3) As the rehabilitation and improvement work will not be completed in a single year, due attention should be paid not only to water drainage in the Project area but also to that in the adjacent other areas throughout the entire construction period.

4) Although the suitable utilization of local labour force and local construction methods is intended for the performance of the construction work, the technical standard of the construction work must be highly reliable by taking into due consideration the fact that the work is implemented by Japanese grant aid and, thereby, generating high expectations on the Bangladesh side in terms of the application of Japanese technologies.

5) All the rehabilitation and improvement work will be implemented within the land which has been already acquired. These boundaries must be confirmed prior to the commencement of the work and the assurance of the concerned authorities and personnel on these boundaries must be obtained.

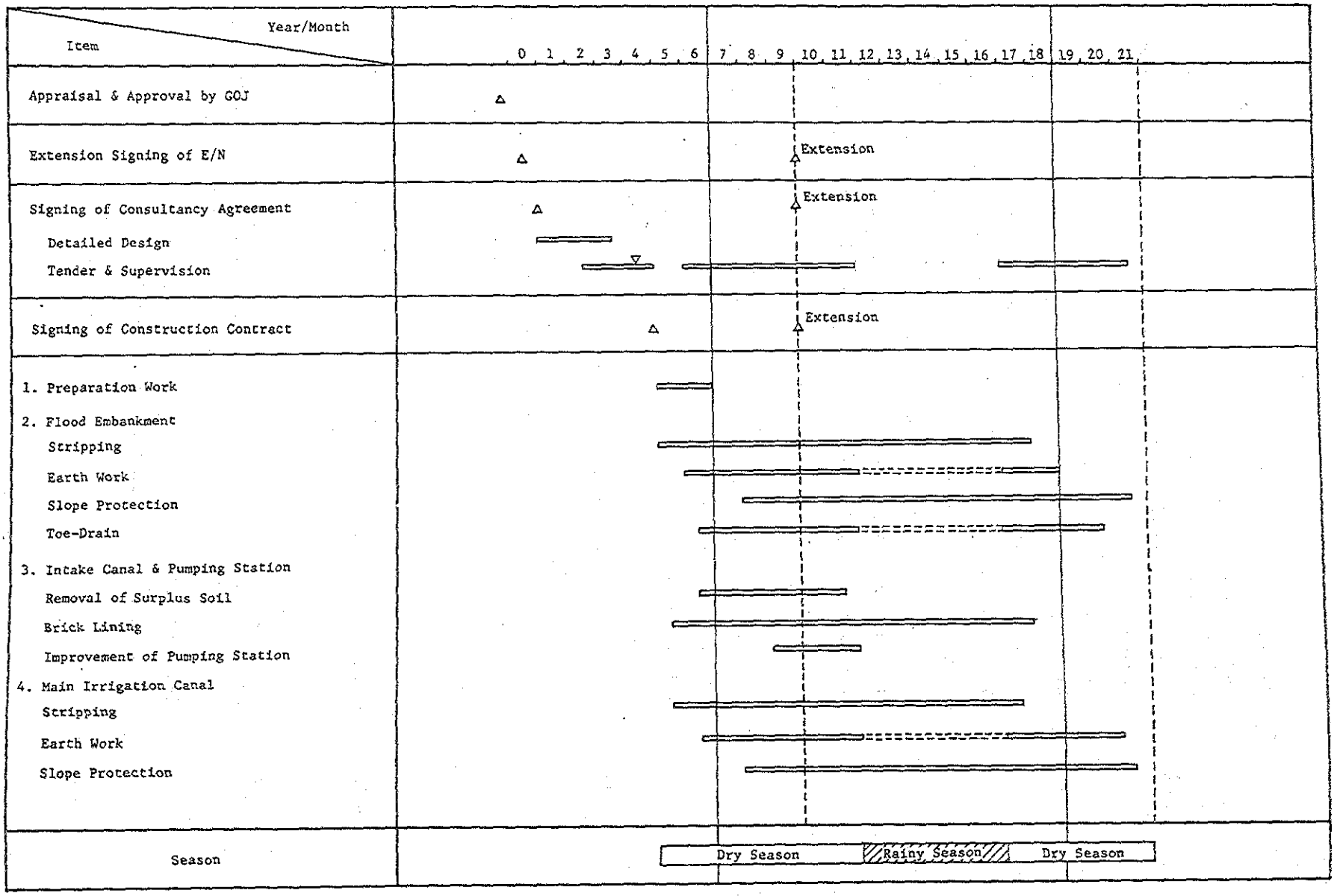
6) As the major earth work can only be implemented in the dry season, the working efficiency must be improved by making the necessary arrangements in advance.

6.3.4 Construction Plan and Construction Supervision Plan

(1) Construction Plan

As has been mentioned in 6.3.2, the rehabilitation and improvement work will be implemented by the Japanese contractor described in 6.1 (3) with Japanese grant aid cooperation. Fig. 6-3-1 shows the implementation schedule.

Fig. 6-3-1 Implementation Schedule



(2) Labour Plan

In principle, the necessary labour for the Project will be locally recruited, excepting the labour for the work requiring advanced techniques. Consequently, engineers, who play a crucial role in the technical supervision and control of the implementation schedule, and those, who take charge of replacing pump parts of the pumping station, will be dispatched from Japan. These Japanese engineers and their respective assignments are listed below.

Staff	Main Work Assignment
Project Manager	General management for all aspects of the contracted work
Civil Engineer (A)	Chief engineer responsible for the foundation of the pumping station, smooth implementation of the work schedule, work completion, quality control, safety control and the guidance/education of local engineers
Civil Engineer (B)	Responsible for the construction of the flood embankment and drainage canals
Civil Engineer (C)	Responsible for the construction of the main irrigation canal
Controller	Responsible for the procurement and control of equipment and materials
Clerk	Responsible for accounting and documentation
Electrician	Supervisor for the electrical work
Test Engineer	Responsible for material and quality control testing

(3) Tender and Construction Supervision Plan

The provision of tender services and the supervision of construction will be undertaken by the consultant based on the contract with the BWDB. The main contents of the consultancy services are shown as follows.

a) Preparation of tender documents

b) Performance of the tender procedure as an agent and analysis/assessment of tender documents

c) Provision of advice for negotiations between the Government of Bangladesh and a successful tenderer

d) Supervision of the rehabilitation and improvement work

f) Final inspection

g) Preparation of monthly progress reports

The staff required for the above services and their main work assignments are shown as follows.

Staff	Main Work Assignment
General Manager	General management of the entire Project
Agricultural Civil Engineer	Full-time and on-the-spot management and technical and work schedule supervision for the entire work
Geologist	Instructions and supervision of materials and quality control tests, and provision of advice on matters pertaining to geology and soil
Spec-Writer	Preparation of tender documents and technical specifications, performance of tender procedure as an agent, advice for the contract with the contractor and final inspection

6.3.5 Equipment and Materials Procurement Plan

The equipment and materials required for the rehabilitation and improvement work will be locally procured as many as possible in accordance with the construction work policy. Those, which cannot be locally procured or are assured with unsatisfactory quality and also cannot be expected to provide a stable supply in terms of

volume and price, will be imported from Japan. The main items to be procured locally and those to be imported from Japan are listed as follows.

(1) Main Items for Local Procurement

Cement, plain reinforcing bars, deformed reinforcing bars, sand for concrete, gravel for concrete, bricks, brick chips, RCC pipes, turf, jute sandbags and wooden piles

(2) Main Items for Procurement in Japan

Small construction machinery (tampers, mixers, vibrators, engine pumps, etc.), water-proof plywood for forms, parts for forms (separators, formties, etc.), release agent for forms, pipe supports, nails, tying wires, parts for water level detection equipment, surveying equipment, stationary and chemicals

6.4 Implementation Schedule

(1) Detailed Design

Following the signing of the E/N between the Governments of Bangladesh and Japan, the BWDB will conclude the agreement for the detailed design work and construction supervision with the consultant. After the agreement has been signed, the consultant will then immediately commence the detailed design work based on the rehabilitation plan worked out through the Basic Design Study while reconfirming the contents of the detailed design and other relevant aspects through discussions with the BWDB at the beginning of the work. It takes 2.5 months to complete the detailed design work.

(2) Selection of Contractor

Following the signing of the E/N for the Project, the consultant will then prepare the tender documents and conduct the tender procedure and evaluation on behalf of the BWDB to select a contractor and, consequently, a successful tenderer will be decided. The successful tenderer will conclude the contract with the BWDB following negotiations. This contract with the contractor should be completed in 3 months after the signing of the E/N. The construction work should commence within 1 month after the signing of the contract and should be completed by the end of March, 1990. Fig. 6-3-1 shows the implementation schedule.

6.5 Rough Estimation of Project Cost

- Measures to be Undertaken by Bangladesh Side

The BWDB is expected to conduct all necessary procedures, including tax exemption, in regard to the smooth importation of the project-related equipment and materials referred to in 6.3.5 (2).

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

7.1 Operation and Maintenance System

The number of water resources development projects in Bangladesh has now exceeded 530 (409 completed and 123 currently in progress) and the BWDB is entirely responsible for the operation and maintenance of the facilities constructed under these projects. The Demonstration Unit is not exceptional and has been put under operation and maintenance by a sub-division of the NNDP which is part of the BWDB, as already described in 4.2.4, and this system will continue to apply for the operation and maintenance work after the completion of the Project. As an integrated operation and maintenance system is planned for the overall N-N Irrigation Project, some 30 employees will be allocated to the relevant work on the completion of the neighbouring Block A-1 Project. As several years are still required for the completion of the Block A-1 Project, however, the immediate operation and maintenance work will be conducted by the following staff mostly dealing with the Demonstration Unit.

Personnel	No.	Remarks
Civil Engineering Section		
Sub-Divisional Engineer	1	
Sub-Assistant Engineers	2	
Work Assistants	4	
Mechanical Section		
Sub-Divisional Engineer	1/2	concurrently serving for other areas
Sub-Assistant Engineer	1/2	do.
Foreman	1/2	do.
Operators	5	full-time
Electrician	1	do.
Mechanic	1	do.
Total	17	

7.2 Operation and Maintenance

Following the completion of the rehabilitation and improvement of the facilities subject to the Project, such work as operation, checking, maintenance, monitoring and repair of the facilities will be conducted under the system described in 7.1 by the BWDB. The BWDB will also establish farmers' organizations and provide guidance and education on farming techniques and other aspects which are indispensable for the appropriate operation of the facilities.

In the course of the current Basic Design Study, agreement was reached between the Bangladesh and Japanese Governments to implement the full-scale rehabilitation of the flood embankment (i.e. its reinforcement by widening and other measures) damaged by flooding in 1987, improvement of the intake canal and the pumping station in view of restoring and expanding their irrigation water supply functions and improvement of the main irrigation canal embankment. In addition, field investigations were made on the secondary and tertiary canals, the completion of which is given the first priority for the BWDB.

Based on the analyses conducted in Japan using the survey results and collected information, it is recommended that the BWDB should pay special attention to the safety and smooth functioning of the rehabilitated facilities as described below.

(1) Operation and Maintenance of Flood Embankment

The construction and maintenance of a stable flood embankment constitute an essential requirement for any flood embankment project and can decide the success or failure of the project. As a major premise of the Project is that no new land will be acquired, extra efforts will be necessary to maintain the safety and stability of the flood embankment. This point was stressed in the Recommendations by the Study Team attached to the Minutes of Discussions and was agreed upon by the Study

Team and the BWDB (see Appendix 1-4). The main points of these recommendations in regard to the operation and maintenance of the flood embankment are as follows.

1) No excavation should be allowed at the land adjacent to the river side of the flood embankment. In addition, the introduction of legal measures to prohibit or control such acts should be taken into consideration.

2) Farmers should be instructed not to pump up irrigation water from the MDC in the Demonstration Unit to outside the Unit over the flood embankment in the dry season or appropriate methods of obtaining irrigation water should be taught to prevent scouring of the embankment. Furthermore, the introduction of legal measures to severely punish those responsible for damage to the embankment should be taken into consideration.

3) The water level in the MDC in the rainy season should be kept as high as possible by controlling pumping operations so that the difference between the water heads inside and outside the flood embankment is minimized while preventing any decline of the drainage function in the Unit.

4) As the slope of the embankment tends to be loose in the rainy season, farmers should be instructed not to use the flood embankment for grazing or for driving livestock, especially oxen.

5) Farmers' organizations should be established to conduct their self-management on the following work.

   a) Regular patrol of the flood embankment to prevent artificial damage such as those described in 1) and 2) above.

b) Early detection of damage due to any reason.

c) Quick repair of animal holes or other damage to prevent long-term negligence of such holes or damage.

6) An emergency communication system should be established between the BWDB and the farmers' organizations described in 5) above.

(2) Operation and Maintenance of Intake Canal

1) Cleaning of the intake canal should be implemented to remove sediment deposits from the canal bed.

2) The sediments so removed should not be left on or near the canal slopes.

(3) Other Irrigation and Drainage Facilities

1) Pipes or culverts with a sufficient sectional flow area should be provided for roads crossing the MIC (such as the access road to the brick factory) to secure the free flow of irrigation water.

2) The MDC and such related facilities as those described in 1) above and turnouts should be cleaned prior to the commencement of irrigation water supply and maintained in favourable conditions during the irrigation period.

3) In the past, the supply of irrigation water to the terminal facilities has sometimes been inadequate, adversely affecting the farmers' willingness to promote irrigated farming or to maintain the irrigation and drainage facilities. Therefore, the BWDB should provide technical and managerial guidance on irrigated farming through the farmers' organizations and also try to make the farmers

aware of the paramount importance of the operation and maintenance of the facilities and water management.

Some of the above recommendations can be immediately implemented by the BWDB while others may require some time to revise the relevant laws or regulations. It is, therefore, hoped that the BWDB will endeavour to implement these recommendations as soon as possible, starting from those which are easiest to implement.

CHAPTER 8 PROJECT APPRAISAL, CONCLUSION AND RECOMMENDATIONS

8.1 Project Appraisal

The breaching of the flood embankment on August 14, 1987 caused flooding to the entire Demonstration Unit, and completely damaged paddy and other crops ready for harvest in the following autumn. With the completion of the emergency rehabilitation work in June, 1988, the Demonstration Unit will again be made free from the threat of floods at least one year after its completion, and average yield can be expected at the end of this year.

The implementation of the Project will not only make the Project area free from flood but also solve the problem of insufficient irrigation water in the period when it is most required (November - February) by means of improvement of such irrigation facilities as the intake canal, pumping station and main irrigation canal. In addition, with the performance of appropriate water distribution control, irrigable area will be increased and bring about high agricultural productivity, which will contribute to the achievement of self-sufficiency in food production.

This Demonstration Unit has, by its completion, brought about the development of regional agriculture and the stability of living conditions of local inhabitants and, as a result, it has been provided with a good reputation by the Bangladesh side as has been stated before. Since it is heavy losses for both countries of Japan and Bangladesh to interrput this kind of excellent project by damages due to a natural calamity, contribution of this Project to agricultural production increases and the stability and improvement of living conditions can be said to be of great significance.

8.2 Conclusion and Recommendations

The smooth implementation and eventual success of the Project require the timely implementation of the work to be undertaken by the Government of Bangladesh in accordance with the implementation schedule (see Fig. 6-3-1).

Due emphasis is put on proper functioning the rehabilitated facilities under appropriate operation and maintenance and keeping them in favourable conditions after the completion of the Project. The stability of the flood embankment must be only was for the success of the Project.

For the success of the Irrigation Project for the Demonstration Unit, the BWDB should thoroughly examine various measures with regard to the operation and maintenance of the facilities described in 7.2 and implement those measures as soon as possible, of which is easier to implement in order. The BWDB should further make effort to establish farmers' organizations for daily operation and maintenance on farm.

APPENDICES

APPENDIX I

1 - 1 Formation of the Basic Design Study Team

Members of the Study Team and their assignments are listed as follows:

Mr. Tokuo TODOROKI, Team Leader
Construction Department
Kantoh Agricultural Administration Office
Ministry of Agriculture, Forestry and Fisheries

Mr. Ryoji NODA, Planning Management
Grant Aid Division, Economic Cooperation Bureau
Ministry of Foreign Affairs

Mr. Toshiaki SHIMAUCHI, Irrigation Planning
Japan Engineering Consultants Co., Ltd.

Mr. Akira HAGIWARA, Irrigation Facilities Design
Japan Engineering Consultants Co., Ltd.

Mr. Ayazo SEKINE, Civil Works Design
Japan Engineering Consultants Co., Ltd.

Mr. Hiromi YAMAGAI, Geological Investigation
Japan Engineering Consultants Co., Ltd.

1 - 2 Itinerary of the Study

Day in ( ) indicates a holoday.

No.	Date/Day	Schedule	Contents of the Study
1.	Feb. 15 Mon	Tokyo-Bangkok	Departure of 1st party from Japan
2.	16 Tue	Bangkok-Dhaka	Arrival of 1st party at Dhaka
			Visit and discussion with Embassy of Japan and JICA
3.	17 Wed		Courtesy visit and submission of Inception Report to Ministry of Irrigation, Water Development and Flood Control and site survey
4.	18 Thu		Courtesy visit, explanation of Inception Report and Questionnaire to and discussion with BWDB and visit to and discussion with JICA
5.	19(Fri)		Site survey on Flood Embankment, Intake Canal, MIC, SIC and TIC /Commencement of levelling of Intake Canal
			Review of data or information such as reports and/or drawings collected in Japan
6.	20 Sat		Site survey being continued
7.	21(Sun)		Review of data and information as mentioned above
8.	22 Mon		Site survey on Flood Embankment, MIC, SIC, and TIC
9.	23 Tue		Discussion with the counterpart of BWDB (S.D.E.)
			Site survey and supervision of boring / Sorting and review of data and information collected in Dhaka
10.	24 Wed	Tokyo-Bangkok	Site survey in Golakandail Village and along Flood Embankment
11.	25 Thu	Bangkok-Dhaka	Arrival of 2nd party at Dhaka
			Visit and discussion with Embassy of Japan and JICA

Day in ( ) indicates a holiday.

No.	Date/Day	Schedule	Contents of the Study
11.	Feb. 25 Thu		Discussion with the counterpart of BWDB and data collection / Sorting and review data and information
			Completion of field work on levelling of Intake Canal
12.	26(Fri)		Site survey with 2nd party on Intake Canal, Pumping Station, MIC, SIC, TIC and Flood Embankment
			Data collection for construction and cost estimation
13.	27 Sat		Courtesy visit to and discussion with ERD, Ministry of Irrigation, Water Development and Flood Control and BWDB
			Internal discussion of the Team
14.	28 Sun		Site survey with 2nd party and the counterpart on MIC, SIC, TIC and Flood Embankment / Completion of boring and other tests
			Preparation of Minutes of Discussion (draft)
15.	29 Mon		Courtesy visit to and discussion with Chairman of BWDB
			Discussion with BWDB on Minutes of discussion
			Reporting the result of Discussion to Embassy of Japan and JICA
16.	Mar. 1 Tue		Signing of Minutes of Discussion between BWDB and the Team
17	2(Wed)		Office work: Sorting and review of data or information collected / Preparatory work of the Study for preparation of basic design plans
18	3(Thu)		Internal team discussion for review of the Study results so far and forecast or recomendation to the future work to be carried out
			Office work being continued
		Dhaka-Bangkok (2nd party)	Departure of 2nd party from Dhaka

Day in ( ) indicates a holiday.

No.	Date/Day	Schedule	Contents of the Study
19.	Mar. 4(Fri)		Office work: Sorting and review of data or information collected / Preparatory work of the Study for preparation of basic design plans
20.	5 Sat		Submission of the letter from the Team leader to BWDB / Discussion with the counterpart of BWDB(S.E.) Commencement of levelling survey on Main Irrigation Canal (MIC) Embankment by employing a local survey team / Supervision of the survey work and geological investigation at the site Office work being continued Investigation relating to construction work through local contractors
21.	6 Sun		Discussion with the counterpart of BWDB (S.E.) Site work: Levelling survey Office work being continued
22.	7 Mon		Discussion with the counterparts of BWDB (E.E.-Design II and S.D.E.-NNDP) on design details Site work: Levelling survey Internal team discussion on the contents of discussion held with BWDB in the morning Office work being continued Preparation of the draft record of discussion with BWDB
23.	8 Tue		Office work: Preparation of the draft record of discussion with BWDB and a request letter to BWDB for data collection / Sorting and review of data or information collected Site work: Levelling survey being continued
24.	9 Wed		Obtaining the approval of JICA, Dhaka, to submit a request letter to BWDB for data collection required by the Team / Submission of the letter to BWDB (att. S.E.-O&M)

Day in ( ) indicates a holoday.

