For official use only

GOVERNMENT OF INDIA
(MINISTRY OF WATER RESOURCES)

BRAHMAPUTRA BOARD

NORTH EASTERN HYDRAULIC AND ALLIED RESEARCH INSTITUTE

REPORT ON
PHYSICAL MODEL STUDY
OF RIVER
JIA-BHARALI

FOR FINALIZATION OF BRIDGE ALIGNMENT ON AND AROUND CHOWKI GHAT (NEAR TEZPUR)

HYDRAULIC LABORATORY

N.E.H.A.R.I.
BRAHMAPUTRA BOARD
GUWAHATI-781030

REPORT NO: NEHARI/RM/2007/6 **NOVEMBER-2007**

PREFACE

The model studies of river Jiabharali were referred by the GREF, Vartak Tezpur, Assam for evolving suitable road bridge alignment and its adequate waterway including river training measures if any required for the proposed bridge. The model study has been undertaken at the North Eastern Hydraulic and Allied Research Institute (NEHARI).

The model was laid out, under the overall supervision of Shri D. J. Borgohain, Chief Engineer (I&W), Brahmaputra Board. Available data was analyzed and bridge alignment and river training measures were evolved in compliance to the provision of the terms of reference of the study. Shri R. K. Baruah, SRO, i/c Hydraulic Laboratory, NEHARI is the group leader for the study and was assisted by the hydraulic research members of NEHARI. Senior officers of Brahmaputra Board witnessed the behavior of the model under existing and proposed conditions and their valuable suggestions were incorporated for the betterment of the model.

Dr. T. G. Antony Balan, former Chairman, Brahmaputra Board, took immense interest during experimentation and also provided his valuable guidance to complete the study. Shri Rajan Nair, Chairman, Brahmaputra Board provided important and valuable suggestions in preparing the study report.

ACKNOWLEDGEMENT

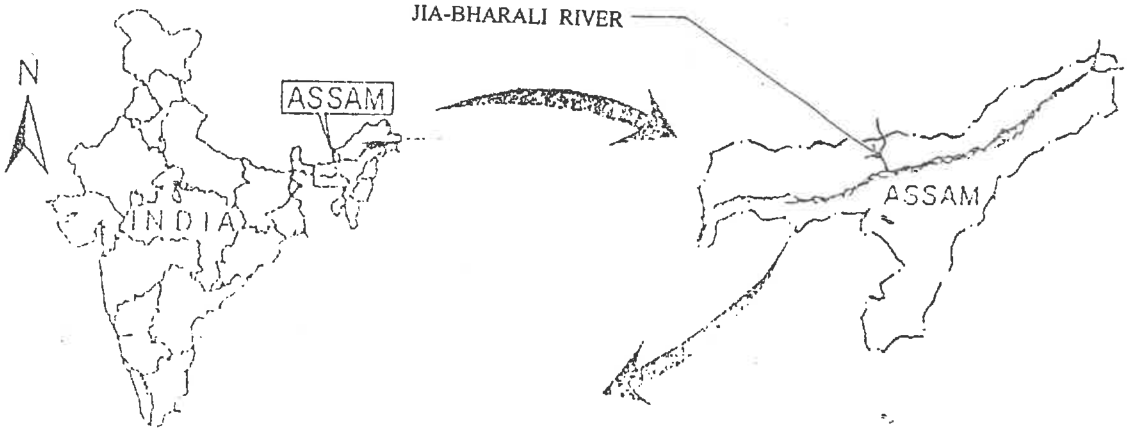
Special thanks are due to the C.W.P.R.S., Pune, who have contributed substantially in completion of the study. Without their active cooperation the task could not have been accomplished. Thanks are also due to the officials of the Water Resources Department, Govt. of Assam, working in the Tezpur regions for their active assistance in furnishing data for this study. I also wish to acknowledge Mr. J.Barman Superintending Engineer, Guwahati Circle, Brahmaputra Board, for his active involvement in completing the study. Thanks are also due to the Field Officers of Nagaon Division Brahmaputra Board for collection of field and hydraulic data for this study, and sharing their views during this study. I also take the opportunity to convey my thanks to the GREF, Vartak, Tezpur, Assam for entrusting the study to NEHARI.

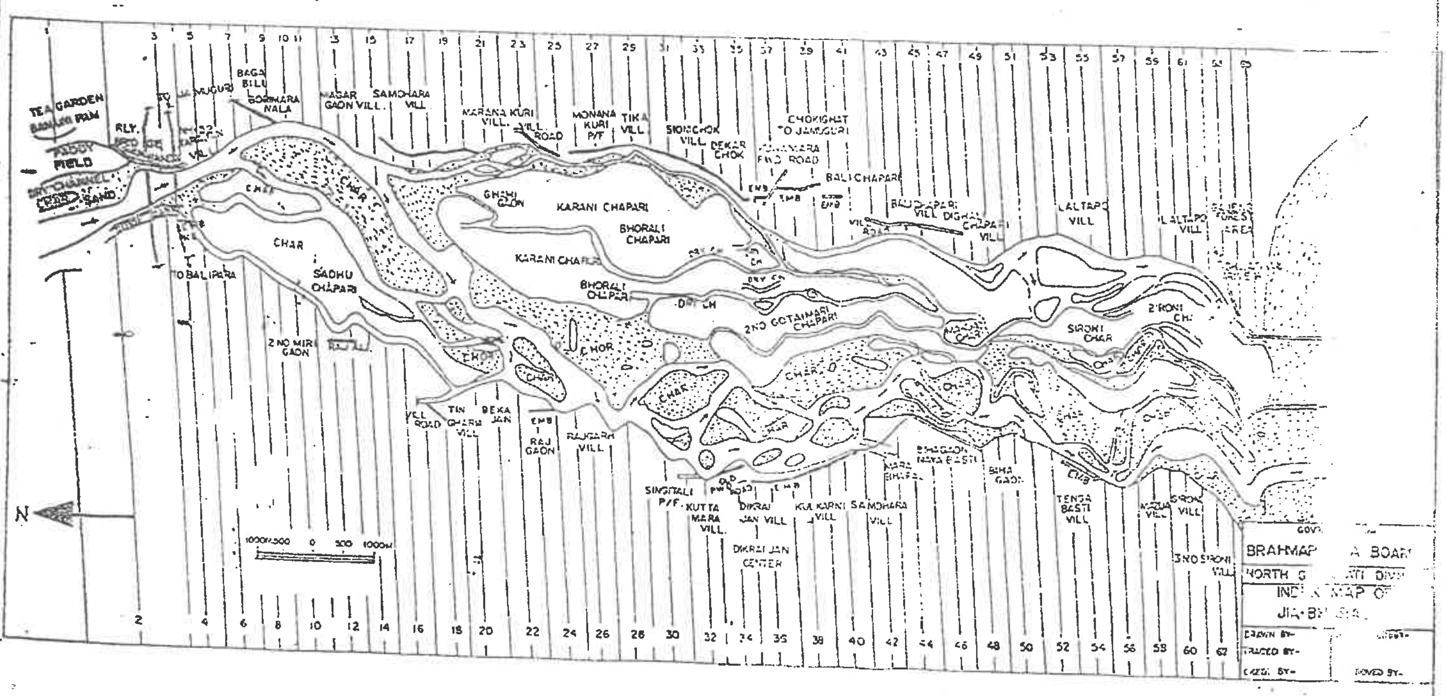
(R.K.BARUAH)
Executive Engineer (SR.O.)
(I/c.-Hydraulic Laboratory)
N.E.H.A.R.I.,
Brahmaputra Board,
Rudreswar: Guwahati-30.

TABLE OF CONTENTS

TABLE OF ANNEXURES AND TABLES

LOCATION MAP





MODEL STUDY REPORT OF JIABHARALI RIVER

1 Introduction The river Jiabharali is one of the major Northern tributaries of river Brahmaputra, between longitude 92^0 00 E and 93^0 25 E and latitude 26^0 30 N and 28^0 00 N with a catchments area of 10,289 sq. km .A number of rivulets and stream join the Jia-bharali on its left and right bank. A total length of the river is about 229 km out of which 166 km flows through hilly terrains of Arunachal Pradesh and remaining 63 km flows through the plains of Assam. The upper reach in Arunachal Pradesh is known as Kameng river. The lower reach of the river in Assam is known as Bharali.

2 Problem The river Jiabharali is flashy in nature & braided in pattern. It has a very steep slope, the average being 62.5cm per km resulting high velocity. The river carries heavy silt load from hilly catchments area during flood and deposits the silt on its bed in the plain. The river is very much aggrading in nature and has a tendency to shift its course towards its both left and right bank. The river is so aggrading in nature that the river consequent to that, transverse gradient has been formed, and the river migrated through the low laying areas in the country side causing havoc to the riverine people. The river width at plain varies from 1 km to 7 km. The Vartak, GREF wants to construct a RCC bridge over this river to link between Tezpur and Jamugurihat in the vicinity of Chaukighat near Tezpur.Since the river width on and around the proposed site becomes 7 km, the posibility of selecting a suitable bridge site was referred to Brahmaputra Board

3 PROPOSALS

During the year 2001, the Executive Engineer, NH-52 Division, Tezpur requested Brahmaputra Board to explore the possibilities of physical model studies of Jiabharali River for fixation of alignment of a bridge likely to be constructed across river Jiabharali near Chaukighat. Accordingly, the Executive Engineer, North Guwahati Division, and RO Hydraulic Laboratory visited their office on 03-03-2001 and subsequently Chaukighat site on the same date along with the officials of NH-52 Division Tezpur. Since the river is braided in pattern and flashy in nature, physical model study was felt necessary so as to evolve a suitable bridge alignment and adequate waterway. It was also felt that such a study would provide deep insight into the river engineering problems of typical nature in a river like Jiabharali having flash flood in monsoon and almost no flow in the winter season. Accordingly, a proposal was put forward for the model study of a 11 km reach of Jiabharali river starting from 4 km upstream of existing NH-52 Bridge to the confluence of Jiabharali into Brahmaputra including collection of soil, field and hydraulic data as required. An estimate amounting to Rs. 63.86 lakh was also submitted for the proposed studies. In the mean time the NH-52 was handed over to the authority of GREF, Vratak Tezpur and no further correspondence was received in this regard. The uncontrolled and untrained flow of Jiabharali has been further creating enormous problem at down stream reach of NH-52 in the subsequent years.

4 FLOW UP ACTION During the month of Nov, 2004, Vartak deposited Rs. 63.86 lakh to carryout the model study as well as collection of entire data required for the proposed studies. Brahmaputra Board started collection of hydraulic data by installing 4 nos gauge sites during flood season of 2005 along the reach to be reproduced in model. River bed drilling and samples of bed and bank materials collection was taken up during December, 2005 and analysis of data was made at the soil laboratory of NEHARI.

The property of soil below 2 m depth of river bed and bank materials was ascertained and C-ф value was found out. The report of this study was made available during June 2006. The field survey and river cross-section of post flood 2005 was taken up and completed during April, 2006. The detail survey plan and 64 nos river cross-section at an interval of 300m including gauge data was made available to NEHATI by the Nagaon Division, Brahmaputra Board during August, 2006 and work order for supply of model bed material was placed during June,2006.

5 Terms of reference of the study The study proposes to examine the most suitable bridge alignment with adequate waterways taking all relevant hydraulic aspects into consideration and to evolve techniques / methodologies for river training measures likely to be required to sustain the river course across the proposed bridge.

6 Requirement of good bridge site

6.1 General

From general considerations, it should be such that the overall cost including bridge itself, approaches and protection works and links to main Highway is minimal. It should provide minimum lead for users and hence should be closed to areas of influence. The alignment should be straight and it should provide adequate clearance (vertical and horizontal) to cross river traffic.

6.2 Technical requirements

The site should be selected keeping in view the technical considerations, viz. River regime, approaches, distance from Tezpur town and existing bridge at up stream, overall width of water channel, bridging length, approaches length, land through which road alignment will pass, stability of bank, confluence of tributaries on the up stream and braiding nature of river.

