crop water requirement	= ETo * Kc/2 = 164 * 1.2/2	=	98.4 mm
Percolation	= P * 15 days = 7 * 15	=	105 mm
Net irrigation requirement			203.4 mm
Irrigation requirement (Ir)	In/E	=	203.4 / 0.765
		=	265 mm / 15 days
		(or =	17.7 mm/day)
		(or =	2.05 lit/sec/ha)

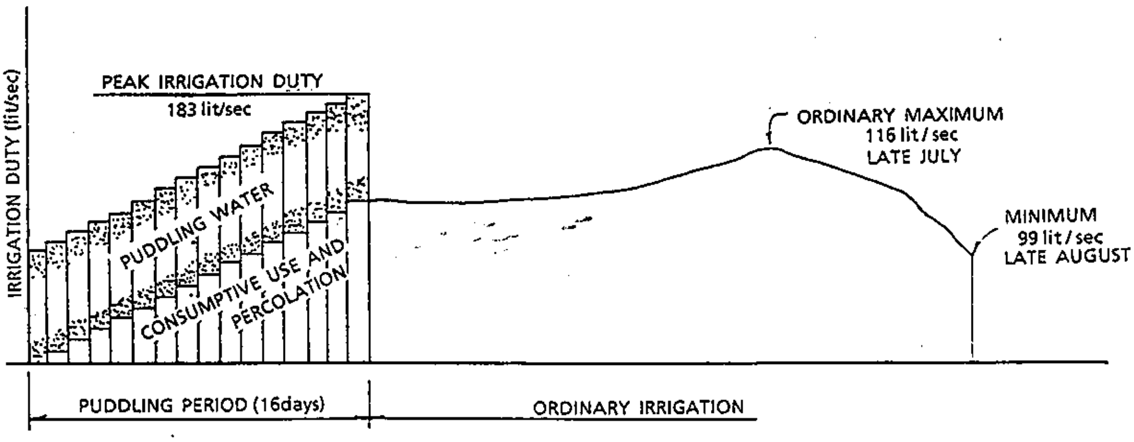
b) Minimum Irrigation Water Requirement

1.75 lit/sec/ha × 56.82 = 99 lit/sec (late August)

Crop water requirement	= ETo * Kc/2 = 146 * 0.95/2	= 69.4 mm
Percolation	= 7 * 15	= 105.0 mm
Net irrigation requirement (In)		= 174.0 mm

Irrigation requirement (Ir) = In/E = 174/0.765
= 227 mm/15 days
(or = 15.1 mm/day)
(or 1.75 lit/sec/ha)

FIGURE 3-3-1 IRRIGATION WATER REQUIREMENT BY GROWING STAGE



(8) Total Water Requirement During Growing Period

Total amount of water requrement during growing period is estimated at 1,055,000 cu.m when separate irrigation system is fully introduced and drainage is operated freely. This amount slightly exceeds the amount of water right (946,030 cu.m) given to the CAPIC. Therefore, it will be needed to save irrigation water by operating drainage checks to control drainage and to raise up groundwater level for decreasing percolation in some area.

Total water requirement = $\Sigma Ir \times A$ = 1,857 mm × 56.82 ha
= 1,055,000 cu.m

Note:

ΣIr : Total water requirement depth=1,857 mm
(refer to Table 3-3-5)

3.3.2. Schematic Diagram of Irrigation System

The schematic diagram is shown in Figure 3-3-4 and Tables 3-3-1 to -3 based on unit water requirement and irrigation areas by canal.

3.3.3. Design of Irrigation Facilities

The lateral irrigation canal to be constructed in the MF receives irrigation water from the afore mentioned Ahi Rud Branch canal at the boundary of the MF, and conveys the water to several irrigation ditches which provide irrigation water to farmlands.

(1) Alignment of Irrigation Ditches

- In case of a separate irrigation system

  Irrigation ditches proposed in the MF are aligned along farm roads for easy operation and maintenance. Each field lot can be directly irrigated from the irrigation ditch. Therefore, irrigation ditches are generally aligned on both sides of farm road. (refer to Figures 3-3-5 and -6)

- In case of irrigation-cum-drainage system (Dual purpose irrigation system)

  In the MF, the dual-purpose irrigation system can be demonstrated to farmers by operating the drainage release(s) located at the upper end of the drainage canal and by operating the check structure(s) on the drainage canal at the same time. In this case, upstream from the check structure, irrigation water can be provided to the field through the drainage canal and downstream from the structure excess water can be drained into the same drainage canal. However, the same variety of rice with almost the same growing stages would be planted in the rice fields as far as possible in the portion between both check structures due to efficient water management to control water level of the drainage canal. The water level of the drainage canal should be kept above that of the rice field's level. (refer to Figure 3-3-5 and -6)

- Plot-to-polot irrigation system

  The inlet located at upper end of the irrigation ditches should be operated to irrigate the field block. The check structure downstream from the said inlet on the irrigation ditch should be closed and other inlets should also be closed during irrigation periods. The irrigation water can flow from the upstream field lot down to the downstream field lot. (refer to Figure 3-3-5 and -6)

(2) Irrigation Canal

Irrigation canals in CAPIC consist of two lateral irrigation canals (LIC) and 12 irrigation ditches (ID).

a) Lateral irrigation canal (LIC)

LIC-1	L = 1,120 m	(concrete block type)
LIC-2	L = 890 m	(concrete block type and MOA precast concrete canal)
<u>Total</u>	<u>L = 2,013 m</u>	

LIC-1 is designed with a gentle canal gradient of 1:5,000 for LIC-1 (1) and 1:3,000 for LIC-1 (2) and (3) to convey water for the TDF and TF as shown in Figure 3-3-7. LIC-1 can reach to the TDF and TF with a water level of EL 99.07 m based on the temporary bench mark, and irrigate the most area of TDF and TF up to an elevation of EL 88.80 m. On the other hand, LIC-2 is designed with steeper gradient of 1:2,000 on LIC-2(1) section, 1:500 on LIC-2(2) section, and 1:600 on LIC-2(3) section as shown in Figure 3-3-7 due to topographic condition. The MOA standard precast concrete canal type A-3 can be adopted for LIC-2(2) and (3) sections. Computation of hydraulic profile is shown in Table 3-3-6 for LIC-1 and Table 3-3-7 for LIC-2, respectively.

b) Irrigation Ditches

There are 12 irrigation ditches which are proposed in the MF. The details are described in thereafter section.

(3) Typical Cross-section of Irrigation Canal

a) Lateral irrigation canal

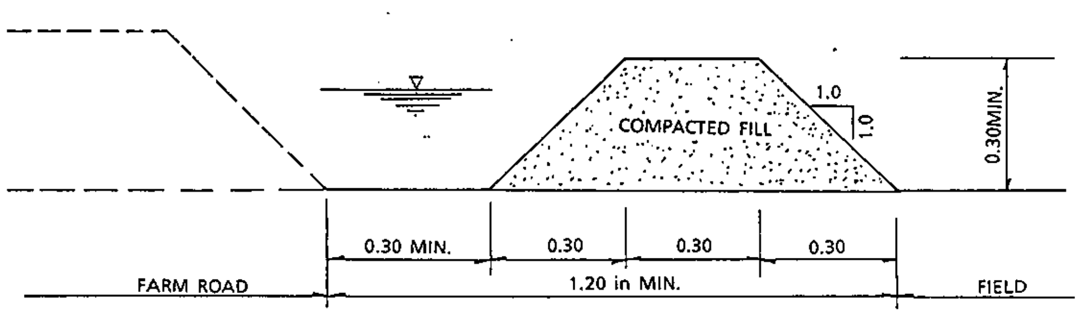
The lateral irrigation canal (LIC) is classified into two types of canal. One is concrete block canal, and the other is MOA standard precast concrete canal as shown in Figure 3-3-8. Both types of canals are not using any reinforcing bars, because of shortage of reinforcing bars in market.

As an alternative type, pedestal thin lined concrete canal is considered. Howerver, this type is not employed Because of larrge land occupation.

b) Irrigation ditches

A side slope of 1:1 for the ditch would be applied. A berm width of 30 cm, a minimum bottom width of 30 cm and a minimum ditch depth of 30 cm are designed for easy construction and maintenance. The lateral irrigation ditch is lined, however, irrigation ditches are unlined in order to minimize construction costs apart from except portions where the ditch runs through sandy soil or in a high embankment portions. This reduces the seepage loss from the ditch. (refer to Figure 3-3-2)

Figure 3-3-2 TYPICAL CROSS SECTION OF IRRIGATION DITCH



(4) Design criteria of irrigation canals

a) Applied equation

The manning equation is applied to determine the suitable cross-section to allow for the adequate discharge required for irrigation. Roughness coefficient of 0.015 for a lined canal and 0.03 for an unlined canal are applied.

Manning Equation $V = S^{1/2} \times R^{2/3}/n$

$Q = A \times V$

Where :

V : Velocity (m/sec)
S : Hydraulic gradient (1/length in m)
R : Hydraulic radius (m) = A/P
n : Roughness coefficient
Q : Discharge (cu.m/sec)
A : Flow area (sq.m)
P : Wetted perimeter (m)

b) Maximum velocities

A maximum velocity is set at 1.5 m/sec for a lined canal and at 0.8 m/sec for an unlined canal. However, it is allowed up to 1.5 times of them for a monentary discherge as in puddling period.

c) Minimum velocity

According to the Agricultural Enginnering Handblock (Japan) and the Design Criteria of Canal No.1 (Japan, the following velocities are instructed as a minimum velocity;

- Non sedimentation velocity, when water is not containing suspended solid more grain-size than silt

  $V = 0.45 \sim 0.90$ m/sec

- Non-grass growing velocity

  $V \geqq 0.7$ m/sec

In the CAPIC area, it is rather difficult to employ above velocities due to gentle slope at most area. LIC-1 has especially a gentle slope to irrigate the TDF and TF up to 98.8m at its end. Consequently, the minimum velocity is set at 0.30 m/sec in this design. Some of sedimentation and grass growing are accordingly not avoidable in the proposed canal. Therefore, it will need to remove sediment and grass in a canal by maintenance. It will not be acceptable to install a sedimentation basin to remove sediment, because most suspended sediment consists of silt in the Ahi Rud at the CAPIC site.

d) Freeboard

A suitable freeboard is necessary to efficiently operate and maintain the irrigation canals. An irrigation ditch without an adequate freeboard will be easily destroyed by overflow resulting from management error. Excessive freeboard, however, will invite higher investment costs in irrigation infrastructure. The freeboard of both a lateral irrigation canal and an irrigation ditch are determined by the following equation.

$$\text{Freeboard} = 0.05\ d + hv + (0.05 \sim 0.15)\ (m)$$

In accordance with the above criteria, a freeboard is set as follows :

Lateral irrigation canal	:	Concrete block canal = 13 cm MOA standard precast concrete canal=7 cm
Irrigation ditch	:	5cm, but allowing up to 3cm for puddling water supply.

(5) Dimension of farm ditches

Based on the above basic figures. dimensions of farm ditches are determined as following Table 3-3-4.

3.3.4. Design of Appurtenant Structures

(1) Check Gate

In order to control water level in canals, a check gate(s) is proposed in the MF. In total, seven(7) check gates are proposed in the MF. The attached Drawings of "Longitudinal Profile" of LIC-1 and LIC-2 show the proposed location of check gates. LIC-2 has five(5) check gates due to steeper slope of the canal bed.

(2) Turn-out

To divert irrigation water to irrigation ditches(ID(s)), 12 turn-out structures are provided in the MF. This structures are constructed at the beginning point of a ID. The turn-out having a width of 40 cm and the minimum delivery head of 5 cm is designed for easier operation.

(3) Drainage Release

A drainage release is proposed to divert irrigation water to a drain ditch when irrigaiton-cum-drainage system is operated in the MF. LIC-1, LIC-2 and ID-8 have three(3), three(3) and one(1) drainage releases, respectively.

(4) Parshall Flume

For measuring irrigation water discharge in an irrigation canal, a parshall flume is proposed. At the diversion point of LIC-2 from LIC-1, two(2) Parshall flumes will be constructed. The 1.5 ft type Parshall flumes are chosen for two(2) LICs due to less loss head, considering parshall flumes can be operated under free flow condition at any time in the LICs. The equation to calculate discharge in a parshall flume of 1.5 ft type is as follows :

$$Q = 1.056 \, Ha^{1.538}$$

where : Q = Discharge (cu.m/sec)
Ha = Depth of gauging point in the converging section(m)

(5) Spillway

For safety operation of irrigation system, two(2) spillways are proposed. The first spillway(1-1) is proposed at the beginning point of LIC-1 to drain excess water away from the canal. The second spillway is proposed at the point of STA.9+43 on LIC-1, that is, about 180m upstream of the siphon structure over the Piteh Rud. To calculate design discharge, the following equation is employed.

$$Q = \{ 2\sqrt{(2g)} \} / 3 \cdot \mu \cdot L \ \{ (h1 + h2) / 2 \}^{1.5}$$

where : Q = Overflow capacity (cu.m/sec)
L = Overflow crest length (m)
μ = Coefficient of discharge
h1 = Upstream over flow depth (m)
h2 = Downstream overflow depth (m)

In case of the spillway 1-1 ;

Q = 0.279 cu.m/sec (= full capacity of Ahi Rud CAPIC Branch 0.462 cu.m/sec - the capacity of LIC-1 0.183 cu.m/sec)
h1 = 0.20m (EL99.78 - El99.65)
h2 = 0.0 m

therefore : L = 4.64 m (say 5.0m)

In case of the spillway 1-2 :

Q = 0.144 cu.m/sec
h1 = 0.13m (freeboard depth)
h2 = 0.0m

therefore : L=5.15 m (say 5.0m)

(6) Piteh Rud siphon

The Piteh Rud siphon is proposed for conveying irrigation water to the TDF and TF over the Piteh Rud with a concrete pipe conduit of ∅ 400mm.

(7) Inlet to a field

Various inlet structures are proposed at each 30 m interval with a minimum delivery head of 20 cm in the consolidated field. In this design, most simple inlet is proposed as some as existing one. At the inlet point on an irrigation ditch, it is rather difficult to extension work regarding to water management, good inlet structures can be introduced because of high investment cost. Figure 3-3-9 shows one of sample drawings of inlets.

Table 3 - 3 - 1 CANAL CAPACITY

NAME OF CANAL		OPERATED UNDER IRRIGATION EXCLUSIVELY		OPERATED UNDER IRRIGATION-CUM-DRAINAGE	
		AREA (ha)	DISCHARGE (lit/sec)	AREA (ha)	DISCHARGE (lit/sec)
Ahi Rud Capic Branch		56.82	183	56.82	183
LIC-1	(1)	56.82	183	56.82	183
	(2)	36.89	147	35.30	144
	(3)	35.30	144	35.30	144
	(4)	32.42	139	35.30	144
	(5)	26.71	128	29.37	133
		21.73	119	23.90	123
LIC-2	(1)	19.93	116	21.52	119
		17.98	113	17.98	113
	(2)	14.74	107	14.74	107
	(3)	6.03	91	10.93	100
ID- 1		1.59	39	-	-
ID- 2		2.88	71	-	-
ID- 3		3.05	75	-	-
ID- 4		2.66	65	-	-
ID- 5		2.81	69	-	-
ID- 6		2.17	53	-	-
ID- 7		1.95	48	-	-
ID- 8		1.16	28	3.24	79
ID- 9		2.08	51	-	-
ID-10		3.81	87	-	-
ID-11		4.90	89	-	-
ID-12		6.03	91	-	-

Note) This table is derived by the equation below.

Q = A1 * 24.5 lit /sec/ha (lit/sec)
Q = 86.9 lit/sec + (A2 - 3.55) * 1.734 lit/sec/ha (lit/sec)

A1 : Irrigation area less than 3.55 ha
A2 : Irrigation area more than 3.55 ha
212 mm * 10,000 / 86,400 = 24.5 lit/sec/ha
15.5 mm * 10,000 / 56,400 = 1.734 lit/sec/ha

Table 3-3-2 DISCHARGE AT ORDINARY MAXIMUN

NAME OF CANAL	OPERATED UNDER IRRIGATION EXCLUSIVELY		OPERATED UNDER IRRIGATION-CUM-DRAINAGE	
	AREA (ha)	DISCHARGE (lit/sec)	AREA (ha)	DISCHARGE (lit/sec)
Ahi Rud Capic Branch	56.82	116	56.82	116
LIC-1 (1)	56.82	116	56.82	116
(2)	36.89	76	35.30	72
(3)	35.30	72	35.30	72
(4)	32.42	66	35.30	72
(5)	26.71	55	29.37	60
	21.73	45	23.90	49
LIC-2 (1)	19.93	41	21.52	44
	17.98	37	17.98	37
(2)	14.74	30	14.74	30
(3)	6.03	12	10.93	22
ID-1	1.59	3.3	-	-
ID-2	2.88	5.9	-	-
ID-3	3.05	6.3	-	-
ID-4	2.66	5.5	-	-
ID-5	2.81	5.8	-	-
ID-6	2.17	4.4	-	-
ID-7	1.95	4.0	-	-
ID-8	1.16	2.4	3.24	6.6
ID-9	2.08	4.3	-	-
ID-10	3.81	7.8	-	-
ID-11	4.90	10	-	-
ID-12	6.03	12	-	-

Note) The ordinary maximum discharge appears in later half of July,
Discharge of ordinary maximum can be computed as follows :

$Q = 2.05 * A$

Q : Ordinary maximum discharge of canal (lit/sec)

A : Irrigation area of canal (ha),

2.05 : Unit water requirement at ordinary maximum (lit/sec/ha)

Table 3 - 3 -3 DISCHARGE AT ORDINARY MINIMUM

NAME OF CANAL		OPERATED UNDER IRRIGATION EXCLUSIVELY		OPERATED UNDER IRRIGATION-CUM-DRAINAGE	
		AREA (ha)	DISCHARGE (lit/sec)	AREA (ha)	DISCHARGE (lit/sec)
Ahi Rud Capic Branch		56.82	99	56.82	99
LIC-1	(1)	56.82	99	56.82	99
	(2)	36.89	65	35.30	62
	(3)	35.30	62	35.30	62
	(4)	32.42	57	35.30	62
	(5)	26.71	47	29.37	51
		21.73	38	23.90	42
LIC-2	(1)	19.93	35	21.52	38
		17.98	31	17.98	31
	(2)	14.74	26	14.74	26
	(3)	6.03	11	10.93	19
ID- 1		1.59	2.8	-	-
ID- 2		2.88	5.0	-	-
ID- 3		3.05	3.2	-	-
ID- 4		2.66	1.4	-	-
ID- 5		2.81	4.9	-	-
ID- 6		2.17	6.8	-	-
ID- 7		1.95	3.4	-	-
ID- 8		1.16	2.0	3.24	5.7
ID- 9		2.08	3.6	-	-
ID-10		3.81	6.7	-	-
ID-11		4.90	8.6	-	-
ID-12		6.03	11	-	-

Note) The ordinary minimum discharge appears in later half of August just begore harvesting. Discharge of the ordinary minimum can be computed as follows :

$Q = 1.75 * A$

Q : Ordinary minimum discharge of canal (lit/sec)

A : Irrigation area of canal (ha),

1.75 : Unit water requirement at ordinary maximum (lit/sec/ha)

TABLE 3-3-4 LIST OF IRRIGATION DITCH

Name of Irri. Ditch	Irri. Area (ha)	Design Discharge (lit/sec)	Length (m)	Hydraulic Gradient (1/)	Roughness Coefficient	Size of Irrigation Ditch			Design Velocity (m/sec)
						Bottom (B, cm)	Flow Depth (FD, cm)	Canal Depth (H, cm)	
ID-1	1.59	31.1 / 3.3	173	1/250	0.030	30	16	30	0.44
ID-2	2.88	56.4 / 5.9	271	1/300	〃	30	22	30	0.48
ID-3	3.05	59.7 / 6.3	286	1/350	〃	30	24	30	0.46
ID-4	2.66	52.1 / 5.5	282	1/450	〃	30	24	30	0.41
ID-5	2.81	55.0 / 5.8	291	1/400	〃	30	24	30	0.43
ID-6	2.17	42.5 / 4.4	293	1/350	〃	30	20	30	0.42
ID-7	1.95	38.2 / 4.0	149	1/450	〃	30	20	30	0.38
ID-8	1.16	63.4	340	1/900	〃	40	29	40	0.54
		22.7 / 2.4				30	18	30	0.25
				1/150		30	11	30	0.49
ID-9	2.08	40.7 / 4.3	208	1/750	〃	30	24	30	0.32
				1/100		30	14	30	0.66
ID-10	3.81	70.0 / 7.8	286	1/500	〃	30	28	35	0.42
ID-11	4.90	71.9 / 10.2	459	1/500	〃	30	29	35	0.42
ID-12	6.03	74.0 / 12.4	447	1/400	〃	30	28	35	0.46
Total	35.09		3,485						

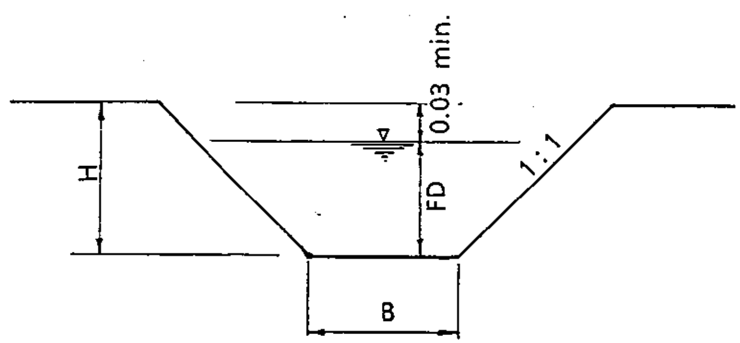


TABLE 3-3-5 WATER REQUIREMENT IN THE CAPIC

Month		Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Reference Crop Evapo.(ETo mm/mon)		62	93	136	165	164	146	105	
Cropping Pattern			Nursery	Land preparation & Transplanting			End of Irrigation	Harvesting	
Water Requirement	Crop Coefficient (kc)		Nursery		1.1	1.2	0.95		
	Period (days)			15	30	15 16	15 16		
	Nursery (mm)		14	5					19
	Land Preparation (mm)			162					162
	Crop Water Requirement (mm)			75	182	189	157		603
	Percolation (mm)			105	210	217	217		749
Total ○ (mm)			14	347	392	406	374		1,533
Rainfall (50 % Prob.)	r (mm)	63	44	25	28	30	46	75	
	re (mm)	47	33	19	21	23	35	56	
Net Irrigation Requirement	In (mm)		0	328	371	383	339		1,421
Irrigation Requirement	Ir (mm)		0	429	485	500	443		1,857

Note)
1. Cropped period is selected as in the Middle Land taking location of CAPIC into consideration
2. Requirement of nursery refers to the Master Plan.
3. Land preparation water refers to Pudding water in case of separate irrigation system.
4. Percolation is dapreding on 7 mm/day in case of separate irrigation system.
5. Rainfall refers to 50 % probability in the Master Plan.
6. In = Wr - re, Ir = In/E = In / 0.765

Table 3-3-6 HYDRAULIC COMPUTATION OF LIC - 1

Station	Distance (m)	Incremental Distance	Structure	Q (cu.m/s)	Canal Slope	V (m/s)	Head loss (m)	Water Level (m)	Depth (m)	Canal Bed (m)
			Air Rud Branch	0.183	1/1,000	0.73		99.58	0.35	99.23
No.0	(Note)	Designed to check up by 0.07m						99.65	0.42	99.23
		286.25	LIC - 1 (1)	0.183	1/5,000	0.37	0.06			
No.2 + 86.25	286.25							99.59	0.45	99.14
		5.027	LIC - 1 (2)	0.144	1/5,000	-	0			
		(Note)	Same Section as LIC - 1 (1)							
No.2 + 91.307	291.307							99.59	0.45	99.14
		2.943	1.5 ft Parshall Flume	0.144	-	-	0.10			
No.2 + 294.25	294.25							99.49	0.42	99.07
		653.75	LIC - 1 (2)	0.144	1/3,000	0.42	0.22			
No.9 + 48	948.00							99.27	0.42	98.85
		1.00	Check Gate 1-2	0.119	-	-	0			
No.9 + 49	949.00							99.27	0.37	98.90
		156.00	LIC - 1 (3)	0.119	1/3,000	0.40	0.05			
No.11 + 5 (IP8)	1,105.00							99.22	0.37	98.85
		15.00	Syphon (ø400)	0.119	-	0.95	0.10			
No.12 + 20	1,120.00							99.12	0.37	98.75
		160.00	LIC -1 (3)	0.119	1/3,000	0.40	0.05			
No.12 + 80	1,280.00							99.07	0.37	98.70

Note)

1. Head loss of 1.5 ft Parshall Flume. (refer to "Water Measurement Manual", USBR)

$Q = 1.056\ ha^{1.538}$

Where :

Q : discharge (cu.m/sec) = 0.144 cu.m/sec

ha : depth at gaging point in the converging section (m)

$ha = (Q/1.056)^{1/1.538} = 0.274$ m

$h_{loss} = 0.3 * ha$

h_{loss} = required minimum head loss for free flow(m)

$h_{loss} = 0.3 * 0.274 * 0.082 = 0.10$ m

2. Head loss of syphon

1) Friction loss

$$hf = L * i = L * 10.57 * C^{-1.85} * D^{-4.87} * Q^{1.85}$$
$$= 14.25 * 10.57 * 130^{-1.85} * 0.40^{-4.87} * 0.119^{1.85}$$
$$= 14.25 * 0.0022 + 0.032 \text{ m} \cdots\cdots \text{Hazen-Williams}$$

i : hydraulic gradient

L : length of pipe (m)

C : coefficient of concrete pipe

Q : discharge (cu.m/sec)

2) Head loss of entrance

$$hen = fen * hv = 0.5 * 0.046 = 0.023 \text{ m}$$

fen : coefficient of entrance loss

fv : velocity head (m)

$fv = v^2/2g = (Q/A)\,2/2g = 90.119/(\pi * 0.5^2 * 0.25))^2/19.6$

3) Head loss of exit

$$hex = fex * hv = 1.0 * 0.046 = 0.046 \text{ m}$$

hex: coefficient of exit loss

4) Total head loss

$$h = hf + hen + hex = 0.032 + 0.023 + 0.046 = 0.101$$
$$= 0.10 \text{ m}$$

Table 3-3-7 HYDRAULIC COMPUTATION OF LIC - 2

Station	Distance (m)	Incremental Distance	Structure	Q (cu.m/s)	Canal Slope	V (m/s)	Head loss (m)	Water level (m)	Depth (m)	Canal Bed (m)
No.0	0							99.59	0.45	99.14
		3.657	B 1.1, H 0.60	0.119	1/2,000	-	0.00			
No.0 + 3.657	3.657							99.59	0.45	99.14
		2.594	1.5 ft Parshall Flume	0.119	-	-	0.11			
No.0 + 6.60	6.60							99.48	0.36	99.12
		193.40	LIC - 2 (1)	0.119	1/2,000	0.47	0.10			
No.2	200.00							99.38	0.36	99.02
		0	Transition	0.107	1/2,000	-	-			
No.2	200.00							99.38	0.25	99.13
		368.50	LIC - 2 (2)	0.107	1/500	0.82	0.74			
No.5 + 68.5	568.50							98.64	0.25	98.39
		324.50	LIC - 2 (3)	0.100	1/600	0.76	0.54			
No.8 + 93.0	893.00							98.10	0.25	97.85

Note) Head loss of 1.5 ft Parshall Flume

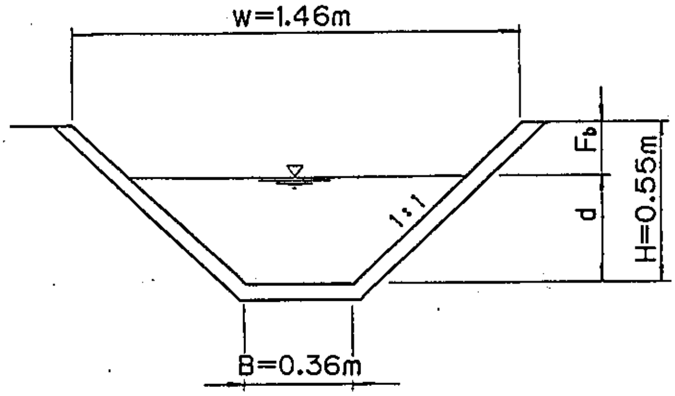
$ha = (Q / 1.056)^{1/1.538} = 0.242$ m

$h_{loss} = 0.3 * ha = 0.3 * 0.242 = 0.073 = 0.11$ m

h_{loss} is set at 0.11 m taking minimum discharge measurement into consideration

FIGURE 3-3-3 RATING CURVE OF AHI RUD CAPIC BRANCH

SECTION



Hydraulie Elements
Slope of Canal : $i = 1/1000$
Roughness coefficent
: $n = 0.014$

$v = \sqrt{i} / n \, R^{2/3}$, $Q = v \cdot A$ …… (Manning Eguation)
v = mean velocty (m/sec)
Q = discharge (m^3/sec)
R = hydraulic mean depth (m)
R = A/P
A = flow area (m^3)
P = wetted perimeter (m)

d	$\sqrt{i}/n$	A (m^2)	P (m)	R (m)	v (m/s)	Q (m/s)	Fb (m)	Remarks
0.20	2.259	0.112	0.926	0.121	0.553	0.062	0.35	
0.25	〃	0.153	1.067	0.143	0.617	0.094	0.30	
0.30	〃	0.198	1.209	0.164	0.676	0.134	0.25	
0.35	〃	0.249	0.350	0.184	0.731	0.183	0.20	Original design
0.36	〃	0.259	1.378	0.188	0.742	0.192	0.20	
0.37	〃	0.270	1.407	0.192	0.752	0.203	0.19	in case
0.38	〃	0.281	0.435	0.196	0.762	0.214	0.18	reducing Fb
0.40	〃	0.304	0.491	0.204	0.782	0.238	0.15	

Free board (Fd) is seccomended as follows;
$Fb = 0.05d + hv + (0.05 \sim 0.15)$ for lined or non-lined canal.
$Fb = 0.05 \times 0.35 + 0.02 + (0.05 \sim 0.15) = 0.02 + 0.02 + (0.05 \sim 0.15)$
$= 0.09 \sim 0.19$ (m)

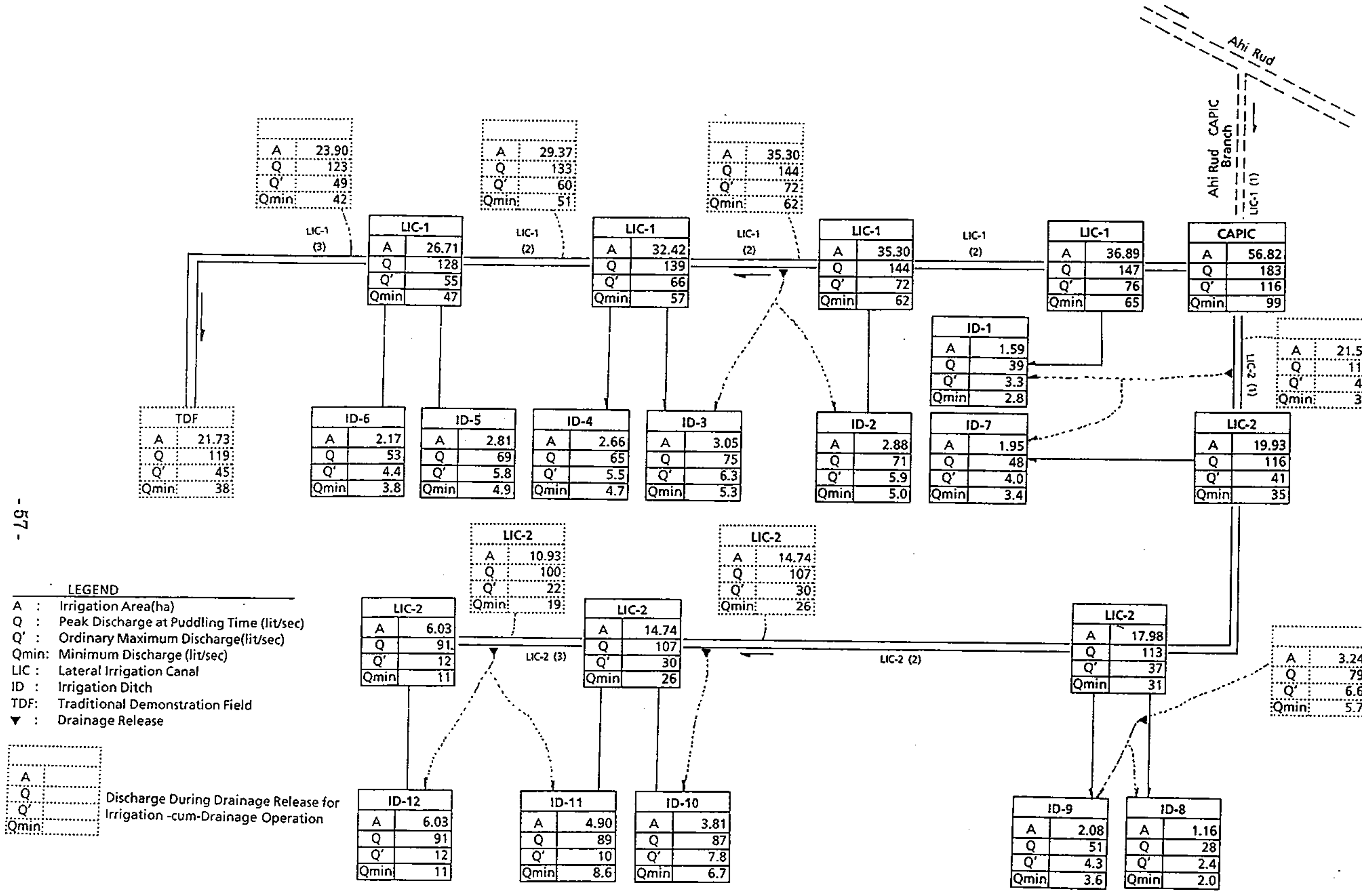
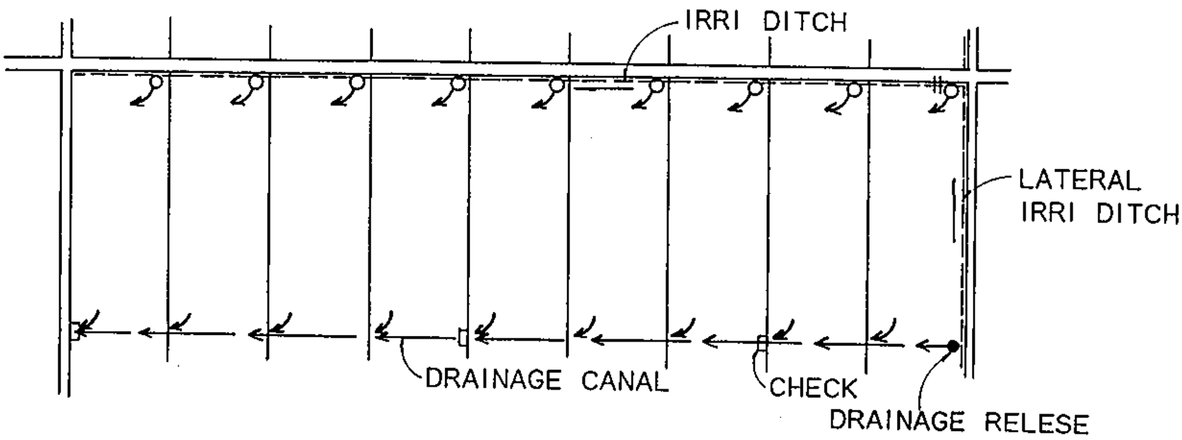
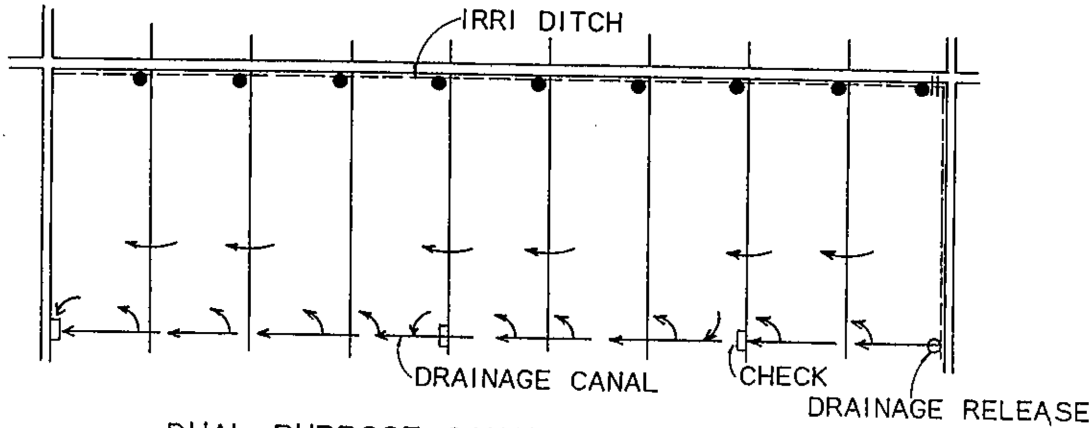


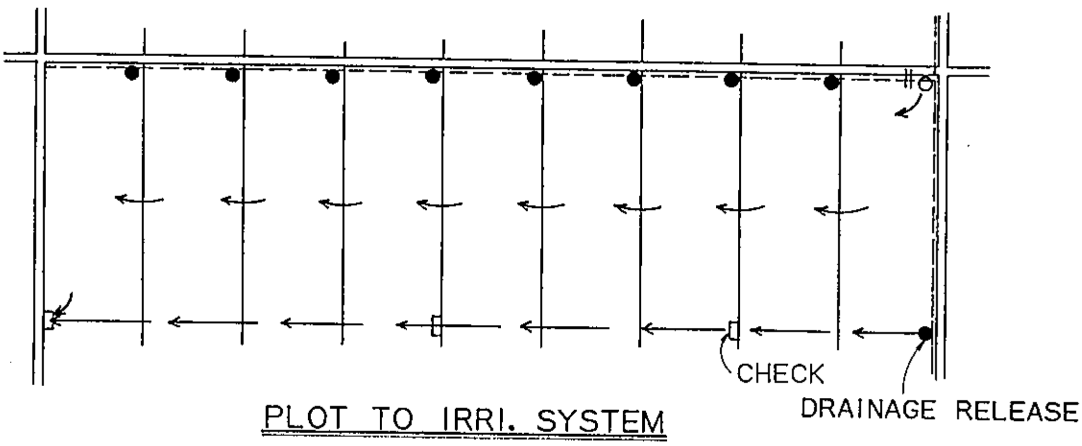
FIGURE 3-3-4 SCHEMATIC DIAGRAM OF IRRIGATION SYSTEM



SEPARATE IRRI. and DRAINAGE SYSTEM



DUAL PURPOSE CANAL IRRI. SYSTEM



PLOT TO IRRI. SYSTEM

Note:

○ OPEN

● CLOSE

FIGURE 3-3-5 VARIOUS IRRIGATION SYSTEM TO BE PRACTISED IN CAPIC

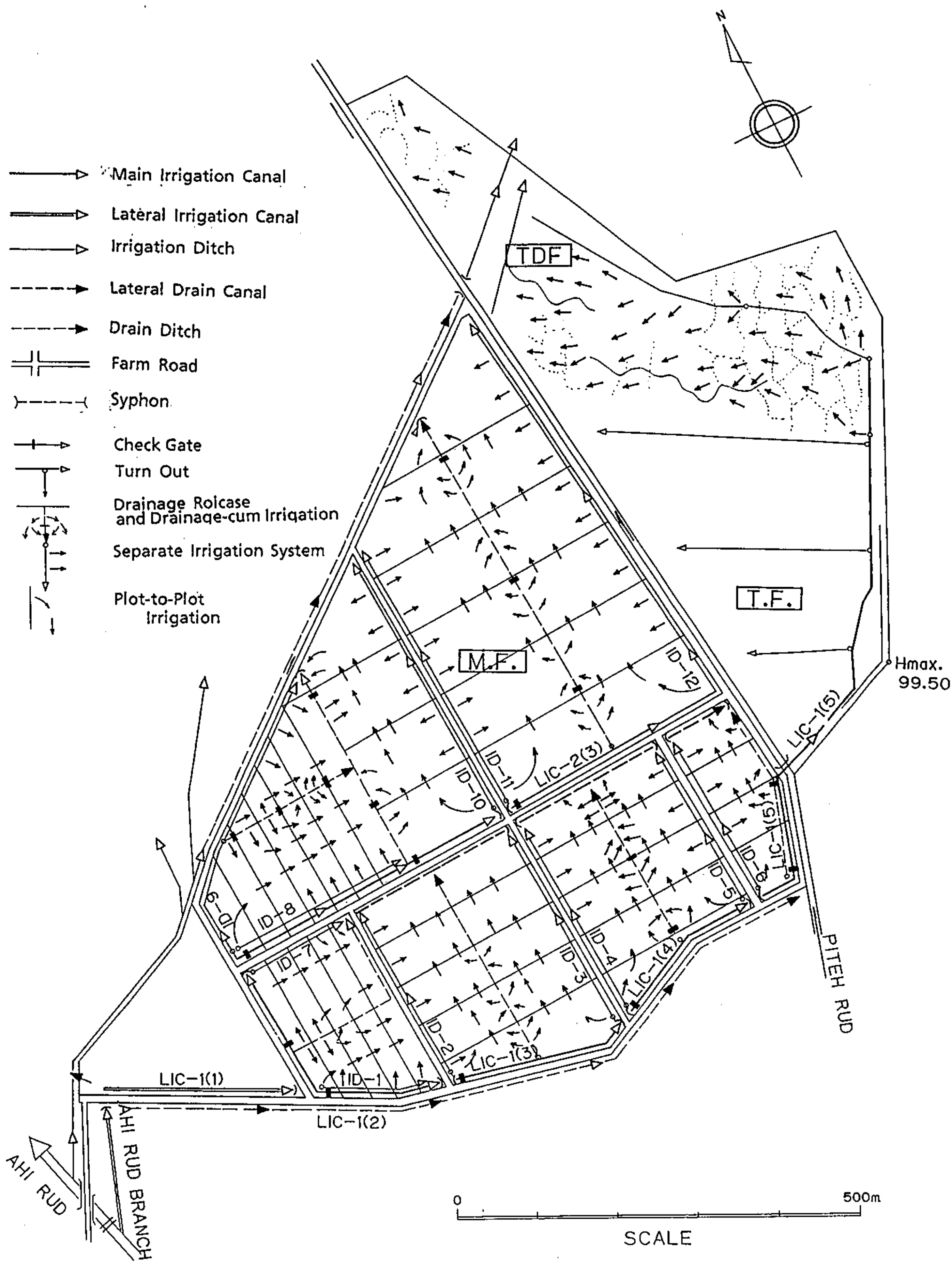
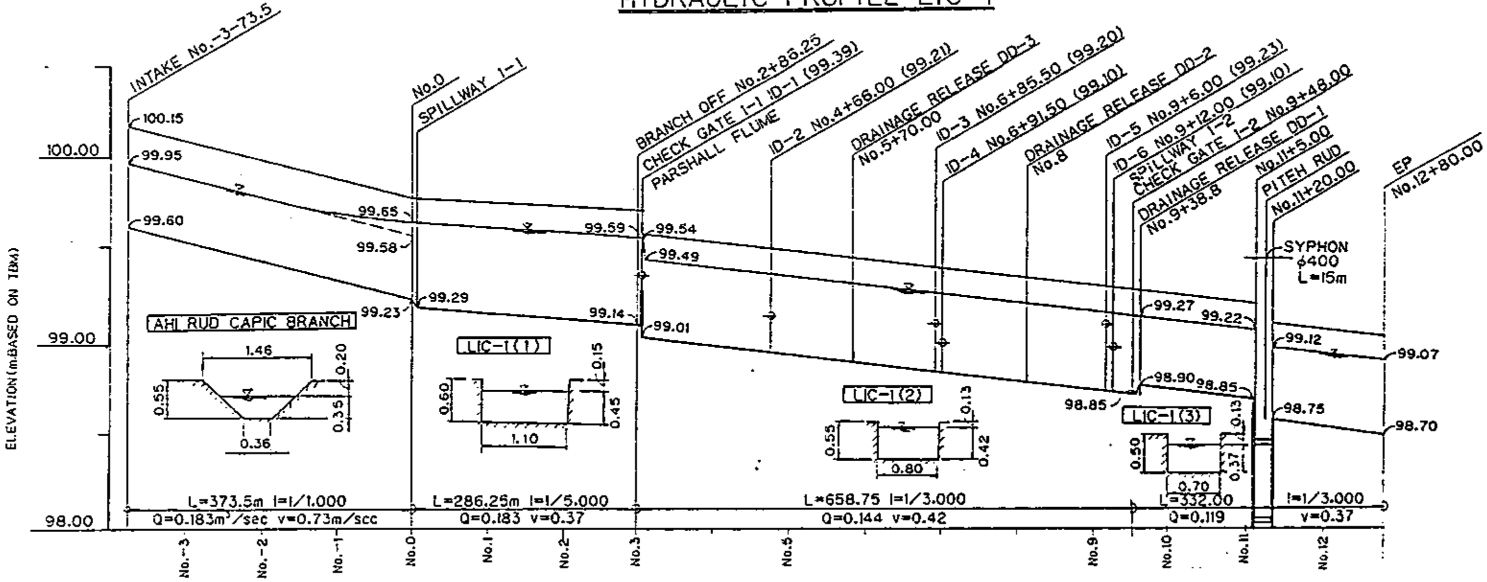


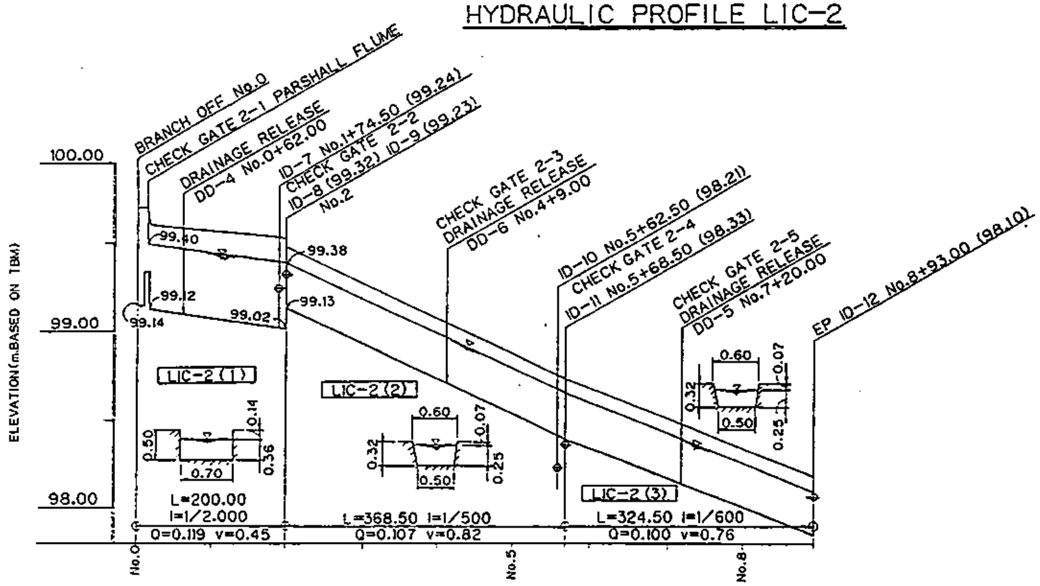
FIGURE 3-3-6 PROPOSED IRRIGATION SYSTEM OF CAPIC

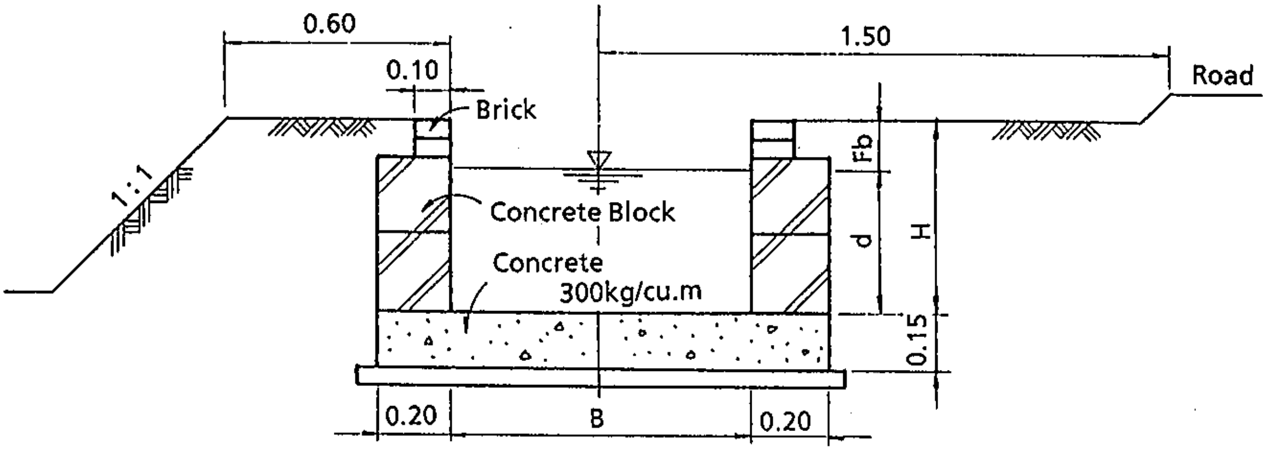
FIGURE 3-3-7 HYDRAULIC PROFILE OF LIC-1 AND LIC-2

HYDRAULIC PROFILE LIC-1



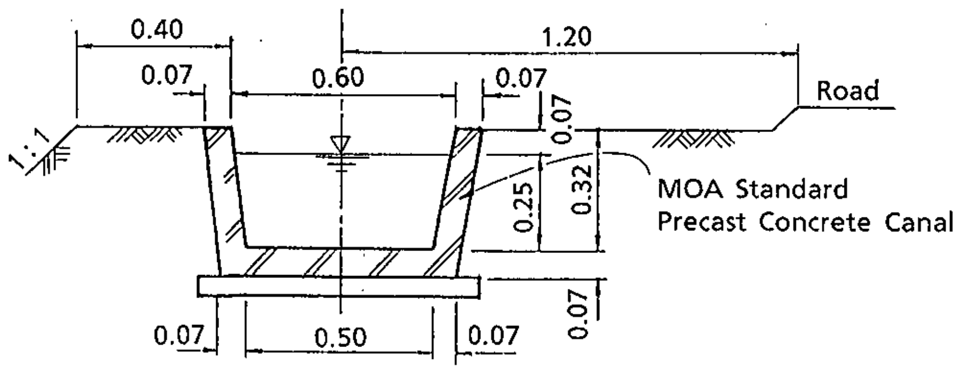
HYDRAULIC PROFILE LIC-2





LIC	Q	i	B(m)	H(m)	d(m)	Fb(m)	v
LIC-1(1)	0.183	1/5000	1.10	0.60	0.45	0.15	0.37
LIC-1(2)	0.144	1/3000	0.80	0.55	0.42	0.13	0.42
LIC-1(3)	0.119	1/3000	0.70	0.50	0.37	0.13	0.37
LIC-2(1)	0.119	1/2000	0.70	0.50	0.36	0.14	0.45

Note ; Q = m^3/sec, v = m/sec



LIC	Q	i	v
LIC-2(2)	0.107	1/500	0.82
LIC-2(3)	0.100	1/600	0.76

Note ; Q = m^3/sec, v = m/sec

FIGURE 3-3-8 TYPICAL CROSS SECTION OF LATERAL IRRIGATION CANAL

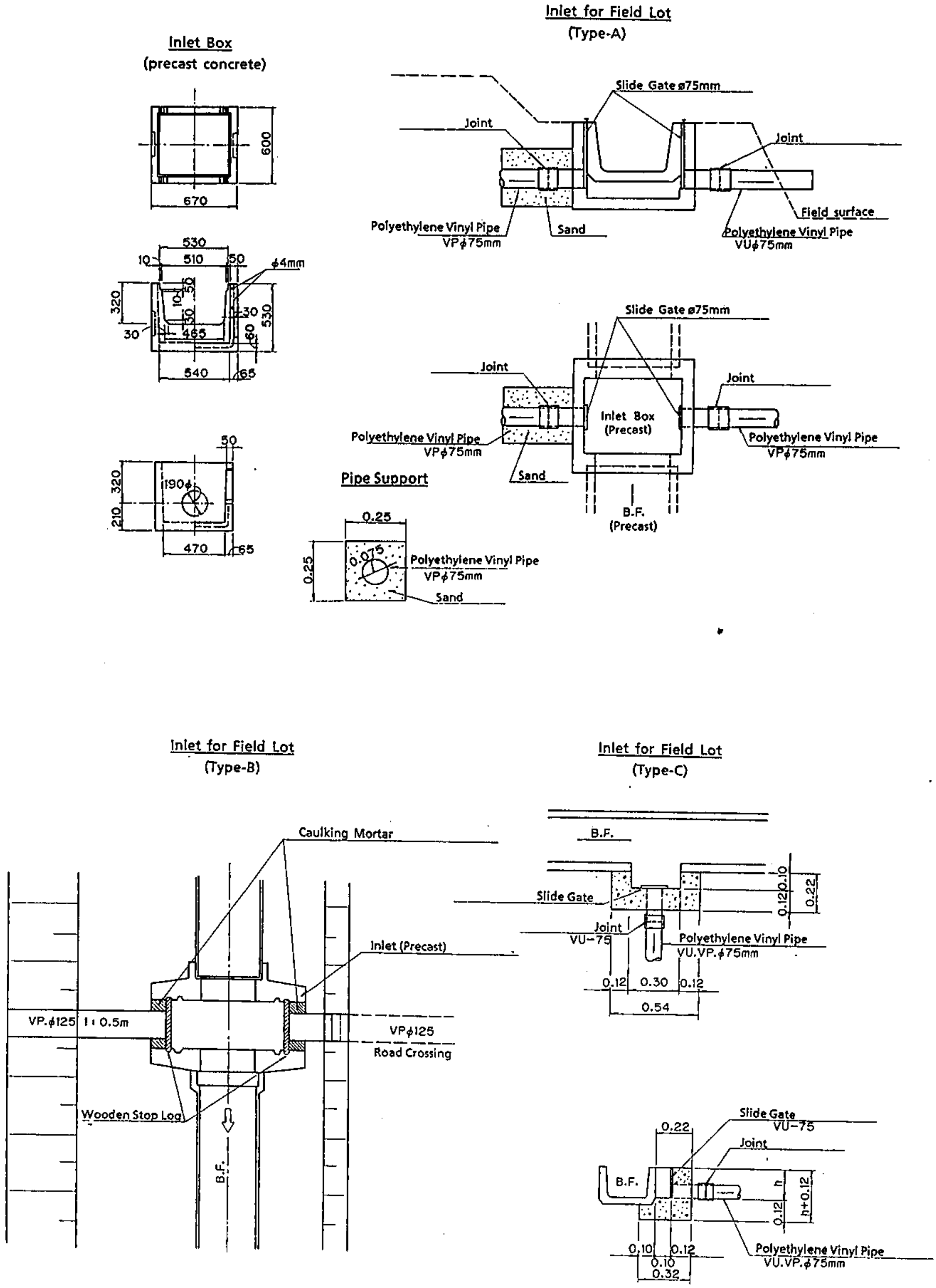


FIGURE 3-3-9 TYPICAL INLET DRAWING AT THE FUTURE STAGE

3.4. Drainage Facilities Plan

3.4.1. Drainage Planning

Most Rain fall during the winter period between September and March in the Project area. And Berseem is proposed as a second crop in the area by the Master plan. The drainage plan should take these factors into consideration for designing. Since during the paddy growing period, heavy rainfall is not observed, the drainage plan would be established taking into consideration winter crop growing.

(1) Inundation Period Without Damage

Surface drainage rate is decided considering the inundation resistance of Berseem during the winter season from September to March. According to the data of Seed Plant Improvement, Mazandaran General Department of Agriculture, MOA, the following growing conditions were examined.

Inundation period	Condition
2 to 3 days	Without damage in the germination period from middle of August to middle of October
5 to 6 days	Without damages in inundation water of 10 to 15 cm depth during the growing period from September to March.

(2) Design Rainfall Study

The two(2) rainfall cases were considered. The first was 2-days of rainfall to be drained within 2 days and the second was 5-days of rainfall to be drained within 5 days. This was the basis for the drainage plan. Taking into consideration the economic conditions of drainage, a probability of 1/5 years would be applied. The design rainfalls are as follows:

2-days rainfall: 118 mm/ 2-days (average rainfall density=118/2 = 59 mm/day) ·········· Applied

5-days rainfall: 167 mm/ 5-days (average rainfall density=167/5 = 33 mm/day)

The above average rainfall density, a larger amount of rainfall, 59 mm/day, would be applied for designing drainage facilities in the MF in order to increase the safety of crop growing by minimizing damage by rainfall.

(3) Run-off Coefficient

For a drainage ditch in the MF, 0.8 of runoff coefficient would be applied and for the Piteh Rud, 0.6 of runoff coefficient would be applied.

(4) Surface Runoff Rate

The following design surface drainage rates would be used based on the design rainfall and runoff coefficient.

For a drainage ditch in the MF = 5.4 lit/sec/ha
For the Piteh Rud = 4.1 lit/sec/ha(=0.41cu.m/sec/sq.km)

(5) Drainage Discharge

- Piteh Rud

The drainage area of the Piteh Rud is estimated at 8.3 sq.km on the boundary of the CAPIC area. Accordingly, a design discharge of the Piteh Rud of 3.4 cu.m/sec is calculated by using the drainage area and the surface runoff rate. (refer to Figure 3-4-1)

Q = 0.41 cu.m/sec/sq.km × 8.3 sq.km = 3.4 cu.m/sec

- CAPIC area

For Main Field including the facility area
Q = 5.4 cu.m/sec/ha × 42.78 ha = 231 lit/sec

- TDF and TF

Q = 5.4 cu.m/sec/ha × 22.87 ha = 123 lit/sec

(6) Subsurface Drainage

Considering high hydraulic conductivity of soil, ranging from 3.14×10^{-3} to 3.18×10^{-3} and groundwater contours, a tile drainage system is not necessary and drainage ditch with a minimum 90-cm-depth would be provided in the MF. (refer to Table 3-4-1 and Figure 3-4-2)

3.4.2. Schematic Diagram of Drainage System

As mentioned in the previous section 3.4.1, the drainage canal will have two (2) functions in the MF. During the irrigation period, that is, the growing time of rice, excess water and losses should be drained out to the Ahi Rud for reuse as irrigation downstream of the CAPIC area. During the winter season, excess water on the MF should be drained towards the Piteh Rud as quickly as possible because of upland crop cultivation in the fields.(refer to Figures 3-4-3)

3.4.3. Design of Drainage Facilities

Drainage infrastructure such as lateral drainage canals and drainage ditches, and appurtenant structures such as road crossings, drops (if necessary), are proposed for better operation of the drainage system in the MF. Check structures are especially important to control water levels in the canal for irrigation when irrigation-cum-drainage systems are operated in some parts of the MF.

(1) Alignment of Drainage Canal

The drainage canal should be aligned between field blocks in order to minimize land for the drainage canal.

(2) Shape and Size of Drainage Canal

Upland drainage canal is proposed due to silty to silty loam soil characteristics in the MF. A trapezoid shape with a side slope of 1 : 1 is designed.

(3) Applied Equation for Determination of Size of Canal

The Manning equation is used for designing canal capacity of drainage ditches and a lateral drainage canal.

(4) Maximum and Minimum Velocities

The maximum velocity of 0.9 m/sec and minimum velocity of 0.3 m/sec are adapted to determine canal capacity.

(5) Minimum Canal Size

As mentioned in the previous section 3-4-1, the minimum depth and bottom width of a drainage canal to be proposed in the MF are 0.9m and 0.3 m taking into consideration the drainage of groundwater tables.

3.4.4. Design of Appurtenant Structures

(1) Road Crossing

At the point where the drainage canal crosses a farm road, a road crossing is proposed. This structure consists of side slopes and canal bed protection works and reinforced concrete pipes with the minimum diameter of 600mm. (refer to Table 3-4-2)

(2) Drainage Check Structure

After land consolidation, a separate irrigation system will sometimes invite a greater amount of irrigation water depending upon soil characteristics. In this case, the groundwater table should be controlled by opening and closing a check gate of stop logs in the structure in order to save a quantity of irrigation water. This structure will be constructed after the necessary investigation of water requirements during the paddy growing period. The check gate of stop logs, however, should be open during the periods of rain and during the winter season. The upper and lower side slopes and canal bottom would be lined by stone masonry and a check gate would be supported by a concrete structure. (refer to Table 3-4-3)

Iron gate structure drawings are presented in the following Figure 3-4-4, as one of sample of iron gates, and the stability analysis of the structure of drainage check are carried out in the following sheets.