No.	Date/Day	Schedule	Contents of the Study
24.	Mar. 9 Wed		Site work: Levelling survey being continued Office work being continued
25.	10 Thu		Submission of the draft record of discussion with BWDB to S.D.E. Site work: Levelling survey being continued/ Completion of field survey work of MIC Embankment / Site investigation at Pumping Station and on Flood Embankment Office work: Sorting, review and examination of site investigation results
26.	11(Fri)		Commencement of levelling survey on SIC by employing a local survey team / Supervision of survey work Office work: Study for preparation of basic design plans / Preparatory work for Field Report / Sorting of geological investigation results
27.	12 Sat.		Site work: Levelling survey being continued Office work being continued
28.	13 Sun		Site work: Levelling survey being continued / Completion of field survey work of SIC Internal team discussion for examination of basic design plans to be proposed for the Project Office work: Preparatory work for Field Report including geological investigation results / Partial amendment of the record of discuesion held with BWDB on March 7, 1988 according to the checking by BWDB (E.E.-Design II)
29.	14 Mon		Submission of the above record of discussion to BWDB (E.E.-Design II) and discussion with him Site work: Instructions of levelling points to be surveyed to the surveyor for spot-elevation survey on Intake Canal and Pumping Station

Day in ( ) indicates a holiday.

No.	Date/Day	Schedule	Contents of the Study
29.	Mar. 14 Mon		Office work: Preparation of the reference for the next discussion on field survey results and basic design plans to be proposed by the Team for the Project
30.	15 Tue		Site work: Investigation on MIC, SIC and TIC / Geological and soil investigation
33.	18(Fri)		Office work: Preparation of the reference of discussion as mentioned above
34.	19 Sat		Discussion with the counterpart of BWDB (S.E.-O&M, E.E.-Design II, E.E.-Dhaka O&M and S.D.E.-NNDP) on design Office work: Checking of survey drawings at the surveyor's office / Preparation of the draft record of discussion held with BWDB in the morning
35.	20 Sun		Office work being continued
36.	21 Mon		Submission to BWDB (S.E.-O&M) of the draft record of discussion held with BWDB on March 19, 1988 Office work: Preparation of draft Field Report
37.	22 Tue		Office work being continued
38.	23 Wed		Submission of BWDB (S.E.-O&M) of draft Field Report / Attendance of site inspection by Chairman and other BWDB's staff Office work: partial amendment of the record of discussion
39.	24 Thu		Office work: Amendment of Field Report / Preparation of basic design (mainly rough estimation of quantity and cost for construction
40.	25(Fri)		Office work being continued
41.	26(Sat)		- do -
42.	27 Sun		Discussion with JICA and Embassy of Japan Office work: Rough estimation of quantity and cost for construction / Preparation of Field Report

Day in ( ) indicates a holiday.

No.	Date/Day	Schedule	Contents of the Study
43.	Mar. 28 Mon		Discussion with BWDB to finalize basic design details / Courtesy calls to Bangladesh authorities concerned Reporting the Study results to JICA and Embassy of Japan
44.	29 Tue	Dhaka-Bangkok	Departure of 1st party from Dhaka
45.	30 Wed	Bangkok-Tokyo	Arrival of 1st party at Tokyo

Notes: The 2nd party consists of Team Leader and Planning Manager.

Addreviation:

BWDB	;	Bangladesh Water Development Board
JICA	;	Japan International Cooperation Agency
MIC	;	Main Irrigation Canal
SIC	;	Secondary Irrigation Canal
TIC	;	Tertiary Irrigation Canal
S.E.	;	Superintending Engineer
E.E.	;	Executive Engineer
S.D.E.	;	Sub-Divisional Engineer
O & M	;	Operation and Maintenance
NNDP	;	N - N Demonstration Project

1 - 3 Concerned Personnel

(1) Bangladesh Government

1) Ministry of Planning

Mr. Md. Nasim	Deputy Secretary External Resources Division (ERD)

2) Ministry of Irrigation, Water Development and Flood Control

Dr. A.T.M. Shamsul Huda	Joint Secretary

3) Bangladesh Water Development Board (BWBD)

Mr. Amjad Hossain Khan	Chairman
Mr. G.H.A. Islam Jaigirdar	Member (Implementation)
Mr. M.N. Huda	Member (Operation & Maintenance)
Mr. Shamsur Rahman	Member (Planning)
Mr. Abdul Khaleque	Chief Engineer Operation & Maintenance
Mr. Lutfur Rahman *1	Superintending Engineer Dhaka O&M Circle
Mr. Anwar Hossain Bhuiyan *2	Executive Engineer Design Circle-II
Mr. Yusuf Ali *3	Executive Engineer Dhaka O&M Division-I
Mr. Nur Mohammad Khan *4	Sub-Divisional Engineer NNDP Sub-Division

*1: Counterpart who coodinates overall work for the Study.

*2: Counterpart who assists the Team in design part of the Study.

*3: Counterpart who acts as a contact person.

*4: Counterpart who assists the Team in field work and supplying necessary data when the Team requires.

(2) Japanese Government

1) Embassy of Japan

His Excellency Mr. Yoshitomo TANAKA	Ambassador to Bangladesh
Mr. Minoru NAKANO	First Secretary

2) Japan International Cooperation Agency (JICA)

Mr. Norio MATSUZAWA	Resident Representative in Bangladesh
Mr. Keizo EGAWA	Deputy Resident Representative

1 - 4 MINUTES OF DISCUSSION

ON

REHABILITATION OF DEMONSTRATION UNIT

IN

N-N IRRIGATION PROJECT

In response to the request of the Government of the People's Republic of Bangladesh (hereinafter referred to as "the Government of Bangladesh"), the Government of Japan decided to conduct a basic design study on rehabilitation of the Demonstration Unit in Narayanganj - Narsingdi (N-N) Irrigation Project Area (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA). As a result of the Follow-up Study which was carried out last December, JICA has, therefore, despatched to Bangladesh the Basic Design Study Team headed by Mr. TOKUO TODOROKI, Deputy Director, Construction Department, Kanto Aggricultural Administration Bureau, Ministry of Aggriculture, Forestry and Fisheries (hereinafter referred to as "the Team") from February 15 to March 1 , 1988. (Some members of the team will stay to complete the study by March 30, 1988.)

The Team had a series of discussions on the Project with the authorities concerned of the Government of Bangladesh and conducted a field survey at the Project site and other concerned areas.

As a result of the study, both parties agree to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Dhaka, March 1, 1988

T. Todoroki

Tokuo Todoroki, Team Leader
Basic Design Study Team
JICA

1/3/88

Mr. M. N. Huda
Member (Operation & Maitenance)
BWBD, Dhaka

ATTACHMENT

1. Objective of the Project

The objective of the Project is to rehabilitate the Demonstration Unit of N-N Irrigation Project which was seriously damaged by the flood in 1987.

2. Project Site

The site of the Project is as shown in Annex 1.

3. Implementing Body of the Project

Bangladesh Water Development Board (BWDB) is responsible for the implementation of the Project.

4. Contents of the Project

The final contents of the Project will be decided by the Government of Japan through future analization work in Japan by the Team. The final decision will be informed to Bangladesh side through JICA Office in Dhaka as soon as possible.

1) Reinforcement of Flood Embankment at full length
(refer to Annex 2-A as an example for rehabilitation)

2) Improvement of Intake Canal and Inlet of the Pumping Station
(refer to Annex 2-B and 2-C as an example for rehabilitation)

3) Improvement of Main Irrigation Canal Embankment only where new land acquisition by Bangladesh side is not needed.

5. Japan's Grant Aid System

Bangladesh side has understood Japan's Grant Aid System in general as explained by the Team.

6. Implementation Programme

A tentative Implementation Programme is shown in Annex 3.

J.J.

1/31 88

7. Measures to be taken by Bangladesh Side

Measures to be taken by Bangladesh side are as follows:-

a) to examine the embankment carefully in both dry and rainy seasons

b) to maitain the embankment suitably as recommended in Annex 4.

c) to complete the Resectioning work on the section 0.0 km - 4.0 km of the Flood Embankment by Bangladesh side within this dry season in 1988 so that a Japanese contractor can commence the Rehabilitation work from the beginning of the next dry season (October in 1988)

d) Bangladesh side will take the best efforts for smooth implementation of the Project (to carry out domecetic procedure quickly and timely in preparing and submitting Project Proforma (P.P.) etc.).

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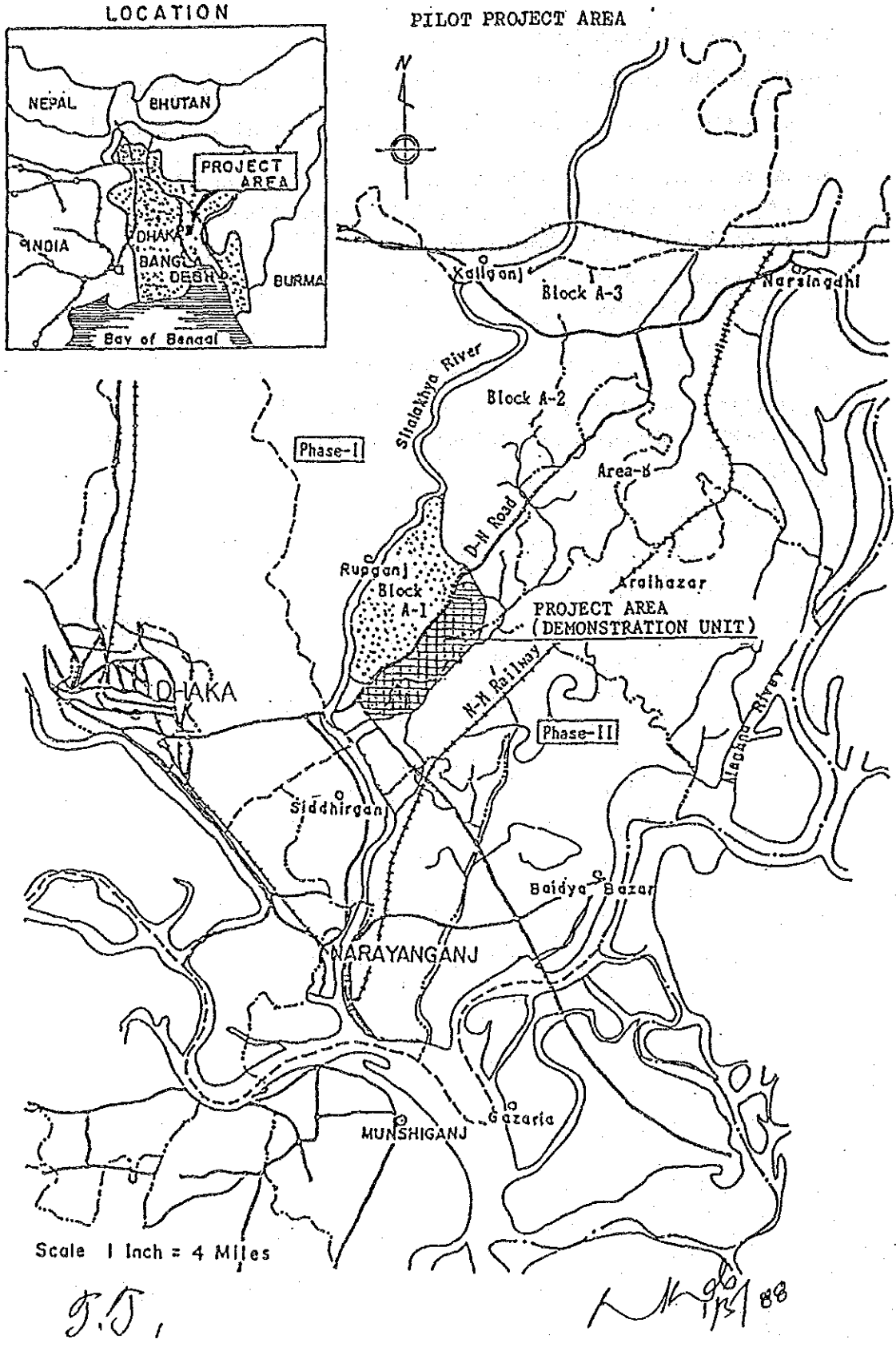
1/12/88

LOCATION MAP

FOR

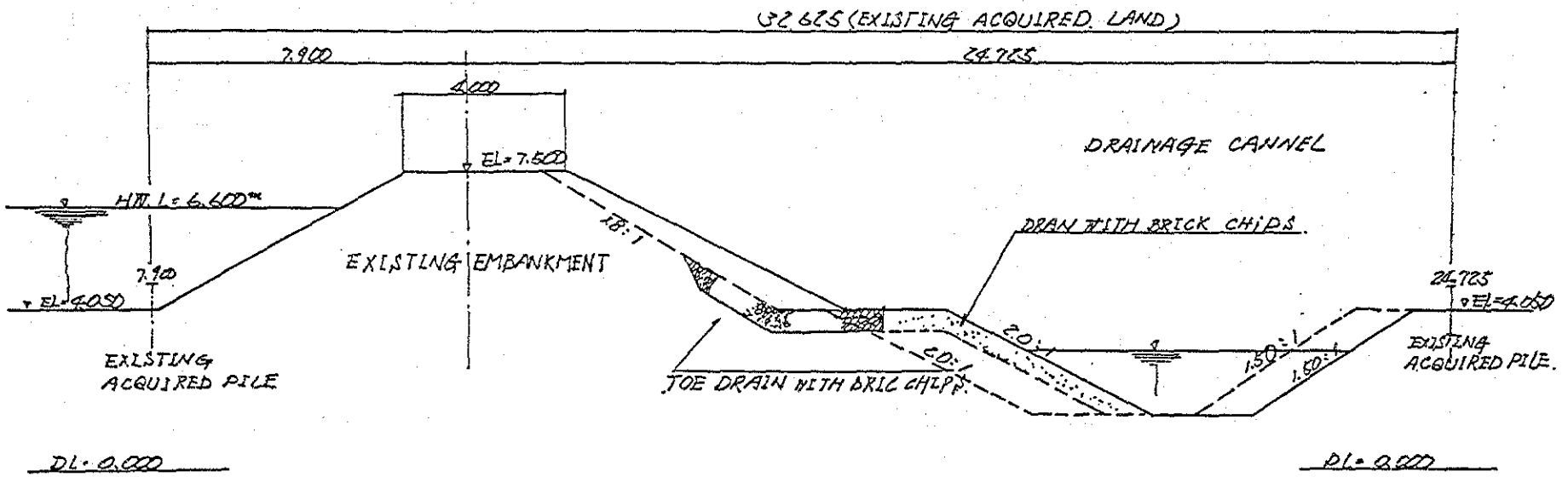
PILOT PROJECT AREA



Annex 2-A

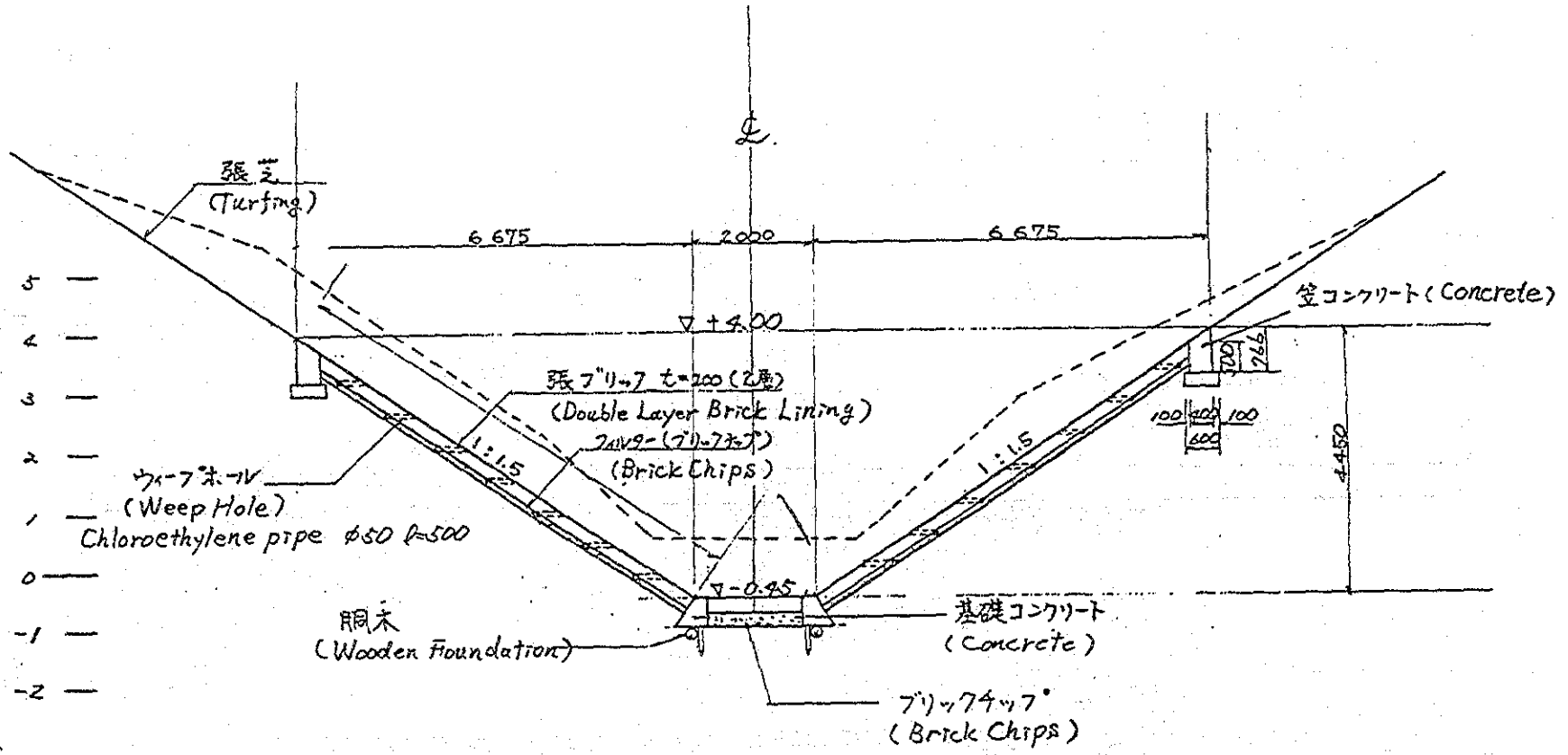
TYPICAL CROSS SECTION OF FLOOD EMBANKMENT