The site proposed for the road bridge on river Jiabharali at Choukighat near Tezpur town is suitable from hydraulic considerations. As per topography of the reach, there appears no other site where the location of the bridge can be termed as decidedly better with respect to its future hydraulic parameters.

7 CHARACTERISTIC OF THE REACH

The reach under study is a braided reach of the river Jia-bharali and appears to be inherently unstable. The char building on and around the river course perhaps partially blocked the old channel and could feasibly have been the trigger that initiated the migration of river on either side. Unless the present trend of formation of multiple channels and sand char changes substantially, it would seem unlikely that the river would be inclined to remain within the present boundary in the foreseeable future. Further widening of this belt may be expected if the spill or over bank flow is not controlled immediately. The growth of sand chars and flood channels may be linked to a high-sustained over bank flow and is conclusive to a long-term increase in braiding. Presently Jia-bharali river enjoys a greater degree of freedom to exercise her braiding power, inundating entire area adjacent to either bank. The bank to bank width of the river is measured to be of almost 7 km, being a quite alarming one in terms of maximum observed discharge(6000 m^3/s) passing through Jia-bharali River

8 HYDROLOGICAL OBSERVATION

The gauge, discharge and silt data of Jiabharali River along the reach under study is available for a fairly good period (1969-1993). The NH-52 crossing and Sirowani site is well within the study reach. For this model study flood gauge data of 2005 was also collected in four different sites including along the tentative bridge sites. Flood frequency analyses of gauge and discharge data for the period 1969 to 1993 at NH-52 crossing have been made. The different return periods flood and corresponding water levels calculated from Log-Pearson Type-III distribution at site NH-52 crossing have been extensively used to simulate model water levels. The frequency analysis as well as the recorded high and low water levels of different years are shown in Annex-I. The maximum observed discharge is reported to be of 9939 m^3/s at NH-52 crossing during 1965 and maximum water level 80.89m (1970) as per Hydrometeorology of the Brahmaputra Basin prepared By Brahmaputra Board. Estimation of Sediment load at NH-52 crossing is shown in Annex-II

9 Physical Model

9.1 Design of model scale A hydraulic scale model is a small-scale reproduction of prototype i.e. reproduction of flow processes, flow states and events, which characterize some hydraulic problems. Experience obtained in practice using hydraulic models and comparing the model and prototype phenomenon, could ensure the determination of appropriate scales for different types of problems. The Froude model law is used most frequently for solving river problems. For this kind of river flow, the effect of gravity is dominant in respect to the effect of the viscous and surface tension forces. Hence, for reproduction of scaler depth with increased roughness, the steepening of flow becomes necessary. This is achieved by distortion of the model adopting vertical scale larger than horizontal scale. In distorted model, the roughness scale becomes 1: (D/VE), where D is the depth scale and VE is the vertical exaggeration i.e. distortion.

The choice of the model scale for the river like Jiabharali which has wide flood plains and having number of braided channels, is governed more on the consideration of availability of space required to accommodate the river model, requirement of water and measurable depth of water in the model. Studies to determine the hydraulic parameters for training the river Jiadhal (protection of banks, reactivating the old channels etc.) dictate the choice of model scales, which need to be combined to suit mostly the flood flow conditions. In the mobile bed model, the movement of model bed materials should generally be similar to the movement of sediment in the prototype for all flows in the ranges to be reproduced. However, when the prototype dimensions are scaled down, tractive forces are so much reduced that the bed movement is not properly reproduced in the model unless very large model is adopted.

In order to increase the tractive force in model to obtain the required movement of bed materials, it is necessary to distort the model using vertical scale large than horizontal scale. However, extreme care has been taken to keep the distortion in minimum as it affects the width-depth ratio of the channel, the velocity distribution across the channel, the slope of the river banks and shape of the control structures. The river reach of 20 km length from 4 km u/s of NH-52 to the confluence of Jiabharali into Brahmaputra and maximum width of 7 km is to be reproduced on the model. The size of the tray available at NEHARI is 120 X 45 m. A horizontal scale of 1:200 and vertical scale of 1: 60 have been selected for modeling the problem reach of Jiabharali at Tezpur, Assam. Scale relationship and verification of model bed movement have been calculated as follows: -

Model scale - Froudian similitude

Horizontal scale ratio - $L_r = 1:200$

Vertical Scale ratio - $D_r = 1:60$

Velocity scale ratio $V_r = 1:\sqrt{D_r} = \sqrt{60} = 7.74$

Time water wave - Tr = 1:200/60 √60 = 1: 30.98

Discharge scale ratio - Qr = 1: L* d*√d = 1: 200 *60 *√60

=1:92952

Force/ stress ratio - fr = 1:200 * 60^2 = 1:7, 20,000

9.2 Construction of model A 20km reach of river Jiabharali 4km u/s of NH-52 to the confluence of Jiabharali into Brahmaputra was approved as the reference reach. The Brahmaputra Board conducted hydrographic survey of the reach during Oct-March2005 & a model of size 100m×45m was laid at NEHARI as per guidance of CWPRS Pune. The construction of was completed during April2007.

9.3 PROVING OF MODEL

The following 6(six) discharges were used to establish water surface relation in model.

a.	Discharge 1:100 year return period ---------	10000	m^3/s
b.	Discharge 1:50 year return period	8000	m^3/s
c.	Maximum observed	6000	m^3/s
d.			
e.		5000	m^3/s
f.		4000	m^3/s
g.		2000	m^3/s

Proving study of model was carried out by installing various gauges at different channels to arrive at an acceptable water surface slope and G-Q relation applicable to all flood channels. The water surface profile of prototype and obtained in model is **shown in fig-1 to 4.** And average water surface slope conformity between proto and model was achieved. The difference of proto and model water slope is found to be within the confidence limit and hence the model is considered to be dynamically similar to that of proto.

The model was visited by Shri M.N. Singh, CRO, CWPRS, Pune during Feb, 2007. As per modification suggested by him, the model was re-moulded and final run was made during August, 2007. The findings of final run and photographic display were taken to Pune during first week of September by the Research officer, NEHARI for discussion. Further suggestion given at Pune was duly tested at model during last week of September, 2007 and the study was concluded. The CWPRS,Pune were associated right from the design ,construction & operational of model.

10 EXECUTIVE SUMMARY

Based on the findings of the detailed studies of Jia-bharali river modeling programme at NEHARI and the further considerations presented herein, the Model Study Report sets out proposal for:

a) suitable alignment of proposed bridge on and around Choukighat including finalization of adequate waterway of bridge
b) guide bund at upstream and downstream of proposed bridge
c) suitable river training schemes such as channel closing dyke, embankment and deflecting spur etc for the confinement of flow within the proposed bridge

This report has explained how the various elements of the proposed bridge and its associated river training works have been carried out in model including the hydrological studies, river hydraulics studies, geotechnical investigation and study of river morphology and how they have contributed to the recommendations.

The Model Study Report gives consideration only to the fixation of suitable bridge alignment with adequate waterways and containment of the Jia-bharali River between proposed bridge and existing highway bridge of NH-52 (11 km up stream of proposed bridge)), being the Study Reach.

The report includes the design parameters of proposed bridge, guide bund river training works together with typical sections/drawings and descriptions of how they could be designed and oriented. Implementation will commence with the construction of guide bund, bridge and channel closing dyke and deflected spur and follows by a continuous flood embankment on both banks extending from the channel closing dyke to the proposed guide bund. The river training measures as proposed are necessary and appear to be unavoidable and are regarded as an important constituent of the proposed bridge.

Priority locations are identified for retiring the existing dyke/embankment.

The proposed recommendations may be referred to as "training for discharge and sediment" across the proposed bridge. The logic behind the approach is to provide a sufficient cross-sectional area for safe passage of maximum flood across the proposed bridge and to induce sufficient velocity by aligning the guide bund and embankment so that the incoming silt remains in suspension along the reach under consideration. It concerns, essentially, proper location, direction and orientation of guide bund and bridge alignment with adequate waterways, channel closing dyke, deflecting spur and its location, alignment and height of flood embankments, critical locations for retiring and strengthening of existing embankment system etc. The overall logic is to train the river for sediment transport aiming at rectification of river bed configuration and efficient movement of suspended and bed load for keeping the channel in good shape within the proposed bridge spans. Since the maximum aggrading capacity of a stream occurs in the vicinity of the dominant flood discharge, it is attempted to change the riverbed in accordance with that shape of flood flow by aligning the flood embankment. However, extensive observations have been made to investigate the actual relationship between the various flow parameters.

Re-percussion on river regime at up stream and down stream is not drastic. Jia-bharali is purely an aggrading river; artificial bank in form of flood embankment may either be destroyed by severe erosion or get buried under deposition. Under the proposed scheme the erosion problem as conclusively identified would be minimal due to curtailment of river freedom which causes enormous flood channels during monsoon. There is also strong indication of burying the proposed river closing dyke and embankment under deposition. Hence the height of embankment above HFL is amplified suitably to take care of such deposition at least for 3 years during which stabilization of channel would take place as anticipated.

The process of bank erosion is constantly active in the down stream reach of proposed bridge and river training for the protection of banks continues to be a "recurring" problem.

Aggrading river like Jia-bharali carries heavy loads of sand and generally splits into a number of braided channels. River cross-sections show the formation of large shoal and char. The fact may be conclusively described as

- When the flood subsides, the flow of sand is checked and large shoals and chars are formed.
- During flood stage, the position of shoals and chars change constantly.
- Since the fluctuation of flood discharge is very rapid, the transport power is substantially reduced; the chars can not be washed away.
- Current go round the chars, and channels wanders in new directions often attack the banks squarely, causing bank erosion.

- Under the above circumstances, confinement of flow within a certain boundary is required to induce axial flow along the proposed bridge. Hence guide bund has to be supplemented with flood embankment for closure of few temporary flood channels.

It is observed from 1998 that the Jia-bharali River never repeats its flood characteristics year to year. The planning and design of bridge for river like Jia-bharali depends largely upon the judgment of experience engineers associated with the Jia-bharali for fairly a good period. However, this report with systematic experimentation on the behaviors of river by means of physical model study would help to restore the general layout of the proposed bridge.

The report is supported by an indicative plan showing the scope of structural works involved as evolved from model study at this stage. The physical model study undertaken at NEHARI has assisted with the identification of the most appropriate lay out for the proposed bridge and its waterway, specifications and river training works to guide the flow across the bridge with the derivation of key hydraulic parameters such as near bank velocity, scour depth and discharge intensity etc.

Velocity distribution is highly variable in the reach and rapid fluctuation of flood discharge also adds additional constraints to velocity distribution. As such an amplified value has been adopted (a probabilistic approach) to take care of such variability.

The proposed measures are required for the stability and the safety of the bridge. They should be constructed as per specification and should receive an appropriate level of maintenance at least for 3 years.

The river training works as evolved from the model study is basically to confine the flow across the proposed bridge.

11 REASION FOR EVOLVING RIVER TRAINING WORKS FOR THE PROPOSED BRIDGE

The tentative site given by the authority of Vartak(GREF) for the proposed bridge is on and around Chaukighat near Tezpur where the river width is almost 7 km. Since the highest recorded discharge is 6000 m^3 /s and 1:100 year returned period flood is only 10000 m^3 /s, a bridge width of 700m is sufficient taking other relevant aspects into consideration for safe passage of such magnitude of flood. The existing bridge at 11 km upstream (NH-52) over the same river is only 680m. So, constriction has to be imposed on the river to a limit where formation of shoal along the bridge could be avoided. According to Lacey, the water way comes to below 500m. Since the river is flashy in nature, development of full scour could not be expected and random deposition of silt along the bridge could not also be overlooked if the waterway for the proposed bridge becomes too wide. Hence constriction has to be imposed if bridge is at all to be constructed. The avulsion of Jiabharali into Marabharali just 1500m downstream of proposed bridge during flood of 2003 added additional constraint. Taking all this aspect into consideration it is proposed to train the river from 3 km downstream of existing bridge up to the avulsion point of Jiabharali into Marabharali. Further, long Guide Bund on either side of proposed bridge is also necessary to induce axial flow across the bridge and closing the avulsion point at 1500m down stream of bridge.