TABLE 3-4-1 THE RESULT OF INSITE DRAINAGE TEST IN CAPIC

Hole No	Hole Depth (cm)	Ground Water Depth From Ground Surface (cm)	Hydraulic conductivity (K) cm/sec	
1	-	-	-	Like No 13
2	163.0	100.0	$K=1.52\times10^{-2}$	
3	196.0	138.0	$K=1.84\times10^{-2}$	
4	204.0	148.0	$K=2.86\times10^{-2}$	
5	-	-	-	Like No 13
6	147.0	77.0	$K=1.22\times10^{-2}$	
7	142.0	46.0	$K=1.09\times10^{-2}$	
8	158.0	95.0	$K=3.18\times10^{-2}$	
9	190.0	149.0	$K=1.15\times10^{-2}$	
10	240.0	169.0	$K=1.29\times10^{-2}$	
11	176.0	68.0	$K=3.14\times10^{-3}$	
12	250.0	166.0	$K=8.87\times10^{-3}$	
13	-	-	-	There were hard material in the Hole It was not possible to continue.
14				
15	195.0	125.0	$K=1.78\times10^{-2}$	
16	184.0	116.0	$K=1.62\times10^{-2}$	
average max min	196.0 250.0 142.0	116.0	1.56×10^{-2} 3.18×10^{-2} 3.14×10^{-3}	

Table 3-4-2 DESIGN OF DRAINAGE ROAD CROSSING (TYPE -B)

1) Calculation of Load equivalent to Soil Thickness(t)

Applied live load = T-10 ton load

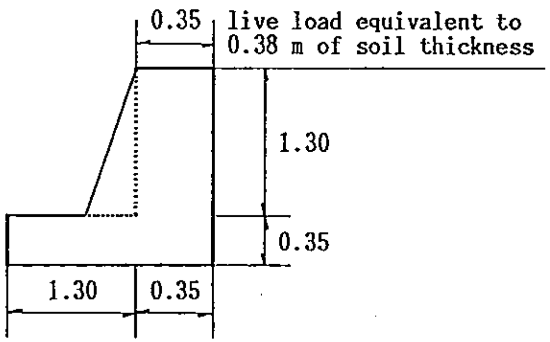
Load equivalent to soil thickness

Vehicle space B = 2.75m. L = 7.00m

Live load = 10 ton/(2.75×7.00) ×(1+0.3) = 0.68ton/sq.m

Equivalent soil thickness(t) = 0.68/1.8ton/cu.m = 0.38m

2) Section of Inlet



3) Design of Wall

M (Moment by load) $= 1/2 \times K \times H^2 \times 1/3 \times H \times \gamma$

$= 1/2 \times 0.3 \times (1.3+0.38)^2 \times 1/3 \times (1.30+0.38) \times 1.8$

$= 0.427$t.m $= 42{,}700$ kg.cm

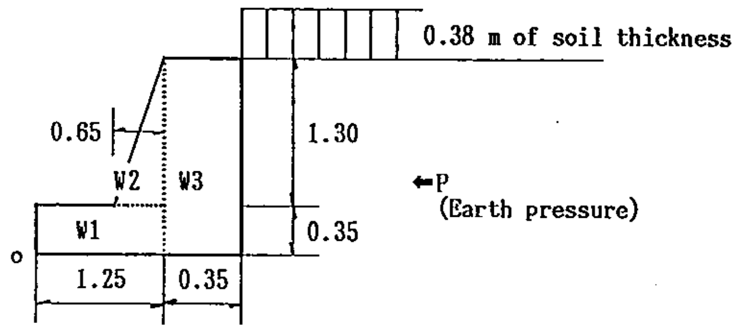
Allowable bending stress of concrete (σ_{cs}) = 2.5kg/sq.cm

Required section modulus(Zr) $= M/\sigma_{cs} = 42{,}700/2.5 = 17{,}080\text{cm}^3$

Section modulus of the wall (z)

$Z = bh^2/6 = 100 \times 35^2 / 6 = 20{,}400\text{cm}^3 > Zr$ OK

4) External Loads



5) Calculation of Moment

Equation	V	H	x	y	Vx	Hy
W1 1.25×0.35×2.3	1.01		0.63		0.64	
W2 0.65×1.3×1/2×2.3	0.97		1.03		1.00	
W3 0.35×1.65×2.3	1.33		1.43		1.90	
P 1/2×0.3×1.8× $(1.65+0.38)^2$		1.11		0.68		0.75
Total (Vo)	3.31	1.11			3.54	0.75

6) Safety against overturning

e = (Vx-Hy) / Vo - L / 2 = (3.54-0.75) / 3.11 - 1.60 / 2 = 0.04

L / 6 = 0.27 > e, OK.

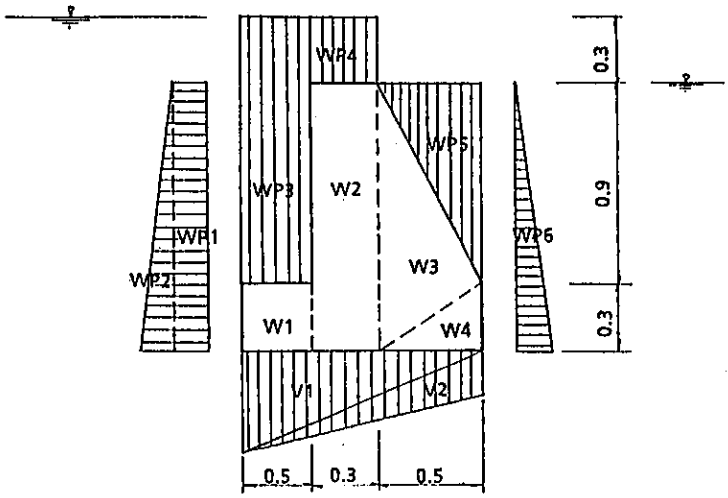
f = 3.54 × 0.75 = 4.7 > 1.2, OK.

7) Safety against sliding

f = 3.31 × 0.7 / 1.11 = 2.1 > 1.2, OK.

Table 3-4-3 STABILITY ANALYSIS OF DRAINAGE CHECK STRUCTURE

1) Design Section



2) Calculation of External Force

No.	Equation	Force V	Force H	Arm length x	Arm length y	Moment Vx	Moment Hy
W1	0.3×0.5×2.3	0.35	-	0.25	-	0.09	-
W2	0.3×1.2×2.3	0.83	-	0.65	-	0.54	-
W3	1.2×0.5×1.2×2.3	0.69	-	0.97	-	0.67	-
W4	0.3×0.5×1/2×2.3	0.17	-	1.13	-	0.19	-
WP1	0.3×1.2×1.0	-	0.36	-	0.60	-	0.22
WP2	1.2×1.2×1/2×1.0	-	0.72	-	0.40	-	0.29
WP3	0.5×1.2×1.0	0.60	-	0.25	-	0.15	-
WP4	0.3×0.3×1.0	0.09	-	0.65	-	0.06	-
WP5	0.9×0.5×1/2×1.0	0.23	-	1.13	-	0.26	-
WP6	1.2×1.2×1/2×1.0	-	-0.72	-	0.40	-	-0.29
U1	1.5×1.3×1/2×1.0	-0.98	-	0.43	-	-0.42	-
U2	1.2×1.3×1/2×1.0	-	-0.78	-	0.87	-	-0.68
	Total	1.98	-0.42			1.54	-0.46

3) Safety against overturning

$e = |\Sigma M / \Sigma V - L/2| = |(1.54 - 0.46)/1.98 - 1.3/2| = 0.11$
$L/6 = 1.3/6 = 0.22$
Therefore; $L/6 = 0.22 > e = 0.11$ OK.

4) Safety against sliding

$|\Sigma H| = 0.42, \ \alpha \Sigma V = 0.7 \times 1.98 = 1.39$

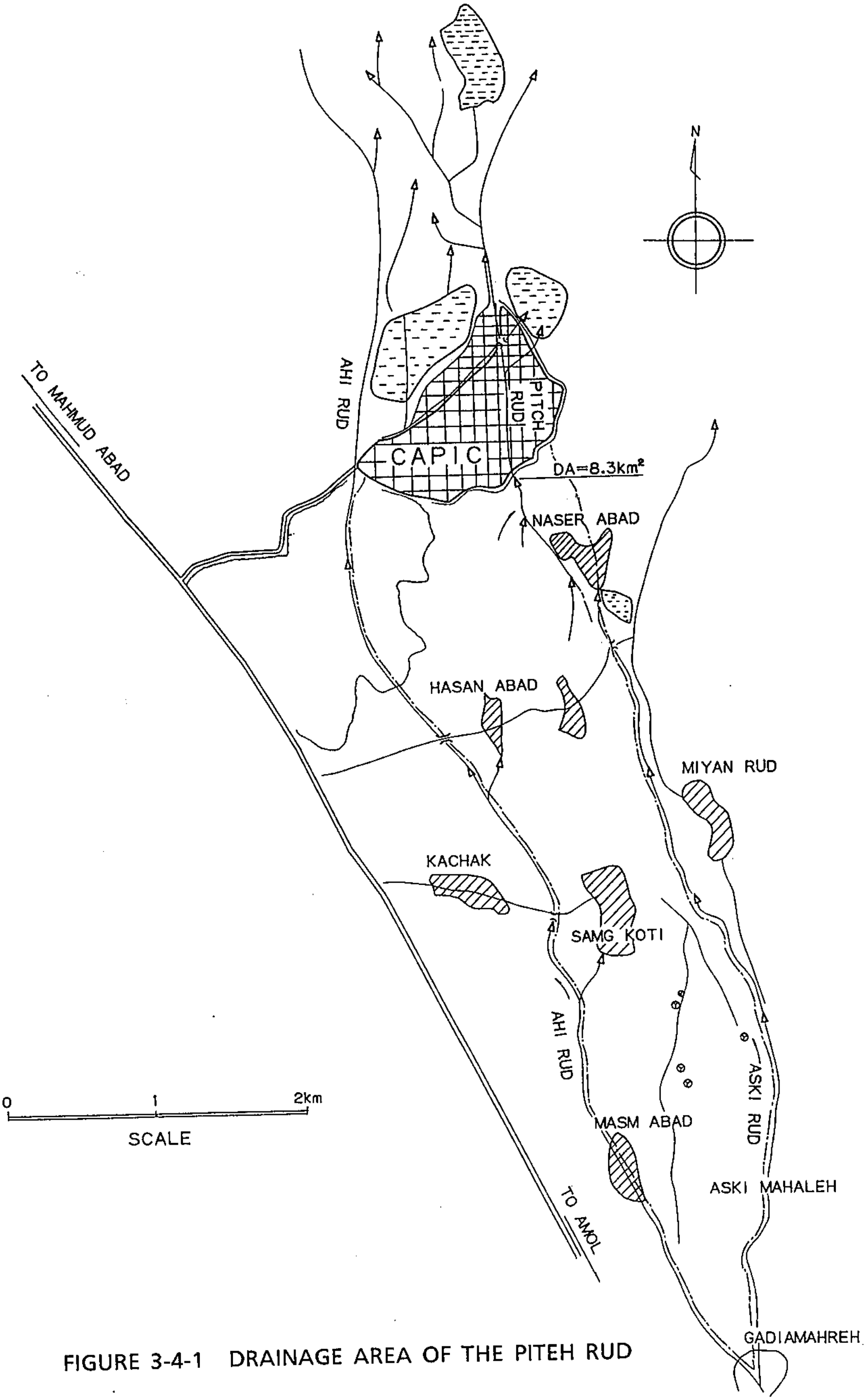


FIGURE 3-4-1 DRAINAGE AREA OF THE PITEH RUD

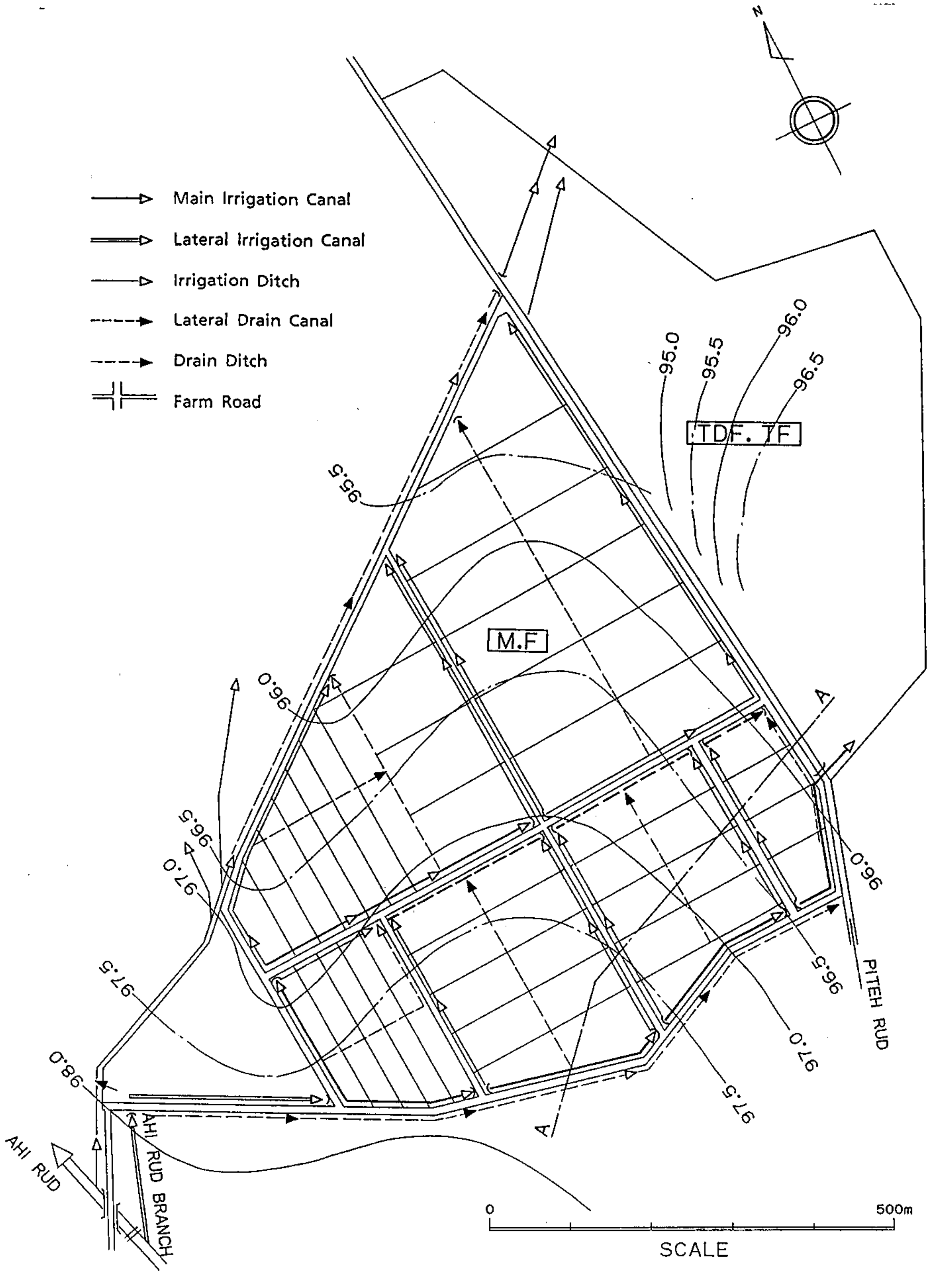
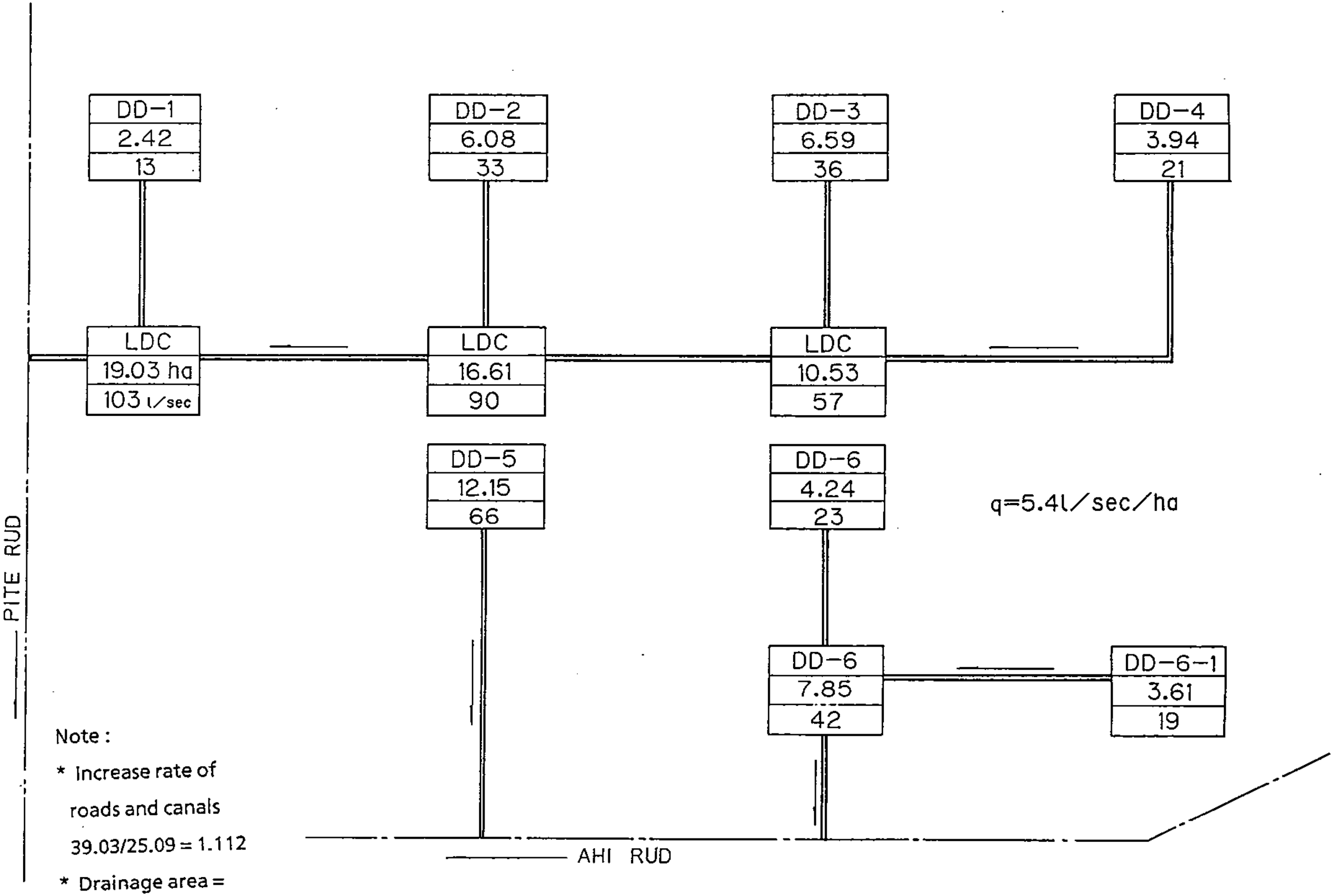


FIGURE 3-4-2 COUNTOUR MAP OF SUBSURFACE GROUNDWATER IN CAPIC

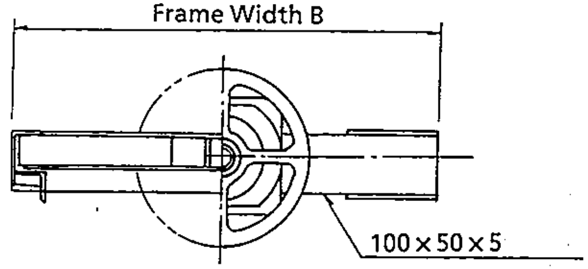
FIGURE 3-4-3 SCHEMATIC DIAGRAM OF PROPOSED DRAINAGE SYSTEM



Note :

* Increase rate of roads and canals 39.03/25.09 = 1.112
* Drainage area = net field area × 1.112

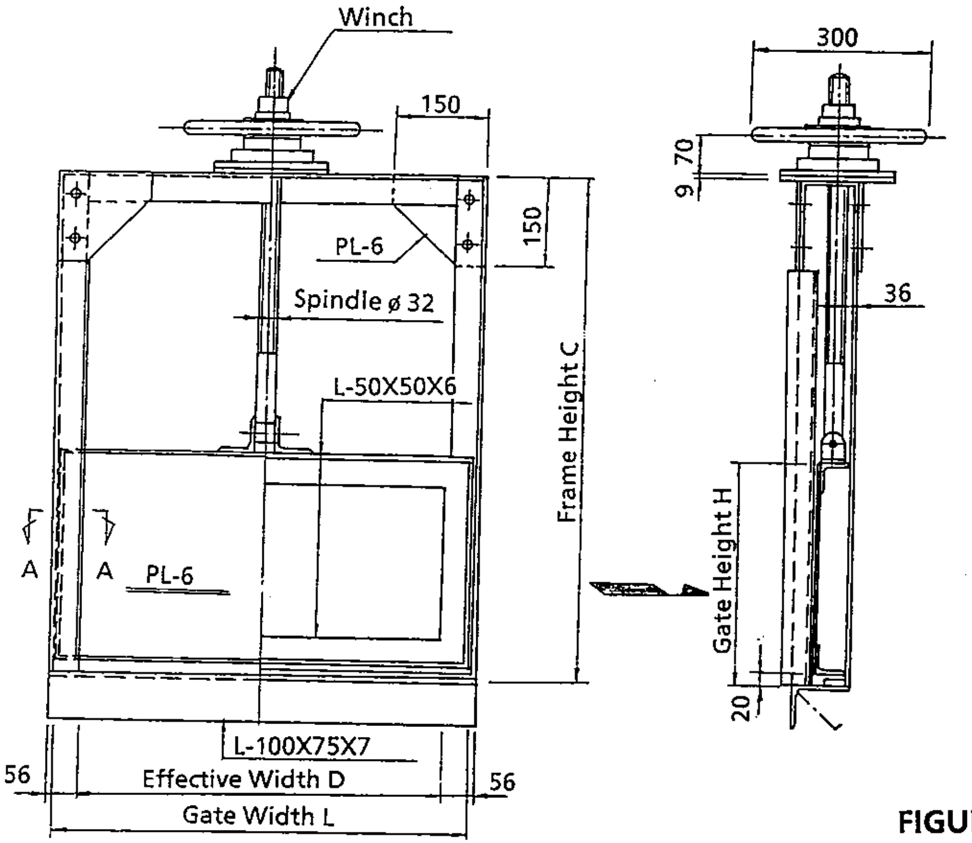
EX.*(1.81 + 1.95) × 1.112

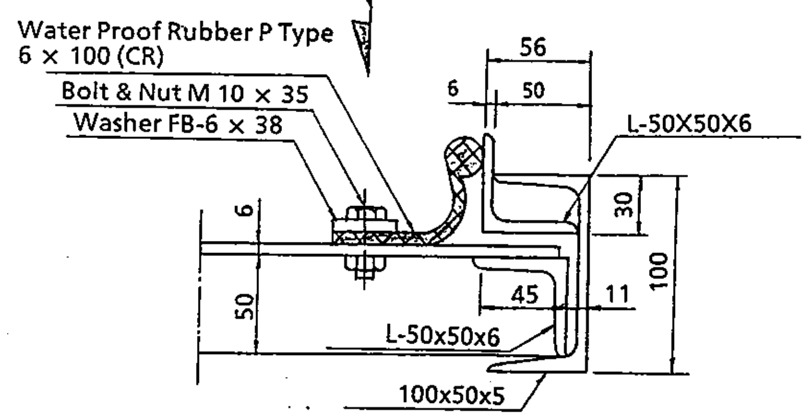


Dimension

D	L	H	B	C	Weight (kg)
500	590	320	612	740	71.45
550	640	355	662	810	81.65
600	690	380	712	860	86.45
650	740	415	762	930	92.65
700	790	440	812	980	97.65
800	890	450	912	1,000	103.75
900	990	500	1,012	1,100	130.85
1,000	1,090	550	1,112	1,200	149.55

(Unit: mm)





SECTION A - A

FIGURE 3-4-4 TYPICAL DRAWING OF IRON GATE

3.5. Farm Road Plan

3.5.1. General

The farm road will play important roles for farming. Farm inputs and outputs are conveyed to and from the farmlands via the farm road. In the land consolidation plan, a proposed road network is determined by the national/provincial road development program and the size of the farm block. However, the size and structure of a farm road are determined based on the farming works, especially the size of farm machinery to be introduced, in order to minimize land taken up by farm roads.

This chapter describes the size and structures of the trunk road, farm roads and their appurtenant structures such as corner cuttings, access toads to field lots, etc.

3.5.2. Size

Three (3) kinds of farm roads for the MF in the CAPIC are proposed, namely a trunk road, and a farm roads (A) and (B).

(1) Trunk road

The width of the trunk road is determined with consideration to future farm mechanization in the Haraz River basin area. In future, adequate road width will be needed for two vehicles to pass on the trunk road without stopping. The roadway of the trunk road in the MF of the CAPIC is determined with two considerations during the farming period. In the growing period, two tractors (30 ps more or less class) must be able to pass each other on the road. During the harvesting period, a combine harvester and another vehicle must pass each other. The passable width for two vehicles is, therefore, determined as 4.5m of the roadway excluding the shoulder width of 0.25m. The total road width of 5.00 m is designed in the MF.
(refer to Figure 3-5-1)

Growing period		Harvest period	
Passing margin	0.3 m	Passing margin	0.3 m
Tractor (30 ps class)	1.7 m	Combine (20 ps class)	2.3 m
Passing clearance	0.3 m	Passing clearance	0.3 m
Tractor (30 ps class)	1.7 m	Tractor (20 ps class)	1.1 m
Passing margin	0.3 m	Passing margin	0.3 m
Total of road way	4.3 m	Total of road way	4.3 m
(say	4.5 m)	(say	4.5 m)
Two (2) shoulders	0.5 m	Two (2) shoulders	0.5 m
Total	5.0 m	Total	5.0 m

(2) Farm road (A)

The farm road(A) has the function of transporting farm inputs and outputs. The road width is determined by considering the period during daily farming and the harvesting periods. In the daily farming period, two 25 ps-class tractors must pass each other on the road. In this case, a 3.0 m-width road will be necessary. At harvesting time, a combine harvester of 30 ps class must traverse the road. A road width of 2.9 m (say 3.0m) will be necessary. The shoulder of 25 cm on both sides of the road is designed. The total width of the farm road is, therefore, determined at 3.5 m.
(refer to Figure 3-5-1)

Farming period		Harvest period	
Passing margin	0.3 m	Passing margin	0.3 m
Tractor (25 ps class)	1.1 m	Combine (30 ps class)	2.3 m
Passing clearance	0.3 m	Passing margin	0.3 m
Tractor (25 ps class)	1.1 m	Total of road way	2.9 m
Passing margin	0.3 m	(say	3.0 m)
Total of road way	3.1 m	Two (2) shoulders	0.5 m
(say	3.0 m)	Total	3.5 m
Two (2) shoulders	0.5 m		
Total	3.5 m		

(3) Farm road (B)

The farm road (B) is a show-case farm road aimed at minimizing land taken up by roads. The function is the same as the previous farm road (A). However, only one tractor traverses the road. The roadway width and the total road width are designed at 2.0 m and 2.5 m, respectively.

(refer to Figure 3-5-1)

Passing margin	0.3 m
Tractor (25 ps class)	1.1 m
Passing margin	0.3 m
Total of road way	1.7 m
	(say 2.0 m)
Two (2) shoulders	0.5 m
Total	2.5 m

3.5.3. Cross-Sectional Dimension

(1) Road Height

The proposed road height is determined by taking into consideration case of entrance to, and exit from, the farmland. However, the trunk road is a main farm road connecting farmland to the market. On the other hand, from other farm roads, farm machinery can go to and from the fields. A difference of 50 cm is the limitation in height between the road surface and field surface, enabling farm machinery, particularly tractors, to climb to the road surface without additional infrastructure. The road surface should be kept dry condition at all times. The height of the roads in the MF of the CAPIC is, therefore, determined as follows;

Road	Road Height
Truck road	50 cm
Other farm road	40 cm

(2) Pavement

Farm roads with gravel pavement to minimuze construction costs are proposed. The embankment materials are secured around the area to be consolidated in order to minimuze construction costs. The thickness of gravel pavement of those farm roads are as follows :

Trunk road	15 cm
Farm road (A)	15 cm
Farm road (B)	10 cm

(3) Side Slopes

Considering embankment materials are of silt to silty loam, obtained from the consolidated area, a side slope of 1 : 1 is adopted to protect the side from slippage. (refer to Figure 3-5-1)

(4) Cross-sectional Slope

Excess water caused by rainfall, especially in winter, should be drained from the road surface as quick as possible. Cross-sectional slopes of five percent (5%) are, therefore, proposed. The excess water drains to both edges from the center of the road. (refer to Figure 3-5-1)

3.5.4. Road Alignment and Length

(1) Road Alignment

The trunk road is aligned with the southern boundary of the CAPIC area. Farm road (A) is aligned to enter and exit to/from each field lot. The farm road (B) is aligned along the south-east part of the MF of the CAPIC area. Farm roads (A) are also located along the Ahi Rud and Piteh Rud as operation and maintenance roads for heavy equipment.

(2) Proposed Road Length

The total length of roads in the MF of the CAPIC would be 4,631 m measured on the topographical map with a scale of 1 : 1,000. The following table presents the proposed length by road and by type.

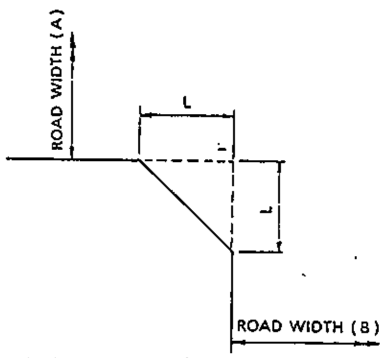
Name of Road	Length	Type	Name of Road	Length	Type
Trunk road	1,140.0 m	-	Farm Road-5	138.0 m	A
Farm Road-1	194.0	A	Farm Road-6	684.0	A
Farm Road-2	276.5	A	Farm Road-7	869.0	A
Farm Road-3	290.0	A	Farm Road-8	290.5	A
Farm Road-4	297.0	B	Farm Road-9	452.0	A
Total				4,631.0 m	(118.7m/ha)
			Trunk Road	1,140.0	(29.2m/ha)
			Type-A	3,194.0	(81.9m/ha)
			Type-B	297.0	(7.6m/ha)

3.5.5. Design of Appurtenant Structures

(1) Corner-cutting

At the intersection of farm roads, adequate corner cutting must be presented to allow for smooth turning of vehicles. The scale of a corner-cuttung is determined based on the width of the road. The design criteria are as follows:

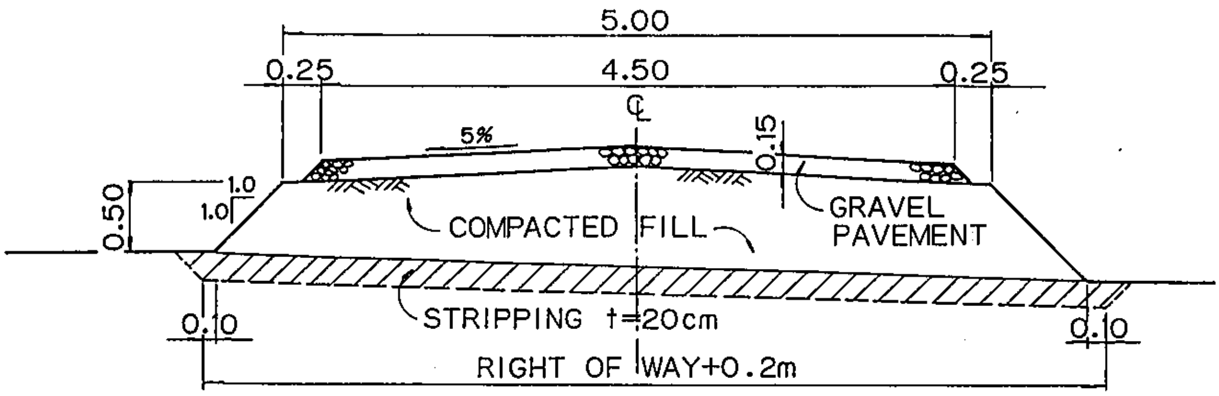
Road width (A)	Other road width(B) 3 m	4 m	5 m
3 m	L=2.0m	1.5	1.0
4	1.5	1.0	1.0
5	1.0	0.5	0



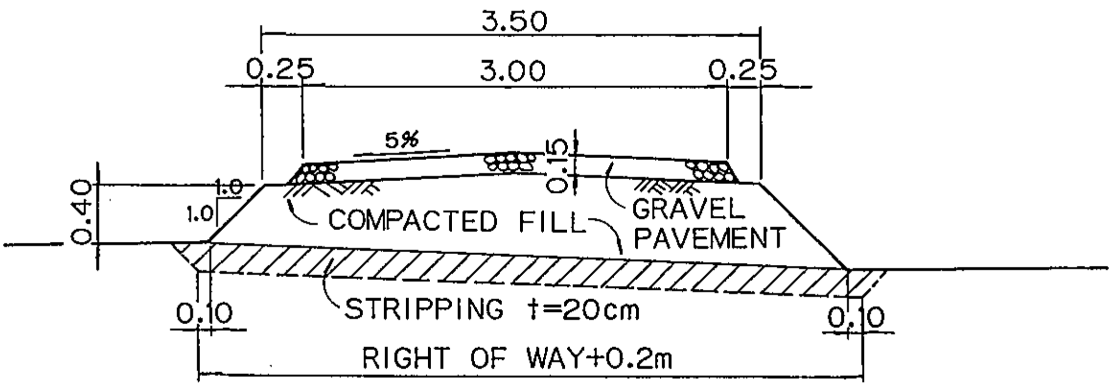
At an intersection point of roads with more than 5 m in width a corner-cuttung is not necessary. In cases where intersecting angle is less than a right angle, the length of corner-cuttung is 1.5 times of the above. (refer to attached Drawings No.21)

(2) Access road to Field Lots

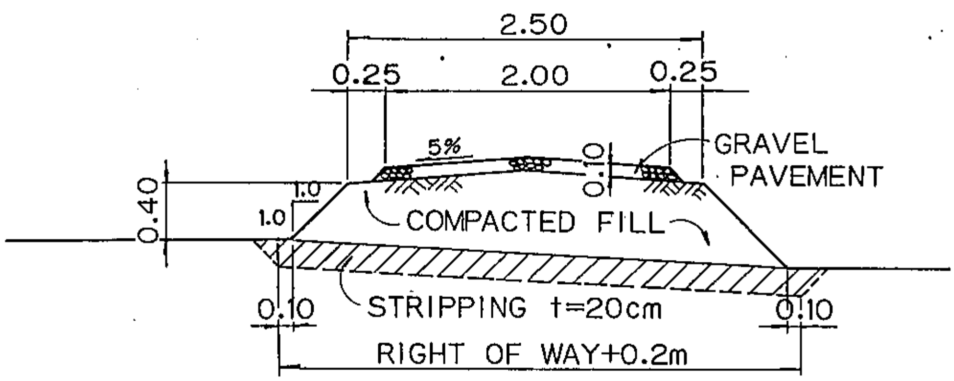
In case the vertical difference between the road surface and the field surface at any place in a field lot is more than 50 cm, access infrastructure should be introduced for smooth farm works. The width of an access road facility is 3 m taking into consideration the turning radius of tractors and combine harvesters. A longitudinal slope of the maximum 32.5 % is applied. Where the difference is less than 50 cm, a temporary crossing tool such as wooden or iron plates will be used over the irrigation ditch. (refer to attached Drawings)



TRUNK ROAD



FARM ROAD(A)



FARM ROAD(B)

FIGURE 3-5-1 TYPICAL CROSS SECTION OF FARM ROAD

CHAPTER 4. BILL OF QUANTITY

CHAPTER 4. BILL OF QUANTITY

4.1. Field Construction

4.1.1. Reclaimed Area

	Main Field	Facility Area	Total
Gross Area	39.03 ha	3.75 ha	42.78 ha
Net Area	35.09	3.37	38.46
Others	3.94	0.38	4.32

(for further details, refer to Table 4-1-1)

4.1.2. Earthworks and Hauling Distance

Item	Unit	Earth Movement Volume	Earth Movement H.Distance (m)	Top Soil Treatment Volume	Top Soil Treatment H.Distance (m)
Top Soil Removal	cu.m	-	-	5,149	22.7
Earth Movement	cu.m	33,840**	61.6**	- *	- *
Land Leveling	ha	35.09	-	-	-
Top Soil Replace	cu.m	-	-	5,149	22.7
Top Soil Leveling	ha	-	-	3.43	-

Note ;* The volume of earth movement in the top soil treatment area is included in the earth movement column.
** Inclusive of earth movement volume (V=5,531cu.m D=73.0m) in the Facility Area
(for further details, refer to Table 4-1-2 and -3, and Figures 4-1-1 and -2)

4.1.3. Construction of Plot Dike

A total plot dike length of 5,921 m is proposed. Table 4-1-1 has more details.

4.1.4. Plot Slope Tamping

The total plot slope tamping area is calculated at 1,357 sq.m. Table 4-1-4 has more detailed information.

4.2. Irrigation Canals

4.2.1. Construction of Irrigation Canals

The total length of the proposed irrigation canals, such as lateral irrigation canals (LICs) and irrigation ditches (IDs), in the MF, is 5,498m with a canal density of 140.7m/ha. Tables 4-2-1 and Figure 4-2-1 show more detailed information about these irrigation canals. The Bill of Quantity to construct these irrigation canals is presented in Table 4-2-2.

4.2.2. Construction of Appurtenant Structures

As appurtenant structures such as road crossings, turn-outs, a siphon, spillways, parshall flumes, drainage releases, and check gates on LICs, and a drainage release on a irrigation ditch (ID-8) are designed. (refer to Table 4-2-3 and -4)

4.3. Drainage Canals

4.3.1. Drainage Canals Construction

A total length of the proposed drainage canals which are called interception drainage canal, lateral drainage canal, and drain ditches respectively, is 3,447m. Table 4-3-1 shows each length of drainage canal in the MF. The canals have a density of 88.3m/ha. Table 4-3-2 shows Bill of Quantity of drainage canal construction. (refer to Tables 4-3-1 and -2, and Figure 4-3-1)

4.3.2. Construction of Appurtenant Structures

The appurtenant structures, such as road crossings and drainage check structures, are proposed in the MF. Tables 4-3-3 to -6 describe more details and show the Bill of Quantity.

4.4. Farm Roads

4.4.1 Construction of Farm Roads

A total length of 4,361 m of road is proposed. The density of farm road is 132.0 m/ha. Further details are presented in Table 4-4-1 and Figure 4-4-1 and Bill of Quantity of farm road construction is presented in Table 4-4-2.

4.4.2. Construction of Appurtenant Structures

The corner cuttings and access roads to filed lots are designed as appurtenant structures of farm roads. Tables 4-4-3 to -7 show Bill of Quantities of those structures.(refer to Figure 4-4-2)

4.5. Experimental Farm

The following field blocks and field lots, which amount 6.42 ha, are designed as an experimental farm.

Field Block No.	Field Lot No.	Acreage (sq.m)	Length of paddy dike (m)	Field Block No.	Field Lot No.	Acreage (sq.m)	Length of paddy dike (m)
1	1	2,040	78	2	5	3,900	-
	2	2,630	97	ST		19,500	520
	3	3,200	116	3	1	4,825	100
	4	3,672	128		2	6,000	100
	5	4,381	-		3	6,000	100
ST		15,923	519		4	6,000	100
					5	6,000	-
2	1	3,900	130			6,000	400
	2	3,900	130	ST		28,825	1,439
	3	3,900	130	Total		64,248	
	4	3,900	130				

Note : ST - Sub-total

Necessary facilities such as field lots, farm roads, irrigation and drainage canals, are designed in the former sections 4-1 to 4-4. Tables 4-5-1 to -8 show lists and the Bill of Quantity of additional necessary facilities in the Experimental Farm. (refer to Drawings No.27, for further details).

TABLE 4-1-1 LIST OF FIELD LOT AND ITS ACREAGE, AND PLOT DIKE

Field Block No.	Field Lot No.	Acreage (sq. m)	Length of plot dike (m)	Field Block No.	Field Lot No.	Acreage (sq. m)	Length of plot dike(m)
1	1	2,040	78	5	1	2,589	100
	2	2,630	97		2	6,000	100
	3	3,200	116		3	6,000	100
	4	3,672	128		4	6,000	100
	5	4,381	-		5	6,000	-
ST		15,923	519	ST		26,589	400
2	1	3,900	130	6	1	4,100	100
	2	3,900	130		2	6,000	100
	3	3,900	130		3	6,000	100
	4	3,900	130		4	6,000	100
	5	3,900	-		5	6,000	-
ST		19,500	520	ST		28,100	400
3	1	4,825	100	7	1	2,180	48
	2	6,000	100		2	3,585	72
	3	6,000	100		3	4,981	92
	4	6,000	100		4	5,511	92
	5	6,000	-		5	5,475	-
ST		28,825	400	ST		21,732	304
4	1	6,446	100				
	2	6,000	100				
	3	6,000	100				
	4	6,000	100				
	5	6,000	-				
ST		30,446	400				

Note; ST- Sub-Total

Field Block No.	Field Lot No.	Acreage (sq. m)	Length of plot dike (m)	Field Block No.	Field Lot No.	Acreage (sq. m)	Length of plot dike(m)
8	1	2, 820	100	11	1	9, 000	150
	2	3, 000	100		2	9, 000	150
	3	3, 000	100		3	9, 000	150
	4	3, 000	100		4	9, 000	150
	5	3, 000	100		5	8, 739	119
	6	3, 000	100		6	4, 248	-
	7	3, 000	-	ST		48, 987	719
ST		20, 820	600				
				12	1	8, 654	149
9	1	1, 912	47		2	8, 886	148
	2	1, 665	65		3	8, 753	147
	3	2, 198	82		4	8, 793	147
	4	2, 693	98		5	8, 745	148
	5	3, 158	-		6	8, 955	149
ST		11, 626	321		7	7, 511	-
				ST		60, 297	888
10	1	9, 000	150				
	2	9, 000	150				
	3	9, 000	150				
	4	11, 078	-				
ST		38, 078	450	Total		350, 923	5, 921
				Facility Area		33, 700	-
				Grand Total		384, 623	5, 921

Note; ST- Sub-Total

TABLE 4-1-2 EARTH WORK VOLUME

				Earth Work Volume and Hauling Distance					
		Area	EL	w/in Field Lot		w/in Field Block		Out of Field Block	
FBN	FLN	(sq. m)	(m)	V (cu. m)	D (m)	V (cu. m)	D (m)	V (cu. m)	D (m)
1	1	2,040	98.99	55	23.9	-	-	-	-
	2	2,630	98.87	106	39.4	-	-	-	-
	3	3,200	98.71	168	47.3	-	-	-	-
	4	3,672	98.60	245	81.0	-	-	-	-
	5	4,381	98.51	338	76.6	-	-	-	-
ST		15,923		912	64.9	-	-	-	-
2	1	3,900	98.94	2	71.4	+ 637	-	-	-
	2	3,900	98.94	91	30.3	- 193	46.4	-	-
	3	3,900	98.65	82	30.2	- 444	67.6	-	-
	4	3,900	98.27	107	27.8	-	-	-	-
	5	3,900	98.20	130	29.9	-	-	-	-
ST		19,500		412	29.7	637	61.2	-	-
3	1	4,825	98.84	244	66.2	-	-	-	-
	2	6,000	98.81	392	46.0	-	-	-	-
	3	6,000	98.47	308	56.0	-	-	-	-
	4	6,000	98.38	369	50.2	-	-	-	-
	5	6,000	98.14	192	27.2	-	-	-	-
ST		28,825		1,505	50.0	-	-	-	-
4	1	6,446	98.93	244	42.5	-	-	-	-
	2	6,000	98.77	381	41.5	-	-	-	-
	3	6,000	98.45	175	34.9	-	-	-	-
	4	6,000	98.36	273	54.6	-	-	-	-
	5	6,000	98.19	451	48.9	-	-	-	-
ST		30,446		1,534	45.1	-	-	-	-
5	1	2,589	98.77	56	38.9	-	-	-	-
	2	6,000	98.74	190	27.5	-	-	-	-
	3	6,000	98.59	170	35.0	-	-	-	-
	4	6,000	98.49	229	37.8	-	-	-	-
	5	6,000	98.28	231	24.1	-	-	-	-
ST		26,589		876	31.5	-	-	-	-

		Area	EL	Earth Work Volume and Hauling Distance					
				w/in Field Lot		w/in Field Block		Out of Field Block	
FBN	FLN	(sq. m)	(m)	V (cu. m)	D (m)	V (cu. m)	D (m)	V (cu. m)	D (m)
6	1	4,100	98.92	199	26.4	-	-	-	-
	2	6,000	98.84	373	36.9	-	-	-	-
	3	6,000	98.64	371	37.3	-	-	-	-
	4	6,000	98.36	473	53.8	-	-	-	-
	5	6,000	98.14	773	53.2	-	-	-	-
ST		28,100		2,189	45.4	-	-	-	-
7	1	2,180	98.82	282	18.9	-	-	-	-
	2	3,585	98.31	726	40.6	-	-	-	-
	3	4,981	98.95	1,221	44.3	-	-	-	-
	4	5,511	97.93	1,083	54.6	-	-	-	-
	5	5,475	97.74	636	44.7	-	-	-	-
ST		21,732		3,948	44.7	-	-	-	-
8	1	2,820	98.96	26	26.4	+1,273	-	-	-
	2	3,000	98.94	-	-	+1,197	-	-	-
	3	3,000	98.93	221	34.3	-	-	-	-
	4	3,000	98.86	3	25.4	-1,118	90.5	-	-
	5	3,000	98.56	-	-	- 139	120.1	-	-
						- 899	93.8		
	6	3,000	98.11	52	34.9	- 298	124.1	-	-
	7	3,000	97.98	98	29.0	-	-	-	-
ST		20,820		400	32.5	2,454	97.5	-	-
9	1	1,912	98.94	44	27.4	+ 477	-	-	-
	2	1,665	98.88	-	-	- 353	54.7	-	-
	3	2,198	98.37	70	18.7	- 124	94.2	-	-
	4	2,693	98.05	75	34.8	-	-	-	-
	5	3,158	97.83	102	24.7	-	-	-	-
ST		11,626		291	26.3	477	65.0	-	-
10	1	9,000	97.94	522	67.8	-	-	-	-
	2	9,000	97.77	381	43.6	-	-	-	-
	3	9,000	97.54	570	79.3	-	-	-	-
	4	11,078	97.54	1,180	68.6	-	-	-	-
ST		38,078		2,653	67.2	-	-	-	-

				Earth Work Volume and Hauling Distance					
		Area	EL	w/in Field Lot		w/in Field Block		Out of Field Block	
FBN	FLN	(sq. m)	(m)	V (cu. m)	D (m)	V (cu. m)	D (m)	V (cu. m)	D (m)
11	1	9,000	98.07	618	39.0	-	-	-	-
	2	9,000	97.80	396	43.4	-	-	-	-
	3	9,000	97.47	155	31.9	+ 708	-	-	-
	4	9,000	97.22	385	31.9	- 262	86.4	-	-
	5	8,739	97.22	734	58.6	- 446	122.1	-	-
						- 960	53.9	-	-
	6	4,248	97.17	136	49.0	+ 960	-	-	-
ST		48,987		2,424	44.6	1,668	77.2	-	-
12	1	8,654	97.83	772	91.1	-	-	-	-
	2	8,886	97.69	651	95.7	-	-	-	-
	3	8,753	97.53	503	43.2	-	-	-	-
	4	8,793	97.19	1,032	51.6	-	-	-	-
	5	8,745	96.78	515	23.4	- 497	85.9	-	-
	6	8,955	96.73	371	81.3	+ 945	-	-	-
	7	7,511	96.73	1,081	86.5	- 537	60.0	-	-
ST		60,297		4,925	69.7	945	79.3	-	-
Total		50,923		22,069	53.0	6,240	82.2	-	-
Facility Area		33,700		5,531	73.0	-	-	-	-
G. Total		384,623		27,600	57.0	6,240	82.2	-	-

Note; FBN-Field Block No. : FL- Field Lot No. : EL- Field Surface Elevation
V-Earth Work Volume : D-Hauling Distance : w/in-within
"+" - Surplus of earth on a field lot, "-" deficit of earth on a field

TABLE 4-1-3 TOP SOIL REMOVAL/REPLACEMENT

FBN	FLN	Area (sq. m)	Thickness (cm)	Volume (cu. m)	Hauling Distance (m)
1	1	2,040	15	306	17.0
	2	2,630	15	395	21.9
	3	3,200	15	480	26.7
8	1	2,820	15	423	23.5
	2	3,000	15	450	25.0
	3	3,000	15	450	25.0
	4	3,000	15	450	25.0
	5	3,000	15	450	25.0
9	1	1,912	15	287	15.9
	2	1,665	15	250	13.9
	3	2,198	15	330	18.3
	4	2,693	15	404	22.4
	5	3,158	15	474	26.3
Total		34,316		5,149	22.7

Earth moving method : Temporary stockpiled method

Note: Hauling Distance = length of longer side/4
FBN: Filed Block No.
FLn: Field Lot No.

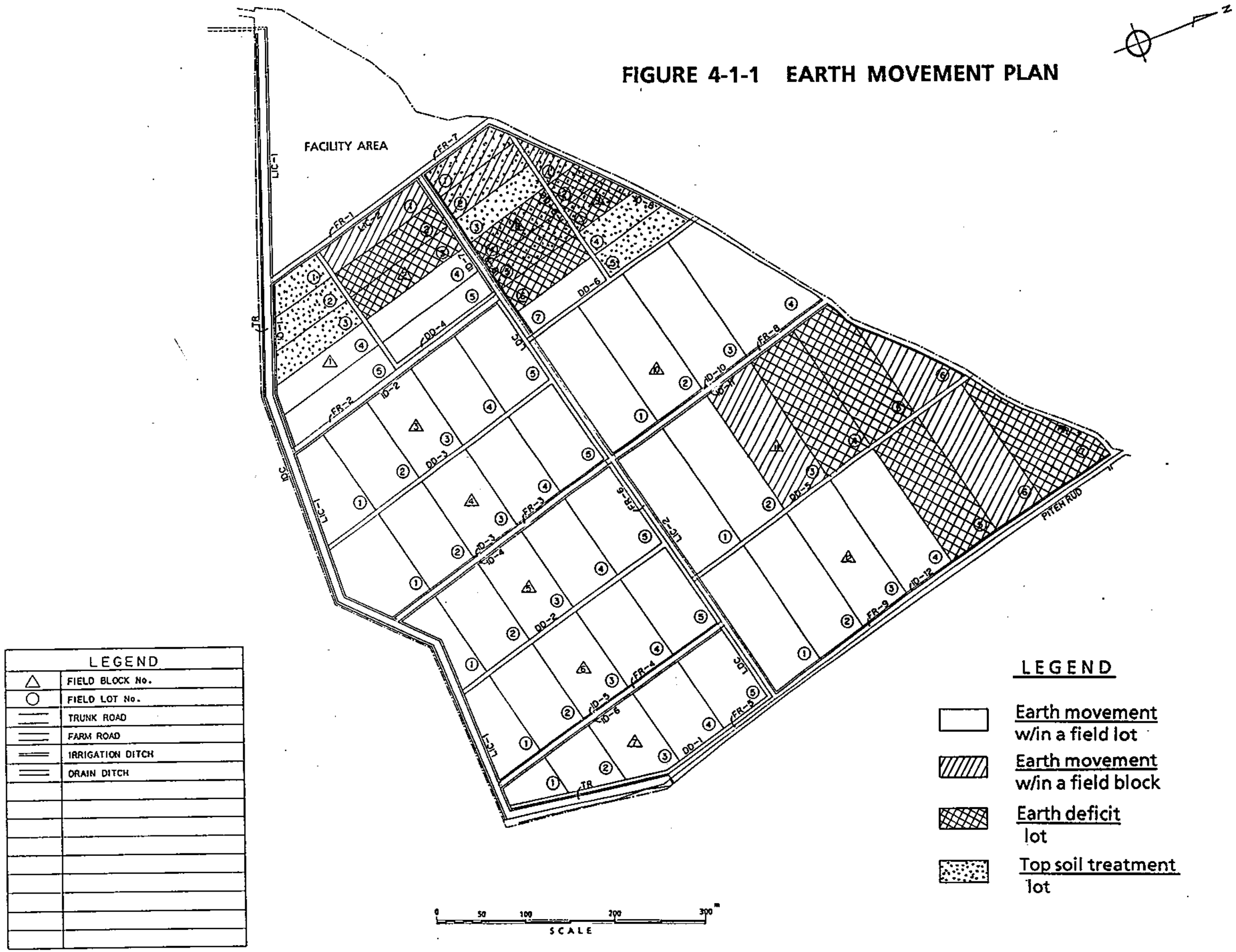
TABLE 4-1-4 SLOPE TAMPING AREA

FBN	FLN	EL_1 ① (m)	EL_2 ② (m)	h (m) ①−②	L (m)	Slope Area (sq. m)
1	1	98.99	98.97	0.02	-	-
	2	98.97	98.71	0.26	97	36
	3	98.71	98.60	0.11	116	18
	4	98.60	98.51	0.09	-	-
Sub-Total						54
2	1	98.94	98.94	0.0	-	-
	2	98.94	98.65	0.29	130	53
	3	98.65	98.27	0.38	130	70
	4	98.27	98.20	0.07	-	-
Sub-Total						123
3	1	98.84	98.81	0.03	-	-
	2	98.81	98.47	0.34	100	48
	3	98.47	98.38	0.09	-	-
	4	98.38	98.14	0.24	100	34
Sub-Total						82
4	1	98.93	98.77	0.16	100	23
	2	98.77	98.45	0.32	100	45
	3	98.45	98.36	0.09	-	-
	4	98.36	98.19	0.17	100	24
Sub-Total						92
5	1	98.77	98.74	0.03	-	-
	2	98.74	98.59	0.15	100	21
	3	98.59	98.49	0.10	100	14
	4	98.49	98.28	0.21	100	30
Sub-Total						65
6	1	98.92	98.84	0.08	-	-
	2	98.84	98.64	0.20	100	28
	3	98.64	98.36	0.28	100	40
	4	98.36	98.14	0.22	100	31
Sub-Total						99
7	1	98.82	98.31	0.51	48	35
	2	98.31	97.95	0.36	72	37
	3	97.95	97.93	0.02	-	-
	4	97.93	97.74	0.19	92	25
Sub-Total						97
8	1	98.96	98.94	0.0	-	-
	2	98.94	98.93	0.01	-	-
	3	98.93	98.86	0.07	-	-
	4	98.86	98.56	0.30	100	42
	5	98.56	98.11	0.45	100	64
	6	98.11	97.98	0.13	100	18
Sub-Total						124
9	1	98.94	98.88	0.06	-	-
	2	98.88	98.37	0.51	65	47
	3	98.37	98.05	0.32	82	24
	4	98.05	97.83	0.22	98	30
Sub-Total						101
10	1	97.94	97.77	0.17	150	36
	2	97.77	97.54	0.23	150	49
	3	97.54	97.54	0.0	-	-
Sub-Total						85

FBN	FLN	EL_1 ① (m)	EL_2 ② (m)	h (m) ①−②	L (m)	Slope Area (sq. m)
11	1	98.07	97.80	0.27	150	57
	2	97.80	97.47	0.33	150	70
	3	97.47	97.22	0.25	150	53
	4	97.22	97.22	0.0	-	-
	5	97.22	97.17	0.05	-	-
Sub-Total						180
12	1	97.83	97.69	0.14	149	30
	2	97.69	97.53	0.16	148	33
	3	97.53	97.19	0.34	147	71
	4	97.19	96.78	0.41	147	85
	5	96.78	96.78	0.0	-	-
	6	96.78	96.61	0.17	149	36
Sub-Total						255
Total						1,357

Note; Slope (sq. m) = $\sqrt{2} \times h \times L$
Where h is less than 10 cm, this work is not performed.

