FLOOD PLAN
COORDINATION
ORGANIZATION
(FPCO)

KREDITANSTALT FÜR
WIEDERAUFBAU (KfW)

CAISSE CENTRALE DE
COOPERATION ECONOMIQUE (CCCE)

BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

PRELIMINARY FAP 21 INVESTMENT REPORT

NOVEMBER 1992

CONSULTING CONSORTIUM FAP 21/22

RHEIN-RUHR ING.-GES.MBH, DORTMUND/GERMANY

COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
PROF.DR. LACKNER&PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

In association with:

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.(BETS)
DESH UPODESH LIMITED (DUL)

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6

FAP 21/22: BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT

PRELIMINARY FAP 21 INVESTMENT REPORT

Table of Contents

Tables

Figures

1 INTRODUCTION

1.1 BACKGROUND

The Project FAP 21/22 was awarded by the Flood Plan Coordination Organization (FPCO) represented by the Kreditanstalt für Wiederaufbau (KfW) to the Joint Venture Rhein-Ruhr Ingenieur-Gesellschaft.mbH as lead partner, Compagnie Nationale du Rhone, Prof.Dr. Lackner & Partners and Delft Hydraulics in association with Bangladesh Engineering and Technological Services Ltd. (BETS) and Desh Upodesh Ltd. (DUL).

The Consultancy Agreement was signed on October 14, 1991. The date of commencement was fixed on December 1, 1991.

The Agreement calls for a strictly limited period for undertaking the Planning Study of the Project with the intention to start the physical implementation of the first test structure immediately after the monsoon period of 1993. To achieve that deadline the Draft Planning Study Report has to be submitted in mid January 1993.

At that time a mission of the Funding Agencies KfW and CFD (ex CCCE) will appraise the results achieved so far by the Project, the appraisal being required to allocate the funds needed for the Test and Implementation Phase, particularly the construction, monitoring and adaption of the tests structures.

1.2 PURPOSE OF THE PRESENT REPORT

The extremely tight time schedule for preparing the construction in the beginning of the Test and Implementation Phase (see Section 1.3) makes it necessary that the "Order to Proceed" be given by the Funding Agencies and GOB at the end of the appraisal mission, viz end of January 1993.

In order to allow for such a fast decision the Funding Agencies and GOB require beforehand a report containing rough cost estimate, basic concept, approach and time schedule for the FAP 21 test structures envisaged. The present report shall give a breakdown of the investment cost for budgeting and cashflow purposes.

The report does not give details on the cost for consultancy services in Phase 2 (Test and Implementation Phase) nor for a possible follow up of FAP 22 activities. These two components are dealt with in a fairly rough manner taking the contractual figures into account and estimating the overall annual expenses.

1.3 TIME FRAME

As already said before the Project had and has to be undertaken under a strict time frame. On the one hand, it is to a large extent governed by the seasonal changes between the monsoon and the dry periods from June to October and from November to May, respectively. On the other hand, the TOR ask for the construction of the first test works in the dry season 1993/94.

The chart in Table 1 allows for an overview of the course of the Project Phases in general and the main activities to be done from now on to achieve the target set. The key date is clearly the **first October to start the physical construction on the first site**. All activities before, which are required to make that date possible, have been determined by a countdown from the key date 1.10.1993.

Taking into account the novelty of the approach for all participants viz Client, Consultant and Contractor (as a subcontractor to the Consultant) as well as the technical difficulties to be aware of in an innovative project as FAP 21/22 is, the periods available for preparing the construction are all but too generous. In fact they are rather tight. Whereas there might be still a flexibility of about 1/2 month in activities like preparation of proposals by the contractors or in his mobilization there is definitely no tolerance in the time of purchasing equipment and material. That has to be done until mid April latest, due to the delivery periods and the time required for further processing of the material, e.g. to produce spiral welded piles from the imported steal plates. Also award of contract to the construction company must not be later than early August in order to allow for transporting the construction material (sand, stones etc.) to the site by barge. Later the river stages would not allow that kind of transport due to missing draught. Road access is not possible without substantial investment into the infrastructure.

The above conditions make it necessary to start the final design and elaboration of the specifications as the first part of the Test and Implementation Phase in February, 1993 as per the time frame set in the Consulting Agreement. It is equally required that the Consultant has full authority to extend subcontracts and purchase orders according to the rules which will be proposed in the Draft Final Report and which would be endorsed in the Order to Proceed, without other prior approvals by the Client and the Funding Agencies.

9

2 APPROACH

2.1 GENERAL

The bank protection test works are directed towards developing new standards for the design as well as the construction and maintenance of cost-effective structures, aiming at being planned and executed by national experts and contractors and using local materials as far as possible.

In order to allow the pilot structures to be tested, they have to be designed at such a (low ?) level of safety that a certain damage of the structure shall be allowed, will even be required. In other words, a test work that will not suffer any damage in the course of the envisaged monitoring and adaptation period of about 3 to 4 years after the construction may be oversized and therefore not be suitable to serve as a standard design. Hence, a test work that will not get damaged or show signs of potential failure could be considered itself a failure.

The future standard design will definitely not be the lowest-cost design that just does not fail. It will not even be the design with the lowest total cost, considering both capital and maintenance cost, since it is generally far more difficult to establish budgets for maintenance and repair than those for construction. Hence the future standard design needs to have an "optimum" relation of capital to maintenance cost, that relation also depending on improvement of institutional arrangements.

Not only the performance of various types of structures at different safety levels will be studied but also the whole design process of bank protection works should be subject of the Project. This includes the accuracy needed for certain design parameters or the additional safety that can or cannot be obtained by mathematical or physical model simulations. Therefore, model investigations are already performed during the planning study and will be continued in the design stage as well as after the construction of the test works, in order to evaluate to which extent these investigations have really helped to find cost-effective solutions. The Project will also investigate whether the application of prohabilistic design methods could lead to an improvement of the design process. The prohabilistic design approach, using fault trees for the structure as a whole, is hoped to allow for an optimization of certain structural elements and for providing the information where improvement of the design may be required. It is intended to include that method in the final design phase, parallely to the deterministic design of the test structures.

For long time bank protection structures have been built on the rivers of Bangladesh using local material, employing manual labour and improving the proven designs come down from former times. In many cases the traditional methods could fulfill the objectives albeit very often demanding continuous and expensive maintenance and repair.

On the Jamuna river however, the conditions for building bank protection are much more difficult than elsewhere, particularly due to the problem soils encountered both as bank and bed material (non-cohesive silty fine sand) together with high flow velocities of as much as 3.0 m/s as an average of a cross-section and up to 4.0 m/s locally. These conditions request special care to be taken in designing and constructing both the slopes and the toe protection. (1) Contrary to what is practiced in other rivers with more cohesive material under water slopes on the Jamuna must not be built under water without a filter, a component with is extremely difficult to be built using geotextiles and impossible without. (2) The falling apron that shall prevent scouring of the toe protection may need a special design for the highly mobile and easily fluidized bed and bank material.

River bank protection structures are either along the bank (revetments) or across the bank (groynes, cross dykes). Both have specific applications: revetments shall protect a bank immediately, generally in a town, occupying as less land as possible and protecting the embankment which is to keep the town free of flooding. Groynes are intended to divert the bank near flow more towards the centre of the river channel and reduce the eroding forces at the bank.

2.2 GROYNES

Groynes need more space than revetments and have, utilizing conventional technology, to be built on a floodplain in front of the embankment.

They should be built in groups series to achieve their main goal viz to reduce the flow velocity at the bank or even to create sedimentation in the so called groyne fields between the groynes. Hence an advantage of groynes would be that flood embankments would not need to have erosion protection. Many groynes have been constructed along the Jamuna, often investing large amounts of funds. However, with few exceptions, all of them have failed and they where sometimes destroyed by the first flood to attack them. There are mainly two reasons for that, in the opinion of the Consultant. The first one refers to the design which does not include the installation of proper filter below the water level and which provides non functional toe protection, probably since the falling apron cannot cope with the huge scour depth originated at the head of the groynes. The second reason refers to the mere size of the construction which, due to the large quantities of earth, sand and protective material to be built in, could often not be finalized before the commencement of the flood leading to a attack on the not yet finalized (= protected) groyne. That effect was in other cases originated by administrative delays in making the funds available and making the construction start.

The Consultant thinks that both problems could be overcome by constructing (partly) permeable groynes as in more detail described in the following section. Their advantages compared to the conventional groynes seem to be striking:

- about a third of the scour depths and extension, hence less or no scour protection needed
- short construction time, hence less problems with the seasonal construction window
- construction mainly with floating equipment, hence saving space for site installation and avoiding special infrastructure to be provided for the construction
- substantial reduction of construction costs.

The physical model tests were so promising that the Consultant strongly recommends to have prototype tests on this type of groynes on the first test site.

2.3 REVETMENTS

In spite of the advantages groynes may have, there are conditions that call for revetments as bank protection. These refer generally to restricted space either on the bank side to protect a town or very important infrastructure or on the water side where groynes would obstruct navigation, particularly in the vicinity of ferry ghats. The revetments so far built on the bank of the Jamuna either failed or needed a continuous and high influx of funds in order to save them from destruction, see also Section 2.1. Hence there is a large scope for improvements. These improvements would mainly focus on introducing up to date bank protection technology and to adapt it as far as possible to the specific Bangladesh and Jamuna conditions.

The test would concentrate to improve certain components of the revetments mainly

- the cover layer
- the filter and
- the toe protection (falling apron)

by applying different design criteria and installing different (partly innovative) materials. Details are given in Section 3.3.2, hence only a few features shall be mentioned at this place

i)	Slope	:	the underwater slope is recommended to be 1:3 (vertical:horizontal) and 1:2 as the slope above the water level; no variations are intended except, may be, a test stretch with a (nearly) vertical wall above low water.
ii)	Cover layer	:	further to conventional material like boulders and CC blocks (cement-concrete) also chemically bonded blocks shall be tested as developed in China.
iii)	Filter layer	:	innovative composite material of geosynthetics, geonaturals (jute) and minerals shall be developed. The tests would refer to placing techniques and technical performance of the filter material.

iv) Toe protection : this component has two aspects, the first one dealing with the optimum depth where to install the protection and the second one dealing with the dimensions (thickness, width) of the falling apron as well as with the material and technology applied (with or without filter, boulders, CC blocks, sand filled bags) and their sizes.