Construction of any bridge along the reach under study usually involves constriction of flow. The channel closing dyke along with deflecting spurs proposed for upstream significantly constricts the flow and the flood embankment on both banks up to the guide bund duly propagated such constriction to the proposed bridge. The effect imposed on the river by this constriction not only induced smooth approach flow across the bridge but also increase depth, duration and inundation of sand chars. The possibilities of random silt deposition here and there are also reduced substantially. Hence the effect of diversion induced by the upstream constriction (channel closing) is highly essential for the flow approaching the proposed bridge. In fact, the reach (11 km) between existing and proposed bridge is left wide open. The river enjoys a high degree of freedom in this reach to exercise her braided mode. Such freedom explains the apparent randomness of silt deposition in terms of both locality and severity. The scheme have greater significance as the constriction imposed in the upstream have been proportionately continued up to the proposed guide bund. An increase of sediment transport with a factor 3 (three) normally would imply an increase of velocity of 30% to 40%. This could only be achieved if very significant morphological changes had taken place. There is indication of such morphological changes with the present structural measures evaluated from the model study in terms of channel closing dyke with deflecting spur and flood embankment on both bank up to the guide bund.

12 RIVER TRAINING MEASURES REPRODUCED IN MODEL

12.1 CHANNEL CLOSING DYKE & DEFLECTING SPUR

A Channel-closing dyke of around 1.6 km length is reproduced across the channel A at cross-section 16 with impervious core, slope pitching and apron towards the riverside. This dyke should also be provided with 1 nos.solid deflecting spurs of 560m lengths. The nose of this solid spur should be of 20m lengths and the entire section should be made of boulder. The body of the remaining 40m length of the solid spur should be made of earth with adequate slope pitching and apron. The remaining length of spur would be slope pitching without apron. The height of the nose should be the difference of the observed HFL and the existing riverbed level of the proposed location. The 1.6 km channel closing dyke with 1 nos.solid deflecting spur tested in model produce desired result. However water spills from downstream of the dyke

12.2 FLOOD EMBANKMENT

Possibilities of lateral migration towards left bank are encountered if the channel closing dyke alone is made to sustain in the present form. Accordingly this dyke is extended up to the upstream guide bund to guide the flow along the proposed bridge in terms of flood embankment of length 1.5 km and 5.1 km at up stream and down stream of channel closing dyke respectively. At discharge 5000 m^3/s more, water started spilling all along the right bank also as a substantial amount of flow is restricted from flowing to the left side of the flood plain by constructing the flood embankment. Hence to guide the flow along the proposed bridge, 4.5 km length flood embankment on right bank starting from existing village road of Ting aria village (c/s17) to the upstream guide bund of proposed bridge is invariably required. Further retirement of existing flood embankment of length 4.2 km at down stream of proposed bridge on right bank is also required as per the flow pattern observed in model. All these proposed flood embankments are reproduced in model for their exact location and height.

12.3 Set back distance of proposed Flood embankment:

Considering the extent and pattern of bank line shifting in the past, and the extent of spill observed in model, the proposed embankment has been aligned assigning a set back distance from the existing major discharge carrying channel. The consideration of such set back distances is:

- according to the sensitivity of the river response to confine the spill flow within the two embankment.
- predictive procedure and observation in model as a triggering mechanism to define what length of the existing embankment need to be retired to secure

optimal level of security against breaching as well as to accommodate 3 years anticipated deposition on and around the embankment.

- to provide flexibility in accommodating likely changes of river course at the time of construction.

The overall implication of the river training measures are that the suggested measures in its present form fulfill the purpose as intended. In fact, the present scheme is a stable solution, on the contrary, the silt deposition on and around the original course within the proposed flood embankment will be reduced as much as 3 times to the present level. Since the flood flow has a freedom of flowing on the both sides of flood plain, there is no reason to aspect any significant changes of present conditions after executing the proposed bridge without flood embankment. Hence, flood embankment is invariably required to guide the flow along the bridge and to impose some degree of curtailment to the random deposition of silt. Without flood embankment as proposed, construction of Bridge along the braid-belt of Jiabharali is not possible.

The position of the flood embankment in relation to the riverbank is at present determined on the basis of model study and long-term bank movement trend and likely future movement providing a construction window of 4 years. At the same time, the set back distance is to be flexible enough to accommodate construction and financial constraints. However, the position of the flood embankment in relation to the present riverbank is also to be examined in terms of trade-off between embankment position and protected area. The closer the embankment is to the river, the less will be the flood plain storage and conveyance and therefore the greater will be the river flow and water level for an event of given return period. Increased discharge and velocity will also result in increase sediment transport and therefore bed degradation. It is observed from the model that for flow events up -to 100-year return period, the water level is not sensitive to the set back distance of the embankment from the present nominal bank line. However, the basic governing principle is to conform as far as possible to natural river plan form characteristics. Prime importance is to be given to maintain as closely as possible the water and sediment conveyance relationship; thereby minimizing the risk of adverse consequences such as bed aggradations. In this respect, key considerations are dominant and bank full discharge, the former having a major influence on channel form and the later on char elevation and the frequency-depth duration of inundation.

13 RECCOMMENDATIONS

13.1 STRUCTURAL MEASURES

The recommended structural measures are classified as:

A River Training

b) closing of undesired flood channels by means of channel closing dyke in between Cross-section no 12 to 17 on left bank (1.60km)

c) flood flow deflection by means of solid deflecting spur placed on the left bank at d/s of cross-section no 15 along the channel closing dyke

.

d) spill water control by mans of earthen flood embankment as :

i) 1.5 km, an extension of channel closing dyke towards up stream from c/s no 12 to c/s 7 (joining existing embankment.)

ii) 5.1 km, an extension of channel closing dyke on left bank towards downstream from c/s no17 to c/s 33 (up to head of guide bund on left bank)

iii) 4.5 km on right bank at upstream of proposed bridge from c/s no 17 to c/s no -32 (head of the guide bund on right bank)

iv) 4.2 km retirement of existing embankment on right bank at down stream of proposed bridge from head of down stream guide bund to c/s no 57.

B Guide bank of proposed Bridge

a) up stream guide bund is aligned at a angle of 10^0 with the bridge axis towards right bank side to avoid deep channel.

b) up stream left side guide bund is also aligned at an angle of 33^0 with the bridge axis towards left side covering the confluence of two channels as well as avoiding deep channel.

The length of both upstream guide bunds is 1500m measured from the bridge axis.

c)1690m long guide bank at downstream of bridge beyond the point of avulsion of Jiabharali into the Morabharali is found adequate to close the avulsion also at right bank.

d) 600m long guide bank at downstream of bridge on left bank.

C Approach Bank

Approach bank along the BCL (C/s no-38) on both side of proposed bridge

D Bridge specification

1. Waterway-1200m
2. No of spans-25, 48m each, 45.85m (clear)
3. No of piers-24
4. Well diameter of foundation-6m
5. Well cap-2.25m,

All these components need to be put in place phase wise for evolving construction sequence. Although each component serves to address a definite hydraulic problem, the components are intrinsically linked and the final form of the strategy will depend on the actual time frame allocated to the implementation of any component.

The recommended river training measures are shown as:

- entire structures on DRG NO -1
- detailed position of channel closing dyke and spurs on DRG NO -2
- details of flood embankment on DRG No-3
- detailed position and specification of guide bund and alignment of bridge on DRG No-4
- details of bridge on DRG NO -5 & 5 A
- typical section of guide bund on DRG NO-6
-
- typical section of spur on DRG NO-7
- typical section of channel closing dyke on DRG NO-8.
- typical section of flood embankment on DRG NO-9

14. DESIGN OF RIVER TRAINING WORKS

14.1 FUNCTIONAL REQUIREMENT

14.2 INTRODUCTION

The river training works proposed for the Jiabharali river reach fall in to mainly four categories. Firstly, there are works associated with the closure of flood channels by channel closing dyke at their upper most bifurcation point. Under this provision, the primary purpose of the works is to confine the flow within the desired course where the potential effect of spilling the floodwater towards the left bank is critical for the proposed bridge. Secondly, works associated with the deflection of flood flow away from the channel closing dyke by solid deflecting spur at critical location where breaching of channel closing dyke is prominent.

Thirdly, construction of flood embankment from the channel closing dyke to the guide bund at up stream and down stream of proposed bridge is necessary for prevention of out-of-bank flow that is currently inundating huge area.

Fourthly, guide bank on up stream and down stream of proposed bridge

The purpose of other secondary works other than proposed bridge is to encourage the river channel to flow a specific plan form.

Since all the river training works are associated with the safety and stability of the proposed bridge, they are to be designed in such a manner that they will perform satisfactorily under the worst combination of hydrodynamic and morphological conditions that may be experienced for a hydraulic event with 100years return period and at the same time requires relatively low maintenance. If local failure does occur due to rapid deposition of sediment or excessive erosion, this should not lead to rapid progressive failure.

The functional requirement of design of bridge and its secondary works are to provide resistance against highly mobile bed and potentially high flow velocity.

14.3 DESIGN CONCEPT

For river like Jia-bharali the bridge and river training works must be designed to survive under the most severe conditions that may be reasonably expected to occur during post construction period.

The proposed bridge, channel closing dyke, spur, flood embankment and guide bunds etc are to be designed as per the design parameters evolved from the model study which will allow performing satisfactorily under severe conditions associated with a flow event with a 100 years return period, giving a combined risk of exceedance of not more than one percent. However, under more severe conditions some displacement of the protective layers would occur, requiring timely remedial measures.

15 DESIGN OF CHANNEL CLOSING DYKE

The purpose of the proposed channel closing dyke is to close an undesired flood channels aiming at to confine the flood flow within the desired course. In fact the primary objective is to induce the axial approach flow within the waterway of proposed bridge. Another way of looking at the same is that if this channel is allowed to exist, confinement of flood flow within the waterway of proposed bridge will not be possible.

The proposed channel-closing dyke is to be designed to provide protection against a flood event of 100years return period. The top of the dyke is to be set at the water level that could occur at any point with a frequency of one in 100years plus a free board of 2.m to cater for degradation of the crest level with time and excessive deposition of silt. The alignment of channel closing dyke is found out from the model study particularly for this water level. This dyke should also be provided with impervious core with slope pitching and apron towards the riverside. This channel-closing dyke may remain in the verge of attack from the backside due to temporary pond of water on the dead channels at a time of suppressed drainage.

15.1 Design criteria to be adopted are:

1). Crest height is that which allows 2.0m free board above 100years returns period flood level.
2) Crest width= 4.5m, section with berm is 3.5m width (the present alignment does show the necessity of berm, However, during construction, the pond water level of country side along the proposed embankment/channel closing dyke will decide.)
3) River side slope, 1V: 2H

Slope stability: -

a) When bank full river level and steady state seepage from pond water on the land side—factor of safety = 1: 1
b) With seismic loading and full level on riverside – factor of safety = 1.25.

At normal state, factor of safety = 1.5
Earth quick acceleration = 0.15g

4) Land side slope, 1V: 2H

Slope stability:

a) With steady state seepage from pond water on the river side and saturated soil on the land side, - factor of safety = 1.25
b) With seismic loading and pond level (max) on the land side, factor of safety = 1.10

At normal state, factor of safety = 1.5
Earth quick acceleration = 0.15g

The soil parameters adopted are: -

1) Bulk density- 19.50 kn/ cum for embankment/dyke
2) Effective angle of internal friction, - ø' = 28°
3) Cohesion c'= 0.15 kn/sq-m

Analysis were carried out for c' = 0 and c' = 1.4KN/sq-m

15.2 Practical implication of result

Mechanical earth moving for mixing of soil is to be ascertained

a) Very silty layers, organic materials must be removed from the local soil.
b) Compaction should be of as high as reasonably practical. Material should be placed in layers not exceeding 200mm thick at close to optimum moisture content and compacted to 90% standard Proctor density.
c) The absolute minimum consideration is clod breaking and this could be enforced.
d) Cross-sectional profile should be achieved.
e) After compaction of embankment, the slope should be grassed.