FIGURE 4-1-1 EARTH MOVEMENT PLAN



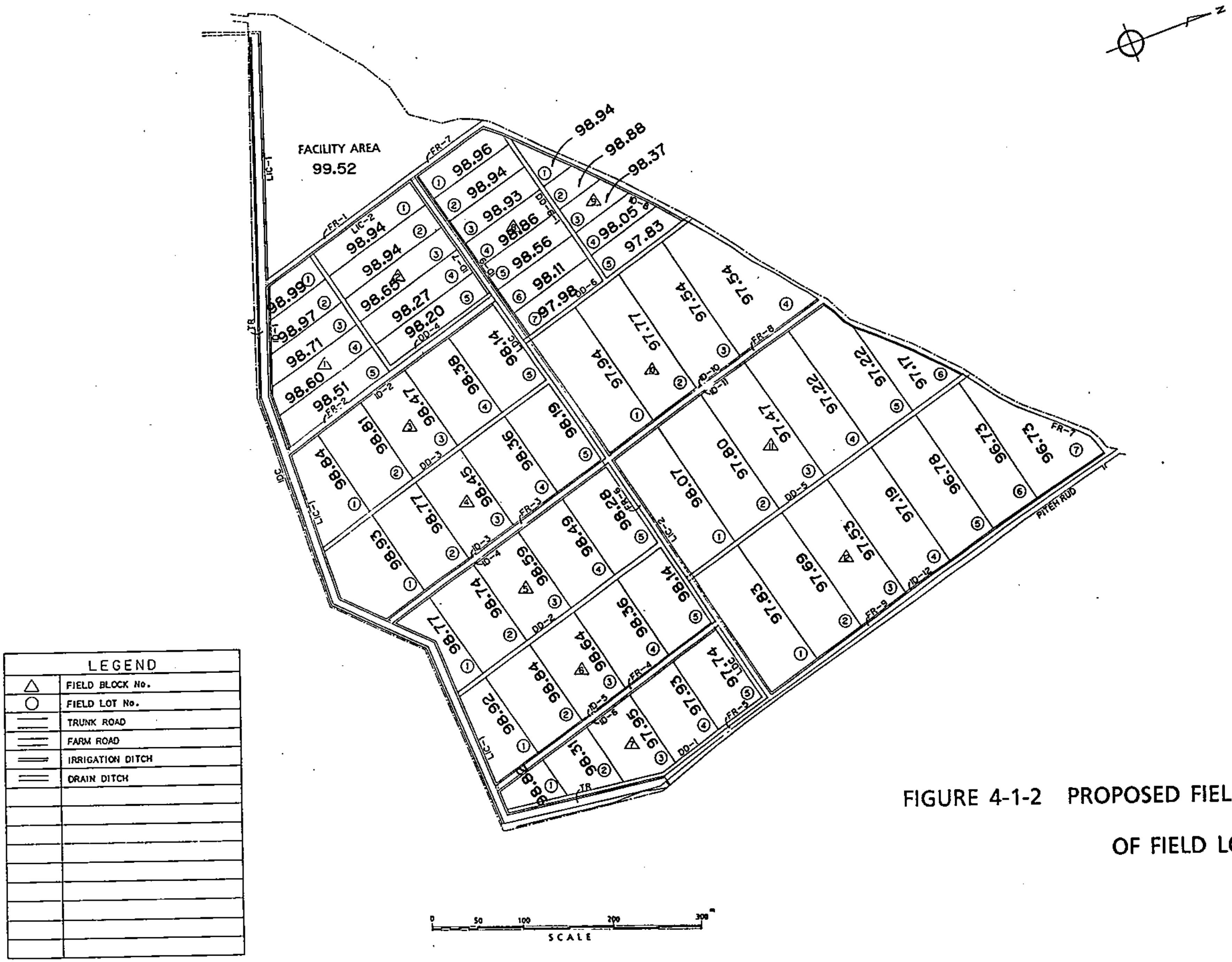
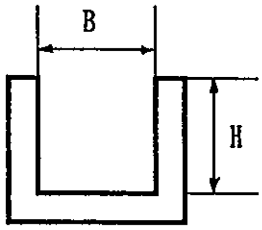


FIGURE 4-1-2 PROPOSED FIELD ELEVATION OF FIELD LOTS IN MF

TABLE 4-2-1 LIST OF IRRIGATION CANALS

Name of Canal	Type	Gross Length (m)	Net Length (m)	--- Size --- B	H
LIC-1	1	288.5	270.6	1.10m	0.60m
"	2	660.5	629.8	0.80	0.55
"	3	171.0	156.0	0.80	0.50
Sub-total		1,120.0	1,056.4		
LIC-2	1		2.4	1.10m	0.60m
	1	199.4	187.0	0.70	0.50
"	2	369.6	357.9	MOA A-3 Type	
"	3	324.0	278.0	MOA A-3 Type	
Sub-total		893.0	825.3		
Total		2,013.0	1,881.7		
ID-1		173.0	173.0	0.30	0.30
ID-2		271.0	271.0	0.30	0.30
ID-3		286.0	286.0	0.30	0.30
ID-4		282.0	282.0	0.30	0.30
ID-5		291.0	291.0	0.30	0.30
ID-6		293.0	293.0	0.30	0.30
ID-7		149.0	149.0	0.30	0.30
ID-8	1	101.0	101.0	0.40	0.35
"	2	136.0	136.0	0.30	0.30
"	3	103.0	103.0	0.30	0.30
ID-9		208.0	208.0	0.30	0.30
ID-10		286.0	286.0	0.30	0.35
ID-11		459.0	459.0	0.30	0.35
ID-12		447.0	447.0	0.30	0.35
Total		3,485.0	3,485.0		



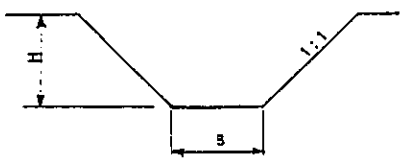


TABLE 4-2-2 BILL OF QUANTITY OF IRRIGATION CANAL CONSTRUCTION

a) Lateral Irrigation Canal

Name of Canal	Net Length (m)	Concrete (150kg/cu.m) @	V	Concrete (300kg/cu.m) @	V	Form @	V	Concrete Block lining @	V
LIC-1	270.6	0.100	27.1	0.298	80.6	0.30	81.2	0.80	216.5
"	629.8	0.065	40.9	0.253	159.3	0.30	188.9	0.80	503.8
"	156.0	0.065	10.1	0.253	39.5	0.30	46.8	0.80	124.8
Sub-total	1,056.4		78.1		279.4		316.9		845.1
LIC-2	2.4	0.100	0.2	0.298	0.7	0.30	0.7	0.80	216.5
	187.0	0.060	11.2	0.238	44.5	0.30	56.1	0.80	503.8
"	357.9	0.036	12.9	-	-	-	-	-	-
"	278.0	0.036	10.0	-	-	-	-	-	-
Sub-total	825.3		34.3		45.2		56.8		720.3
Total	1,881.7		112.4		324.6		373.7		1,565.4

Name of Canal	Net Length (m)	Brick lining (150kg/cu.m) @	V	Precast Canal MOA A-3 Type @	V	Stripping (cu.m)	Compacted Fill (cu.m)
LIC-1	270.6	0.40	108.2	-	-	160	332
"	629.8	0.30	188.9	-	-	344	1,192
"	156.0	0.20	31.2	-	-	84	890
Sub-total	1,056.4		328.3	-	-	588	2,414
LIC-2	2.4	0.40	1.0	-	-	-	-
	187.0	0.20	37.4	-	-	98	268
"	357.9	-	-	2	716	147	672
"	278.0	-	-	2	556	130	384
Sub-total	825.3		38.4		1,272	375	1,324
Total	1,881.7		366.7		1,272	963	3,738

Name of Canal	Net Length (m)	Slope Tamping (sq. m)	Excavation (cu. m)	Backfill (cu. m)	Sand (cu. m)	Mortar @	Mortar V
LIC-1	270.6	117	286	103	-	0.026	7.04
"	629.8	488	662	218	-	0.024	15.12
"	156.0	355	172	97	-	0.022	3.43
Sub-total	1,056.4	960	1,120	418	-	-	25.59
LIC-2	2.4	-	-	-	-	0.026	0.06
	187.0	104	200	30	-	0.022	4.11
"	357.9	389	199	-	88	-	-
"	278.0	188	175	-	78	-	-
Sub-total	825.3	681	574	30	166		4.17
Total	1,881.7	1,641	1,694	448	166		29.76

b) Irrigation Ditch

Canal Name	Net Length (m)	Compacted Fill @	Compacted Fill V	Excavation (manual) @	Excavation (manual) V	Excavation (manual) @	Excavation (manual) V
ID-1	173.0	0.48	83	0.18	31	1.45	251
ID-2	271.0	0.36	98	0.18	49	1.25	339
ID-3	286.0	0.36	103	0.18	51	1.25	358
ID-4	282.0	0.36	102	0.18	51	1.25	353
ID-5	291.0	0.36	105	0.18	52	1.25	364
ID-6	293.0	0.36	105	0.18	53	1.25	366
ID-7	149.0	0.36	54	0.18	27	1.25	186
ID-8	101.0	0.64	65	0.26	26	1.50	152
"	136.0	0.36	49	0.18	24	1.25	170
"	103.0	0.46	47	0.18	19	1.45	149
ID-9	208.0	0.36	75	0.18	37	1.25	260
ID-10	286.0	0.43	123	0.23	66	1.50	429
ID-11	459.0	0.43	197	0.23	106	1.50	689
ID-12	447.0	0.39	174	0.18	80	1.40	626
	3,485.0		1,380		672		4,692

TABLE 4-2-3 LIST OF APPURTENANT STRUCTURES

Name of structure	Location
a) LIC-1	
1. Spillway 1-1	No.0
2. Road crossing (TR)	No.0+5.5
3. Road crossing (FR-1)	No.2+79.75
4. Turn-out with branch off (ID-1)	No.2+85.45
5. Parshall flume(w=1.5ft)	No.2+91.31
6. Road crossing (FR-2)	No.4+59.50
7. Turn-out (ID-2)	No.4+65.50
8. Drainage release(DD-3)	No.5+69.50
9. Turn-out (ID-3)	No.6+85.00
10. Road crossing (FR-3)	No.6+86.00
11. Turn-out (ID-4)	No.6+91.00
12. Drainage release	No.7+99.50
13. Turn-out (ID-5)	No.9+ 5.50
14. Road crossing (FR-4)	No.9+ 6.50
15. Turn-out (ID-6)	No.9+11.50
16. Drainage release	No.9+38.30
17. Spillway 1-2	No.9+43.00
18. Check gate 1-2	No.9+48.00
19. Siphon	No.11+5.00

Name of structure	Location
b) LIC-2	
1. Check gate 2-1 with branch-off	No.0
2. Parshall flume	No.0+3.66
3. Drainage release	
4. Turn-out (ID-7)	No.1+93.55
5. Road crossing(FR-6)	No.1+94.55
6. Drainage release DD-6 w/ check gate 2-3	No.4+ 8.50
7. Turn-out ID-10	No.5+62.00
8. Road crossing(FR-8)	No.5+63.00
9. Turn-out ID-11 w/ check gate 2-4	No.5+68.00
10. Drainage release DD-6 w/ check gate 2-3	No.4+ 8.50

c) Irrigation Ditch (ID)

1. Drainage release DD-6 on ID-8

TABLE 4-2-4 BILL OF QUANTITY OF APPURTENANT STRUCTURES

a) Road crossing (n= 7)

Item	unit	FR-1	FR-2	FR-3	FR-4
Excavation	cu. m	-	26	23	23
Backfill	cu. m	-	18	16	16
Concrete (300kg/cu. m)	cu. m	3. 48	2. 97	2. 48	2. 48
Concrete (150kg/cu. m)	cu. m	0. 43	0. 36	0. 30	0. 30
Form	sq. m	23. 10	25. 38	21. 48	21. 48
Reinforced bar (D10)	m	433. 4	287. 5	239. 6	239. 6
Reinforced bar (D14)	m	59. 8	68. 6	57. 2	57. 2

	unit	FR-6	FR-8	TR	Total
Excavation	cu. m	-	17	-	89
Backfill	cu. m	-	13	-	63
Concrete (300kg/cu. m)	cu. m	2. 19	1. 83	4. 88	20. 31
Concrete (150kg/cu. m)	cu. m	0. 27	0. 25	0. 49	2. 40
Form	sq. m	18. 67	15. 44	29. 16	154. 71
Reinforced bar (D10)	m	265. 7	186. 3	357. 6	2, 009. 7
Reinforced bar (D14)	m	22. 1	44. 7	94. 2	403. 8

b) Turnout (n=10)

Item	unit	Type-A		Type-B		Type-C	
		@	V	@	V	@	V
n	Place	5	-	1	-	1	-
Excavation	cu. m	included in road crossing construction work					
Backfill	cu. m	included in road crossing construction work					
Dry masonry (t=15cm)	sq. m	-	-	-	-	-	-
Concrete (300kg/cu. m)	cu. m	0. 44	2. 20	0. 30	0. 30	0. 37	0. 37
Concrete (150kg/cu. m)	cu. m	0. 07	0. 36	0. 06	0. 06	0. 07	0. 07
Form	sq. m	3. 56	17. 80	2. 13	2. 13	2. 46	2. 46
Reinforced bar(φ4)	m	-	-	-	-	-	-
Reinforced bar (D10)	m	33. 4	167. 0	24. 8	24. 8	29. 7	29. 7
Reinforced bar (D14)	m	14. 9	74. 5	10. 5	10. 5	12. 5	12. 5
Steel plate(t=9mm)	kg	-	-	-	-	-	-

Item	unit	ID-1*1	ID-7	ID-8, 9*2	Total
n	Place	1	1	1	10
Excavation	cu. m	included in road crossing construction work			
Backfill	cu. m	included in road crossing construction work			
Dry masonry (t=15cm)	sq. m	3. 0	2. 9	6. 7	12. 6
Concrete (300kg/cu. m)	cu. m	2. 62	0. 47	1. 62	7. 58
Concrete (150kg/cu. m)	cu. m	0. 33	0. 07	0. 29	1. 18
Form	sq. m	11. 85	3. 38	8. 85	46. 47
Reinforced bar(φ4)	m	-	5. 0	-	5. 0
Reinforced bar (D10)	m	209. 7	41. 6	156. 1	628. 9
Reinforced bar (D14)	m	-	-	-	97. 5
Steel plate (t=9mm)	kg	153	57	199	409
Iron gate 1100x600mm	pc	1	-	-	1
Iron gate 400x600mm	pc	1	-	-	1
Iron gate 400x550mm	pc	-	1	2	3
Iron gate 700x500mm	pc	-	-	1	1

Note: *1 with a branch off structure
*2 with a check gate 2-2 structure

c) Siphon (n=1)

Item	unit	Volume
Excavation	cu. m	141
Backfill	cu. m	48
Compacted fill	cu. m	208
Concrete(300kg/cu. m)	cu. m	13. 9

Concrete(150kg/cu.m)	cu.m	0.7	
Form	sq.m	101.0	
Reinforced bar (D10)	m	490.9	
Reinforced bar (D14)	m	760.6	
Reinforced bar (D16)	m	73.3	
Wet masonry (t=30cm)	sq.m	4.0	
Brick wall	sq.m	0.4	
Darwell bar (D16)	m	12	
Mortar	cu.m	0.034	(=0.002+0.012+0.02)
RC pipe φ400mm@3.5	pc	5	

d) Spillway (n=2)

Item	unit	1-1	1-2	Total
n	Place	1	1	2
Excavation	cu.m	included in road crossing construction work		
Backfill	cu.m	included in road crossing construction work		
Wet masonry (t=15cm)	sq.m	14	17	31
Dry masonry (t=30cm)	sq.m	-	11	11
Concrete (300kg/cu.m)	cu.m	3.64	-	3.64
Concrete (150kg/cu.m)	cu.m	0.43	-	0.43
Form	sq.m	14.27	-	14.27
Reinforced bar (D10)	m	128.3	-	128.3

e) Parshall flume (n=2)

Item	unit	LIC-1	LIC-2	Total
n	Place	1	1	2
Excavation	cu.m	included in road crossing construction work		
Backfill	cu.m	included in road crossing construction work		
Concrete (300kg/cu.m)	cu.m	0.83	0.83	1.66
Concrete (150kg/cu.m)	cu.m	0.21	0.21	0.42
Form	sq.m	8.01	8.01	16.02
RC pipe φ400mm@2.5m	pc	1	1	2

f) Drainage release(n=6)

Item	unit	Type-1		Type-2		Type-3		Total
		@	V	@	V	@	V	
n	Place	3	-	1	-	2	-	6
Excavation	cu.m	included in road crossing construction work						-
Backfill	cu.m	included in road crossing construction work						-
Wet masonry (t=15cm)	sq.m	10	30	10	10	10	30	70
Concrete (300kg/cu.m)	cu.m	0.33	0.99	0.31	0.31	0.30	0.60	1.90
Concrete (150kg/cu.m)	cu.m	0.07	0.21	0.07	0.07	0.06	0.12	0.40
Form	sq.m	2.11	6.33	1.96	1.96	2.21	4.42	12.71
Reinforced bar(φ4)	m	5.0	15.0	5.0	5.0	5.0	10.0	30.0
Reinforced bar (D10)	m	33.6	100.8	32.0	32.0	3.8	7.6	111.6
Steel plate (t=9mm)	sq.m	64	192	57	57	64	192	441
Iron gate 400x550mm	pc	1	3	1	1	-	-	4
Stop log	cu.m	-	-	-	-	0.016	0.032	0.032

g) Check Gate (n=2)

Item	unit	1-2	2-1	Total
n	Place	1	1	2
Excavation	cu.m	included in road crossing construction work		
Backfill	cu.m	included in road crossing construction work		
Concrete (300kg/cu.m)	cu.m	0.61	-	0.61
Concrete (150kg/cu.m)	cu.m	0.08	-	0.08
Form	sq.m	3.90	-	3.90
Reinforced bar (D10)	m	51.6	-	51.6
Steel plate (t=9mm)	kg	39	-	39
Iron gate 800x550mm	pc	1	-	1
Iron gate 1100x600mm	pc	-	1	1

i) Drainage release on ID-8 (n=1)

Item	unit	Quantity
n	Place	1
Excavation	cu. m	-*1
Backfill	cu. m	-*1
Wet masonry	sq. m	10
Concrete (300kg/cu. m)	cu. m	0.302
Concrete (150kg/cu. m)	cu. m	0.055
Form	sq. m	2.21
Reinforced bar (∮4mm)	m	5.0
Reinforced bar (D10)	m	3.8
Stop log (wood)	cu. m	0.016

Note: *1 Earth work volume is inculuded in the canal construction work.

FIGURE 4-2-1 LOCATION MAP OF IRRIGATION CANAL

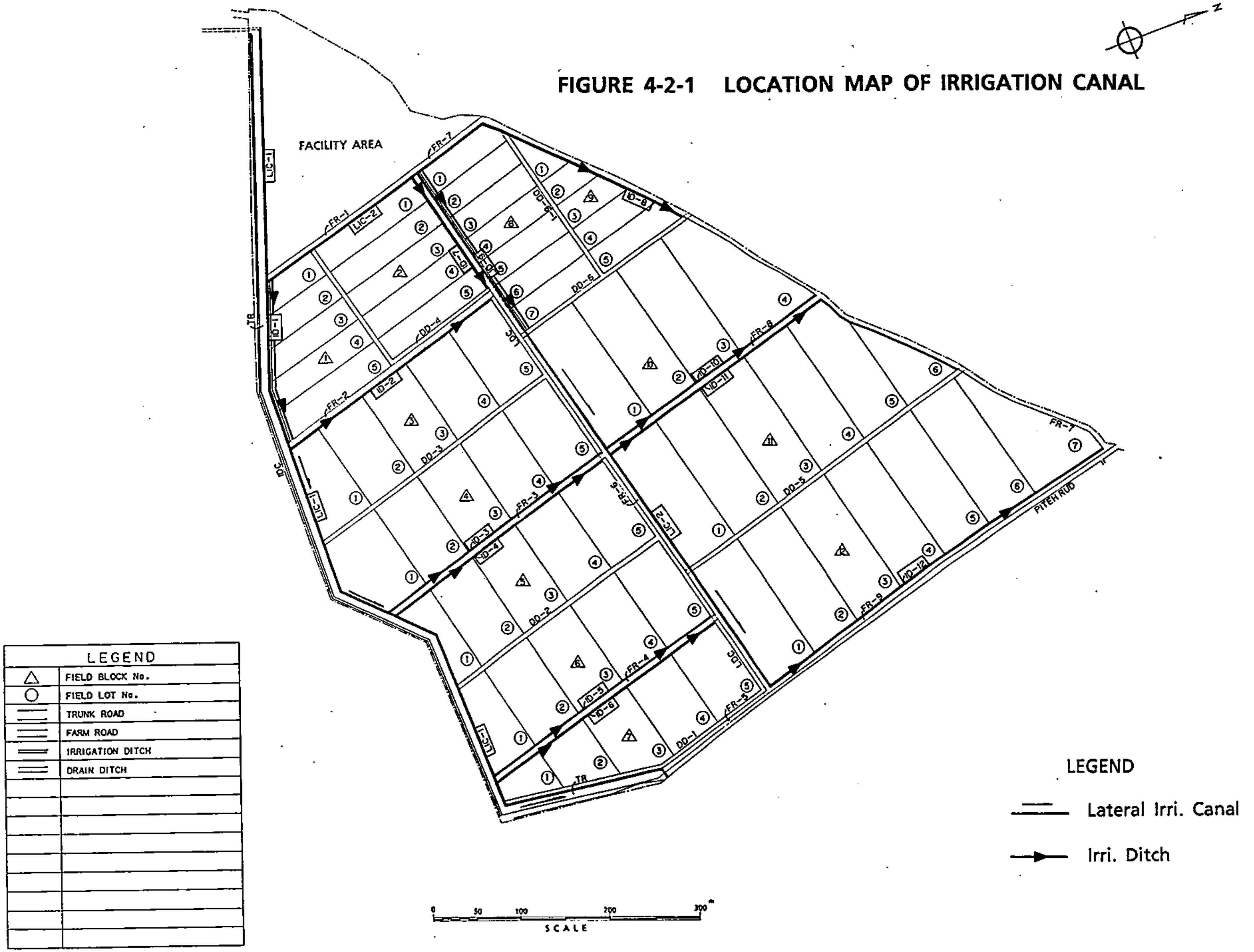


TABLE 4-3-1 LIST OF DRAINAGE CANAL

Name of Canal	Length and Size: Length (m)	Bottom Width (m)	Average Depth (m)	Remarks
IDC	936.5	0.30	1.28	Interception Drainage Canal (IDC)
LDC	524.0	0.30	1.07	Lateral Drainage Canal (LDC)
DD-1	312.0	0.30	0.98	Drain Ditch (DD)
DD-2	270.0	0.30	0.91	
DD-3	300.0	0.30	0.89	
DD-4	284.5	0.30	0.94	
DD-5	382.0	0.30	0.96	
DD-6	232.0	0.30	0.78	
DD-6-1	206.0	0.30	1.03	
Total	3,447.0			

TABLE 4-3-2 BILL OF QUANTITY OF DRAINAGE CANAL CONSTRUCTION

Name of Canal	Length	Excavation		Compacted Fill		Slope Tamping	
	(m)	@	V	@	V	@	V
IDC	936.5	2.022	1,894	-	-	3.620	3,390
LDC	524.0	1.466	768	0.18	94	3.875	2,030
DD-1	312.0	1.254	391	0.18	56	3.620	1,129
DD-2	270.0	1.235	333	0.36	97	4.426	1,195
DD-3	300.0	1.111	333	0.36	108	4.271	1,281
DD-4	133.0	1.331	177	0.18	24	4.271	568
"	151.5	1.331	202	0.36	55	4.271	647
DD-5	382.0	1.530	584	0.36	138	4.808	1,837
DD-6	232.0	1.015	235	0.36	84	4.172	968
DD-6-1	206.0	1.463	301	0.36	74	4,709	970
Total	3,447.0		5,218		730		14,015

TABLE 4-3-3 LIST OF DRAINAGE ROAD CROSSING

Canal Name	Road Name	Type	Gate	Remarks
	Location and Type			
IDC	-	-		
LDC	FR-2	A		
"	FR-3	A		
"	FR-4	A		
"	FR-5	B		to Piteh Rud
DD-1	-	-		
DD-2	-	-		
DD-3	-	-		
DD-4	-	-		
DD-5	FR-7	B		to Ahi Rud
DD-6	FR-7	B		to Ahi Rud
DD-6-1	-	-		
Total	6 places	(Type-A : 3 places) (Type-B : 3 Places)		

TABLE 4-3-4 BILL OF QUANTITY OF DRAINAGE ROAD CROSSING

		Work volume				
		Type-A (n=3)		Type-B (n=3)		Total
		@	V	@	V	
Excavation	:	included in canal excavation works				-
back fill	:		- do -			-
Concrete (200 kg/cu.m)	: cu.m	: 1.49	4.47	3.66	10.98	15.45
Concrete (150 kg/cu.m)	: cu.m	: 0.16	0.48	-	-	0.48
Form	: sq.m	: 8.51	25.53	18.70	56.10	81.63
Wet masonry	: sq.m	: 9.06	27.18	9.87	29.61	56.79
Backfill Gravel	cu.m	: 2.72	8.16	2.96	8.88	17.04
Dry masonry	: sq.m	: 30.37	91.11	40.52	121.56	212.67
RC pipe @3.5m (600 mm in dia.)	: pcs	: 1	3	1	3	6
" @2.0m (600 mm in dia.)		1	3	1	3	6
Vynil pipe (40 mm in dia.)	: m	: 1.6	4.8	1.6	4.8	9.6

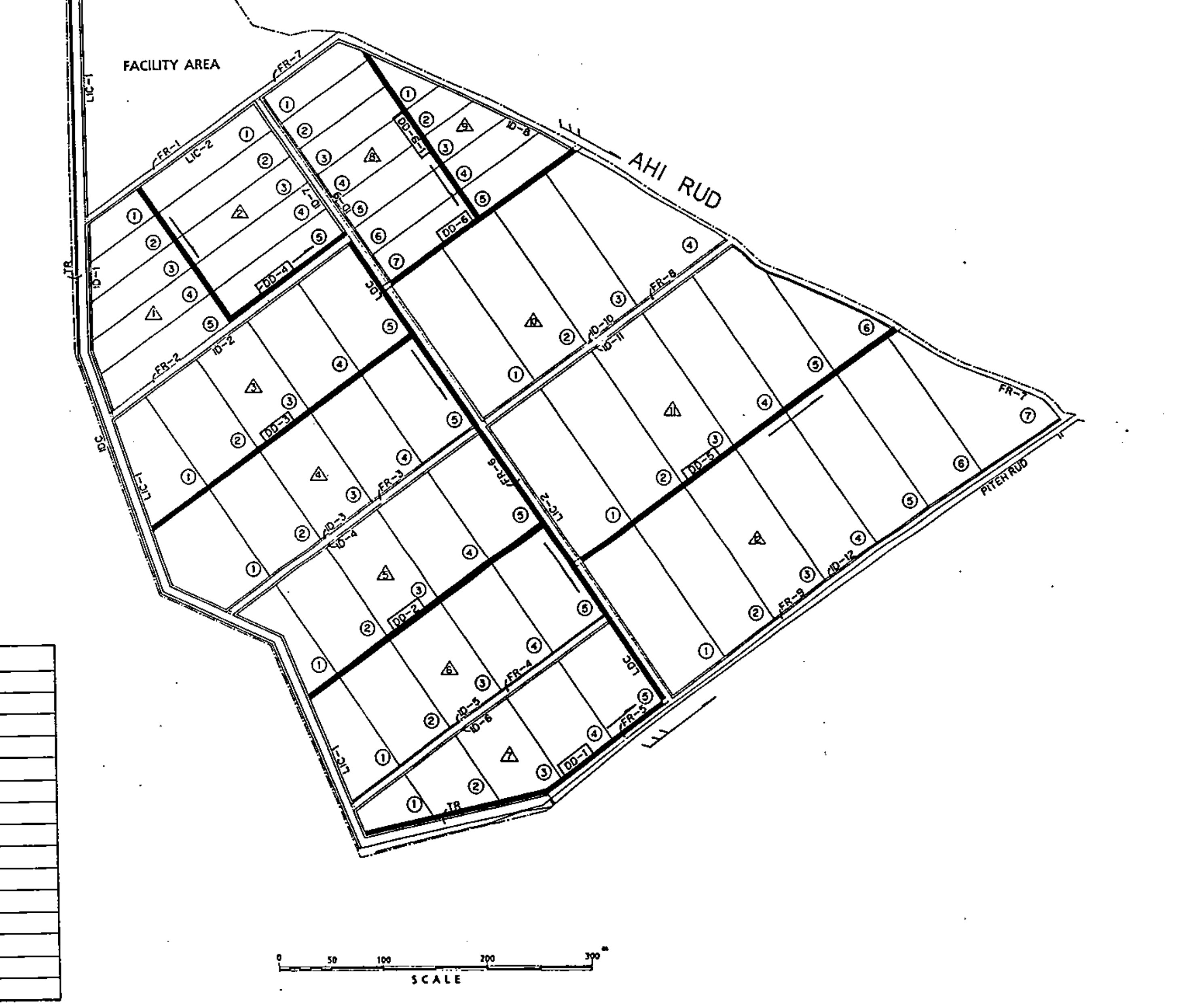
TABLE 4-3-5 LIST OF DRAINAGE CHECK STRUCTURE

Canal Name	No. of Check	Remarks
IDC	-	Interception Drainage Canal
LDC	2	Lateral Drainage Canal
DD-1	3	Drain Ditch
DD-2	3	
DD-3	3	
DD-4	3	
DD-5	4	
DD-6	2	
DD-6-1	3	
Total	23	

TABLE 4-3-6 BILL OF QUANTITY OF DRAINAGE CHECK STRUCTURE

		Check (n= 23)	
	Unit	@	V
Concrete (200 kg/cu. m)	cu. m	2.44	56.1
Form	sq. m	12.96	298.1
Dry Masonry	sq. m	36.62	842.3
Wooden Stop log	cu. m	0.036	0.83

FIGURE 4-3-1 LOCATION MAP OF DRAINAGE CANAL



LEGEND	
△	FIELD BLOCK No.
○	FIELD LOT No.
	TRUNK ROAD
	FARM ROAD
	IRRIGATION DITCH
	DRAIN DITCH

TABLE 4-4-1 LIST OF FARM ROAD

Name of Canal	Length	Total Road Width	Paved Width	Paved Area	Type
	(m)	(m)	(m)	(sq. m)	
TR	1,140.0	5.00	4.50	5,130	TR
FR-1	194.0	3.50	3.00	582	A
FR-2	276.5	3.50	3.00	829.5	A
FR-3	290.0	3.50	3.00	870	A
FR-4	297.0	2.50	2.00	594*	B
FR-5	138.0	3.50	3.00	414	A
FR-6	684.0	3.50	3.00	2,052	A
FR-7	869.0	3.50	3.00	2,607	A
FR-8	290.5	3.50	3.00	871.5	A
FR-9	452.0	3.50	3.00	1,356	A
Total	4,631.0			15,306.0	
(TR	1,140.0m)			14,712 (more than W = 3.0m)	
(Type-A	3,194.0m)			594 (less than W = 3.0m)	
(Type-B	297.0m)				

TABLE 4-4-2 BILL OF QUANTITY OF FARM ROAD CONSTRUCTION

Road Name	Length	Stripping		Compacted Fill		Slope Tamping		Gravel Pavement	
	(m)	@	V	@	V	@	V	@	V
TR	1,140.0	1.248	1,423	5.045	5,751	1.754	2,000	0.675	769.5
FR-1	194.0	0.980	190	3.976	771	1.414	274	0.450	87.3
FR-2	132.5	0.886	117	2.868	380	1.315	174	0.450	59.6
FR-2	144.0	0.890	128	2.907	419	1.344	194	0.450	64.8
FR-3	290.0	0.926	269	3.360	974	1.598	463	0.450	130.5
FR-4	297.0	0.746	222	2.265	673	1.739	516	0.450	59.4
FR-5	138.0	1.040	144	4.672	645	2.404	332	0.450	62.1
FR-6	684.0	0.962	658	3.837	2,625	1.853	1,267	0.450	307.9
FR-7	869.0	0.872	758	2.253	1,958	1.216	1,057	0.450	391.1
FR-8	290.5	0.922	268	3.305	960	1.570	456	0.450	130.7
FR-9	452.0	0.944	427	3.577	1,616	1.725	780	0.450	203.4
Total	4,631.0		4,604		16,772		7,513		2,266.3

Excavation: FR-1 194.0m x 2.687cu.m/m = 15cu.m (Excavation of Side ditch)

TABLE 4-4-3 LIST OF CORNER CUTTING

Road Name	Itrsct. Road	No. of Corner Cutting by Type: Total	A-1	A-2	A-3	A-4	A-5	B-1	B-2	B-3	B-4	B-5
TR	-	-	-	-	-	-	-	-	-	-	-	-
FR-1	TR	2	1	-	-	-	-	1	-	-	-	-
"	FR-6	1	1	-	-	-	-	-	-	-	-	-
FR-2	TR	2	-	1	-	-	-	1	-	-	-	-
"	FR-6	2	2	-	-	-	-	-	-	-	-	-
FR-3	TR	2	1	-	-	-	-	-	1	-	-	-
"	FR-6	2	2	-	-	-	-	-	-	-	-	-
FR-4	TR	2	2	-	-	-	-	-	-	-	-	-
"	FR-6	2	1	1	-	-	-	-	-	-	-	-
FR-5	FR-6	1	-	1	-	-	-	-	-	-	-	-
FR-6	-	-	-	-	-	-	-	-	-	-	-	-
FR-7	FR-6	1	1	-	-	-	-	-	-	-	-	-
FR-8	FR-6	2	2	-	-	-	-	-	-	-	-	-
"	FR-7	2	1	-	-	-	-	1	-	-	-	-
FR-9	FR-6	1	1	-	-	-	-	-	-	-	-	-
"	FR-7	1	1	-	-	-	-	-	-	-	-	-
	Total	23	16	3	-	-	-	3	1	-	-	-

Note; Itrsct. = Intersection, FR = Farm Road

TABLE 4-4-4 BILL OF QUANTITY OF CORNER CUTTING

Type	Places	Compacted fill @	Compacted fill V	Slope tamping @	Slope tamping V
A-1	16	1.000	16	2.000	32
A-2	3	1.300	4	2.600	8
B-1	3	1.949	6	2.121	13
B-2	1	2.533	3	2.757	8
Total	23		29		51

TABLE 4-4-5 LIST OF ACCESS ROAD TO FIELD

Road Name	Itrsct. Road	Type Total	1	2	S1	S2	S3	S4	Location FBN	FLN
TR	ID-1	5	2	3	-	-	-	-	1	1, 2, 3, 4, 5
"	LIC-1	5	-	-	-	-	2	3	1	1, 2, 3, 4, 5
FR-1	-	-	-	-	-	-	-	-		
FR-2	ID-2	-	-	-	-	-	-	-		
FR-3	ID-3	-	-	-	-	-	-	-		
"	ID-4	-	-	-	-	-	-	-		
FR-4	ID-5	-	-	-	-	-	-	-		
"	ID-6	3	1	2	-	-	-	-	7	2, 3, 5
FR-5	-	-	-	-	-	-	-	-		
FR-6	ID-9	4	2	2	-	-	-	-	8	4, 5, 6, 7
"	LIC-2	4	-	-	2	2	2	3	8	4, 5, 6, 7
"	ID-7	3	1	2	-	-	-	-	2	3, 4, 5
FR-7	ID-8	2	-	2	-	-	-	-	9	3, 4
FR-8	ID-10	-	-	-	-	-	-	-		
"	ID-11	3	3	-	-	-	-	-	11	3, 4, 5
FR-9	ID-12	-	-	-	-	-	-	-		
Total		24	9	11	2	2	2	3		

Note; Itrsct. = Intersection, FR = Farm Road

TABLE 4-4-6 BILL OF QUANTITY OF ACCESS ROAD TO FIELD

		Compacted Fill		RC pipe 400mm	500mm	600mm	Concrete	Form
Type	Places	@	V	(pcs)	(pcs)	(pcs)	(cu. m)	(sq. m)
1	9	3.319	30	9	-	-	8.3	30.2
2	11	7.521	83	22	-	-	20.2	67.8
S1	2	3.319	6	-	6	-	3.7	8.6
S2	2	7.521	15	-	30	-	5.2	16.2
S3	2	3.319	6	-	-	6		
S4	3	7.521	15	-	-	30		
Total	24		155	31	36	36	37.4	122.8

TABLE 4-4-7 BILL OF QUANTITY OF WET MASONRY OF PITEH RUD

Item	Unit	Quantity
Wet masonry (t=30cm)	sq. m	645.6
Concrete (200kg/cu. m)	cu. m	29.49
Form	sq. m	112.56

FIGURE 4-4-2 LOCATION MAP OF ACCESS ROAD TO FIELD LOTS

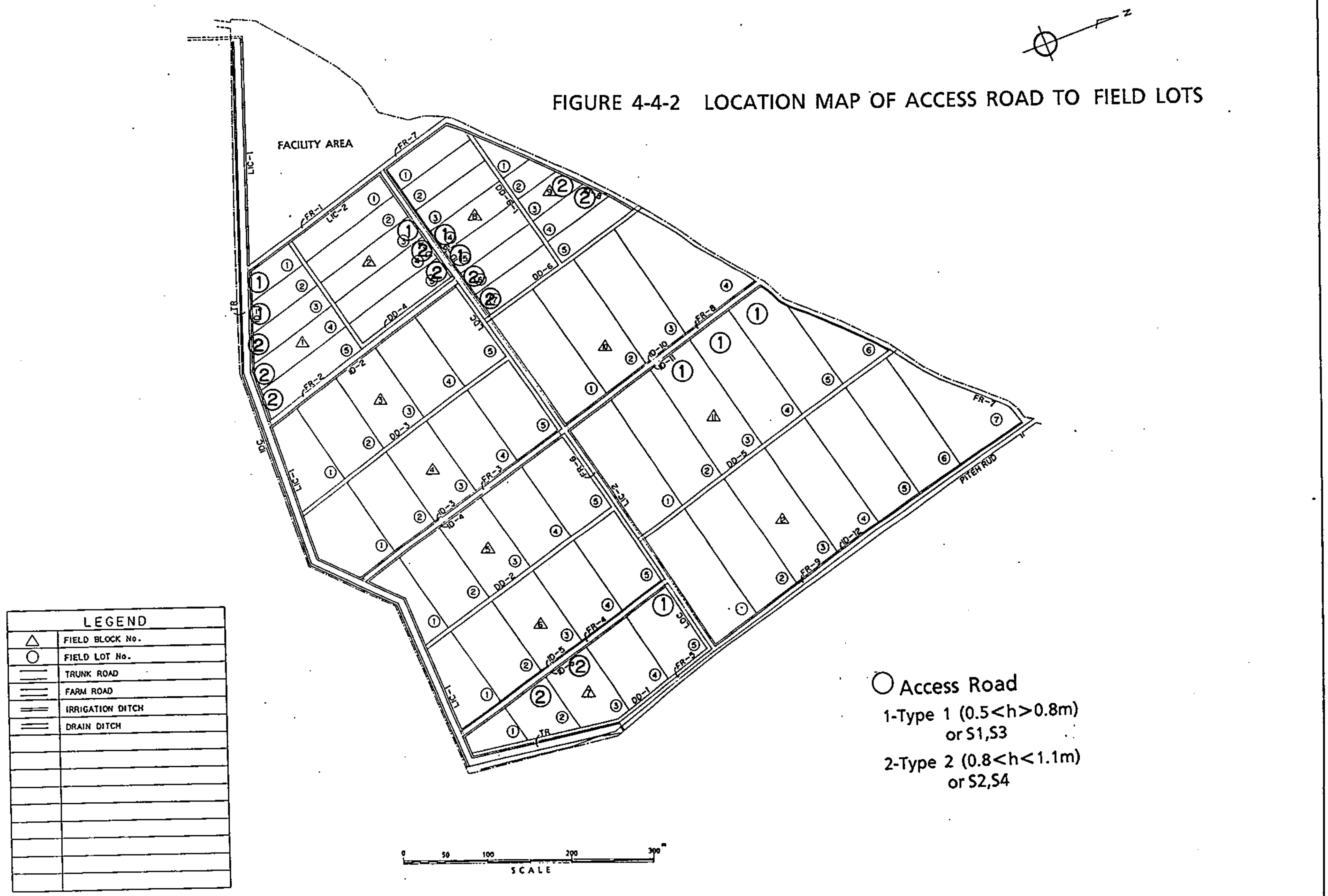


FIGURE 4-4-1 LOCATION MAP OF FARM ROAD

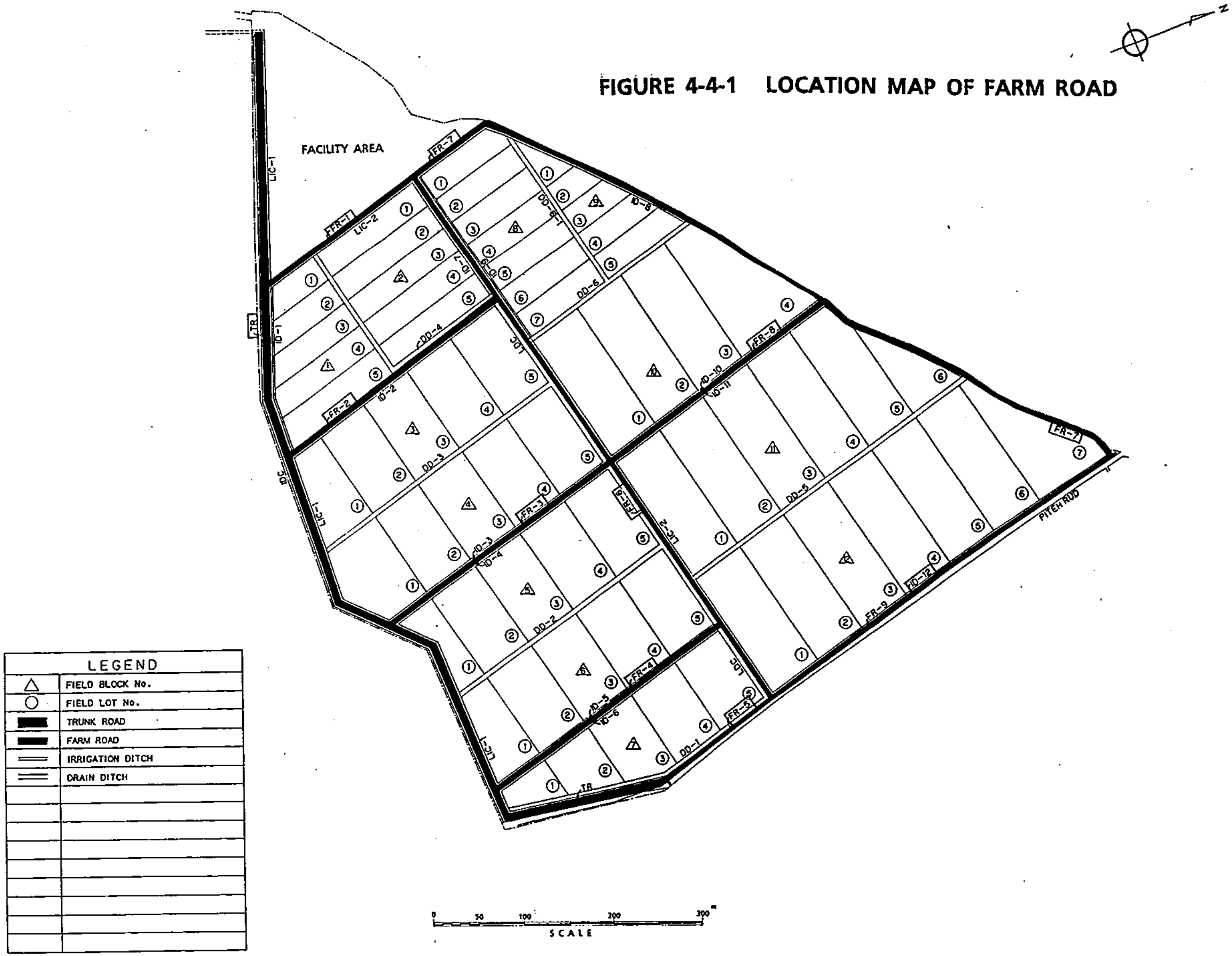


TABLE 4-5-1 LIST OF FARM ROAD IN EXPERIMENTAL FARM

Name of Road	Total Length	Net Length	Total Road Width	Type
FRD-1	111.0m	111.0m	2.50m	2
FRD-2	111.0	111.0	2.50	2
FRD-3	111.0	111.0	2.50	2
FRD-4	111.0	111.0	2.50	2
FRD-5	151.0	151.0	1.50	1
FRD-6	151.0	141.0	1.50	1
FRD-7	151.0	141.0	1.50	1
FRD-8	82.0	82.0	3.50	3
FRD-9	120.0	120.0	3.50	3
FRD-10	120.0	116.5	1.50	1
FRD-11	61.0	61.0	1.50	1
FRD-12	101.0	101.0	3.50	3
FRD-13	101.0	101.0	3.50	3
Total	1,482.0	1,458.5		
(Type-1	634.0m	610.5m)		
(Type-2	444.0m	444.0m)		
(Type-3	404.0m	404.0m)		

TABLE 4-5-2 BILL OF QUANTITY OF FARM ROAD IN EXPERIMENTAL FARM

Name of Road	Net Length (m)	Type	Compacted Fill @	Compacted Fill V	Slope Tamping @	Slope Tamping V
FRD-1	111.0	2	0.915	102	0.849	94
FRD-2	111.0	2	0.915	102	0.849	94
FRD-3	111.0	2	0.915	102	0.849	94
FRD-4	111.0	2	0.915	102	0.849	94
FRD-5	151.0	1	0.570	86	0.849	128
FRD-6	141.0	1	0.570	80	0.849	120
FRD-7	141.0	1	0.570	80	0.849	120
FRD-8	82.0	3	1.293	106	0.849	70
FRD-9	120.0	3	1.293	155	0.849	102
FRD-10	116.5	1	0.570	66	0.849	99
FRD-11	61.0	1	0.570	35	0.849	52
FRD-12	101.0	3	1.293	131	0.849	86
FRD-13	101.0	3	1.293	131	0.849	86
Total	1,458.5			1,278		1,239

TABLE 4-5-3 BILL OF QUANTITY OF FARM DITCHES IN EXPERIMENTAL FARM

Name of F.Ditch	Length (m)	Type	Cmpctd' Fill (cu.m)	Slope Tamping (sq.m)	Name of F.Ditch	Length (m)	Type	Cmpctd' Fill (cu.m)	Slope Tamping (sq.m)
FD-1	150	1	30	128	FD-4-6	29	1	6	25
FD-2	112	1	22	95	FD-5	112	1	22	95
FD-2-1	29	1	6	25	FD-5-1	29	1	6	25
FD-2-2	29	1	6	25	FD-5-2	29	1	6	25
FD-2-3	29	1	6	25	FD-5-3	29	1	6	25
FD-2-4	29	1	6	25	FD-5-4	29	1	6	25
FD-2-5	29	1	6	25	FD-5-5	29	1	6	25
FD-2-6	29	1	6	25	FD-5-6	29	1	6	25

TABLE 4-5-3 BILL OF QUANTITY OF FARM DITCHES IN EXPERIMENTAL FARM (cont'd)

Name of F.Ditch	Length (m)	Type	Cmpctd. Fill (cu.m)	Slope Tamping (sq.m)	Name of F.Ditch	Length (m)	Type	Cmpctd. Fill (cu.m)	Slope Tamping (sq.m)
FD-3	112	1	22	95	FD-6	112	1	22	95
FD-3-1	29	1	6	25	FD-6-1	29	1	6	25
FD-3-2	29	1	6	25	FD-6-2	29	1	6	25
FD-3-3	29	1	6	25	FD-6-3	29	1	6	25
FD-3-4	29	1	6	25	FD-6-4	29	1	6	25
FD-3-5	29	1	6	25	FD-6-5	29	1	6	25
FD-3-6	29	1	6	25	FD-6-6	29	1	6	25
FD-4	112	1	22	95	FD-7	76	1	15	65
FD-4-1	29	1	6	25	FD-8	80	1	16	68
FD-4-2	29	1	6	25	FD-9	114	1	23	97
FD-4-3	29	1	6	25	FD-10	118	1	24	100
FD-4-4	29	1	6	25	FD-11	137	1	27	116
FD-4-5	29	1	6	25	Total	2,105		425	1,799

Note:
Compacted Fill: (0.3+0.9)x 0.3 x 1/2 /0.9 = 0.2 cu.m/m
(note; 0.9 is soil conversion factor from compacted condition to natural one)
Slope Tamping : $\sqrt{2}$ x 0.3 x 2 = 0.85 sq.m/m

TABLE 4-5-4 LIST OF FD ROAD CROSSING IN EXPERIMENTAL FARM

Name of F.Ditch	Crossed Farm road	Type	Name of F.Ditch	Crossed Farm road	Type
FD-1	-	-	FD-8	FRD-10	1
FD-2	FRD-5	1	FD-9	FRD-10	1
"	FRD-6	1	FD-10	FRD-10	1
"	FRD-7	1	"	FRD-11	1
FD-3	FRD-5	1	FD-11	FRD-10	1
"	FRD-6	1	"	FRD-11	1
"	FRD-7	1	ID-2	FRD-12	3
FD-4	FRD-5	1	"	FRD-13	3
"	FRD-6	1	LIC-2	FRD-5	4
"	FRD-7	1	"	FRD-6	4
FD-5	FRD-5	1	"	FRD-7	4
"	FRD-6	1	Total		26
"	FRD-7	1	Type-1	21 places	
FD-6	FRD-5	1	Type-2	0 "	
"	FRD-6	1	Type-3	2 "	
"	FRD-7	1	Type-4	3 "	
FD-7	-	-			

TABLE 4-5-5 BILL OF QUANTITY OF FD ROAD CROSSING IN EXPERIMENTAL FARM

Item	unit	Type 1	Type 3	Type 4	Total	
n		21	2	3	26	
Concrete						
300kg/cu.m		-	-	0.8	0.8	
200kg/cu.m		13.5	2.7	1.0	17.2	
150kg/cu.m		-	-	0.4	0.4	
Form	m²	52.8	10.1	17.4	80.3	
RC Pipe ∮400mm	pc	21	4	-	25	(L=2.5m)
Reinforced bar	kg	-	-	30	30	

TABLE 4-5-6 BILL OF QUANTITY OF FARM DRAIN IN EXPERIMENTAL FARM

Name of F.Drain	Length (m)	Cmpctd. Fill (cu.m)	Slope Tamping (sq.m)	Name of F.Drain	Length (m)	Cmpctd. Fill (cu.m)	Slope Tamping (sq.m)
FDR-1	148.5	59	378	FDR-5	75.0	30	191
FDR-2	75.0	30	191	FDR-5-1	26.0	10	25
FDR-2-1	26.0	10	25	FDR-5-2	26.0	10	25
FDR-2-2	26.0	10	25	FDR-5-3	26.0	10	25
FDR-2-3	26.0	10	25	FDR-6	75.0	30	191
FDR-3	75.0	30	191	FDR-6-1	26.0	10	25
FDR-3-1	26.0	10	25	FDR-6-2	26.0	10	25
FDR-3-2	26.0	10	25	FDR-6-3	26.0	10	25
FDR-3-3	26.0	10	25	FDR-7	58.0	23	148
FDR-4	75.0	30	191	FDR-8	98.0	39	250
FDR-4-1	26.0	10	25	FDR-9	127.5	51	325
FDR-4-2	26.0	10	25	Total	1,197.0	472	2,431
FDR-4-3	26.0	10	25				

Note;
B/Q per m
Compacted fill
  (0.9 + 0.3) x 0.3 x 1/2 x 2 / 0.9 = 0.4 cu.m/m
Slope tamping area per m
  $\sqrt{2}$ x (0.3 + 0.6) x 2 = 2.546 sq.m/m

TABLE 4-5-7 LIST OF FD ROAD CROSSING IN EXPERIMENTAL FARM

Name of F.Ditch	Crossed Farm road	Type	Canal Protection Work	Name of F.Ditch	Crossed Farm road	Type	Canal Protection Work
FDR-1	FRD-1	2	-	FDR-5	FRD-6	1	-
"	FRD-2	2	1	"	FRD-7	1	-
"	FRD-3	2	1	FDR-6	FRD-6	1	-
"	FRD-4	2	-	"	FRD-7	1	-
FDR-2	FRD-6	1	-	FDR-7	-	-	-
"	FRD-7	1	-	FDR-8	FRD-10	1	-
FDR-3	FRD-6	1	-	FDR-9	FRD-10	1	-
"	FRD-7	1	-	"	FRD-11	1	-
FDR-4	FRD-6	1	-	Total	(places)	17	2
"	FRD-7	1	-	(Type-1	13 places)		
				(Type-2	4 places)		

TABLE 4-5-8 BILL OF QUANTITY OF FDR ROAD CROSSING AND CANAL PROTECTION WORK IN EXPERIMENTAL FARM

Item	unit	FDR Road Crossing ----- TYPE -------- 1	2	Canal Protection Work	Total
n	Places	13	4	2	17 (2)
Concrete					
200 kg/cu.m		11.7	5.1	-	16.8
Form	m²	43.1	18.1	-	61.2
Pipe (∮400mm)					
L=2.5m	pc	-	8	-	8
L=3.5m	pc	13	-	-	13
Dry Masonry	m²	-	-	5.7	5.7

Note; ( ) Canal protection work

CHAPTER 5. CONSTRUCTION PLAN

CHAPTER 5. CONSTRUCTION PLAN

5.1. Construction Mode

The construction works of this Project consist of field construction, constructions of irrigation and drainage canals, and construction of farm roads. The major component of which is the field construction which is composed of top soil treatment, earth moving, land leveling and other infrastructure such as plot dikes.

From the engineering point of view, and considering construction components and quantities, the construction mode "Force Account" by the CAPIC office would be applied.

5.2. Construction Plan

5.2.1. Construction of Field

Before beginning any construction, obstructions such as trees, grass, stems, stones, etc., should be cleared. Field construction works can then be carried out such as top soil treatment, cutting and filling of earth, land-leveling, top soil replacement and land-leveling of top soil, in that order. This work will be executed by "swampy" type bulldozer of 16 ton-class. Filling work should be carefully undertaken in compaction and extra-filling, considering the consolidation settlement of land after finishing the work. The leveling works should be carried out three (3) times after cutting and filling and four (4) times in the top soil treatment area. A thickness of top soil of more than 15 cm should be secured on the field lot after the top soil treatment.

5.2.2. Irrigation Facilities

Since a lateral irrigation canal is to be constructed along the farm roads, the construction works will be scheduled for the final period of the Project construction schedule to avoid damage by heavy construction equipment. Compaction works of backfill will be done by manual labor.

On the other hand, since irrigation ditches are designed as earth-lined canals, the embankment materials should be secured from the fields. A the time of earth moving and road construction, therefore, the embankment materials should be kept on the land for canals and compaction works shall be executed in line with road compaction works at same time and in the same way. After compaction of embankment materials, the excavation work necessary to make the trapezoid shape and side-slope tamping works should be carried out.

The appurtenant structures such as road crossings, turn-outs, etc. should be carried out after finishing embankment work of farm roads.

These construction works should be carried out starting from the upstream to downstream portions.

5.2.3. Drainage Infrastructure

This work should be executed prior to all other related works mentioned in this section as the drainage canals will be useful to drain away excess water due to rainfall and groundwater during the construction period, especially during the winter season. The construction works should be carried out starting from the downstream section to upstream sections. At the intersecting points with farm roads, reinforced pipes should temporarily be positioned.

The drainage canals are designed as unlined canals. Backhoe with a trapezoid bucket (0.3~0.4 cu.m class), are used for excavation while bulldozers should be used for compaction of embankment materials. Surplus earth from excavation should be used for earth moving materials. The side-slope tamping works should be performed at the conclusion of the construction period.

5.2.4. Farm Road Infrastructure

Top soil of 20 cm thickness below the farm road width is removed before the road embankment works. Materials are obtained from adjacent fields to be land-consolidated. The thickness of spreading embankment materials is within 30 cm by bulldozer(s). Compaction work will also be carried out by bulldozer(s).

The gravel for the pavement of farm roads should be hauled from outside the Project area at the end of the construction period.

5.3. Required Construction Equipment

5.3.1. Selection of Necessary Equipment

For constructing the necessary infrastructure, the following equipment is required. The necessary equipment may change depending on the soil moisture and soil-bearing capacity. Considering the field conditions of the Project site and meteorological and hydrological conditions, the following equipment will be necessary. However, these conditions will chang according to weather, etc., in which case the equipment will be changed to more effective one.

- Top soil removal	: Swampy type bulldozer, 16 ton class
- Cutting and filling	: - do -
- Land leveling	- do -
- Top soil replacement	: - do -
- Excavation	: Backhoe, 0.3 to 0.4 cu.m class
- Compaction	: Standard type bulldozer, 21ton class
- Spreading	: Bulldozer (16 or 21 ton class) or Motor grader (3.7 m class)
- Hauling works of materials	: Dump truck (11 ton class)
- Loading and unloading	: Dozershovel (1.4 cu.m capacity)
- Concrete mixing	: Concrete mixer (0.5 cu.m)
- Lighting or supply of electricity for temporary pump	: Electric generator (20 KVA)

5.3.2. Workability of Equipment

The workability of the required equipment is calculated by the equation of "Cost Estimate Series No.1, Cost Estimate Standard on Land Improvement Project, Ministry of Agriculture, Forest and Fisheries (MAFF) in Japan, 1989, due to the absence of dependable and exact data in the country. The workability of major items and equipment is as follows :

Work Item	Applied Equipment	Workability
1. Cutting and filling of earth		
hauling distance(D)= 61.6m	SW 16 ton Bulldozer	21.44 cu.m/hr
hauling distance(D)= 22.7m	SW 16 ton Bulldozer	73.76 cu.m/hr
2. Land leveling		
Cutting and filling area	SW 16 ton Bulldozer	1.030 ha/hr
Top soil treatment area	SW 16 ton Bulldozer	0.084 ha/hr
3. Stripping work	SW 16 ton Bulldozer	127.5 cu.m/hr
4. Combination works of spreading and compaction of embankment materials for road construction	ST 21 ton Bulldozer	62.09 cu.m/hr
5. Compaction of embankment materials for road construction	ST 21 ton Bulldozer	141.75 cu.m/hr
6. Spreading of embankment materials for road construction	ST 21 ton Bulldozer	110.40 cu.m/hr
7. Spreading of gravel materials for road pavement *1	ST 3 ton Bulldozer	230 sq.m/100sq.m
8. Excavation of small scale canal by trapezoid shaped bucket *2	0.35 cu.m backhoe w/ trapezoid shaped bucket	13.99 m/hr

Note : *1 : Spreading width of more than 3.0m and thickness of materials of more than 10cm
*2 : Cross sectional area to be excavated is 1.5 sq.m/m
SW : swampy type
ST : standard type
(refer to Tables 5-3-1 to -9)

5.3.3. Workable Days for Equipment

The total number of workable days is calculated based on rainfall data and holidays during the construction period from November to March. The data available for the 10 year period from 1975 to 1985 at the Babol Sar station are used.

To calculate the number of workable days for land consolidation works, the following rule (from "Cost Estimate Series No.3, Cost Estimate Standard on Land Improvement Project, MAFF, 1989 in Japan) is used due to the absence of dependable and exact data in the country :

Amount of rainfall	Ratio of Rest days by rainy days
0 to 4.9 mm	No day for rest
5.0 to 9.9 mm	0.5 rest days by one (1) rainy day
10.0 to 29.9 mm	1.5 rest days by one (1) rainy day
30.0 to 49.9 mm	2.5 rest days by one (1) rainy day
More than 50.0 mm	3.5 rest days by one (1) rainy day

In addition to the above, all works on Fridays ceases. The total number of workable days is, therefore, 21 days a month. The remaining 9 days are wither rest resulting from rainy days or due to holidays. (refer to Tables 5-3-10)

5.3.4. Necessary Quantity of Equipment

Based on the above mentioned basic figures such as workability, workable days, construction period, the necessary quantity of heavy equipment is calculated and the results of calculations are shown in Table 5-3-1 to -9.

5.4. Construction Schedule

The construction schedule, considering the workabilities of heavy equipment, workable days, work order, and construction period, is presented in Figure 5-4-1.

5.5. Technical Specifications

The following technical specifications are presented for "Force Account" construction mode. The criteria for supervision on construction works are also included in these specifications. The specification covers temporary works and mobilization of constraction equipment, earthworks, concrete works, pipe works, stone works and farm road works.

TECHNICAL SPECIFICATIONS
FOR
CONSTRUCTION
OF
THE MAIN FIELD
IN
CAPIC

JANUARY, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

(JICA)

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SECTION 1. TEMPORARY WORKS AND MOBILIZATION OF CONSTRUCTION EQUIPMENT

101 Temporary Works

The temporary works consist of the following :

(1) Access roads and temporary detours in any places required at the construction.

(2) Temporary drainage canal to drain the site and road crossing infrastructure.

(3) Temporary power and water supplies at the construction site.

102 Mobilization of Equipment

All the necessary construction equipment required for the construction works shall be mobilized and moved into the Project site in time for the respective works programmed prior to construction. Construction Equipment, once moved into the Project area shall not be permitted, prior to the completion of the Contract works, to be moved out or transferred to another project site without the written approval of the Project Engineer.

SECTION 2. EARTHWORKS

201 Scope

This scope covers stripping, excavation of a farmland, land leveling, fill and backfill for structures, surface of soil handling and disposal of excavated materials.

202 Cleaning and Grubbing at Site

(1) Cleaning the right-of-way, borrow, quarry, farmland and stockpiled area will be cleared before construction begins. Such clearing consists of the removal and disposal, in a manner approved by the Engineer, of all trees, stumps, stems, brush, roots, vegetation and other objectionable matters within the work area.

All materials to be burned shall be piled neatly and in a suitable condition shall be burned completely. Special precautions shall be taken at all times to prevent fire from spreading. Necessary and suitable equipment and supplies should be prepared for fire fighting should the need arise.

(2) Grubbing shall consist of the removal of tree stumps, roots, brush, and rubbish from the work area to be occupied by the embankment and permanent structures and from the surface of excavation, and elsewhere as directed by the Engineer. It shall include scraping of the natural ground surface at an adequate depth by all effective means to remove vegetation and other objectionable materials.

The holes resulting from the grubbing up shall be filled with materials approved by the Engineer and then well compacted.

203 Stripping, Removal of Top Soil

The stripped top soil shall be transported and temporarily stored at a place for soil reuse. Before commencing the works, the place for at a storage of the top soil shall be decided upon by the Engineer. Thickness of stripping of the top soil is 15 centimeters(cm) in depth, unless otherwise shown on the drawings or directed by the

Engineer. The works include stripping, collecting, Loading, hauling, unloading, and stockpiling at a location directed by the Engineer.

204 Cutting and Filling for Farmland

(1) After stripping and removal of the top soil, the subgrade of farmland shall be made as level as possible by cutting and filling. The cutting portion of the subgrade desirable shall be slightly lower than the filing portions The proposed elevation, of subgrade for the lower rice field shall not exceed that of the upper neighboring rice fields.

(2) The leveling of subgrade for farmland shall be regulated within a tolerance approximately 7.5 cm.

(3) Until sufficient the bearing capacity and impermeability for subgrade is obtained, it should be compacted in order to avoid differential settlement and extreme seepage after execution of cutting and filling by the use of a compactor or other appropriate equipment as directed by the Engineer.

205 Land Leveling work

After compaction of cutting and fulling works, the stored soil described in Item 203 shall be hauled and refilled at the original place, The leveling of refilled surface shall be performed to avoid uneven land through means approved by the Engineer so as to make the surface of each lot confirm to a tolerance of approximately five(5) cm at five(5) points on each farm lot.

206 Excavation for Canal

Excavation shall be performed in a workmanlike manner and in accordance with the lines, grades and dimensions shown in the Drawings or as directed by the Engineer. Excavation operations shall be such that all materials suitable for embankment shall be separated from objectionable materials that are to be disposed of. All excavated surfaces shall be trimmed to the required slopes and grades within the following tolerances :

Item	Tolerances
Profile of invert of channel and ditches	3 cm
Profile of operation road and access roads	9 cm
Side slope above minimum elevation of operation roads	30 cm

- The extreme of these tolerances should not be continuous beyond a distance of 40 m measured at any place, in any direction, parallel to the excavated surface.

Precautions shall be taken to preserve, in an undisturbed condition, materials beyond the designated lines of excavation and materials loosened beyond the excavation limits resulting from excavation operations. They should be considered defective work and be compacted or removed and replaced with compacted embankment as directed by the Engineer.

207 Excavation for Structures

Excavation generally means the excavation of earth material such as soil, sand and gravel other than rock. Unless otherwise approved, no excavation shall be permitted under water. The site shall be kept well drained and free from inundation caused by rainfall or groundwater during construction.

(1) Excavation of drainage canals and foundation of structures shall be carried out in accordance with the lines, grades, slopes and dimensions as shown the Drawings or as directed by the supervisor or the Engineer.

(2) In case of overexcavation which is not approved or directed by the supervisor or the Engineer, the filling and compaction works shall be composed of the same material.

(3) If the required bearing capacity for the structures is not obtained by the excavation shown in the Drawings, the excavation shall continue until the allowed bearing capacity is obtained.

(4) Prior consent is quite essential for carrying out spoil dumping at any place where excavated materials deemed unsuitable as fill material and to be removed to.