The Consultant will chose in the tune of say eight different combinations out of the sheer endless number of possible variations. These combinations will have to be chosen in such a way as to test as many new alternatives and, on the other hand, as to allow an unambiguous identification of the individual effects and variations. The alternative constructions have to be arranged in such a way to avoid that one failing design would cause the failure of the next ones (zipper effect).

3 BASIC CONCEPTS

3.1 SELECTION OF TEST SITES

The determination of the sites where to construct the test structures was obviously one of the key decisions of the Project: after all, the structures are not only to be tested but also to serve their protection purpose. To allow continuous discussion, checking and optimization in selecting the test sites a procedure was followed which started right at the beginning of the Project and consisted in a stepwise narrowing of the alternative areas. From a first list of 14 areas 5 came into closer consideration, see Fig.1, of which 2 sites viz Kamarjani and Bahadurabad are now envisaged. A set of criteria was developed to assess the alternatives areas, the main and decisive criteria being:

i) "Certainty of Attack" Criterion
That criterion takes into account the fast and often erratic changes of the river's planform. Past morphological changes were evaluated and forecast methods were developed to determine with a certain degree of confidence that the preselected sites would remain exposed to flow attack throughout the Test and Implementation Phase.

ii) "Something to Defend" Criterion
To make practical use of the investment for the test structures and to allow the population to accept the Project it is necessary that the test structures be erected at locations which require the protection of a town, infrastructure or the like.

iii) "Fitting in Overall Strategy" Criterion
That criterion serves as a link between the two Project components FAP 21 and FAP 22. It shall make sure that the hard points created by the Bank Protection (FAP 21) component would fit into the overall strategy of the River Training/AFPM (FAP 22) component. That criterion could only be applied after having developed alternative scenarios for the FAP 22 component.

The present report does not give all the details of the screening process but will inform, at the beginning of the related subsections, how the finally selected test sites fulfill the conditions set. On this opportunity mention should be made that paralelly to the main study on the selected test sites a preliminary study is being done on two additional sites which may come into consideration in case one or both of the test sites had to be dropped for morphological reasons. The construction of the test works is planned in such a way as to allow for a rapid change of the site if so required.

3.2 TEST SITE 1: KAMARJANI

3.2.1 Description of the Site

Kamarjani is situated on the right bank of the Jamuna, about 15 km downstream of the confluence of the Teesta river. The area experiences serious bank erosion which is likely to continue over the coming years. Hence, the probability of the test structure to be exposed to flow attack until the end of the Test and Implementation Phase is rather high. The test site is situated upstream of the Manos river regulator, an important infrastructure which would be protected as would be the village Rasulpur downstream of it. The test structure would finally be the northern most fixed point on the right bank between the confluence of the Teesta and the Ganges, in a series of 8 to 10 "hard points" to prevent the right bank moving further towards the west, with in Phase 1 of a Jamuna river training programme.

Based on the results of topographical and hydrographical surveys, hydrometric measurements, physical and mathematical model tests the following design criteria for the test structures at Kamarjani were fixed:

Standard low water level SWL	:	+ 15.0 m PWD
a design flood level	:	SWL + 7.5 m
scour depth	:	6 m below river bed
design flow velocity	:	3.0 m/s
significant wave height	:	1.0 m

3.2.2 Description of the Test Structures

The first test structure at Kamarjani will be implemented in the dry season 1993/94. Based on the results of the model tests it was decided to construct 5 permeable groynes with a length of 120 m each, and with an orientation of about 15° to the flow direction.

The investigations for solid groynes had shown large scours up to about 20 m in depth. As already mentioned in Section 2.2 the scours could be very substantially reduced, to about 5 m only or even less, arranging groynes with progressing permeability towards their heads. Hence no provision of a falling apron would be required. However, the scour depth has to be taken into account when determining the required embedded length of the piles. For safety reasons, material necessary for scour protection (CC blocks, boulders, sand filled bags) would be stored for being used in case of an emergency.

The landward end of the groynes would be impermeable and either be built as a conventional earth dam on the flood plain or as a sheet pile cofferdam. The permeable sections, starting with about 10% permeability and increasing to about 70% permeability at the heads, would be built partly of concrete piles and partly of steel piles, both of them being manufactured in Bangladesh.

The variations that will be investigated are:

1. **Impermeable stretch**
   - 1.a earth dam
   - 1.b sheet pile cofferdam
2. **Permeable stretch**
   - 2.a steel piles (each pile consisting of 3 tubes 20 cm in diametre)
   - 2.b concrete piles (single piles, 50 cm in diametre)
3. **Provision of scour protection material**

Further details are given in Fig. 2 to Fig. 5.

3.3 TEST SITE 2: BAHADURABAD

3.3.1 Description of the Site

Bahadurabad is the only test area on the left bank which promises to have a fair probability for a continuous and sufficient flow attack during the Test and Implementation Phase. Bahadurabad is the eastern end of the most important railway ferry connection of the country and the test structure would help stabilizing the total area to avoid too large reconstruction works of the access tracks. Further the test structures would protect the village of Belgacha from being washed away from continuous erosion. As to the long term prospective of a hard point at Bahadurabad, such a protected area would not be required in the final phase of one of the 3 possible scenarios envisaged, say around the year 2040, of a possible river training programme which would focus on shifting the left bank to the east. However, before that time as well as indefinitely in the other two possible scenarios of FAP 22 the place would need to be protected. Hence, the probability that the structures would become unnecessary is quite low and, above all, so far in the future that it would anyhow be the end of the structure's life time.

Based on the results of topographical and hydrographical surveys, hydrometric measurements, physical and mathematical model tests the following design criteria for the test structures at Bahadurabad were fixed:

Standard low water level SWL	:	+ 13.0 m PWD
a design flood level	:	SWL + 7.5 m
scour depth	:	5 to 11 m below river bed
design flow velocity	:	3.5 m/s
significant wave height	:	1.0 m

3.3.2 Description of the Test Structures

The implementation of the test structures at Bahadurabad is planned for the dry season 1994/95 i.e. in two years from now. Hence, the planning of the alternatives for that site is still less detailed than the planning for the Kamarjani site.

For constructing the three main components of a revetment, notably

- the cover layer,
- the filter layer and
- the toe protection

innumerable alternatives have been developed around the world which cannot listed here and now. After carefully sorting out all construction methods and materials that are not appropriate for becoming potential standard solutions on the Jamuna because they are either technically not fitting the requirements, or involving too demanding construction techniques or too expensive materials that could be replaced be cheaper/local ones, the following alternative designs are under closer consideration to be applied on the test structures:

1. Cover Layer

a) above low water level/ground water level

- wire mesh gabions filled with bricks (vertical face)
- wire mesh gabions filled with boulders (vertical face)
- rip-rap with stones or boulders
- rip-rap with chemically bonded sand blocks (Chinese system)
- rip-rap with cement grout
- rip-rap with bitumen grout
- concrete blocks, regularly placed
- open stone asphalt
- wire mesh gabions filled with bricks
- wire mesh gabions filled with boulders

b) below low water level/ground water level

- rip-rap with boulders
- rip-rap with chemically bonded sand blocks (Chinese system)
- concrete blocks, random placed
- cable connected blocks
- blocks connected to geotextile
- geotextile bags filled with sand/lean sand asphalt
- tubular fabrics filled with sand/lean sand asphalt
- wire mesh mattresses filled with stones/boulders

28

2. Filter Layer

a) above low water level/ground water level

. granular filter
. lean sand asphalt
. geotextile filter (one layer)
. geotextile filter (multi layer, e.g. geosynthetics & geonaturals)

b) below low water level/ground water level

. geotextile filter (one layer)
. geotextile filter (multi layer, e.g. geosynthetics & geonaturals)
. geotextile sand mat.

3. Toe Protection

. boulders
. CC blocks (cement concrete)
. chemically bonded sand blocks (Chinese system)
. geotextile bags, partial filled with sand
. cable connected blocks as extension of revetment
. tubular fabrics filled with sand or lean sand asphalt as extension of revetment
. wire mesh mattresses filled with stones/bricks
. scour prevention mat.

A very important detail to be investigated in the Consultant's view is the level and the dimensions of the falling apron. Being one of the decisive components for the overall safety of bank protection also some additional model tests are envisaged on that field.

A preliminary choice of the alternatives as well as the design of the test/structure are being be elaborated and will be proposed in the Draft Final Report whereas the final decisions will only have to be taken around mid 1994.

The layout of the test structure is shown in Fig. 8 and some typical cross-sections in Fig. 9.

4 PRELIMINARY BUDGETING

4.1 GENERAL

The tentative budgeting as broken down in Table 2 to Table 7 is based on three main principles:

i) keeping the ceiling amount of DM 70 million as laid down in the Consulting Agreement
ii) estimating the local component construction cost based on realistic 1991/1992 prices as asked for in the Guidelines for Project Assessment and inflated by 10% annually for the real construction period; the foreign component was subjected to an annual inflation rate of 4%
iii) assuming the amount required for adaptation works as about 10% annually of the original construction cost.

The cost for the consulting services were taken from the Consulting Agreement as DM 20 million adding another DM 5 million - as per the ToR - for possible FAP 22 follow up activities and as contingencies.

The general breakdown of the contract amount given in Table 2 is reflecting the above principles.