16 Design criteria of deflecting spur (solid)

16.1 Hydrological

The hydrological design event is one with a 100 years return period and this event has been derived from 19 years (1971 to 1998) simulation of gauge-discharge data of planning horizon. (25 to 30 years). The satisfactory values for design measured below the 100year return period flood level is:

a) at the nose of spur- 10.20m (maximum)

b) at the toe of channel closing dyke parallel revetment...9.24m

The falling apron is to be designed to distribute the equivalent of at least two layers of armour material over the deformed slope face considering development of full scour. In case of unusal scour exceeding these values, sufficient in-built-reserve of material is needed for redistribution of armour material. In fact, model test and experience indicate that the redistributed armour material forms a uniform single layer requiring sufficient armour material for this single layer over the complete surface. These sufficient materials may be estimated for scour depth of 1.33 times more than original scour depth considered for design in all cases.

Sizes have to be determined according to the choice and availability of material. The crest level is as per water level observed in model for 100-year return period flood plus 2.0 m allowances including free board. A single layer of placed armouring extends from the crest to the lowest water level (bed level+30cm) and from that level to the apron setting depth, armouring will be dumped to form the equivalent of two layers.

The spurs should be anchored to the Channel Closing Dyke and spur should be inclined at an angle of 10 to 15 degrees to up stream as specified in detailed drawing.

18 Discharge intensity

The maximum discharge intensity to be considered in design below the 100 years return period flood level is: -

a) 20 cum per meter-run for proposed spurs
b) 17 cum/m-run for parallel revetment

19 Silt factor = 0.77

20 STATUS OF THE PRESENT STUDY

The study conducted is final and would not need more in-depth investigation and overall view of other aspects so far the present terms of study reference is concerned

21 Conclusions

The model reach is a highly braided belt of river Jia-bharali, the situation is far more complex because the proportion of total discharge carried by each wide and shallow channel, is constantly varying in response to the change in the up stream confluence geometry, which itself is adjusted in response to the changing flow division around the u/p stream char or sand bar. A small change in the division of flow at the entry cross-section of model results in a highly non-linear chain reaction of adjustments all the way down the reach. This implies that due to large seasonal range of flow conditions and rapid fluctuation of discharge, the braided channel is constantly adjusting to the changing flow and these changes result in rapid movement of sand dunes and much larger sand bars. The dunes move at a faster rate than sand bar. The attempt of each channel to adjust its waveform to the changing conditions results in excessive erosion. Infact, the channel impinges on the main flood plain or stable char and loss of cultivable land is inevitable. The inundation of entire area on the either bank of Jia-bharali is the convincing evidence and erosion is an obvious candidate. Since the Jia-bharali is inherently unstable river, it is not possible to predict where erosion would take place until the plan form had been at least partially stabilized. So during the model study, stress had been given to identify the possible boundaries to the behaviour of the river as noticed and assign priority to the values for parameter of practical interest such as near bank velocity, maximum near channel depth, over all bank movement and induced plain form characteristics.

The management of river reach from existing NH-52 Bridge to 1.70 km downstream of proposed bridge of Jiabharali river is equally important for stability of the said bridge and curtailment of some degree of freedom presently enjoyed by the river to exercise her braiding power. The over all concepts is to encourage the river, by means of selected structural intervention, to become stabilized within the flood embankment as proposed. The optimum channel width required, either from bank to bank or embankment to embankment for braided river like Jiabharali is a subject of research. However, the set back distance of dyke proposed for extension up to the up stream guide bund on both bank would induce a channel section which will keep incoming silt in suspension and at the same time it will provide sufficient space to accommodate flash flood.

---the model shows the strong possibility that constriction can be imposed on the river without any significant effect on the existing river regime

The river training measures as recommended from the model studies are invariably required for the proposed bridge. In absence of river training measures, no bridge is possible to construct under the present plan-form of the river. These river training measures will substantially reduce the erosion problem of the reach both upstream and downstream of bridge. The closing of avulsion point of Jiabharali into Morabharali is invariably required to maintain the flow along Jiabharali in addition to protect the entire area of downstream of bridge including Tezpur University from the erosion and flood. The scheme so proposed has a long term benefit so far erosion of Jiabharali is concerned along the reach from NH-52 to the confluence of Jiabharali with Brahmaputra.

22 BRIDGE STRUCTURES REPRODUCED IN MODEL

The road bridge structures along with their abutment, approach banks and guide bunds were then reproduced in the model as per following details:

i) Bridge pier structures as per their details given in Para 3 above
ii) Waterway: Over all waterways of 1200m is divided into 25 spans supported by 24 piers. Each spans measures 48m in length centre to centre.
iii) Location of abutment: Right abutment is located at a distance of 180m meter from the existing embankment along the cross-section no-38 and left abutment is on the bank of the channel at a distance of 1200m from the right abutment.
iv) Approach banks: Aligned in line with the bridge alignment on both banks.
v) Guide bunds : 1500m at upstream on both bank and 1690m and 600m at downstream on right and left bank respectively.
vi) Afflux bunds, connecting the upstream ends of the right and left guide bunds with the proposed flood embankment on both sides were reproduced in model.

A plan indicating above details is shown in Fig-4. Detail layout plan of guide bunds is shown in Fig-5. Photo- 3 to 8 show the various views of these structures reproduced in model.

23 Model studies

i) Most suitable alignment of a bridge
ii) Adequate waterway of bridge
iii) Effect of reduction of waterway from 7 km flood plan to 1200m on water levels upstream, afflux and backwater length.
iv) Layout design of guide bunds and their performance.

v) Foundation design of pier as per as scour depth is concerned.
vi) Key design parameters like maximum velocity, discharge intensity, scour depth.
vii) Layout of river training measures to guide the flow across the bridge.

The studies as mentioned above were conducted for 100 year return period flood of 10,000 m^3/s. Pier foundation was checked for 500-year design flood of 12000 m^3/s.

23.1 Water levels, Afflux and Backwater length

In order to assess the effect of reduction in the waterway from 7 km to 1200m, water levels were observed in the model at various gauge locations located upstream of bridge including along the proposed bridge axis. Water levels were also observed at just down stream of guide bunds. These locations are indicated in Fig-8. Water levels observed in the model at these locations are given in table-1. The maximum water levels observed at proposed bridge was of the order of RL 73.76m.

For estimation of afflux due to constriction of waterway, water levels were observed at just upstream of guide bunds. The maximum water level was at RL 75.90m and the afflux was of the order of only 0.55m

23.2 PIER DESIGN

The Vartak, being the sponsoring authority of the study neither supplies neither design drawings nor any details of the proposed road bridge. However, to reproduce in model , considering all hydraulic aspects, a RCC bridge of standard design have been worked out and salient features of pier design are as under,

DETAIL SPECIFICATION OF PROPOSED ROAD BRIDGE

SL NO	PARTICULARS	SPECIFICATION
1	RCC deck and piers	
2	Waterway	1200m
3	No of spans	25
4	No of piers	24
5	Piers width	2.25m
6	Span width Centre to centre Clear	 48.00m 45.75m
7	Type of foundation	RCC Well
8	Well diameter	6.00m
9	High flood level	RL 73.76m
10	Top of pier cap	RL 75.26m
11	Top of well cap	RL 65.10m
12	Foundation level	RL 44.76m

The drawings of above salient features are presented in DRG 5 & 5A

23.3 Layout design of guide bund

Guide bund upstream of bridge

The existing channel geometry plays a very important role in determining length, shape, and size of the guide bund. Long guide bund at upstream of proposed bridge on either bank is work-out form the model studies to induce axial flow across the bridge by substantially reducing the obliquity of flow. The radius of curved head is taken as 0.4 P_w (P_w ~L~1200) which comes to 480m. With this radius, there is no probability of forming intense eddies due to the curved flow near it. The guide bank is curved well round to the back of afflux bund / embankment and no further extension beyond the embankment is required. It is seen in model that a sweep angle of 130^0 can kept the deepest embayment tangential to it. In order to effect reduction in the waterway from 7 km to 1200m, the right side guide bund is aligned at a angle of 10^0 with the bridge axis towards right bank side to avoid deep channel. The left side guide bund is also aligned at an angle of 33^0 with the bridge axis towards left side covering the confluence of two channels as well as avoiding deep channel. The length of both upstream guide bunds is 1500m measured from the bridge axis. These guide bunds are provided with single radius curved heads. Detail layout plan of guide bunds is given in Fig- 6 It may be mentioned here that the layout of the guide bunds including their alignment, their upstream and downstream lengths, and radius of curved heads were finalized so as to guide/induce the flow smoothly and axially toward the bridge and to distribute the flow in all the spans of the bridge keeping even end spans active. Performance of the guide bunds was checked in respect of flow pattern, discharge distribution and discharge intensities in various span of the bridge. Water levels, depth of flow and velocities were also observed along the guide bunds.

Guide bund down upstream of bridge

There is an avulsion channel of Jiabharali into Morabharali (an abandoned channel of River) just 1.6km down stream of proposed bridge. This avulsion took place during flood of 2003 and present model study term did not cover the activity of this newly activated channel. In fact when the present study was accepted in principle, there was no such avulsion. However proposed bridge will constrict the river width from 7 km to 1200m just upstream of this avulsion is now become a matter of concern. It is seen from the flow behavior that almost 75% discharge tends to flow throw this avulsion channel with the proposed bridge in position. The percentage of discharge flowing throw this avulsion channel was 55% in absence of bridge. Hence 20% increase of flow may be attributed to the constriction imposed by the proposed bridge. Since there are number of important infrastructures on and around the Morabharali just down stream of proposed bridge, the flood and erosion activities will be increased considerably after construction of the bridge. Hence, closing of this avulsion appears to be invariably required for sustainability of river course across the bridge as well as to take care of the fanning out effect of the bridge at downstream. Hence the guide bank on right bank at downstream of proposed bridge is extended up to 1690m, covering the avulsion point of Jiabharali into Morabharali. The radius of curved head is limited to 100m only and joined with the existing embankment However the length of guide bund on left bank at downstream of proposed bridge is limited to 600m only.

In this particular study the training bunds are provided on both bank and length of bund has been considered from two important requirements. The first being the maximum obliquity of flow which must be limited to a reasonable value and approach banks on both sides which must be fully protected in the event of the main channel of the river embaying considerably behind the training works. Since the embankment on both bank extends over a considerable distance u/s of the bridge site without any abrupt change in the general direction of flow an artificial guide bank on the other flank of such a bridge is unlikely to be subjected to a high degree of oblique attack.

23.4 Flow Pattern The flow patterns, as observed in the model along the guide bunds, at the bridge and at downstream of bridge, were recorded in Photos -7 & 8. It may be seen from these photos that upstream curved heads of guide bunds performs very satisfactorily in guiding the river flow smoothly towards the bridge. It is also seen that the flow is well distributed in all the spans of the bridge. The flow between the guides bunds appear to be reasonably normal to the bridge axis. No parallel or return flow is seen along downstream face of approach banks of the proposed bridge.

23.5 Discharge Distribution at proposed bridge: Observations were made in the model by measuring water level, depth of flow and flow velocities in each span of the bridge in order to estimate distribution of discharge and discharge intensities in various spans of the bridge. Discharge passing through each individual span and total river discharge passing through the bridge was computed.. Based on these data, discharge distribution in terms of percentage of total discharge and discharge intensities in various spans of the bridge is then worked out. The velocities, discharge intensities and discharge distribution observed/ worked out are given in table 2 & 3. The plots of discharge distribution and discharge intensities are shown in Fig- 7 to 8. From these data, it may be seen that discharge distribution varies from 2.6% to 7.2 %. Similarly the discharge intensities vary from 5 m^3/s to 15.6 m^3/s. The data thus give rise to the conclusion that flow is well distributed in all the spans of the bridge.