(5) Existing concrete and/or brick structures, such as culverts, brick walls, etc., should be demolished and disposed of accordingly.

208 Embankment and Backfill

These items cover the specifications for embankment and backfill works as shown in the Drawings or otherwise as directed by the Engineer. The earth for drainage canal embankment and related structures shall be furnished and positioned. The slope of the embankment shall be made according to the shaping of slope indicated in the Drawings. The backfill, as referred to herein, will be defined as refill works.

(1) The earth for the backfill works should be made free from roots, stones of more than one (1) cm in diameter, and other objectionable matter. Backfill materials shall be placed in layers, with each layer being not more than fifteen (15)cm thick before compaction, and then thoroughly compacted by power compactor(s) or bulldozer(s).

(2) No backfill materials should be placed on concrete structures before a period of fourteen (14) days has elapsed after positioning the concrete.

(3) The embankment works should be carried out in conformity with the lines, grades, and dimensions indicated on the Drawings, unless otherwise directed by the Engineer. The Engineer may instruct the changing of a slope of the embankment works in respect of soil conditions at the site. Such a change will be made according to the quantities of materials available.

(4) Any embankment materials which are rendered unsuitable after being positioned at the site, will be replaced. Such objectionable fill materials shall be re-excavated and removed for disposed in the spoil area. The excavated area shall be refilled with suitable materials.

(5) Backfill for the construction of the pipeworks shall be carried out after laying the pipes. The backfill up to 60 cm above the

top of the pipe shall be made soon after completion of the joints. The heavy equipment, including trucks, should not be used for spreading and rolling compaction of the abovementioned backfill works.

(6) When sufficient materials for embankment and backfill are unavailable from the ditch materials or earth moving works, additional materials should be obtained from sources directed by the Engineer. The materials should be adequate in quality for such a purpose.

(7) Embankment shall be constructed in horizontal layers which extend the full width of the embankment. The thickness of the layers should not exceed 15 cm after compaction. When a layer of material is dissimilar from the preceding layer, the materials shall be blended by disking, mixing, scarifying, or a combination of these methods. Compacted embankment shall be compacted to not less than 90% compaction when testes in accordance with laboratory compaction test for soils, American Standard for Testing Materials (ASTM) 698-427.

SECTION 3. CONCRETE WORKS

301 Scope

This Section deals with all the concrete construction to be carried out as shown in the Drawings or otherwise directed by the Engineer. This includes the necessary work to :

(1) Furnish all materials, and mix, transport, place, finish, protect and cure concrete.

(2) Furnish, construct, erect and remove forms.

(3) Construct expansion and contraction joints, and furnish and place for water stop, joint fillers and sealing compound.

(4) Furnish, store, cut, bend and properly place the reinforcement steel bars required for the work.

Concrete shall be composed of portland cement, fine and coarse aggregates, water, and if necessary, admixtures or agents approve by the Engineer. The design of concrete mixtures and consistency shall be as specified in this section.

All the applicable provisions of the ASTM or equivalent shall be as specified in this Section.

302 Cement

(1) General : The cement for mortar and concrete works shall be of a quality which conforms to the requirements of the Standard Specification of Portland Cement. Special Cement may be used subject to the approval of the Engineer provided it meets the requirement of Portland Cement with respect to strength, soundness, and setting time.

(2) Storage : The cement, in unbreakable sealed bags shall be stored in a dry, weathertight and properly ventilated warehouse with adequate provisions for the prevention of absorption of moisture. All storage facilities should be to permit easy access for inspection and identification. Sacked cement shall not be stocked higher than 14 sacks for storage for a period of not longer than 30 days and not higher than seven(7) sacks for a longer period. Any cement stored at the Project site over two

(2) months shall not be used unless retest proves that it is satisfactory.

303 Water

The water used in concrete, mortar and grout shall be free from objectional quantities of silt, organic matter, alkali, salts, and other impurities.

304 Fine Aggregate

(1) General : The fine aggregate is used to designate aggregates in which the maximum size of particles is five(5) millimeters(mm) and shall consist of natural sand, manufactured sand, or a combination of both. The shape of particles shall be generally spherical or cubical and reasonably free from flat or elongated particles.

(2) Quality : The sand shall be clean, hard, dense, durable uncoated rock fragments and shall be free from injurious amounts of dirt, organic mater, and other deleterious substances and be well-graded from fine to coarse. The fine aggregates as delivered to the mixer shall have a fineness modulus of not less than 2.30 or more than 3.00. The sum of the percentages of all deleterious substance shall not exceed 5 % by weight. Fine aggregates having a specific gravity of less than 2.60 may be rejected.

(3) Storage : Fine aggregates shall be stored in such a manner as to avoid the inclusion of any foreign materials in the concrete. The storage or stock piles shall be constructed so as to prevent segregation. All fine aggregates shall remain in free drainage storage for at least 72 hours prior to use. Sufficient live storage shall be maintained at all times to permit continuous placement of concrete.

305 Coarse Aggregate

(1) General : The coarse aggregate used should be the designated aggregates and of such sizes as to fall within the range of

five(5) to 50 mm or any size or range within such limits. It shall consist of natural gravel, crushed rock, or mixture of both. The crushed coarse aggregate shall be generally spherical or cubical and reasonably free from flat or elongates particles.

(2) Quality : The coarse aggregates shall be clean, hard, dense, durable, uncoated rock fragments and shall be free from injurious amounts of dirt, organic matter, and other deleterious substances and be well graded from fine to coarse within the nominal size ranges hereinafter specified in the classes of concrete. Coarse aggregates shall contain not more than 1.5 % of materials passing the No.200 sieve by meshing, nor more than 5 % of soft fragments. It shall have an abrasion loss of not more than 45 % at 500 revolutions. Coarse aggregates having a specific gravity of less than 2.60 may be rejected.

(3) Maximum size : Unless otherwise directed, the maximum sizes of aggregates to be used in concrete for the various parts of the work shall be in accordance with the following :

General Use	Maximum Aggregate Diameter
A. Reinforced Concrete	25 mm
B. Plain Concrete	
For less 7.5 cm in thickness	25 mm
For over 7.5 cm in thickness	40 mm
C. Level Concrete	50 mm

306 Proportion for Concrete Mixes

The proportion for mixtures for all classes of concrete shall be designed to obtain compressive strength within 28 days as directed by the Engineer. The amount of water to be used in the concrete shall be regulated as required to secure concrete of the proper consistency. The slump of concrete at the time of placing shall not exceed 7.5 cm for concrete elsewhere. Mix proportions can be estimated by means of specific examples or available data but should be tested to meet the required strength. In cases where a quantity of concrete is small and structures are simple, a mix proportion by volume may be permitted by the Engineer as guided below :

Class	Min. 28 days Compressive Strength	Mim. Use of Cement	Mix proportions by volume Cement : fine aggregate : Coarse aggregate
A. (reinforced concrete)	210 kg/sq.cm	300 kg.cu.m	cf. 1 : 2 : 4
B. (plain concrete)	180 kg/sq.cm	200 kg.cu.m	cf. 1 : 3 : 6
C. (leveling concrete)	135 kg/sq.cm	150 kg.cu.m	cf. 1 : 4 : 8

Other proportions for mixed design may be directed by the Engineer at the site.

307 Batching and Mixing

(1) Concrete shall be machined-mixed. Hand mixing shall be allowed only in cases of emergency when there is a machine breakdown or malfunction, and in the construction of small structures where the total volume of concrete is less than two(2) cubic meters(cu.m).

(2) Measuring devices shall be suitably designed and constructed for the purpose and shall be weighing separately the cement, fine and coarse aggregates. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1.0 % of the desired weights. Cement in standard bags need not be weighted. The water measuring instruments shall be of such a type as to be readily controlled to obtain an accuracy of 1.5 % of the desired quantity of water.

(3) The aggregate shall be dampened by watering if it is drier than the condition known as saturated surface dry.

(4) Cement paste for the first batch shall contain sufficient cement mortar to coat the inside of the drum to avoid the reduction of the required mortar content of the mix.

(5) The mixing time of concrete shall be more than two (2) minutes but less than five (5) minutes. Overmixing, requiring the introduction of additional water to preserve the required consistency, will not be permitted. The mixer shall be completely emptied before receiving the materials for the

succeeding batch and shall be kept clean and washed after stopping work at the end of each shift.

(6) The temperature of the concrete when it is being placed shall be not more than 32°C and not less than 4°C in moderate weather, or 10°C when the mean daily temperature drops below 4°C.

(7) Truck mixer will be permitted only when the mixers and trier operation are such that the concrete throughout the mixed batch and from batch to batch is uniform with respect to consistency and grading. Any concrete retained in truck mixers long enough to require additional water to permit satisfactory placing shall be discarded.

308 Conveying

The concrete shall be conveyed from mixer to forms, as rapidly as practicable, by methods which prevent segregation or loss of ingredients. The method and equipment used for transporting concrete, and the time that elapses during transportation, shall be such as to cause no appreciable segregation of coarse aggregate or slump loss in excess of 2.5 cm in the concrete as it is delivered to the work site. Retempering of concrete will not be permitted. There shall be no vertical drop greater than 1.5 meters(m) except where suitable equipment is provided to prevent segregation.

309 Laying

(1) Concrete shall be laid only in the presence of the Engineer or his duly authorized representatives.

(2) All concrete for earth foundations shall be laids upon clean, damp surfaces free from standing or running water. Prior to laying concrete, the earth foundation shall be satisfactorily compacted in accordance with approved methods by the Engineer.

(3) The surface of construction joints shall be clean, rough, and surface dry when covered with fresh concrete or mortar. Cleaning should consist of the removal of all laitance, loose,

or defective concrete, coatings, sand, sealing compound if used, and other foreign materials.

(4) Formed concrete shall be placed in continuous approximately horizontal layers, the depth of which shall generally not exceed 50cm, unless otherwise specified.

(5) The permissible depth of concrete in one lift will be as shown in the detailed Drawings or as directed for each structure by the Engineer. Unless otherwise authorized or shown, lift of mass concrete shall not exceed 1.5 m in height and a minimum of 72 hours should elapse between the placing of each successive lift.

(6) Concrete shall be vibrated until it has been consolidated to the maximum practicable density, is free from rock pockets of coarse aggregate, and fits snugly against all surface of forms and embedded materials by use of mechanical vibrators, sticks, or wooden hammers.

(7) The manipulation of concrete adjacent to the surface of the lift in connection with completing lift placement shall be the minimum necessary to produce not only the degree of consolidation desired in the surface layer of concrete but also s surface with the desired degree of roughness for bonding with the next lift.

(8) Exposed unformed surface of concrete shall be brought to uniform surfaces and worked with suitable tools to a reasonably smooth wood-float or steel-trowel finish as directed.

(9) In laying concrete through reinforcement, care should be taken that no segregation of the coarse aggregate occurs, In the bottom of beams and slabs, where the congestion of steel near the forms makes positioning difficult, a layer of mortar of the same cement-sand ratio as used in the concrete shall be first deposited in order to cover the surface.

310 Forms

(1) Forms shall be used to shape the concrete in the required lines with sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in correct position. Forms shall be sufficiently tight to prevent mortar loss from the concrete.

(2) Chamfer strips shall be placed in the corners of forms for exposed exterior corner so as to produce beveled edges.

(3) At the time concrete is placed in the forms, their surface should be free from any objectionable materials and oiled to prevent sticking.

(4) Form bolts or clamps should be used to fasten forms. The use of ties consisting of spacer and wire instead of clamps will be permitted but spacers must be completely removed before or during the placement of concrete. Bolts or clamps shall be positive in action and shall be sufficient in strength and number to prevent displacement of the forms. They shall be of a type which can be entirely remove or cut back two(2) cm or more below the finished surface of the concrete surface.

(5) Forms shall be removes as soon as possible to enable the earliest practicable repair of surface imperfections, but in no case shall they be removed before approval of the Engineer.

(6) Any necessary repair or treatment shall be performed at once. All porous and fractured concrete shall be removed by chipping openings into the concrete with dimensions as directed, and the chipped openings shall be filled with dry-pack, mortar, or concrete, as directed.

311 Curing and Protection

(1) All concrete shall be kept continuously moist for a period of not less than seven (7) consecutive days after being layed by sprinkling, spraying or by other approved method or combination methods applicable to local conditions.

(2) If concrete is cured by membrane curing, it should be sprayed uniformly with sealing compound. The sealing compound shall conform to AASHO Designation : M - 148 Type II.

312 Reinforcing Steel Bars

(1) All steel reinforcing materials for concrete works as indicated on the Drawings shall be furnished. All reinforcement shall be prepared, cleaned, cut, bent and placed, as shown in the detailed Drawings or directed by the Engineer. All chains, supports and ties should be furnished, Reinforcement shall be reasonably free from loose, flaky rust and scale, and free from oil, grease, and other costing which might destroy or reduce its bonding with the concrete.

(2) All steel reinforcement bars shall conform to the requirement of ASTM : A-615 or equivalent standard. All bars shall be of the deformed type unless otherwise specified on the Drawings and shall be Grade 40.

(3) The distance from the center of the main reinforcement to the concrete surface shall be five (5) cm apart from those portions shown in the Drawings. The concrete covering the stirrups, spacing bars, and similar secondary reinforcement may be reduced by the diameter of such bars, unless otherwise indicated by the Engineer.

(4) The splicing length in reinforcement bars shall be at least thirty (30) times the diameter of the bar and should be bound by steel wire.

(5) The reinforcements shall be secured in position by use of metal or concrete supports, spaces, or tie. Such supports shall be of sufficient strength to maintain the reinforcement in place throughout the concreting operation. The supports shall be used in such a manner as to not be exposed or contribute in any way to the discoloration or deterioration of the concrete.

313 Tolerance for Concrete Construction

Variations in alignment, grade and dimensions of the structures from the established alignment, grade and dimensions shown in the Drawings shall be within the tolerances specified in the following tables. Concrete works that exceeds the tolerance limits specified herein may be required to be remedied, or removed and replaced by the Engineer.

(1)	Variation from vertical : In the line & surface of column, piers, and walls.	Exposed in 3 m .... Backfilled in 3 m	12 mm 20 mm
(2)	Variation from the level or from the grades indicated in the Drawings : - In floors, inverts, ceilings and beam soffits	In 3 m .... In 12 m more	12 mm 20 mm
(3)	Variation of linear structure lines from established positions in plan and related position of walls :	In any bay or 6 m max . In 12 m more	12 mm 25 mm
(4)	Variation in locations of sleeves and sizes and locations of floor openings and wall openings :	....	6 mm
(5)	Variation in cross-sectional dimensions of columns, beams, and in the thickness of slabs and walls :	Minus .... Plus	6 mm 12 mm

314 Concrete construction

All concrete construction shall conform to the provision of the above section and to detailed requirements of the following paragraphs.

(1) All structures shall be built to the specified lines, grades, and dimensions. The location of all construction joints shall be as shown in the Drawings or as instructed by the Engineer. All timber, metal or other accessories necessary for its completion as shown in the Drawings shall be placed and attached to each structure.

(2) The dimensions of each structure shown in the Drawings will be subject to those changes as may be found necessary by the Engineer to adapt the structures to the actual field conditions.

315 Precast Concrete Construction

(1) Precasting of concrete may be resorted to as an alternative to cast-in-situ concrete for certain structures such as small size of canal and other small structures. Reinforced concrete pipes are excluded from this paragraph.

(2) In transporting and placing the precast concrete, extreme care shall be observed in handling, storage, movement and erection to avoid crashing, twisting, or other distortions that will result in cracking or damage to the precast concrete. Precast concrete members shall be handled, transported, and erected in an upright position and the points of support and direction of the reactions with respect to the member shall be approximately the same as when the member is in final position.

(3) Individual components under precast concrete shall conform to the corresponding provision of this section 3 and will be subject to the usual testing for concrete.

SECTION 4. PIPE WORKS

401 Scope

This Section covers fabrication and installation of all pipes, fittings and other incidental appurtenances for turnouts, culverts, canal crossings, drainage crossings, and other structures shown in the Drawings including hauling, laying, installing, jointing and all other works necessary to produce a completed facility.

402 Fabrication of R.C. Pipes

(1) The pipes shall meet the requirements of the Standard Specifications for Reinforced Concrete Culvert Pipes ASTM : C361-571 or the latest revision. Concrete for pipes shall have a minimum compressive strength of 210 kg/sq.cm in 28 days. The maximum size of aggregates shall be 20 mm. Reinforcing bars shall be plain, grade SD 30. Lapping of ends of the ring bars shall not be less than 48 bar diameter.

(2) The quality of all materials, the process of fabrication, and the finished pipes shall be subject to inspection and approved by the Engineer. Such inspection may be made at the place of manufacture, or at the work site after delivery, or at both places, and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements.

403 Construction Method

(1) Care shall be taken during loading, transporting, and unloading to prevent the pipes, fittings, or coatings from damage. Under no circumstance shall pipes or fittings be dropped or rolled against one another. All pipes or fittings shall be examined and no piece shall be installed which is found to be defective.

(2) If any defective pipe or fittings is discovered after it has been installed, it shall be removed and replaced with a sound pipe or fitting in a satisfactory manner.

(3) All pipes and fittings shall be thoroughly clean before installation. Particular care shall be taken not to overstress threaded connections at joints.

(4) Excavation for pipe installation shall be in conformity with Section 2. The bottom of the trench shall be finished accurately according to grade and prepared in such a way to provide a firm and uniform beating throughout the entire pipeline length. In cases where the foundation is composed of a gravel layer, the foundation shall be replaced by suitable soil materials of more than ten (10) cm in thickness. It should be compacted sufficiently under the instruction of the Engineer.

(5) The pipes shall be laid carefully, ends fully and closely jointed, and true to the lines and grades as shown in the Drawings. Each pipe section shall be securely attached to the adjoining section unless otherwise specified and should be filled with stiff mortar.

(6) The mortar shall be placed so as to form a durable watertight joint. After each section of pipe is laid and before the succeeding section is laid, the lower portion of the hub shall be plastered thoroughly on the inside with mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. After the section is laid, the remainder of the joint shall then be wiped and finished smoothly. After the mortar of the joint sets, the construction of the reinforced concrete collar shall be performed as in the Drawings.

(7) Any pipe which is not in accurate alignment or which shows any undue settlement after being layed, or is damaged, shall be removed and relaid or replaced with a new one.

(8) Cuttings of the pipe shall be kept to the minimum. When the cuts are necessary, they shall be perpendicular to the axis of the pipe and smooth. The cuts should be made with tools in conformity with the pipe manufacture's recommendations or under the instruction of the Engineer.

(9) After the pipes have been installed and the mortar joints and reinforced concrete have sufficiently set, selected materials from excavation or borrow shall be placed alongside the pipes in layers not exceeding 15 cm in thickness and compacted thoroughly, layer upon layer. The backfilling for pipes shall be done simultaneously at both sides and shall conform to the provisions prescribed in Section 2.

SECTION 5. STONE WORKS

501 Scope

The works under this Section shall consist of furnishing and placing appropriate size of stones or spalls for dry masonry and wet masonry with cement mortar, in accordance with the Drawings and this specification or as directed by the Engineer.

502 Materials

(1) The stones consist of round natural stones and shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended. Other stones shall not be used unless otherwise specified.

(2) Unless other sizes are shown in the Drawings, stones shall have a thickness of not less than 150 mm, and widths of not less than one and one half(1.5) times their respective thickness, and length of not less than one and one half(1.5) times their respective thickness but not exceeding 300 mm.

(3) Mortar for wet masonry shall consist of one (1) part cement to three (3) parts fine aggregate by volume with sufficient water to produce a thick and creamy mixture conforming to the provisions of Section 3.

503 Excavation

(1) The beds for masonry shall be excavated to the required depths and slope and then trimmed and compacted as shown in the Drawings. All foreign materials such as lumps of earth, wooden pegs and stumps, toots, other debris and water shall be thoroughly removed.

(2) The masonry shall be founded in a toe trench dug in conformity with the Drawings or as instructed by the Engineer. The trench shall be filled with stone of the same class as that specified for the masonry works unless otherwise specified.

504 Dry Masonry

(1) Stones shall be placed by hand or individually by machines. They shall be laid with close joints and shall be firmly bedded into the slope and against the adjoining stones. Each stone shall be laid with its longest axis perpendicular to the slope in close contact with each adjacent stone.

(2) The stones shall be thoroughly rammed into place and the finished surface shall be presented as even. Interstices between stones shall be filled with small broken fragments firmly wedged into place.

(3) Stones shall be well-arranged in such a manner that they can resist appreciable disturbance. Where big spaces occur between sont and bed surface, the said spaces shall be filled with spalls or appropriate sized stones.

505 Wet Masonry

(1) The wet masonry shall consist of hand placed stones presenting an even exposed surface. Stones shall be placed to form a layer of masonry works with a thickness of 300 mm, perpendicular to the slope, unless otherwise shown in the Drawings.

(2) The interstices and joints shall be filled with mortar consisting of one(1) part cement to three(3) parts fine aggregates or as directed by the Engineer. The materials for mortar are to be mixed shall be accurately measured by volume. The water contents and consistency shall be suitable for workability.

(3) Fourty(40) mm weep holes shall be formed in the mortared face at two(2) m spacing vertically and horizontally, unless otherwise shown on the Drawings. The minimum of two(2) weep holes shall be placed in each section of wet masonry.

(4) Within 24 hours of construction, the joints on all exposed faces shall be raked clean of loose mortar and pointed with the specified mortar.

(5) Wet masonry shall be protected from the sun and kept moist for at least the specified time. It shall be protected from freezing during the winter season appropriate measures approved or directed by the Engineer.

(6) All masonry which is damaged shall be removed and replaced.

506 Tolerance

The allowable to tolerances for finished surface shall be :

(1) Protrusions or depressions are not to exceed ten (10) mm above or below the average plane level in any one (1) square meter of surface.

(2) The thickness of masonry works are not to be less than the stated dimensions in the Drawings or under these specifications.

SECTION 6. FARM ROAD WORKS

601 Scope

(1) The farm roadworks include setting out of alignment, cleaning and grubbing, stripping, excavation, embankment, and gravel pavement.

(2) The location, type, longitudinal profiles, transversal sections and other details of the works shall be in conformity with the Drawings.

602 Cleaning and Grubbing

This work shall be carried out in conformity with the provision of Section 2, "Earth Works".

603 Stripping of Top soil

This works shall be carried out in conformity with the provision of Section 2, "Earth Works".

604 Excavation for Road Bed

Road bed shall be excavated to the elevation as shown in the Drawings or as directed by the Engineer. The excavated materials shall be transported and deposited in the storage pile designated by the Engineer.

605 Embankment

The embankment shall be constructed of suitable materials in accordance with this specification and in conformity with the lines, grade, and dimensions shown in the Drawings or as established by the Engineer.

(1) The area of excavated foundations shall be compacted sufficiently by compactor or by means directed by the Engineer.

(2) Before positioning the first fill on such compacted foundation areas, the surface must be scarified to a depth of not less than

50 mm, in order to roughen the surface and provide good bonding for the fill placed upon it.

(3) The fill shall be placed and spread in continuous layers parallel to the major axis of the farm road.

(4) The spread of each layer shall not exceed 25 cm in thickness.

(5) where the surface has dried too much for proper bonding, it should be uniformly sprinkled with water, scarified, harrowed and mixed until the moisture content of the in-place materials is within the required limits. If the moisture content of the in-place material is higher than the limit required, such fill shall be controlled until its moisture content is within the required limit or it should be removed from the site if directed by the Engineer.

606 Compaction

Each layer of the fill material shall be compacted by an appropriate compactor so that the fill material forms a single homogeneous mass. When so directed by the Engineer, hand-operated heavy duty tampers and/or smooth-faced vibrating rollers shall be used for the compaction of fill material placed in area inaccessible to the compaction equipment selected for normal use. These tampers or rollers shall be air, gasoline, or diesel powered. They shall be easily manoeuvrable and of sufficient capacity to obtain the specified density.

The dry density of the fill shall be not less than the required degree of compaction of 90 %.

Note : Degree of compaction

$$= \frac{\text{Dry density of fill in-situ}}{\text{Max. dry density of standard compaction}} \times 100\ (\%)$$

607 Testing of Fill

Compaction or a density test shall be performed every 200 m length of farm roads. Method of testing shall be in accordance with the standard laboratory compaction test in soil, (ASTM : 698-427). The density of fills in place will be determined by using the sand cone method.

608 Gravel Pavement

(1) Aggregates for gravel pavement shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel, and fuller of natural or crushed sand or other finely divided mineral matter. The composite material shall be well distributed in terms of size of particles, and be free from vegetable matter and lumps or balls of clay, and be of such nature that it can be compacted readily to form a firm and stable subgrade.

(2) The aggregates shall be placed as a uniform mixture on a prepared subgrade in a quantity which will provide the required compacted thickness.

(3) Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, the aggregate shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 150 mm.

(4) The aggregates shall be spread with equipment that will provide a uniform layer which when compacted will conform to designed level and traverse slopes as shown in the Drawings. The allowable to tolerance shall be as specified hereunder :

Permitted variation from design thickness of layer	± 20 mm
Permitted variation from design level of surface	+ 10 mm - 20 mm
Permitted surface irregularity measured by 3-m straight-edge	± 20 mm

TABLE 5-3-1 WORKABILITY OF BULLDOZER

1. Working Item : Cutting and filing of earth and top soil treatment works

2. Applied Equipment : Swamp type bulldozer (16 ton class)

3. Equation

$$Q = \frac{60 \cdot q \cdot f \cdot E}{Cm}$$

Where: Q - Workability per hr (cu.m/hr)
q - Capacity per cycle (cu.m)
Bulldozer (Swamp, 16 ton class) 2.09 cu.m
f - Soil conversion factor = 1.00

	Condition of soil		
	Natural	Loose	Compacted
Sand	1.00	1.20	0.95
Sandy soil	1.00	1.25	0.90
Clayey soil	1.00	1.35	0.90 (applied)

E - Work efficiency
Conditions : refer to note
Cm - Necessary time for operation per cycle (min)
Cm = 0.034 · L + 0.25 L - hauling distance (m)
In case of L=61.6m for cutting and filling, Cm=2.34 min
In case of L=22.7m for top soil removal, Cm=1.02 min
In case of L=22.7m for top soil replace, Cm=1.02 min

4. Workability per hr
In case of cutting and filling, Q= 60 x 2.09 x 1.00 x 0.4 / 2.34 = 21.44 cu.m/hr
In case of top soil removal, Q= 60 x 2.09 x 1.00 x 0.6 / 1.02 = 73.76 cu.m/hr
In case of top soil replace, Q= 60 x 2.09 x 1.00 x 0.55 / 1.02 = 67.62 cu.m/hr

5. Necessary working hours and days
5.1 Net working hour (NWH)
1) Cut and fill works : Working volume = 33,840 cu.m
NWH = 33,840 cu.m / 21.44 cu.m/hr = 1,578.4 hr
2) Top soil treatment : Working volume = 5,149 cu.m
NWH = 5,149 cu.m / 73.76 cu.m/hr = 61.5 hr
NMH = 5,149 cu.m / 67.62 cu.m/hr = 76.1 hr

5.2 Working hour per day = 6.1 hr

5.3 Net working day (NWD)
1) Cut and Fill works NWD = 1,578.4 hr / 6.1 hr/day = 258.8 days
2) Top soil removal NWD = 61.5 hr / 6.1 hr/day = 10.1 days
3) Top soil replace NWD = 76.1 hr / 6.1 hr/day = 12.5 days

5.4 Gross working days
1) Cut and Fill works = 258.8 days x 30/21 = 369.7 days
2) Top soil treatment Top soil removal 10.1 days x 30/21 = 14.4 days
Top soil replace 12.5 days x 30/21 = 17.9 days
Note; In a month, the number of rainy days and Friday would calculate at 11 days during the construction period from November to March. The net workable day, therefore, is 21 days a month.

5.5 Necessary number of bulldozer
1) Cut and Fill works
In case of 80 days' construction period, 369.7 / 80 = 4.6 bulldozers
2) Top soil treatment
In case of 30 days' construction period
Top soil removal 14.4 / 30 = 0.5 bulldozer
Top soil replace 17.9 / 30 = 0.6 bulldozer

Note:

1. Work efficiency (E) of Bulldozer for Land Consolidation

Work Item	Good	Fair	Poor	Remarks
	Work Conditions			
1) Top soil removal				
Sandy soil	0.85~0.75	0.75~0.65	0.65~0.55	
Clayey soil	0.75~0.65	0.65~0.55	0.55~0.45	applied
2) Earth moving				
Sandy soil	0.60~0.55	0.55~0.45	0.45~0.40	
Clayey soil	0.50~0.45	0.45~0.35	0.35~0.30	applied
Soil with gravel	0.55~0.50	0.50~0.40	0.40~0.35	
3) Top soil replace				
Sandy soil	0.80~0.70	0.70~0.60	0.60~0.50	
Clayey soil	0.70~0.60	0.60~0.50	0.50~0.40	applied

Remarks:

1. Under the conditions of wide working place, good foundation, high speed working and enough thickness (about 20 cm) of earth volume, the highest E value should be applied.
2. Under the opposite conditions of the above, the lowest E value should be applied.
3. In case that the working condition is ranged between the above, the middle E value would be applied.
4. For the Ultra Swampy Type Bulldozer, the lowest E value would be applied

2. Soil classification:

Categories	Classified soil(s)
Sand	sand
Sandy soil	sandy loam, loam, silty loam
Clayey soil	clay, clay loam
Soil with gravel	gravel, sand with gravel and/or gravel with sand,
Rock	crashed rock

Source:
Cost Estimate Series No.1, Cost Estimate Standard on Land Improvement Project, Ministry of Agriculture, Forestry and Fishery (MAFF), 1989

TABLE 5-3-2 WORKABILITY OF BULLDOZER

1. Work Item : Land leveling

2. Applied Equipment : Swamp bulldozer (16 ton class)

3. Equation

$$S = So . E$$

Where: S - Workability per hr (ha/hr)
So - Standard workability per hr (0.186 ha/hr)
E - Work efficiency (= 0.7 for cut and fill area)
(= 0.45 for top soil treatment area)

4. Workability per hr
In case of a cut and fill area
S = 0.186 x 0.7 = 0.130 ha/hr
In case of a top soil treatment area
S = 0.186 x 0.45 = 0.084 ha/hr

5. Necessary working hours and days

5.1 Net working hour
- Cut and fill area
Working volume = 35.09 ha
35.09 / 0.13 = 269.9 hr
- Top soil treatment area
Working volume = 3.43 ha
3.43 / 0.084 = 40.8 hr

5.2 Working hour per day = 6.1 hr

5.3 Net working day
Cut and fill area = 269.9 hr / 6.1 hr = 44.2 days
Top soil treatment area = 40.8 hr / 6.1 hr = 6.7 days

5.4 Gross working days
Cut and fill area = 44.2 x 30 / 21 = 63.1 days
Top soil treatment area = 6.7 x 30 / 21 = 9.6 days
In a month, the number rainy days will assume at 9 days during the construction period. The net workable day is 21 days per month.

5.5 Necessary number of bulldozer
Cut and fill area
In case of 30-days working period
63.1 / 30 =.2.1 bulldozers
Top soil treatment area
In case of 10-days working period
9.6 / 10 = 1.0 bulldozers

Note:

1. Standard workability per hour (So)

Equipment	Class	So		
Bulldozer	11 ton	0.177	(ha/hr)	
"	15 "	0.187	"	
Swamp bulldozer	13 "	0.167	"	
"	16 "	0.186	"	(applied)
Ultra S. bulldozer	13 "	0.175	"	
"	18 "	0.214	"	

2. Work efficiency (E)

Work Item	Work Conditions Good	Fair	Poor	
1) Land Leveling				
Back and Fill area	0.90	0.70	0.50	(applied)
Top soil treatment area	0.60	0.45	0.30	(applied)

Remarks:
- Good work condition
  Under the conditions of good foundation, soil with suitable moisture, easy land leveling work, etc.
- Poor work condition
  Under the opposite conditions of the above
- Fair work condition
  Under the conditions between above two conditions
- Working times of land leveling work by above condition are as follows:

Work Item	Work Conditions Good	Fair	Poor
Land Leveling			
Back and Fill area	LSD 2 times	LSD 3~2 times	LSD 4 times
	SSD 1 time	SSD 2 time	SSD 1~2 times
Top soil treatment area	LSD 3~4 times	LSD 4 times	LSD 5 times
	SSD 2 time	SSD 2~3 time	SSD 3~4 times

Remarks: LSD - The bulldozer should move to the direction of the long side of a filed lot.
SSD - The bulldozer should move to the direction of the short side of a filed lot.

TABLE 5-3-3 WORKABILITY OF BULLDOZER

1. Work Item : Stripping works

2. Applied equipment : Swamp bulldozer (16 ton class)

3. Equation

$$Q = \frac{60 \cdot q \cdot f \cdot E}{Cm}$$

Where: Q - Workability per hr (cu.m/hr)
q - Capacity per cycle (cu.m)
Bulldozer (Swamp, 16 ton class) 2.09 (applied)
f - Soil conversion factor = 1.00
E - Work efficiency (E= 0.6)
Cm - Necessary time for operation per cycle (min)
Cm = 0.034 . L + 0.25 L - hauling distance (= 10m)
In case of L=10, Cm= 0.59 min

4. Workability per hr

Q= 60 x 2.09 x 1.00 x 0.6 / 0.59 = 127.5 cu.m/hr

5. Necessary working hours and days

5.1 Net working hour
Working volume = 4,604 cu.m (refer to Table 4-4-1)
4,604 / 127.5 = 36.1 hr

5.2 Working hour per day = 6.1 hr

5.3 Net working day = 36.1 hr / 6.1 hr = 5.9 days

5.4 Gross working days = 5.9 x 30 / 21 = 8.4 days
In a month, the number rainy days will assume at 9 days during the construction period. The net workable day is 21 days per month.

5.5 Necessary number of bulldozer
In case of 10-days working period
8.4 / 10 = 0.8 bulldozer

Note:

1. Work efficiency (E)

Work Item	Work Conditions Good	Fair	Poor	
1) Top soil removal				
Sandy soil	0.85~0.75	0.75~0.65	0.65~0.55	
Clayey soil	0.75~0.65	0.65~0.55	0.55~0.45	(applied)
2) Earth movement				
Sandy soil	0.60~0.55	0.55~0.45	0.45~0.40	
Clayey soil	0.50~0.45	0.45~0.35	0.35~0.30	
Soil with gravel	0.55~0.50	0.50~0.40	0.40~0.35	
3) Top soil replace				
Sandy soil	0.80~0.70	0.70~0.60	0.60~0.50	
Clayey soil	0.70~0.60	0.60~0.50	0.50~0.40	

Remarks:

1. Under the conditions of wide working place, good foundation, high speed working and enough thickness (about 20 cm) of earth volume, the highest E value should be applied.
2. Under the opposite conditions of the above, the lowest E value should be applied.
3. In case that the working condition is ranged between the above, the middle E value would be applied.
4. For the Ultra Swampy Type Bulldozer, the lowest E value would be applied

Soil classification:

Categories	Classified soil(s)
Sand	sand
Sandy soil	sandy loam, loam, silty loam
Clayey soil	clay, clay loam
Soil with gravel	gravel, sand with gravel and/or gravel with sand,
Rock	crashed rock

Source:

Cost Estimate Series No.1, Cost Estimate Standard on Land Improvement Project, Ministry of Agriculture, Forestry and Fishery (MAFF), 1988

TABLE 5-3-4 WORKABILITY OF BULLDOZER

1. Working Item : Combination works of spreading and compaction of embankment materials for road construction

2. Applied Equipment : Standard type bulldozer 21 tons class

3. Equation

$$Q = Qs \times Qc / (Qs + Qc)$$

Where: Q - Workability per hr of combination work (cu.m/hr)
Qs- Workability of spreading (110.4 cu.m/hr)
Qc- Workability of compaction (141.75 cu.m/hr)

4. Workability per hr of Combination Works (Q)

$$Q = 110.40 \times 141.75 / (110.40 + 141.75)$$
$$= 62.09 \text{ cu.m/hr}$$

5. Necessary working hours and days

5.1 Net working hour (NWH)
Working volume = 16,772 cu.m (refer to Table 4-4-2)
NWH = 16,772 cu.m / 62.09 cu.m/hr = 270.12 hr

5.2 Working hour per day = 5.9 hr

5.3 Net working day (NWD)
NWD = 270.12 hr / 5.9 hr/day = 45.8 days

5.4 Gross working days (GWD)
GWD = 45.8 days x 30/21 = 65.4 days

Note; In a month, the number of rainy days and Friday would calculate at 11 days during the construction period from November to March. The net workable day, therefore, is 21 days a month.

5.5 Necessary number of bulldozer
In case of 50 days' construction period, 65.4/50 = 1.3 bulldozers

TABLE 5-3-5 WORKABILITY OF BULLDOZER

1. Working Item : Compaction of embankment materials for road construction
2. Applied Equipment : Standard type bulldozer 21 tons class
3. Equation

$$Q = \frac{V \cdot W \cdot D \cdot E}{N}$$

Where: Q - Workability per hr (cu.m/hr)
V - Compacting speed (m/hr)
Bulldozer (Standard, 21 ton class) (= 3,500 m/hr)
W - Effective compaction width per operation (= 0.9m)
D - Compacted thickness (= 0.30m)
E - Work efficiency (= 0.6)
N - Necessary number of operation on required compaction (= 4)

2. Workability per hr
3500 x 0.9 x 0.3 x 0.60 / 4 = 141.75 cu.m/hr

Note:

1) Effective compaction width and compacting speed by equipment

Equipment	Class	E. C. Width	C. Speed	
Bulldozer	11 ton	0.7 m	3,500 m/hr	
- do -	15 ton	0.8	"	
- do -	21 ton	0.9	"	(applied)
Vibrating roller	2.5~2.8 ton	0.7	1,000 m/hr	
	3~5 ton	0.8	"	
Tire roller	8~20 ton	1.8	3,500 m/hr	
Swamp	13 ton	1.3 m	3,500 m/hr	
Bulldozer	16 ton	1.5 m	"	

2) Work efficiency

Equipment Name	----- Work Conditions --- Good	Fair	Poor	Remark
Bulldozer	0.80	0.60	0.40	(0.6 is applied.)
Vibrating roller	0.40	0.40	0.40	
Tire roller	0.60	0.40	0.20	
Swamp bulldozer	0.80	0.60	0.40	

Remarks:
(1) Good condition:
In case of good balance between supply of material and workability, good materials for embankment and compaction, no rolling of working place and no obstruction
(2) Fair condition:
condition between good and poor conditions
(3) Poor condition:
In case of bad balance between supply of material and workability, much waiting time, poor materials with much moisture ratio, complicated geographic conditions and much work loss

3) Necessary number of operation on required compaction

Item	Equipment	Class	C. thickness	N.N. of operation	
Road embankment	Bulldozer	15 ton	0.30 m	5 times	
"	"	21 "	0.30 "	4 "	(applied)
Subgrade	"	15 "	0.20 "	7 "	
"	"	21 "	0.20 "	6 "	

TABLE 5-3-6 WORKABILITY OF BULLDOZER

1. Working Item : Spreading of embankment materials for road construction

2. Applied Equipment : Standard type bulldozer 21 tons class

3. Equation

$$Q = 10 \, . \, E \, (A \, . \, D + B)$$

Where: Q - Workability per hr (cu.m/hr)
E - Work efficiency (= 0.6)
A - Coefficient of Spreading
Bulldozer, Standard, 21 ton class (= 18)
D - Spreading thickness (= 0.30m)
B - Coefficient of Spreading
Bulldozer, Standard, 21 ton class (= 13)

2. Workability per hr (Q)

$$Q = 10 \times 0.6 \times (18 \times 0.3 + 13) = 110.4 \text{ cu.m/hr}$$

Note:

1) Work efficiency

----- Work Conditions ---

Good	Fair	Poor	Remark
0.80	0.60	0.40	(0.6 is applied.)

Remarks:

(1) Good condition:
In case of good balance between supply of material and workability, good materials for embankment and compaction, no rolling of working place and no obstruction

(2) Fair condition:
condition between good and poor conditions

(3) Poor condition:
In case of bad balance between supply of material and workability, much waiting time, poor materials with much moisture ratio, complicated geographic conditions and much work loss

2) Coefficient of spreading

Equipment	Class	C. of Spreading A	C. of Spreading B	
Bulldozer (Standard)	3 ton	4	3	
	6 "	7	5	
"	9 "	9	7	
"	11 "	11	8	
"	15 "	13	9	
"	21 "	18	13	(applied)
" (swamp)	13 "	10	8	
"	16 "	13	9	

TABLE 5-3-7 WORKABILITY OF BULLDOZER

1. Working Item : Spreading of gravel materials for road pavement

2. Applied Equipment : Standard type bulldozer 3 tons class

3. Applied Condition : The spreading width of a road is more than 3 meters. Thethickness of materials is more than 10 cm.

4. Workability per hr = 230 sq.m/hr

5. Labor for assistance of spreading works = 0.34 person/100 sq.m

6. Necessary working hours and days

6.1 Net working hour (NWH)

-Calculation of Working volume

Name of Road	Length (m)	Paved Width (m)	Paved Area (sq.m)	by machine (sq.m)	by man power (sq.m)
TR	1,140.0	4.50	5,130.0	5,130.0	0
FR-1	194.0	3.00	582.0	582.0	0
FR-2	276.5	3.00	829.5	829.5	0
FR-3	290.0	3.00	870.0	870.0	0
FR-4	297.0	2.00	594.0	-	594
FR-5	138.0	3.00	414.0	414.0	0
FR-6	684.0	3.00	2,052.0	2,052.0	0
FR-7	869.0	3.00	2,607.0	2,606.0	0
FR-8	290.5	3.00	871.5	871.5	0
FR-9	452.0	3.00	1,356.0	1,356.0	0
Total	4,631.0		15,306.0	14,712.0	594

Net Working hours = 14,712 / 230 = 64.0 hr
Required man power = 594 x 0.34 / 100 = 26.2 man·day

6.2 Working hour per day = 5.9 hr (bulldozer)

6.3 Net working day (NWD)
NWD = 64.0 hr / 5.9 hr/day = 10.8 days by machine

6.4 Gross working days (GWD)
GWD = 10.8 hr x 30/19 = 17.1 days (by machine)
GWD = 26.2 hr x 30/19 = 41.4 man.day (by man power)
Note; In a month, the number of rainy days and Friday would calculate at 11 days during the construction period from November to March. The net workable day, therefore, is 19 days a month.

6.5 Necessary number of bulldozer
In case of 20 days' construction period, 17.1/20 = 0.86 bulldozer
41.4/20 = 2.1 men

TABLE 5-3-8 WORKABILITY OF BACKHOE

1. Applied Work : Excavation of small scale canal by trapezoid shaped bucket
2. Applied equipment : 0.35 cu.m class backhoe of bucket capacity on trapezoid shape
3. Applied condition : less than 2.5 sq.m of cross sectional area to be excavated
4. Equation

$V = Vo \cdot E$
$E = E1 \cdot E2$

Where : V = Workability per hr (m/hr)
Vo = Based on the following equation
$Vo = 129.6 \cdot qo \cdot \alpha / A$
qo : Rated capacity (0.35 cu.m)
A : Cross sectional area to be excavated (= 1.5sq.m/m)
α : Coefficient by rotated angle of boom (= 0.89)
$E1$ = Coefficient by size of cross sectional area to be excavated = $0.23 \cdot A + 0.68 = 0.23 \times 1.5 + 0.68 = 1.03$
$E2$ = Coefficient by soil and work conditions (= 0.50)

5. Workability per hr
$E = E1 \cdot E2 = 1.03 \times 0.50 = 0.52$ (= 0.515)
$Vo = 129.6 \cdot qo \cdot \alpha / A = 129.6 \times 0.35 \times 0.89 / 1.5 = 26.9$ m/hr
$V = Vo \cdot E = 26.9 \times 0.52 = 13.99$ m/hr

6. Necessary working hours and days

6.1 Net working hour
Working volume = 3,447 m
3,447 / 13.99 = 246.4 hr

6.2 Working hour per day = 6.1 hr

6.3 Net working day = 246.4 hr / 6.1 hr = 40.4 days

6.4 Gross working days = 40.4 days x 30 / 21 = 57.7 days
In a month, the number rainy days will assume at 9 days during the construction period. The net workable day is 21 days per month.

6.5 Necessary number of bulldozer
In case of 45-days working period
57.7 / 45 = 1.3 backhoes

Note:

1. Coefficient by rotated angle of boom

Rotated angle(°)	45	90	135	180	
Coefficient(α)	1.00	<u>0.89</u>	0.83	0.76	(applied)

2. Coefficient by soil and work conditions

	-------- Work conditions -------			
Soil	Good	Fair	Poor	
Sandy soil	0.75	0.60	0.45	
Clayey soil	0.65	<u>0.50</u>	0.35	(applied)
Soil w/ gravel	0.60	0.45	0.30	

Remarks;

Work conditions in good : in case of loose materials, easy excavation, no obstruction on work and continuous work is available

in poor : in case of stiff materials to be excavated, many obstructions on works and continuous work is difficult.

in fair : In case between goon and poor conditions

TABLE 5-3-9 WORKABILITY OF BACKHOE

1. Applied Work : Excavation

2. Applied equipment : 0.35 cu.m class backhoe

3. Applied condition : 1~4m depth to be excavated

4.- Equation

$$Q = \frac{3,600 \cdot q \cdot f \cdot E}{Cm}$$

Where : Q = Workability per hr (cu.m/hr)
q = Excavation volume per cycle (cu.m/cycle)
q = qo x K = 0.35 x 0.8 = 0.28
qo : Rated capacity (0.35 cu.m)
K : Coefficient of loading = 0.8

f = Soil conversion factor (f=1,0)
E = Work efficiency (E=0.60)

5. Workability per hr
Q = 3,600 x 0.28 x 1.0 x 0.60 / 30
= 20.16 cu.m/hr

6. Necessary working hours and days

6.1 Net working hour
Working volume = 140.9 cu.m
140.9 / 20.16 = 7.0 hr

6.2 Working hour per day = 6.1 hr

6.3 Net working day = 7.0 hr / 6.1 hr = 1.1 days

6.4 Gross working days = 1.1 days x 30 / 21 = 1.6 days
In a month, the number rainy days will assume at 9 days during the construction period. The net workable day is 21 days per month.

6.5 Necessary number of bulldozer
In case of 2-days working period
1.6 / 2 = 0.8 backhoes

Note:

1. Relation between rotated angle of a boom and circle time

Rotated angle(°)	45	90	135	180
Circle time (sec)	28	30	32	35 (applied)

2. Work efficiency

	-------- Work conditions -------						
	Natural ground			Loose conditions			
Soil	Good	Fair	Poor	Good	Fair	Poor	
Sandy soil	0.80	0.65	0.50	0.85	0.70	0.55	
Clayey soil	0.75	0.60	0.45	0.80	0.65	0.50	(applied)
Crashed rock	-	-	-	0.65	0.50	0.35	

Remarks;

Work conditions in good : in case of loose ground, 1~4m excavated depth, and no obstruction things, continuous works are available.

in poor : in case of stiff ground to be excavated, obstruction things and continuous work is difficult.

in fair : In case between goon and poor conditions

TABLE 5-3-10 ESTIMATION OF WORKABLE DAYS (1 of 2)

Rainfall	1975/76 Nov	Dec	Jan	Feb	Mar	Total	1976/77 Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	25	24	29	20	27	126	27	26	20	26	30	129
5 to 10	1	5	1	4	3	13	1	-	4	1	-	6
10 to 30	2	2	1	5	1	11	2	4	5	1	1	13
30 to 50	2	-	-	-	-	2	-	1	2	-	-	3
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

Rainfall	1977/78 Nov	Dec	Jan	Feb	Mar	Total	1978/79 Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	28	23	28	23	28	130	21	27	27	21	28	124
5 to 10	-	6	1	2	-	9	2	1	2	4	1	10
10 to 30	-	1	2	3	3	9	4	3	2	3	2	14
30 to 50	2	1	-	-	-	3	1	-	-	-	-	1
MT 50 mm	-	-	-	-	-	0	2	-	-	-	-	2

Rainfall	1979/80 Nov	Dec	Jan	Feb	Mar	Total	1980/81 Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	27	25	25	21	28	126	26	24	28	24	26	128
5 to 10	1	2	1	3	2	9	-	-	-	1	2	3
10 to 30	1	2	5	4	1	13	3	7	1	4	3	18
30 to 50	1	1	-	-	-	2	1	-	2	-	-	3
MT 50 mm	-	1	-	-	-	1	-	-	-	-	-	0

Rainfall	1981/82 Nov	Dec	Jan	Feb	Mar	Total	1982/83 Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	27	31	29	20	25	132	19	29	24	27	25	124
5 to 10	-	-	1	3	5	9	4	2	3	1	2	12
10 to 30	2	-	1	5	1	9	4	-	3	-	4	11
30 to 50	1	-	-	-	-	1	2	-	1	-	-	3
MT 50 mm	-	-	-	-	-	0	1	-	-	-	-	1

Rainfall	1983/84 Nov	Dec	Jan	Feb	Mar	Total	1984/85 Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	26	26	27	22	30	131	19	25	28	20	27	119
5 to 10	1	1	1	6	-	9	6	2	2	4	2	16
10 to 30	3	3	3	1	1	11	4	2	1	4	2	13
30 to 50	-	-	-	-	-	0	1	2	-	-	-	3
MT 50 mm	-	1	-	-	-	1	-	-	-	-	-	0

Note; MT - more than

	Total Rainy Day 0 to 5mm	5 to 10	10 to 30	30 to 50	MT 50mm
1975/76	126	13	11	2	0
1976/77	129	6	13	3	0
1977/78	130	9	9	3	0
1978/79	124	10	14	1	2
1979/80	126	9	13	2	1
1980/81	128	3	18	3	0
1981/82	132	9	9	1	0
1982/83	124	12	11	3	1
1983/84	131	9	11	0	1
1984/85	119	16	13	3	0
Total	1269	96	122	21	5
Average	126.9	9.6	12.2	2.1	0.5
No Workable Days	0	4.8	18.3	5.3	1.8

Workable days including Friday 126.9 + 9.6 + 12.2 + 2.1 + 0.5 - 4.8 - 18.3 - 5.3 - 1.8 = 121.1

TABLE 5-3-10 ESTIMATION OF WORKABLE DAYS (2 of 2)

	1975/76						1976/77					
Rainfall	Nov	Dec	Jan	Feb	Mar	Total	Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	3	3	4	3	4	17	4	3	1	3	4	15
5 to 10	-	1	1	1	-	3	-	-	1	-	-	1
10 to 30	1	-	-	-	-	1	-	1	2	1	-	4
30 to 50	-	-	-	-	-	-	-	1	-	-	-	1
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

	1977/78						1978/79					
Rainfall	Nov	Dec	Jan	Feb	Mar	Total	Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	4	4	4	4	4	20	4	5	3	4	5	21
5 to 10	-	1	-	-	-	1	-	-	1	-	-	1
10 to 30	-	-	-	-	-	-	-	-	-	-	-	-
30 to 50	-	-	-	-	-	-	-	-	-	-	-	-
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

	1979/80						1980/81					
Rainfall	Nov	Dec	Jan	Feb	Mar	Total	Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	4	2	4	4	3	17	4	1	5	3	4	17
5 to 10	1	1	-	-	1	2	-	-	-	-	-	-
10 to 30	-	-	-	-	-	-	-	3	-	1	-	4
30 to 50	-	1	-	-	-	1	-	-	-	-	-	-
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

	1981/82						1982/83					
Rainfall	Nov	Dec	Jan	Feb	Mar	Total	Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	4	4	4	3	2	17	2	5	4	4	4	19
5 to 10	-	-	-	-	2	2	2	-	-	-	-	2
10 to 30	-	-	1	1	-	2	-	-	-	-	-	-
30 to 50	-	-	-	-	-	-	-	-	-	-	-	-
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

	1983/84						1984/85					
Rainfall	Nov	Dec	Jan	Feb	Mar	Total	Nov	Dec	Jan	Feb	Mar	Total
0 to 5mm	2	4	4	3	4	17	4	2	4	3	4	17
5 to 10	-	-	-	-	-	-	-	-	-	-	-	-
10 to 30	2	1	-	1	1	5	1	2	-	1	1	5
30 to 50	-	-	-	-	-	-	-	-	-	-	-	-
MT 50 mm	-	-	-	-	-	-	-	-	-	-	-	-

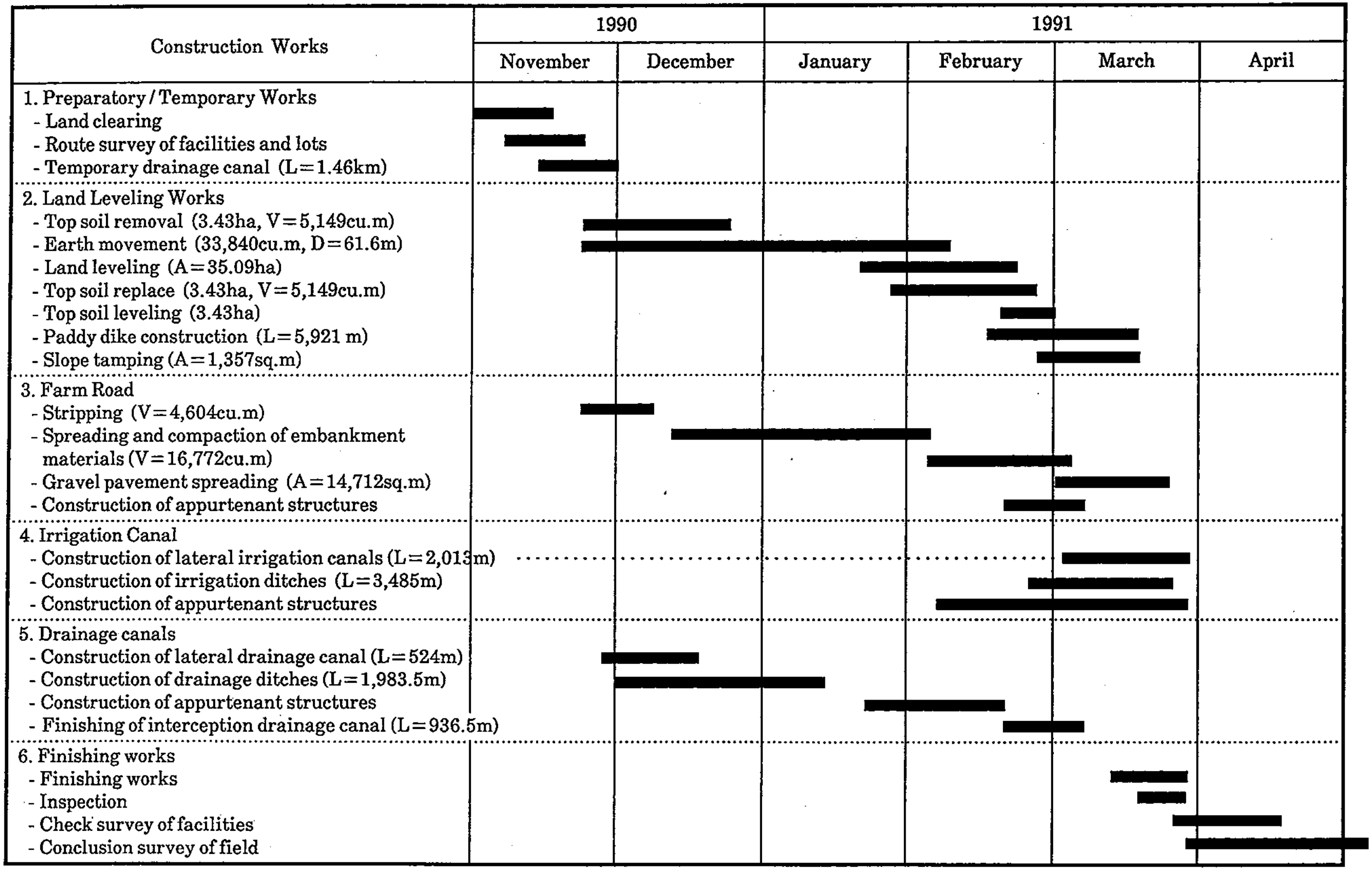
Note: MT - more than

	Total Rainy Day on Friday				
	0 to 5mm	5 to 10	10 to 30	30 to 50	MT 50mm
1975/76	17	3	1	0	0
1976/77	15	1	4	1	0
1977/78	20	1	0	0	0
1978/79	21	1	0	0	0
1979/80	17	2	0	1	0
1980/81	17	0	4	0	0
1981/82	17	2	2	0	0
1982/83	19	2	0	0	0
1983/84	17	0	5	0	0
1984/85	17	0	5	0	0
Total	177	12	21	2	0
Average	17.7	1.2	2.1	0.2	0.0
No Workable Days	0	0.6	3.2	0.5	0.0

Workable days including Friday 121.1 - 17.7 - 1.2 - 2.1 - 0.5 + 0.6 + 3.2 + 0.5
= 104.2

Average workable days per month = 104.2 / 5 = 20.8 days
say 21 days

FIGURE 5-4-1 TENTATIVE CONSTRUCTION SCHEDULE



CHAPTER 6. COST ESTIMATE

CHAPTER 6. COST ESTIMATE

6.1. Basic Conditions

The Project costs are estimated as stated in the following conditions.

6.1.1. Estimated Cost Items

The estimated costs cover the necessary civil engineering works mentioned in the previous Chapters to construct the Main Field (MF) in the CAPIC, excluding costs for land acquisition and compensation, survey works, and construction administration and supervision.

6.1.2. Unit Costs

The units costs are composed of material costs, labor costs and hiring costs of construction equipment. The unit costs are collected from contractors and machine dealers in Amol and adjacent areas as of October, 1990. All unit costs of machinery include depreciation and repair costs, operator's fees and fuel fees. (refer to Table 6-1-1 to -3)

6.2. Cost Estimate

The cost of the Project under this conditions is estimated in Table 6-2-1 to -2.