4.2 ESTIMATED CASH FLOW FOR THE CONSTRUCTION WORKS

The tentative cost and cash flow for the sites at Kamarjani and Bahadurabad are summarized in Table 3 and Table 4, respectively. There are four main items which may be commented as follows:

Item 1: Imported by Consultant
In test site 1, these are crucial items for coping with the strict time schedule set. The steel piles that will be tested on the Kamarjani site will be manufactured (rolled and spiral welded) in a factory in Bangladesh. The required steel will however be imported beforehand either by the factory or the Consultant directly, depending on the more favourable terms for cost and delivery time.

The purchase of equipment for Kamarjani refers to a medium size, say 100 t capacity multi purpose crawler crane with special accessories like dragline, pile driving unit, pile vibrating unit and pile jetting unit. It will form the core of the construction equipment amended by other equipment locally rented from BWDB, BIWTA or local contractors and serve for both construction and adaptation works.

29

Item 2: Local purchase by Consultant

The order to manufacture the piles, both steel and spurs concrete piles, has to be given earlier than executing the subcontract for the construction works. Hence the purchases need to be done by the Consultant directly.

Item 3: Subcontract

The payments to the subcontractor shall be effected "close to the work" on an either bi-monthly or monthly basis. The advance payment refers to the cost for mobilizing and purchasing construction material and will have to be backed by an irrevocable unconditional first class bank guarantee on first written demand. The disbursement of the final payment will be subject to prior approval of the works. For the present preliminary budgeting equal installments have been assumed which may later on be modified according to the needs.

The local costs have been estimated on adapted BWDB schedule of rates and include a contractor's overhead of 25% as usual for that kind of work and cost calculation in Bangladesh.

Item 4: Contingencies

That item corresponds to about 20% of the total local cost (item 2 + item 3). It refers to both physical and financial contingencies.

4.3 TENTATIVE BUDGETING

The budgeting and cash flow requirements are based on the schedule of expenses as given in Table 5 which combines the Tables 3 and 4, amended by a tentative payment schedule for the adaptation works. The individual cumulative costs as well as the total cumulative cost are graphically shown in Table 6 and numerically in Table 7, both tables containing also the proposed disbursement schedule to the Consultant. Regarding the time frame set for the commencement of the construction works reference is made to Section 1.2 of the present report and to Table 1.

Since the Consultant is not to prefinance the construction works and in order to allow for the financial flexibility required for test works a type of revolving fund is proposed with quarterly installments to assure liquidity.

As per the Consulting Agreement, for each construction and adaptation year an interim balance for the subcontract services rendered during that year will be prepared and submitted to the Funding Agency. The approved (either negative or positive) balance shall be compensated with the next quarterly installment due.

It is proposed to define the construction (and adaptation) years according to the cycle set by the seasons and hence be the works, having the transition from one year to the next on 30 June/1st July. This would result in the following construction years:

Construction year 1	:	February 1, 1993 to June 30, 1994
Construction year 2	:	July 1, 1994 to June 30, 1995
Construction year 3	:	July 1, 1995 to June 30, 1996
Construction year 4	:	July 1, 1996 to June 30, 1997
Construction year 5	:	July 1, 1997 to December 31, 1997

TABLE 1

FAP 21 TEST STRUCTURES

PRELIMINARY TIME SCHEDULE FOR FINAL DESIGN, CONSTRUCTION AND ADAPTATION

VERSION NO 1

20 NOVEMBER 1992

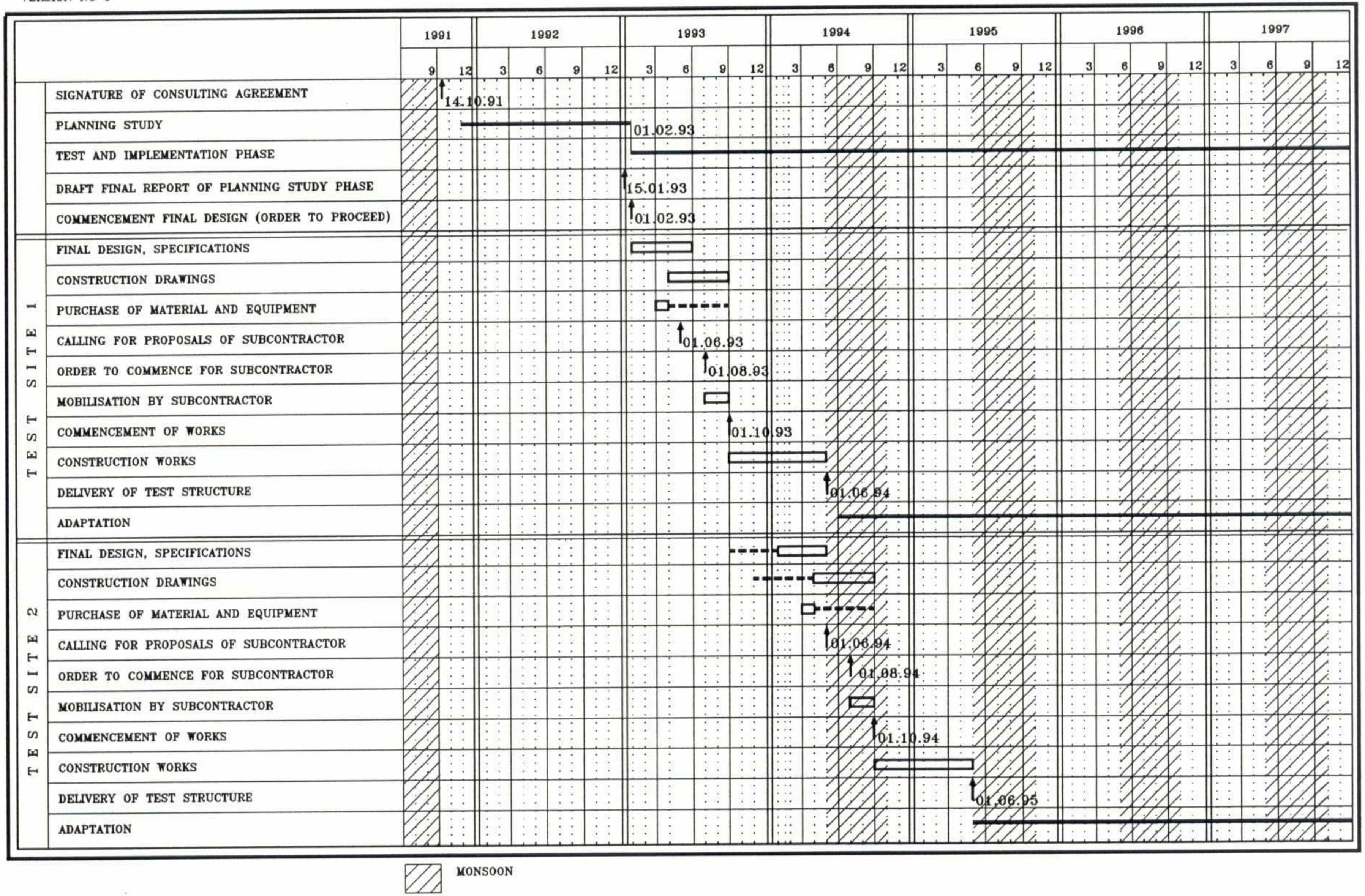


TABLE 2

FAP 21/22
GENERAL BREAKDOWN OF CONTRACT AMOUNT

VERSION 1 20 NOVEMBER 1992

	DM
Consultancy Agreement Phase 1 + 2	20,000,000
Contingencies + FAP 22 Consultancy	5,000,000
Construction	35,800,000
Monitoring / Adaptation	9,200,000
TOTAL CONTRACT AMOUNT	70,000,000

202

TABLE 3

FAP 21 TEST STRUCTURES

PRELIMINARY COST AND CASH FLOW OF TEST SITE 1 : KAMARJANI

VERSION 1 — 20 NOVEMBER 1992

		TK	DM	DATE
1	**IMPORTED BY CONSULTANT**			
1.1	Equipment	69,000,000	3,000,000	01-04-93
1.2	Steel plates for piles	62,100,000	2,700,000	15-04-93
1.3	Geotextiles bags and filter	2,875,000	125,000	15-04-93
1.4	Monitoring eqipment	4,600,000	200,000	01-01-94
	TOTAL ITEM 1	**138,575,000**	**6,025,000**	
2	**LOCAL PURCHASE BY CONSULTANT**			
2.1	Steel piles (rolling + transport)	64,000,000	2,782,600	01-07-93
2.2	Concrete piles (production + transport)	11,904,000	517,600	01-07-93
2.3	Equipment transport	3,125,000	135,900	01-07-93
	TOTAL ITEM 2	**79,029,000**	**3,436,100**	
3	**SUBCONTRACT**			
3.1	Advance payment	26,248,000	1,141,200	01-08-93
3.2	1st installment	22,540,000	980,000	01-10-93
3.3	2nd installment	22,540,000	980,000	01-12-93
3.4	3rd installment	22,540,000	980,000	01-02-94
3.5	4th installment	22,540,000	980,000	01-04-94
3.6	5th installment	22,540,000	980,000	01-06-94
3.7	Final installment	15,833,200	688,400	01-08-94
	TOTAL ITEM 3	**154,781,200**	**6,729,600**	
4	**CONTINGENCIES**	48,514,800	2,109,300	
	TOTAL ITEM 4	**48,514,800**	**2,109,300**	
	TOTAL TEST SITE 1	**420,900,000**	**18,300,000**	

Observations :

1) Exchange rate : DM 100 equal to Tk 2,300
2) Costs based on 1991/1992 prices inflated by annually 10% for local and 4% for foreign cost