23.6 Water levels and velocities along the guide bunds Water levels, depth of flow and velocities were measured at various points along the guide bunds for 100 year return period flood of 10,000m^3/s. The location of these points of measurement is shown in fig- 9 and observed values are given in table – 4. The water levels along guide bunds varied from 74.90m at head to 73.95m at tail end. With free board of 1.5m, top of guide bund shall gradually vary from 76.40m at head to RL 75.26m at tail. Maximum velocity observed along right and left guide bund is order of 2.70m/ s and 2.60m/ s respectively. The maximum discharge intensities along the right and left guide bund is worked out to be of 14.4$m^3/s/m$ and 13.28$m^3/s/m$ respectively.

24 Foundation design of Bridge piers

Estimation of scour depth around bridge pier mainly governs the hydraulic design of pier foundation. Scour around bridge pier is a combined effect of general scour of river bed due constriction of waterway and local scour due to obstruction of flow by pier. The general bed scour is mainly governed by discharge intensities where as pier size and its shape largely influences the local scour at the pier. For foundation design, depth of scour around bridge pier was estimated from the maximum discharge intensity and maximum water level (HFL) observed in the model for design flood of 10,000 m^3/s.

24.1 Estimation of scour depth

According to Lacey formula, for discharge intensity of 20$m^3/s/m$ and silt factor of 0.77, depth of scour due to constriction of flow was worked out to be of 11m below HFL.
According to Raudkivi, Melville, Sutherland and Ettem, the depth of local scour due to pier obstruction is estimated to be of 2.4 times the pier size/diameter. For well

foundation of 6m diameter, depth of local scour was worked out to 14.4m. Adding together these two scour depths, total depth of scour was estimated to be 26m below HFL of RL 73.76m.

The scour depths, as estimate from the model data and also from above design practices formula are given blow for comparison.

1. NEHARI model studies 26.00m
2. Indian Railway Design Practices 23.00m
3. India Road Congress Design Practice 21.10m
4. Formula suggested by Dr S.V.Chitale 29.00m

The scour depth as estimated from the model data is in well agreement with those computed according to Indian Railway Design Practices and also with that computed as per formula recommended by Dr. S.V. Chitale. However,the scour depth of 29m computed as per the formula suggested by Dr. S.V. Chitale is recommended for design of pier foundation of proposed bridge at Chaukighat near Tezpur over river Jiabharali. The scour level at the bridge pier is worked out to be of RL 44.76m.

. Providing grip length of 12.0m, foundation level of bridge pier is worked out to RL32.76m. Top of well cap shall be kept at 8.66m below HFL i.e at RL 65.10m However, the nature of soil strata at the proposed site may be taken into account while finalizing the foundation level.

25 Discussions

25.1Water levels, Afflux and Backwater length

Waterway of 1200m provided for the bridge is already more than 2.50 times greater than Lacey waterway requirement. Hence no significant increase in the water levels, backwater length and afflux is expected on account of reduction of waterway. Since the flood embankment on either bank is proposed to train the river from 10 km up stream of proposed bridge, the highest water level as recorded along the flood embankment would duly take care of the back water effect due to afflux. This has been confirmed by the data observed in model.

25.2Guide bund

It may be seen from the pattern record in Photos 7 and 8 that river flow from the extreme right side and left side channels is guided smoothly and axially towards the road bridge, and no parallel or returns flow is seen on downstream side of bridge thus providing adequate safety to the approach banks. It may also be seen from Table-2 and 3 and Fig. - 7that flow is very well distributed in all the spans of road bridge. As seen from Table- 4 and Fig. – 10 that the velocities and discharge intensities observe along the guide bunds are neither very high nor very low which indicates that neither excessive scour nor deposition of silt will take place along the guide bunds. On the basics of these results of model studies, it can be concluded that overall performance of the guide bund is satisfactory.

25.3 Estimation of Scour Depth

Railway Board had collected prototype data of various bridge on Central Railway, which was then analyzed by RDSO. As per their analysis, the depth of scour around bridge pier in case of river with firm banks but erodable bed and flow inclined to the pier up to 35°, was found where $D_L = 1.35(q^2/f)^{1/3}$. In the present case, the depth of scour worked out to 23.0m according to Railway Design Practices, 26m as per NEHARI model data and 29.0m according to formula suggested by Dr S.V.Chitale. Though all these three values compare well, scour depth of 29.0m, being the highest, is recommended for design of pier foundation of the bridge.

26 CONCLUSIONS

(a)The orientation of bridge is properly fixed to give axial and normal flow through the bridge as could be seen from the flow pattern observed in the model.

(b)Flow conditions were all free and smooth for all ranges of flood discharges keeping waterway at 1200m. Hence fixing waterway has been guided by additional considerations of overall economy, ease and time of construction etc.

(c)The afflux caused was not appreciable being about 0.55m for 1200 m waterway. The study did not simulate bed scour and hence real afflux could be much less if flood duration is sustained to induce full scour. But here it may not be the case and full scour may not be developed (as width provided is much larger than lacey requirement).

ANNEXTURE- I

(Refer para -7)

RIVER : JIA - BHARALI

SITE : N.T. ROAD CROSS [illegible]

LOG - PEARSON TYPE III

YEAR	PEAK (CUMEC)	REARRANGED PEAK	Y = LN(Q)	(Y-YAVG)	(Y-YAVG)^2	(Y-YAVG)^3	R[illegible]
1969	5548.670	6004.873	8.700	0.581	0.337	0.196	1
1970	3994.990	5755.050	8.658	0.538	0.290	0.156	2
1971	4886.550	5548.670	8.621	0.502	0.252	0.126	3
1972	5294.514	5493.250	8.611	0.492	0.242	0.119	4
1973	5755.050	5294.514	8.574	0.455	0.207	0.094	[illegible]
1974	3971.101	4886.550	8.494	0.375	0.140	0.053	[illegible]
1975	3850.262	4459.033	8.403	0.283	0.080	0.023	[illegible]
1976	4021.362	4021.362	8.299	0.180	0.032	0.006	[illegible]
1977	5493.250	3994.990	8.293	0.173	0.060	0.005	9
1978	4459.033	3971.101	8.287	0.167	0.028	0.005	10
1979	6004.873	3850.262	8.256	0.136	0.019	0.003	11
1980	2392.156	3369.038	8.122	0.003	0.000	0.000	12
1981	2335.396	3207.423	8.073	-0.046	0.0002	-0.000	13
1982	2216.289	2991.051	8.003	-0.116	0.013	-0.002	14
1983	2991.051	2744.792	7.917	-0.202	0.041	-0.008	[illegible]
1984	2554.187	2701.254	7.901	-0.218	0.348	-0.010	16
1985	1592.667	2658.580	7.886	-0.234	0.055	0.013	17
1986	2631.709	2631.709	7.875	-0.244	0.060	-0.015	[illegible]
1987	3369.038	2607.118	7.866	-0.253	0.064	-0.016	19
1988	2701.254	2554.187	7.845	-0.274	0.075	-0.021	20
1989	3207.423	2392.156	7.780	-0.339	0.115	-0.039	21
1990	2607.118	2335.396	7.756	-0.364	0.132	-0.048	22
1991	2178.049	2216.289	7.704	-0.416	0.173	-0.075	23
1992	2744.792	2178.049	7.686	-0.433	0.188	-0.081	24
1993	2658.580	1592.667	7.373	-0.746	0.557	-0.416	25

YAVG = 8.119 3.180 0.045 N 25

STD.DEV = 0.364

SKEW COF = 0.042

RETURN PERIOD (YEAR)	K	DISCHARGE (M)
2	-0.0071	3350.487
5	0.4781	3997.739
10	1.2862	5364.990
25	1.7653	6387.207
50	2.0763	7152.827
100	2.3571	7922.643

(Refer para-7)

GUMBEL'S E. V. DISTRIBUTION

RIVER : JIA - BHARALI

SITE : N. ~ CROSSIN

YEAR	PEAK (CUMEC)	REARRA-NGED PEAK Q	RANK M	RETURN PERIOD T=N+1/M	QAVG-Q	(QAVG-Q)^2 *10^2	REDUCED VARIATE
1969	5548.670	6004.873	1	26.000	-2426.498	588.789	
1970	3994.990	5755.050	2	13.000	-2176.675	473.792	
1971	4886.550	5548.670	3	8.667	-1970.295	388.206	
1972	5294.514	5493.250	4	6.500	-1914.845	366.675	
1973	5755.050	5294.514	5	5.200	-1716.139	294.513	
1974	3971.101	4586.550	6	4.333	-1308.175	171.132	
1975	3850.262	4459.033	7	3.714	-880.658	77.556	
1976	4021.362	4021.362	8	3.250	-442.987	19.624	
1977	5439.250	3994.990	9	2.889	-416.615	17.357	
1978	4459.033	3971.101	10	2.600	-392.726	15.423	
1979	6004.873	3850.262	11	2.364	271.887	7.392	
1980	2392.156	3369.068	12	2.167	209.337	4.382	
1981	2335.396	3207.423	13	2.000	370.952	13.761	
1982	2216.289	2991.051	14	1.857	587.324	34.495	
1983	2991.051	2744.792	15	1.733	833.583	69.486	
1984	2554.87	2701.254	16	1.625	877.121	76.934	
1985	1592.667	2658.580	17	1.529	919.795	84.602	
1986	2631.709	2631.709	18	1.444	946.666	89.618	
1987	3369.068	2607.118	19	1.368	971.257	94.334	
1988	2701.254	2554.187	20	1.300	1024.188	104.896	
1989	3207.423	2392.156	21	1.238	1186.219	140.711	
1990	2607.118	2335.396	22	1.182	1242.979	154.500	
1991	2178.049	2216.289	23	1.130	1362.086	185.528	
1992	2744.792	2178.049	24	1.083	1400.326	196.091	
1993	2658.580	1592.667	25	1.040	1985.708	394.303	

QAVG 3578.37456 N = 25 SUM OF (QAVG-Q)^2 = 4064.10094 *10^4

STD. DEV = 1301.298

CO. VAR = 0.364

RETURN PERIOD	DISCHARGE (M)		
2	3364.608	U =	2992.737
5	4514.603	ALFA =	1014.618
10	5276.00		
20	6006.350		
25	6238.026		
50	6951.713		
100	7660.129		

(Refer para-7

D - INDEX TEST - GUMBEL DISTRIBUTION

RANK	Qobs	PROBABILITY OF NON - EXCO.	Qcomp.	ABS(Qobs Qcomp)
1	6004.873	0.962	6278.627	273.754
2	5755.050	0.923	5554.844	200.206
3	5548.670	0.885	5122.226	426.444
4	5493.250	0.846	48.8.332	684.918
5	5294.514	0.808	4559.075	735.439
6	4886.550	0.769	4350.317	536.233

SUM - 2856.993

D - INDEX - 0.798405

D - INDEX TEST - LOG PEARSON III

RANK	Qobs	PROBABILITY OF EXCEED.	INPUT K - VALUES	Qcomp.	ABS (Qobs Qcom:
1	6004.873	0.038	1.796	6458.988	454.11[illegible]
2	5755.050	0.077	1.470	5736.227	18.8[illegible]3
3	5578.970	0.115	1.165	5133.436	415.2[illegible]4
4	5493.250	0.154	0.850	4577.296	915.954
5	5294.514	0.192	0.543	4093.310	1201.204
6	4886.550	0.231	0.428	3925.491	961.059

SUM = 3966.38868

D - INDEX = 1.18076866

(Refer para-7.