TABLE 6-1-1 LIST OF BASIC UNIT COSTS AND PRICES

Description	Specifications	Unit	Price (rials)	Remarks
1. Hiring of Machinery				
Bulldozer	15 tons	hr	5,500	
"	21 tons	"	7,500	
Hydraulic	0.3 cu.m	"	6,000	Wheel type
excavator	0.6 cu.m	"	8,000	Crawler type
Loader	1.5 cu.m	"	10,000	Wheel type
Dump truck	4 tons	"	3,500	
"	8 "	"	4,000	
"	11 "	"	5,500	
Cargo truck	1 "	day	15,000	
"	6 "	"	40,000	
"	4 "	hr	3,000	
"	8 "	"	4,000	
"	11 "	"	5,000	
Mini bus		day	20,000	
Water lorry	6 cu.m	hr	5,000	
Truck crane	15 tons	"	10,000	
"	20 "	"	12,000	
Road roller	6-8 "	"	6,000	
Tire roller	9-15 "	"	8,000	
Tamper	60-80 kg	mo	800,000	
Concrete Vibrator	D28 mm	hr	1,300	
Motor Grader	2200 mm	"	12,000	
Submergible pump	D 50, 0.4 kw		380,000	Price robin w/o hose
2. Materials (Iron/Steel)				
Reinforcing bar	#2 mm	kg	1,200	
"	#4 mm	"	1,000	
"	#6 mm	"	780	
"	#8 mm	"	760	
Deformed bar	D10 mm(0.616 kg/m)	m	500	R.6000/12m
"	D12 mm(0.888 kg/m)	"	750	R.9000/12m
"	D14 mm(1.209 kg/m)	"	960	R.11500/12m
"	D20 mm(2.466 kg/m)	"	1,330	R.16000/12m
Steel pipe	dia 2"	m	6,200	R.37000/6m
"	dia 4"	"	9,200	R.55000/6m
Steel plate	t = 9mm	kg	700	
"	t =12mm	"	700	
Equal angle iron	6 x 50 x 50 mm	"	700	
"	7 x 100 x 100 mm	"	1,000	
Nails		"	1,100	
High strength bolts		"	800	
Iron wire		"	1,200	

3. Materials (Concrete/Asphalt)

Portland cement		ton	60,000	(G)
Concrete	200 kg/cu.m	cu.m	9,000	(G) cement only
"	300 kg/cu.m	cu.m	12,000	(G) cement only
Form	Wooden	sq.m	1,500	
RC pipe	Rashid(Guilan)			
dia. 400 mm	t=50 mm,L=3.5 m	pc	95,000	
dia. 500 mm	t=56 mm,L=3.5 m	"	98,000	
dia. 600 mm	t=68 mm,L=3.5 m	"	102,000	
dia.1000 mm	t=95 mm,L=3.5 m	"	127,000	
dia.1250 mm	t=110mm,L=3.5 m	"	148,000	
	Ahwaz(Khuzestan)			Mater.+Trans.
dia. 500 mm	t=65 mm,L=2.5 m	"	37,000	20+17=37,000
dia. 600 mm	t=75 mm,L=2.5 m	"	49,000	26+23=49,000
dia.1000 mm	T=110mm,L=2.5 m	"	114,000	59+55=114,000
Asphalt		ton	40,000	compound

4. Materials (Wood)

Timber	for beams	ton	70,000	domestic
"	for others	cu.m	540,000	imported

5. Materials (Stone/Brick)

Fine aggregate	less than 5mm dia.	cu.m	7,000	for concrete
Broken Stone	20 mm dia.	cu.m	4,000	for concrete
Stone		cu.m	3,000	
Brick		pc	18	

6. Oil/Gas

Gasoline		lit	30	(G)
Kerosene		"	4	(G)
Engine oil		"	250	

7. Glass

Glass	t=4.6mm	sq.m	8,000	domestic
	t= 6 mm	"	25,000	imported

8. Paint

Rust prevention		sq.m	1,000	
Oil paint		kg	3,000	2500/kg
Emulsion	for mortar	sq.m	500	

9. Compound Price

Brick-laying		sq.m	5,000	
Concrete blocks laying		sq.m	4,500	

TABLE 6-1-2 SUMMARY OF UNIT COST

No.	Work Item	Specification	Unit	Cost (rials)
1	Cut and fill of earth moving	Bulldozer SW-16ton	cu.m	257
2	Cutting and filling of top soil removal	Bulldozer SW-16ton	cu.m	75
3	Cutting and filling of top soil replacement	Bulldozer SW-16ton	cu.m	81
4	Land leveling of earth moving area	Bulldozer SW-16ton	ha	63,308
5	Land leveling of top soil area	Bulldozer SW-16ton	ha	98,726
6	Stripping	Bulldozer SW-16ton	cu.m	43
7	Combination of spreading and compaction works of embankment materials	Bulldozer ST-21ton	cu.m	121
8	Compaction of embankment materials	Bulldozer ST-21ton	cu.m	53
9	Spreading of embankment materials	Bulldozer ST-21 ton	cu.m	68
10-1	Spreading of paving materials (gravel)	Bulldozer ST-3 ton	sq.m	24
10-2	Spreading of paving material (gravel) by manual	manual	sq.m	42
11	Excavation of small canal	Back hoe (0.35cu.m)	m	429
12	Construction of plot dike	machine+manual	m	124
13	Slope tamping	manual	sq.m	133
14-1	Excavation	manual	cu.m	1,050
14-2	Excavation	Backhoe(0.35cu.m)	cu.m	298
15	Backfill	manual	cu.m	249
16-1	Pipe placement	∮400 mm x 3.5m excluding materials	pc	7,297
16-2	Pipe placement	∮500 mm x 3.5m excluding materials	pc	7,297
16-3	Pipe placement	∮600 mm x 3.5m excluding materials	pc	8,097

16-4 Pipe placement	∮400 mm x 2.5m excluding materials	pc	3,682
16-5 Pipe placement	∮500 mm x 2.5m excluding materials	pc	4,106
16-6 Pipe placement	∮600 mm x 2.5m excluding materials	pc	4,429
17-1 Wet masonry	t=30cm including materials	sq.m	6,094
17-2 Wet masonry	t=15cm including materials	sq.m	3,861
18-1 Dry masonry	t=30cm including materials	sq.m	2,110
18-2 Dry masonry	t=15cm including materials	sq.m	1,458
19-1 Mortar	1,100 kg/cu.m	cu.m	75,100
19-2 Mortar	720 kg/cu.m	cu.m	53,350
19-3 Mortar	530 kg/cu.m	cu.m	42,650
20 MOA A-3 Precast concrete canal	50cm (B) x 32cm (H) x 50cm(L)	pc	2,874

TABLE 6-1-3 BREAKDOWN OF UNIT COST

1. Cut and fill of earth moving
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 21.44 cu.m/hr (Hauling distance D= 61.6m)
   refer to Table 5-3-1
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied)
   Unit Cost : 5,500 / 21.44 = 257 rials/cu.m

2. Cut and fill of top soil removal
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 73.76 cu.m/hr (Hauling distance D= 27.2m)
   refer to Table 5-3-1
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied.)
   Unit Cost : 5,500 / 73.76 = 75 rials/cu.m

3. Cut and fill of top soil replacement
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 67.62 cu.m/hr (Hauling distance D= 27.2m)
   refer to Table 5-3-1
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied.)
   Unit Cost : 5,500 / 67.62 = 81 rials/cu.m

4. Land leveling of earth moving area
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 0.130 ha/hr (refer to Table 5-3-2)
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied.)
   ①Machine cost : 5,500 / 0.130 = 42,308 rials/ha
   ②Labor Cost : 3,500 rials/day / 6 men/ha = 21,000 rials/ha
   Total(Unit Cost= ① +②) 63,308 rials/ha

5. Land leveling of top soil area
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 0.084 ha/hr (refer to Table 5-3-2)
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied.)
   ①Machine cost : 5,500 / 0.084 = 65,476 rials/ha
   ②Labor Cost : 3,500 rials/day / 9.5 men/ha = 33,250 rials/ha
   Total(Unit Cost= ① +②) 98,726 rials/ha

6. Stripping works
   Equipment : Swampy type Bulldozer (16 ton)
   Workability : 127.5 cu.m/hr (refer to Table 5-3-3)
   Hired charge : 5,500 rials/hr (The cost of 15 ton bulldozer is applied.)
   Unit Cost : 5,500 / 127.5 = 43 rials/cu.m

7. Combination of spreading and compaction works of embankment materials
   Equipment : Standard type Bulldozer (21 ton)
   Workability : 62.09 cu.m/hr (refer to Table 5-3-4)
   Hired charge : 7,500 rials/hr
   Unit Cost : 7,500 / 62.09 = 121 rials/cu.m

8. Compaction of embankment materials
   Equipment : Standard type Bulldozer (21 ton)
   Workability : 141.75 cu.m/hr (refer to Table 5-3-5)
   Hired charge : 7,500 rials/hr
   Unit Cost : 7,500 / 141.75 = 53 rials/cu.m

9. Spreading of embankment materials
Equipment : Standard type Bulldozer (21 ton)
Workability : 110.4 cu.m/hr (refer to Table 5-3-6)
Hired charge : 7,500 rials/hr
Unit Cost : 7,500 / 110.4 = 68 rials/cu.m

10-1. Spreading of paving materials (gravel) by bulldozer
Equipment : Standard type Bulldozer (3 ton)
Workability : 230 sq.m/hr (refer to Table 5-3-7)
Hired charge : 2,750 rials/hr (50% of the cost of 15 ton bulldozer is assumed)
①Machine cost : 2,750 / 230 = 12 rials/sq.m
②Labor Cost : 3,500 rials/day x 0.34 men/100sq.m = 12 rials/sq.m
Total(Unit Cost= ① +②) 24 rials/sq.m

10-2. Spreading of paving materials (gravel) by manual
Workability 1.2. men/100 sq.m (thickness is more or equal to 10 cm)
Labor cost 3,500 rials/man.day
Unit cost = 3,500 x 1.2/100 sq.m = 42 rials/sq.m

11. Excavation of small canal
Equipment : 0.35 cu.m Backhoe with a trapezoid shaped bucket
Workability : 13.99 m/hr (refer to Table 5-3-8)
Hired charge : 6,000 rials/hr
Unit Cost : 6,000 / 13.99 = 429 rials/m

12. Construction of plot dike
Embankment volume per m (0.3 x 0.9) x 0.3 x 1/2 / 0.9 = 0.2 cu.m/m
Slope tamping volume $\sqrt{2}$ x 0.3 x 2 = 0.85 sq.m/m
①Compaction by Bulldozer 0.2 x 53 rials/cu.m = 11 rials/m
②Slope tamping work by manual =0.85 x 133 rials/sq.m= 113 rials/m
Total(Unit Cost= ① +②) 124 rials/m

13. Slope tamping work by manual
Workability 0.38 men/10 sq.m
Labor cost 3,500 rials/man.day
Unit cost = 3,500 x 0.38/10 sq.m = 133 rials/sq.m

14-1. Excavation by manual
Workability 3.0 men/10 cu.m
Labor cost 3,500 rials/man.day
Unit cost = 3,500 x 3.0/10 cu.m = 1,050 rials/cu.m

14-2. Excavation by machine
Equipment : 0.35 cu.m Backhoe
Workability : 20.16 m/hr (refer to Table 5-3-9)
Hired charge : 6,000 rials/hr
Unit Cost : 6,000 / 20.16 = 298 rials/cu.m

15. Backfill by manual
Workability 0.71 men/10 cu.m
Labor cost 3,500 rials/man.day
Unit cost = 3,500 x 0.71/10 cu.m = 249 rials/cu.m

16-1 to -3. Pipe placement (∮400~600mm L=3.5m)

	Price	Unit	∮400~500mm @	∮400~500mm Cost	∮600mm @	∮600mm Cost
Workability (pcs/day)			12.3	-	11.3	-
Scaffolding man	7,000*1	men	-	-	1.0	7,000
Skilled labor	5,250*2	men	2.0	10,500	1.0	5,250
Common labor	3,500	men	3.5	12,250	3.5	12,250
Truck crane (15ton)	10,000	hr	6.7	67,000	6.7	67,000
Total				89,750		91,500
Unit cost per piece		rials/pc		7,297		8,097

Note; *1 - Assumed price = common labor 3,500 x 2 = 7,000 rials/day
*2 - Assumed price = common labor 3,500 x 1.5 = 5,250 rials/day

16-4 to -6. Pipe placement (∮400~600mm L=2.5m)

	Price	Unit	∮400mm @	∮400mm Cost	500mm @	500mm Cost	∮600mm @	∮600mm Cost
Workability (pcs/day)			14.8	-	13.7	-	12.7	-
Skilled labor	5,250*1	men	2.0	10,500	2.0	10,500	2.0	10,500
Common labor	3,500	men	3.0	10,500	3.5	12,250	3.5	12,250
Truck crane (5ton)	5,000*2	hr	6.7	33,500	6.7	33,500	6.7	33,500
Total				54,500		56,250		56,250
Unit cost per piece		rials/pc		3,682		4,106		4,429

Note; *1 - Assumed price = common labor 3,500 x 1.5 = 5,250 rials/day
*2 - Assumed price = half price of 15 ton truck crane

17-1. Wet masonry (including materials) per sq.m (t=30cm)

Item	Specification	Quant'y	Unit	Price	Cost
-Materials-					
Boulder	∮25 cm ±	0.30	cu.m	3,000	900
Packed concrete	150 kg/cu.m	0.119	cu.m	8,000	952
Backfill gravel	∮5~15 cm	0.339*1	cu.m	3,000	1,017
Packed materials*2		0.068	cu.m	3,000	204
Vinyl pipe*3	∮40mm	0.16	m	5,000	800
Others		0.20	%		775
-Labor-					
Mason		0.063	men	7,000*5	441
Skilled labor		0.018	men	5,250*6	95
Common labor		0.260*4	men	3,500	910
Total					6,094

Note; *1 t=0.30m x 1.0 sq.m x 1.13 = 0.339 cu.m (loss 13%)
*2 20% of backfill gravel = 0.339 x 0.2 = 0.068 cu.m
*3 0.50 m/pc / 3 sq.m = 0.16m/sq.m.(1 piece per 3 sq.m)
*4 mason works 0.122 men/sq.m + Packed concrete 0.036 men/sq.m + Backfill gravel 0.34 x 3.0/10cu.m = 0.260 men/sq.m
*5 Assumed price = common labor 3,500 x 2 = 7,000 rials/day
*6 Assumed price = common labor 3,500 x 1.5 = 5,250 rials/day

17-2. Wet masonry (including materials) per sq.m (t=15cm)

Item	Specification	Quant'y	Unit	Price	Cost
-Materials-					
Boulder	∮15 cm ±	0.15	cu.m	3,000	450
Packed concrete	150 kg/cu.m	0.050*1	cu.m	8,000	400
Backfill gravel	∮5~15 cm	0.170*2	cu.m	3,000	510
Packed materials		0.034*3	cu.m	3,000	102
Vinyl pipe	∮40mm	0.16*4	m	5,000	800
Others		0.20			452
-Labor-					
Mason		0.057	men	7,000*6	399

17-2. (continued)

Skilled labor		0.015	men	5,250*7	79
Common labor		0.191*5	men	3,500	669
Total					3,861

Note; *1 t=0.15m x 1.0 sq.m x 1/3 = 0.05 cu.m
Note; *2 t=0.15m x 1.0 sq.m x 1.13 = 0.170 cu.m (loss 13%)
*3 20% of backfill gravel = 0.170 x 0.2 = 0.034 cu.m
*4 0.50 m/pc / 3 sq.m = 0.16m/sq.m (1 piece per 3 sq.m)
*5 mason works 0.110 men/sq.m + Packed concrete 0.030 men/sq.m + Backfill gravel 0.17 x 3.0/10cu.m = 0.191 men/sq.m
*6 Assumed price = common labor 3,500 x 2 = 7,000 rials/day
*7 Assumed price = common labor 3,500 x 1.5 = 5,250 rials/day

18-1. Dry masonry (including Materials) per sq.m (t=0.30m)

Item	Specification	Quant'y	Unit	Price	Cost
-Materials-					
Boulder	∮25 cm ±	0.30	cu.m	3,000	900
Packed gravel	∮ 5 cm ±	0.118	cu.m	3,000	354
-Labor-					
Mason		0.0147	men	7,000*2	103
Common labor		0.215	men	3,500	753
Total					2,110

Note; *1 t=0.20m x 1.0 sq.m x 1.13 = 0.226 cu.m (loss 13%)
*2 Assumed price = common labor 3,500 x 2 = 7,000 rials/day

18-2. Dry masonry (including Materials) per sq.m (t=0.15m)

Item	Specification	Quant'y	Unit	Price	Cost
-Materials-					
Boulder	∮15 cm ±	0.15	cu.m	3,000	450
Packed gravel	∮ 5 cm ±	0.05*1	cu.m	3,000	150
-Labor-					
Mason		0.057	men	7,000*2	399
Common labor		0.131	men	3,500	459
Total					1,458

Note; *1 t=0.15m x 1.0 sq.m x 1/3 = 0.05 cu.m
*2 Assumed price = common labor 3,500 x 2 = 7,000 rials/day

19. Mortar per cu.m by manual operation

			Ratio					
			1:1		1:2		1:3	
	Price	Unit	@	Cost	@	Cost	@	Cost
Cement	60,000	ton	1.1	66,000	0.72	43,200	0.53	31,800
Sand	7,000	cu.m	0.75	5,250	0.95	6,650	1.05	7,350
Common labor	3,500	men	1.1	3,850	1.0	3,500	1.0	3,500
Total				75,100		53,350		42,650

20. MOA A-3 (Precast Concrete Canal)

Item	Specification	Quant'y	Unit	Price	Cost
-Materials-					
Concrete	300kg/cu.m	0.047	cu.m	12,000	564
Form		0.90	sq.m	1,500	1,350
Mortar 1:2		0.0009*3	cu.m	53,350	48
-Labor-					
Common labor		0.107*1	men	3,500	374
Placement (Common labor)		0.11*2	men	3,500	385
Unloading (Skilled labor)		0.002*3	men	5,250*5	11
〃 (Common labor)		0.002*4	men	3,500	7
Truck crane (5ton)		0.027*6	hr	5,000*7	135
Total					2,874

Note:

*1 for form composition and dismantling, cleaning, and oil coating
0.90 sq.m x 1.12men/10sq.m = 0.101 men
for curing of concrete
0.31 (0.62 x 0.50) sq.m x 0.2 men/10sq.m = 0.006 men
Total = 0.107 men

*2 21men/100m x 0.5 = 0.11men/m

*3 Caulking mortar 0.0009 cu.m/place

*4 Unloading
Skilled labor 0.0147men/cu.m x 0.74 x 0.39 x 0.5 = 0.002men/pc
Common labor 0.0162men/cu.m x 0.74 x 0.39 x 0.5 = 0.002men/pc

*5 Assumed price = common labor 3,500 x 1.5 = 5,250 rials/day

*6 Hauling of Canals : Truck crane 3.91ton/hr D=500m
2.8ton/time/(0.047x2.3ton) = 25.9 pcs (say = 26 pcs)
3.91/2.8 = 1.4, 26 x 1.4 = 36.4 pcs/hr(= 1/36.4 = 0.027hr/pc)

*7 Assumed price = half price of 15 ton truck crane

TABLE 6-2-1 SUMMARY OF COST ESTIMATE

(Unit : rials)

Item	Quantity	Unit	Project Cost	Remarks
A. Field Construction	42.78	ha	12,971,751	
B. Irrigation Canals			28,691,743	
C. Drainage Canals	3,447	m	8,649,958	
D. Farm Roads	3,447	m	11,464,946	
E. Experimental Farm	6.42	ha	4,233,996	
F. Preparatory and Temporary Works	42.78	ha	10,067,791	
Sub-total			76,080,185	
G. Physical Contingency (within 10% of above total)		LS	7,607,815	
Total			83,688,000	

TABLE 6-2-2 BREAK DOWN OF PROJECT COST

Item	Quantities	unit	Unit Cost (rials)	Cost (rials)	Unit price No.
A. Filed construction					
A.1 Earth works					
- Top soil removal	5,149	cu.m	75	386,175	2
- Cutting and filling	33,840	cu.m	257	8,696,880	1
- Land leveling	35.04	ha	63,308	2,218,312	4
- Top soil replacement	5,149	cu.m	81	417,069	3
- Land leveling of top soil treatment area	3.43	ha	98,726	338,630	5
Sub-total				12,057,066	
A.2. Plot dike construction	5,921	m	124	734,204	12
Sub-total				734,204	
A.3. Plot slope tamping work	1,357	sq.m	133	180,481	13
Sub-total				180,481	
Total				12,971,751	
B. Irrigation Canals					
B.1. Irrigation canal construction					
a) Lateral Irrigation Canal (LIC)					
- Concrete (150kg/cu.m)	112.4	cu.m	6,750*1	758,700	T 6-1-1
- Concrete (300kg/cu.m)	324.6	cu.m	12,000	3,895,200	T 6-1-1
- Form	373.7	sq.m	1,500	560,550	T 6-1-1
- Concrete block lining	1,565.4	sq.m	4,500	7,044,300	T 6-1-1
- Brick lining	328.3	sq.m	5,000	1,641,500	T 6-1-1
- Mortar lining (1:2)	29.76	cu.m	53,350	1,587,696	19-2
- Precast C. Canal MOA A-3	588	pcs	2,874	1,689,912	20
- Stripping	2,414	cu.m	43	103,802	6
- Compacted fill	3,738	cu.m	121	452,298	7
- Slope tamping	1,641	sq.m	133	218,253	13
- Excavation	1,649	cu.m	1,050	1,731,450	14-1
- Backfill	448	cu.m	249	111,552	15
- Sand	166	cu.m	3,000	498,000	T 6-1-1
Sub-total				20,293,213	
Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%					
b) Irrigation Ditch (ID)					
- Compacted fill	1,380	cu.m	121	166,980	7
- Excavation (manual)	672	cu.m	1,050	705,600	14-1
- Slope tamping	4,692	sq.m	133	624,036	13
Sub-total				1,496,616	
Total				21,789,829	

B. 2. Appurtenant structures

a) Road crossing (n= 7)

- Excavation	89	cu. m	1,050	93,450	14-1
- Backfill	63	cu. m	249	15,687	15
- Concrete(150kg/cu. m)	2.4	cu. m	6,750*1	16,200	
- Concrete(300kg/cu. m)	20.3	cu. m	12,000	243,600	T 6-1-1
- Form	154.7	sq. m	1,500	232,050	T 6-1-1
- Reinforced bar (D10)	2,009.7	m	500	1,004,850	T 6-1-1
- Reinforced bar (D14)	403.8	m	960	387,648	T 6-1-1
Sub-total				1,993,485	

Note; *1 assumed price = Concrete 200kg/cu. m (9000rials/cu. m) x 75%

b) Turn-out (n=10)

- Dry masonry (t=15cm)	12.6	cu. m	1,458	18,371	18-2
- Concrete (300kg/cu. m)	7.6	cu. m	12,000	91,200	T 6-1-1
- Concrete (150kg/cu. m)	1.2	cu. m	6,750*1	8,100	
- Reinforced bar(∮4mm)	0.5	kg	1,000	500	T 6-1-1
- Reinforced bar(D10)	628.9	m	500	314,450	T 6-1-1
- Reinforced bar(D14)	97.5	m	960	93,600	T 6-1-1
- Form	11.9	sq. m	1,500	17,850	T 6-1-1
- Steel plate (t=9mm)	409	kg	700	286,300	T 6-1-1
- Iron gate (1100x600mmx1pc)	103.75	kg	1,000	103,750	T 6-1-1
- Iron gate (400x600mmx1pc)	71.45	kg	1,000	71,450	T 6-1-1
- Iron gate (400x550mmx1pc)	214.35	kg	1,000	214,350	T 6-1-1
- Iron gate (700x500mmx1pc)	97.65	kg	1,000	97,650	T 6-1-1
Sub-total				1,317,571	

Note; *1 assumed price = Concrete 200kg/cu. m (9000rials/cu. m) x 75%

c) Siphon (n=1)

- Excavation(machine)	141	cu. m	298	42,018	14-2
- Backfill	48	cu. m	249	11,952	15
- Compacted fill	208	cu. m	121	25,168	7
- Dry masonry (t=15cm)	12.6	sq. m	1,458	18,371	18-2
- Concrete (300kg/cu. m)	13.9	cu. m	12,000	166,800	T 6-1-1
- Concrete (150kg/cu. m)	0.7	cu. m	6,750*1	4,725	
- Reinforced bar(∮4mm)	0.5	kg	1,000	500	T 6-1-1
- Reinforced bar(D10)	490.9	m	500	245,450	T 6-1-1
- Reinforced bar(D14)	760.6	m	960	730,176	T 6-1-1
- Reinforced bar(D16)	73.3	m	1,145*2	83,929	
- Wet masonry (t=30cm)	4.0	sq. m	6,094	24,376	17-1
- Brick lying	0.4	sq. m	5,000	2,000	T 6-1-1
- Darwell bar (D16)	12	m	1,145*2	13,740	
- Mortar (1:1)	0.034	cu. m	75,100	2,553	19-1
- RC pipe (∮400mm@3.5m)	5	pc	95,000	475,000	T 6-1-1
- Pipe placement (∮400mm@3.5m)	5	pc	7,297	36,485	16-1
Sub-total				1,883,243	

Note; *1 assumed price = Concrete 200kg/cu. m (9000rials/cu. m) x 75%
*2 assumed price = (960rials/m(D14) + 1330(D20))/2 = 1,145 rials/m

d) Spillway (n=2)

- Wet masonry (t=15cm)	31	cu. m	3,861	119,691	17-2
- Dry masonry (t=30cm)	11	cu. m	2,110	23,210	18-1
- Concrete (150kg/cu. m)	0.4	cu. m	6,750*1	2,700	
- Concrete (300kg/cu. m)	3.6	cu. m	12,000	43,200	T 6-1-1
- Form	14.3	sq. m	1,500	21,450	T 6-1-1
- Reinforced bar (D10)	128.3	m	500	64,150	T 6-1-1
Sub-total				274,401	

Note; *1 assumed price = Concrete 200kg/cu. m (9000rials/cu. m) x 75%

e) Parshall flume (n=2)

- Concrete (150kg/cu.m)	0.4	cu.m	6,750*1	2,700	
- Concrete (300kg/cu.m)	1.7	cu.m	12,000	20,400	T 6-1-1
- Form	16.0	sq.m	1,500	24,000	T 6-1-1
- RC pipe ∮400mm@2.5m	2	pc	37,000*2	74,000	T 6-1-1
- Pipe placement	2	pc	3,682	7,364	16-4
Sub-total				128,464	

Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%
*2 applied the price of 500mm in dia., due to no data

f) Drainage release (n=6)

- Wet masonry (t=15cm)	70	sq.m	3,861	270,270	17-1
- Concrete (150kg/cu.m)	0.4	cu.m	6,750*1	2,700	
- Concrete (300kg/cu.m)	1.9	cu.m	12,000	22,800	T 6-1-1
- Form	12.7	sq.m	1,500	19,050	T 6-1-1
- Reinforced bar (∮4mm)	3.0	kg	1,000	3,000	T 6-1-1
- Reinforced bar (D10)	111.6	m	500	55,800	T 6-1-1
- Steel plate(t=9mm)	441	kg	700	308,700	T 6-1-1
- Iron gate (400x550mm)	285.8	kg	1,000	285,800	T 6-1-1
- Stop log (wooden)	0.032	cu.m	540,000	17,280	T 6-1-1
Sub-total				985,400	

Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%

g) Check gate (n=2)

- Concrete (150kg/cu.m)	0.1	cu.m	6,750*1	675	
- Concrete (300kg/cu.m)	0.6	cu.m	12,000	7,200	T 6-1-1
- Form	3.9	sq.m	1,500	5,850	T 6-1-1
- Reinforced bar (D10)	51.6	m	500	25,800	T 6-1-1
- Steel plate(t=9mm)	39	kg	700	27,300	T 6-1-1
- Iron gate (800x550mm)	97.65	kg	1,000	97,650	T 6-1-1
- Iron gate (1100x600mm)	97.65	kg	1,000	97,650	T 6-1-1
Sub-total				262,125	

Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%

i) Drainage release (n=1, ID-8)

- Wet masonry (t=15cm)	10	sq.m	3,861	38,610	17-2
- Concrete (150kg/cu.m)	0.1	cu.m	6,750*1	675	
- Concrete (300kg/cu.m)	0.3	cu.m	12,000	3,600	T 6-1-1
- Form	2.2	sq.m	1,500	3,300	T 6-1-1
- Reinforced bar (∮4mm)	0.5	kg	1,000	500	T 6-1-1
- Reinforced bar (D10)	3.8	m	500	1,900	T 6-1-1
- Stop log (t=5cm)	0.016	cu.m	540,000	8,640	T 6-1-1
Sub-total				57,225	

Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%

Total	6,901,914
G.Total	28,691,743

C. Drainage canals

C.1. Drainage canal construction

- Excavation	3,447	m	429	1,478,763	11
- Compacted fill	730	cu.m	121	88,330	8
- Slope tamping	14,015	sq.m	133	1,863,995	13
Total				3,431,088	

C.2. Appurtenant structures

a) Drainage road crossing (n=6)					
- Concrete (200 kg/cu.m)	15.5	cu.m	9,000	139,500	T 6-1-1
- Concrete (150 kg/cu.m)	0.5	cu.m	6,750*1	3,375	9000 x 75%
- Form	81.6	sq.m	1,500	122,400	T 6-1-1
- Wet masonry	56.8	sq.m	6,094	346,139	17-1
- Dry masonry	212.7	sq.m	2,110	448,797	18-1
- RC pipe ∮600mm @3.5m	6	pcs	102,000	612,000	T 6-1-1
- RC pipe ∮600mm @2.5m	6	pcs	49,000	294,000	T 6-1-1
- Pipe placement ∮600mm @3.5m	6	pcs	8,097	48,582	16-3
- Pipe placement ∮600mm @2.5m	6	pcs	4,429	26,574	16-6
Sub-total				2,041,367	

Note; *1 assumed price = Concrete 200kg/cu.m (9000rials/cu.m) x 75%

b) Drainage check structure					
- Concrete (200 kg/cu.m)	56.1	cu.m	9,000	504,900	T 6-1-1
- Form	298.1	sq.m	1,500	447,150	T 6-1-1
- Dry masonry	842.3	sq.m	2,110	1,777,253	18-1
- Wooden stop log	0.83	cu.m	540,000	448,200	T 6-1-1
Sub-total				3,177,503	
Total				5,218,870	
G.Total				8,649,958	

D. Farm Roads

D.1. Farm road construction					
- Stripping	4,604	cu.m	43	197,972	6
- Compacted fill	16,772	cu.m	121	2,029,421	7
- Slope tamping	7,513	sq.m	133	999,229	13
- Gravel	2,266.3	cu.m	3,000	6,798,900	T 6-1-1
- Gravel paving (machine)	14,712	sq.m	24	353,088	10-1
- Gravel paving (manual)	594	sq.m	42	24,948	10-2
Total				10,403,558	

D.2. Appurtenant Structures

a) Corner cutting (n=23)					
- Compacted fill	29	cu.m	121	3,509	7
- Slope tamping	51	sq.m	133	6,783	13
Sub-total				10,292	

b) Access road to field (n=24)					
- Compacted fill	155	cu.m	121	18,755	8
- RC pipe ∮400 mm @=3.5m	31	pc	95,000	2,945,000	T 6-1-1
- RC pipe ∮500 mm @=3.5m	36	pc	98,000	3,528,000	T 6-1-1
- RC pipe ∮600 mm @=3.5m	36	pc	102,000	3,672,000	T 6-1-1
- Pipe placement ∮400 mm @=3.5m	31	pc	7,297	226,207	16-1
- Pipe placement ∮500 mm @=3.5m	36	pc	7,297	262,692	16-2
- Pipe placement ∮600 mm @=3.5m	36	pc	8,097	291,492	16-3
- Concrete (200kg/cu.m)	37.4	cu.m	9,000	336,600	T 6-1-1
- Form	122.8	sq.m	1,500	184,200	T 6-1-1
Sub-total				11,464,946	

c) Wet masonry of Piteh Rud (L=165m)					
- Wet masonry (t=30cm)	645.6	sq.m	6,094	3,934,286	17-1
- Concrete(200kg/cu.m)	29.5	cu.m	9,000	265,500	T 6-1-1
- Form	112.6	sq.m	1,500	168,900	T 6-1-1
Sub-total				4,368,686	
Total				15,843,924	
G.Total				26,247,482	

E. Experimental Farm

E.1 Farm Road (L=1,482m)

- Compacted fill	1,278	cu.m	121	154,638	7
- Slope tamping	1,239	sq.m	133	164,787	13
Total				319,425	

E.2 Farm Ditches (L=2,105m)

(1) Canal					
- Compacted fill	425	cu.m	121	51,425	7
- Slope tamping	1,799	sq.m	133	239,267	13
Sub-total				290,692	
(2) FD Road Crossing (n=26 places)					
- Concrete 150kg/cu.m	0.4	cu.m	6,750*1	2,700	
- Concrete 200kg/cu.m	17.2	cu.m	9,000	154,800	T 6-1-1
- Concrete 300 kg/cu.m	0.8	cu.m	12,000	9,600	T 6-1-1
- Form	80.3	sq.m	1,500	120,450	T 6-1-1
- RC pipe φ400mm@2.5m	25	pc	37,000	925,000	T 6-1-1
- Pipe placement φ400mm@2.5m	25	pc	3,682	92,050	16-4
- Reinforced bar (D10)	57	m	500	28,500	T 6-1-1
Sub-total				1,333,100	
Note; *1 - Assumed cost =concrete 200kg/cu.m (9,000) x 75%					
Total				1,623,792	

E.3 Farm Drain (L=1,197m)

(1) Canal					
- Compacted fill	472	cu.m	121	57,112	7
- Slope tamping	2,431	sq.m	133	323,323	13
Sub-total				380,435	
(2) FD Road Crossing (n=17)					
- Concrete 200kg/cu.m	16.8	cu.m	9,000	151,200	T 6-1-1
- Form	61.2	sq.m	1,500	91,800	T 6-1-1
- RC pipe φ400mm@2.5m	8	pc	37,000	296,000	T 6-1-1
- RC pipe φ400mm@3.5m	13	pc	95,000	1,235,000	T 6-1-1
- Pipe placement φ400mm@2.5m	8	pc	3,682	29,456	16-4
- Pipe placement φ400mm@3.5m	13	pc	7,297	94,861	16-1
- Dry masonry (t=30cm)	5.7	sq.m	2,110	12,027	18
Sub-total				1,910,344	
Total				2,290,779	
G.Total				4,233,996	

F. Preparatory and Temporary Works

F.1 Preparatory work

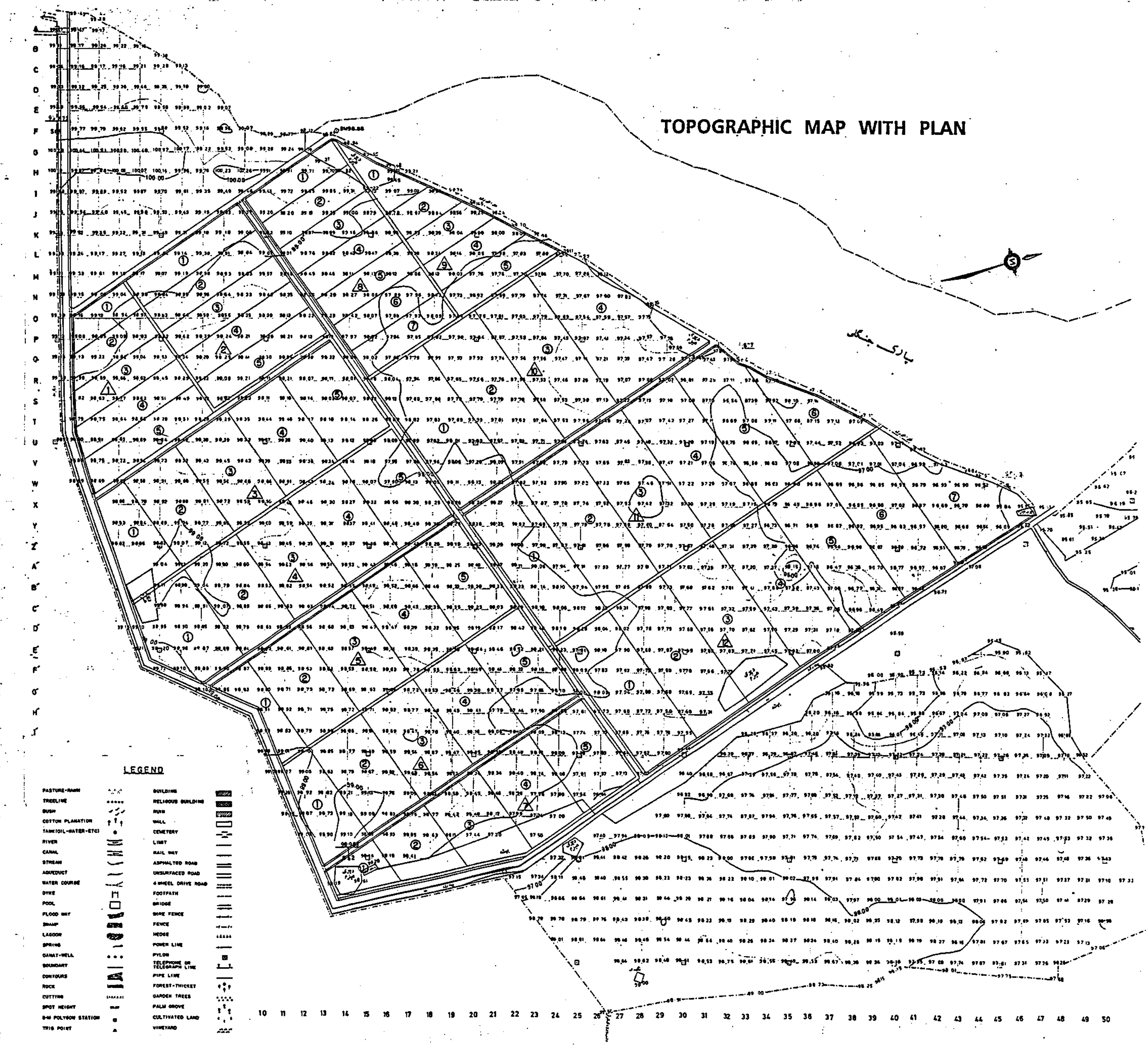
- Land clearing					
427800/900	475	men	4,500	2,137,500	
Total				2,137,500	

F.2 Temporary work

- Submergible pump				
81places x 5days/place / 21 days/month	20	month	380,000	7,600,000
- Temporary pipe for Piteh Rud Wet Masonry Work				
dia. 600mm RC pipe@3.5	3	pc	102,000	306,000
Pipe placement dia.600mm@3.5	3	pc	8,097	24,291
Total				7,930,291
G.Total				10,067,791

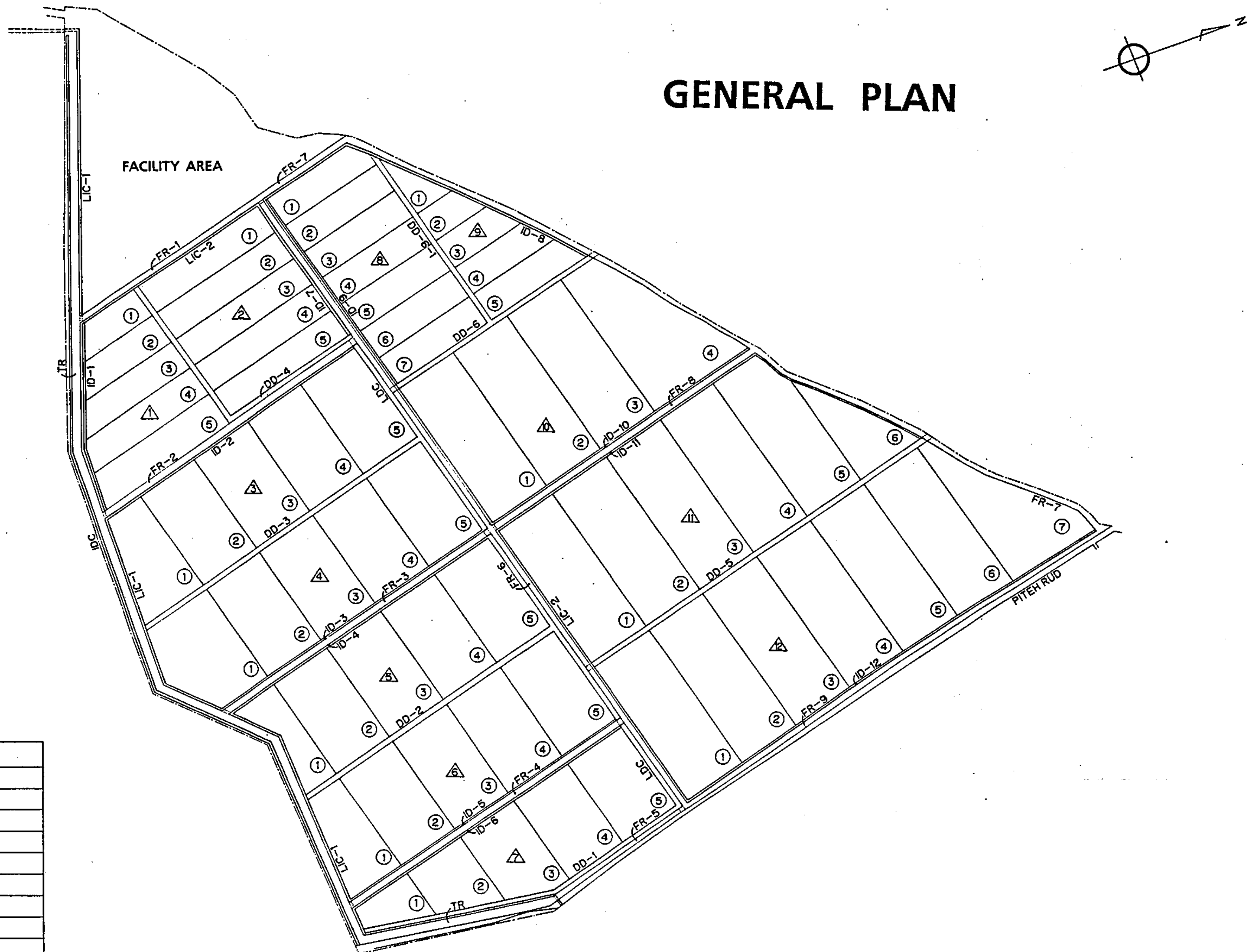
DRAWINGS

LIST OF DRAWINGS

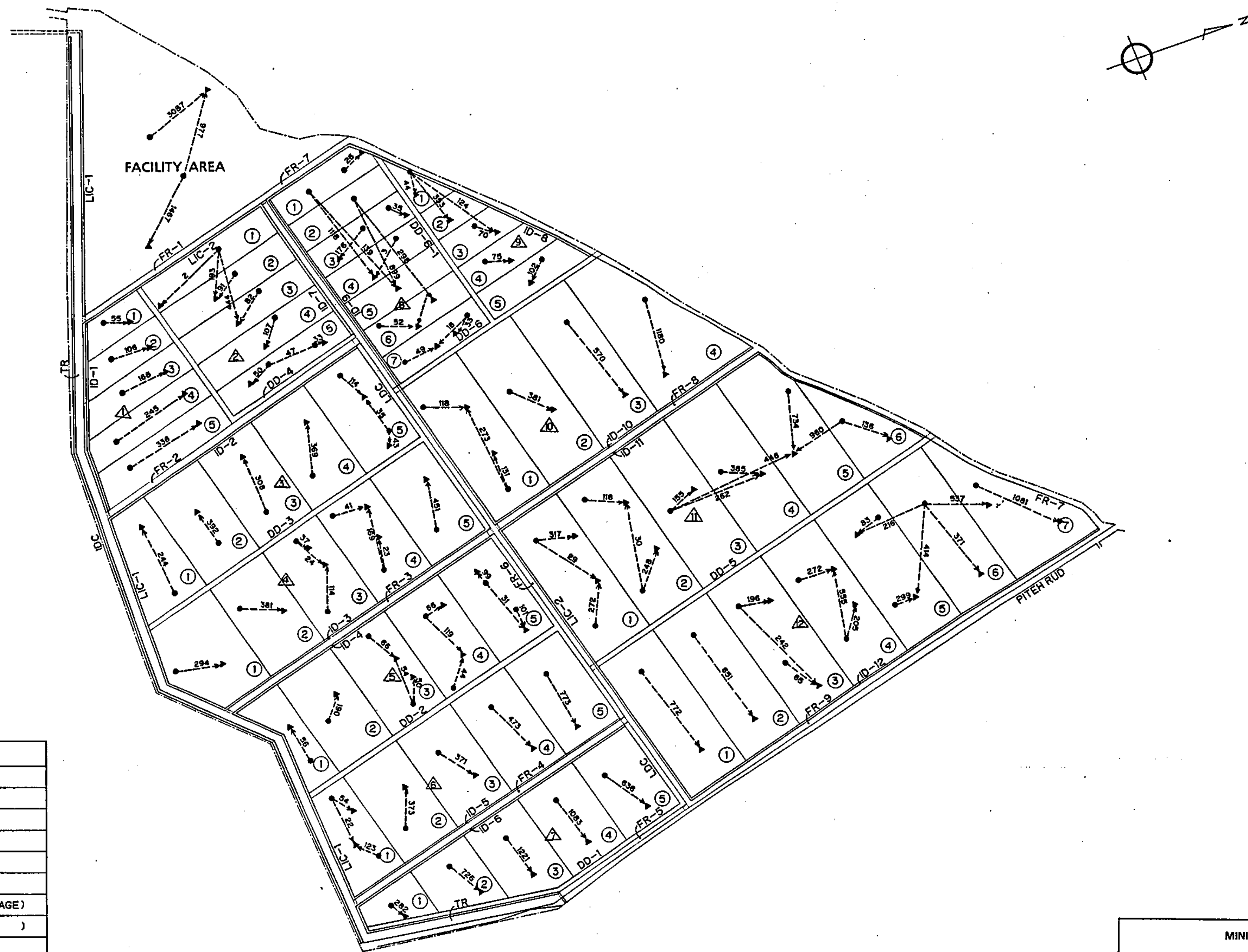


TOPOGRAPHIC MAP WITH PLAN
پارک جنگلی
LEGEND
PASTURE-RANGE
TREELINE
BUSH
COTTON PLANATION
TANK(OIL-WATER-ETC)
RIVER
CANAL
STREAM
AQUEDUCT
WATER COURSE
DYKE
POOL
FLOOD WAY
SWAMP
LAGOON
SPRING
QANAT-WELL
BOUNDARY
CONTOURS
ROCK
CUTTING
SPOT HEIGHT
B-M POLYGON STATION
TRIG POINT
BUILDING
RELIGOUS BUILDING
RUIN
WALL
CEMETERY
LIMIT
RAIL WAY
ASPHALTED ROAD
UNSURFACED ROAD
4 WHEEL DRIVE ROAD
FOOTPATH
BRIDGE
WIRE FENCE
FENCE
HEDGE
POWER LINE
PYLON
TELEPHONE OR TELEGRAPH LINE
PIPE LINE
FOREST-THICKET
GARDEN TREES
PALM GROVE
CULTIVATED LAND
VINEYARD

GENERAL PLAN



LEGEND	
△	FIELD BLOCK No.
○	FIELD LOT No.
	TRUNK ROAD
	FARM ROAD
	IRRIGATION DITCH
	DRAIN DITCH



LEGEND	
△	FIELD BLOCK No.
○	FIELD LOT No.
——	TRUNK ROAD
——	FARM ROAD
——	IRRIGATION DITCH
——	DRAIN DITCH
•	CUT POINT (WEIGHTED AVERAGE)
▲	FILL POINT (〃)
--294-->	EARTH MOVING and VOLUME

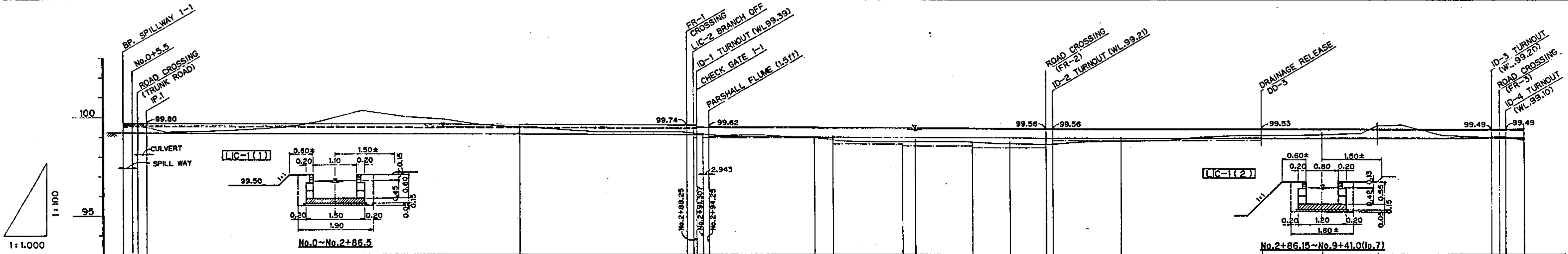
MINISTRY OF AGRICULTURE

HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT

VECTOR OF EARTH MOVING

SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 3	APPROVED		

JAPAN INTERNATIONAL COOPERATION AGENCY

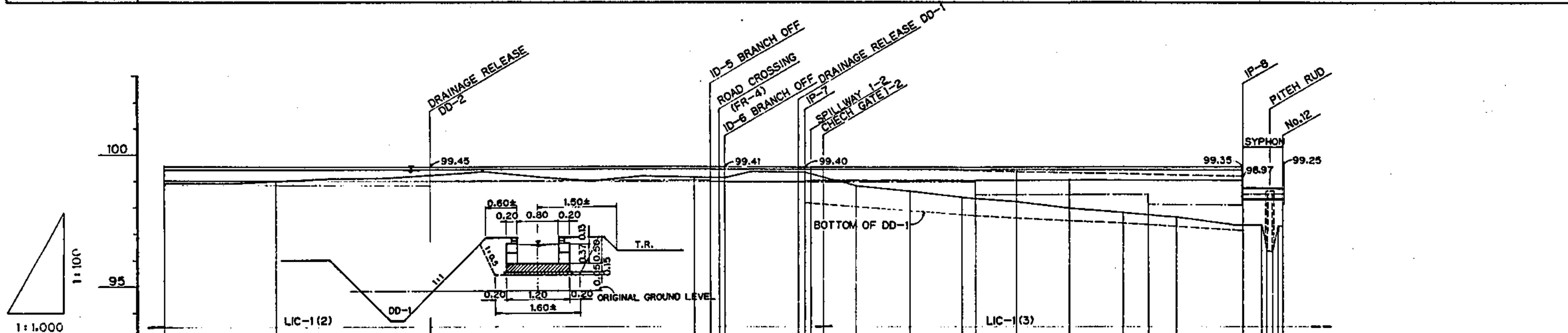


D. DISCHARGE (Lit/sec) / Bed Slope: Q=183 lit/sec, I=1:5,000 — Q=144 lit/sec, I=1:3,000 — Q=144 lit/sec — Q=139 lit/sec, I=1:3,000

	STATION	No.0 +5.5 +8.0 IP.1	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+20	+40
PROPOSED	WATER LEVEL (m)	99.65 99.65 99.65 99.65	99.65	99.64	99.64	99.64	99.63	99.63	99.62	99.62	99.62	99.61	99.61	99.60
PROPOSED	CANAL BOTTOM (m)	99.23 99.20 99.20 99.20	99.20	99.19	99.19	99.19	99.18	99.18	99.17	99.17	99.17	99.16	99.16	99.15
PROPOSED	ELEVATION Right (m)	99.50												
PROPOSED	ELEVATION Left (m)													
	ELEVATION (m)	99.47 99.47	99.24	99.26	99.33	99.50	99.82	100.37	100.08	99.93	99.65	99.55	99.38	99.27
	CUMULATIVE DISTANCE (m)	0.0 5.5 8.0 12.0	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0	220.0	240.0
	DISTANCE (m)	0.0 5.5 2.5 4.0	8.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	6.5	20.0
	CURVE													

	STATION	+60	+80 +83 +86.25 +91.307 +94.25	No.3	+20	+40	IP.2	+60	+80	IP.3 No.4	+20	+40 IP.4	+60 +63 +66.0	+80
PROPOSED	WATER LEVEL (m)	99.60	99.59 99.59 99.49	99.49	99.48	99.47	99.47	99.47	99.46	99.45	99.45	99.44 99.44	99.43 99.43 99.43	99.43
PROPOSED	CANAL BOTTOM (m)	99.15	99.14 99.14 99.07	99.07	99.06	99.05	99.05	99.05	99.04	99.03	99.03	99.02 99.02	99.01 99.01 99.01	99.01
PROPOSED	ELEVATION Right (m)		99.50 98.99		98.99 98.97			98.97 98.71		98.71 98.60	98.60 98.51		98.51 98.84	
PROPOSED	ELEVATION Left (m)													
	ELEVATION (m)	99.27	99.27 99.16 99.16	99.10	99.13	99.00	99.00	98.82	98.79	98.80 98.80	98.81	98.69 98.69	98.69 98.69 98.69	98.75
	CUMULATIVE DISTANCE (m)	260.0	280.0 283.0 286.25 291.307 294.25	300.0	320.0	340.0	347.0	360.0	380.0	397.5 400.0	420.0	440.0 445.0	460.0 463.0 466.0	480.0
	DISTANCE (m)	20.0	20.0 3.0 3.25 5.057 2.943	5.75	20.0	20.0	7.0	13.0	20.0	17.5 2.5	20.0	20.0 5.0	15.0 3.0 3.0	14.0
	CURVE													

	STATION	No.5	+20	+40	+60	+70	+80	No.6	+20	IP.5	+40	+60	+80 +85.5 +88.5 +91.5	No.7
PROPOSED	WATER LEVEL (m)	99.42	99.41	99.41	99.40	99.40	99.39	99.39	99.38	99.38	99.37	99.37	99.36 99.36 99.36	99.35
PROPOSED	CANAL BOTTOM (m)	99.00	98.99	98.99	98.98	98.98	98.97	98.97	98.46	98.96	98.95	98.95	98.94 98.94 98.94	98.93
PROPOSED	ELEVATION Right (m)					98.84 98.93							98.93 98.77	98.77
PROPOSED	ELEVATION Left (m)													
	ELEVATION (m)	98.83	98.82	99.00	99.10		99.05	99.10	99.20	99.60	99.60	99.10	99.00 99.00 99.00 99.00	98.85
	CUMULATIVE DISTANCE (m)	500.0	520.0	540.0	560.0	570.0	580.0	600.0	620.0	628.0	640.0	660.0	680.0 685.5 688.5 691.5	700.0
	DISTANCE (m)	20.0	20.0	20.0	20.0		20.0	20.0	20.0	8.0	12.0	20.0	20.0 5.5 3.0 3.0	8.5
	CURVE													



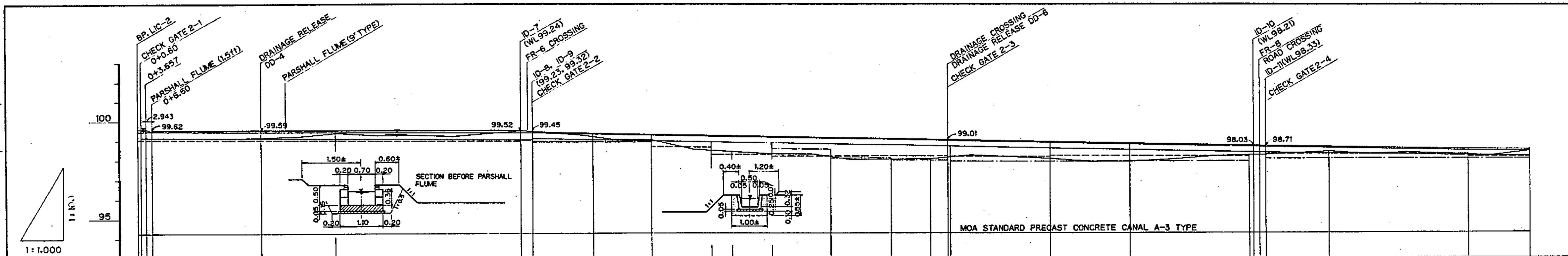
D. DISCHARGE (Lit/sec) / Bed Slope: Q=133 lit/sec — Q=128 lit/sec, I=1:3,000 — Q=1230 lit/sec — Q=119 lit/sec

	STATION	No.7	+20	+40 IP.6	+60	+80	No.8	+20	+40	+60	+80	No.9 +6 +9 +12
PROPOSED	WATER LEVEL (m)	99.35	99.35	99.34	99.33	99.32	99.32	99.31	99.31	99.30	99.29	99.29 99.28
PROPOSED	CANAL BOTTOM (m)	98.93	98.93	98.92	98.91	98.90	98.90	98.89	98.89	98.88	98.87	98.87 98.86
PROPOSED	ELEVATION Right (m)	98.77					98.77 98.92					98.92 98.82
PROPOSED	ELEVATION Left (m)											
	ELEVATION (m)	98.85	98.83	98.91 98.91	98.99	99.01	99.14	99.26	99.05	98.87	99.09	99.00 99.00 99.00 99.00
	CUMULATIVE DISTANCE (m)	700.0	720.0	740.0 741.5	760.0	780.0	800.0	820.0	840.0	860.0	880.0	900.0 906.0 909.0 912.0
	DISTANCE (m)	8.5	20.0	20.0 1.5	18.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0 6.0 3.0 3.0
	CURVE											

	STATION	+20	+38.8 +40 IP.7 +43 +48	+60	+80	No.10	+20	+40	+60	+80	No.11 IP.8 +11 +14 +16 IP.9 +20
PROPOSED	WATER LEVEL (m)	99.28	99.27 99.27	99.26	99.26	99.25	99.24	99.24	99.23	99.22	99.22 99.22 99.12
PROPOSED	CANAL BOTTOM (m)	98.86	98.85 98.85 98.90	98.89	98.89	98.88	98.87	98.87	98.86	98.85	98.85 98.85 98.75
PROPOSED	ELEVATION Right (m)					98.82 98.31			98.31 97.95		97.95
PROPOSED	ELEVATION Left (m)										98.97 98.97
	ELEVATION (m)	99.19	99.19 99.19 99.00	98.61	98.40	98.20	98.00	97.80	97.60	97.40	97.20 97.20 97.20 96.16 96.16 97.15 97.15
	CUMULATIVE DISTANCE (m)	920.0	940.0 941.0 943.0 948.0	960.0	980.0	1000.0	1020.0	1040.0	1060.0	1080.0	1100.0 1105.0 1112.0 1114.0 1116.0 1118.0 1120.0
	DISTANCE (m)	8.0	38.8 1.2 1.0 2.0 5.0	12.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0 5.0 7.0 2.0 2.0 2.0 2.0
	CURVE										

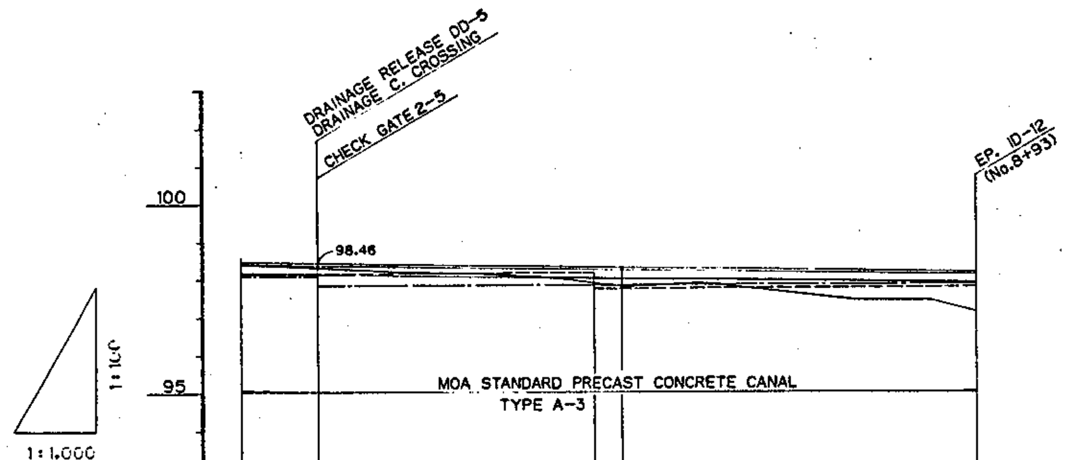
NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE LIC-1			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 4	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



D. DISCHARGE (Lit/sec) / Bed Slope: Q=119 lit/sec; Q=116 lit/sec, I=1:2,000; Q=107 lit/sec, I=1:500; Q=100 lit/sec; Q=91 lit/sec, I=1:600

STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	PROPOSED ELEVATION Left (m)	PROPOSED ELEVATION Right (m)	PROPOSED CANAL BOTTOM (m)	PROPOSED WATER LEVEL (m)	CURVE
No.0 +3.657 +6.60	0.0 3.657 2.943	0.0 3.657 6.600	99.16	99.50	98.99	99.14 99.14 99.12	99.59 99.59 99.48	
+20	13.40	20.0	99.10			99.11	99.47	
+40	20.0	40.0	99.05			99.10	99.46	
+60 +62	20.0	60.0 62.0	99.10		98.99 98.94	99.09 99.09	99.45 99.45	
+80	20.0	80.0	99.17			99.08	99.44	
No.1	20.0	100.0	99.34			99.07	99.43	
+20	20.0	120.0	99.24			99.06	99.42	
+40	20.0	140.0	99.25			99.05	99.41	
+60	20.0	160.0	99.18			99.04	99.40	
+80	20.0	180.0	99.33			99.03	99.39	
+94.05	14.05	194.05	99.43	99.50	98.94	99.02	99.38	
No.2	20.0	200.0	99.42	98.96	98.94	99.02 99.13	99.38	
+20	20.0	220.0	99.29			99.09	99.34	
				98.96 98.94				
+40	20.0	240.0	99.02			99.05	99.30	
+60	20.0	260.0	99.01	98.94 98.93	98.94 98.65	99.01	99.26	
+80	20.0	280.0	98.48			98.97	99.22	
				98.93 98.86	98.65 98.27			
No.3	20.0	300.0	98.38			98.93	99.18	
+20	20.0	320.0	98.28	98.86 98.56	98.27 98.20	98.89	99.14	
+40	20.0	340.0	98.29			98.85	99.10	
+50	10.0	350.0		98.56 98.11	98.20 98.14			
+60	10.0	360.0	98.00			98.81	99.06	
+80	20.0	380.0	98.04	98.11		98.77	99.02	
No.4	20.0	400.0	98.06			98.73	98.98	
+9	9.0	409.0	98.18	97.98 97.94		98.71	98.96	
+20	11.0	420.0	98.25			98.69	98.94	
+40	20.0	440.0	98.12			98.65	98.90	
+60	20.0	460.0	98.06		98.14 98.19	98.61	98.86	
+80	20.0	480.0	97.89			98.57	98.82	
No.5	20.0	500.0	97.92			98.53	98.78	
+20	20.0	520.0	98.00			98.49	98.74	
+40	20.0	540.0	98.19			98.45	98.70	
+60 +62.5 +65.5 +68.5	20.0 2.5 3.0 3.0	560.0 562.5 565.5 568.5	98.26 98.26 98.26 98.26	97.94 98.07	98.19 98.28	98.41 98.41 98.40 98.39	98.66 98.65 98.65 98.64	
+80	11.5	580.0	98.36			98.37	98.62	
No.6	20.0	600.0	98.40			98.34	98.59	
+20	20.0	620.0	98.28			98.30	98.55	
+40	20.0	640.0	98.35			98.27	98.52	
+60	20.0	660.0	98.23			98.24	98.49	
					98.28 98.14			
+80	20.0	680.0	98.18			98.20	98.45	
No.7	20.0	700.0	98.40	98.09	98.14	98.17	98.42	