TABLE 4

FAP 21 TEST STRUCTURES

PRELIMINARY COST AND CASH FLOW OF TEST SITE 2 : BAHADURABAD

VERSION 1 — 20 NOVEMBER 1992

		TK	DM	DATE
1	**IMPORTED BY CONSULTANT**			
1.1	Geotextiles (geosynthetics)	9,200,000	400,000	01-04-94
1.2	Monitoring equipment	5,750,000	250,000	01-01-95
	TOTAL ITEM 1	**14,950,000**	**650,000**	
2	**LOCAL PURCHASE BY CONSULTANT**			
	(to be filled in later, if required)			
	TOTAL ITEM 2	**0**	**0**	
3	**SUBCONTRACT**			
3.1	Advance payment	39,450,000	1,715,200	01-08-94
3.2	1st installment	31,050,000	1,350,000	01-10-94
3.3	2nd installment	31,050,000	1,350,000	01-11-94
3.4	3rd installment	31,050,000	1,350,000	01-12-94
3.5	4th installment	31,050,000	1,350,000	01-01-95
3.6	5th installment	31,050,000	1,350,000	01-02-95
3.7	6th installment	31,050,000	1,350,000	01-03-95
3.8	7th installment	31,050,000	1,350,000	01-04-95
3.9	8th installment	31,050,000	1,350,000	01-05-95
3.10	Final installment	36,200,000	1,573,900	01-08-95
	TOTAL ITEM 3	**324,050,000**	**14,089,100**	
4	**CONTINGENCIES**	63,500,000	2,760,900	
	TOTAL ITEM 4	**63,500,000**	**2,760,900**	
	TOTAL TEST SITE 2	**402,500,000**	**17,500,000**	

Observations :

1) Exchange rate : DM 100 equal to Tk 2,300
2) Costs based on 1991/1992 prices inflated by annually 10% for local and 4% for foreign cost

TABLE 5

FAP 21 TEST STRUCTURES

PRELIMINARY CASH FLOW BREAK DOWN FOR CONSTRUCTION AND ADAPTATION

VERSION 1 — 20 NOVEMBER 1992

DATE	ITEM	AMOUNTS IN DM		
		Itemwise	Datewise	Cumulative
	PAYMENTS BY CONSULTANT			
	CONSTRUCTION TEST SITE 1: KAMARJANI *			
01.04.93	1.1 Purchase Equipment	3,000,000	3,000,000	3,000,000
15.04.93	1.2 Purchase Steel	2,700,000		
	1.3 Purchase Geotextiles	125,000	2,825,000	5,825,000
01.07.93	2 Local Purchase	3,436,100	3,436,100	9,261,100
01.08.93	3 Advance Payment Subcontractor	1,141,200		
	4 1/3 Contingencies	703,100	1,844,300	11,105,400
01.10.93	3.2 1st Installment Subcontractor	980,000	980,000	12,085,400
01.12.93	3.3 2nd Installment Subcontractor	980,000	980,000	13,065,400
01.01.94	1.4 Monitoring Equipment	200,000		
	4 1/3 Contingencies	703,100	903,100	13,968,500
01.02.94	3.4 3rd Installment Subcontractor	980,000	980,000	14,948,500
01.04.94	3.6 4th Installment Subcontractor	980,000	980,000	15,928,500
01.06.94	3.7 5th Installment Subcontractor	980,000	980,000	16,908,500
01.08.94	3.8 Final Payment Subcontractor	688,400		
	4 1/3 Contingencies	703,100	1,391,500	18,300,000
	SUBTOTAL KAMARJANI	18,300,000	18,300,000	
	CONSTRUCTION TEST SITE 1: BAHADURABAD **			
01.04.94	1.1 Purchase Geotextiles	400,000	400,000	400,000
01.08.94	3.1 Advance Payment Subcontractor	1,715,200	1,715,200	2,115,200
01.10.94	3.2 1st Installment Subcontractor	1,350,000		
	4 1/3 Contingencies	920,300	2,270,300	4,385,500
01.11.94	3.3 2nd Installment Subcontractor	1,350,000	1,350,000	5,735,500
01.12.94	3.4 3rd Installment Subcontractor	1,350,000	1,350,000	7,085,500
01.01.95	3.5 4th Installment Subcontractor	1,350,000		
	1.2 Monitoring Equipment	250,000	1,600,000	8,685,500
01.02.95	3.6 5th Installment Subcontractor	1,350,000		
	4 1/3 Contingencies	920,300	2,270,300	10,955,800
01.03.95	3.7 6th Installment Subcontractor	1,350,000	1,350,000	12,305,800
01.04.95	3.8 7th Installment Subcontractor	1,350,000	1,350,000	13,655,800
01.05.95	3.9 8th Installment Subcontractor	1,350,000	1,350,000	15,005,800
01.08.95	3.10 Final Payment Subcontractor	1,573,900		
	4 1/3 Contingencies	920,300	2,494,200	17,500,000
	SUBTOTAL BAHADURABAD	17,500,000	17,500,000	
	ADAPTATION WORKS			
01.10.94	Kamarjani	1,000,000	1,000,000	1,000,000
01.04.95	Kamarjani	1,000,000	1,000,000	2,000,000
01.10.95	Kamarjani	800,000		
	Bahadurabad	1,000,000	1,800,000	3,800,000
01.04.96	Kamarjani	800,000		
	Bahadurabad	1,000,000	1,800,000	5,600,000
01.10.96	Kamarjani	800,000		
	Bahadurabad	1,000,000	1,800,000	7,400,000
01.04.97	Kamarjani	500,000		
	Bahadurabad	500,000	1,000,000	8,400,000
01.10.97	Kamarjani	400,000		
	Bahadurabad	400,000	800,000	9,200,000
	SUBTOTAL ADAPTATION	9,200,000	9,200,000	