NON SCALE



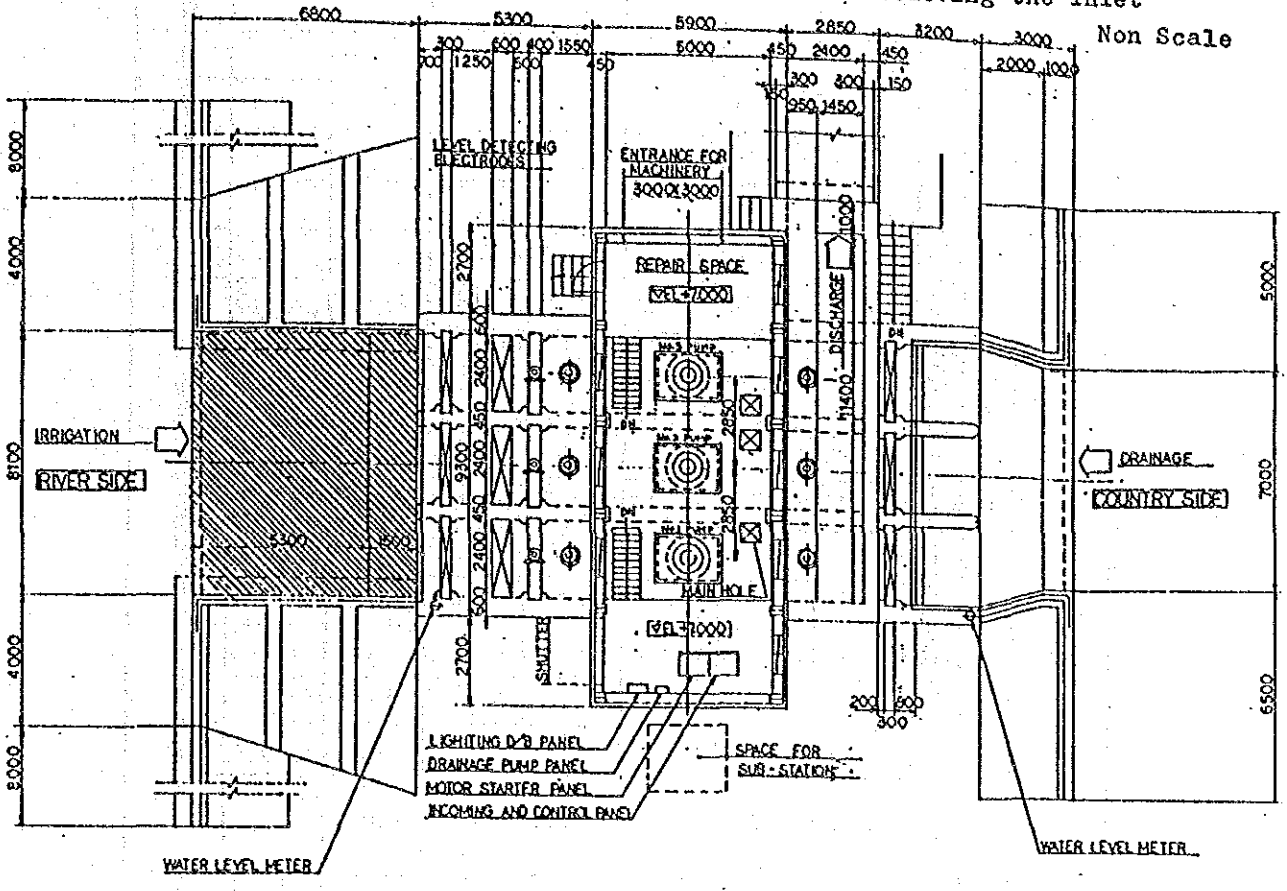
11/5/88

TYPICAL CROSS SECTION OF INTAKE CANAL SCALE: 1/100

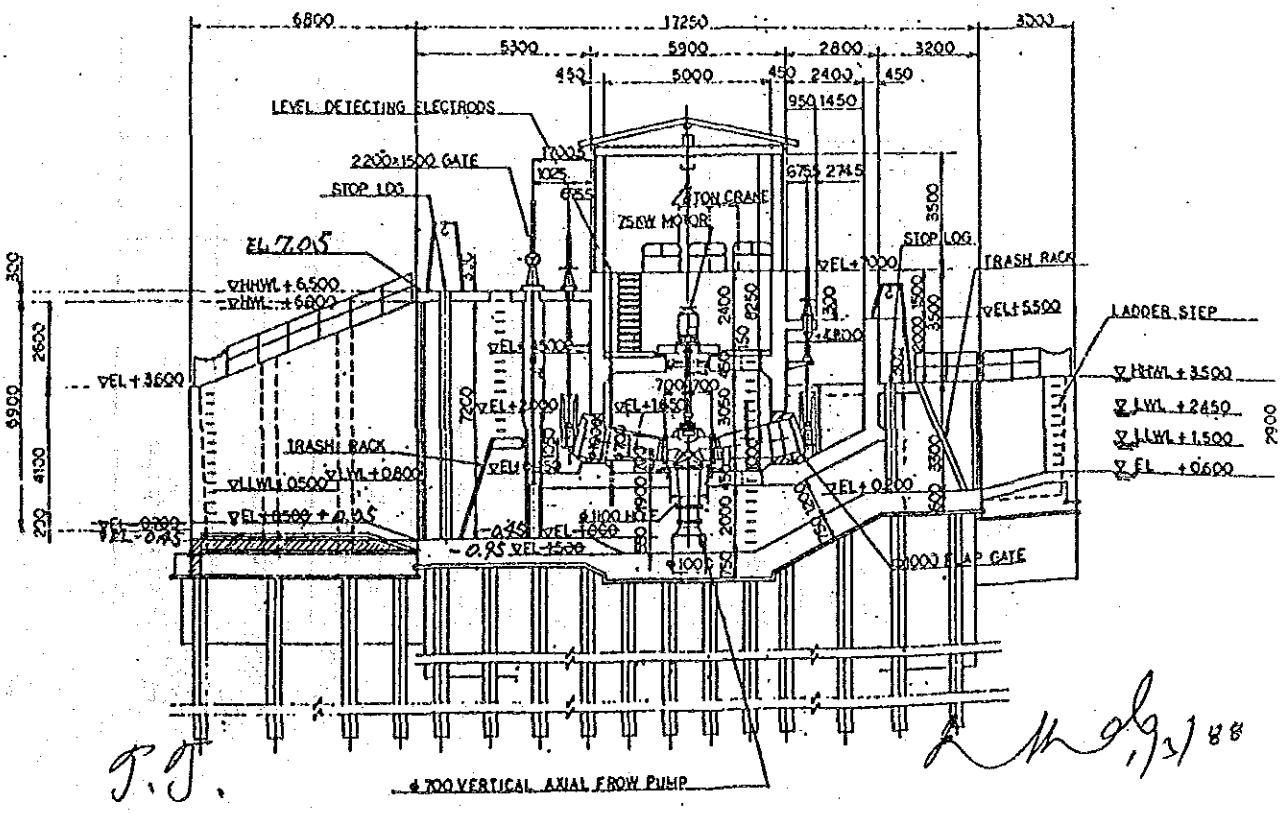


Improvement of Pumping Station by means of removing the Inlet

Non Scale



: A part to be improved



Annex 3

Implementation Programme

: Home Work

: Field Work

Item \ Year / Month	1988												1989												1990		
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Basic Design Study on Rehabilitation of D.U																										
Approval for Implementation by cabinet						▽																				
Exchange of Note						▽																				
Consultant Contract						▽																				
Detailed Design																										
Tender & Tender Evaluation																										
Construction Contract									▽																	
Construction																										

RECOMMENDATION FOR MAITENANCE

Recommended to take the following measures beyond BWDB's Maitenance Team to protect the Flood Embankment and to avoid its de struction which may jeoperdize inhabitants' lives and their fortune inside.

1) to organize farmers' communities as far as possible for

   a) watching and supervising periodically the embankment against artifical destruction

   b) finding timely the damaged parts caused by any reasons

   c) fulfilling up the animal holes and caring damages on the embankment suitably

   d) cleaning and reexcavating silt periodically the Drainage Channels

2) to organize Emergency Communication System between the above mentioned farmers' communities and BWDB.

1/3/88

T. J.

1 - 5 RECORD OF DISCUSSION FOR DESIGN DETAILS (1ST)

ON

REHABILITATION OF DEMONSTRATION UNIT

IN

N-N IRRIGATION PROJECT

The first discussion captioned above was held between the Japanese Basic Design Study Team (called as "the Team") and BWDB's counterpart who are assigned to the above-mentioned project (called as "the Counterpart") as follows:-

Date: March 7, 1988

Place: Office Room of BWDB (Operation & Maintenance)

Attendance: - From BWDB

Mr. Anwar Hossain Bhuiyan	E.E. Design Circle-II, Dhaka
Mr. Nur Mohammad Khan	SD.E. MNDP-Division, Dhaka
- From the Team (JEC)	
Mr. Toshiaki Shimauchi	Irr. Planning & Management
Mr. Akira Kagiwara	Irrigation Facilities Design
Mr. Ayazo Sekino	Civil Work Design
Mr. Hiromi Yamagai	Geological Investigation
Dr. S.M. Parvez Mohit	Interpreter (Local Staff of JEC, Dhaka)

The items discussed are shown in attachment herewith.

T. Shimauchi

(Toshiaki Shimauchi)
From the Team

C.C. FOR INFORMATION TO:

1. Member (Operation & Maintenance), BWDB
2. Chief Engineer, North-Eastern Zone, BWDB
3. Superintending Engineer, Dhaka O&M Circle

Contd.....(2).....

4. Executive Engineer, Design Circle-II, BWDB
5. Executive Engineer, Dhaka O&M Division-I, BWDB
6. Sub-Divisional Engineer, MNDP Sub-Division, BWDB
7. Mr. M. Nakano
   First Secretary, Embassy of Japan
8. Mr. N. Matsuzawa
   Resident Representative, JICA, Dhaka
9. Mr. H. Takada
   Resident Engineer, JEC, Dhaka

ATTACHMENT

1. Items of Discussion

The both parties discussed about the following items, based on the Clause 4. (Contents of the Project) in the Minutes of Discussion signed between the Team and BWDB on March 1, 1988.

1) A basic design plan proposed by the Team on Reinforcement of Flood Embankment at full length
2) A basic design plan proposed by the Team on Improvement of Intake Canal and Inlet of the Pumping Station
3) Improvement of Main Irrigation Canal Embankment only where new land acquisition by Bangladesh side is not needed

2. Contents of Discussion

2.1 Reinforcement of Flood Embankment

In respect of the captioned item, the Team proposed the widening method as shown in Figure-1 and explained its design policy. According to the basic design plan on Reinforcement of Flood Embankment proposed, reinforcing plan is considered within the existing acquired land and the following are mainly pointed out.

1) Widening of crest: 4.0 m (3.0 m after Emergency Repair Work)
2) Making slope gentle: 1 : 2.0 (1 : 1.8 - ditto -)
3) Width of berm step: 3.0 m (as same as original width)

As a result of the aboves, the Main Drainage Channel should be reduced.

4) Side core facing outside slope at full length
5) Toe drain inside slope at full length

The above 2 of 4) and 5) are designed to take the permeating water-line down as lower as possible.

On the above basic design plan proposed by the Team, the Counterpart pointed out the following views.

(a) Study on causes of failure of Flood Embankment and relationship to the basic design plan

(b) Study for an assesment on stability and/or sand boiling of the existing embankment body and comparison with the basic design plan

(c) Toe drain:
BWDB has no experience at any embankment with the toe drain at full length

Void of chipped brick will be filled with soil and may not work well in the future

This will involve huge maintenance cost which is not desirable

(d) Core-wall:
Core-wall facing outside slope may require regular maintenance due to slope failure. Accordingly the Counterpart requested a study for the feasibility of a center core in place of the side core proposed by the Team.

Regarding Toe Drain and Side Core, the Team will continuously study to make BWDB's maintenance work as more less as possible.

2.2 Improvement of Inlet of the Pumping Station and Intake Canal

1) The Team explained that as the existing pumping station has been built 55 cm higher than the exact design level, this caused difficulty on water supply in the irrigation season. The Team thereby proposed that difficulty relating to pumping station might be almost cleared away by removing the river side inlet (apron) which makes an obstacle at the inflow of the water, 50 cm down from its existing level. The Team, therefore, proposed the method shown in Annex 2-C in the Minutes of Meeting for a basic design plan of improvement of Inlet of the Pumping station. The counterpart mentioned that the existing pumping euipment is systematized automatically to stop the pumping operation at the water level of + 0.80 m. (actually this level corresponds to 1.35 m). As an improvement to the present difficulty on water supply, the Team further proposed that the resetting the float swich down to a lower position will make it possible to operate the pump much longer than before.
2) The counterpart opined that since the project is under operation since 1984, the difficulty as mentioned by the Team need to be identified on the basis of actual data. For doing so water level record both in the river side and project side, pumping record (discharge), water level at automatic pump stoppage and its period and any other related data during irrigation season for all the years after completion of pump station are requierd to be officially collected and consulted. The both parties confirmed that the submergense depth according to original design were 1.75 m (difference between level of pump suction inlet - 0.95 m and LWL + 0.80) and 1.45 m (differenoce between - 0.95 m and LLWL of 0.50 m) considering design LWL & LLWL of intake canal. The Counterpart also mentioned that due to the rise of the suction floor by 0.55 m. the submergence depth to pump suction inlet now also

reduces to that amount i.e. available submergence depth considering design LWL & LLWL are now 1.20 m and 0.90 m respectively.
The Counterpart accordingly considered that by implementing the proposed plan of lowering the inlet apron only will not improve the present pump submergence depth. Moreover proposal of lowering the float to lower pump stoppage level will reduce this existing depth also. Under this condition, the pump might be subjected to cavitational problem. The Counterpart, therefore, requested the Team to consult the pump maker and to try to solve the problem of cavitation, if required, by model tests. However, before proposing any further design plan, problem identification based on the actual data as mentioned are necessary. The Team also agreed on these proposals.

2.3 Improvement of Main Irrigation Canal (MIC) Embankment

In respect of the above-captioned item, the Team is carring out levelling survey which is under field work at present. Therefore a basic design plan on this item will be proposed by the Team to KWDB after completion of the su rvey.

- OVER -

Figure-1 TYPICAL CROSS SECTION OF FLOOD EMBANKMENT

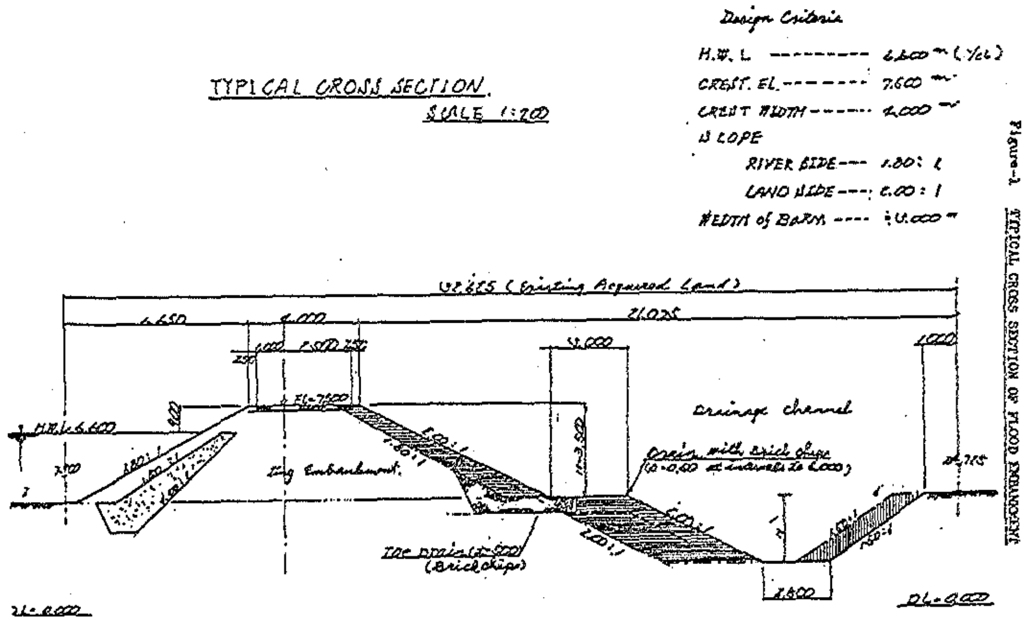


Figure-1 TYPICAL CROSS SECTION OF FLOOD EMBANKMENT

4/4 (6)

RECORD OF DISCUSSION FOR DESIGN DETAILS (2ND)
ON
REHABILITATION OF DEMOSTRATION UNIT
IN
N-W IRRIGATION PROJECT

The second discussion captioned above was held between the Japanese Basic Design Study Team (called as "the Team") and BWDB's counterpart who are assigned to the above-mentioned project (called as "the Counterpart") as follows:-

Date : March 19, 1988
Place: Office Room of BWDB (Operation & Maintenance)
Attendance:

- the Counterpart from BWDB -

Mr. Lutfur Rahman	S.E. Dhaka O&M Circle, Dhaka
Mr. Anwar Hossain Bhuiyan	E.E. Design Circle-II, Dhaka
Mr. Yusuf Ali	E.E. Dhaka O&M Division-I
Mr. Nur Mohammad Khan	SD.E. NNDP-Division, Dhaka

- members from the Team -

Mr. Toshiaki Shimauchi	Irr. Planning & Management
Mr. Akira Nagiwara	Irrigation Facilities Design
Mr. Ayazo Sekine	Civil Works Design
Mr. Hiromi Yamagai	Geological Investigation

The discussion was advanced in accordance with the reference paper prepared by the Team, of which contents were discussed between the both parties with explanation by the Teamm. The items and contents discussed are recorded as attached herewith.

Dhaka, March 19, 1988 recorded by:

(Toshiaki Shimauchi)
On behalf of the Attendance

Contd.....(2).....

ENCLOSURES:

1. Attachment as above.
2. Items of Discussion for Design Details (2nd) (refer to Annex-1).
3. Reference of Discussion for Design Details (2nd) (refer to Annex-2).
4. Geological Profile (refer to Annex-3).

C.C. FOR INFORMATION TO:

1. Member (Operation & Maintenance), BWDB, Dhaka.
2. Chief Engineer, North-Eastern Zone, BWDB, Dhaka.
3. Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka.
4. Executive Engineer, Design Circle-II, BWDB, Dhaka.
5. Executive Engineer, Dhaka O&M Division-I, BWDB, Dhaka.
6. Sub-Divisional Engineer, NNDP Sub-Division, BWDB, Dhaka.
7. Mr. M. Nakano
   First Secretary, Embassy of Japan, Dhaka.
8. Mr. N. Matsuzawa
   Resident Representative, JICA, Dhaka.
9. Mr. H. Takada
   Resident Engineer, JEC, Dhaka.

ATTACHMENT

1. Items of Discussion

The both parties discussed about various items for design details as shown in Annex 1.

2. Contents of Discussion

Introduction

At the beginning of discussion, the both parties confirmed the record of the last discussion and found out that a part of items had dropped from the item 2.2. Therefore, the both parties decided to record it hereinafter as the item 3) of 2.2.

"3) Regarding Improvement of Intake Canal, the Team proposed the slope protection method by brick lining shown in Annex 2b of the Minutes of Discussion for a basic design plan.
On this plan, the Couterpart explained that maintenance of broken brick lining will be a costly affairs to BWDB if stability of the slope is not assured by this means. Accordingly the Counterpart requested the Team to study and identify cause of slope failure and justify the necesity of lining other than probable alternative solution.
The Team will do these and check stability of the slope, based on the results of boring and soil tests."

2.1 Basic Design Condition / Criteria

No special discussion was made on this matter.

2.2 Basic desgin plans to be adopted on the Project

2.2.1 Reinforcement of Flood Embankment

1) Widening of Embankment
(refer to item (a) of 2.1 in Annex 2)

Nothing special was discussed on this item.

2) Core Wall and Toe Drain
(refer to item (b) and (c) of 2.1 in Annex 2)

To a question from the Counterpart what are the purposes or reasons proposing core-wall and toe-drain, the Team pointed out that the main reasons of those above were mentioned in lower half of page 2 to upper part of page 3 in the Reference of Discussion prpared by the Team (refer to Annex 2).

The Counterpart explained that the shape of this flood embankment with the crest width of 4.00 m and the slope gradient of 2 : 2.0, was not so different from many other embankments which had been, mostly without those measures, constructed by BWDB in accordance with the Bangladesh Standard and which had stood against many floods came every year. Accordingly, the Counterpart mentioned that BWDB hesitated to adopt those measures only for this flood embankment.
To the opinion of the Counterpart, the Team explained, with the Geological Profile (refer to Annex 3), that materials on the embankment body in the section after 3.40 km point from Puming Station was not so different from those at the breached portion where the emergency repair work was constructed with core and toe-drain. In addition to the above explanation, the Team furthermore explained about the following points.

- If the embankment was constructed without toe-drain, even if it was shaped any figure, seepage water may ooze out of the surface of slope.
  In point of view to the long range, this may connect with a failure.

- It is supposed that the seepage line may actually rise up more than the expected line because of animal holes and other affective factors inside of the embankment body.

Regarding the measures for prevention of seepage, BWDB's decision was pended. The final decision of BWDB will be imformed to the Team on the next discussion after the review by the Counterpart on the proposal by the Team.

In addition to the opinion before, the Counterpart suggested the following two (2) points.

(1) If core-wall and toe-drain would be adopted as the measures

for reinforcement of the embankment, a monitoring survey should be carried out against the embankment repaired by the emergency work as a model in the flood season after completion of the work.

(2) At the last flood, many seriously damaged portions were seen besides the breached portion. It is supposed that many collapses must have happened anywhere along the embankment if the flooded water did not become same level at both of the river side and the land side of the flood embankment. In view of the above situation, if the measures for seepage water would be executed for reinforcement of the flood embankment, those should be provided for full length of the embankment.

3) Consideration on Slope Protection of Main Drainage Channel(MDC) (refer to item (d) of 2.1 in Annex 2)

In respect of the captioned items, the Team explained that it would be provided only for the sections of the 3 existing bridges and for the curve sections of the channel to which part the drainage water rushed against its slope.

In connection with the above bridges, the Counterpat requested newly to build another 5 numbers at least of foot-bridges (5 feet grade in width by concrete) to benefit for the land owner who lived outside to cross over the drainage channel for their farming.

On this matter, the Team repried that it was very difficult to realize the request because the request was not suitable to the objectives of this Project, however, the Team would convey to their government that it was strongly requested by BWDB.

In respect of the location of bridges to be required to build, BWDB will give data through Sub-Divisional Engineer (SDE).

4) Other Considerations
(refer to item (e) of 2.1 in Annex 2)

No special discussion was mad on this item.

5) Other Items

(1) Brick Pavement

- Regarding the brick pavement on crest proposed by the Team on Figure - 1 in Annex 2, the Counterpart suggested that the brick pavement would make repairing work to animal holes taken by BWDB every year as a maintainance work for the embankment difficult.