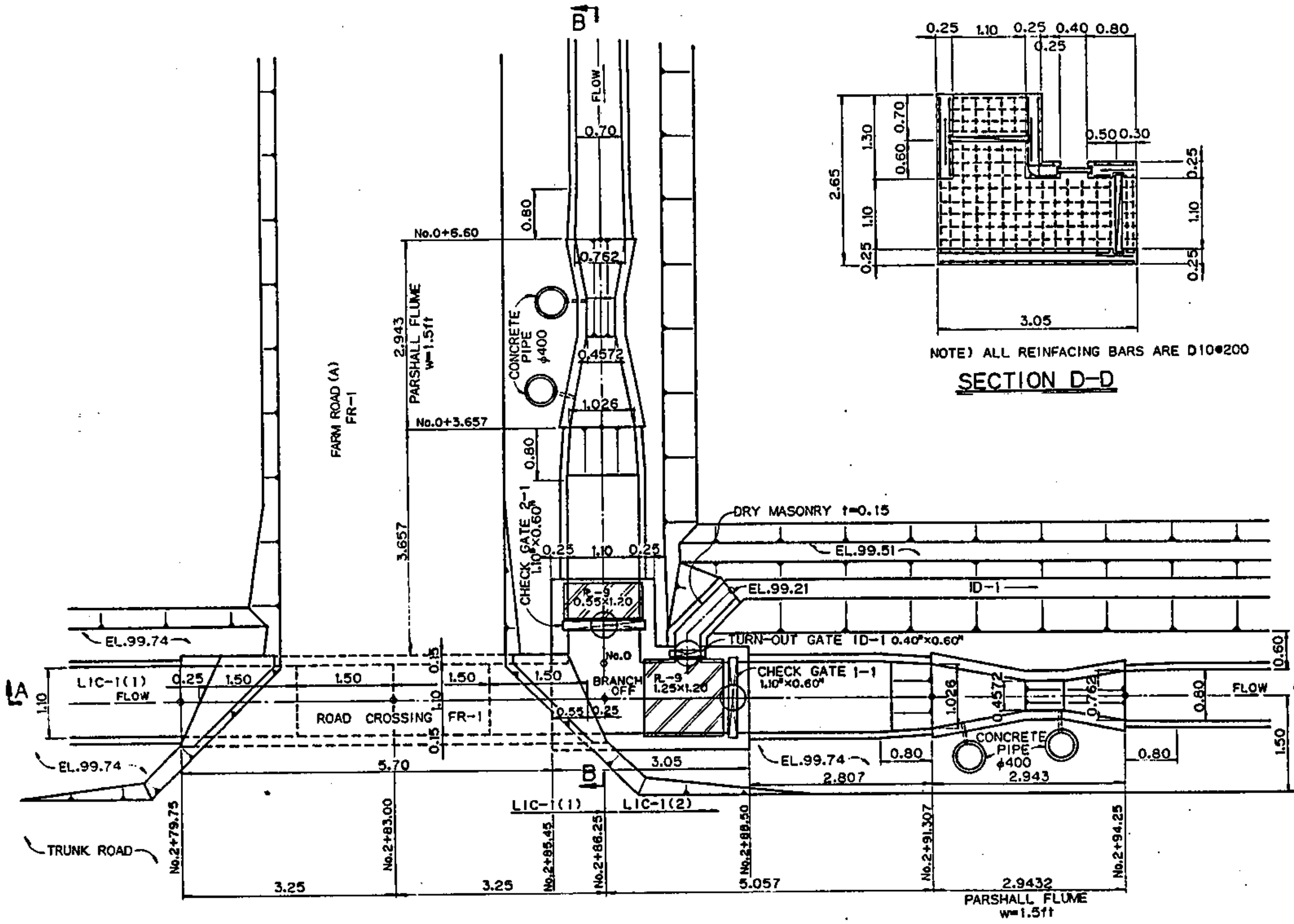


D. DISCHARGE (Lit/sec) / Bed Slope: Q=100 lit/sec; Q=91 lit/sec, I=1:600

STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	PROPOSED ELEVATION Left (m)	PROPOSED ELEVATION Right (m)	PROPOSED CANAL BOTTOM (m)	PROPOSED WATER LEVEL (m)	CURVE
No.7	20.0	700.0	98.40		98.14	98.17	98.42	
+20	20.0	720.0	98.23	98.07 97.83		98.14	98.39	
+40	20.0	740.0	98.16			98.10	98.35	
+60	20.0	760.0	98.09			98.07	98.32	
+80	20.0	780.0	98.00			98.04	98.29	
					98.14 97.74			
No.8	20.0	800.0	97.73			98.00	98.25	
+20	20.0	820.0	97.85			97.97	98.22	
+40	20.0	840.0	97.61			97.94	98.19	
+60	20.0	860.0	97.40			97.90	98.15	
+80	20.0	880.0	97.40			97.87	98.12	
EP (No.8+93)	13.0	893.0	97.07	97.83	97.74	97.85	98.10	

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

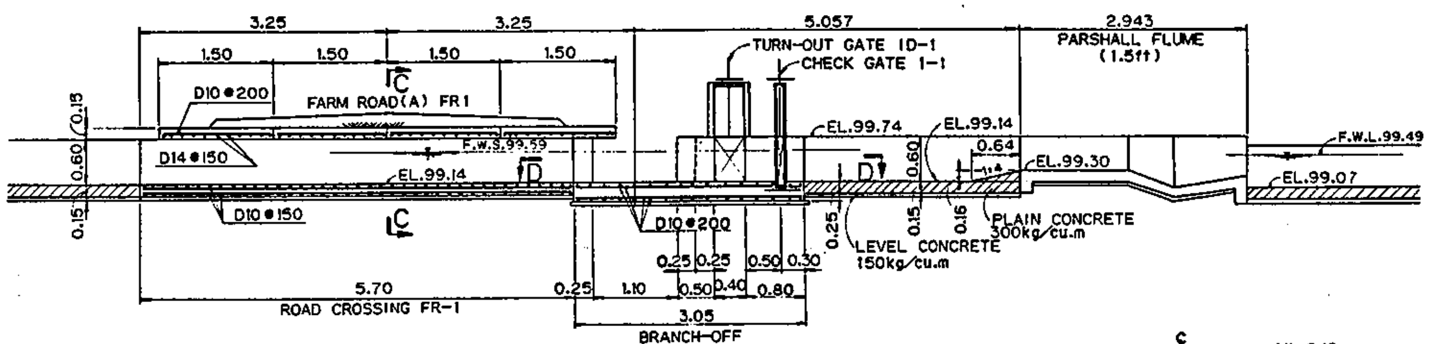
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE LIC-2			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No.	5	APPROVED	
JAPAN INTERNATIONAL COOPERATION AGENCY			



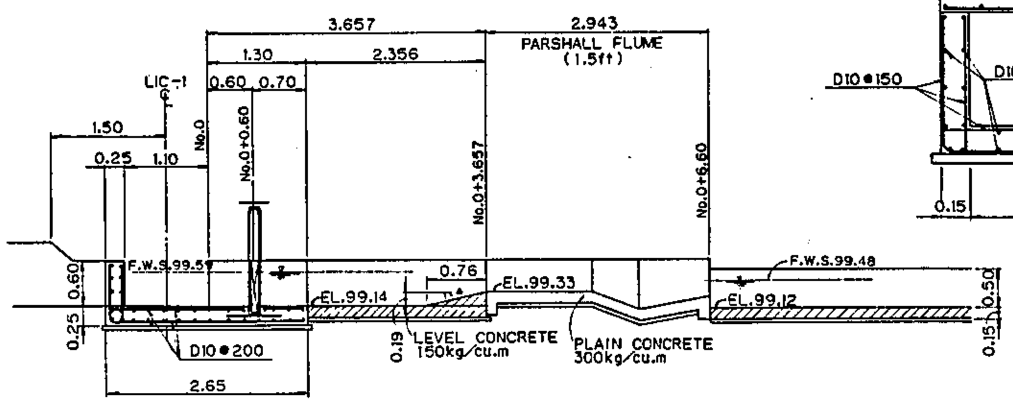
PLAN
SCALE 1:50

NOTE) ALL REINFACING BARS ARE D10@200

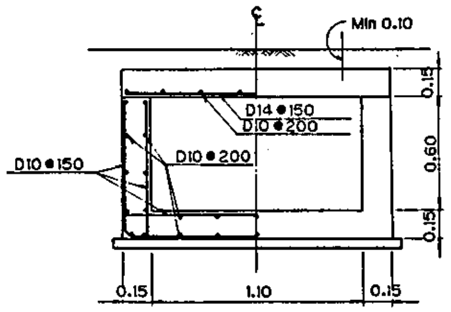
SECTION D-D



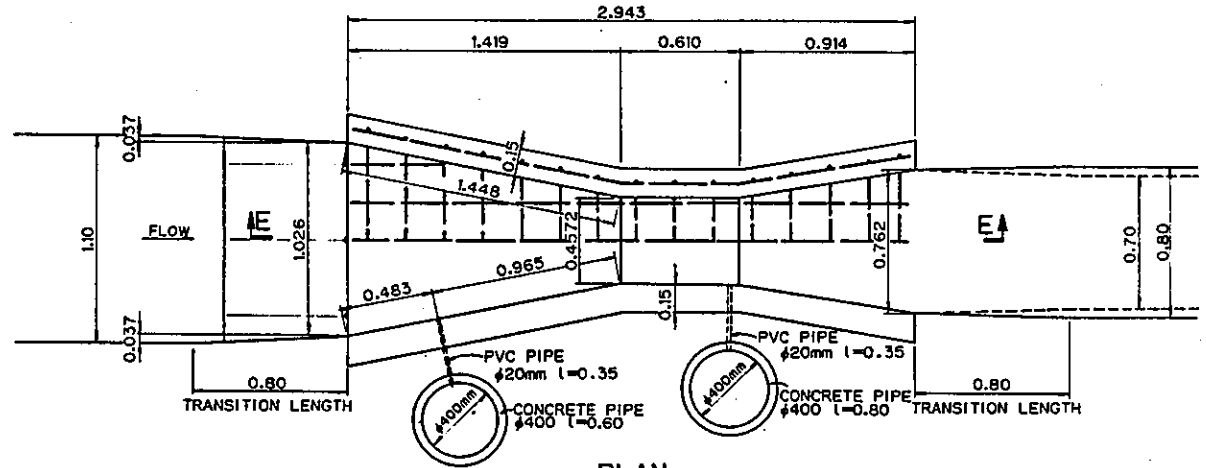
SECTION A-A
SCALE 1:50



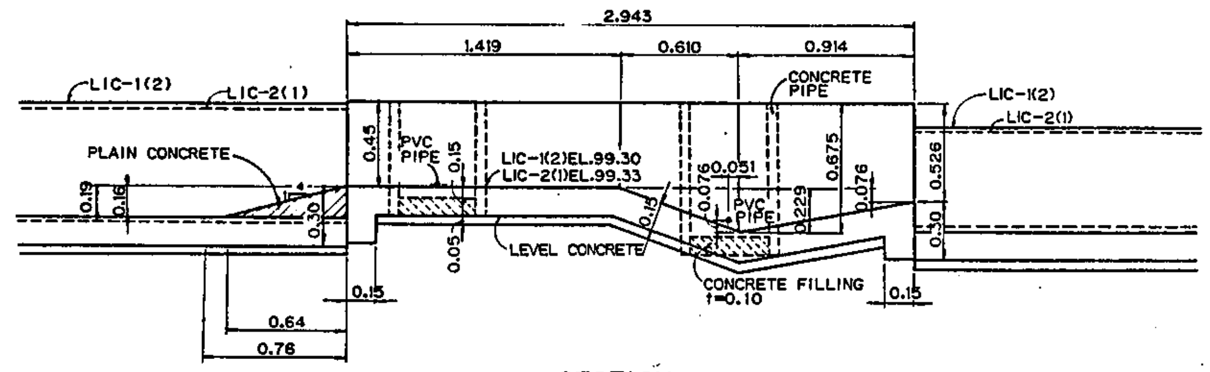
SECTION B-B
SCALE 1:50



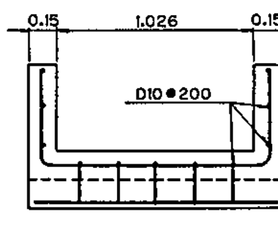
SECTION C-C



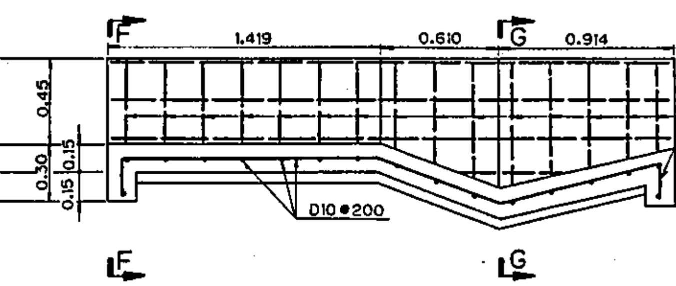
PLAN
SCALE 1:20



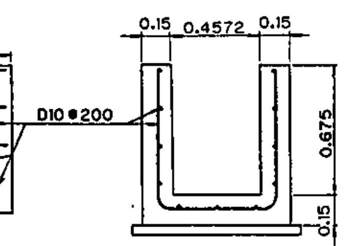
SECTION
SCALE 1:20



SECTION F-F
SCALE 1:20



SECTION E-E
SCALE 1:20

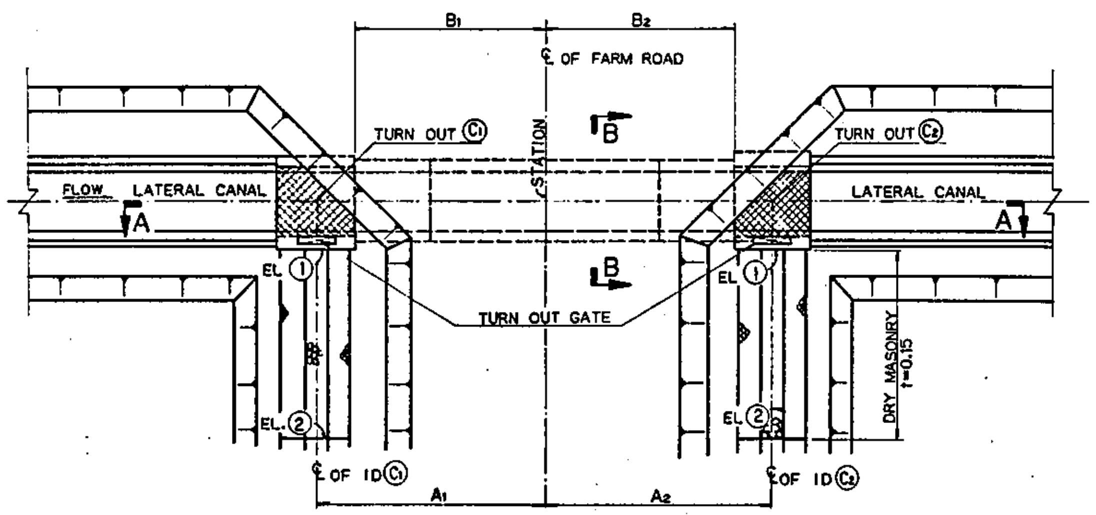


SECTION G-G
SCALE 1:20

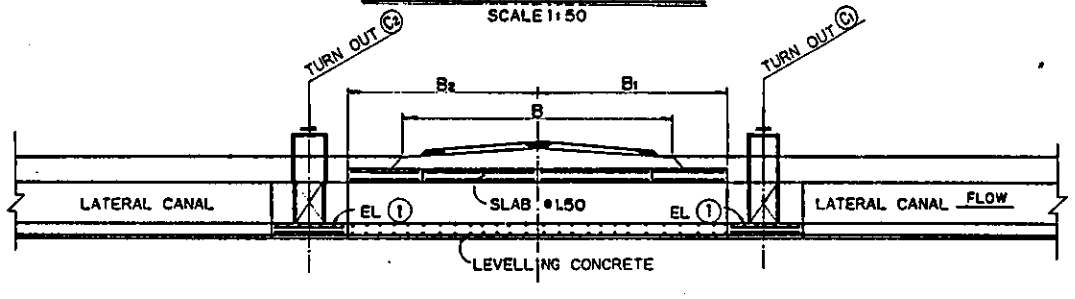
PARSHALL FLUME

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

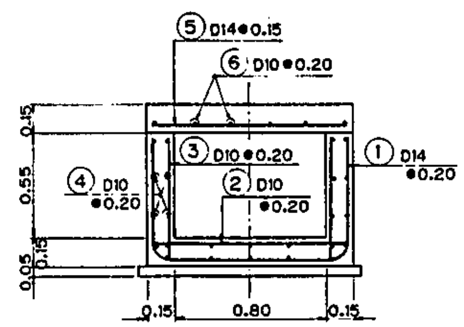
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
ROAD CROSSING(FR-1), BRANCH OFF, CHECK GATE (1-1, 2-1) PARSHALL FLUME AND TURN-OUT (ID-1)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 6	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



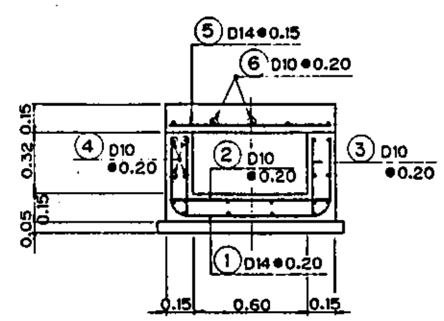
PLAN OF ROAD CROSSING
SCALE 1:50



SECTION A–A
SCALE 1:50



SECTION B–B(TYPE A)
SCALE 1:20

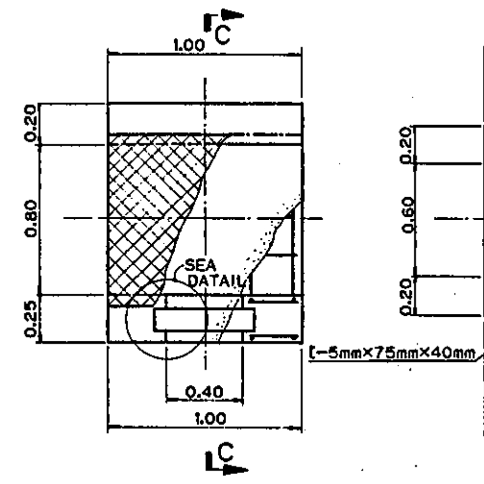


SECTION B–B(TYPE B)
SCALE 1:20

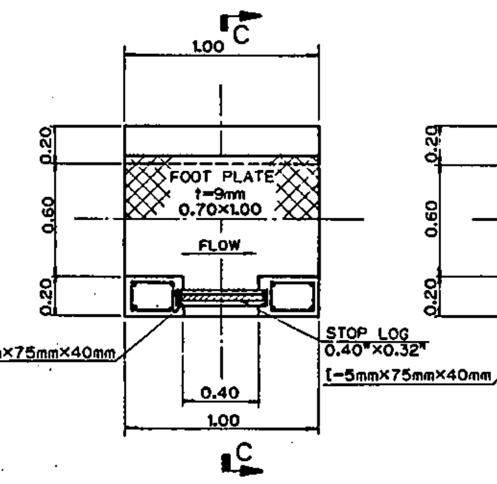
DIMENSION TABLE

ROAD NAME	FR 2	FR 3	FR 4	FR 8
STATION	No.4+63.0	No.6+88.5	No.9+9.0	No.5+65.5
ROAD CROSSING	TYPE A	TYPE A	TYPE A	TYPE B
LATERAL CANAL	LIC-1(2)	LIC-1(2)	LIC-1(2)	LIC-2(3)
TURN OUT C_1	—	ID-3 TYPE A	ID-5 TYPE A	ID-10 TYPE B
C_2	ID-2 TYPE A	ID-4 TYPE A	ID-6 TYPE A	ID-11 TYPE C
ELEVATION EL1	99.01	98.94	98.86	(R) 98.41 (L) 98.39
EL2	—	98.93	98.96	97.89
EL3	99.86	98.83	98.87	98.01
DIMENSION A_1	—	3.00	3.00	3.00
A_2	3.00	3.00	3.00	3.00
B_1	3.50	2.50	2.50	2.50
B_2	2.50	2.50	2.50	2.50
B	3.50	3.50	2.50	3.50
CHECK GATE	—	—	—	2–4

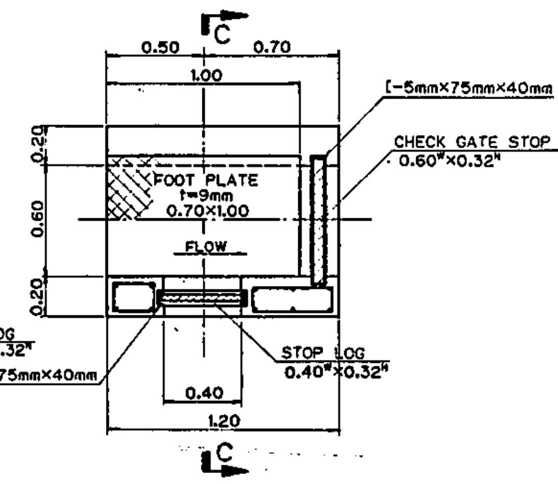
ROAD CROSSING



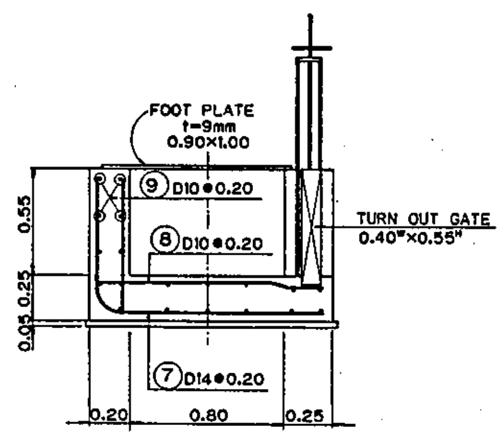
TYPE A PLAN
SCALE 1:20



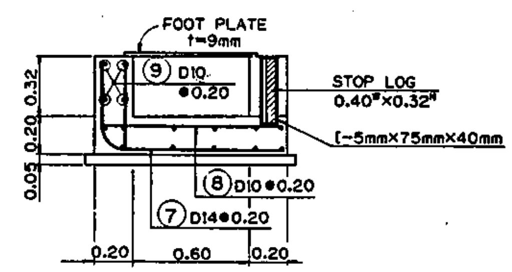
TYPE B PLAN
SCALE 1:20



TYPE C PLAN
SCALE 1:20



SECTION C–C(TYPE A)
SCALE 1:20

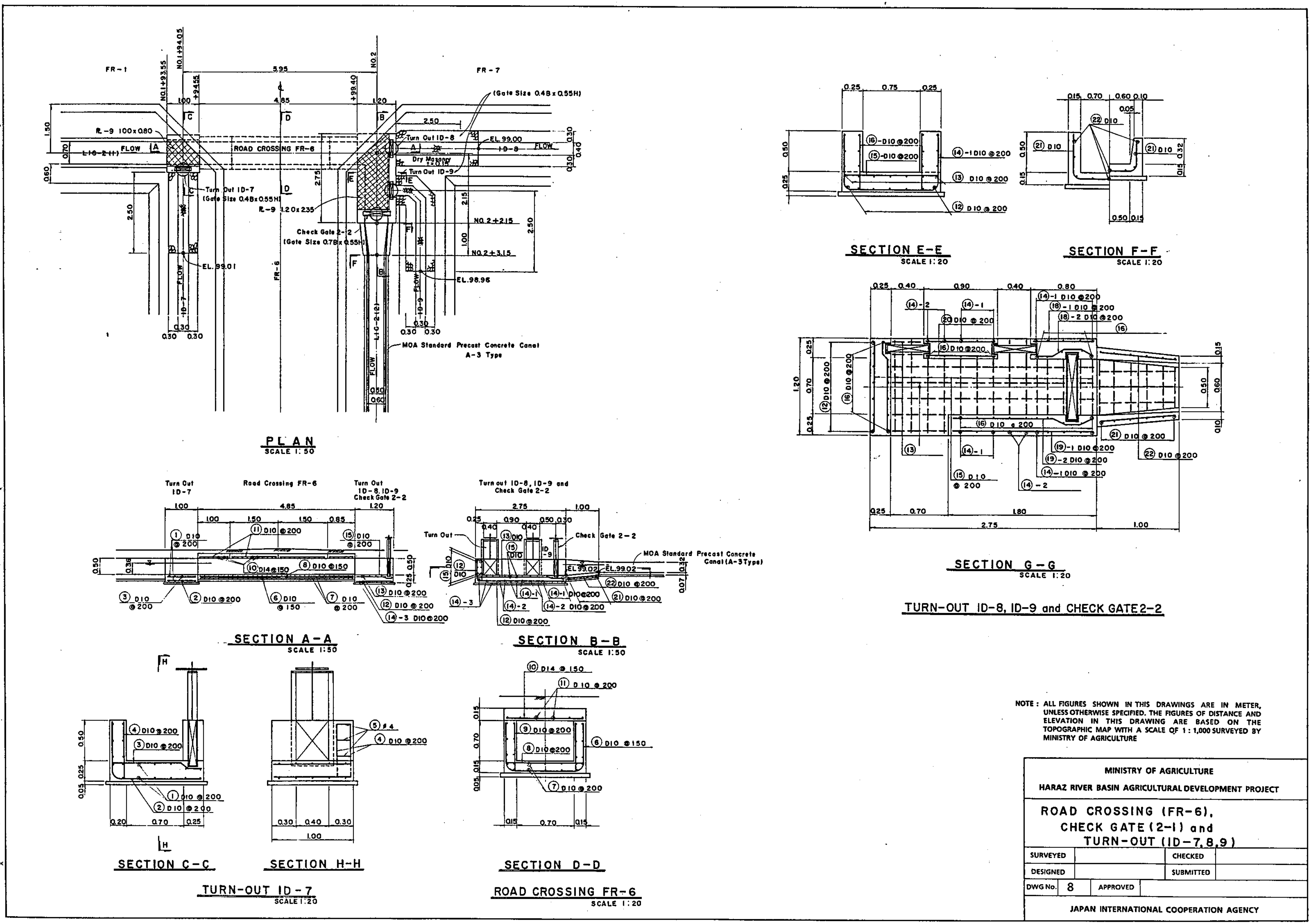


SECTION C–C(TYPE B&C)
SCALE 1:20

TURN OUT

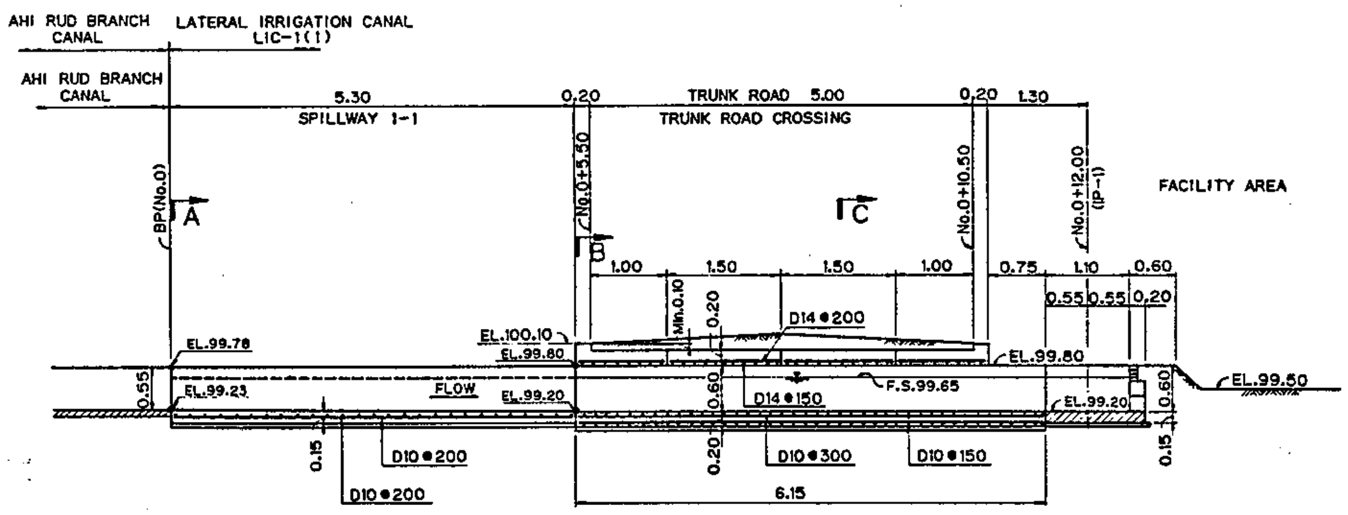
NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
ROAD CROSSING (FR-2, 3, 4, 8), CHECK GATE (2-4) AND TURN-OUT (ID-2, 3, 4, 5, 6, 10 AND 11)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 7	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

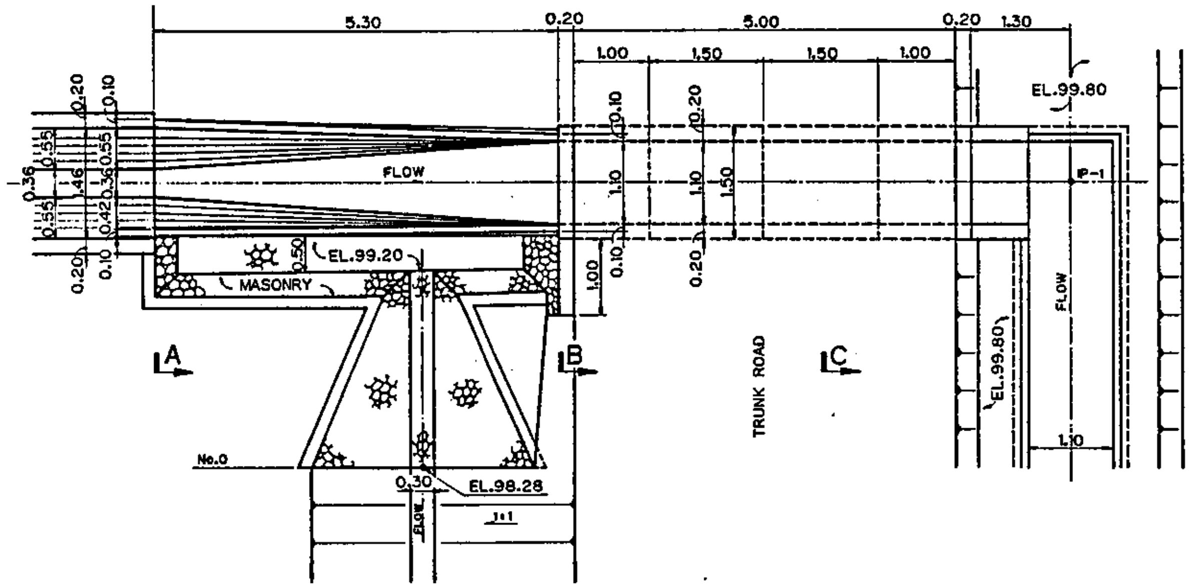


NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

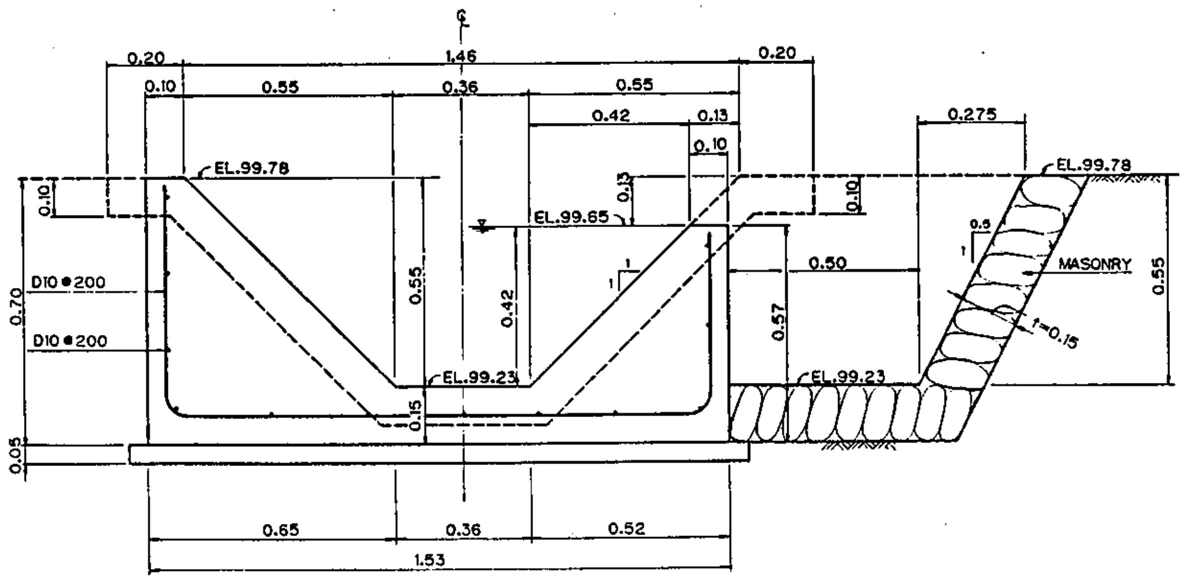
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
ROAD CROSSING (FR-6), CHECK GATE (2-1) and TURN-OUT (ID-7,8,9)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 8		APPROVED	
JAPAN INTERNATIONAL COOPERATION AGENCY			



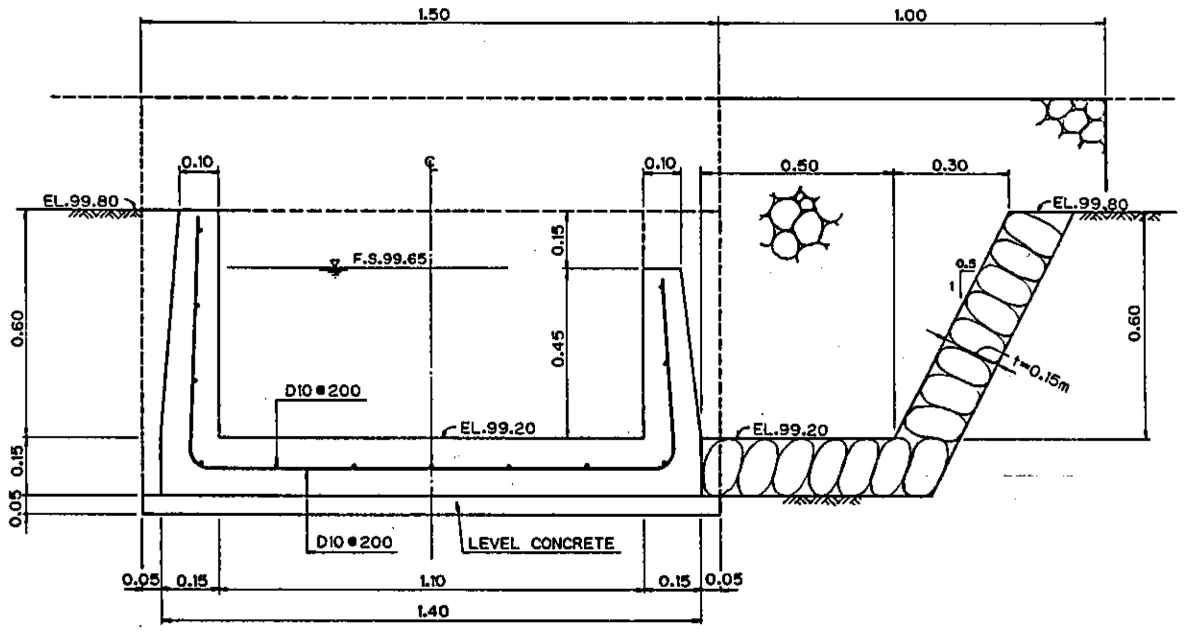
PLOFILE
SCALE 1 : 50



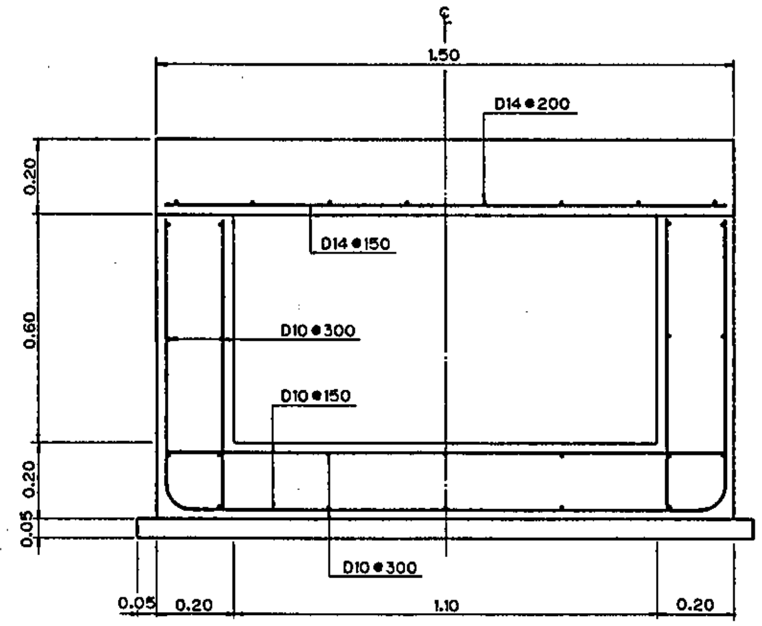
PLAN
SCALE 1 : 50



SECTION A-A
SCALE 1 : 10



SECTION B-B
SCALE 1 : 10



SECTION C-C
SCALE 1 : 10

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

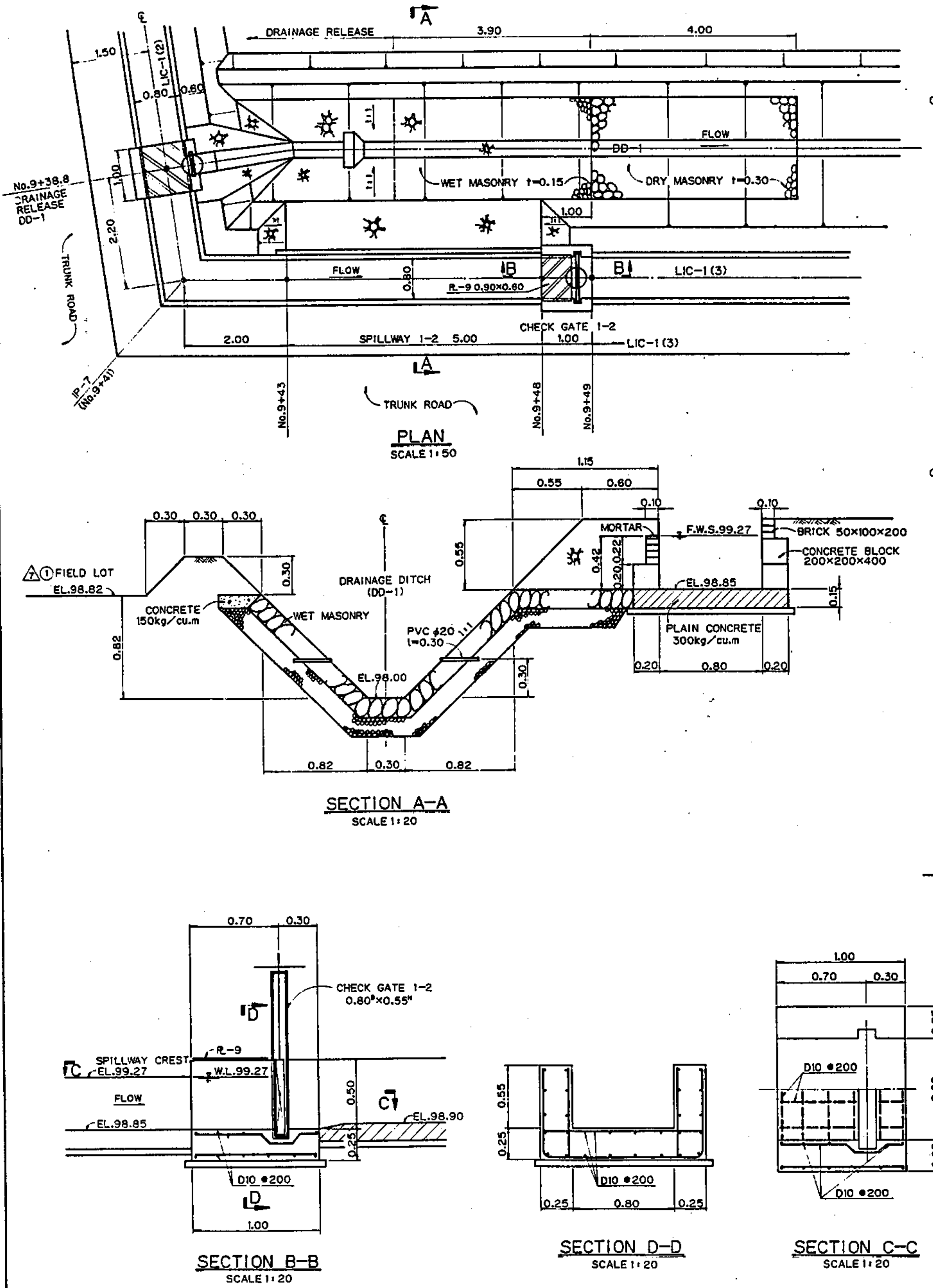
MINISTRY OF AGRICULTURE

HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT

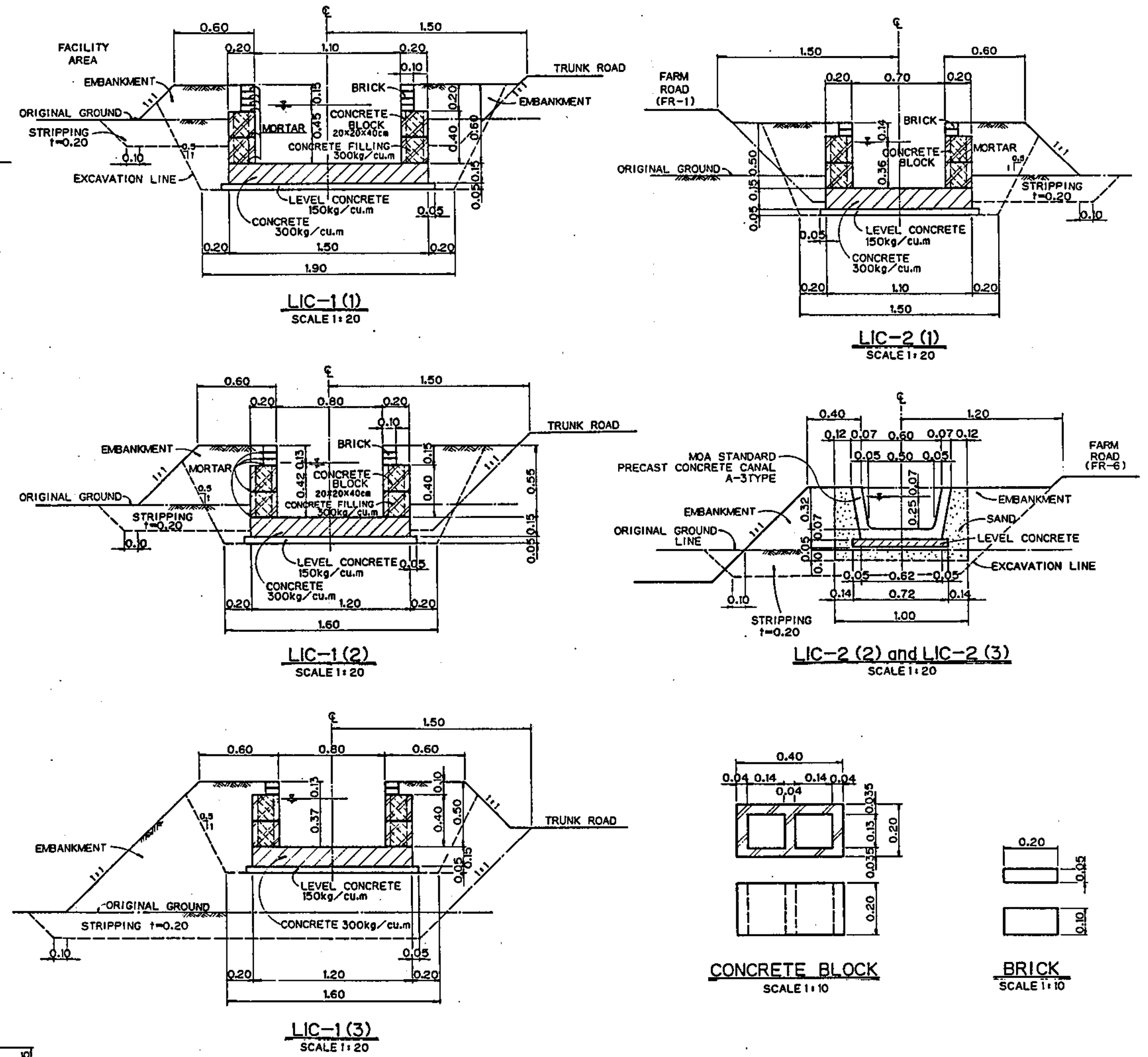
SPILLWAY 1-1 AND TRUNK ROAD CROSSING (LIC-1)

SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No.		APPROVED	

JAPAN INTERNATIONAL COOPERATION AGENCY



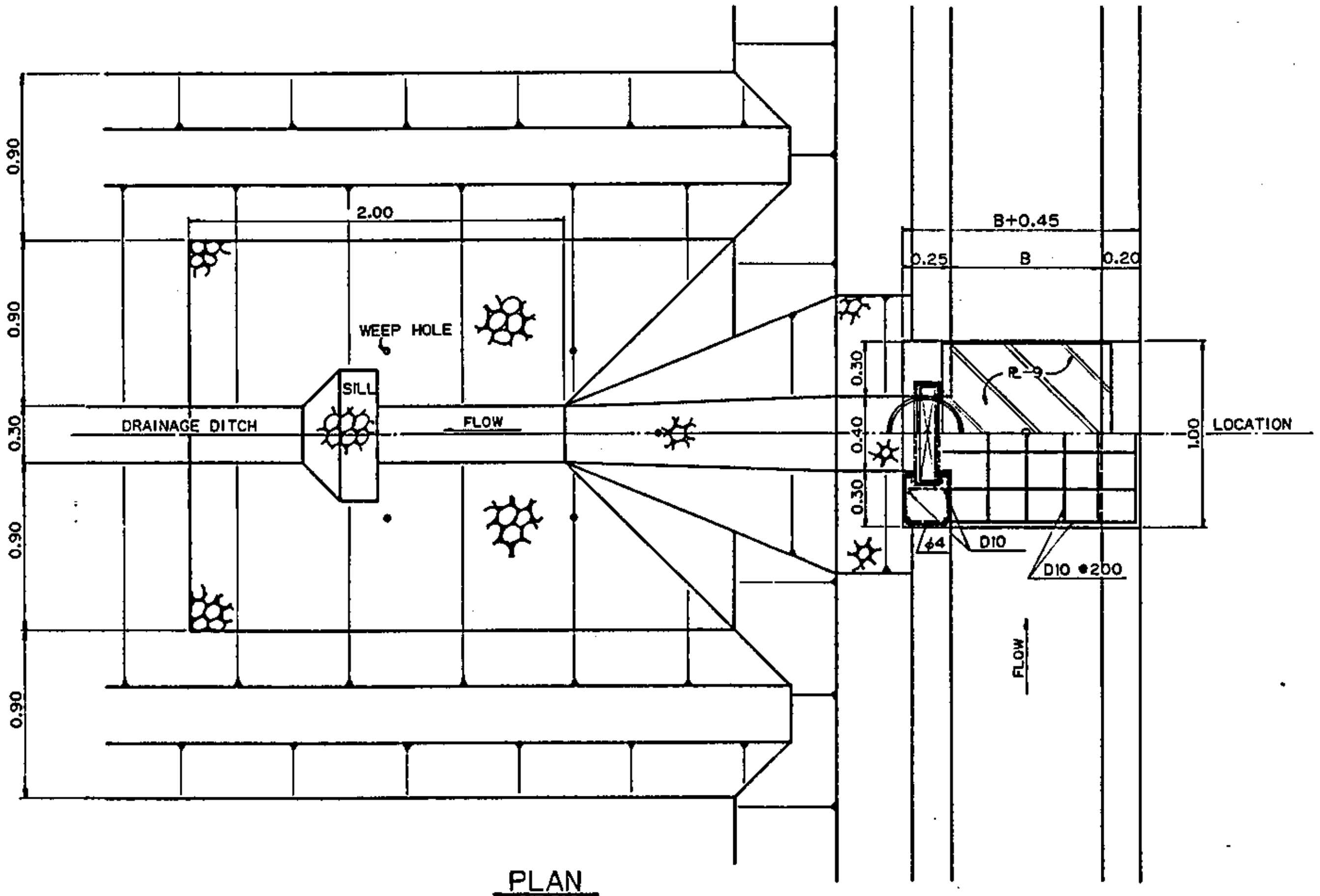
SPILLWAY 1-2 & CHECK GATE 1-2



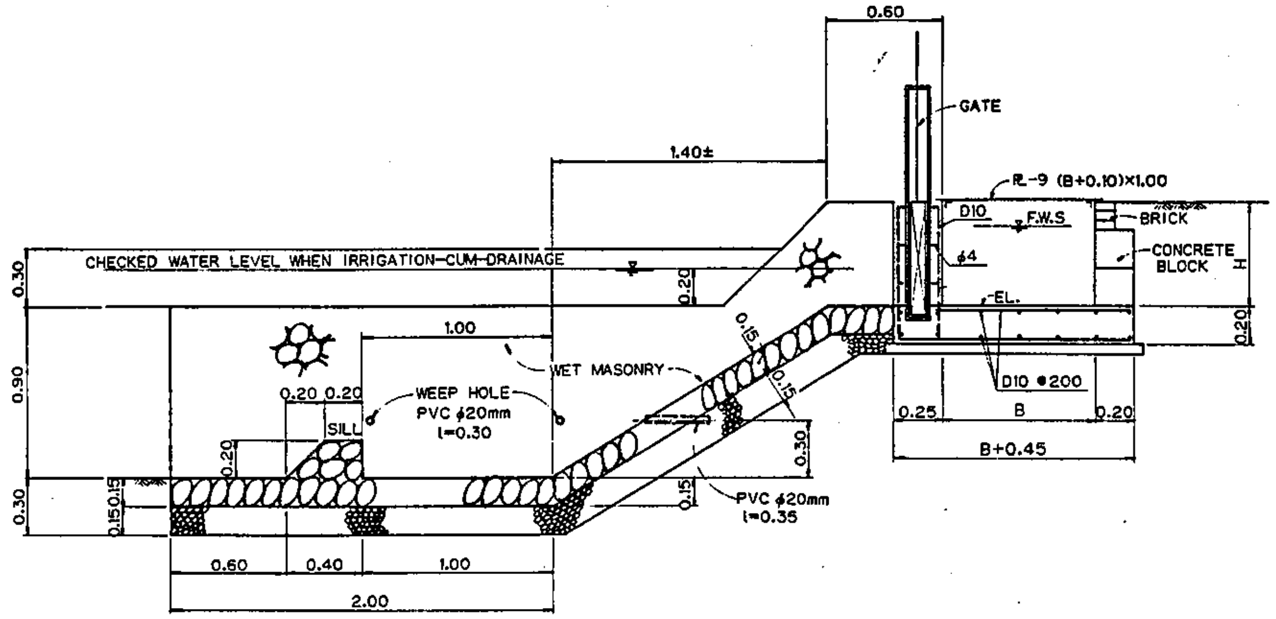
LATERAL IRRIGATION CANALS

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LATERAL IRRIGATION CANALS SPILLWAY 1-2 AND CHECK GATE 1-2			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 10	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



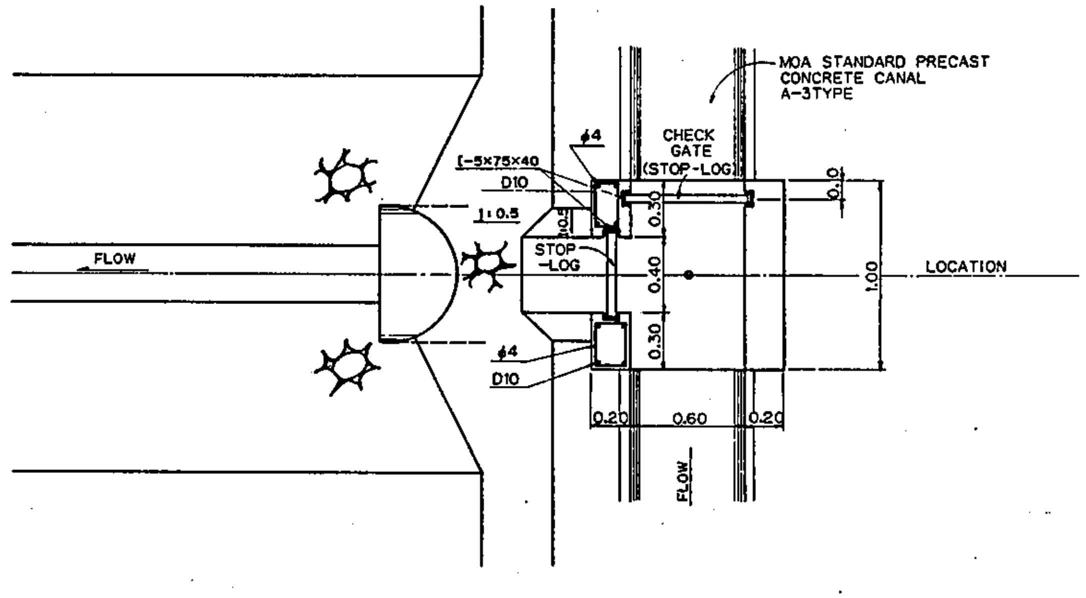
PLAN
SCALE 1:20



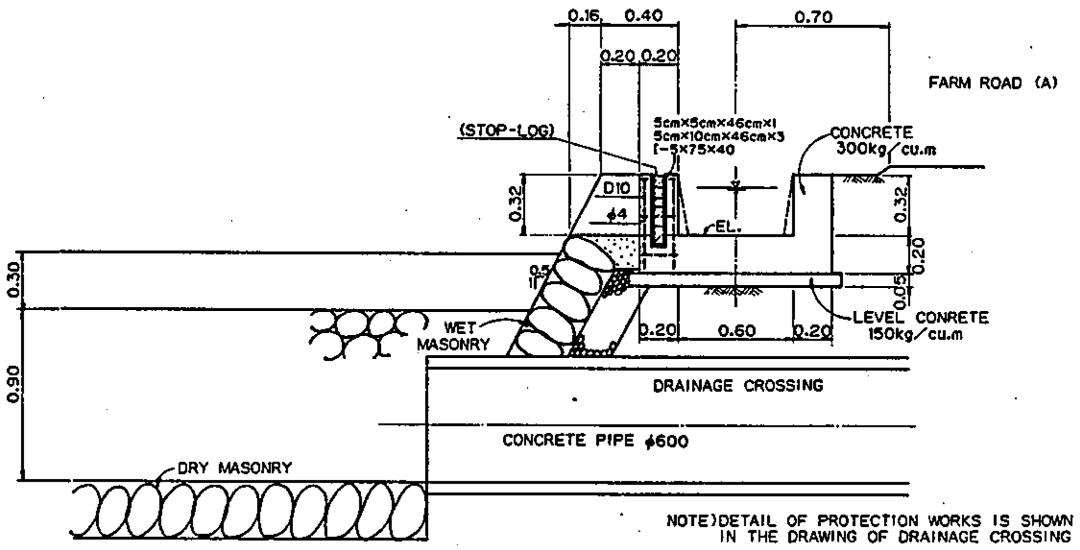
SECTION
SCALE 1:20

SILL TYPE PROTECTION

DRAINAGE RELEASE	CANAL	LOCATION	CANAL SIZE		EL	GATE SIZE		PLATE SIZE
			B	H		B	H	
DD-1	LIC-1 (2)	No.9+38	0.80	0.55	98.85	0.40	0.55	0.90×1.00
DD-2	〃	No.8+0	〃	〃	98.90	〃	〃	〃
DD-3	〃	No.5+70	〃	〃	98.98	〃	〃	〃
DD-4	LIC-2 (1)	No.0+62	0.70	0.50	99.09	0.40	0.50	0.80×1.00



PLAN
SCALE 1:20



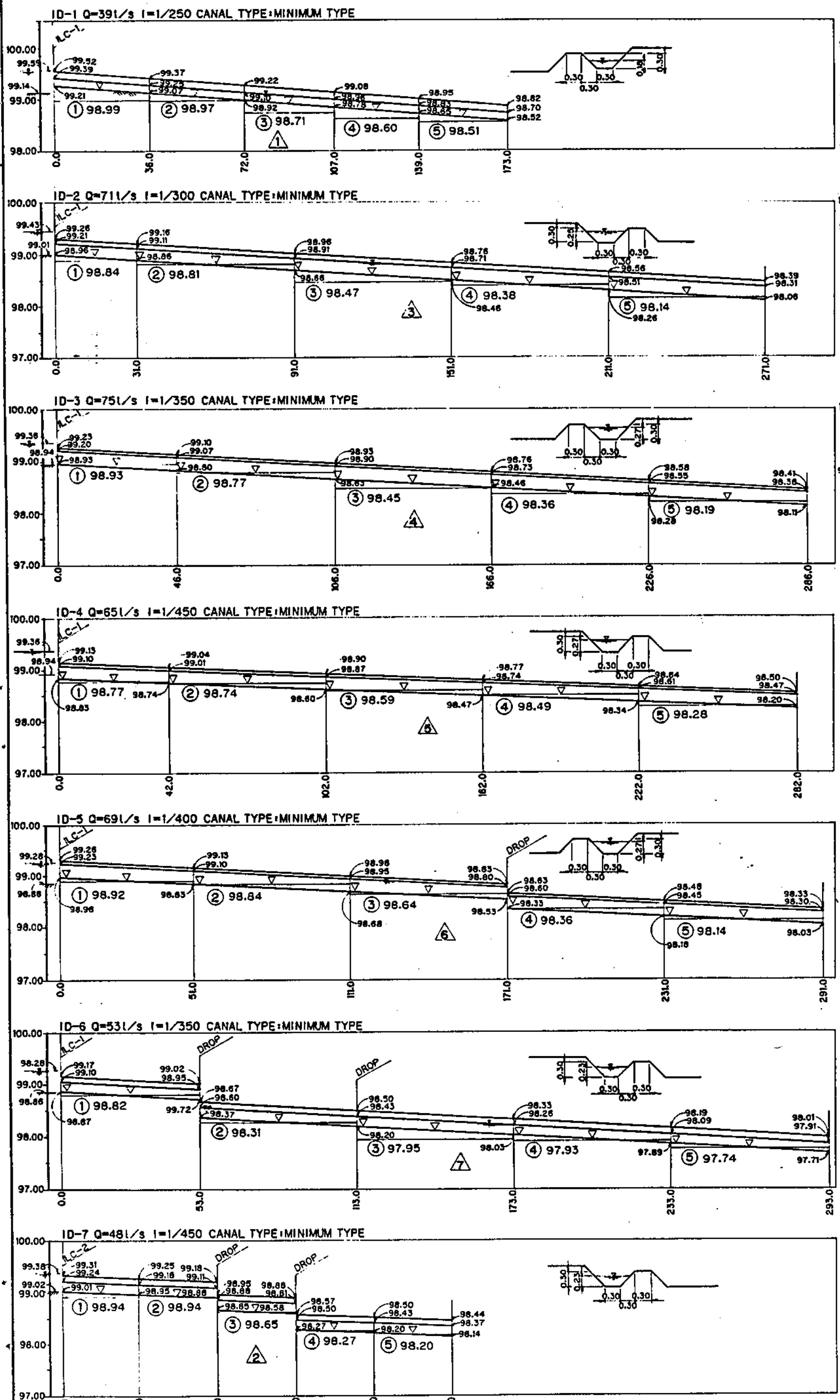
SECTION
SCALE 1:20

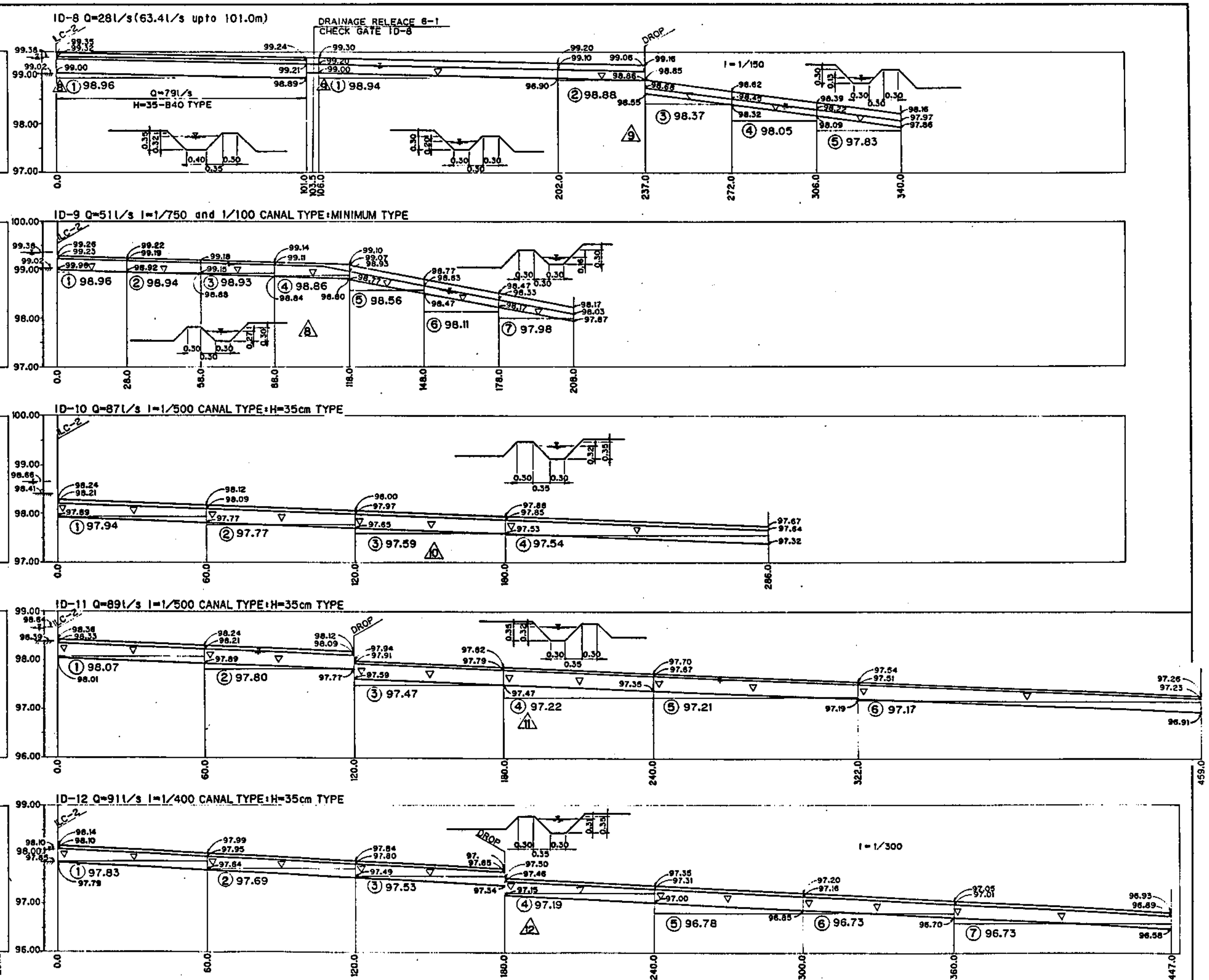
SILL TYPE PROTECTION

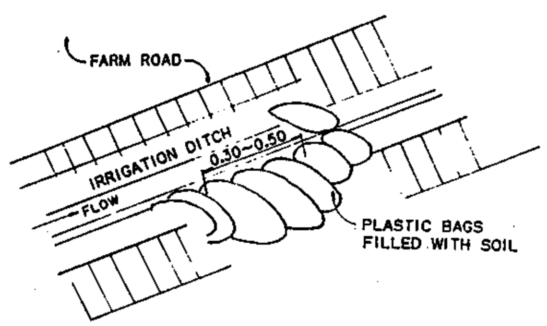
DRAINAGE RELEASE	CHECK GATE	CANAL	LOCATION	EL	CANAL SIZE		REMARK
					B	H	
DD-5	2-5	LIC-2 (3)	No.7+20	98.14	0.60	0.32	WITH DRAINAGE CROSSING
DD-6	2-3	LIC-2 (2)	No.4+9	98.71	〃	〃	〃
DD-6-1	ID-8	ID-8	103.5m	98.89	ID TYPE B=0.40, H=0.35		WITHOUT DRAINAGE CROSSING SILL TYPE PROTECTION TO BE APPLIED