* DETAILS SEE TABLE 2, ** DETAILS SEE TABLE 3

TABLE 6

VERSION 1

20 NOVEMBER 1992

FAP 21 TEST STRUCTURES

ESTIMATED TOTAL CASH FLOW AND BUDGET REQUIREMENT

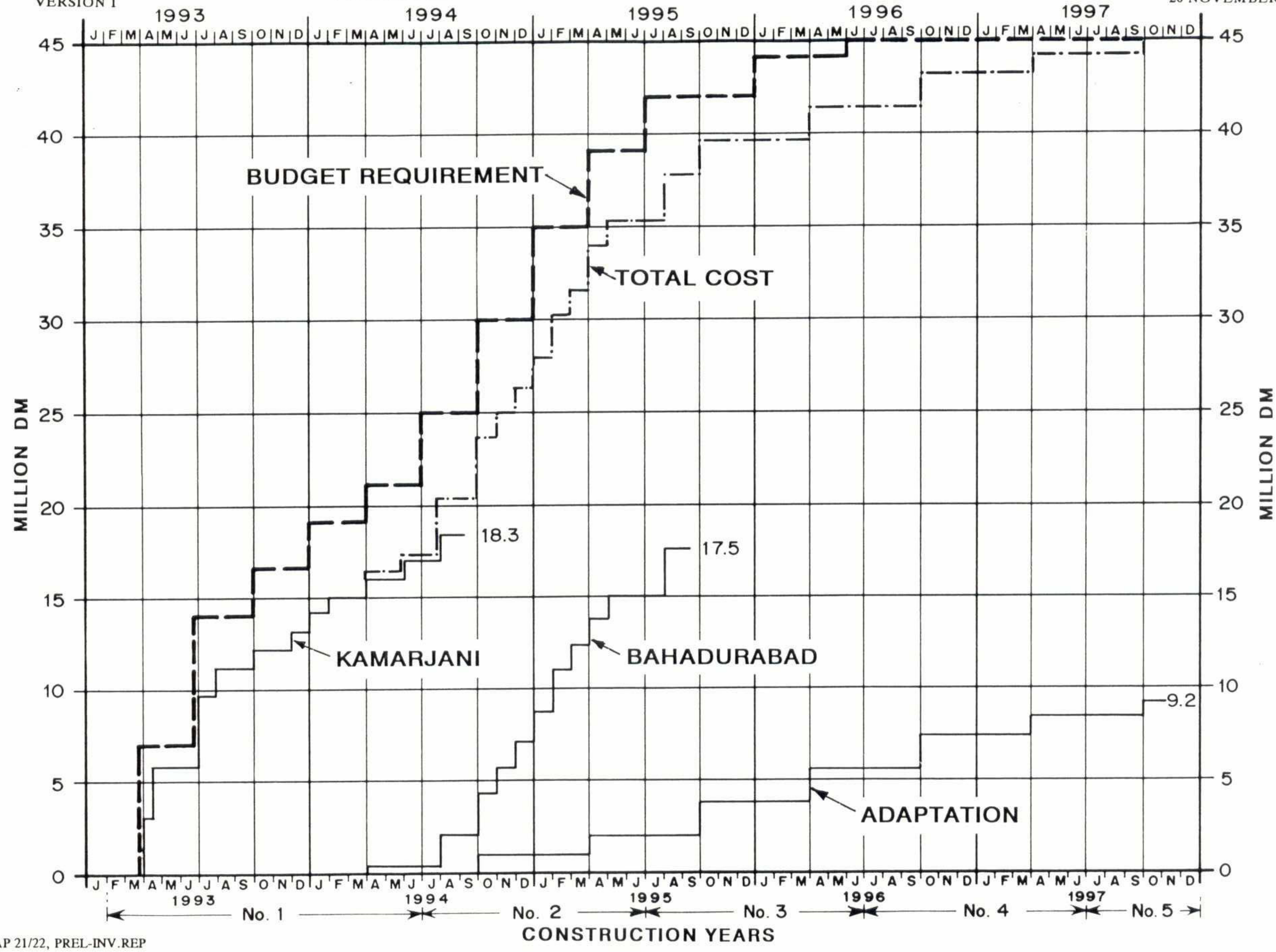


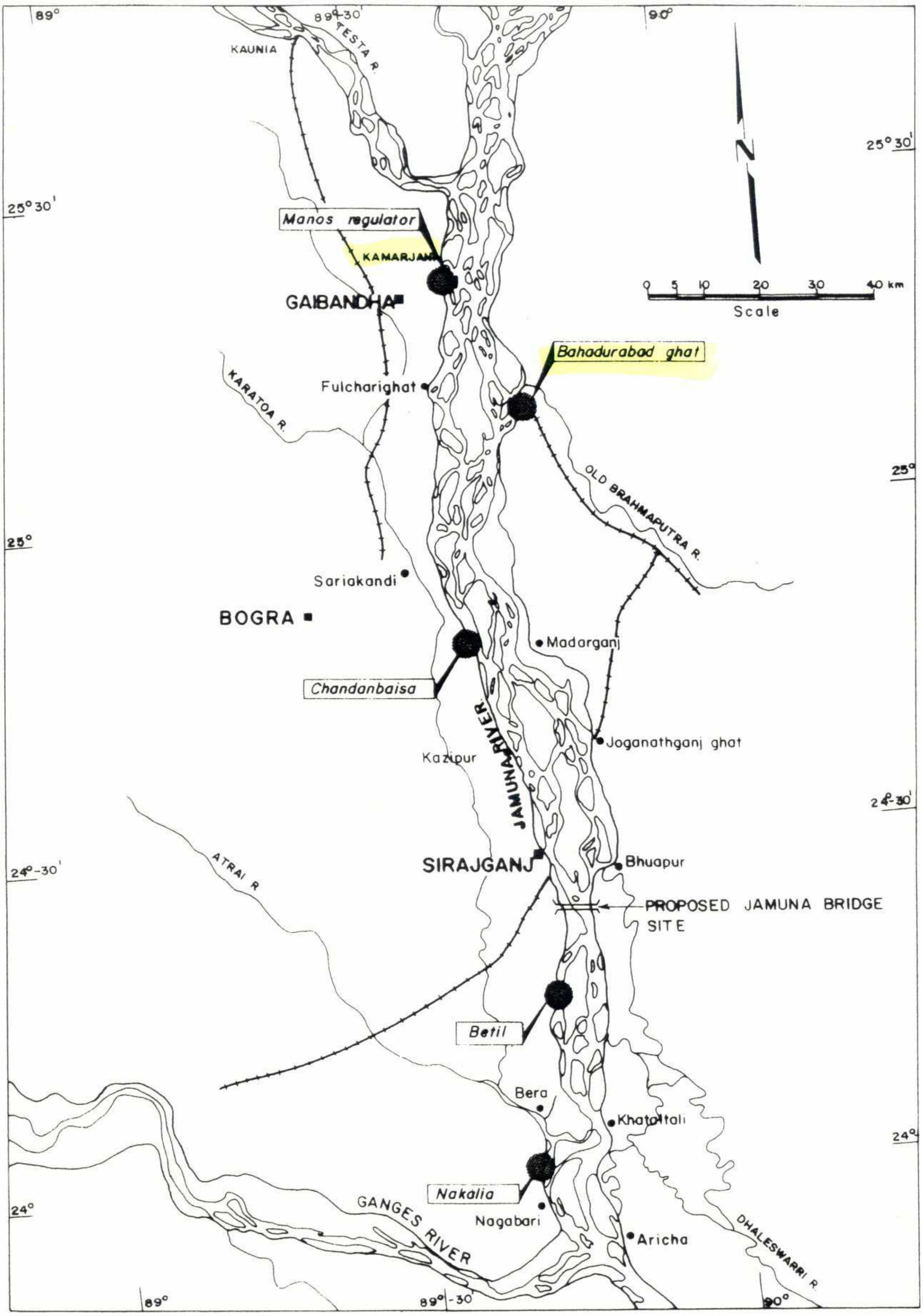
TABLE 7

FAP 21 TEST STRUCTURES

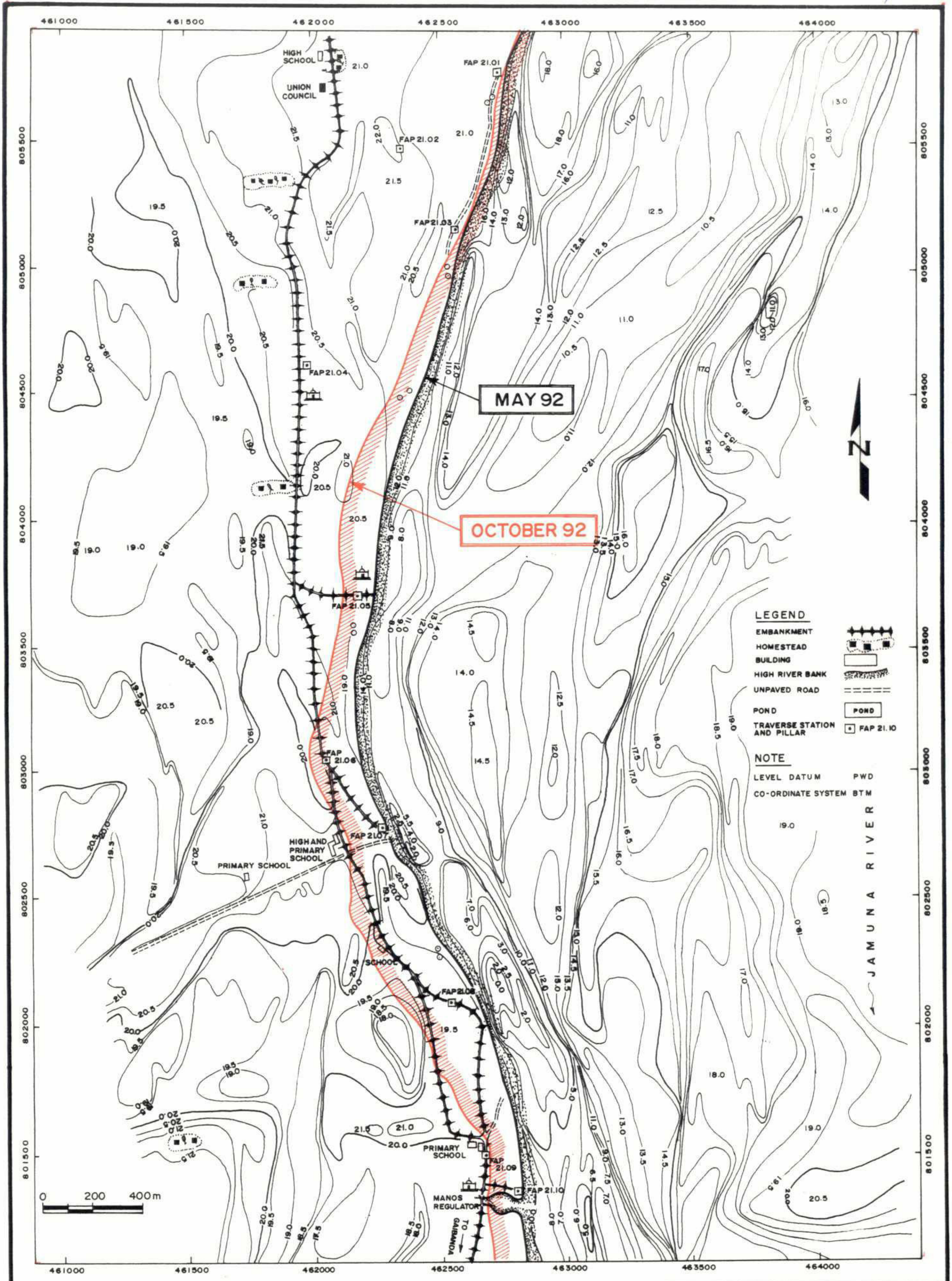
ESTIMATED TOTAL CASH FLOW AND BUDGET REQUIREMENT

VERSION 1 — 20 NOVEMBER 1992

PAYMENTS BY CONSULTANT IN DM					BUDGET IN DM		
DATE	ITEM	AMOUNT	TOTAL	CUMULATIVE	AMOUNT	CUMULATIVE	DATE
01.04.93	Construction Kamarjani	3,000,000	3,000,000	3,000,000	7,000,000	7,000,000	31.03.93
15.04.93	Construction Kamarjani	2,825,000	2,825,000	5,825,000			
01.07.93	Construction Kamarjani	3,436,100	3,436,100	9,261,100	7,000,000	14,000,000	30.06.93
01.08.93	Construction Kamarjani	1,844,300	1,844,300	11,105,400			
01.10.93	Construction Kamarjani	980,000	980,000	12,085,400	2,500,000	16,500,000	30.09.93
01.12.93	Construction Kamarjani	980,000	980,000	13,065,400			
01.01.94	Construction Kamarjani	903,100	903,100	13,968,500	2,500,000	19,000,000	31.12.93
01.02.94	Construction Kamarjani	980,000	980,000	14,948,500			
01.04.94	Construction Kamarjani	980,000					
	Construction Bahadurabad	400,000	1,380,000	16,328,500	2,000,000	21,000,000	31.03.94
01.06.94	Construction Kamarjani	980,000	980,000	17,308,500	4,000,000	25,000,000	30.06.94
01.08.94	Construction Kamarjani	1,391,500					
	Construction Bahadurabad	1,715,200	3,106,700	20,415,200			
01.10.94	Construction Bhadurabad	2,270,300					
	Adaptation Kamarjani	1,000,000	3,270,300	23,685,500	5,000,000	30,000,000	30.09.94
01.11.94	Construction Bhadurabad	1,350,000	1,350,000	25,035,500			
01.12.94	Construction Bhadurabad	1,350,000	1,350,000	26,385,500			
01.01.95	Construction Bhadurabad	1,600,000	1,600,000	27,985,500	5,000,000	35,000,000	31.12.94
01.02.95	Construction Bhadurabad	2,270,300	2,270,300	30,255,800			
01.03.95	Construction Bhadurabad	1,350,000	1,350,000	31,605,800			
01.04.95	Construction Bhadurabad	1,350,000					
	Adaptation Kamarjani	1,000,000	2,350,000	33,955,800	4,000,000	39,000,000	31.03.95
01.05.95	Construction Bahadurabad	1,350,000	1,350,000	35,305,800	3,000,000	42,000,000	30.06.95
01.08.95	Construction Bahadurabad	2,494,200	2,494,200	37,800,000			
01.10.95	Adaptation Kamar.+Bahad.	1,800,000	1,800,000	39,600,000	2,000,000	44,000,000	31.12.95
01.04.96	Adaptation Kamar.+Bahad.	1,800,000	1,800,000	41,400,000			
01.10.96	Adaptation Kamar.+Bahad.	1,800,000	1,800,000	43,200,000	1,000,000	45,000,000	30.06.96
01.04.97	Adaptation Kamar.+Bahad.	1,000,000	1,000,000	44,200,000			
01.10.97	Adaptation Kamar.+Bahad.	800,000	800,000	45,000,000			
	TOTAL		**45,000,000**		**45,000,000**		