- The dicision of BWDB if the brick pavement on crest should be adopted on this project, or not, was pended. That will be informed to the Team later after review by BWDB. The both parties confirmed that the brick pavement was unprior to core-wall and/or toe-drain mentioned before.

(2) Specification of Construction

In request of some items to be specified in the specification of construction, the Counterpart suggested the Team to mention the following matters in it at the preparation of it.

(1) Earth Work by using Machinary

The embankment should be constructed by using compacting machinary, such as soil compactor, engine tamper or small vibration roller, controling density of the compacted soil to achieve the density in 90 % or more of maximum dry-density at earth work.

(2) Turfing

Turfing should be given on the following parts.

- both side slopes of the embankment
- both side shoulders of the crest of 2 feet (0.60 m) in each side width
- all width of the berm step
- upper part of embankment side of MDC slope down to its HWL.

2.2.2 Improvement of Intake Canal and Inlet of Pumping Station

1) Intake Canal

(1) Present Conditions and Consideration of Slop Damages
(refer to (a) and (b) of 2.2, 1) in Annex 2)

The Team explained the present conditions and their consideration of slopedamages showing the photographs and the survey results.

(2) Measures for Improvement
(refer to item (c) of 2.2 , 1) in Annex 2)

The Counterpart put the following views on the proposed measures suggested by the Team.

- Brick blocks will be better to use for brick lining.
  The brick blocks may consist of several bricks joined with cement mortar, and be normally formed into the size of 15" x 15" x 6". It may be suitable to use a larger size one than the above normal one for the Project.
- Weep holes (drainage pipes) with PVC will be filled with soil due to siltation, therfore, it will be difficult to maintain its effect. Brick chips laid under the brick blocks and some gaps between the blocks will work as weep-holes instead of them.

The Team will review the above proposal.

The Counterpart asked to the Team that it is necessary to widen the section of the canal at the section from the confluence of the two streams where the drainage channel of the Project joins to the original stream (Tatkir Khal) to the Lakhya River, because in which section, the water rises up by those above two flows.
On this matter, the Team answered to judge that it may not make problems because the proposed section of the canal will become wider than the existing one by cutting its slopes.

2) Pumping Station
(refer to item 2) of 2.2 in Annex 2)

The Counterpart mentioned that BWDB agrees to lower down the inlet apron as proposed by the Team and put the view that the condition should be taken on the stability of the structures of Pumping Station while dismantling the inlet apron.

On this matter, the Team explained that the inlet apron separately built from the retaining walls and may not affect the sheet piles as a result of the study. However, the Team mentioned that the Team would review the original design and explain the results after the review in the study report.
In case of the modification of the lower limit water level of pump operation in dry season, it is necessary to obtain the guarentee against the functional disorder of the pump.

2.2.3 Improvement of MIC Embankment

1) General Section of MIC
(refer to upper part of Fiure - 7 on page 12 in Annex 2)

The both parties confirmed design conditions on the figure of Typical Cross Section of MIC proposed by the Team as follows;-

a. Design EWL : EL 5.25 m (4.70 + 0.55 = 5.25 m)
b. Free board : Fb=0.60 m (Standard)
c. Elevation of crest : EL 5.85 m (5.25 + 0.60 = 5.85 m)
d. Width of crest : W =2.00 m
e. Canal bank slope : Canal side; 1 : 2.0
   Farm side ; 1 :1.5
f. At improvement of the canal, it should be done to the canal side where land acquisition is not needed.

2) Part Section of MIC as Flood Embankment
(refer to lower part of Figure - 7 on page 12 in Annex 2)

Regarding the part section of MIC in Barba area, the Counterpart suggest the Team to match the design elevation of crest to that of Flood Embankment.
On this matter, the Team explained logically that it is unnecessary to raise up the crest so high, pointing out some definit reasons or view points.
The Counterpart mentioned that the failure of this part of the embankment may cause failure to nearby the existing bridge on N-N Road which will result total disruption of communication also.
Accordingly, this part of the embankment needs to design as a flood embankment similar to the main flood embankment of the Project.

BASIC DESIGN STUDY
ON REHABILITATION OF DEMONSTRATION UNIT
IN N-N IRRIGATION PROJECT

Annex 1 .

ITEM OF DISCUSSION FOR DESIGN DETAILS (2ND)

Introduction

- Confirmation of the last discussion's record

1. Basic Design Conditions / Criteria
   - Confirmation of conditions and/or criteria

     (HHWL, HWL, LWL, LLWL, Quantities of irrigation water and drainage water and other conditions or criteria if necessary).

2. Basic Design Plans to be adopted on the Project (Proposal)
   - Reconfirmation of condition or criteria for each item
   - Explanation of basic design plans proposed by the Team

     (Cause of difficulties, design policy of the proposal, purposes or effects of the proposed work items and other explanation if necessary)
   - Discussion of the proposal

   2.1 Reinforcement of Flood Embankment at full length
   - (a) Widening method within the existing acquired land
   - (b) Core-wall outside
   - (c) Toe drain inside
   - (d) Consideration for slope protection of Main Drainage Channel
   - (e) Other consideration on seriously damaged portions

   2.2 Improvement of Intake Canal and Inlet of the Pumping Station
   - (a) Present conditions of facilities and equipments in their level
   - (b) Portions or points to be improved
   - (c) Proposal for improvement of Intake Canal
   - (d) Proposal for improvement of Pumping Station
   - (e) Other consideration if necessary

   2.3 Improvement of Main Irrigation Canal Embankment only where new land acquisition by Bangladesh side is not needed
   - (a) Present conditions in a view of survey results
   - (b) Scope of rehabilitation works on MIC embankment under way by BWDB under IDA finance.

3. Implementation Plan
   - Schedule after field survey (home office study / preparation of P.P.)

BASIC DESIGN STUDY
ON REHABILITATION OF DEMONSTRATION UNIT
IN N-N IRRIGATION PROJECT

REFERENCE OF DISCUSSION
FOR
DESIGN DETAILS (2ND)

MARCH, 1988

BASIC DESIGN STUDY TEAM, JICA

1. Basic Design Condition / Criteria

1.1 Water Level

a. HWL : 6.60 m (1/25, quoted from the design of N-N Block A-1)
b. LWL : 0.80 m (1/10, quoted from the original Basic Design)
c. LLWL: 0.50 m (- ditto -).

1.2 Quantity of Water

a. Irrigation water: Q = 2.20 cu-m/sec
b. Drainage water : Q = 3.18 cu-m/sec
(both figures are quoted from the original Basic Design).

1.3 Conditions for Flood Embankment

a. Land acquisition: Necessary land for reinforcement will not acquired additionally any more, so that embankment shall be reinforced within the existing acquired land.
b. Land use: In connection with the above, the land should be used as effectively as possible.
c. Main Drainage Channel: This may be reduced by widening of embankment. However, the widening should be designed to keep necessary section area for drainage channel.
d. Specification on part details

1)	Width of crest :	4.00 m or more
2)	Width of berm step:	3.00 m or more
3)	Free board :	0.90 m (quoted from the design of N-N Block A-1)
4)	Elevation of crest:	7.50 m (based on the above)
5)	Gradient of slope :	1 : 1.80 or more gentle
6)	Space on land use :	may permit a less space.

2. Basic Design Plans (Proposal)

The paper prepared here is to explain the contents of basic design plans proposed by the study team for rehabilitation works to be implemented as a Japanese Grant Aid project.

The explanation of basic design plans will be developed below item by item of rehabilitation works.

2.1 Reinforcement of Flood Embankment

A basic design plan proposed by the study team for reinforcement of Flood Embankment is as shown in Figure-1 (Typical Cross Section of Flood Embankment).

In the figure, the study team mainly proposes three (3) items of Widening Embankment, Core wall and Toe drain as a measure of reinforcement of Flood Embankment based on the following consideration.

1) Widening of Embankment
The Flood Embankment should be widened within the existing acquired land (W = 32.625 m).
This means that the embankment must be widened to the land side.

2) Core wall
A core wall should be placed under the river side slope for a purpose to lower the level of water permeating into the embankment, especially at the section beyond some 3.40 km point from the Pumping Station.

3) Toe drain
A toe drain should be settled down to the toe of the land side slope at full length of the embankment for a purpose to prevent the water permeating through the embankment body from spouting at middle of the land side slope.

1) General Consideration

In respect of the above 2 items of 2) and 3), the study team further mentions a view of these items studied through the field survey as follows:-

(a) Geological Conditions

According to the results of geological investigation (boring on the flood embankment), the flood embankment consists of loose fine sand or soft clayey silt, which are not homogeneous. Especially in the section beyond some 3.40 km point from the Pumping Station, it is commonly found out that the existing (original) embankment was built with unsuitable materials, such as loose fine sand and silt with N-value of 2 - 4 and has many animal holes and some voids seem to be due to insufficiency of compaction in its body. These conditions are much similar to the breached portion.
The above mention means that the embankment body in this section is much permeable more than the other section.

(b) Necessity of Core wall

Accordingly, in the section like this, it is very important to prevent the flood water coming directly into the embankment body. This is another reason why the study team proposes to place a core wall under the river side slope.

(c) Seepage Line and Toedrain

While, although the embankment is widened and made its slope more gentle than the original one, its slope may not become more gentle than the grade of 1 : 2.0 because of widening within the existing

acquired land. Accordingly, it can not be said that the embankment has enough length in its width to lower the seepage line downto under the toe of its slope (refer to Figure-2a). Figure-2b shows the seepage line in the case of placing core wall. These figures are drawn based on calculation, so it is supposed that the actual seepage line is presumbly rising up more than the calculated one because of animal holes, less homogeneousnes of the embankment materials and other uncertain factors.

In considering to keep a long-period stability of the embankment with steep slope, it is much important to prevent the seepage water from spouting onto the surface of back slope. The seepage water must be drained out before it reaches the surface of slope. This is the reason why the study team proposes to settle a toe drain under the land side slope at full length.

2) Design Details

(1) Core wall

a. The design details of core wall are as shown in Figure-1.

b. The study team is carring out site investigation, looking forward to find out less permeable materials along D-N Road. (Soil tests are under operation at present).

c. Regarding the core wall, the study team was suggested by the Counterpart of BWDB at the last meeting to place the core-wall in the center of the embankment (refer to Figure-3a).

However, at a result of the office studies, the study team judged that the suggested core wall is unsuitable to lower the seepage line.

To expect the effect of core wall, it should be placed downto the bottom of the embankment as shown in Figure-3b. Even in this case, it is unadvisable because cutting volume of soil for settling core becomes large bulk (refer to Figure-3b).

(2) Toe drain

a. The design details of toe drain are as shown in Figure-4.

b. In this basic design, the study team considers to make the maintenance work of BWDB after completion as much easier or more less as possible.

c. The study team considers to put jute mat on the toe drain to keep it working effectively from filling with soil.

(3) Slope protection of Main Drainage Channel

. For the particular parts or portions, such as the parts of the existing bridges and curve section, the study team considers to design a slope protection with brick lining.

(4) Other considerations

. As one of other consideration, the study team consider to design large-size core wall at the sections where the Tatkir Khal closes to the embankment.

Figure – 1 TYPICAL CROSS SECTION OF FLOOD EMBANKMENT

SCALE 1 : 100

Design Criteria

1. H.W.L ---------- 6.600 m ---- (1/25)
2. Elevation of Crest ------ 7.500 m
3. Width of Crest ------ 4.000 m
4. Slope
   - River Side ------ 2.00 : 1
   - Land Side ------ 1.80 : 1
5. Width of Berm Step --- 3.000 m

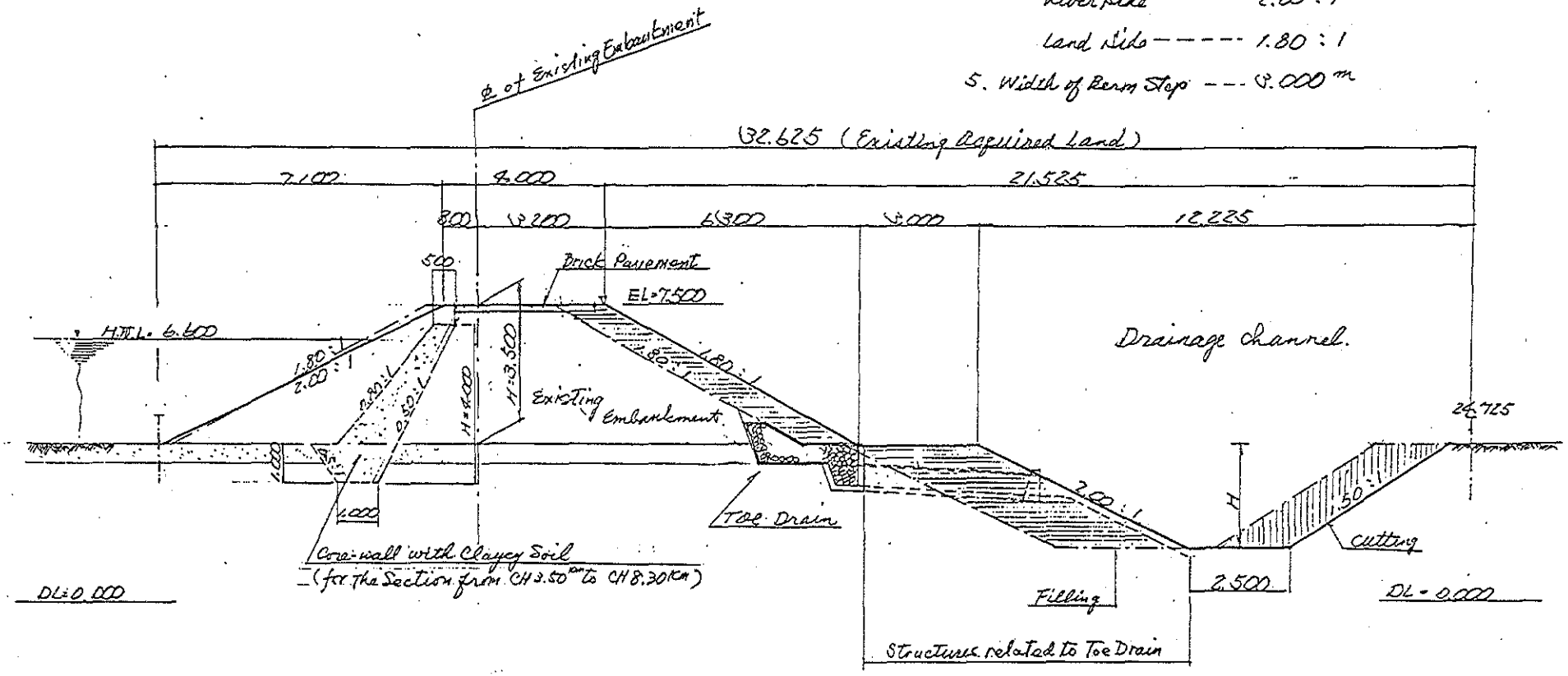


Figure – 2a SEEPAGE LINE IN THE EMBANKMENT (Without Core Wall)

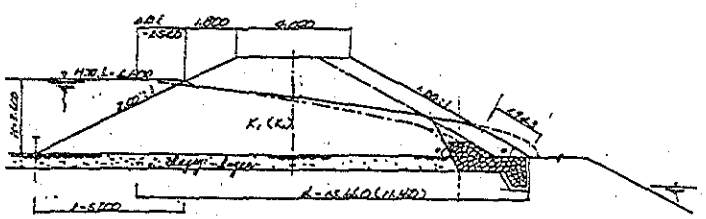


Figure – 2b SEEPAGE LINE IN THE EMBANKMENT (With Core Wall)

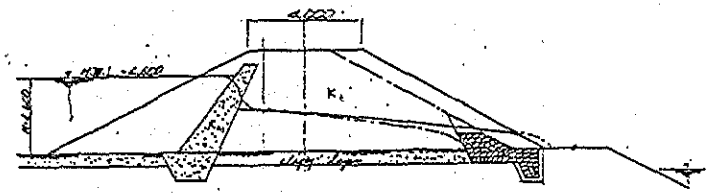


Figure – 3a CENTER CORE (suggested by EMDB)

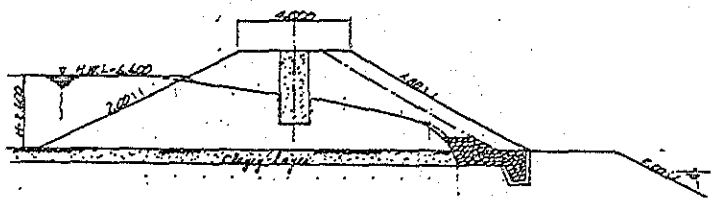


Figure – 3b EARTH WORK FOR CENTER CORE

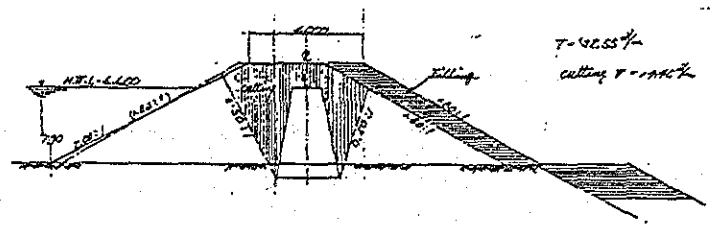


Figure – 3c EARTH WORK FOR PROPOSED CORE WALL

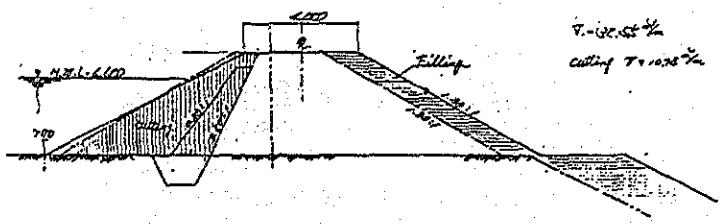
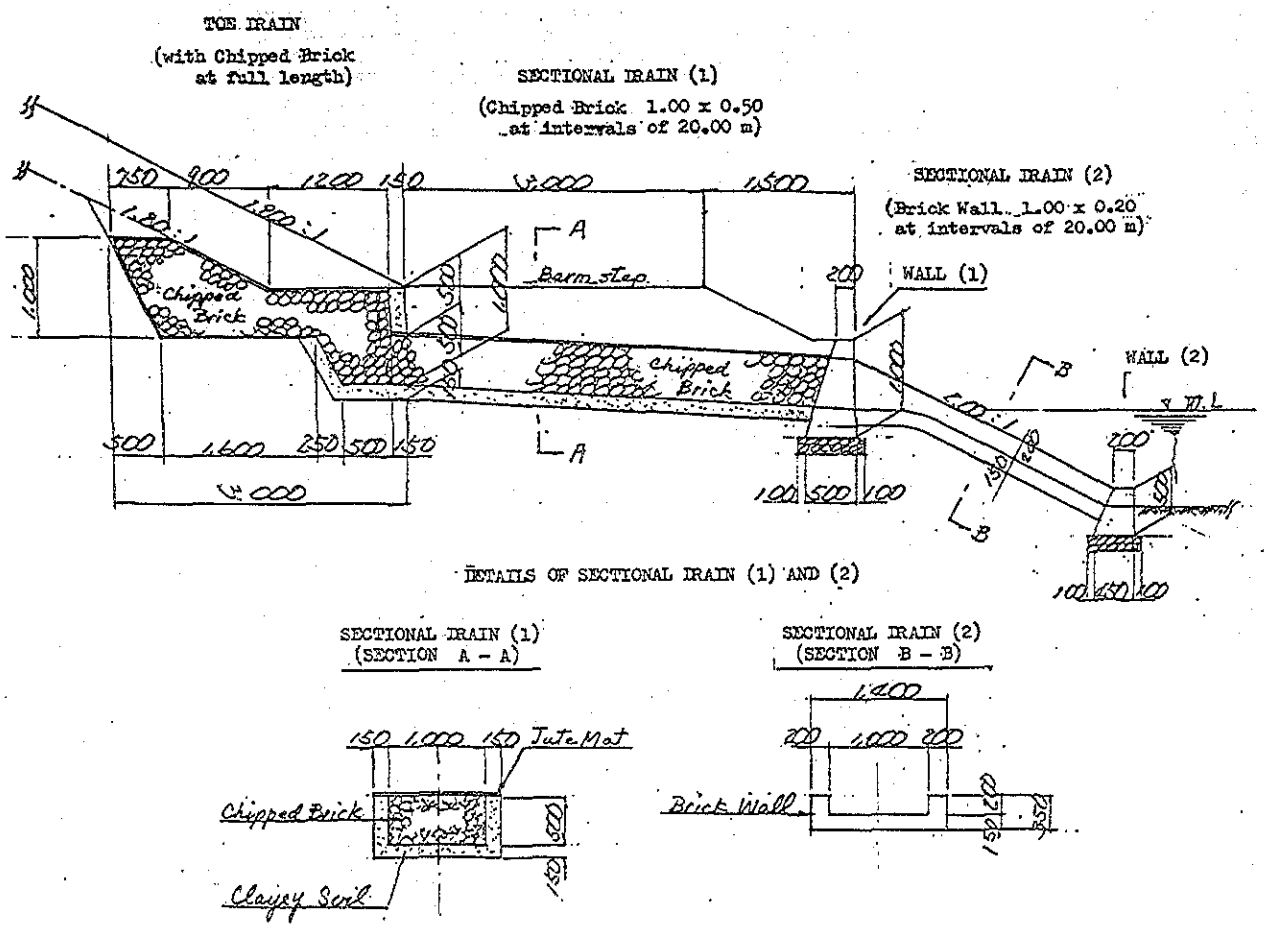
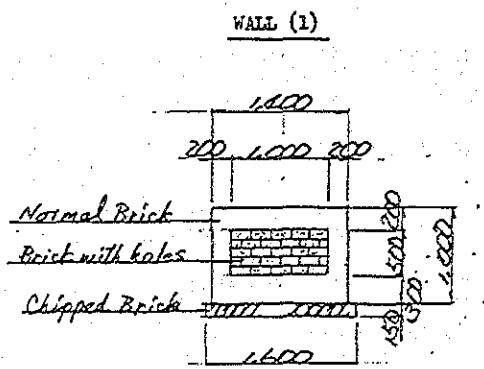


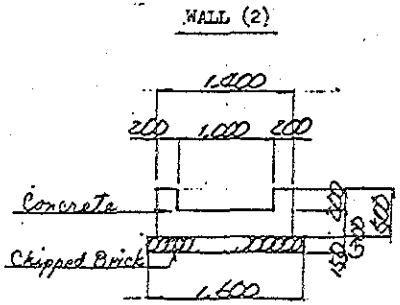
Figure – 4 DETAILS OF TOE DRAIN AND ITS RELATED STRUCTURES

SCALE 1 : 50



DETAILS OF SECTIONAL DRAIN (1) AND (2)





2.2 Improvement of Intake Canal and Pumping Station

This work item consists of improvement of Intake canal and improvement of Pumping Station.