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
DRAINAGE RELEASE AND CHECK GATE (2-3, 2-4, ID-8)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 11	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			





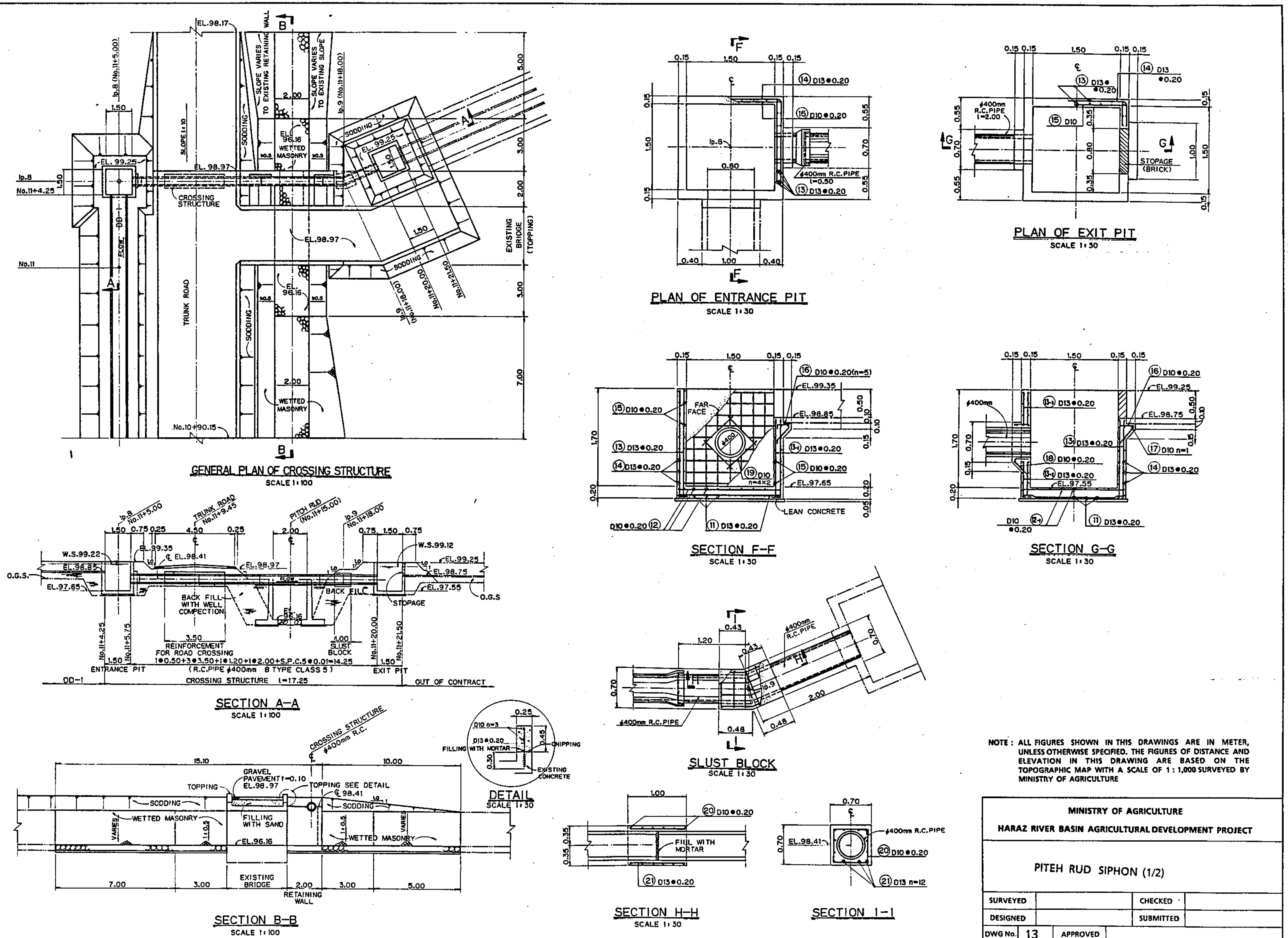


INLET

NOTE

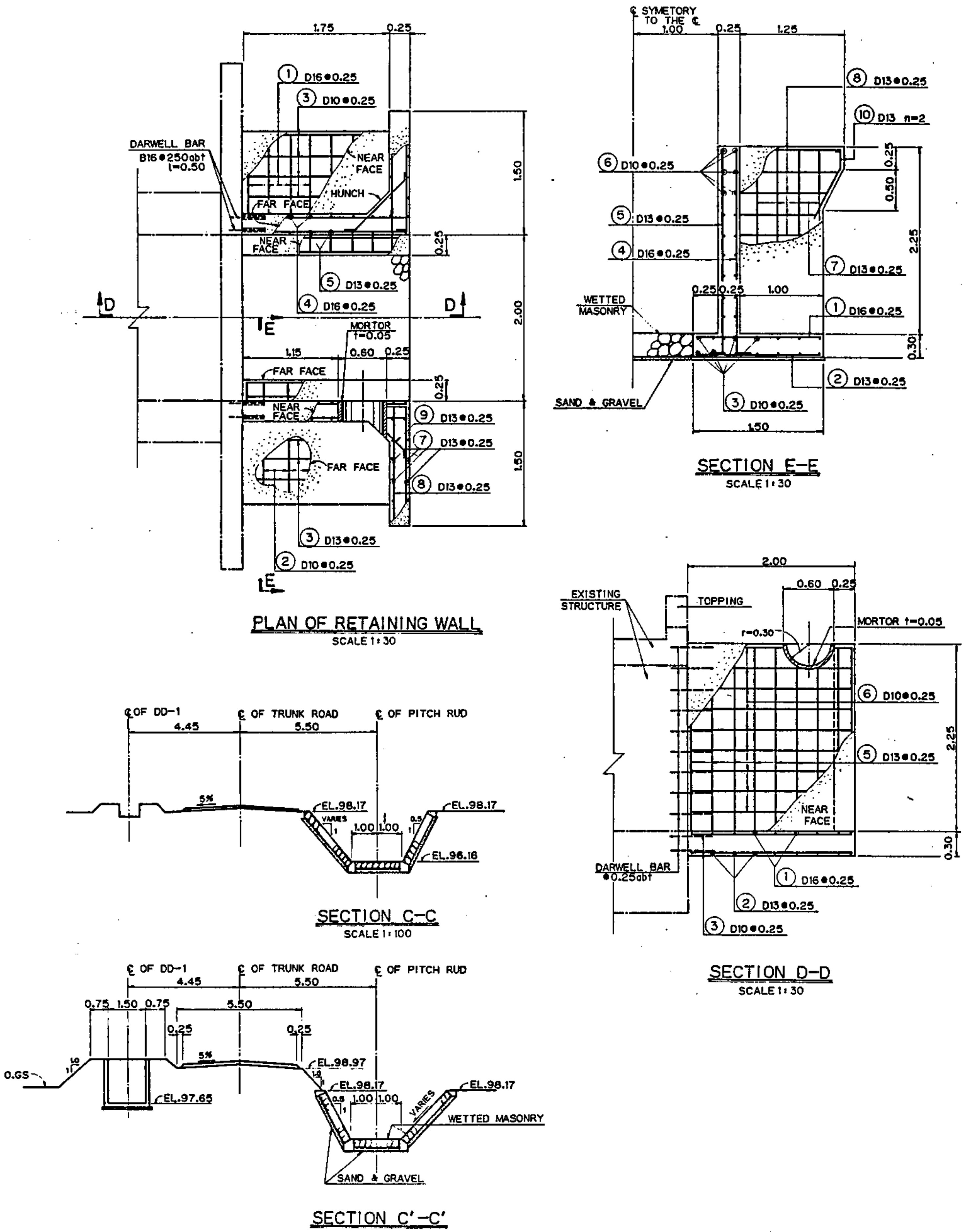
1. ALL FIGURES SHOWN IN THIS DRAWING ARE IN METER, UNLESS OTHERWISE SPECIFIED.
2. △ NUMBER OF FIELD BLOCK.
   ○ NUMBER OF FIELD LOT.
3. ▽ INLET(DETAILED ARE SHOWN IN DWG No.)

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE OF IRRIGATION DITCHES			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No.	12	APPROVED	
JAPAN INTERNATIONAL COOPERATION AGENCY			



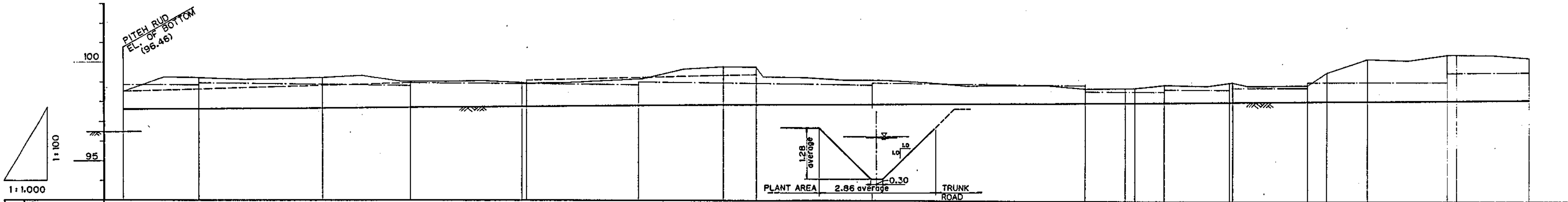
NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
PITEH RUD SIPHON (1/2)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 13	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



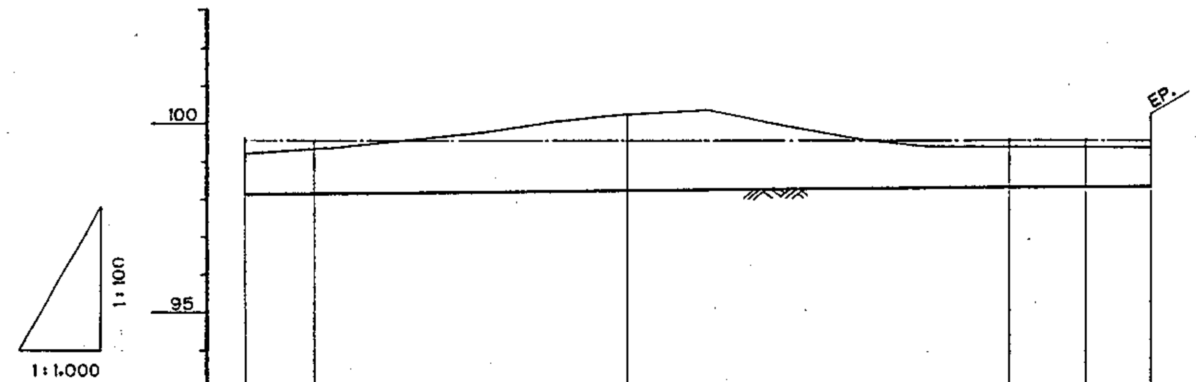
NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
PITEH RUD SIPHON (2/2)			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 14	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



D. DISCHARGE (Lit/sec): Q=279l/sec
Bed Slope: I=1/1300

STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	PROPOSED ELEVATION Left (m)	PROPOSED ELEVATION Right (m)	PROPOSED CANAL BOTTOM (m)	PROPOSED WATER LEVEL (m)	CURVE
No.0	0.0	0.0	(96.46) 98.46	98.82	98.46	97.56	98.46	
+20	20.0	20.0	99.19					
+40	20.0	40.0	99.19	98.82 / 98.92				
+60	20.0	60.0	99.09					
+80	20.0	80.0	99.09					
No.1	20.0	100.0	99.16					
+20	20.0	120.0	99.26					
+40	20.0	140.0	98.99	98.92 / 98.77				
+60	20.0	160.0	98.99					
+80	20.0	180.0	98.99					
No.2 / IP.1	20.0 / 2.0	200.0 / 202.0	98.91 / 98.91		99.04			
+20	18.0	220.0	98.90					
+40	20.0	240.0	99.00					
+60	20.0	260.0	99.10	98.77 / 98.93		97.76		
+80	20.0	280.0	99.60					
No.3	20.0	300.0	99.72					
IP.2 / +20	16.0 / 4.0	316.0 / 320.0	99.72 / 99.21		99.34			
+40	20.0	340.0	99.21					
+60	20.0	360.0	99.10					
+80	20.0	380.0	99.10	98.93 / 98.84				
No.4	20.0	400.0	99.00					
+20	20.0	420.0	98.82					
+40	20.0	440.0	98.82					
+60	20.0	460.0	98.83					
+80	20.0	480.0	98.66	98.84 / 98.51		97.93		
No.5 / IP.3	20.0 / 4.5	500.0 / 504.5	98.69 / 98.69					
+20	15.5	520.0	98.86	98.51 / 98.60				
+40	20.0	540.0	98.80					
IP.4 / +60	13.0 / 7.0	553.0 / 560.0	98.97 / 98.79	98.60 / 98.71				
+80	20.0	580.0	98.82					
IP.5	9.5	589.5	98.82	98.71 / 98.97		98.01		
No.6	10.5	600.0	99.59					
+20	20.0	620.0	99.16	98.97 / 98.99				
+40	20.0	640.0	99.12					
+60	20.0	660.0	99.39	98.99 / 99.50		98.07		
+80	20.0	680.0	99.39					
No.7	20.0	700.0	99.21			98.10	99.00	



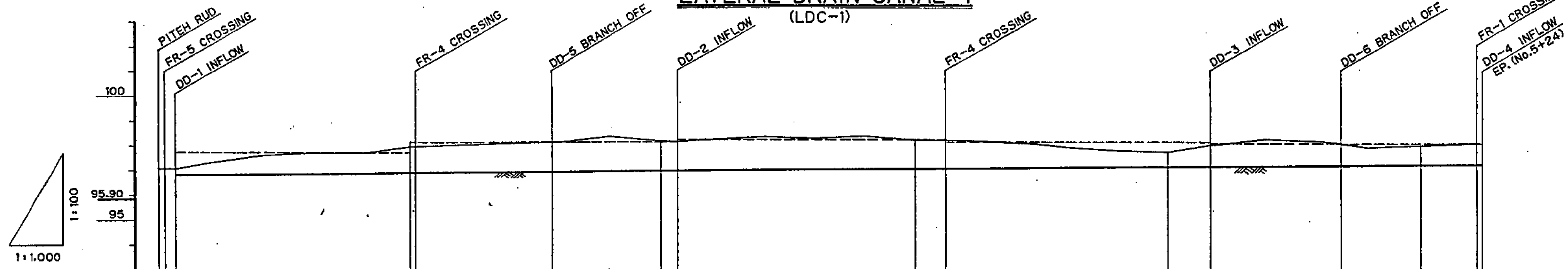
D. DISCHARGE (Lit/sec): Q=279l/sec
Bed Slope: I=1/1300

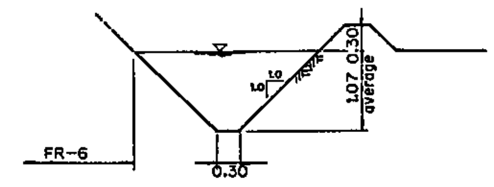
STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	PROPOSED ELEVATION Left (m)	PROPOSED ELEVATION Right (m)	PROPOSED CANAL BOTTOM (m)	PROPOSED WATER LEVEL (m)	CURVE
No.7	20.0	700.0	99.21	99.50		98.10	99.00	
IP.6 / +20	18.0 / 2.0	718.0 / 720.0	99.58 / 99.33					
+40	20.0	740.0	99.58					
+60	20.0	760.0	99.75					
+80	20.0	780.0	99.98					
No.8	20.0	800.0	100.19					
+20	20.0	820.0	100.29					
+40	20.0	840.0	99.81					
+60	20.0	860.0	99.48					
+80	20.0	880.0	99.33					
No.9	20.0	900.0	99.36					
+20	20.0	920.0	99.31					
EP	16.5	936.5	99.31	99.50	99.21	98.28	99.18	

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
INTERCEPTION DRAINAGE CANAL			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 15	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

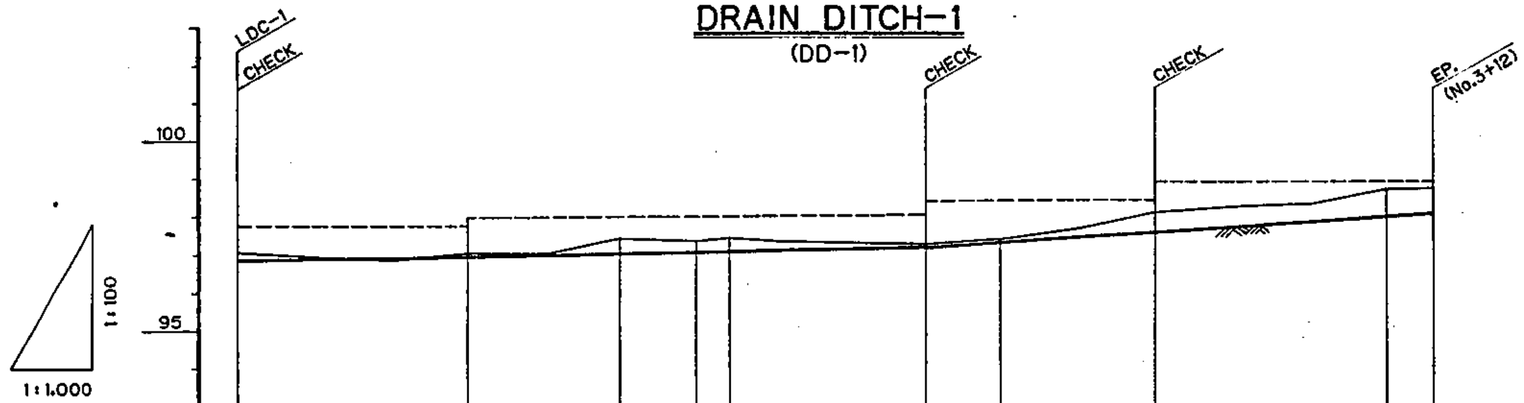
LATERAL DRAIN CANAL-1
(LDC-1)

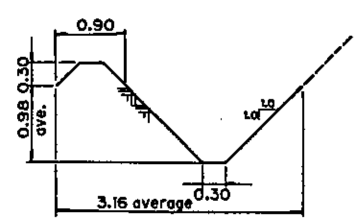




D. DISCHARGE (Lit/sec) Bed Slope	Q=103l/sec I=1/1300																																				
			Q=90l/sec I=1/1300												Q=57l/sec I=1/1300												Q=21l/sec I=1/1300										
PROPOSED WATER LEVEL (m)	96.93		97.74													97.90												98.06									98.14
PROPOSED CANAL BOTTOM (m)	96.03		96.84													97.00												97.16									97.24
PROPOSED ELEVATION Right (m)			97.74					97.74	98.14						98.14	98.28						98.28 98.19						98.19	98.14						98.14		
PROPOSED ELEVATION Left (m)																																					
ELEVATION (m)	97.07	97.07	97.07	97.33	97.61	97.73	97.73	98.01	98.01	98.05	98.11	98.22	98.22	98.40	98.19	98.19	98.27	98.40	98.35	98.43	98.25	98.25	98.26	98.15	98.00	97.86	97.89	98.08	98.08	98.30	98.26	98.18	98.01	98.04	98.12	98.12	98.12
CUMULATIVE DISTANCE (m)	0.0	2.0	6.0	20.0	40.0	60.0	80.0	100.0	102.0	120.0	140.0	156.5	160.0	180.0	200.0	206.5	220.0	240.0	260.0	280.0	300.0	312.0	320.0	340.0	360.0	380.0	400.0	417.5	420.0	440.0	460.0	468.5	480.0	500.0	520.0	522.0	524.0
DISTANCE (m)	0.0	2.0	4.0	14.0	20.0	20.0	20.0	20.0	2.0	18.0	20.0	16.5	3.5	20.0	20.0	6.5	13.5	20.0	20.0	20.0	20.0	12.0	8.0	20.0	20.0	20.0	20.0	17.5	2.5	20.0	20.0	8.5	11.5	20.0	20.0	2.0	2.0
STATION	No.0	+2	+6	+20	+40	+60	+80	No.1	+2	+20	+40	+56.5	+60	+80	No.2	+ 6.5	+20	+40	+60	+80	No.3	+12	+20	+40	+60	+80	No.4	+17.5	+20	+40	+60	+68.5	+80	No.5	+20	+22	EP (No.5+24)
CURVE																																					

DRAIN DITCH-1
(DD-1)



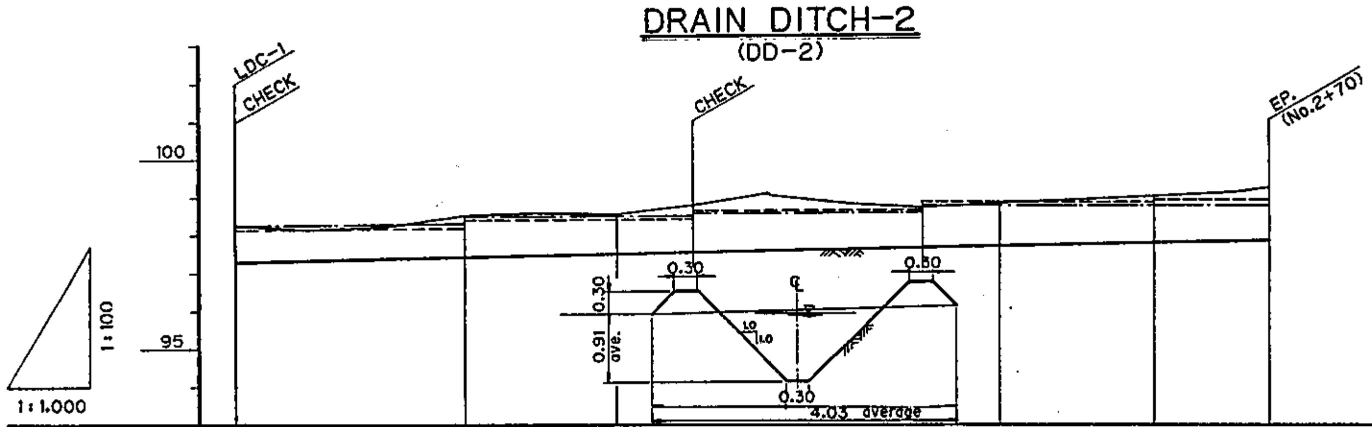


D. DISCHARGE (Lit/sec) Bed Slope	Q=13l/sec I=1/700										Q=13l/sec I=1/160							
PROPOSED WATER LEVEL (m)	97.74										98.00							98.82
PROPOSED CANAL BOTTOM (m)	96.84										97.10							97.92
PROPOSED ELEVATION Right (m)	97.74			97.74 97.93			97.93 97.95				97.95 98.31			98.31 98.82				98.82
PROPOSED ELEVATION Left (m)																		
ELEVATION (m)	97.07	96.90	96.84	97.00	97.00	97.40	97.30	97.40	97.30	97.20	97.20	97.30	97.60	98.00	98.10	98.20	98.61	98.61
CUMULATIVE DISTANCE (m)	0.0	20.0	40.0	60.0	80.0	100.0	120.0	129.0	140.0	160.0	180.0	200.0	220.0	240.0	260.0	280.0	300.0	312.0
DISTANCE (m)	0.0	20.0	20.0	20.0	20.0	20.0	20.0	9.0	11.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	12.0
STATION	No.0	+20	+40	+60	+80	No.1	+20	IP.1	+40	+60	+80	No.2	+20	+40	+60	+80	No.3	EP (No.3+12)
CURVE																		

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE LDC-1, and DD-1			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 16	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

DRAIN DITCH-2
(DD-2)

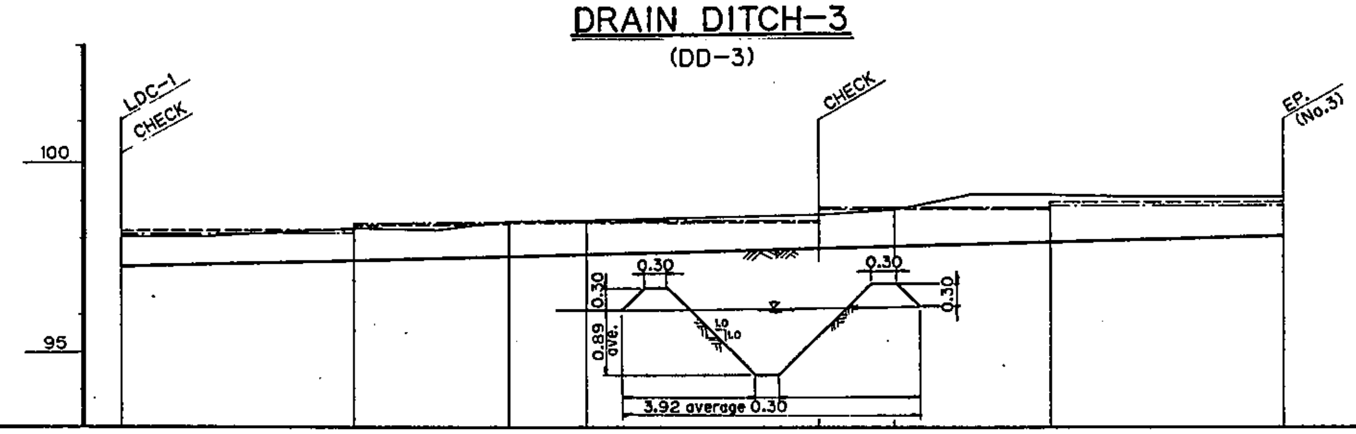


D. DISCHARGE (Lit/sec): Q=33l/sec; Bed Slope: I=1/400

STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	ELEVATION Left (m)	ELEVATION Right (m)	CANAL BOTTOM (m)	WATER LEVEL (m)
No.0	0.0	0.0	98.19	98.28	98.14	97.24	98.14
+20	20.0	20.0	98.10				
+40	20.0	40.0	98.18				
+60	20.0	60.0	98.45	98.28 / 98.49	98.14 / 98.36		
+80	20.0	80.0	98.55				
No.1	20.0	100.0	98.50				
+20	20.0	120.0	98.75	98.49 / 98.59	98.36 / 98.64		
+40	20.0	140.0	99.09				
+60	20.0	160.0	98.81				
+80	20.0	180.0	98.71	98.59 / 98.74	98.64 / 98.84		
No.2	20.0	200.0	98.79				
+20	20.0	220.0	98.99				
+40	20.0	240.0	99.00	98.74 / 98.77	98.84 / 98.92		
+60	20.0	260.0	99.10				
EP (No.2+70)	10.0	270.0	99.27	98.77	98.92	97.84	98.74

CURVE

DRAIN DITCH-3
(DD-3)

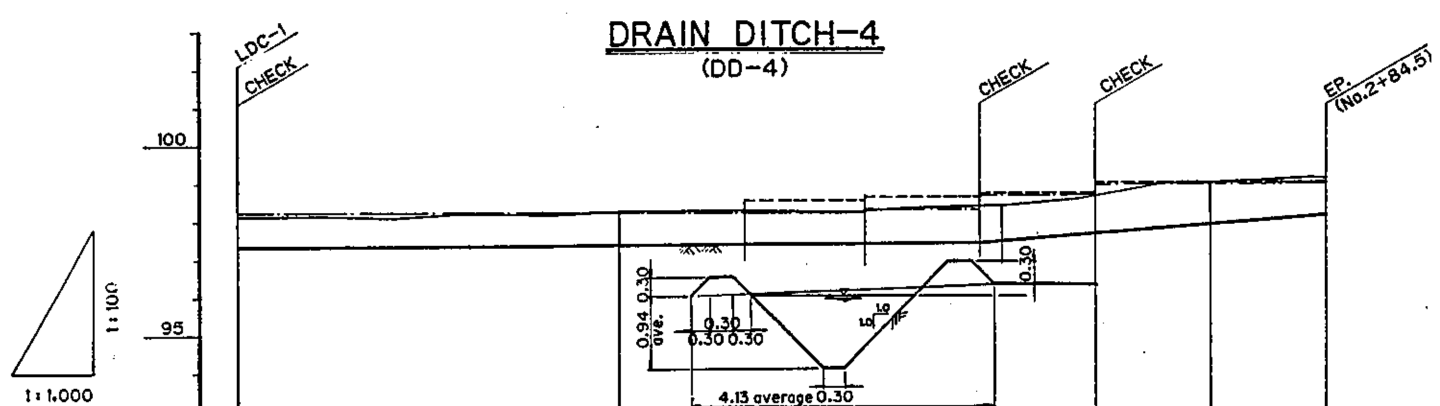


D. DISCHARGE (Lit/sec): Q=36l/sec; Bed Slope: I=1/400

STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	ELEVATION Left (m)	ELEVATION Right (m)	CANAL BOTTOM (m)	WATER LEVEL (m)
No.0	0.0	0.0	98.08	98.14	98.19	97.24	98.14
+20	20.0	20.0	98.05				
+40	20.0	40.0	98.13				
+60	20.0	60.0	98.24	98.14 / 98.38	98.19 / 98.36		
+80	20.0	80.0	98.29				
No.1	20.0	100.0	98.43				
+20	20.0	120.0	98.46	98.38 / 98.47	98.36 / 98.45		
+40	20.0	140.0	98.50				
+60	20.0	160.0	98.56				
+80	20.0	180.0	98.61	98.47 / 98.81	98.45 / 98.77		
No.2	20.0	200.0	98.72				
+20	20.0	220.0	99.16				
+40	20.0	240.0	99.13	98.81 / 98.84	98.77 / 98.93		
+60	20.0	260.0	99.11				
+80	20.0	280.0	99.11				
EP (No.3)	20.0	300.0	99.11	98.84	98.93	97.99	98.89

CURVE

DRAIN DITCH-4
(DD-4)



D. DISCHARGE (Lit/sec): Q=21l/sec, Bed Slope: I=1/2700 (No.0 to +94.5); Q=21l/sec, Bed Slope: I=1/120 (+94.5 to EP)

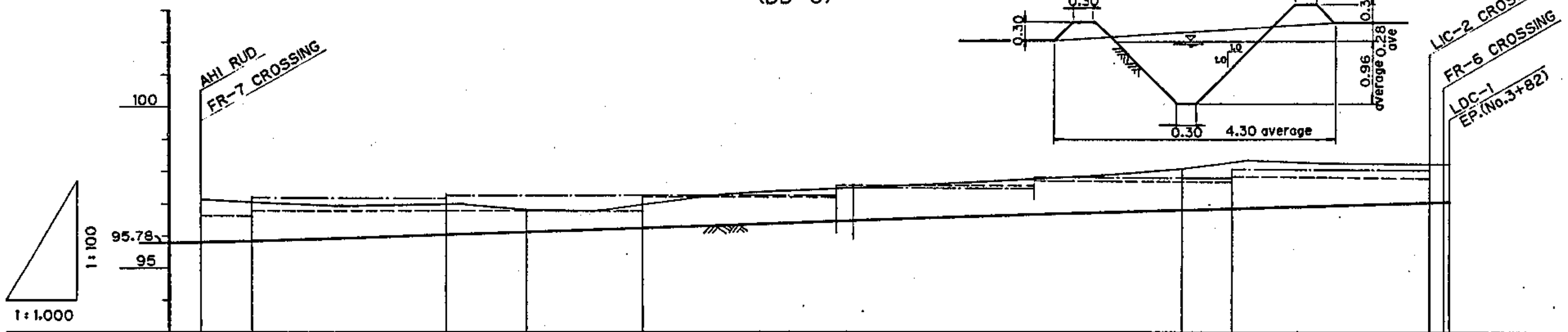
STATION	DISTANCE (m)	CUMULATIVE DISTANCE (m)	ELEVATION (m)	ELEVATION Left (m)	ELEVATION Right (m)	CANAL BOTTOM (m)	WATER LEVEL (m)
No.0	0.0	0.0	98.12	98.20	98.14	97.30	98.20
+20	20.0	20.0	98.12				
+40	20.0	40.0	98.04				
+60	20.0	60.0	98.17		98.14 / 98.38		
+80	20.0	80.0	98.11				
No.1	20.0	100.0	98.23				
+20	20.0	120.0	98.22		98.38 / 98.47		
IP.1	13.0	133.0	98.25		98.47 / 98.51		
+40	7.0	140.0	98.22				
+60	20.0	160.0	98.22	98.20 / 98.27	98.51 / 98.60		
+80	20.0	180.0	98.32				
+94.5	14.5	194.5		98.27 / 98.65	98.60 / 98.71	97.37	98.27
No.2	5.0	200.0	98.34				
+20	20.0	220.0	98.52	98.65 / 98.94	98.71 / 98.97		
+40	20.0	240.0	98.90				
+60	20.0	260.0	98.98		98.97 / 98.99		
+80	20.0	280.0	99.10				
EP (No.2+84.5)	4.5	284.5	99.10	98.94	98.99	98.12	99.02

CURVE

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE DD-2, -3 and -4			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 17	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

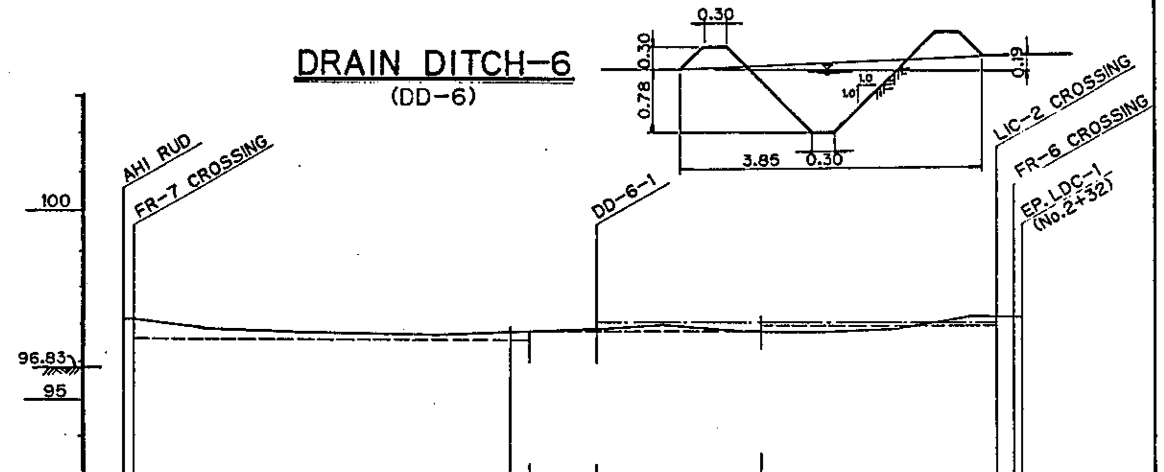
DRAIN DITCH-5
(DD-5)



	D. DISCHARGE (Lit/sec) Bed Slope	WATER LEVEL (m)	CANAL BOTTOM (m)	ELEVATION Right (m)	ELEVATION Left (m)	ELEVATION (m)	CUMULATIVE DISTANCE (m)	DISTANCE (m)	CURVE
No.0 +2	Q=66l/sec I=1/180	96.70	95.80	96.61		97.10 97.10	0.0 2.0	0.0 2.0	
+15.5 +20				96.61 96.78	97.17	97.00	15.5 20.0	13.5 4.5	
+40						96.93	40.0	20.0	
+60						97.00	60.0	20.0	
+80					97.17 97.22	96.98	80.0	20.0	
No.1						96.80	100.0	20.0	
+20						96.73	120.0	20.0	
+40				96.78 97.19		97.00	140.0	20.0	
+60						97.25	160.0	20.0	
+80						97.38	180.0	20.0	
No.2		97.27	96.37	97.19 97.53	97.22 97.47	97.46	200.0	20.0	
+20						97.57	220.0	20.0	
+40						97.71	240.0	20.0	
+60				97.53 97.69	97.47 97.80	97.79	260.0	20.0	
+80						97.89	280.0	20.0	
No.3						98.10	300.0	20.0	
+20				97.69 97.83	97.80 98.07	98.33	320.0	20.0	
+40						98.28	340.0	20.0	
+60						98.24	360.0	20.0	
+76 +80 EP (No.3+82)		97.89	96.89	97.83	98.07	98.23 98.23 98.23	376.0 380.0 382.0	16.0 4.0 2.0	

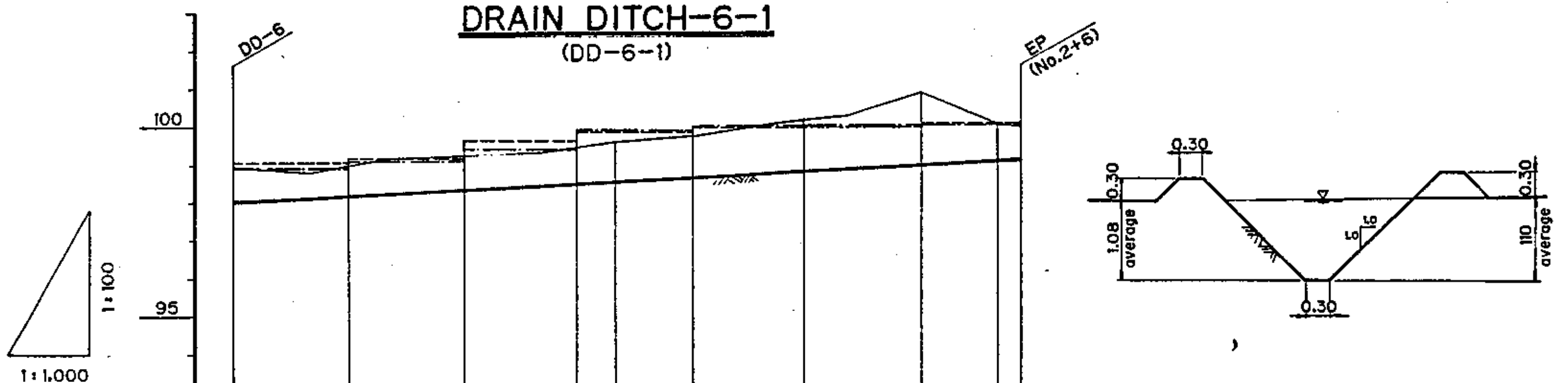
(STATION in first column; PROPOSED: D. DISCHARGE, WATER LEVEL, CANAL BOTTOM, ELEVATION Right, ELEVATION Left)

DRAIN DITCH-6
(DD-6)



STATION	D. DISCHARGE (Lit/sec) Bed Slope	WATER LEVEL (m)	CANAL BOTTOM (m)	ELEVATION Right (m)	ELEVATION Left (m)	ELEVATION (m)	CUMULATIVE DISTANCE (m)	DISTANCE (m)	CURVE
No.0 + 2.5	Q=42l/sec I=1/1200		96.85	97.54	97.83	98.11 98.11	0.0 2.5	0.0 2.5	
+20						97.88	20.0	17.5	
+40						97.78	40.0	20.0	
+60						97.75	60.0	20.0	
+80						97.69	80.0	20.0	
No.1				97.54 97.77		97.78	100.0	20.0	
+20 +22.5	Q=23l/sec I=1/1200		96.95		97.83 97.98	97.85 97.85	120.0 125.5	20.0 2.5	
+40						97.94	140.0	17.5	
+60				97.77 97.94		97.82	160.0	20.0	
+80						97.82	180.0	20.0	
No.2						97.86	200.0	20.0	
+20 +26 +30 EP (No.2+32)			92.04	97.94	97.98	98.18 98.18 98.18 98.18	220.0 226.0 230.0 232.0	20.0 6.0 4.0 2.0	

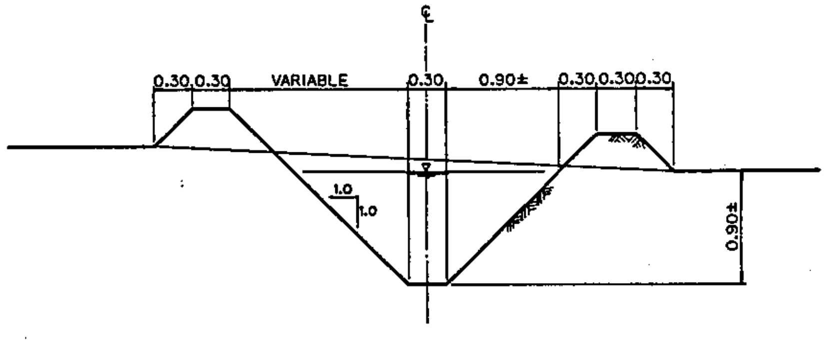
DRAIN DITCH-6-1
(DD-6-1)



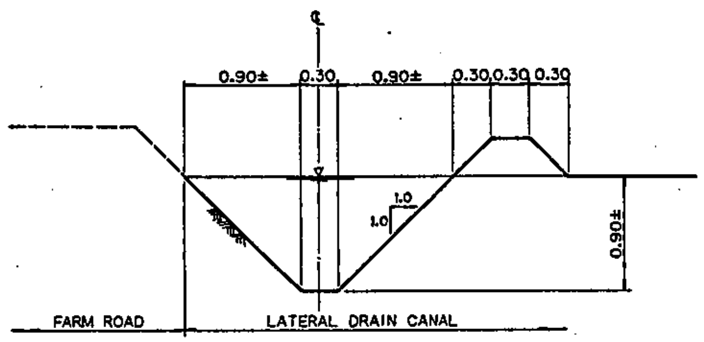
STATION	D. DISCHARGE (Lit/sec) Bed Slope	WATER LEVEL (m)	CANAL BOTTOM (m)	ELEVATION Right (m)	ELEVATION Left (m)	ELEVATION (m)	CUMULATIVE DISTANCE (m)	DISTANCE (m)	CURVE
No.0	Q=19l/sec I=1/180	97.25	96.95	97.98	97.83	97.85	0.0	0.0	
+20				97.98 98.11	97.83 98.05	97.72	20.0	20.0	
+40						98.12	40.0	20.0	
+60				98.11 98.56	98.05 98.37	98.23	60.0	20.0	
+80				98.56 98.86	98.37 98.88	98.28	80.0	20.0	
No.1						98.56	100.0	20.0	
+20				98.86 98.93	98.88 98.94	98.70	120.0	20.0	
+40				98.93 98.94		99.00	140.0	20.0	
+60						99.22	160.0	20.0	
+80				98.94 98.96		99.82	180.0	20.0	
No.2 EP (No.2+6)		97.09	98.09	98.96	98.94	98.94 98.88	200.0 206.0	20.0 6.0	

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

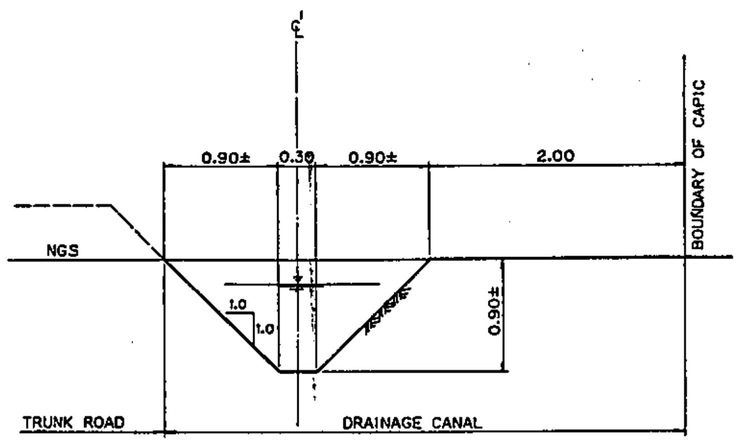
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE DD-5.-6 and -6-1			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 18	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			



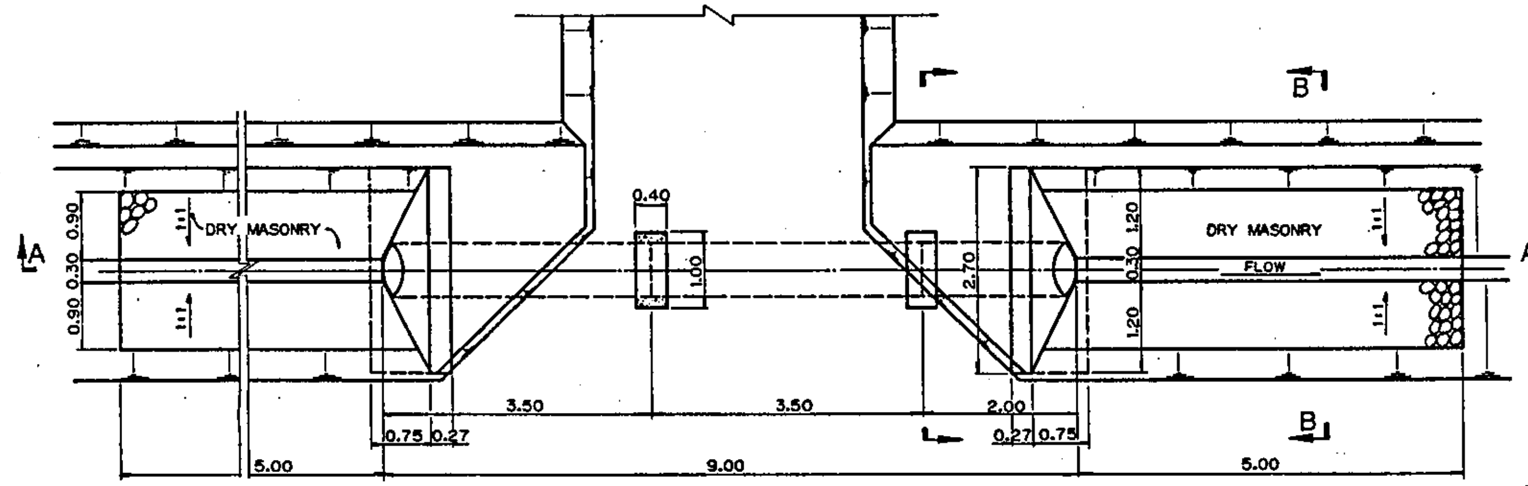
TYPICAL CROSS SECTION OF DRAIN DITCH
SCALE 1:30



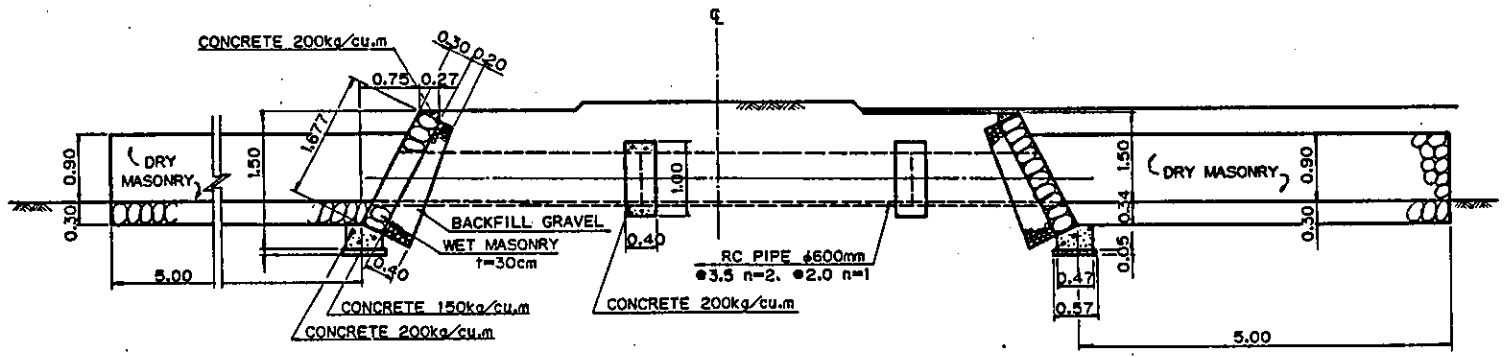
TYPICAL CROSS SECTION OF LATERAL DRAIN CANAL
SCALE 1:30



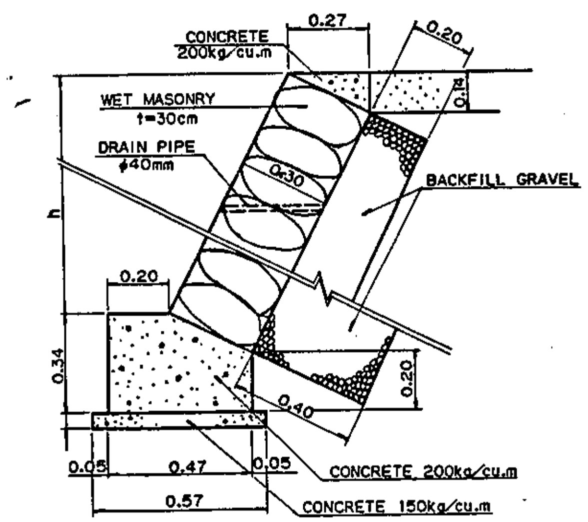
TYPICAL CROSS SECTION OF INTERCEPTION DRAINAGE CANAL
SCALE 1:30



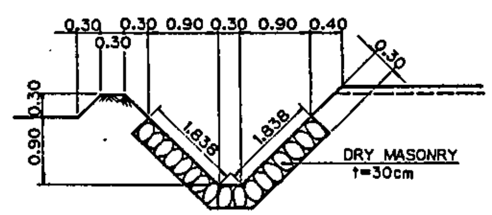
PLAN
SCALE 1:50



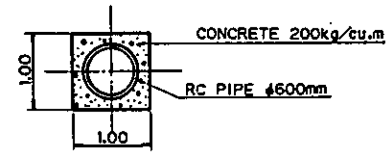
SECTION A–A
SCALE 1:50



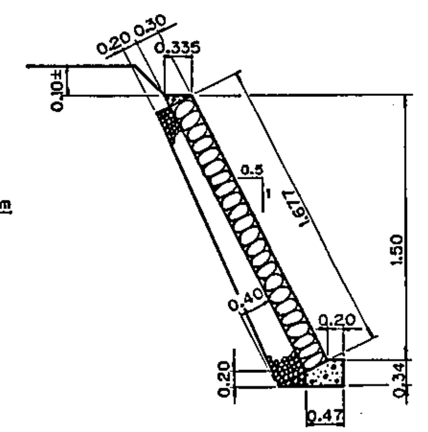
DETAIL OF WET MASONRY



SECTION B–B
SCALE 1:50



SECTION C–C
SCALE 1:50



WET MASONRY
NO SCALE
(REFER TO DETAIL OF WET MASONRY)

DRAINAGE ROAD CROSSING
(TYPE–A)

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

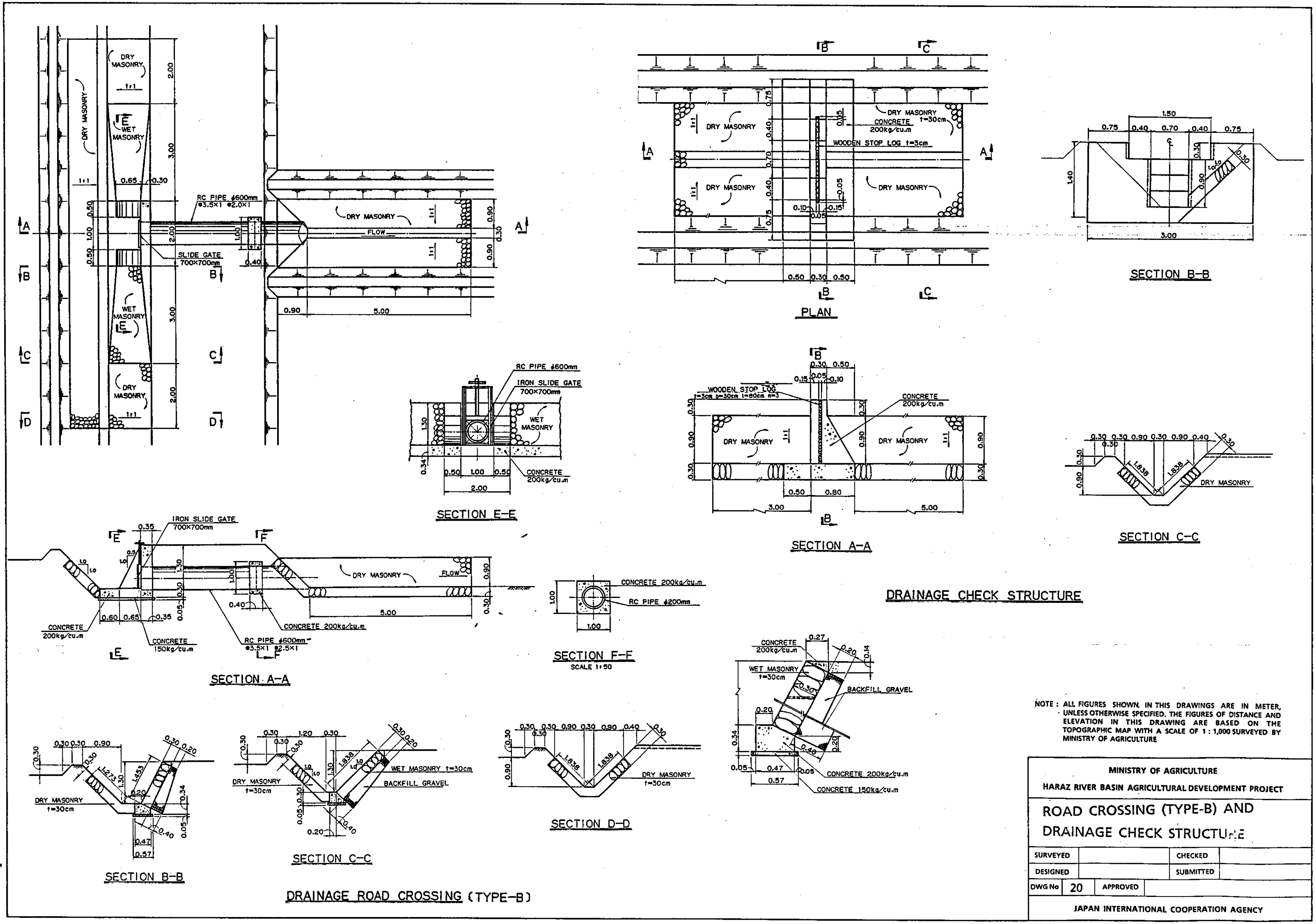
MINISTRY OF AGRICULTURE

HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT

TYPICAL CROSS SECTION OF DRAINAGE CANAL AND ROAD CROSSING
(TYPE-A)

SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 19	APPROVED		

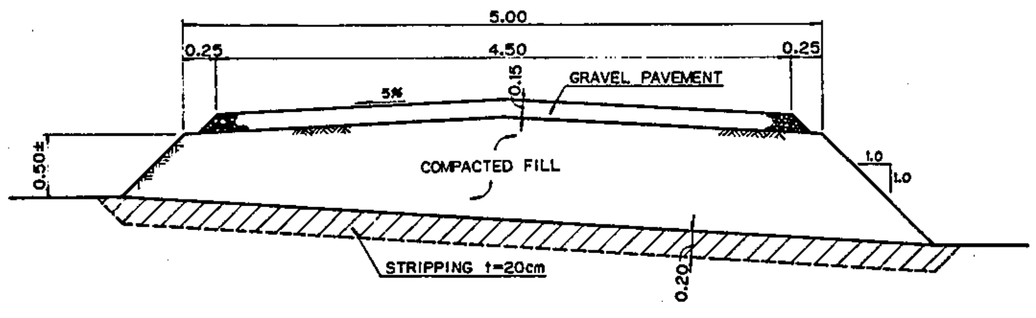
JAPAN INTERNATIONAL COOPERATION AGENCY



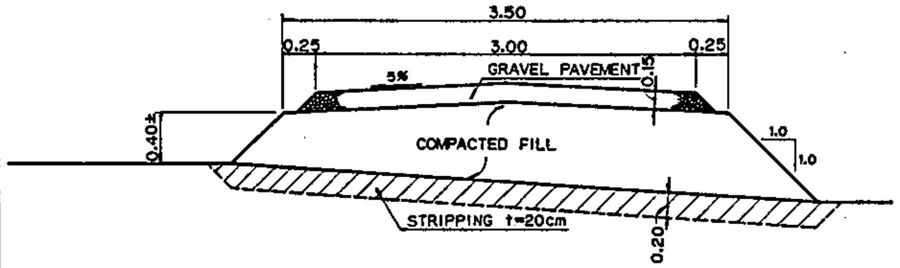
NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
ROAD CROSSING (TYPE-B) AND DRAINAGE CHECK STRUCTURE			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No	20	APPROVED	
JAPAN INTERNATIONAL COOPERATION AGENCY			

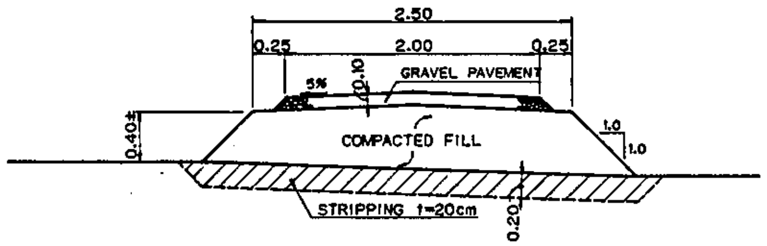
TYPICAL CROSS SECTION OF FARM ROAD



TRUNK ROAD(TR)