STATEMENT SHOWING HIGH AND LOW WATER LEVEL

Name of river :JIA - BHARALI

Name of site :SIROWANI d/s of N.T. Camp

Year	High Flood Level (metre)	Date	Low Water Level (metre)	Date	Flood lift	Remarks
1	2	3	4	5	6	7
1982	68.860	28.7.82	66.300	29.3.82	2.56	
1983	68.750	1.9.88	66.560	11.3.83	2.19	
1984	69.700	24.7.84	66.030	8.4.84	3.67	
1985	69.710	27.7.85	66.890	11.3.85	2.82	
1986	69.930	18.9.86	66.760	2.3.86	3.17	
1987	70.455	15.8.87	67.100	27.2.87	3.36	
1988	70.750	27.8.87	66.950	4.4.88	3.80	
1989	68.930	16.6.89	67.250	10.4.89	1.68	
1990	68.480	25.6.90	66.950	24.2.90	1.53	
1991	70.100	12.7.91	66.880	27.3.91	3.22	
1992	69.22	28.8.92	67.05	1.6.92	2.17	
1993	70.79	31.8.93	66.43	5.3.93	4.36	
1994	68.33	17.7.94	67.22	24.3.94	1.11	

Refer para 7.

STATEMENT SHOWING HIGH AND LOW WATER LEVEL

Name of river :JIA - BHARALI

Name of site : N.H. CROSSING

Danger Level = 76.90 M

Table 3.7.1. (contd.)

1	2	3	4	5	6	7
1981	77.56	02.07.81	74.02	6.6.81	3.54	data is no available for N & Dec'81
1982	77.66	27.07.82	74.02	27,28,29, 30.5.82	3.64	Not available or Oct, Nov. Dec/82
1983	77.59	03.06.83	74.02	24.3,25.3.83	3.57	
1984	77.51	27.07.84	73.91	21,22,23,24,25,12/84	3.60	Jan, Feb, March/82
1985	76.700	29.06.85	73.78	12.2.85	2.92	Data is not available from July to Dec/85
1986	77.33	19.07.86	73.55	29,30,31,& 1,2,3,4, 5/2/86	3.78	Data not available for the month of Nov. and Dec' 86
1987	Data is not available					
1988	-do-					
1989	77.78	16.06.89	73.07	4.2.89	4.71	
1990	76.11	28.05.90	74.16	26.1.90 27.1.90 28.1.90	1.95	
1991	77.63	4.7.91	73.90	17.4.91	3.73	
1992	77.69	17.9.92	74.24	3.11.92	3.45	
1993	77.88	20.6.93	74.27	03.1.93	3.61	Data not available from Aug/93 to Dec/93

Refer para - 7.

STATEMENT SHOWING HIGH AND LOW WATER LEVEL

Name of river :JIA - BHARALI

Name of site : N.H. CROSSING Danger Level = 76.90 M

Year	High Flood Level in M	Date	Low Water Level in M	Date	Flood Lift	Remarks
1	2	3	4	5	6	7
1969	78.70	1.7.69	76.04	30/12 31/12	2.66	Jan to June/69 data not available
1970	80.89	21.7.70	75.58	13.3.70	5.31	
1971	78.81	16.6.71	75.76	31.12.71	3.05	
1972	77.36	27.7.72	74.08	20.12 21.12	3.28	
1973	77.258	16.6.73	74.04	21.1.73	3.218	
1974	77.90	17.7.74	74.008	23,24,25/1	3.892	
1975	77.635	30.6.75	74.25	31/12	3.385	
1976	77.05	01.7.76	73.94	26,27,28,29/12	3.11	
1977	77.60	16.8.77	73.78	15,16,17,18/2	3.82	
1978	76.97	23.6.78	73.00	2.4.78	3.97	
1979	77.74	02.07.79	73.01	22.3.79	4.73	
1980	77.75	23.09.80	73.95	23/1,23/2	3.80	

STATEMEN . SHOWING TL :: .T DATA

Site - N.T. Ro: d Crossing

1. Maximum annual Silt load: 2338.367 HM
2. Minimum Annual Silt load: 33.957 HM

Catchment area : 10,289 Sq.Km.

Year	Coarse Sediment in H.M	Medium Sediment in H.M	Fine Sediment in H.M	Annual Silt Yield of the Catchment in H.M	Silt Yield per unit of Catchment area in H.M/Sq.Km.	Remarks
1	2	3	4	5	6	7
1978	1253.208	879.997	205.162	2338.367	0.227	
1979	851.132	376.699	135.524	1363.355	0.133	
1980	56.530	92.306	55 127	203.963	0.020	
1981	13.432	11.747	8.778	33.957	0.003	
1982	42.629	6.530	5.509	54.668	0.005	
1983	124.510	92.998	47.732	265.240	0.026	
1984	103.344	67.336	33.849	204.529	0.020	
1985	210.425	108.129	74.364	392.918	0.038	
1986	260.208	116.042	47.720	423.970	0.041	
1987	N.A	N.A	N.A	-	-	
1988	N.A	N.A	N.A	-	-	
1989	61.755	13573.299	227.902	13862.956	1.347	
1990	64.820	148.402	149.706	362.927	0.035	
TOTAL	3041.993	15473.485	991.373	19506.85	1.895	
Average	276.54	1406.68	90.12	1782.44	0.172	
%	15.59	79.33	5.08	100.00		

ESTIMATION OF SCOUR AROUND BRIDGR PIER-COMPUTATIONS

DESIGN DATA:

Discharge (Foundation) : 10000 cum/s (1:100 year)
Silt factor 0.77
Waterway: 1200m
Span width: 48m (Centre to centre)
Well diameter: 6.0m
Pier width: 2.25m
Model data:
HFL RL 73.76m
Velocity (Max): 3.60m/s
Discharge intensity: 20 $m^3/s/m$

1) According to model data:
   Scour due to constriction of flow ($d_{Lq)}$:

$d_{Lq} = 1.34\ (q2/f\ )^{1/3}$
$= 1.34\ [(20)^2/\ 0.77)]\ 1/3$
= 10.75m below HFL of 73.76m

Local scour due to pier obstruction (d_{se}):
i) According to Laursen :

(d_{se}) = [1.5 K (Y_0/b)] b, where Y_0 = flow depth = 6.25m (model)
b =Well diameter = 6.0m
k = Pier coefficient ~0.9

(d_{se}) =9.4m below general scour bed level

ii) According to Shen :

= [3.4 $F^{2/3}$] b, where b = well diameter, F = Pier Froud Number= V/ (gb) $^{0.5}$, V = Flow velocity =3.20m/s (model data) = 10.97m below general scour bed depth level

iii) According to Raudkivi, Melville, Sutherlaad and Ettem:

(d_{se}) = (2.4) b, where b = Well diameter = 6.0m
(d_{se}) = 14.4m below general scour bed level

Considering the maximum value of 14.4m as local scour due to pier obstruction and 10.75m as depth of scour of due to constriction,
Total Depth of Scour D_s =10.75m + 14.4m
=25.15 say 26.0m below HFL 73.76 m

2) **According to Indian railway design practice :**

$D_s = 2\ d_{LQ}$

$D_s = 2\ d\ [0.473\ (Q/f)^{1/3}]$

$= 2[0.473\ (10000/\ 0.77)^{1/3}]$

$= 20.0m$

3) According to Indian Road Congress Design Practice :

$D_s = 2\ d_{Lq}$

$D_s = 2\ [1.34\ (q2/f)^{1/3}]$

$= 2[1.34\{(20.0)^2/\ 0.77\}^{1/3}]$

$= 21.10m$

4) According to Dr. S.V. Chitale :

$D_s = 1.7\ d_{Lq} + 2.5\ (b)$

$= 1.7[1.34\{(13.2)^2/\ 0.77\}^{1/3}] + 2.5x6$

$= 28.63m$, say 29.0m below HFL

Total scour depth (Ds) according to:
*NEHARI model studies......................26.0m
* According to Indian railway design practices......... 20.0m
* According to Indian Road Congress.......................21.10m

*According to Dr. S.V. Chitale 29.0m
Scour depth of 29.0 m below HFL is therefore recommended for design of pier foundation.

DESIGN OF GUIDE BUND

Guide bund is to be designed for a maximum discharge of 10000cum/s. The design parameters are given below:

High flood level at proposed bridge axis, corresponding to Q= 10000 cum/s= RL 73.76m
With 2m free board,RL of top of Guide bund =75.76m
Maximum velocity of flow 3.6m/s (observed along right guide bund)
Intensity of discharge=22m^3/s/m (observed along right guide bund)
Silt factor of bed material = 0.77
Corresponding d_{50} of bed and bank material= 0.19mm
River bed level as per cross-section near proposed bridge-RL 65.13m (deepest)
Side slope of guide bund- 1V:2H
Angle of sloping bank Θ=26.56°

COMPUTATION

Wt of stone for protection works,

$W= 0.02323 S_s V^6 k/ (S_s-1)^3$ (using Isbash formula for weight of stone)

Where W= Wt. of stone in kg, S_s= specific gravity of stone=2.65

V= velocity in m/s= 4.0 m/s

$$K=\frac{1}{[1-\sin^2 \Theta/\sin^2\phi]\ 0.5}$$

Where Θ = 26.56 °,

ϕ=Angle of repose of bank material=30°

K= 2.23

$W= 0.02323*2.65*(3.6)^6*2.23/ (2.65-1)^3$

= 125.2kg

Assuming mean dia of stone (D_{50}) in creates=0.23m

Porosity (e) = $0.245+0.0864/ (D_{50})^{0.21}$= 0.3626

The mass specific gravity (S_m) of the stone in creates:

$S_m = (1-e)\ Ss = (1-0.3626)*2.65 =1.6891$

Volume of creates = $W/ S_m (1000)$ =125.2/1.6891*1000

= 0.07412m^3

Thickness of pitching (River side), $T= V^2/ [2g (S_s -1)]$

$= (4.0)^2 / [2*9.81(2.65-1)]$

=0.4942m

Area of creates= Volume of creates/Thickness= 0.07412/0.4942=0.1500m^2

Hence use stone having mean dia 0.23m in creates of 0.5x0.5x0.5m in one layer for the sloping portion on the river side of the guide bunds.