The study team explains each difficulty and its improving measure of the aboves as follows:-

1) Intake Canal

(a) Present Conditions

The intake canal is an earth waterway used for 2 purposes of irrigation and drainage. Accordingly, it works as an irrigation canal to send stream water from Lakhya River to the Pumping Station and as a drainage channel to let out the water from the Demonstration Project area to the river.

The canal is about 6 - 7 m high in its slope height, and many parts of slope eroded and portions partly collapsed are found out in its slopes.

(b) Consideration of Slope Damages

The study team judges that the slope damages of Intake Canal might be due to duplication of the following affective factors.

- Collapse or sliding of slope caused by repetition of water flow and up and down of water level by tide in dry season and by drainage water in rainy season
- Cutting waterway slope steeper than the upper slope at re-excavation of the canal bed on maitenance work
- Leaving the re-excavated soil with an unstable condition near by or in the slope of the canal.
- Erosion due to the natural drainage water from surounding areas (lower parts of slope)
- Soft soil in geological factor (related to water content)
- Erosion caused by oozing the under-ground water out of slope.

(c) Measures for Improvement

Considering the above-mentiond factors, the study team proposes a basic design plan for its improvement as shown in Figure-5.

In the plan, the study team proposes a slope protection by brick lining method as a mesure for improvement of Intake Cnal to keep it away from the above-mentioned factors as much as possible, based on the following considerations.

- Recutting the existing slope to remove the loose earth on it and to lower the level of canal bed
- Protecting the cut slope by brick lining with weep holes for the under ground water behind it to ooze out
- Placing a wooden beam foundation under the concrete bases because of soft ground on the bed.
- Stability of slope will be analysed in home office work in Japan based on the results of geological and soil investigation

- According to the results of analyses, the study team might propose an alternative basic design plan on this item.

2) Pumping Station

(a) Present Conditions

Part elevations at the Pumping Station are as shown in Figure-6.

These elevations shwn in the figure are as confirmed by the both members of BWDB and the study team at the last meeting.

The both members above have basically understood that a diffeality at operation of irrigation is caused by a fact that the evry part of the Pumping Station was built 0.55 m higher than the original design level.

(b) Improvement to be undertaken

In respect of improvement of Pumping Station, the study team proposes replacing of inlet apron as showing with hatch mark in Figure-6.

However, the study team was suggested by BWDB side that the pump equipments are systematized automatically to stop its operation.

On this matter, the study team is cosulting details of the supplied equipments to the pump maker in Japan. But the study team has no reply yet at present, so continuously asking them.

2.3 Improvement of Main Irrigation Canal (MIC) Embankment

(a) Present Condition

Regarding the present condtion, the study team carried out levelling for topographical survey by employing a local surveyors.

In this survey, profile levelling of MIC at full length (9.20 km) and cross section levelling with 47 sections were carried out along MIC Embankment.

The survey results will be effectively used on this basic design study and also on the subseqent detailed design.

(b) Improvement to be undertaken

A basic design plan to be proposed for improvement of MIC Embankment is as shown in Figure-7.

The design details are under examination at present. The study team will cralify the scope of work on this item, based on the survey results and rehabilitation work under way by BWDB with IDA finance.

Figure - 5 TYPICAL CROSS SECTION OF INTAKE CANAL

SCALE 1 : 100

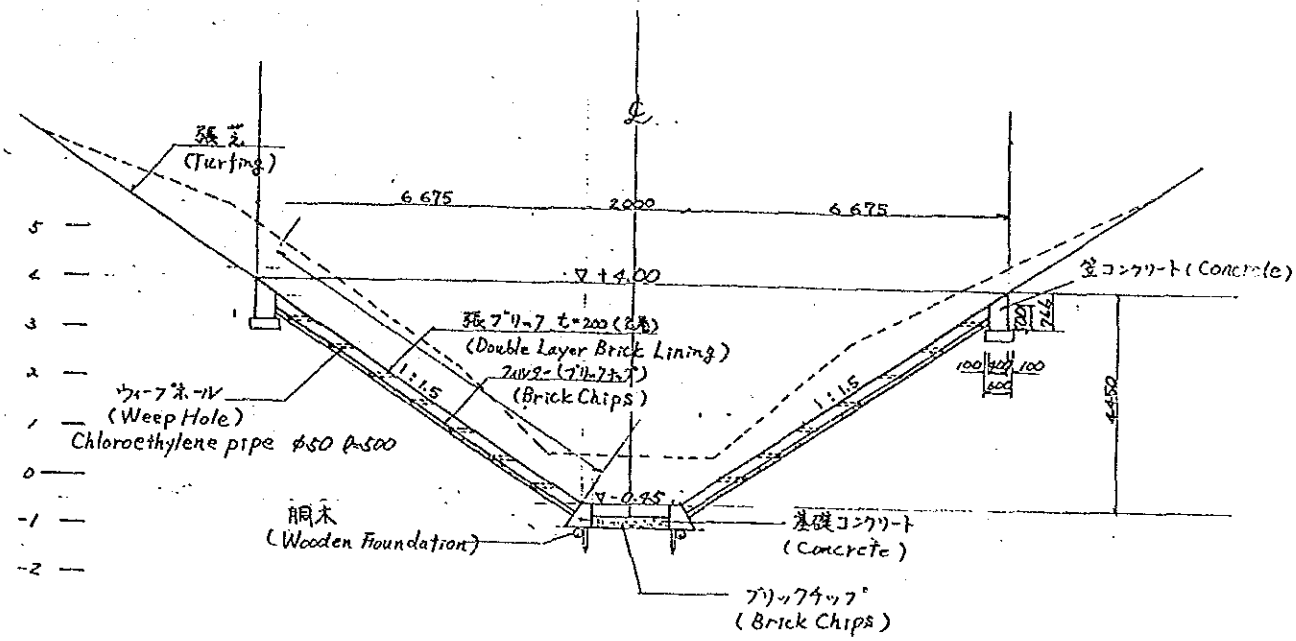
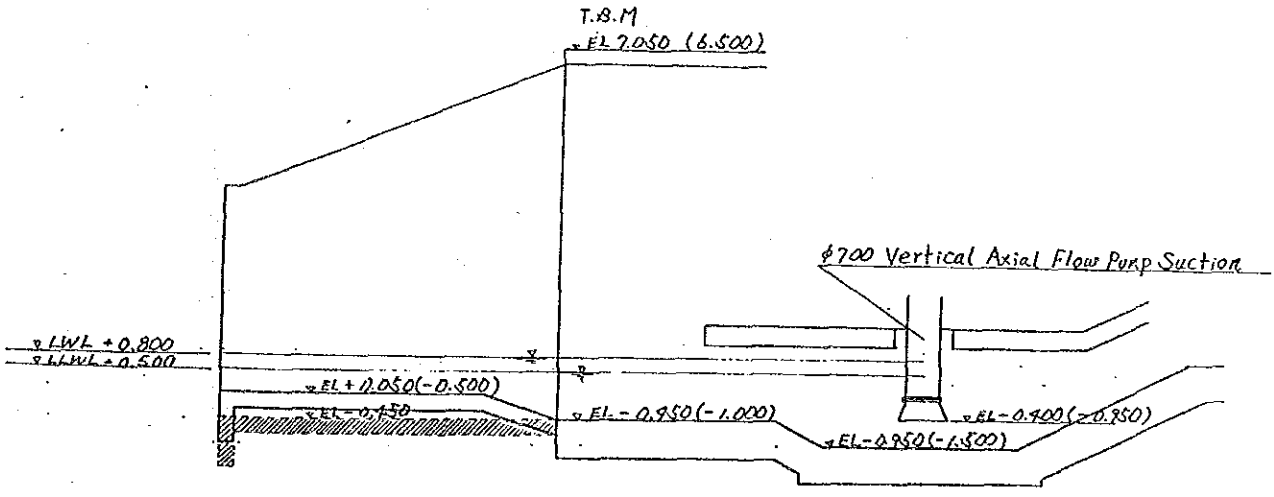


Figure - 6 PART ELEVATIONS AT PUMPING STATION



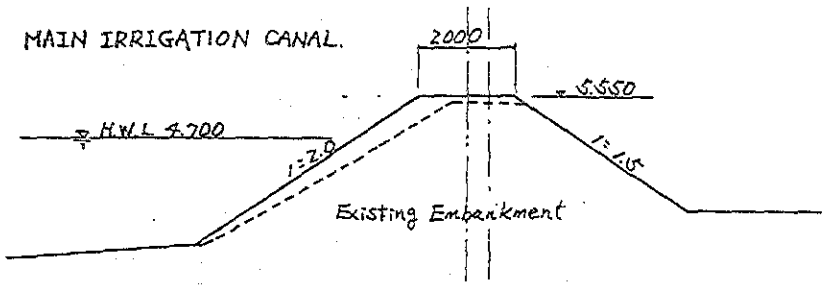
NOTES : Without ( ) : Existing (As built)
Within ( ) : Original Design

▨ : Removal of Inlet

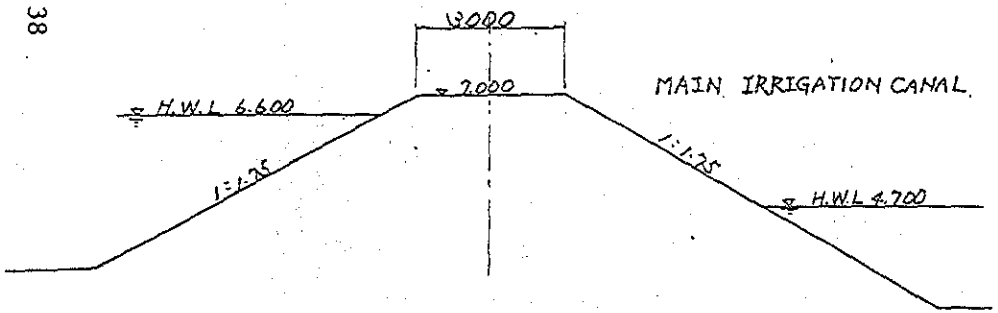
Figure – 7 TYPICAL CROSS SECTION OF MAIN IRRIGATION CANAL EMBANKMENT

SCALE 1 : 100

TYPICAL CROSS SECTION



PORTION OF REINFORCEMENT OF FLOOD EMBANKMENT (IN BORPA)



* The Embankment under way by B.W.D.B.

1 - 6 The View of the Japanese Basic Design Study Team on the Construction Work of Flood Embankment under way by BWDB

JICA BANGLADESH OFFICE
(JAPAN INTERNATIONAL COOPERATION AGENCY)
DIT PLOT NO. 70, BLOCK-B
ROAD NO. 21, BANANI, DHAKA-13
BANGLADESH
PHONE : 604285, 600062.

JICA

Ref-No. BDS-Re/001
March 1, 1988

Mr. M. N. Huda
Member (Operation & Maintenance)
Bangladesh Water Development Board
Dhaka

Sub:- The View of the Japanese Basic Design Study Team on the Construction Work of the Flood Embankment under way by BWDB

Dear Mr. Huda,

1) The rehabilitation work at full length of the flood embankment of the Demonstration Unit is expected to be commenced since the beginning of the next dry season (October in 1988) under Japanese Grant Aid.

2) In spite of the above-mentioned new rehabilitation work under Japanese Grant Aid, Babgladesh has to face the next monsoon season which may cause another destruction on the damaged flood embankment. Therefore the temporal rehabilitation (Emergency Repair Construction) for the half last part of the embankment (4.0 - 8.3 km) is under way by Japanese Grant Aid, and another half's rehabilitation (0.0 - 4.0km) is undertaken by Bangladesh side against the next monsoon season.

3) Through the field survey, our team has found several serious damages in the part of the embankment undertaken by Bangladesh side (above-mentioned 0.0 - 4.0 km) caused by animal holes and artificial reasons especially damages through pumping-up from the main drainage channel beyond the embankment by farmers outside of Demonstration Unit which make the crest width of the embankment less than 2.5 m.

4) In this point, our basic design study team would like to advise BWDB to concentrate Bangladesh side construction works on good caring those above-mentioned seriously damaged parts in this dry season.

Yours faithfully,

轟 篤久夫
T. Todoroki

(Tokuo Todoroki)
Team Leader
Basic Design Study Team
JICA

Contd..... ..... P/2.....

C.C. TO:

1. Mr. Amjad Hossain Khan
   Chairman
   Bangladesh Water Development Board
   Dhaka

2. Dr. A.T.M. Shamsul Huda
   Joint Secretary
   Ministry of Irrigation, Water Development & Flood Control
   Dhaka

3. Mr. Md. Nasim
   Deputy Secretary
   External Resources Division
   Ministry of Planning

4. Mr. Minoru Nakano
   First Secretary
   Embassy of Japan
   Dhaka

5. Mr. Norio Matsuzawa
   Resident Representative
   Japan International Cooperation Agency
   Dhaka

1 - 7 List of Data collected

	Title	Issue	Remarks
1.	Mouza Map alongthe aquired land for Secondary Irrigation Canal and Tertiary Irrigation Canal	Bangladesh Water Development Board (BWDB)	Copy
2	Data recorded on the Lakhya River at Demra in 1987	BWDB	Copy
3	Data of the Pumping Operation recorded from 1984 upto 1988	BWDB	Copy
4	Planning documents for Operation & Maintenance of Irrigation System	BWDB	Type(organ-ization diagram)
5	Tender documents of rehabilita-tion work being carried out by BWDB	BWDB	Copy

APPENDIX II

2 - 1 Drawings

2 - 2 Figures and Tables

TYPICAL CROSS SECTION OF FLOOD EMBANKMENT

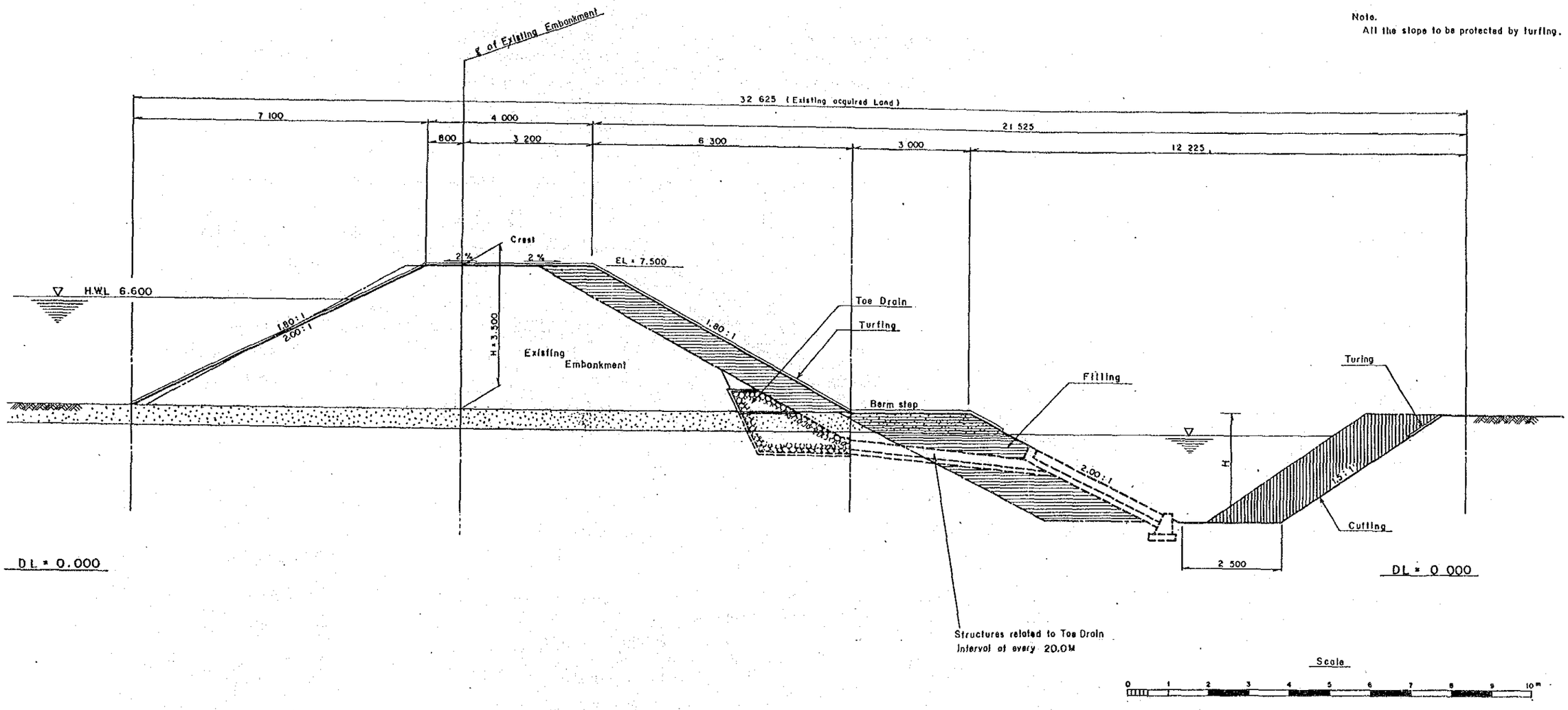
EXAMPLE

Existing Embankment Line

Filling

Cutting

Note.
All the slope to be protected by turfing.