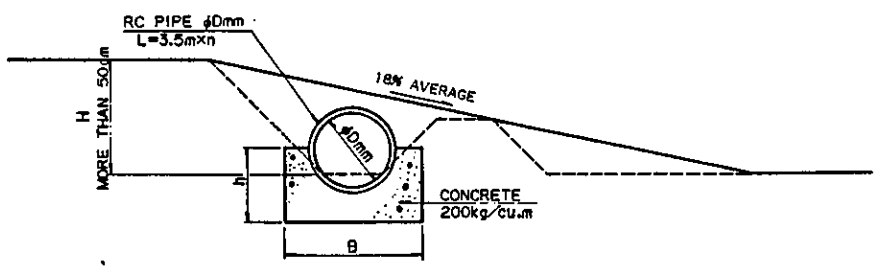


FARM ROAD–A(FR)

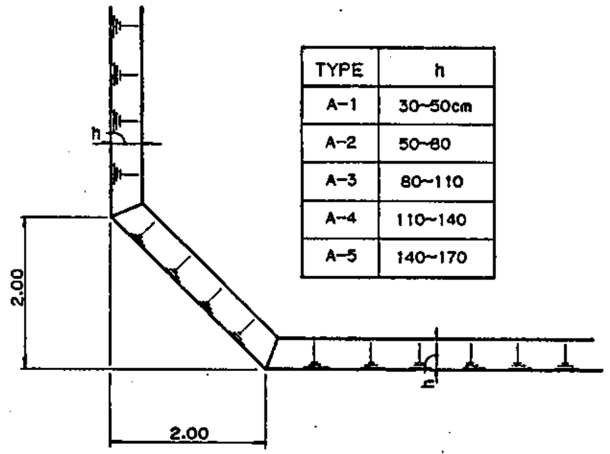


FARM ROAD–B(FR)

TYPICAL CROSS SECTION OF FARM ROAD
SCALE 1:30

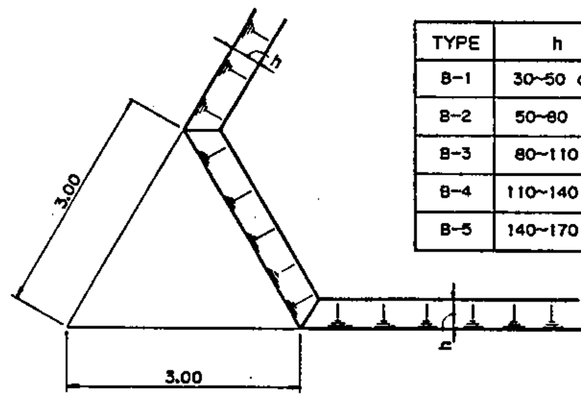


SECTION A–A



TYPE	h
A–1	30~50cm
A–2	50~80
A–3	80~110
A–4	110~140
A–5	140~170

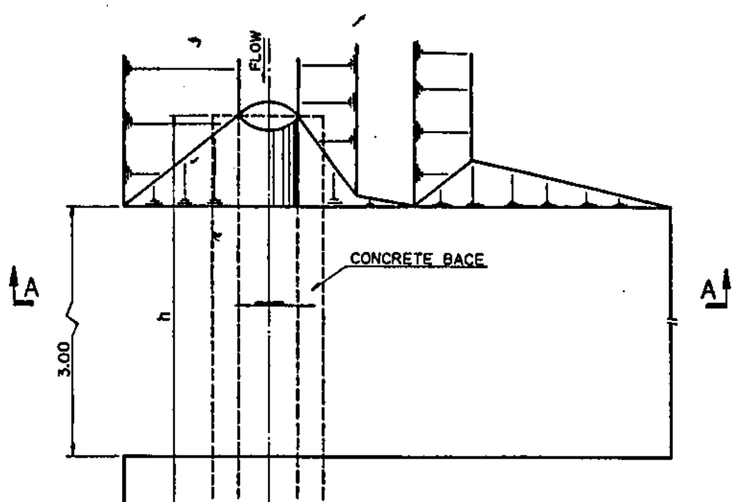
TYPE–A



TYPE	h
B–1	30~50 cm
B–2	50~80
B–3	80~110
B–4	110~140
B–5	140~170

TYPE–B

CORNER CUTTING
SCALE 1:50

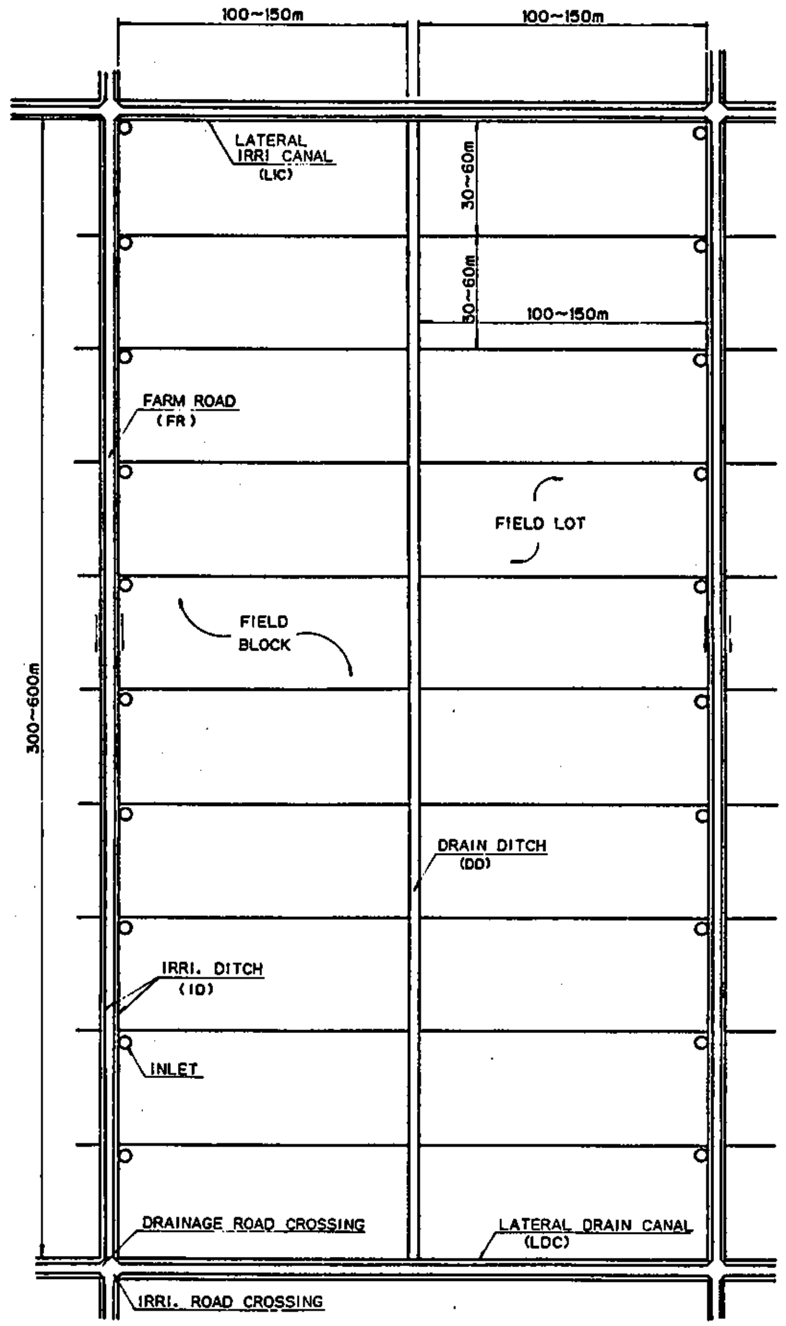


PLAN

ACCESS ROAD TO FIELD
NO SCALE

DIMENSION

TYEP	h	D	n	l
1	40cm	400mm	1pc	3.5m
2	40	400	2	7.0
S1	45	500	1	3.5
S2	45	500	2	7.0
S3	50	600	1	3.5
S4	50	600	2	7.0

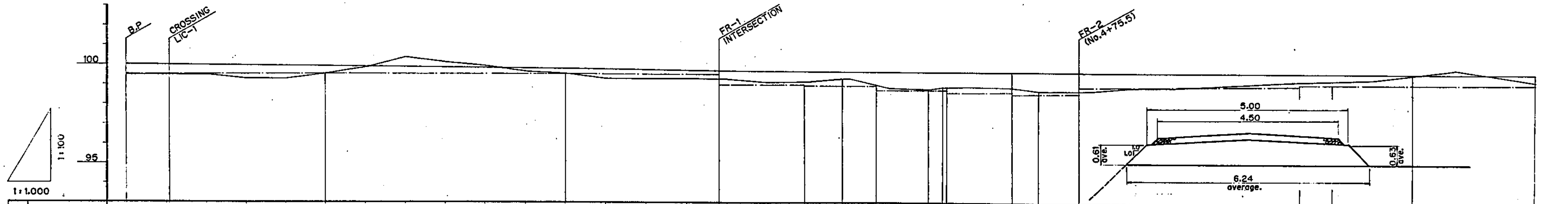


TYPICAL LAYOUT PROPOSED FACILITIES
NO SCALE

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

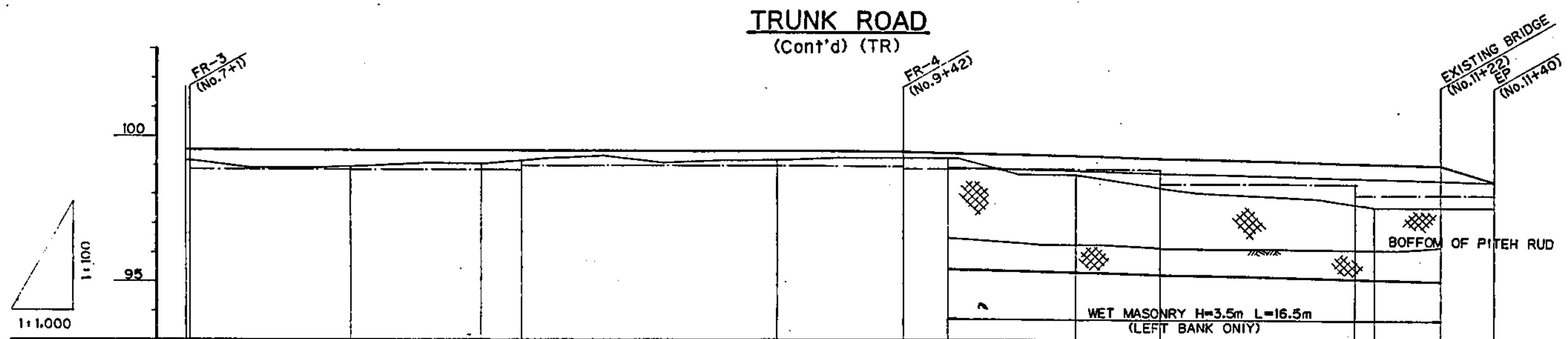
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
TYPICAL CROSS SECTION OF FARM ROAD and ITS APPURTENANT STRUCTURE, and TYPICAL LAYOUT OF FIELD BLOCK			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 21	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

TRUNK ROAD
(TR)

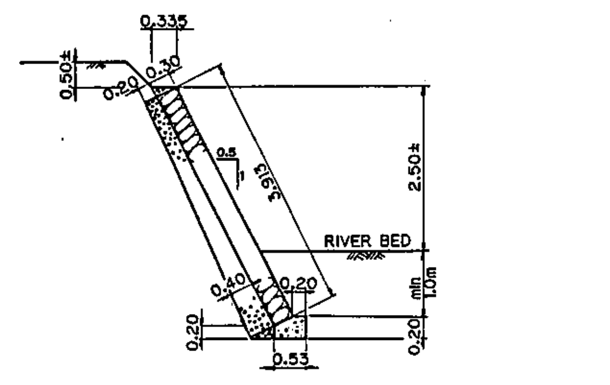


		No.0	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+20	+40	+60	+80	+96 / No.3	+20	+40	IP.1 / +60	+80	No.4	IP.2	+20	+40	IP.3 / +60	+75.5	+80	No.5	+20	+40	+60	+80	No.6	+20	+40 / IP.4	+60	+80	No.7
PROPOSED	BERM EL. of ID	99.80	99.80														99.74										99.56												99.49
	ROAD SURFACE ELEVATION	100.00	100.00	99.98	99.96	99.95	99.93	99.91	99.89	99.87	99.86	99.84	99.82	99.80	99.78	99.76	99.75	99.73	99.71	99.70 / 99.70	99.68	99.66	99.65	99.65	99.63	99.62 / 99.61	99.60	99.60	99.59	99.58	99.57	99.56	99.56 / 99.55	99.55	99.54	99.53	99.52	99.51	99.50
	ELEVATION Right (m)																																						
	ELEVATION Left (m)	99.50															99.50 / 98.99		98.99 / 98.97		98.97 / 98.71		98.71 / 98.60		98.60 / 98.51		98.51	98.84					98.84 / 98.93						98.93
ELEVATION (m)		99.43	99.47	99.24	99.26	99.32	99.52	99.82	100.36	100.08	99.93	99.65	99.55	99.28	99.27	99.27	99.28 / 99.27	99.10	99.15	99.29 / 99.29	98.82	98.79	98.89	98.89	98.86	98.69 / 98.69	98.66	98.66	98.83	98.82	98.90	99.00	99.10	99.15	99.20	99.47 / 99.47	99.72	99.40	99.10
CUMULATIVE DISTANCE (m)		0.0	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0	220.0	240.0	260.0	280.0	296.0 / 300.0	320.0	340.0	357.0 / 360.0	380.0	400.0	408.0	420.0	440.0	455.0 / 460.0	475.5	480.0	500.0	520.0	540.0	560.0	580.0	600.0	620.0	640.0 / 641.0	660.0	680.0	700.0
DISTANCE (m)		0.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0 / 4.0	20.0	20.0	17.0 / 3.0	20.0	20.0	8.0	12.0	20.0	15.0 / 5.0	15.5	4.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0 / 1.0	19.0	20.0	20.0
STATION		No.0	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+20	+40	+60	+80	+96 / No.3	+20	+40	IP.1 / +60	+80	No.4	IP.2	+20	+40	IP.3 / +60	+75.5	+80	No.5	+20	+40	+60	+80	No.6	+20	+40 / IP.4	+60	+80	No.7
CURVE																																							

TRUNK ROAD
(Cont'd) (TR)



		No.7 / +1	+20	+40	IP.5 / +60	+80	No.8	+20	+40	+60	+80	No.9	+20	+40	IP.6 / +60	+80	No.10	+20		+40	+60	+80	No.11	+20 / +22	EP
PROPOSED	BERM EL. of ID	99.49												99.41										99.35	
	ROAD SURFACE ELEVATION	99.50	99.50	99.49	99.49	99.48	99.48	99.48 / 99.48	99.47	99.47	99.46	99.46	99.45	99.45	99.40	99.34	99.29	99.24	99.22	99.18	99.13	99.08	99.02	98.97	98.46
	ELEVATION Right (m)																								
	ELEVATION Left (m)	98.93 / 98.77						98.77 / 98.92						98.92 / 98.82					98.82 / 98.31				98.31 / 97.95		97.95
ELEVATION (m)		99.10 / 99.10	98.85	98.83	98.91 / 98.91	98.99	98.99	99.18	99.26	99.02	99.09	99.09	99.19	99.19	99.19 / 99.19	98.61	98.61	98.18		98.00	97.90	97.80	97.50	97.50 / 97.50	97.50
CUMULATIVE DISTANCE (m)		700.0 / 701.0	720.0	740.0	755.5 / 760.0	780.0	800.0	820.0	840.0	860.0	880.0	900.0	920.0	940.0	955.0 / 960.0	980.0	1000.0	1020.0		1040.0	1060.0	1080.0	1100.0	1120.0 / 1122.0	1140.0
DISTANCE (m)		20.0 / 1.0	19.0	20.0	15.5 / 4.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	15.0 / 5.0	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0 / 2.0	18.0
STATION		No.7 / +1	+20	+40	IP.5 / +60	+80	No.8	+20	+40	+60	+80	No.9	+20	+40	IP.6 / +60	+80	No.10	+20		+40	+60	+80	No.11	+20 / +22	EP
CURVE																									

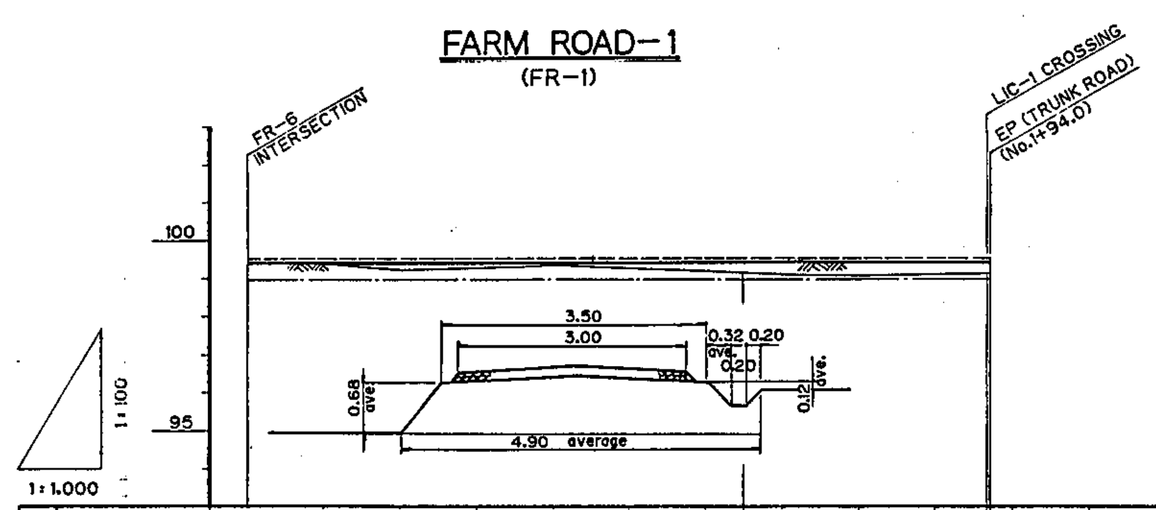


TYPICAL CROSS SECTION OF WET MASONRY OF PITEK RUD

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

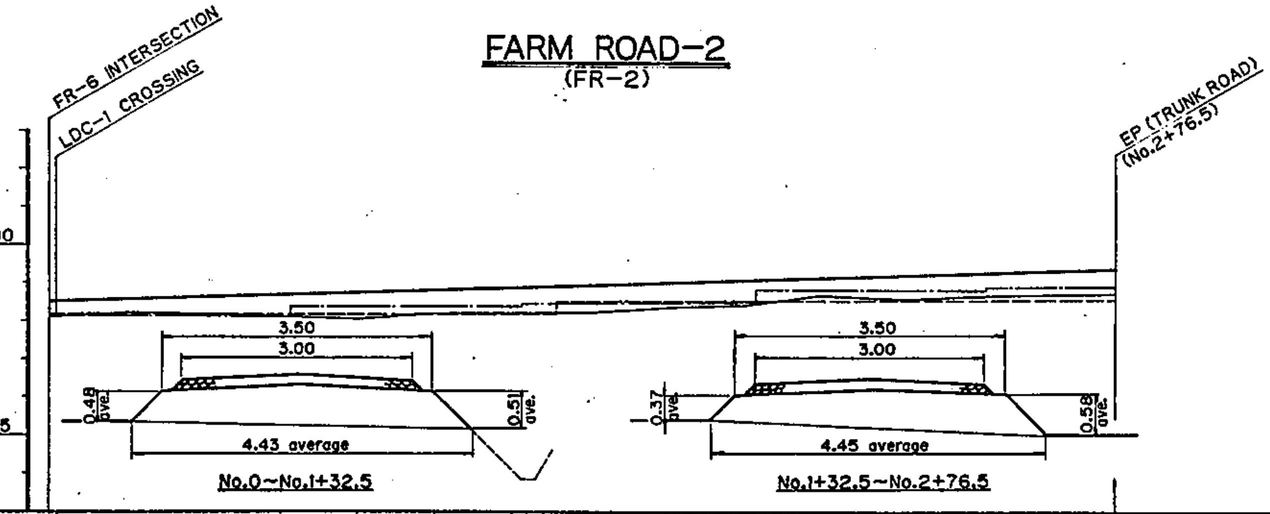
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL PROFILE TR			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 22	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

FARM ROAD-1
(FR-1)



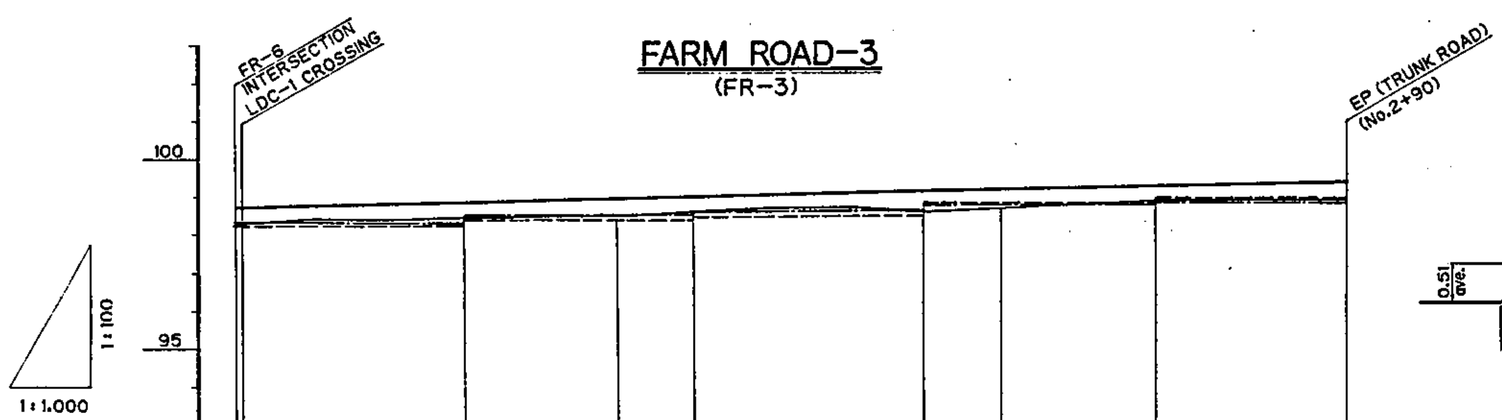
PROPOSED	BERM EL. of ID	99.52										99.73
	ROAD SURFACE ELEVATION	99.55							99.68			99.75
	ELEVATION Right (m)	99.52										99.52
	ELEVATION Left (m)	98.94							98.94 98.99			98.99
ELEVATION (m)		99.41	99.33	99.18	99.25	99.32	99.24	99.16		99.10	99.06	99.15	99.16 99.16
CUMULATIVE DISTANCE (m)		0.0	20.0	40.0	60.0	80.0	100.0	120.0		140.0	160.0	180.0	193.0 194.0
DISTANCE (m)		0.0	20.0	20.0	20.0	20.0	20.0	20.0		20.0	20.0	20.0	13.0 1.0
STATION		No.0	+20	+40	+60	+80	No.1	+20		+40	+60	+80	+93 EP (No.1+94)
CURVE												

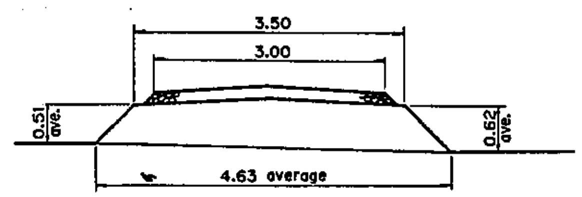
FARM ROAD-2
(FR-2)



PROPOSED	BERM EL. of ID	98.39															99.29
	ROAD SURFACE ELEVATION	99.28 98.50			98.67			98.85	98.88			99.02			99.19		99.30 99.60
	ELEVATION Right (m)	98.20							98.20 98.51								98.51
	ELEVATION Left (m)	98.14			98.14 98.38			98.38 98.47				98.47 98.81			98.81 98.84		98.84
ELEVATION (m)		98.12 98.12	98.22	98.21	98.13	98.11	98.23	98.22	98.28	98.28	98.34	98.42	98.68	98.54	98.67	98.69	98.69
CUMULATIVE DISTANCE (m)		0.0 1.5	20.0	40.0	60.0	80.0	100.0	120.0	132.5	140.0	160.0	180.0	200.0	220.0	240.0	260.0	276.5
DISTANCE (m)		0.0 1.5	18.5	20.0	20.0	20.0	20.0	20.0	12.5	7.5	20.0	20.0	20.0	20.0	20.0	20.0	16.5
STATION		No.0 +1.5	+20	+40	+60	+80	No.1	+20	+32.5	+40	+60	+80	No.2	+20	+40	+60	EP (No.2+76.5)
CURVE																	

FARM ROAD-3
(FR-3)



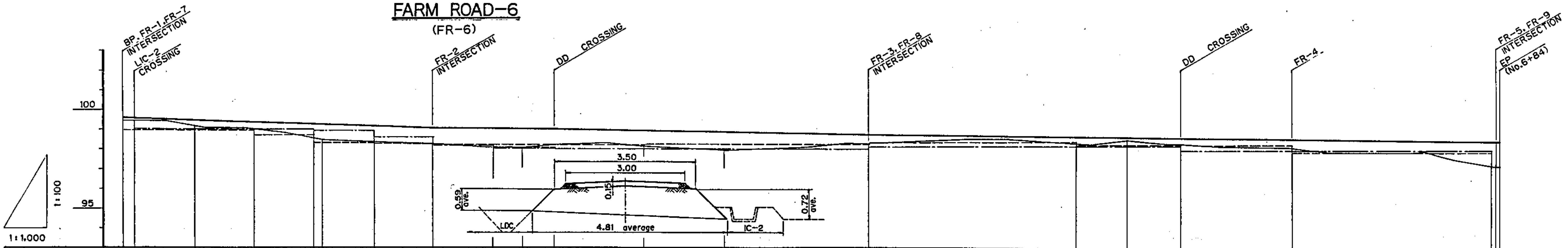


PROPOSED	BERM EL. of ID	98.53															99.26
	ROAD SURFACE ELEVATION	98.75 98.68			98.81			98.95			99.08			99.22			99.50
	ELEVATION Right (m)	98.19			98.19 98.36			98.36 98.45			98.45 98.77			98.77 98.93			98.93
	ELEVATION Left (m)	98.28			98.28 98.49			98.49 98.59			98.59 98.74			98.74 98.77			98.77
ELEVATION (m)		98.25 98.25	98.36	98.35	98.40	98.46	98.45	98.55	98.63	98.68	98.56	98.63	98.73	98.85	98.88	98.87	98.90
CUMULATIVE DISTANCE (m)		0.0 1.5	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0	220.0	240.0	260.0	280.0	290.0
DISTANCE (m)		0.0 1.5	18.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	10.0
STATION		No.0 +1.5	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+20	+40	+60	+80	EP (No.2+90)
CURVE																	

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL·PROFILE FARM ROAD-1.-2 and-3			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 23	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

FARM ROAD-6
(FR-6)

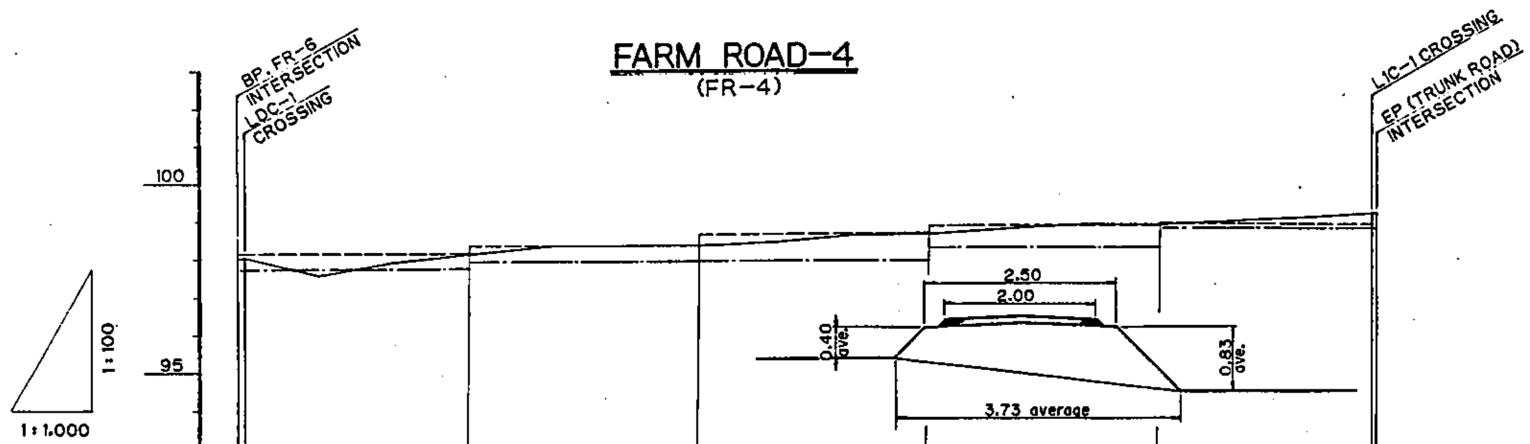


PROPOSED															
BERM EL. of ID	99.52							99.03			98.72				98.17
ROAD SURFACE ELEVATION	99.55	99.48	99.36	99.41	99.35	99.28	99.21	99.05		98.86	98.75	98.60		98.44	98.30
ELEVATION Right (m)	98.94		98.94 98.65	98.65 98.27	98.27 98.20	98.20 98.14			98.14 98.19		98.19 98.28	98.28 98.14		98.14 98.74	97.74
ELEVATION Left (m)	98.96	98.96 98.94	98.94 98.93	98.93 98.86	98.86 98.56	98.56 98.11	98.11 97.98	97.98 97.94			97.94 98.07		98.07 97.83		97.83

ELEVATION (m)	99.40 99.40	99.37	99.02	99.02	98.75	98.39	98.30	98.26	98.12	98.00	98.03	98.18 98.20	98.23	98.08	98.00	97.88	98.00	98.05
CUMULATIVE DISTANCE (m)	0.0 5.5	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0	216.0 220.0	240.0	260.0	280.0	300.0	320.0	340.0
DISTANCE (m)	0.0 5.5	14.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0 4.0	20.0	20.0	20.0	20.0	20.0	20.0
STATION	No.0 +5.5	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+16 +20	+40	+60	+80	No.3	+20	+40
CURVE																		

ELEVATION (m)	98.26	98.25 98.30	98.40	98.45	98.47	98.28	98.19	98.40	98.21 98.22	98.11	98.04	98.01	97.73	97.73	97.73	97.40	97.07 97.07 97.07
CUMULATIVE DISTANCE (m)	360.0	372.0 380.0	400.0	420.0	440.0	460.0	480.0	500.0	520.0 527.0	540.0	560.0	580.0 583.5	600.0	620.0	640.0	660.0	680.2 682.0 684.0
DISTANCE (m)	20.0	12.0 8.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0 7.0	13.0	20.0	20.0 3.5	16.5	20.0	20.0	20.0	20.0 2.0 2.0
STATION	+60	+72 +80	No.4	+20	+40	+60	+80	No.5	+20 +27	+40	+60	+80 +83.5	No.6	+20	+40	+60	+80 +82 EP (No.6+84)
CURVE																	

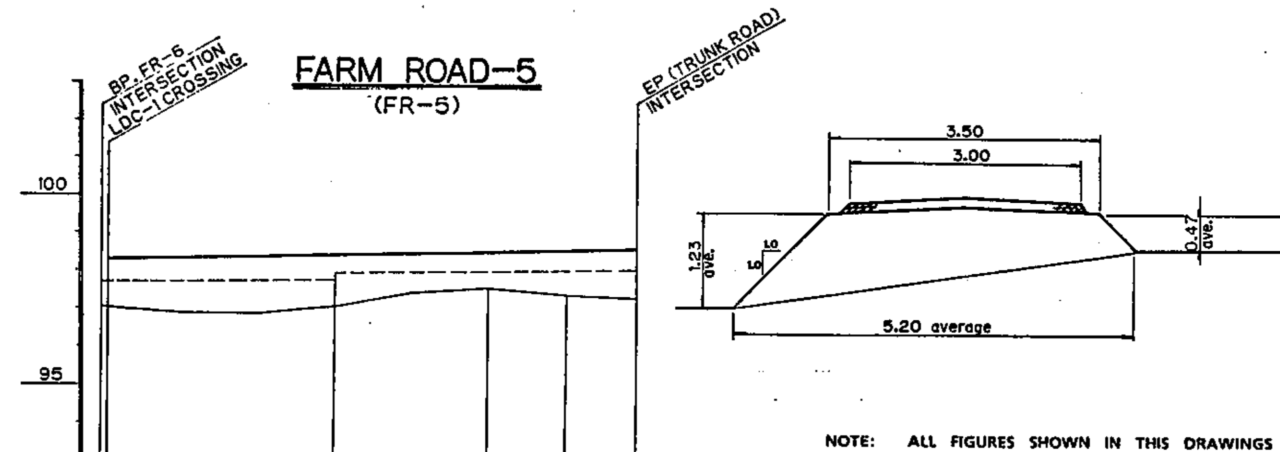
FARM ROAD-4
(FR-4)



PROPOSED								
BERM EL. of ID	99.31		98.86					99.31
ROAD SURFACE ELEVATION	98.44	98.67	98.92	99.04	99.14	99.24	99.26	99.45
ELEVATION Right (m)	98.14	98.14 98.36	98.36 98.64		98.64 98.84		98.84 98.92	98.92
ELEVATION Left (m)	97.74	97.74 97.93	97.93 97.95		97.95 98.31		98.31 98.82	98.82

ELEVATION (m)	98.00 98.00	97.55	97.90	98.29	98.30	98.32	98.34	98.45	98.61	98.63	98.75	98.88	98.83	98.98	99.10	99.19 99.19
CUMULATIVE DISTANCE (m)	0.0 1.5	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0	220.0	240.0	260.0	280.0	296.0 297.0
DISTANCE (m)	0.0 1.5	18.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0 1.0
STATION	No.0 +1.5	+20	+40	+60	+80	No.1	+20	+40	+60	+80	No.2	+20	+40	+60	+80	+96 EP
CURVE																

FARM ROAD-5
(FR-5)



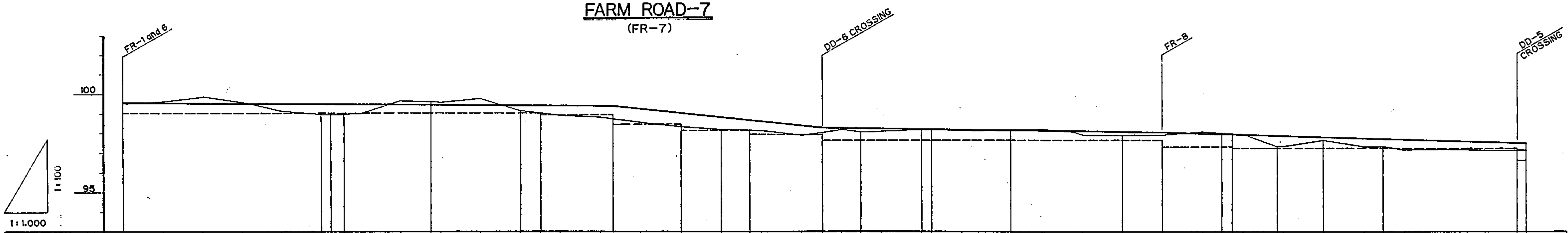
PROPOSED				
BERM EL. of ID				
ROAD SURFACE ELEVATION	98.30	98.23	98.44	98.46
ELEVATION Right (m)	97.74	97.74 97.93	97.93 97.95	97.95
ELEVATION Left (m)				

ELEVATION (m)	97.07 97.07	96.90	96.84	97.00	97.40	97.50	97.30	97.20
CUMULATIVE DISTANCE (m)	0.0 1.5	20.0	40.0	60.0	80.0	100.0	120.0	138.0
DISTANCE (m)	0.0 1.5	18.5	20.0	20.0	20.0	20.0	20.0	18.0
STATION	No.0 +1.5	+20	+40	+60	+80	No.1	+20	EP (No.1 +38)
CURVE								

NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

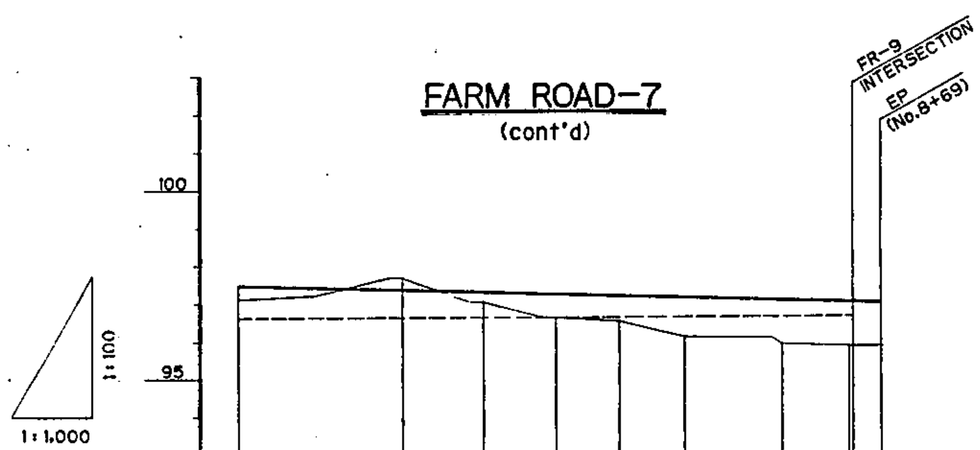
MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL・PROFILE FARM ROAD-4.-5 and-6			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 24	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

FARM ROAD-7
(FR-7)

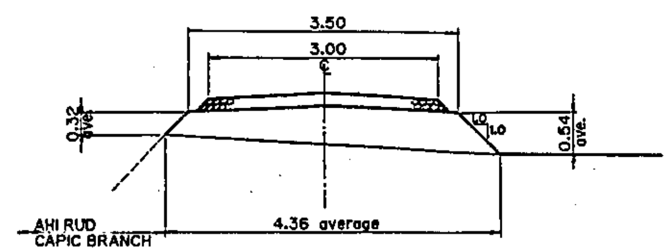


STATION	PROPOSED BERM EL. of ID	PROPOSED ROAD SURFACE ELEVATION	PROPOSED ELEVATION Right (m)	PROPOSED ELEVATION Left (m)	ELEVATION (m)	CUMULATIVE DISTANCE (m)	DISTANCE (m)	CURVE
No.0	99.32	99.55	98.96		99.46	0.0	0.0	
+20					99.55	20.0	20.0	
+40					99.80	40.0	20.0	
+60					99.50	60.0	20.0	
+80					99.09	80.0	20.0	
No.1					98.88	100.0	20.0	
IP.1					98.88	104.5	4.5	
IP.2		99.40	98.96 / 98.94		98.88	111.0	6.5	
+20					98.94	120.0	9.0	
+40					99.55	140.0	20.0	
IP.3					99.55	155.0	15.0	
+60					99.50	160.0	5.0	
+80					99.71	180.0	20.0	
No.2					99.10	200.0	20.0	
		99.31	98.94 / 98.88					
+20					98.83	220.0	20.0	
+40					98.74	240.0	20.0	
	99.18 / 98.87	99.28	98.88 / 98.37					
+60					98.45	260.0	20.0	
+80		98.93	98.37 / 98.05		98.24	280.0	20.0	
No.3					98.10	300.0	20.0	
		98.56	98.05 / 97.83					
+20					98.04	320.0	20.0	
+40					97.80	340.0	20.0	
	98.18	98.18	97.83 / 97.54					
+60					98.11	360.0	20.0	
IP.5					97.99	369.5	9.5	
+80					98.05	380.0	10.5	
No.4					98.12	400.0	20.0	
IP.6		98.10			98.12	405.0	5.0	
+20					98.05	420.0	15.0	
+40					98.05	440.0	20.0	
IP.7		98.04			98.10	444.5	4.5	
+60					98.10	460.0	15.5	
+80					97.80	480.0	20.0	
No.5					97.80	500.0	20.0	
+20 (IP.8)	97.71 (97.65)	97.94	97.54 / 97.22		97.80	520.0	20.0	
+40					97.99	540.0	20.0	
IP.9					97.99	549.5	9.5	
		97.85	97.22 / 97.17					
+60 (IP.10)					97.86	560.0	10.5	
+77.5 (IP.11)					97.23	577.5	17.5	
+80					97.23	580.0	2.5	
No.6					97.55	600.0	20.0	
+20					97.24	620.0	20.0	
IP.12					97.24	630.0	10.0	
+40					97.11	640.0	10.0	
+60					97.11	660.0	20.0	
+80 (IP.13)					97.10	680.0	20.0	
+96	97.29	97.47	97.17 / 96.61		97.10	696.0	16.0	
No.7					97.10	700.0	4.0	

FARM ROAD-7
(cont'd)



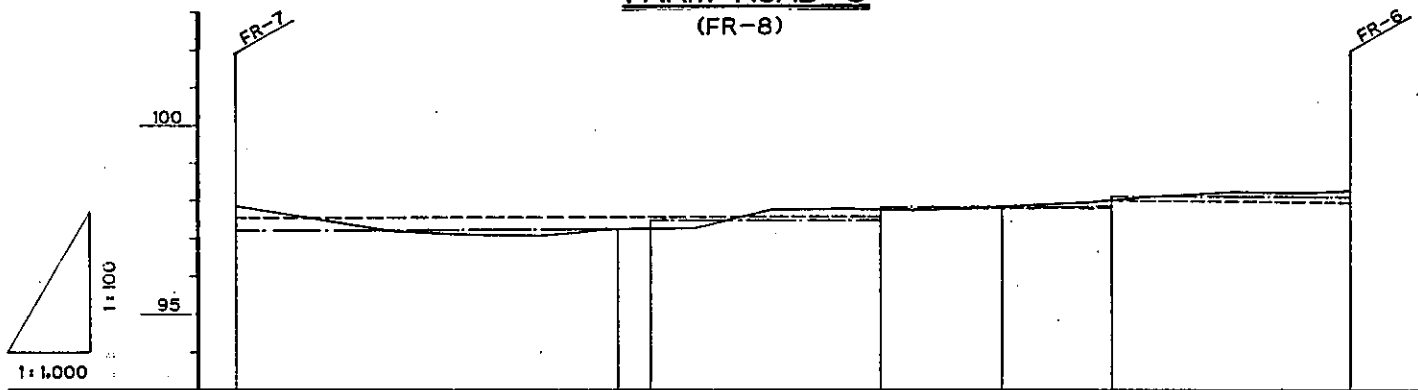
STATION	PROPOSED BERM EL. of ID	PROPOSED ROAD SURFACE ELEVATION	PROPOSED ELEVATION Right (m)	PROPOSED ELEVATION Left (m)	ELEVATION (m)	CUMULATIVE DISTANCE (m)	DISTANCE (m)	CURVE
No.7		97.46	96.61		97.10	700.0	4.0	
+20					97.17	720.0	20.0	
+40		97.35			97.67	740.0	20.0	
IP.13					97.67	743.0	3.0	
+60					97.03	760.0	17.0	
IP.14					97.03	764.5	4.5	
+80					96.62	780.0	15.5	
IP.15					96.62	783.5	3.5	
No.8					96.50	800.0	16.5	
IP.16					96.10	817.0	17.0	
+20					96.10	820.0	3.0	
+40					96.09	840.0	20.0	
IP.17					95.90	842.5	2.5	
+60					95.85	860.0	17.5	
+61		97.00	96.61		95.85	861.0	1.0	
EP (No.8+69)					95.85	869.0	8.0	

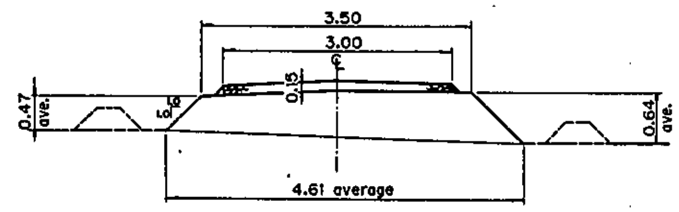


NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL・PROFILE FARM ROAD-7			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 25	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

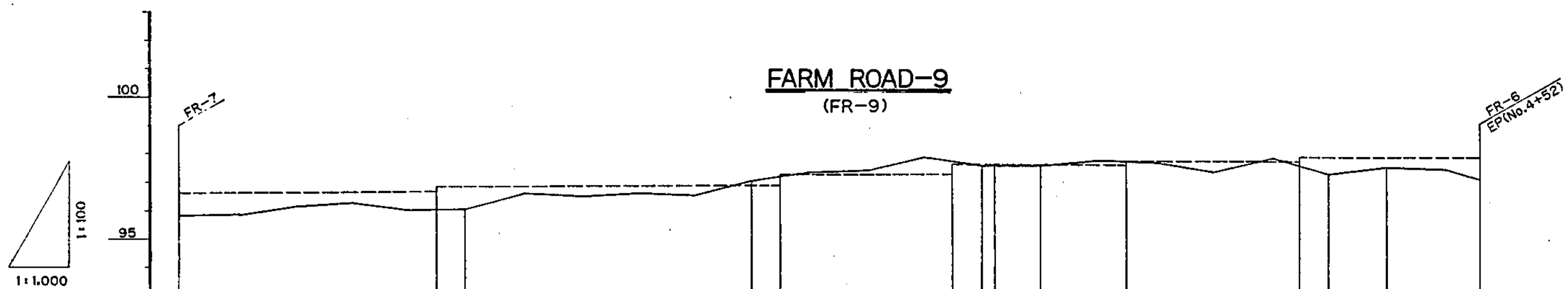
FARM ROAD-8
(FR-8)

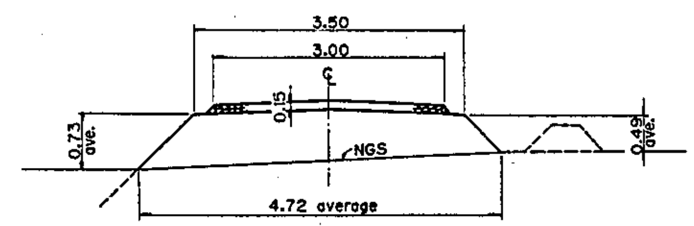




		No.0	+20	+40	+60	+80	No.1		+20	+40	+60		+80	No.2	+20		+40	+60	+80	EP (No.2+ 90.5)
PROPOSED	BERM EL. of ID	97.71						97.96				98.10				98.24				98.39
PROPOSED	ROAD SURFACE ELEVATION	97.94						98.04				98.10				98.38			98.68	98.75
PROPOSED	ELEVATION Right (m)	97.54										97.54 97.77				97.77 97.94				97.94
PROPOSED	ELEVATION Left (m)	97.22						97.22 97.47				97.47 97.80				97.80 98.07				98.07
ELEVATION (m)		97.80	97.49	97.13	97.07	97.07	97.23		97.36	97.72	97.74		97.73	97.82	97.91		98.13	98.24	98.21	98.23
CUMULATIVE DISTANCE (m)		0.0	20.0	40.0	60.0	80.0	100.0		120.0	140.0	160.0		180.0	200.0	220.0		240.0	260.0	280.0	290.5
DISTANCE (m)		0.0	20.0	20.0	20.0	20.0	20.0		20.0	20.0	20.0		20.0	20.0	20.0		20.0	20.0	20.0	10.5
STATION		No.0	+20	+40	+60	+80	No.1		+20	+40	+60		+80	No.2	+20		+40	+60	+80	EP (No.2+ 90.5)
CURVE																				

FARM ROAD-9
(FR-9)

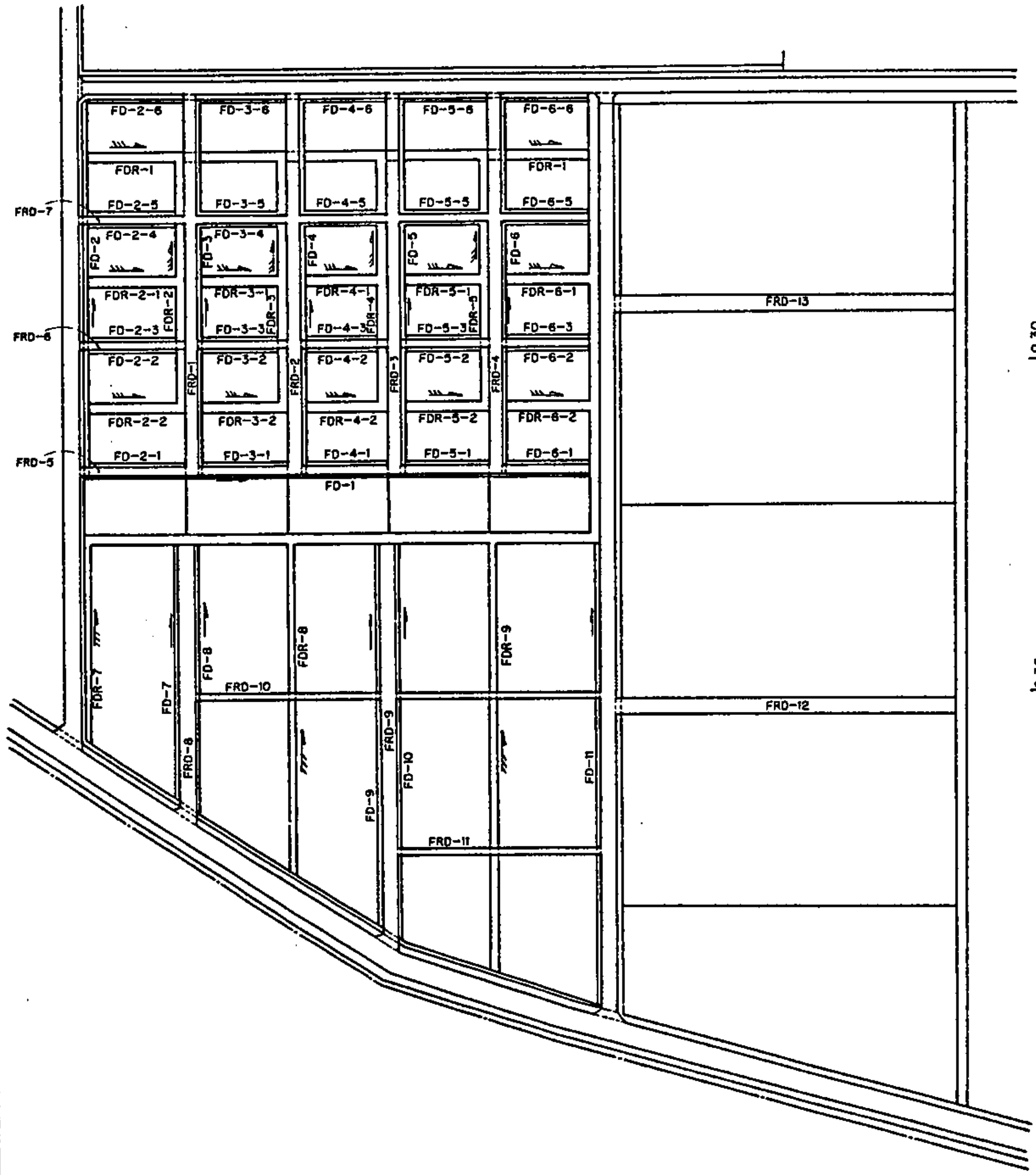


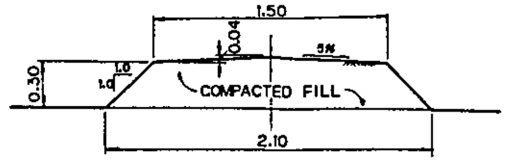


		No.0	+20	+40	+60	+80		No.1	+20	+40	+60	+80	No.2		+20	+40	+60		+80 IP.1	No.3	+20	+40	+60	+80		No.4	+20	+40	EP (No.4+ 52)
PROPOSED	BERM EL. of ID	96.86					97.12							97.47				97.64			97.82				97.99				98.17
PROPOSED	ROAD SURFACE ELEVATION	97.00					97.26							97.60				97.78			97.95				98.12				98.30
PROPOSED	ELEVATION Right (m)	96.61					96.61 96.78							96.78 97.19				97.19 97.53			97.53 97.69				97.69 97.83				97.83
PROPOSED	ELEVATION Left (m)																												
ELEVATION (m)		95.83	95.82	96.09	96.19	95.97		96.00	96.55	96.42	96.59	96.49	97.00		97.29	97.37	97.80		97.50 97.50	97.50	97.70	97.60	97.30	97.80		97.26	97.50	97.40	97.07
CUMULATIVE DISTANCE (m)		0.0	20.0	40.0	60.0	80.0		100.0	120.0	140.0	160.0	180.0	200.0		220.0	240.0	260.0		280.0 284.5	300.0	320.0	340.0	360.0	380.0		400.0	420.0	440.0	452.0
DISTANCE (m)		0.0	20.0	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	20.0		20.0	20.0	20.0		20.0 4.5	15.5	20.0	20.0	20.0	20.0		20.0	20.0	20.0	12.0
STATION		No.0	+20	+40	+60	+80		No.1	+20	+40	+60	+80	No.2		+20	+40	+60		+80 IP.1	No.3	+20	+40	+60	+80		No.4	+20	+40	EP (No.4+ 52)
CURVE																													

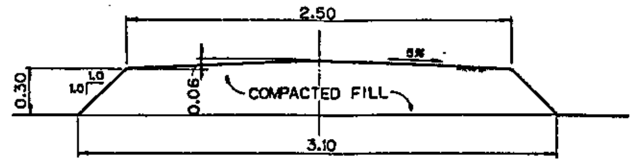
NOTE: ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LONGITUDINAL・PROFILE FARM ROAD-8 and-9			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No. 26	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			

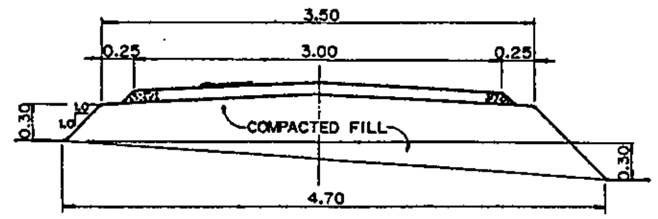




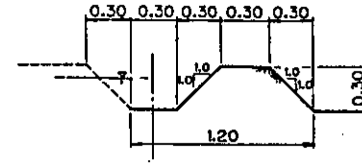
FARM ROAD (FRD) (TYPE 1)



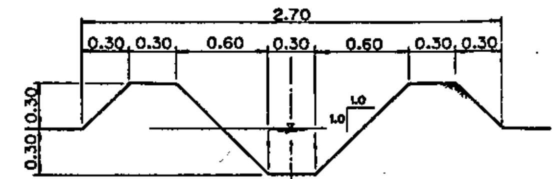
FARM ROAD (FRD) (TYPE 2)



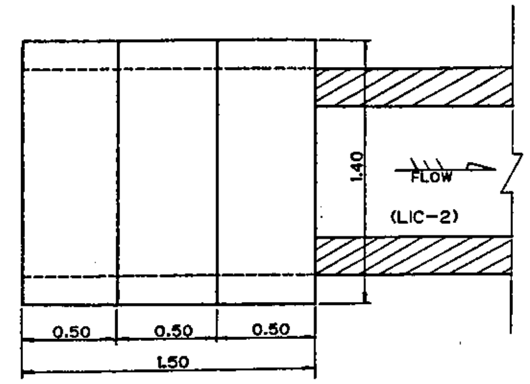
FARM ROAD (FRD) (TYPE 3)



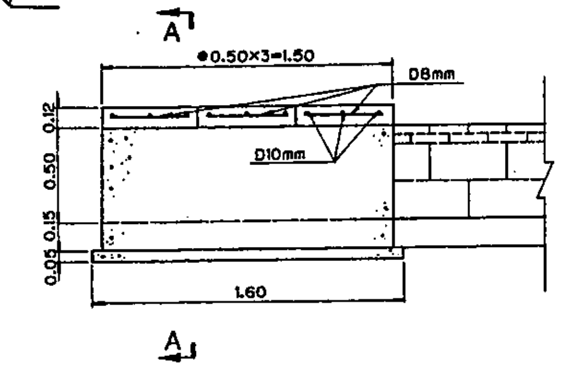
FARM DITCH (FD)



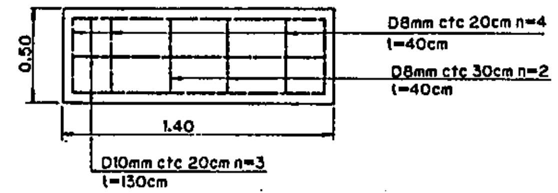
FARM DRAIN (FDR)



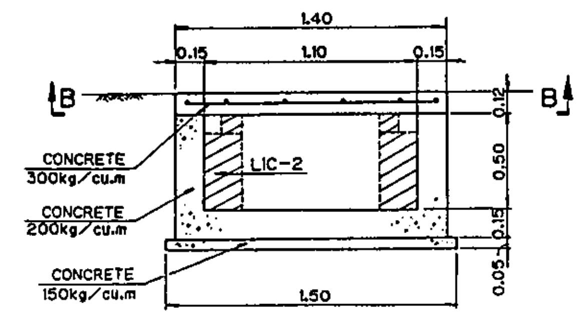
PLAN



PLOFILE



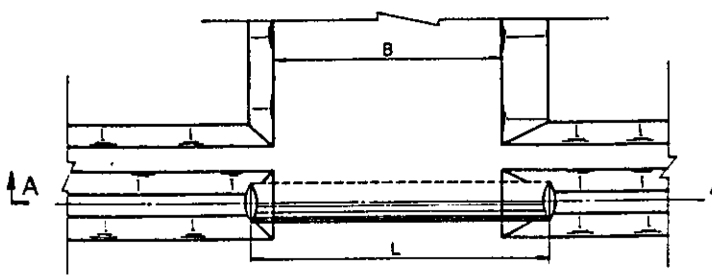
SECTION B-B



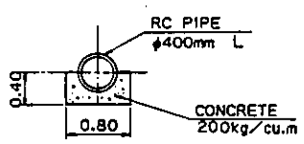
SECTION A-A

FD ROAD CROSSING (TYPE-4)

SCALE 1:50



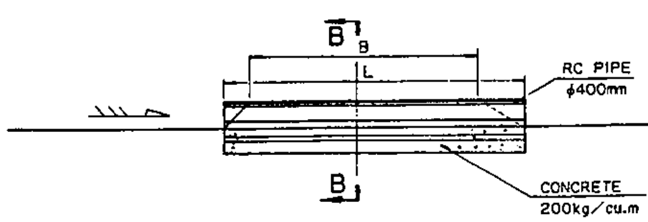
PLAN



SECTION B-B

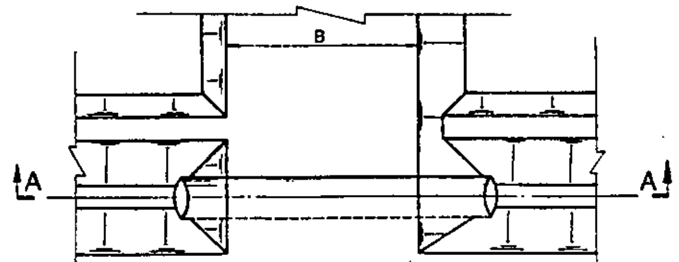
DIMENSION

TYPE	B	L	REMARKS
1	1.5m	2.5m	
2	2.5	3.5	
3	3.5	5.0	

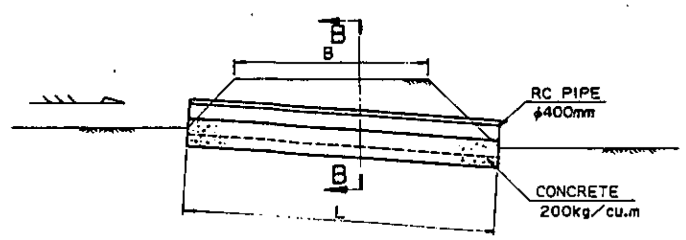


SECTION A-A

FD ROAD CROSSING



PLAN



SECTION A-A

DIMENSION

TYPE	B	L	REMARKS
1	1.5m	3.5m	
2	2.5	5.0m	
3	3.5	5.0	

FDR ROAD CROSSING

NOTE : ALL FIGURES SHOWN IN THIS DRAWINGS ARE IN METER, UNLESS OTHERWISE SPECIFIED. THE FIGURES OF DISTANCE AND ELEVATION IN THIS DRAWING ARE BASED ON THE TOPOGRAPHIC MAP WITH A SCALE OF 1 : 1,000 SURVEYED BY MINISTRY OF AGRICULTURE

MINISTRY OF AGRICULTURE			
HARAZ RIVER BASIN AGRICULTURAL DEVELOPMENT PROJECT			
LAYOUT and DRAWINGS OF EXPERIMENTAL FARM and NECESSARY FACILITIES			
SURVEYED		CHECKED	
DESIGNED		SUBMITTED	
DWG No 27	APPROVED		
JAPAN INTERNATIONAL COOPERATION AGENCY			