PRESELECTED TEST AREAS	**FAP - 21/22** **Bank Protection and River Training/** **AFPM Pilot Project**
	PRELIMINARY FAP 21 INVESTMENT REPORT — FIG. 1



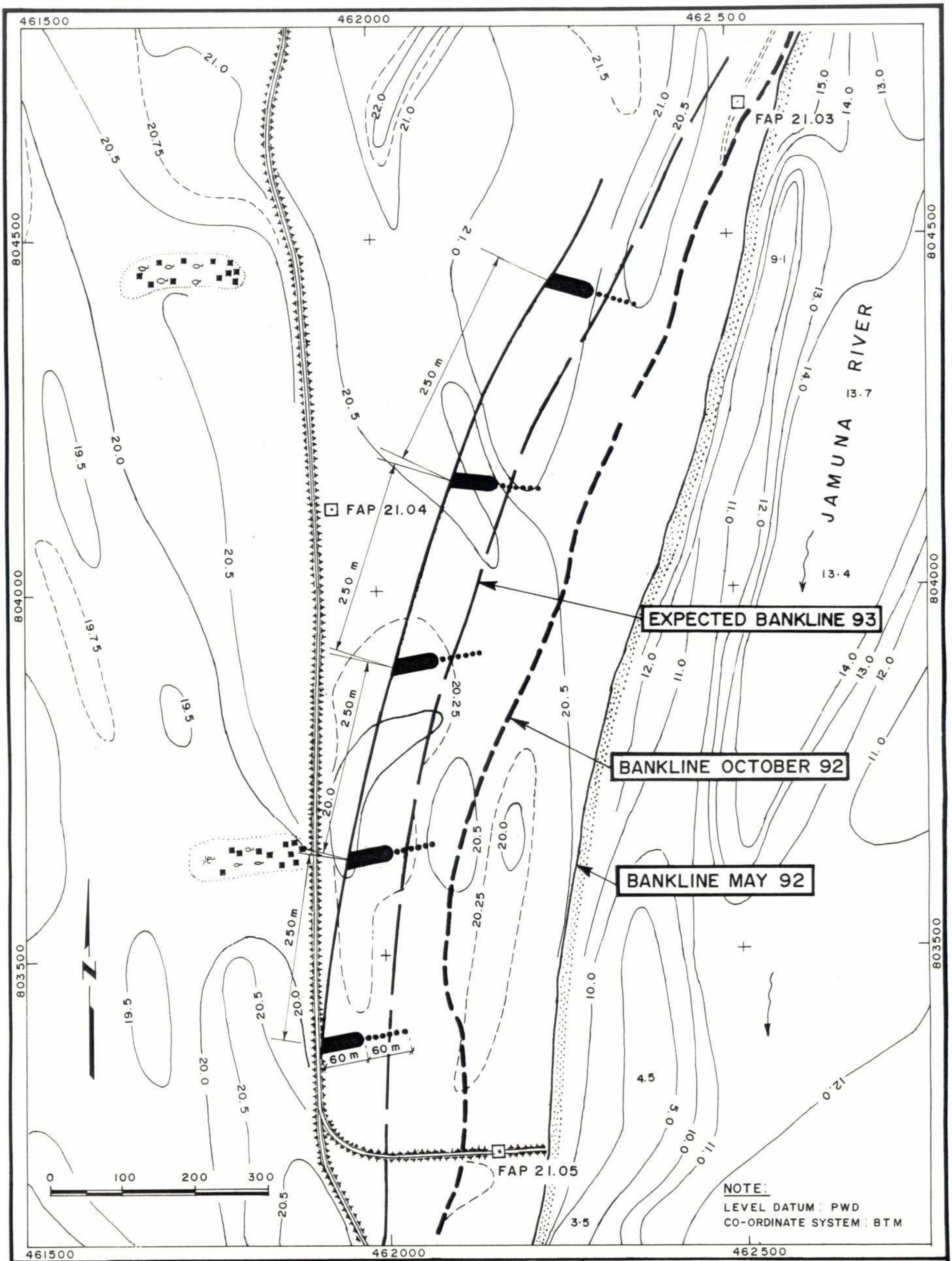
KAMARJANI
CHANGE OF BANKLINE
FROM MAY TO OCTOBER 1992

FAP – 21/22

BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT

PRELIMINARY FAP 21 INVESTMENT REPORT

FIG. 2



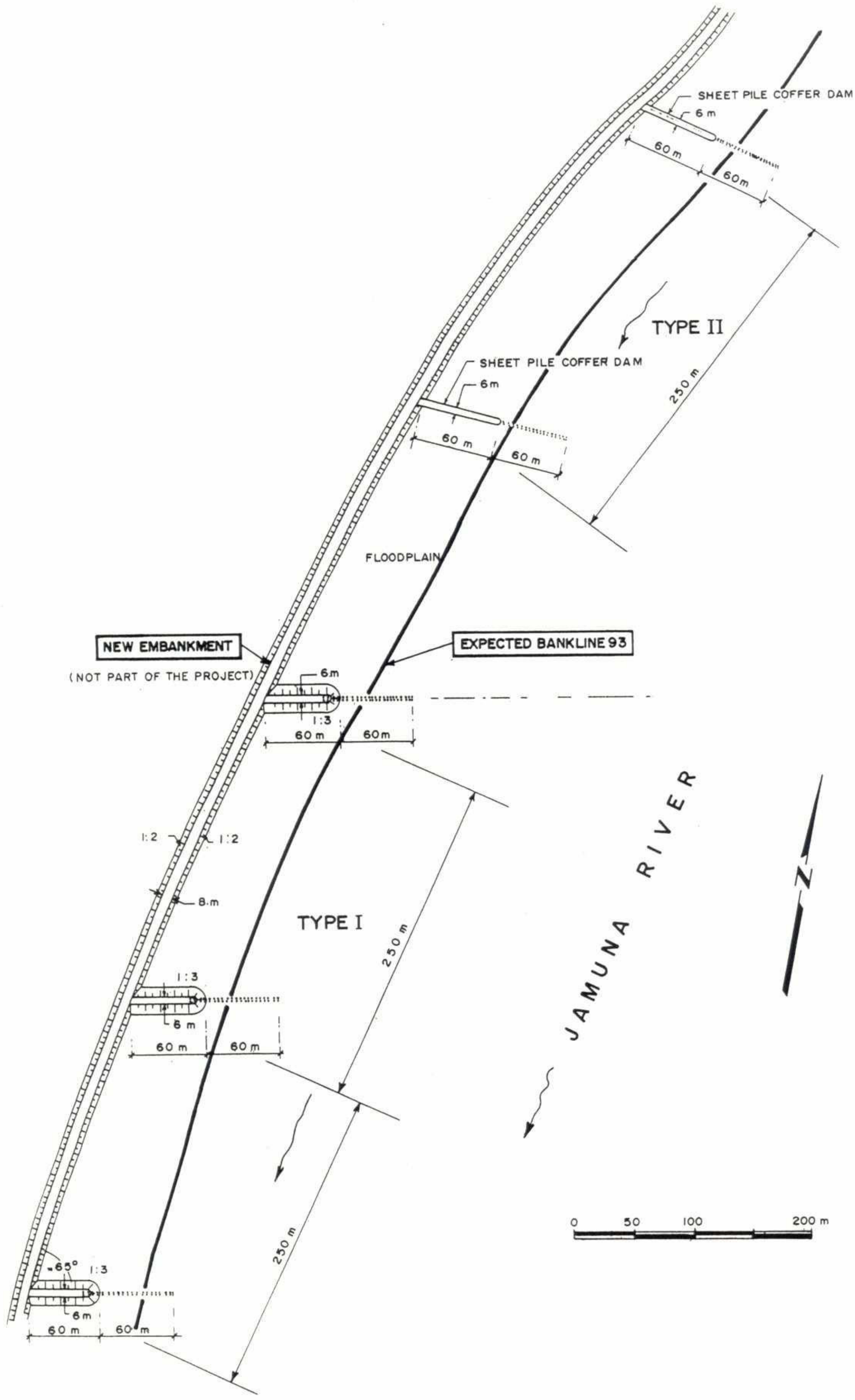
LAYOUT OF GROYNES
AT KAMARJANI TEST SITE
GENERAL LAYOUT