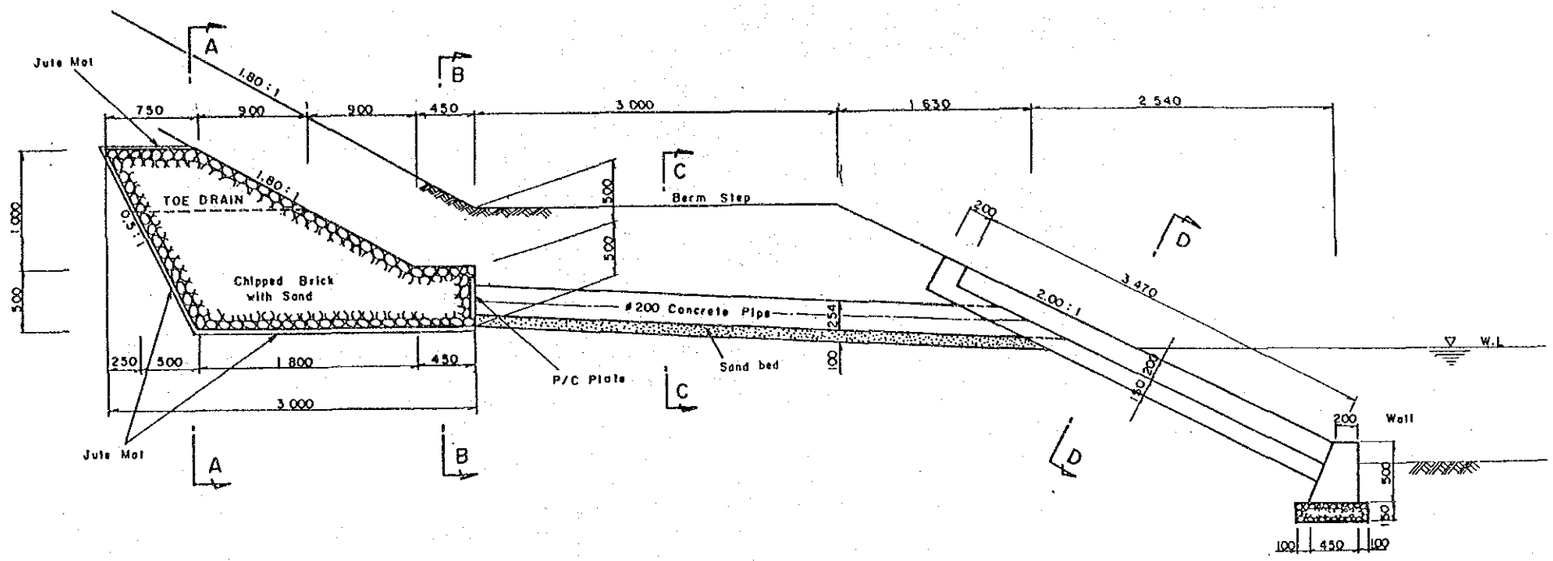
NARAYANGANJ-NARSINGDI IRRIGATION PROJECT REHABILITATION OF DEMONSTRATION UNIT THE PEOPLE'S REPUBLIC OF BANGLADESH
TYPICAL CROSS SECTION OF FLOOD EMBANKMENT
Date ; May 1988 | D.W.G NO.1
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure - 2 DETAILS OF TOE DRAIN AND RELATED STRUCTURE

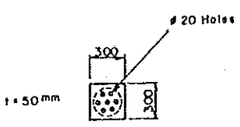
Toe Drain
(With Chipped Brick
at full Length)

SECTIONA DRAIN (1)
(ø200 Concrete Culvert pipe
at Interval every 20.0 M)

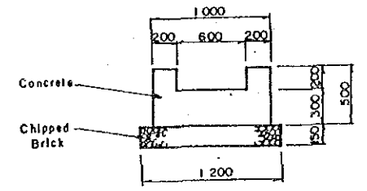
SECTIONAL DRAIN (2)
(Brick Wall 0.6 x 0.2
at interval every 20.0M)



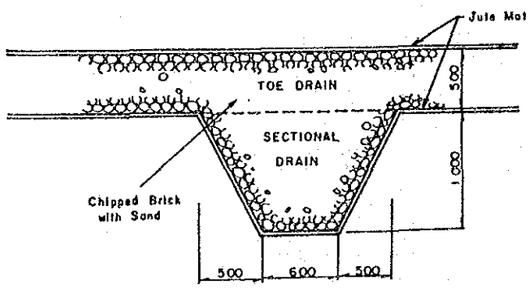
P/C PLATE



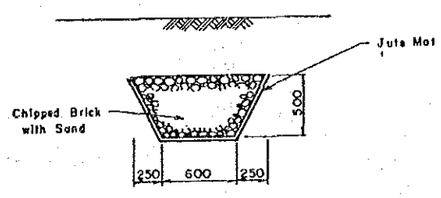
WALL



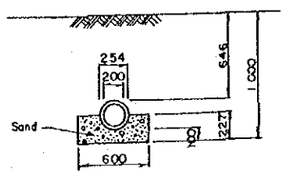
SECTION A - A



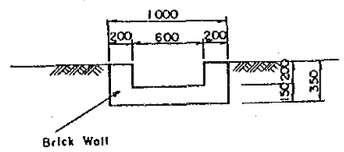
SECTION B - B



SECTION C - C



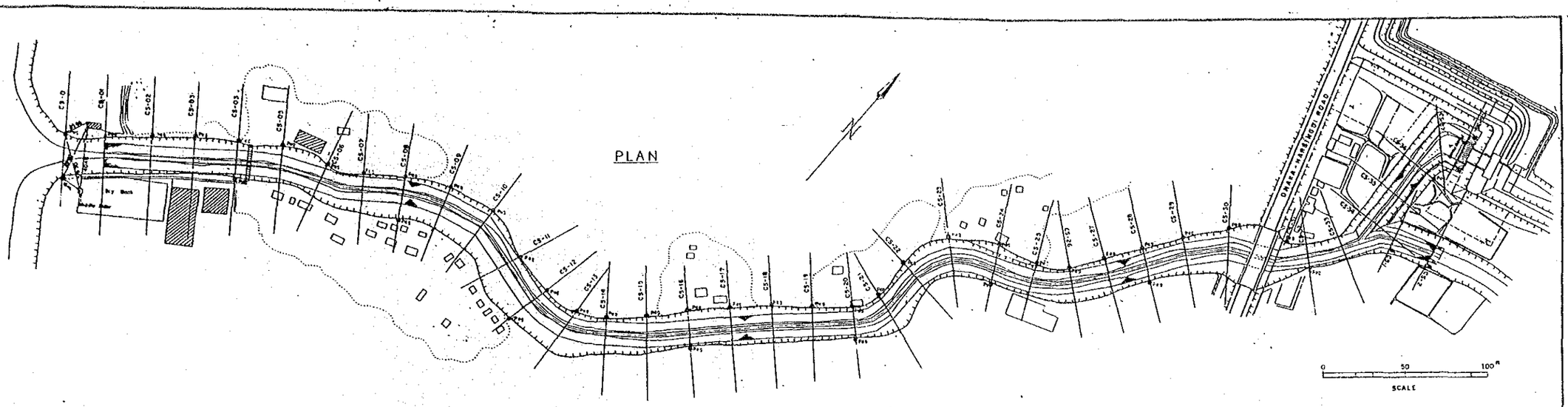
SECTION D - D



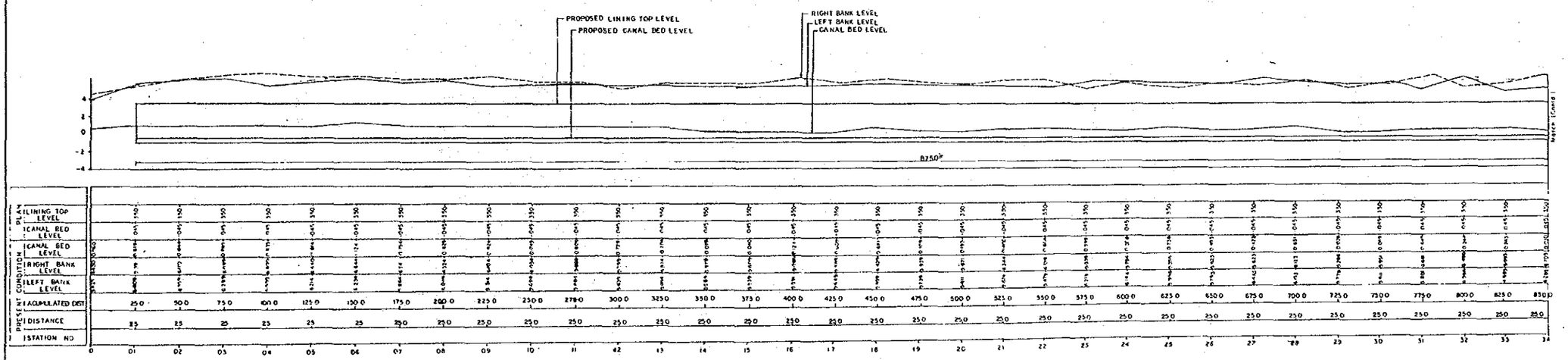
SCALE

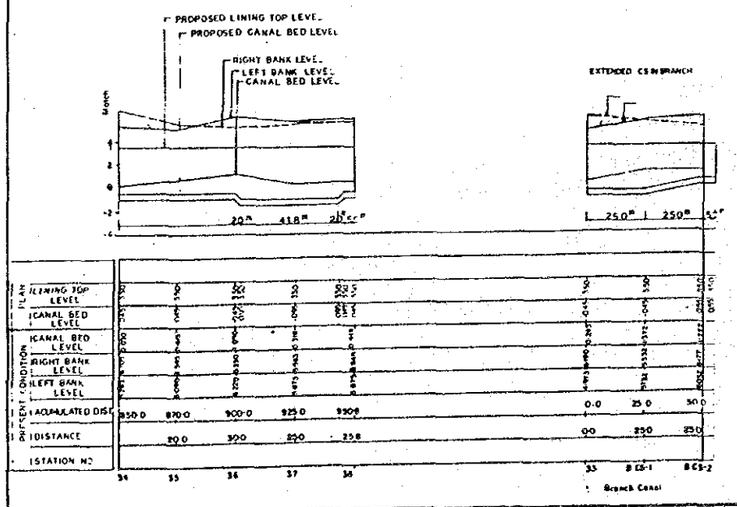
NARAYANGANJ-NARSINGDI IRRIGATION PROJECT REHABILITATION OF DEMONSTRATION UNIT THE PEOPLE'S REPUBLIC OF BANGLADESH
DETAILS OF TOE DRAIN AND CRSS DRAINAGE STRUCTURES
Date ; May 1988 — D.W.G NO. 2
JAPAN INTERNATIONAL COOPERATION AGENCY

PLAN

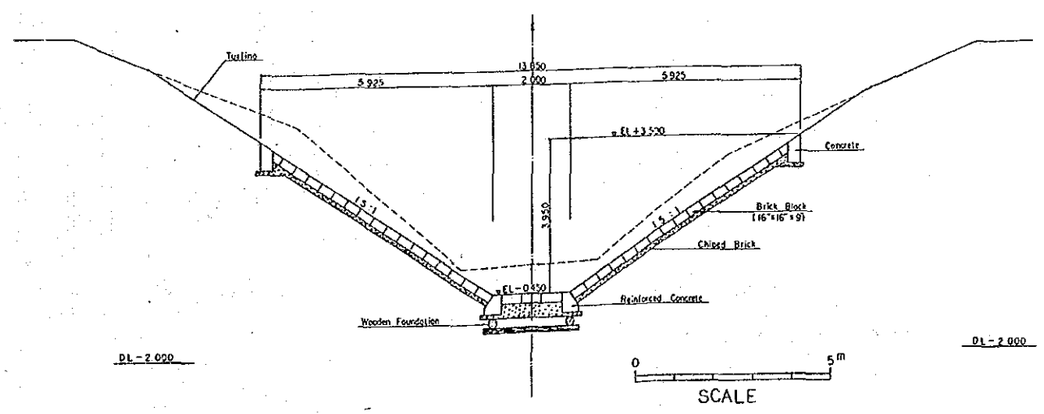


PROFILE





TYPICAL CROSS SECTION OF INTAKE CANAL

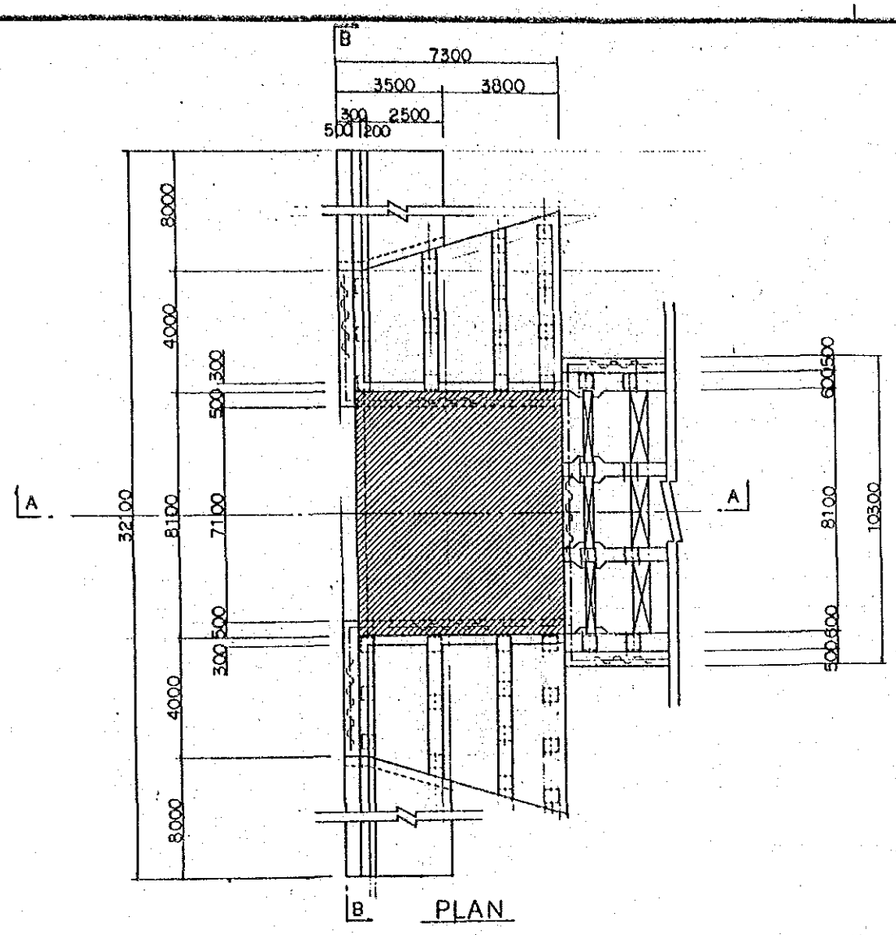


NARAYANGANJ-NARSINGDI IRRIGATION PROJECT
REHABILITATION OF DEMONSTRATION UNIT
THE PEOPLE'S REPUBLIC OF BANGLADESH

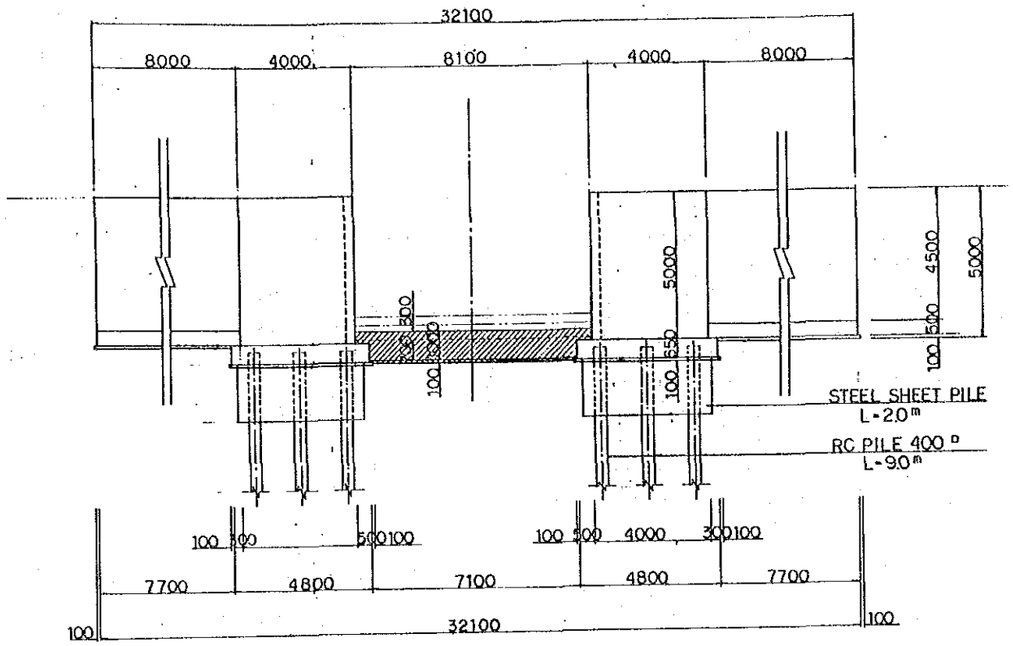
PLAN AND PROFILE
OF INTAKE CANAL

Date ; May 1988 | D.W.G NO 3

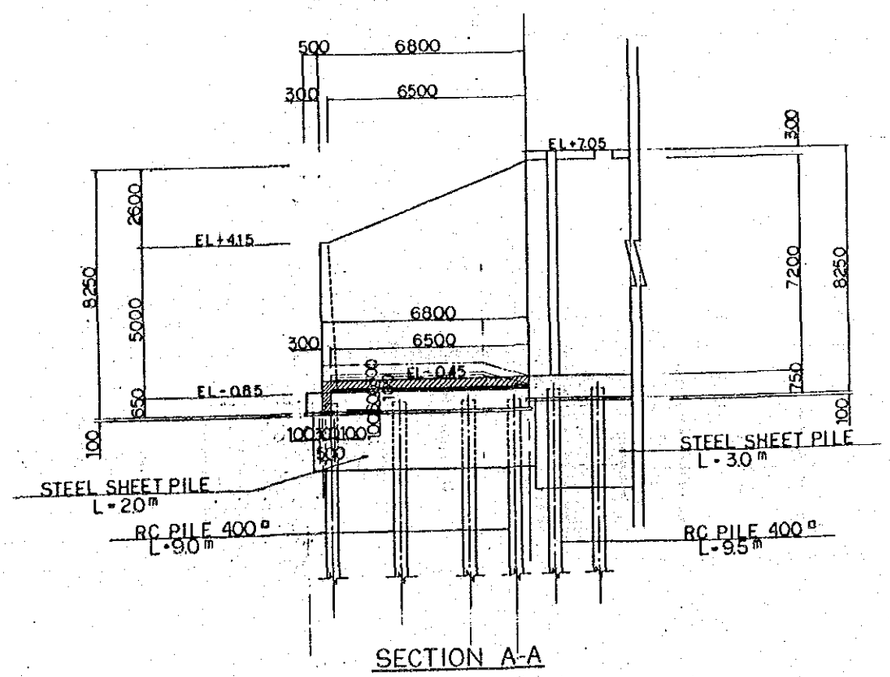
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN



SECTION B-B



SECTION A-A

NOTES :

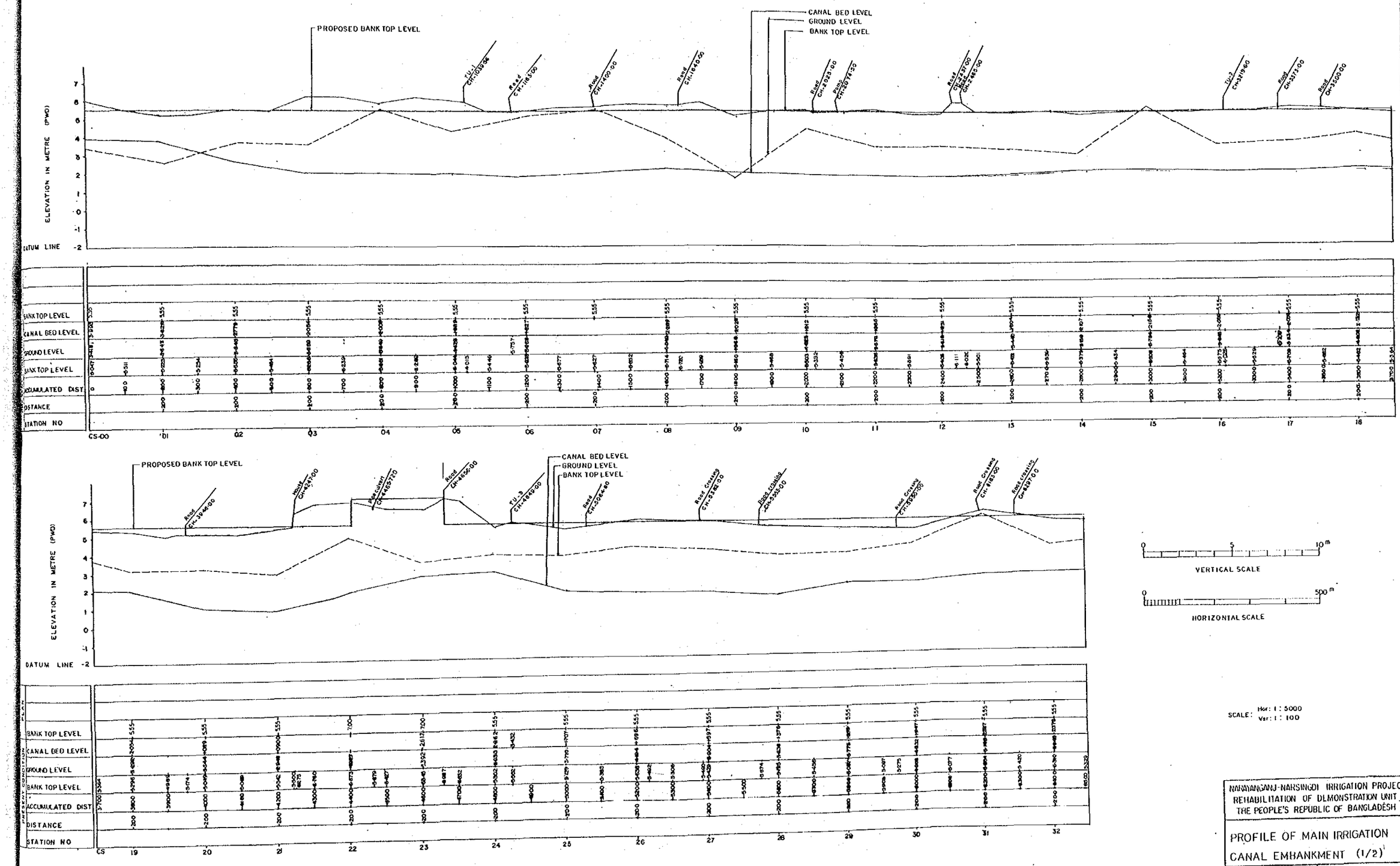
: A part of to be removed.