DESIGN OF APRON (RIVER SIDE)

Lacey's scour depth D_L =1.35 [q2/f] $1^{/3}$
= 1.35$[22^2 /0.77]^{1/3}$
= 12.0m

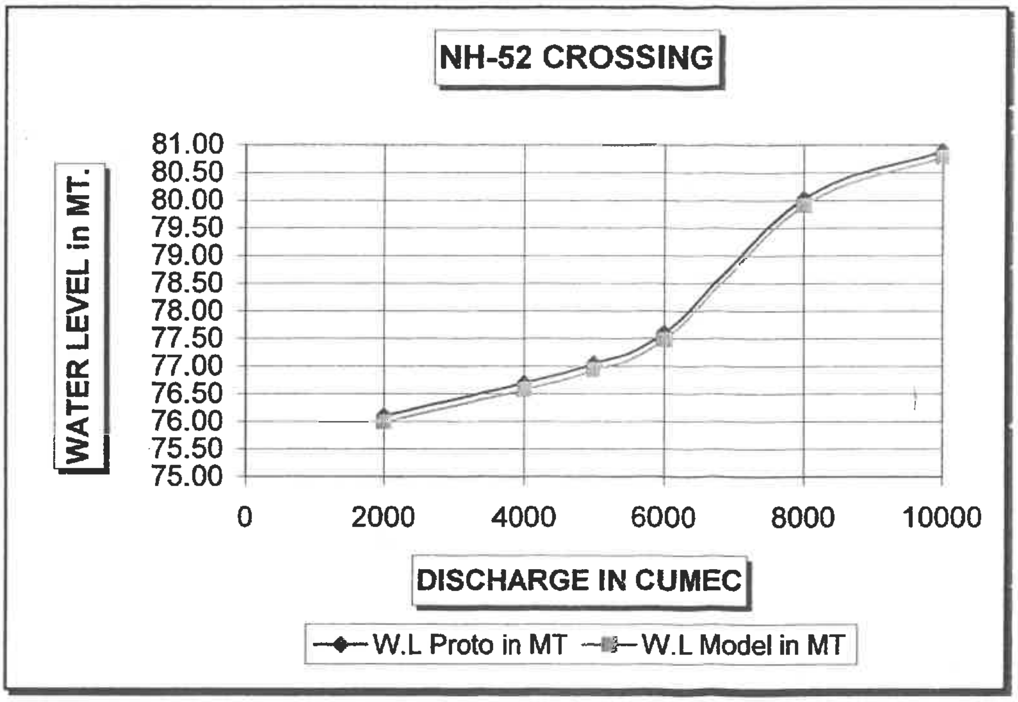
i) Considering 2D Lacey = 12.0 x 2.0 =24.0m
Considering the HFL at the proposed bridge,
Deepest scour level (D_{SL}) = HFL -2 D_L = 73.76-24.0=49.76m
Depth of scour below bed level, DS= Bed level - D_{SL}=65.13–49.76 49.88=15.37m
Quantities of stone/m of apron= $5^{1/2}$ x 15.37 x 1m = 34cum/m
Add 20% for under water laying losses=34x 1.20=41 cum/m
Width of apron= 1.5 D_S =1.5 x 15.25 =22.88m, say 23m
(as per IS code)
Provide width of apron as 45m then
Thickness of apron = Quantities of stone/m of apron / width of Apron = 41/45 =0.90m
Hence provide 45m width apron with two layers of stones in creates of size 1m x1m x 0.45m

ii) Considering 1.5D Lacey's,
1.5 x12.0= 18m
Considering the HFL at the proposed bridge
Deepest scour level (D_{SL}) = HFL -1.5 D_L = 73.76-18.0= 55.76m

Depth of scour below bed level, DS = Bed level -D_{SL}=65.13 -55.76 =9.37m
Quantities of stone/m of apron = $5^{1/2}$ x 9.37 x 1m = 21cum/m
Add 20% for under water laying losses=21 x1.20=26cum/m
Width of apron= 1.5 D_S =1.5 x 9.37 =14m'
(as per IS code)
Provide width of apron as 30m then
Thickness of apron = Quantities of stone/m of apron / width of Apron = 26/30 =0.86m
Hence provide 30m width apron with two layers of stones in creates of size 1m x1m x 0.43m

Location	Discharge in cumec	W.L Proto in m	W.L Model in m
NH-52	10000	80.89	80.78
	8000	80.03	79.91
	6000	77.60	77.48
	5000	77.05	76.93
	4000	76.70	76.58
	2000	76.10	75.99

FIG-1-G-Q relation between proto and model



Location	Discharge in Cumec	W.L Proto in m	W.L Model in m
OVER C/S-8	10000	79.99	79.87
	8000	79.13	79.01
	6000	76.70	76.58
	5000	76.14	76.03
	4000	75.80	75.69
	2000	75.20	75.10

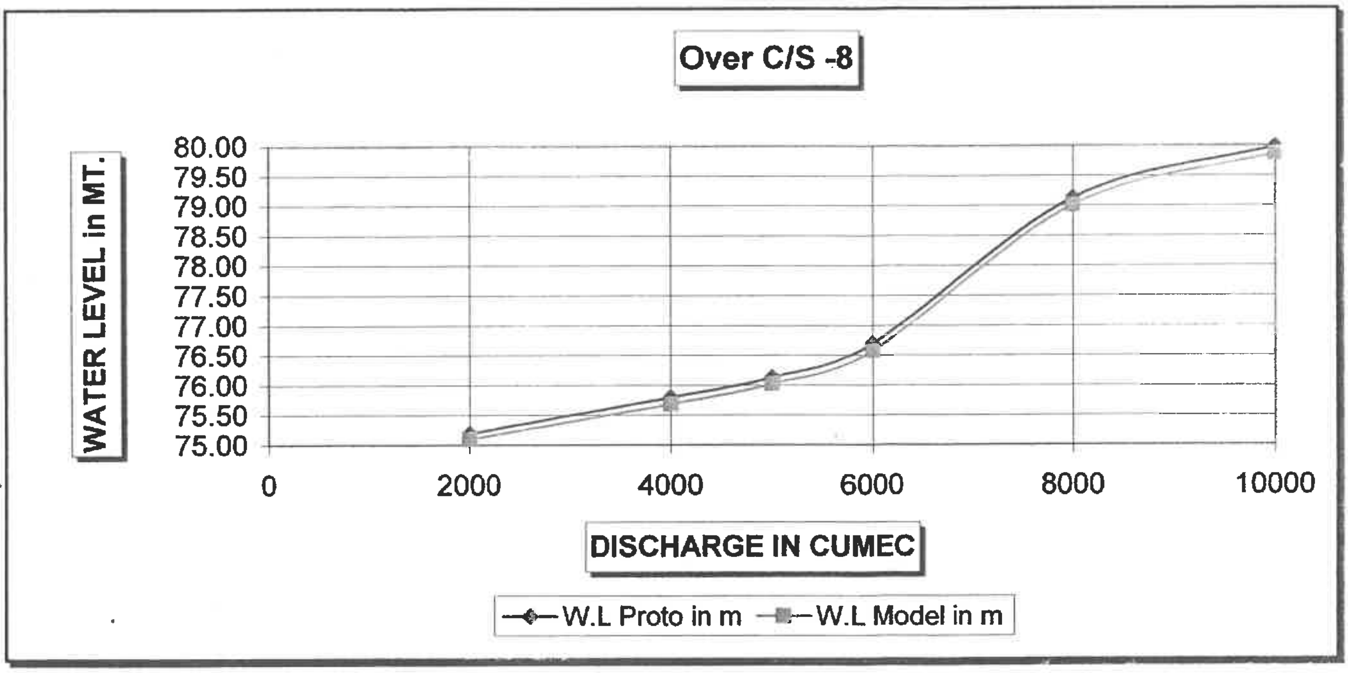


FIG - 2 G-Q relation between proto and model at C/S no -8

Location	Discharge in Cumec	W.L Proto in MT	W.L Model in MT
OVER C/S-38	10000	73.88	73.76
	8000	73.02	72.9
	6000	70.62	70.51
	5000	70.10	69.98
	4000	69.70	69.59
	2000	69.12	69.00

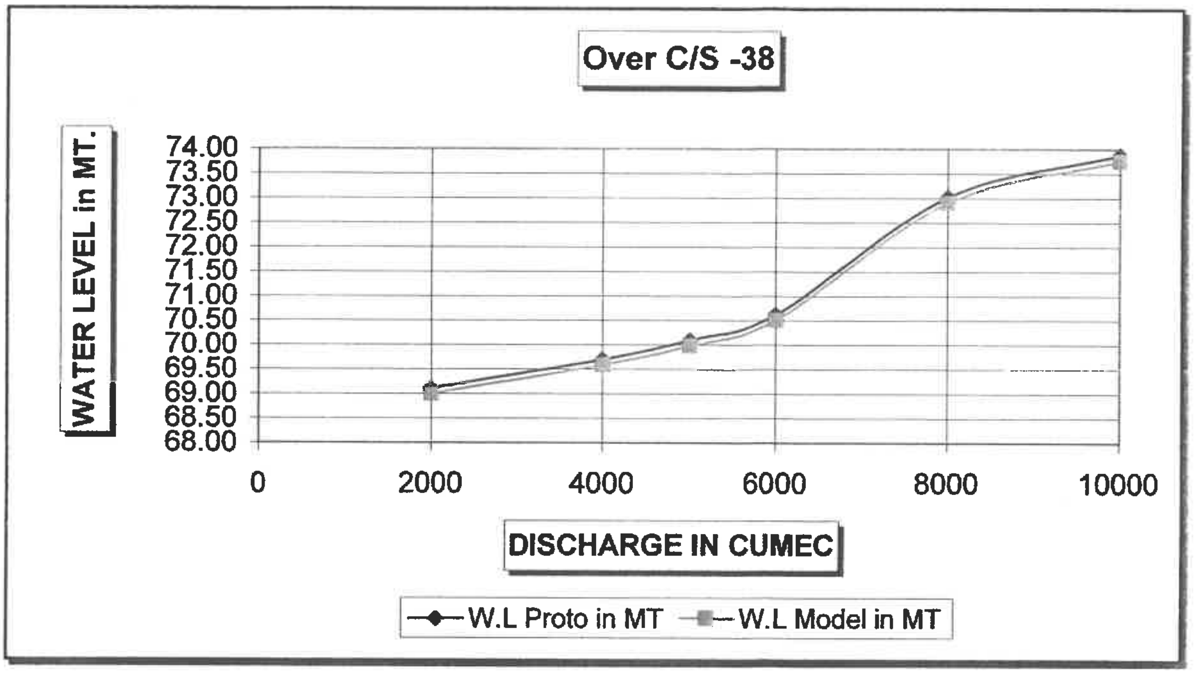
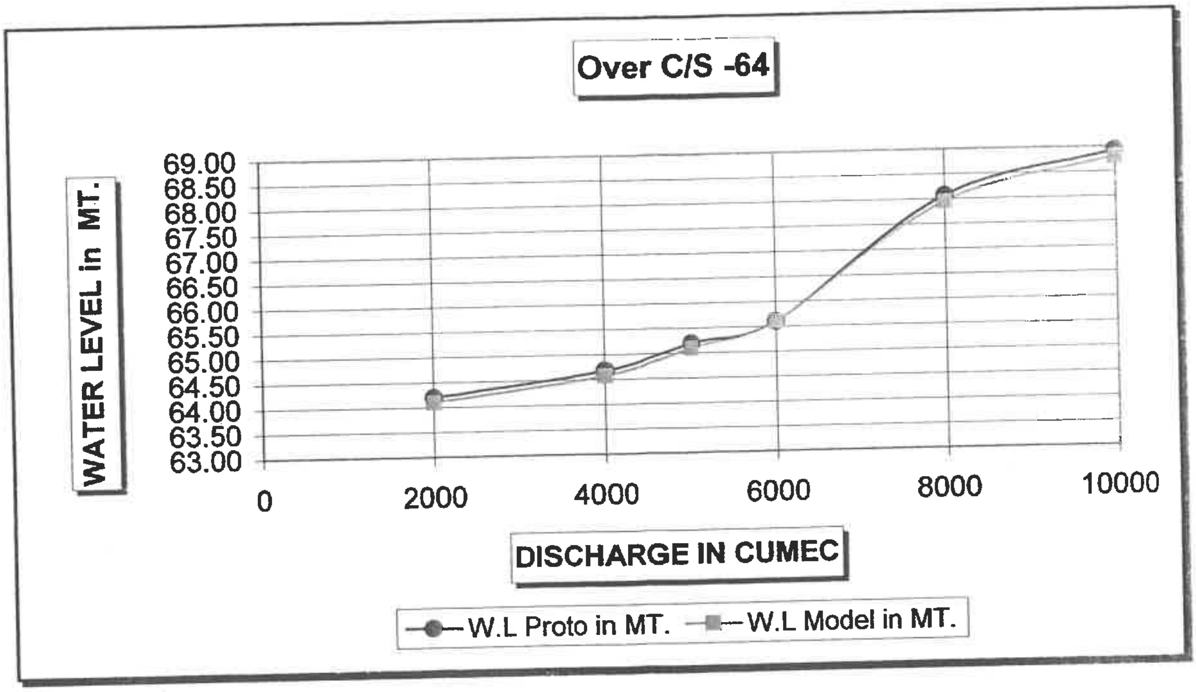