FAP – 21/22

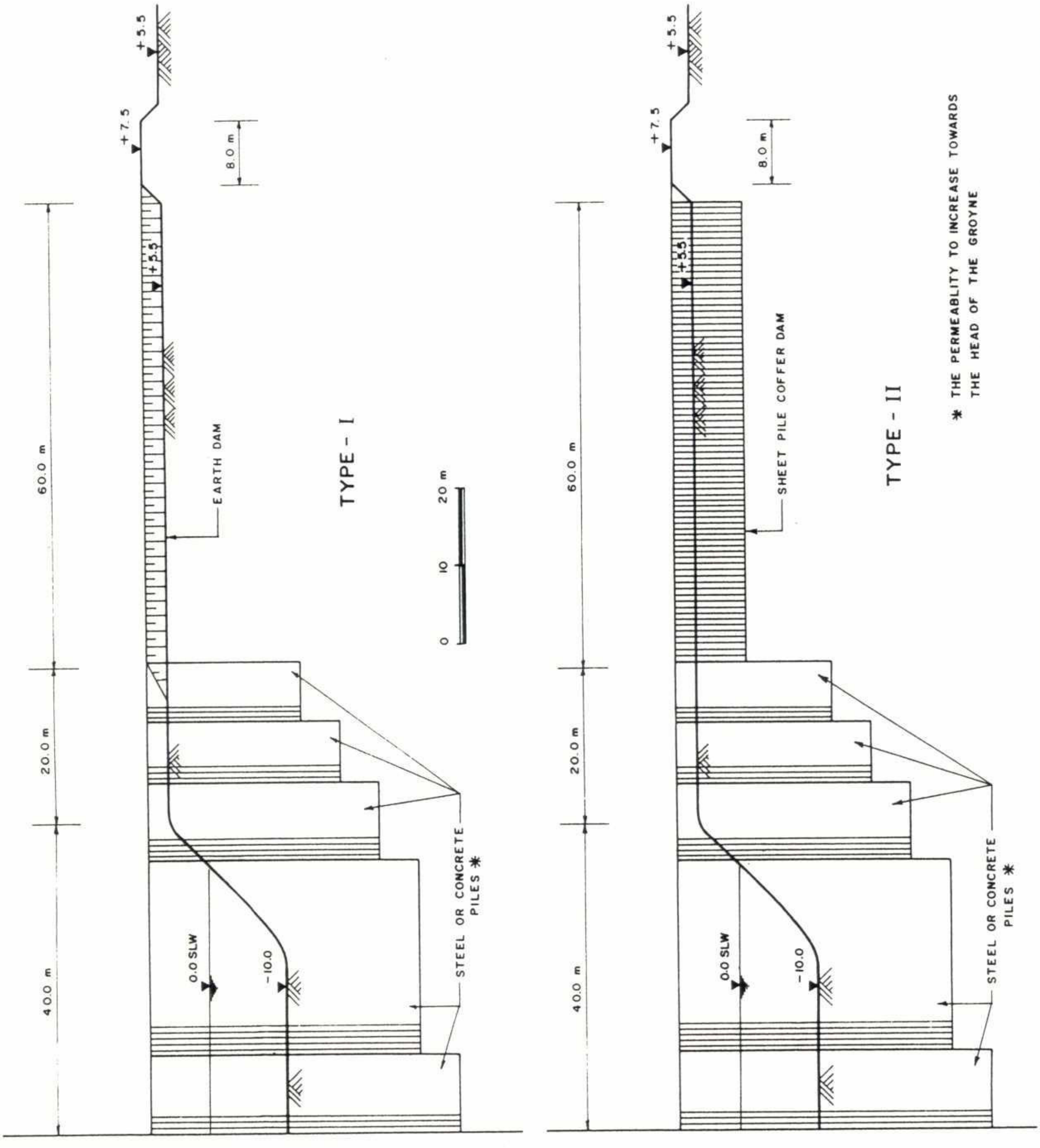
BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT

PRELIMINARY FAP 21 INVESTMENT REPORT

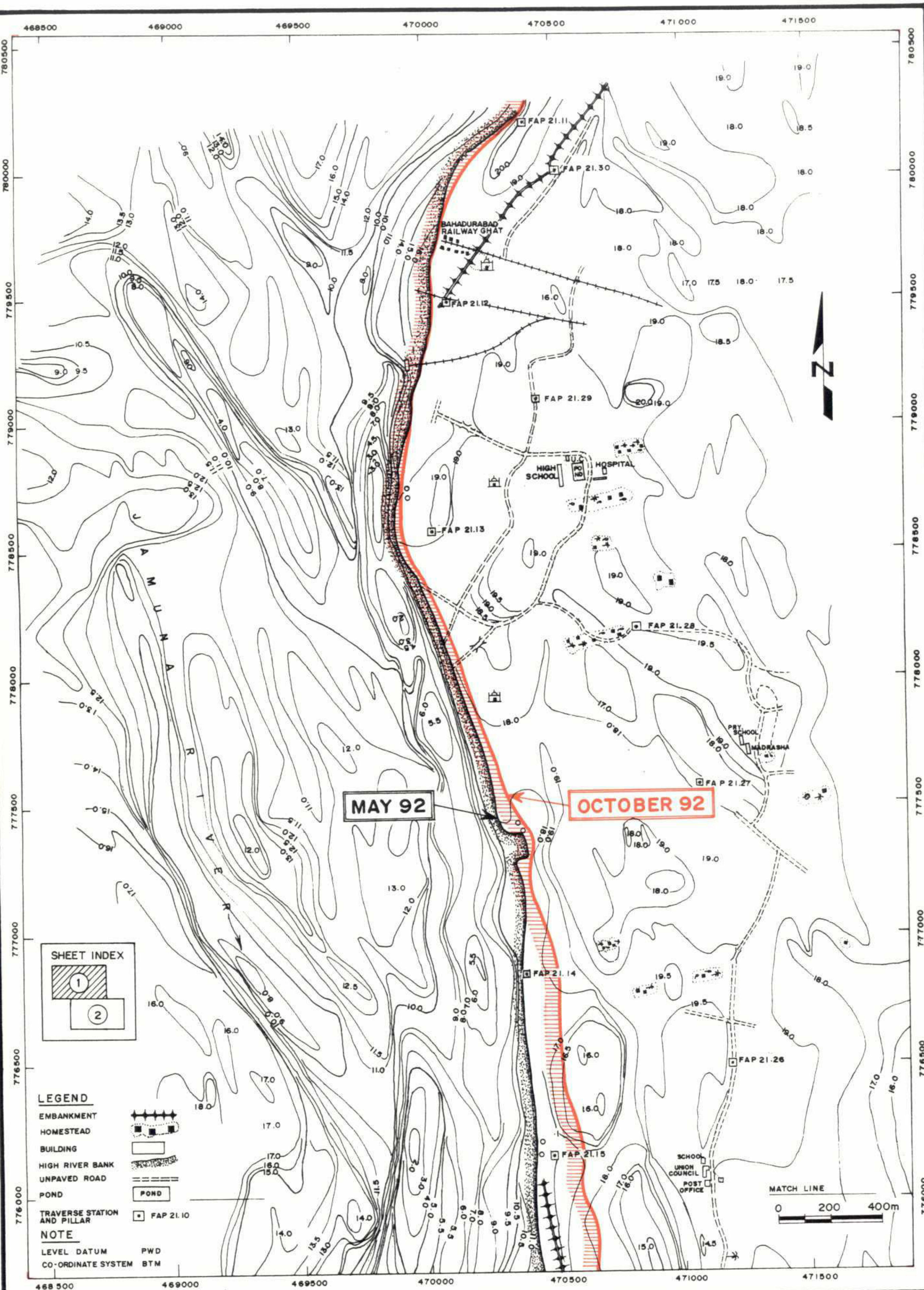
FIG. 3



LAYOUT OF GROYNES AT KAMARJANI TEST SITE DETAILS	**FAP – 21/22** BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT
	PRELIMINARY FAP 21 INVESTMENT REPORT — FIG. 4



LONGITUDINAL SECTIONS OF GROYNES AT KAMARJANI TEST SITE	**FAP – 21/22** **BANK PROTECTION AND RIVER TRAINING / (AFPM) PILOT PROJECT**	
	PRELIMINARY FAP 21 INVESTMENT REPORT	FIG. 5