: A part of to be reconstructed.

SCALE

0 5 10m

NARAYANGANJ-NARSINGDI IRRIGATION PROJECT REHABILITATION OF DEMONSTRATION UNIT THE PEOPLE'S REPUBLIC OF BANGLADESH	
IMPROVEMENT OF INLET APRON	
Date ; May 1988	D.W.G NO. 4
JAPAN INTERNATIONAL COOPERATION AGENCY	



0 5 10 m
VERTICAL SCALE

0 500 m
HORIZONTAL SCALE

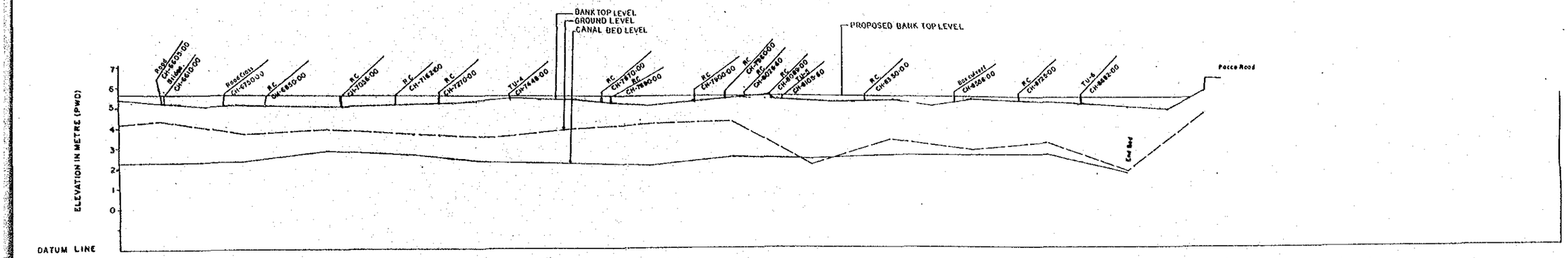
SCALE: Hor: 1 : 5000
Ver: 1 : 100

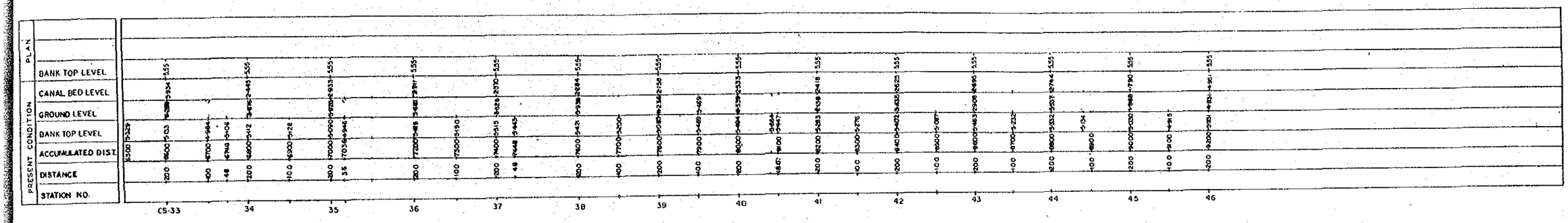
NARAYANGANJ-NARSINGDI IRRIGATION PROJECT
REHABILITATION OF DEMONSTRATION UNIT.
THE PEOPLE'S REPUBLIC OF BANGLADESH

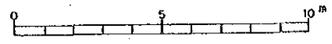
PROFILE OF MAIN IRRIGATION CANAL EMBANKMENT (1/2)

Date ; May 1988 | D.W.G NO.5

JAPAN INTERNATIONAL COOPERATION AGENCY

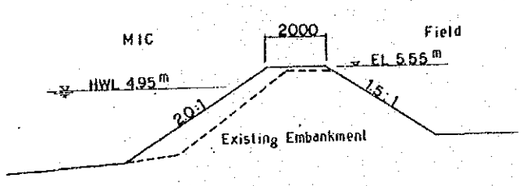




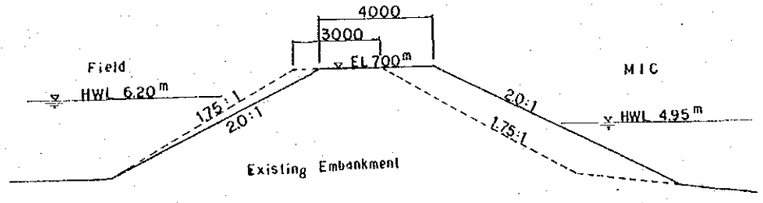


TYPICAL CROSS SECTIONS OF M.I.C EMBANKMENT

GENERAL SECTION



PORTION OF FLOOD EMBANKMENT IN BARBA



SCALE: HOR: 1:5000
VER: 1:100

NARAYANGANJ-NARSINGDI IRRIGATION PROJECT REHABILITATION OF DEMONSTRATION UNIT THE PEOPLE'S REPUBLIC OF BANGLADESH
PROFILE OF MAIN IRRIGATION CANAL EMBANKMENT (2/2)
Date ; May 1988 | D.W.G NO.6
JAPAN INTERNATIONAL COOPERATION AGENCY

Table A2-2-1 High Water Level (Mean) in Lakhya River (unit: m PWD)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1974	-	-	-	2.18	3.08	3.81	5.50	6.30	5.76	4.57	2.99	2.14	
1975	1.77	1.67	1.69	2.09	2.62	3.33	4.52	5.24	5.06	4.29	2.92	2.12	3.11
1976	1.70	1.62	1.73	2.03	2.60	3.80	5.19	5.06	4.93	3.61	2.50	2.10	3.07
1977	1.65	1.52	1.68	2.41	3.18	4.35	4.99	5.48	5.26	4.29	2.73	2.10	3.30
1978	1.60	1.54	1.61	1.92	2.93	4.27	4.95	5.23	4.75	3.83	2.52	1.91	3.09
1979	1.61	1.38	1.59	-	-	-	-	5.10	4.98	4.22	2.57	2.13	
1980	1.68	1.63	1.77	2.14	3.03	3.86	4.73	5.69	5.42	4.21	2.81	2.10	3.26
1981	1.70	1.55	1.66	2.19	2.55	3.33	4.82	5.42	5.16	3.64	2.57	1.99	3.05
1982	1.57	1.51	1.48	2.14	2.51	3.44	4.70	5.05	4.88	3.40	2.22	1.87	2.90
1983	1.66	1.50	1.90	2.15	2.85	3.44	4/58	5.16	5.51	4.76	3.04	2.05	3.22
1984	1.75	1.49	1.68	2.16	3.03	4.37	5.20	5.46	5.48	4.43	2.54	1.95	3.30
1985	1.56	1.57	1.92	2.23	2.61	3.95	4.88	5.13	4.95	4.32	2.78	2.04	3.26
1986	1.65	1.50	1.61	2.06	2.49	2.70	4.40	4.76	4.83	4.57	3.02	1.94	2.96
Average	1.65	1.54	1.69	2.14	2.79	3.72	4.87	5.31	5.15	4.16	2.71	2.03	3.13

Table A2-2-2 Low Water Level(Meam) in Lakhya River

(unit: m PWD)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1974	-	-	-	1.78	2.85	3.64	5.45	6.27	5.74	4.52	2.71	1.72	
1975	1.33	1.17	1.18	1.61	2.26	3.07	4.40	5.21	5.03	4.23	2.68	1.72	2.82
1976	1.26	1.12	1.24	1.57	2.21	3.65	5.14	5.03	4.91	3.41	2.15	1.68	2.78
1977	1.19	0.94	1.21	2.05	2.96	4.25	4.94	5.45	5.23	4.21	2.47	1.69	3.05
1978	1.15	1.03	1.06	1.39	2.35	3.93	4.92	5.20	4.74	3.70	2.17	1.54	2.77
1979	1.16	0.94	1.05	-	-	-	-	5.06	4.95	4.18	2.25	1.71	
1980	1.23	1.10	1.23	1.57	2.75	3.73	4.68	5.66	5.40	4.13	2.48	1.64	2.97
1981	1.23	1.07	1.14	1.75	2.12	3.08	4.74	5.40	5.13	3.50	2.21	1.62	2.75
1982	1.15	1.06	0.99	1.70	2.20	3.17	4.66	5.00	4.83	3.25	1.86	1.41	2.61
1983	1.16	0.95	1.36	1.69	2.56	3.25	4.51	5.10	5.48	4.69	2.76	1.62	2.93
1984	1.30	1.01	1.13	1.67	2.66	4.25	5.16	5.42	4.69	4.32	2.23	1.51	2.95
1985	1.12	1.06	1.41	1.75	2.20	3.78	4.82	5.08	4.90	4.19	2.47	1.66	2.87
1986	1.29	0.96	1.05	1.55	2.10	2.63	4.30	4.67	4.75	4.49	2.76	1.56	2.68
Average	1.21	1.04	1.16	1.67	2.44	3.54	4.81	5.27	5.06	4.06	2.40	1.62	2.83

Table A2-2-3 Soil Characteristics for Stability Annalysis of Embankment

Soil Characteristics

Layer No	Wet Density (t/m3)	Saturated Density (t/m3)	Cohesion (t/m2)	Angle of Internal Friction (°)	
1	1.75	1.86	3.00	20.00	---- Existing Enbankment Body
2	1.75	1.85	1.50	5.00	--- Core
3	1.75	1.90	3.20	15.00	---- Proposed Embankment Body
4	1.75	1.90	3.20	15.00	---- 〃
5	1.75	1.80	3.00	15.00	---- Top Soil
6	1.75	1.80	3.00	15.00	---- 〃
7	1.80	1.80	2.00	30.00	---- Substrata

Table A2-2-4 Soil Characteristics for Stability Annalysis of Intake Canal

Soil Characteristics

Layer No	Wet Density (t/m3)	Saturated Density (t/m3)	Cohesion (t/m2)	Angle of Internal Friction (°)	
1	1.60	1.70	2.50	10.00	---- Upper Layer
2	1.60	1.70	2.50	10.00	---- Upper Layer
3	1.60	1.60	2.00	3.00	---- Middle Layer
4	1.70	1.70	4.00	3.00	---- Lower Layer

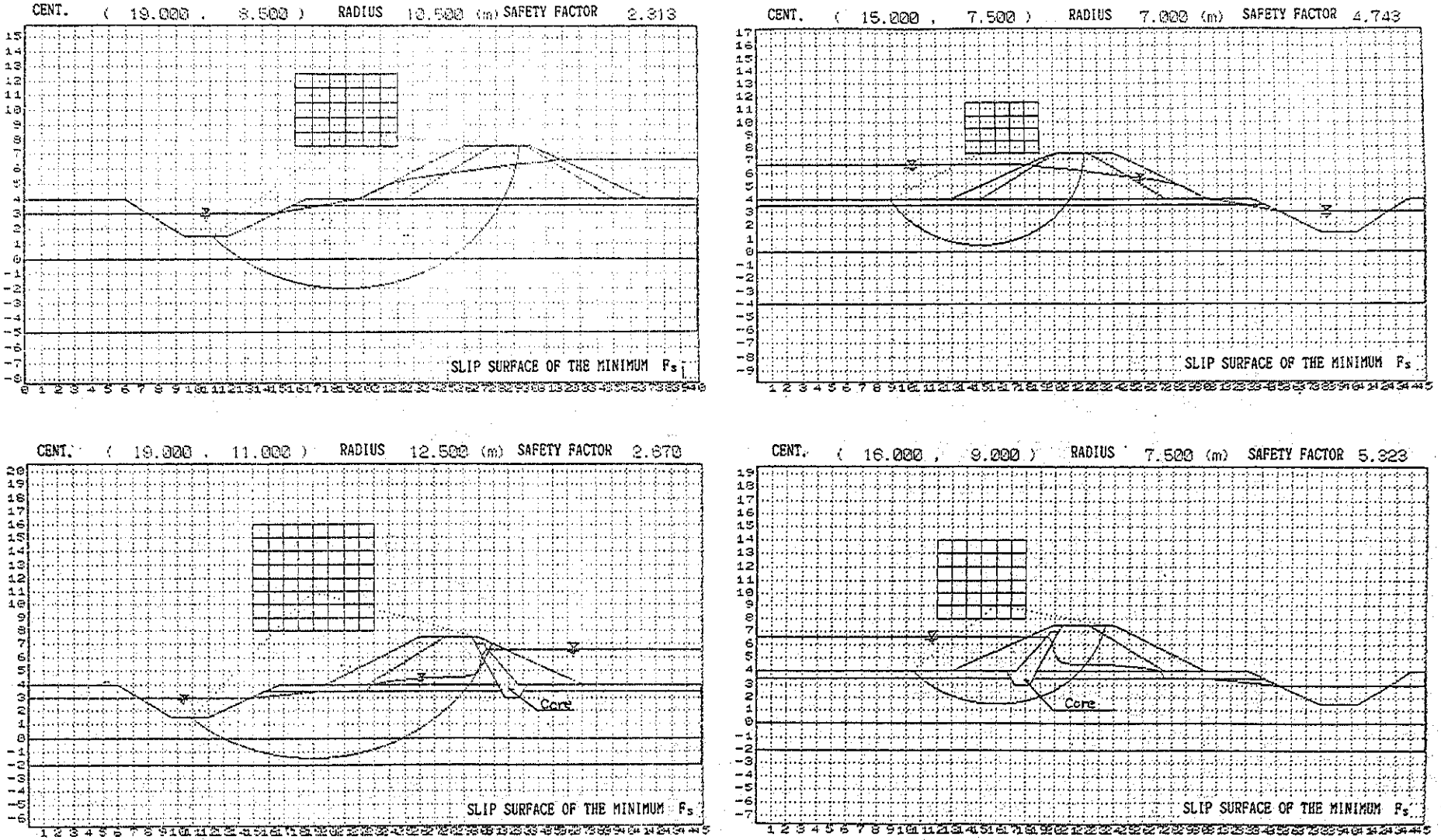


Fig. A2-2-1 Result of Stability Annalysis(1)

Result of Calculation for the Sliding through the Core-wall

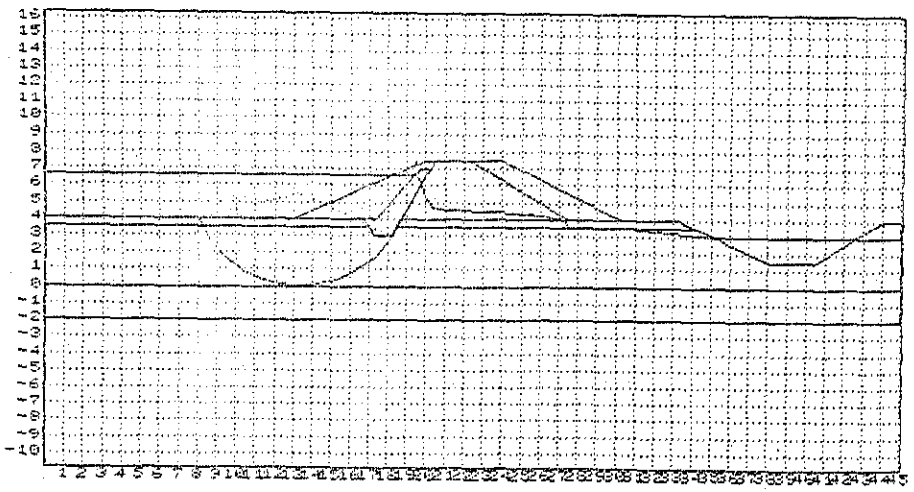
Slide Circle (Upper)

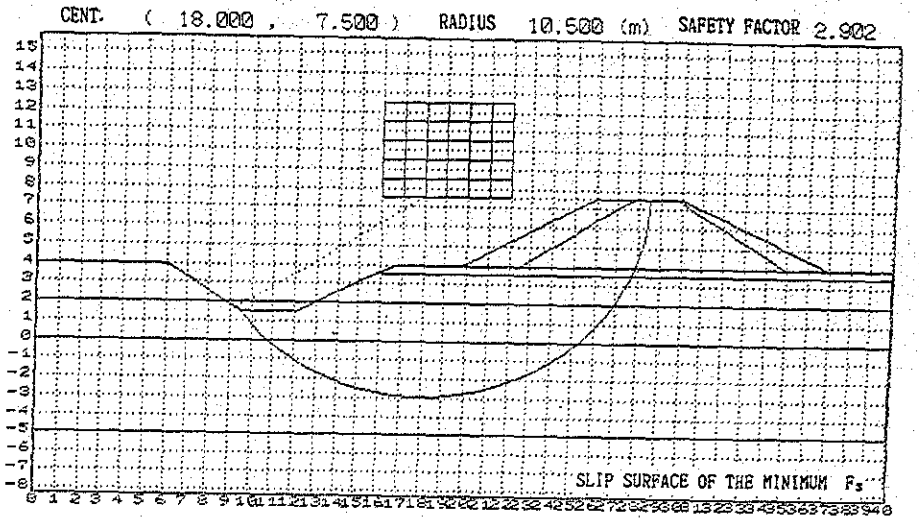
Start Point	X	=	8.034 (m)	Y	=	4.000 (m)
End Point	X	=	18.180 (m)	Y	=	3.020 (m)
Centre of Circle	X	=	13.306 (m)	Y	=	5.568 (m)
Radius	R	=	5.500 (m)			
Angle of Arc			135.840 (°)			
Length of Straight Part			4.468 (m)			

Slide Circle (Lower)

Start Point	X	=	20.250 (m)	Y	=	6.980 (m)
End Point点	X	=	20.364 (m)	Y	=	7.443 (m)
Centre of Circle	X	=	19.364 (m)	Y	=	7.443 (m)
Radius 径	R	=	1.000 (m)			
Angle of Arc			27.597 (°)			

Shearing Moment	T	=	8.639 (t/m)
Resistant Moment	S	=	51.421 (t/m)
Due to "c"			43.551 (t/m)
Due to "φ"			7.871 (t/m)
Safty Factor	F	=	5.952





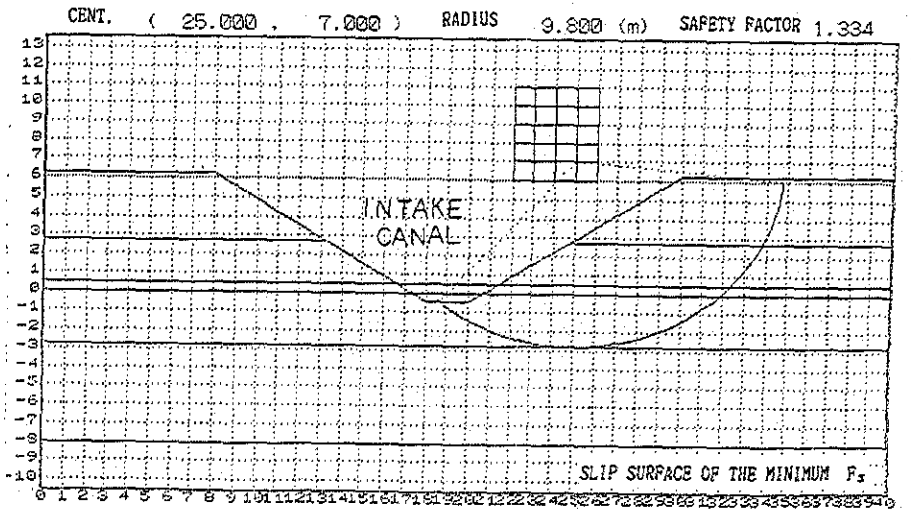


Fig. A2-2-2 Result of Stability Annalysis(2)

APPENDIX III

3 - 1 Surveying

3 - 2 Soil Investigation

3 - 1 Surveying

1. Contents of Topographical Survey carried out

Topographical survey carried out in the field for this basic design study are as follows:-

Table A3-1-1 Contents of Topographical Survey

Canals	Length of Profile	Numbers of Cross Section	Remarks
	km	nos	
Intake canal	0.95	41	Profile & Cross Section
MIC Embankment	9.20	47	- do -
SIC No.1	0.61	6	- do -
SIC No.2	1.35	9	- do -
SIC No.3	1.20	7	- do -
SIC No.4	1.51	9	- do -
SIC No.5	1.10	8	- do -
SIC No.6	0.54	4	- do -
SIC No.7	0.40	4	- do -
	km	nos	
	16.86	135	

2. Results of Topographical Survey on Turnouts
The survey results of levelling survey on Turnouts are as follows:-

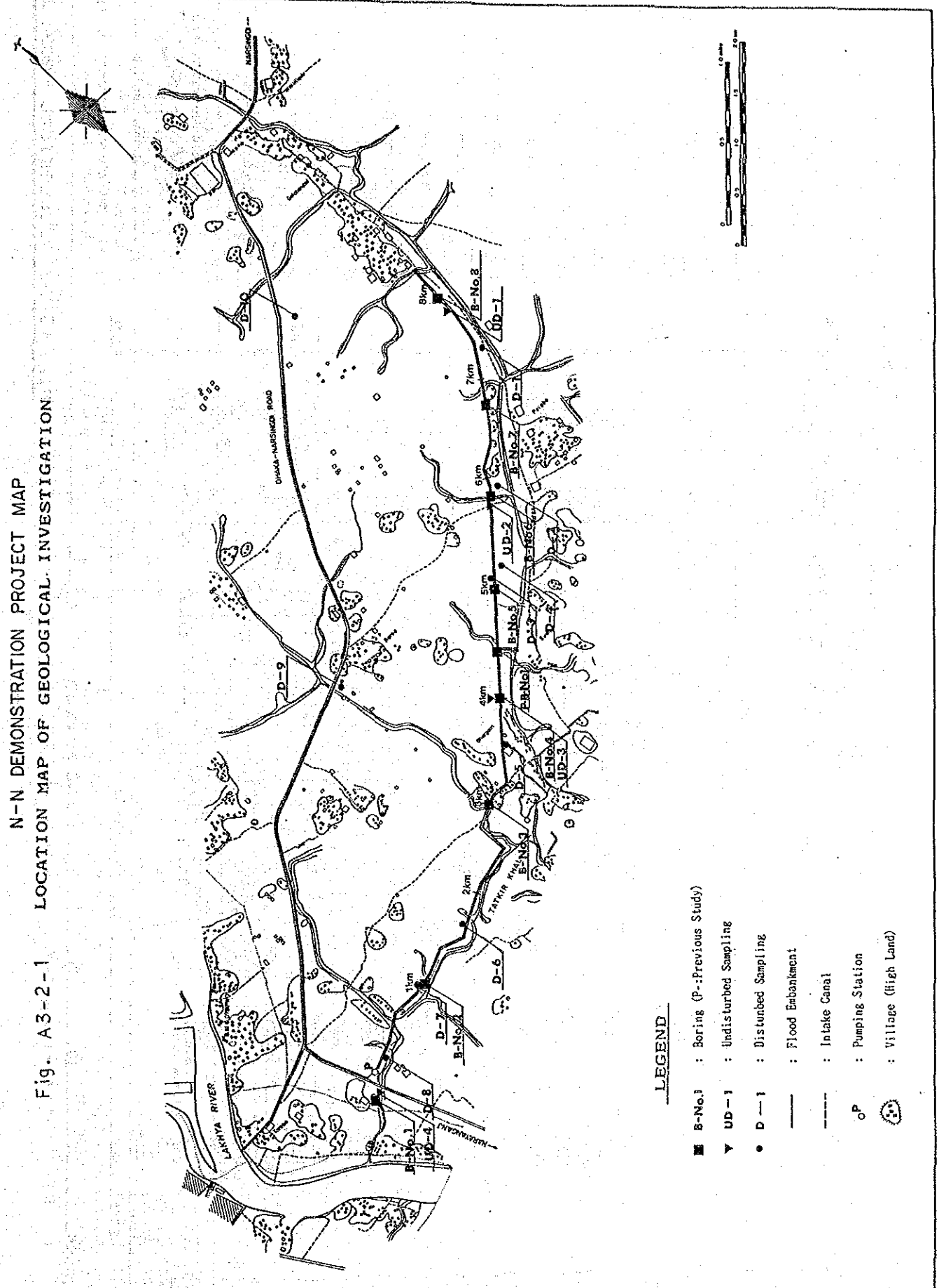
Table A3-1-2 Survey Results of Levelling on Turnouts

Turnouts	Location from Pump Station	Elevation at the Bottom	Remarks
	km	m	
Turnout No.1	1.040	EL 4.034	
Turnout No.2	3.220	EL 4.027	
Turnout No.3	4.849	EL 4.022	
Turnout No.4	7.448	EL 3.991	
Turnout No.5	8.106	EL 3.987	
Turnout No.6	8.882	EL 3.971	

Notes: MIC: Main Irrigation Canal
SIC: Secondary Irrigation Canal
EL.: Elevation (m PWD)

N-N DEMONSTRATION PROJECT MAP

Fig. A3-2-1 LOCATION MAP OF GEOLOGICAL INVESTIGATION



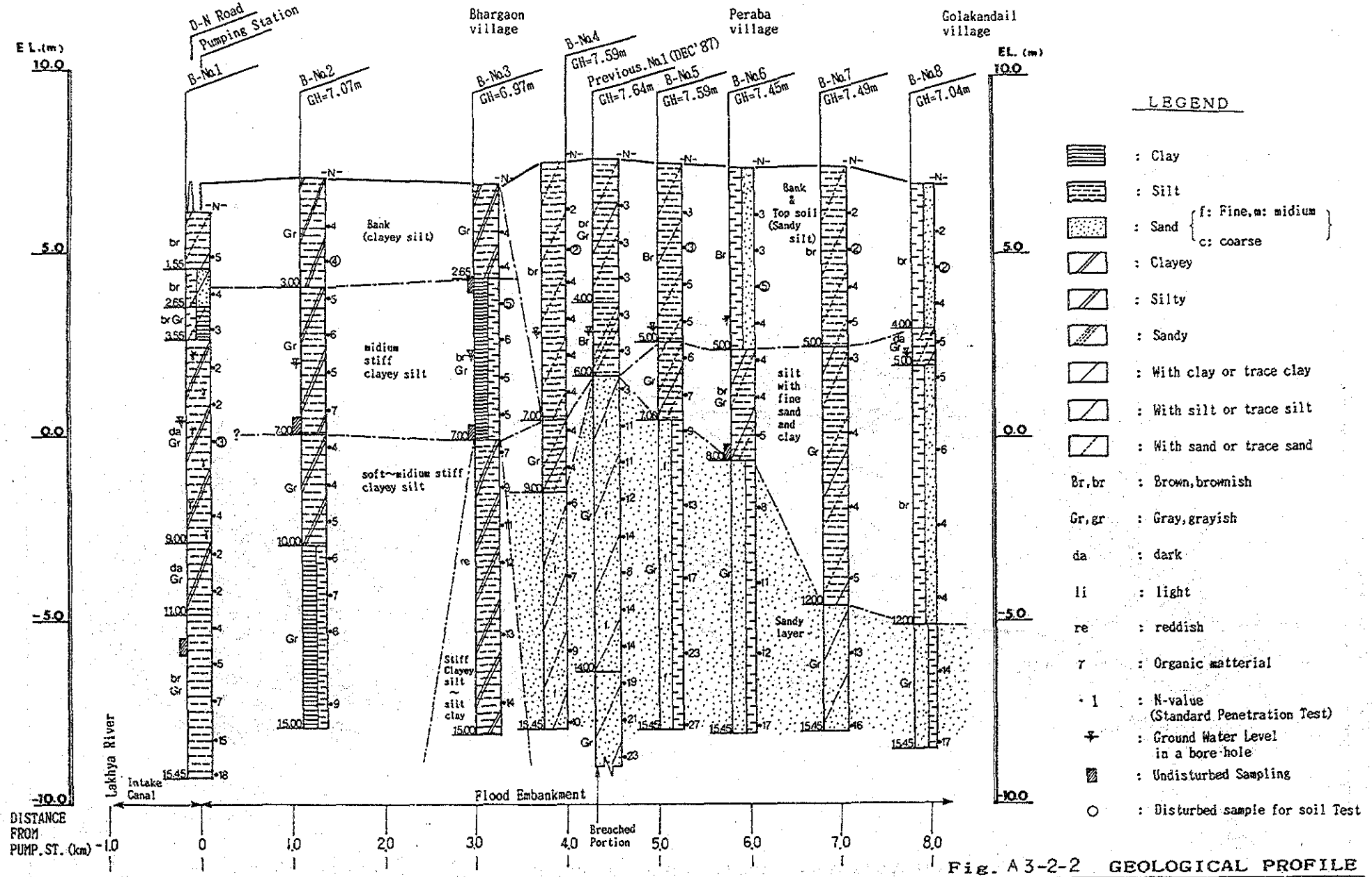


Fig. A3-2-2 GEOLOGICAL PROFILE

Bore chart of boring No. 1 Elevation 6.20 m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 24-2-88
Date completed 24-2-88
GRW. Table 5.69 m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
1	1.55	1.55	Brownish soft silt with clay trace fine sand.		5	
2	2.65	1.10	Brownish very loose silt and fine sand trace clay.		4	
3	3.55	0.90	Brownish gray very soft silt and clay trace fine sand.		3	
4					2	
5					2	
6					3	
7						
8					4	
9	9.00	5.45	Dark gray very soft clayey silt and organic matter.		2	
10					2	
11	11.00	2.00	Dark gray very soft clayey silt.		4	
12					5	
13					7	
14					15	
15	15.45	4.45	Brownish gray medium soft to stiff clay with silt.		18	

disturbed sample □ undisturbed sample ▨

Fig. A 3-2-3 (1)

Bore chart of boring No. 2 Elevation 7.07 m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 25-2-88
Date completed 25-2-88
GRW. Table 5.05 m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
1					4	
2					4	
3	3.00	3.00	Gray soft clayey silt.		5	
4					6	
5					5	
6					7	
7	7.00	4.00	Gray midium stiff clayey silt.		4	
8					4	
9					5	
10	10.00	3.00	Gray soft clayey silt.		6	
11					7	
12					8	
13						
14					9	
15	15.00	5.00	Gray midium stiff clay and silt.			

disturbed sample □ undisturbed sample ▨

Fig. A3-2-3 (2)

Bore chart of boring № 3 Elevation 6.97 m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 26-2-88
Date completed 26-2-88
GRW.Table 4.73 m

reduced elevation	depth	thickness	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
	2.65	2.65	Gray soft clayey silt.		4 4	d
	7.00	4.35	Brownish gray medium stiff clay and silt.		5 6 5 5	
	15.00	8.00	Reddish medium stiff to stiff silt with clay.		7 9 11 12 13 14	

disturbed sample [d] undisturbed sample

Fig. A3-2-3(3)

Bore chart of boring № 4 Elevation 7.59m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 26-2-88
Date completed 26-2-88
GRW.Table 4.65 m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
	7.00	7.00	Brownish very loose silt with fine sand trace clay		2 2 4 4 4 4	d
	9.00	2.00	Gray soft silt with fine sand with clay.		4 6	
	15.45	6.45	Gray loose to medium dense fine sand with silt.		7 9 10	

disturbed sample [d] undisturbed sample

Fig. A 3-2-3 (4)

Bore chart of boring No. 5 Elevation 7.59 m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 27-2-88
Date completed 27-2-88
GRW. Table 4.50 m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
	5.00	5.00	Brown very loose silt with fine sand.		3 3 5 5 6 7 9 13 17 23 27	
	7.00	2.00	Gray very loose silt with fine sand trace clay.			
	15.45	8.45	Gray medium dense fine sand and silt.			

disturbed sample □ undisturbed sample ▨

Fig. A 3-2-3 (5)

Bore chart of boring No. 6 Elevation 7.45 m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 27-2-88
Date completed 27-2-88
GRW. Table 4.22 m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm	remarks soil samples
	5.00	5.00	Brownish very loose silt and fine sand.		3 3 5 4 4 4 5 8 11 12 17	
	8.00	3.00	Brownish gray soft silt with clay trace fine sand.			
	15.45	7.45	Gray medium dense very fine sand and silt.			

disturbed sample □ undisturbed sample ▨

Fig. A3-2-3 (6)

Bore chart of boring No. 7 Elevation 7.49m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 28-2-88
Date completed 28-2-88
GRW.Table 4.34m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm (10 20 30 40 50 60 70 80 90)	remarks soil samples
	5.00	5.00	Brownish very loose silt with fine sand.		2 2 4 5 3	d
	12.00	7.00	Gray very loose silt with fine sand trace clay.		4 4 5 13	
	15.45	3.45	Gray medium dense very fine sand with silt.		16	

disturbed sample □ undisturbed sample ▨

Fig. A3-2-3 (7)

Bore chart of boring No. 8 Elevation 7.04m

Method of boring : —Percussion
Diameter of boring : —100mm
Inclination : —Vertical

Date started 28-2-88
Date completed 28-2-88
GRW.Table 4.67m

reduced elevation	depth (m)	thickness (m)	strata encountered	log	standard penetration tests blows/30cm (10 20 30 40 50 60 70 80 90)	remarks soil samples
	4.00	4.00	Brownish very loose silt and fine sand.		2 2 4 5	d
	5.00	1.00	Dark gray soft silt with trace clay.			
	12.00	7.00	Brownish very loose silt and fine sand.		6 4 14	
	15.45	3.45	Gray medium dense fine sand and silt.		17	

disturbed sample □ undisturbed sample ▨

Fig. A3-2-3 (8)

Table A3-2-1 Contents of Boring

Bore Hole No.	Distance from the Pumping Station (m)	Depth (m)	Standard Penetration Test (times)	Undisturbed Samples (pieces)
1	- 150	15	14	1
2	+1,100	15	13	1
3	+3,000	15	12	2*
4	+4,000	15	12	-
5	+5,000	15	11	-
6	+5,850	15	11	1
7	+6,800	15	10	-
8	+7,800	15	10	-
TOTAL		120	93	5

* One of them was collected from the existing embankment material and the others were obtained from the substrata under the embankment.

Table A3-2-2 Locations of Undisturbed Samples

Sample No.	Location: Distance from the Pumping Station
UD - 1	on the flood embankment : 7,700 m
UD - 2	- ditto - : 5,800 m
UD - 3	- ditto - : 4,000 m
UD - 4	on the right side slope of the intake canal : - 150 m

Table A3-2-3 SOIL TEST RESULTS SUMMARY (1/2)

(Intake Canal, Flood Embankment and its Foundation)

B/H No. or Sample No.	Distance from Pump.St.	Object	Depth (m)	Particle Size Distribution (%)				Consistency Limit		SG	MC (%)	Unit Weight (g/cm³)	Classification	UCS qu (kg/cm²)	Triaxial Comp.		Remarks
				> 2 mm	2~74 mm μm	74~5 μm μm	5 > μm	LL (%)	PI						c (kg/cm²)	φ (°)	
B-1	150 m	Intake Canal	6.00~6.45	0	4	54	42	85	36	2.698	58.12	—	MH	—	—	—	LL: Liquid Limit
			11.55~12.00	0	4	54	42	52	22	2.682	42.18	1.702	MH	0.636	0.46	4	
UD-4			0.5 (slope)	0	7	52	41	69	33	2.650	70.29	1.593	MH	0.590	0.30	5	PI: Plasticity index
d-1	500 m	Embankment	0.5	0	4	84	12	42	14	2.672	(15.79)	—	ML	—	—	—	
B-2	1,100 m	ditto	2.00~2.45	0	4	78	18	44	16	2.659	30.08	—	ML	—	—	—	SG: Specific gravity
		Foundation	6.55~7.00	0	2	74	24	44	18	2.677	31.72	1.835	ML	0.725	0.34	1	
d-2	1,500 m	Embankment	0.5	0	3	87	10	33	9	2.668	(10.47)	—	ML	—	—	—	MC: Moisture content
d-3	2,500 m	ditto	0.5	0	20	78	2	N.P	N.P	2.677	(8.24)	—	—	—	—	—	
B-3	3,000 m	ditto	2.55~3.00	0	4	49	47	58	31	2.683	30.19	1.807	CH	1.856	0.64	3	UCS:qu Unconfined comperssion strength
		Foundation	3.00~3.45	0	11	80	9	39	16	2.661	28.97	—	CL	—	—	—	
		ditto	6.55~7.00	0	2	47	51	65	39	2.685	28.22	1.840	CH	1.725	0.54	5	C: Cohesion
d-4	3,500 m	Embankment	0.5	0	12	75	13	36	16	2.680	(15.92)	—	CL	—	—	—	
B-4	4,000 m	ditto	2.00~2.45	0	6	86	8	35	11	2.685	28.43	—	CL	—	—	—	φ: Angle of internal friction
UD-3	4,000 m	ditto	0.5 (Slope)	0	12	78	10	33	7	2.671	25.82	1.787	ML	0.772	0.39	22	
d-5	4,500 m	ditto	0.5	0	8	71	21	33	15	2.671	(14.28)	—	CL	—	—	—	
B-5	5,000 m	ditto	2.00~2.45	0	4	87	9	34	11	2.654	27.72	—	CL	—	—	—	
d-6	5,500 m	ditto	0.5	0	16	45	39	N.P	N.P	2.670	(6.04)	—	—	—	—	—	
UD-2	5,800 m	ditto	2.5	0	1	76	23	44	16	2.676	29.28	1.812	ML	1.672	0.74	7	
B-6	5,850 m	ditto	3.00~3.45	0	10	82	8	38	13	2.671	33.13	—	CL	—	—	—	
		Foundation	7.55~8.00	0	9	78	13	36	10	2.672	30.10	1.754	ML	1.203	0.20	36	
d-7	6,400 m	Embankment	0.5	0	9	87	4	42	14	2.669	(15.72)	—	ML	—	—	—	
B-7	6,800 m	ditto	2.00~2.45	0	5	89	6	35	11	2.665	28.17	—	CL	—	—	—	
d-8	7,500 m	ditto	0.5	0	18	76	6	N.P	N.P	2.677	(9.18)	—	—	—	—	—	
UD-1	7,700 m	ditto	0.5 (Slope)	0	3	78	19	42	14	2.675	27.29	1.660	ML	—	0.34	28	
B-8	7,800 m	ditto	2.00~2.45	0	14	84	2	39	11	2.671	33.06	—	ML	—	—	—	

Table A3-2-4 SOIL TEST SUMMARY (2/2)

(Material for Embankment & its Core-wall)

Sample No.	Location (P.S.:Pumping Station)	Depth (m)	Particle Size Distribution (%)				Consistency Limit		SG	MC (%)	Classification	Compaction Test		Triaxial Comp.		Permeability K(cm/sec)	Remarks
			>2 mm	2~74 mm μm	74~5 μm μm	5> μm	LL (%)	PI				MDD (g/cm³)	OMC (%)	c (kg/cm²)	φ (°)		
D-1	7450 m from P.S. R/S. 50 m	0.5	0	5	65	30	46	20	2.675	23.67	ML	1.670	20.50	0.27	19		MDD: Maximum Dry Density OMC: Optimum Moisture Content
D-2	5900 m from P.S. R/S. 50 m	0.5	0	5	61	34	38	16	2.677	21.58	CL	1.651	20.05	0.37	13		
D-3	5100 m from P.S. on the MDC(L/S)	0.5	0	2	60	38	43	21	2.654	28.41	CL	1.603	20.50	0.44	13		
D-4	5200 m from P.S. R/S. 40 m	0.5	0	2	82	16	46	19	2.675	32.84	CL (ML)	1.610	20.56	0.22	21		
D-5	3500 m from P.S. R/S. 40 m	0.5	0	3	74	23	44	20	2.670	29.07	CL	1.618	20.00	0.24	20		
D-6	1700 m from P.S. on the MDC(L/S)	0.5	0	8	53	39	57	31	2.681	18.04	CH	1.602	21.50	0.37	12		
D-7	1000 m from P.S. on the MDC(L/S)	0.5	0	6	52	42	47	19	2.672	16.36	ML	1.586	20.25	0.31	17		
D-8	300 m from P.S. R/S. 50 m	0.5	0	4	65	31	48	23	2.677	19.71	CL	1.611	21.00	0.36	16		
D-9	Brick factory along D-N Road (4 km from P.S.)	4.0	0	1	60	39	60	30	2.670	52.83	CH	1.413	27.40			Impermeable	
D-10	— ditto — (8 km from P.S.)	1.5	0	4	77	19	41	16	2.678	27.14	CL	1.632	19.50			Impermeable