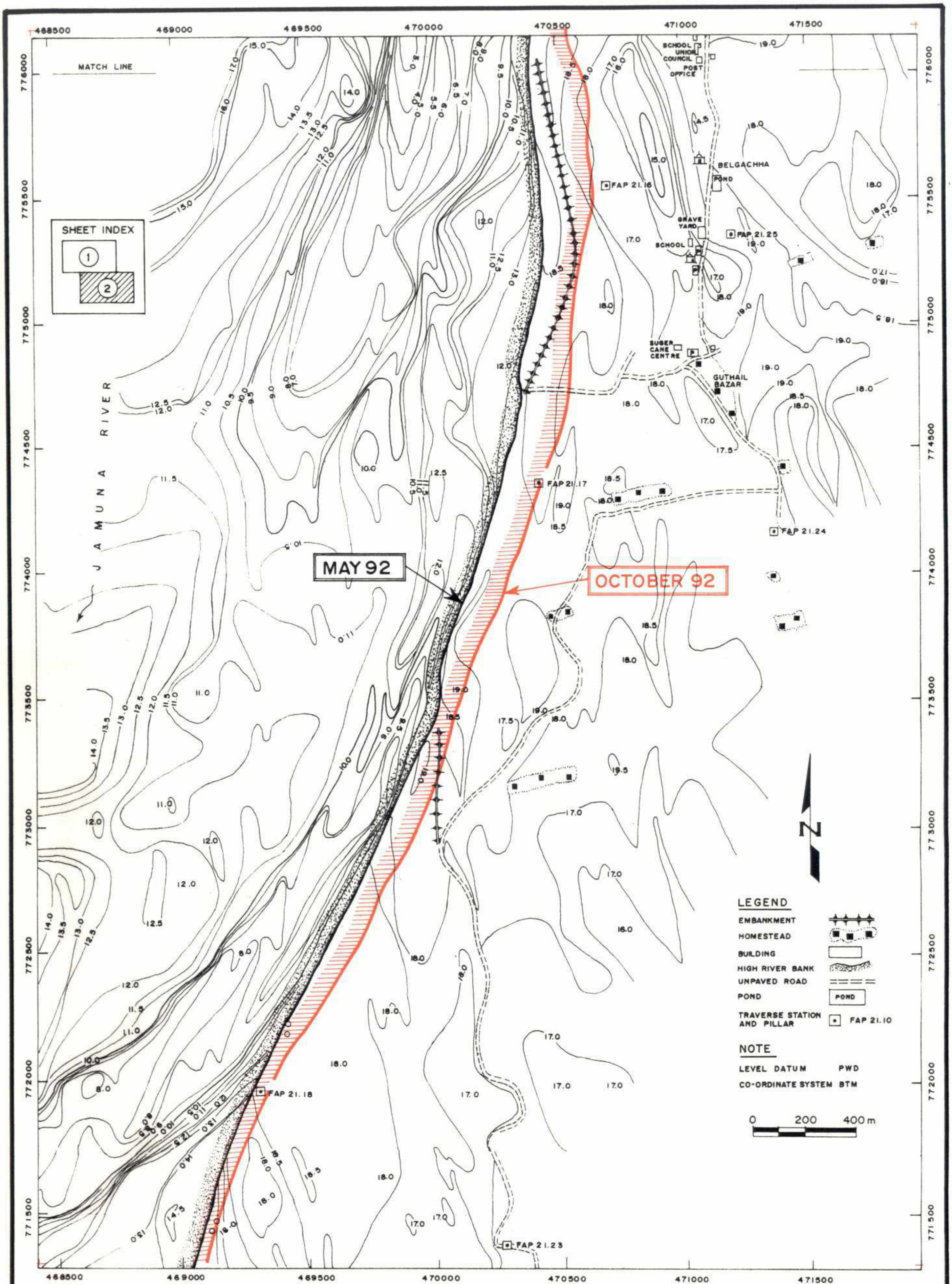
BAHADURABAD
CHANGE OF BANKLINE FROM MAY TO OCTOBER 1992
NORTHERN STRETCH

FAP - 21/22

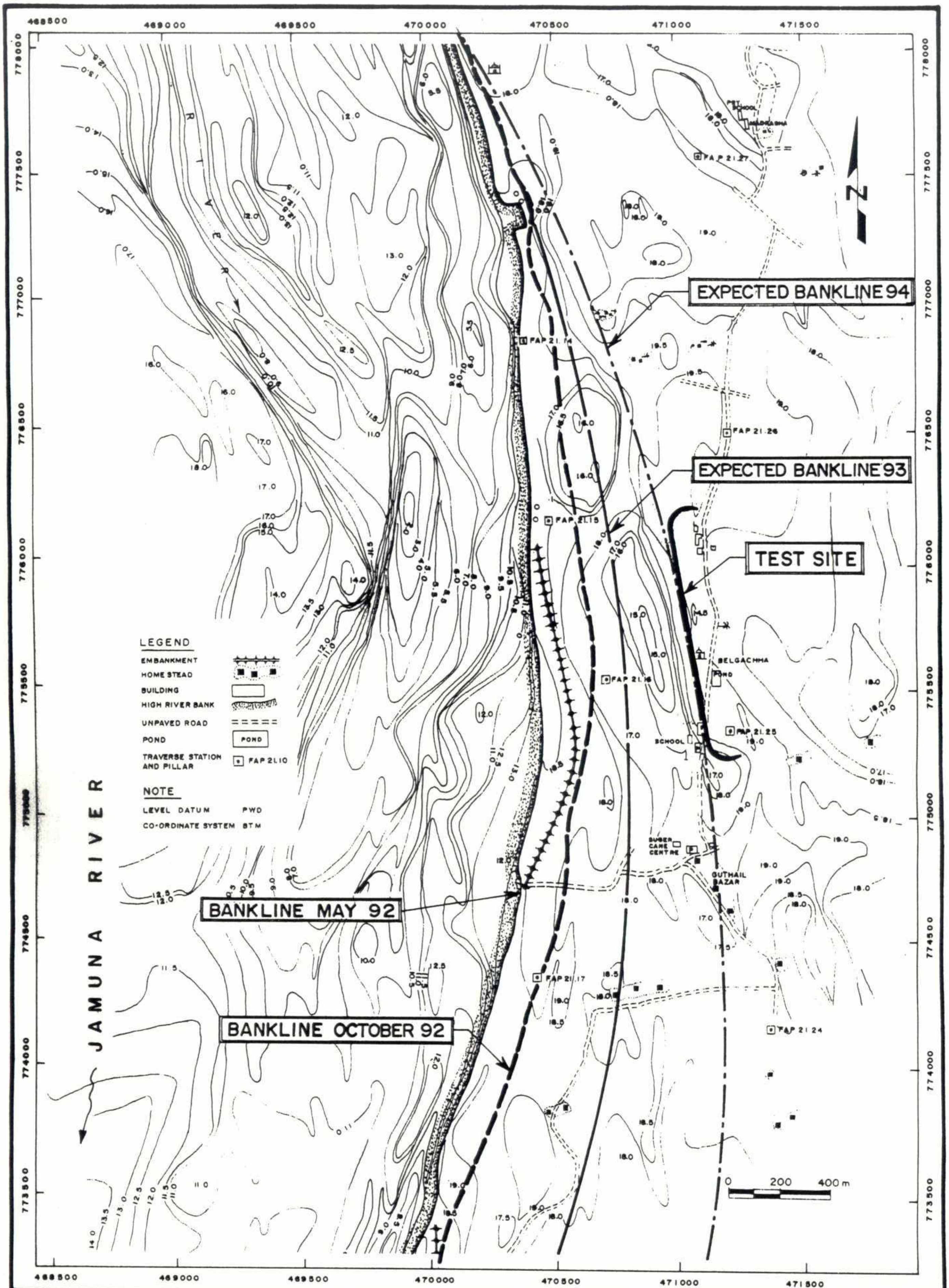
BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT

PRELIMINARY FAP 21 INVESTMENT REPORT

FIG. 6



BAHADURABAD CHANGE OF BANKLINE FROM MAY TO OCTOBER 1992 SOUTHERN STRETCH	FAP - 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT	
	PRELIMINARY FAP 21 INVESTMENT REPORT	FIG. 7



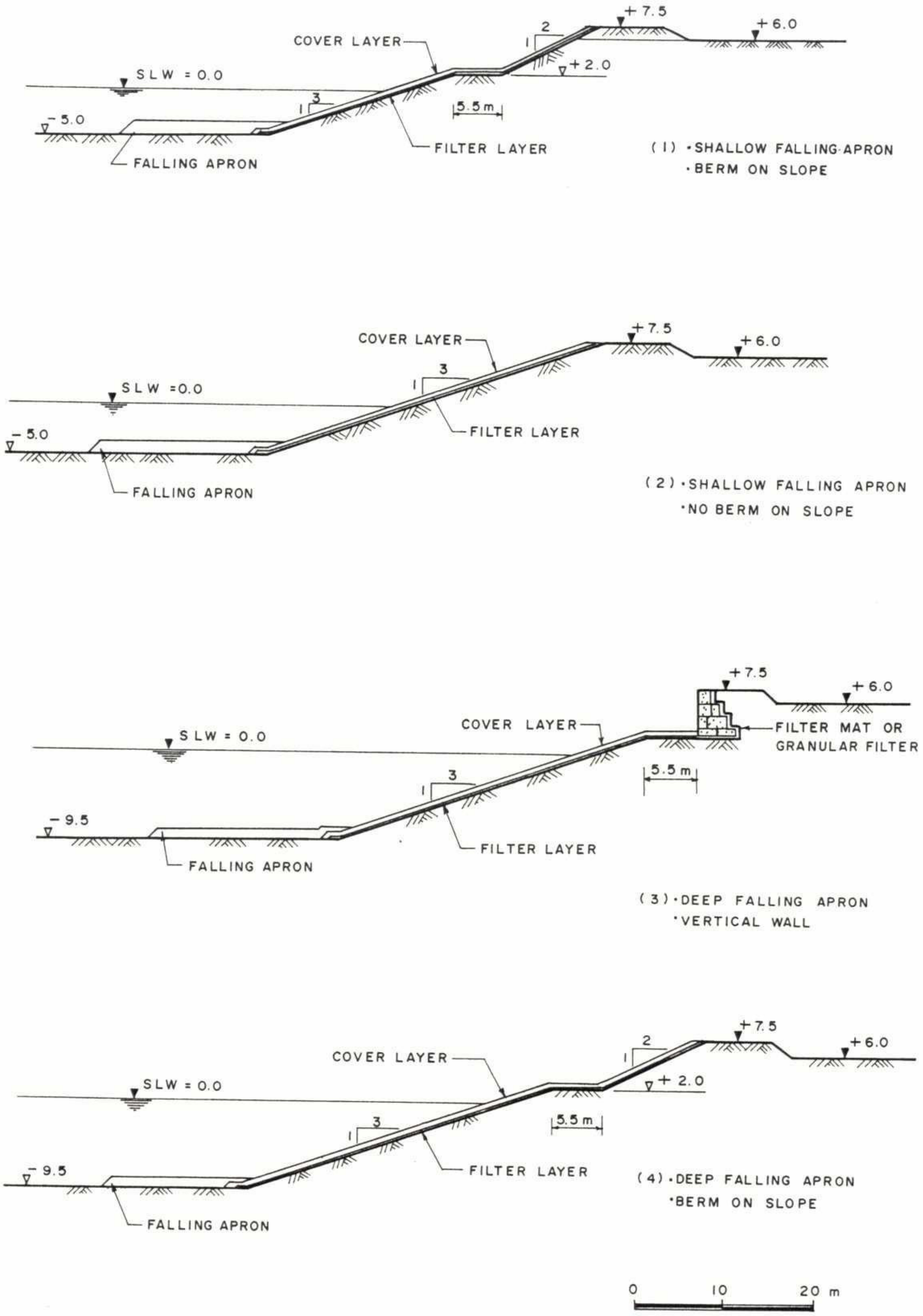
LOCATION OF TEST SITE
AT BAHADURABAD

FAP - 21/22
BANK PROTECTION AND RIVER TRAINING/
(AFPM) PILOT PROJECT

PRELIMINARY FAP 21
INVESTMENT
REPORT

FIG. 8

G8



SELECTION OF CROSS SECTIONS
FOR EMBANKMENT
AT BAHADURABAD TEST SITE

FAP – 21/22

BANK PROTECTION AND RIVER TRAINING/
(AFPM) PILOT PROJECT

PRELIMINARY FAP 21
INVESTMENT
REPORT

FIG. 9