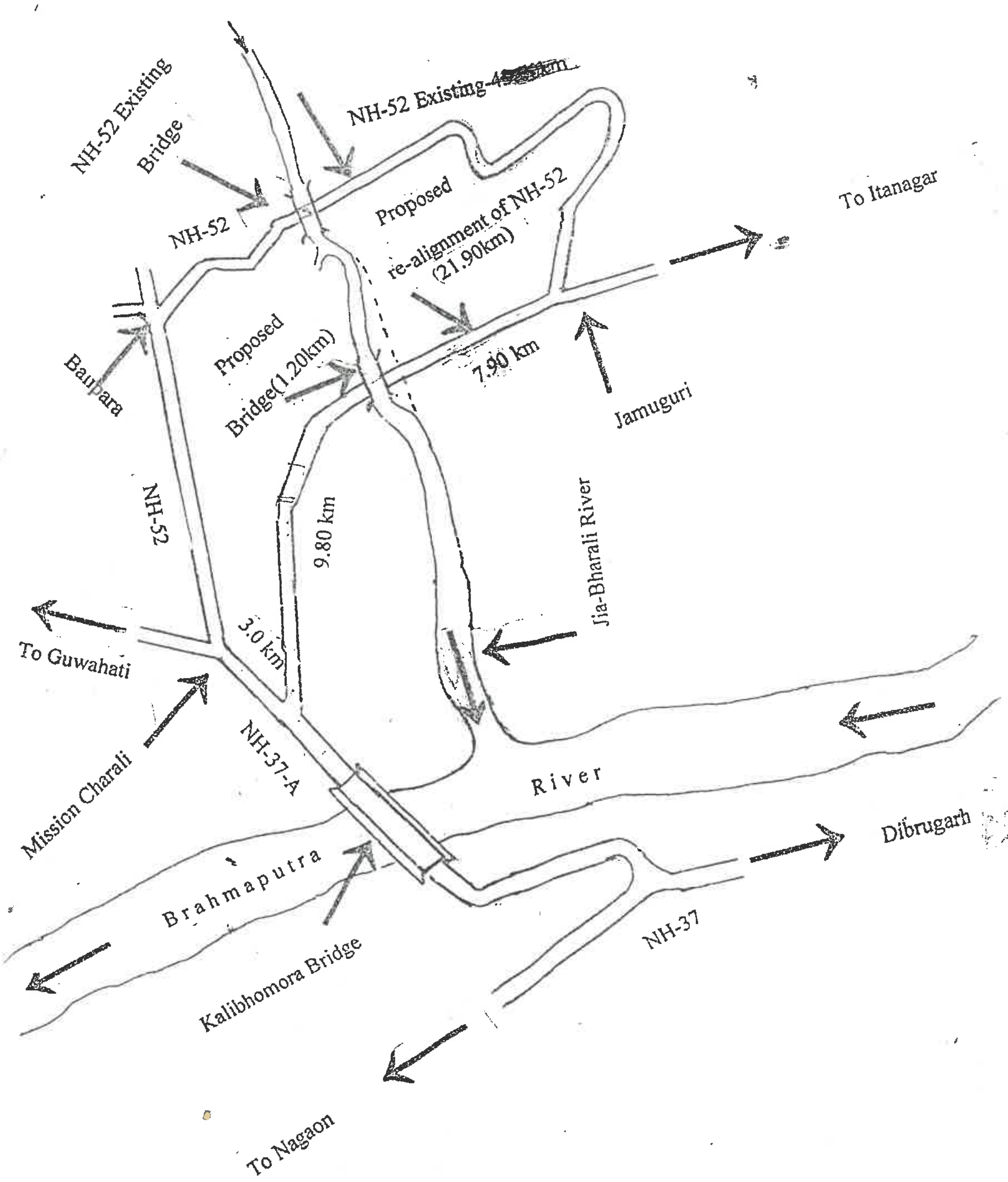
FIG-3 G-Q relationbetween proto and model at C/S-38(BCL)

Location	Discharge IN Cumec	W.L Proto in MT.	W.L Model in MT.
Over C/S-64	10000	68.93	68.81
	8000	68.07	67.95
	6000	65.60	65.6
	5000	65.20	65.10
	4000	64.68	64.58
	2000	64.20	64.10

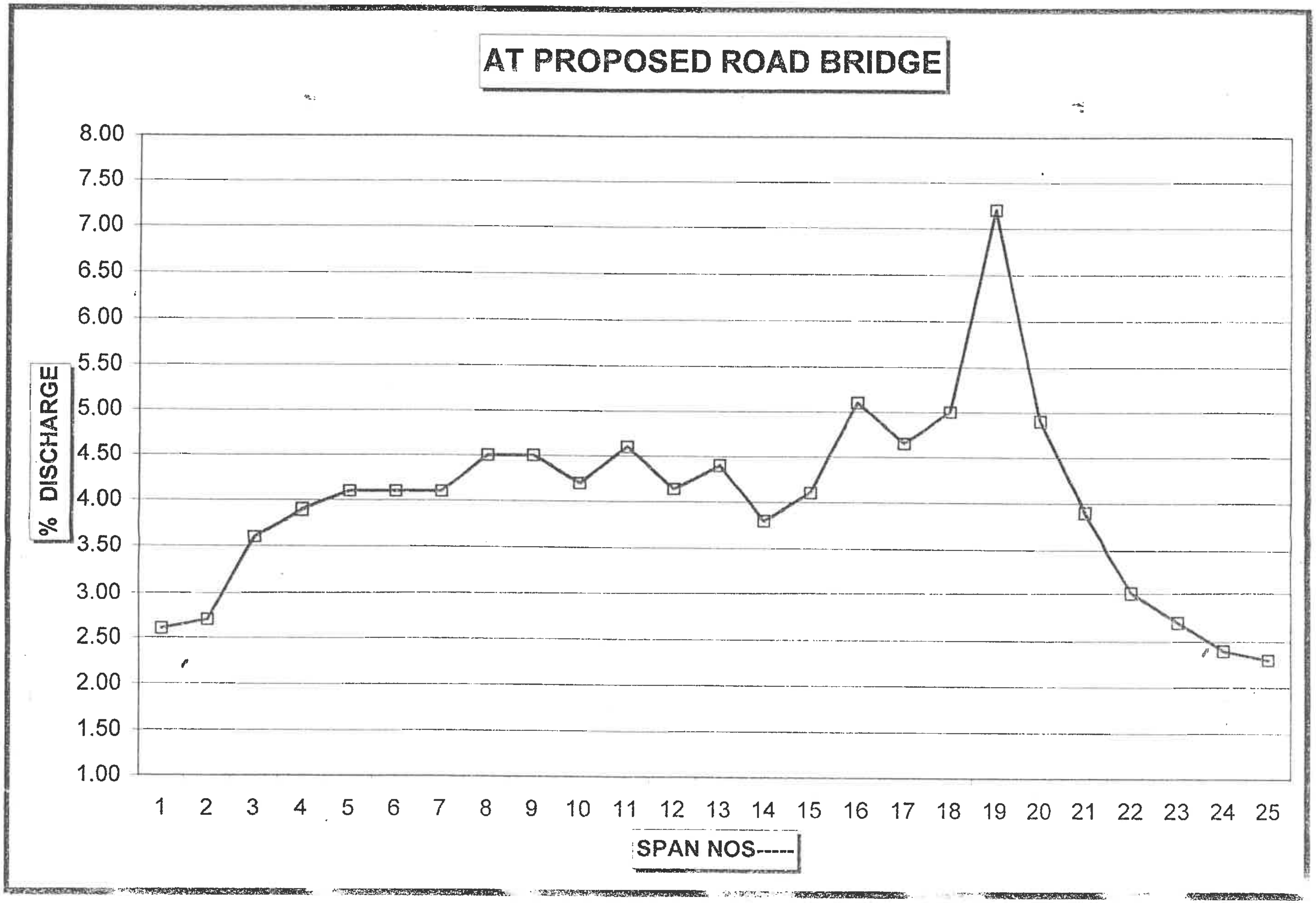


GIG-4 G-Q relation between proto and model at C/S 64

CONSTRUCTION OF BRIDGE ACROSS RIVER JIA-BHARALI AT CHOWKIGHAT ON NH-52



Not to scale



AT PROPOSED ROAD BRIDGE
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
% DISCHARGE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
SPAN NOS-----

FIG-7

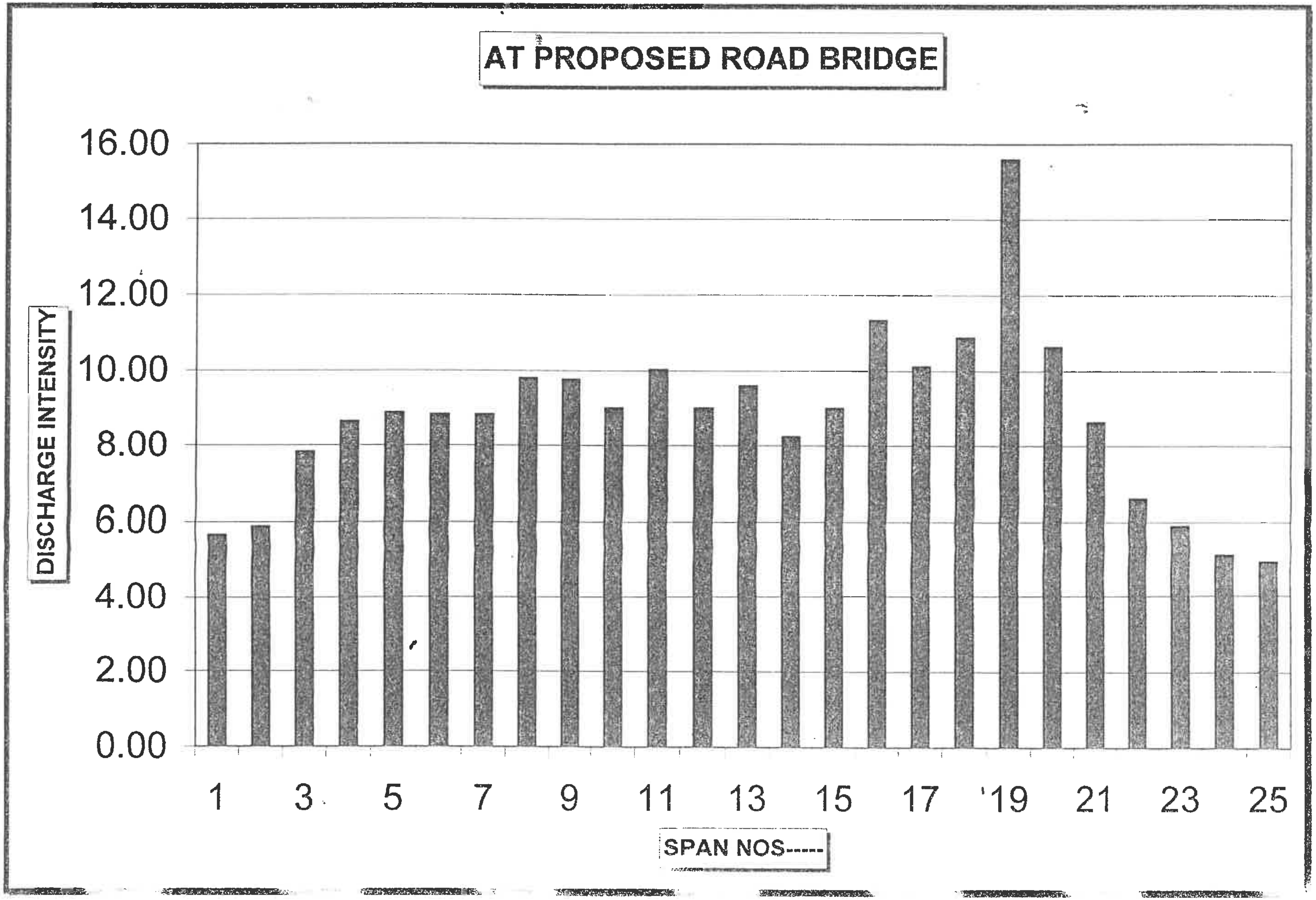
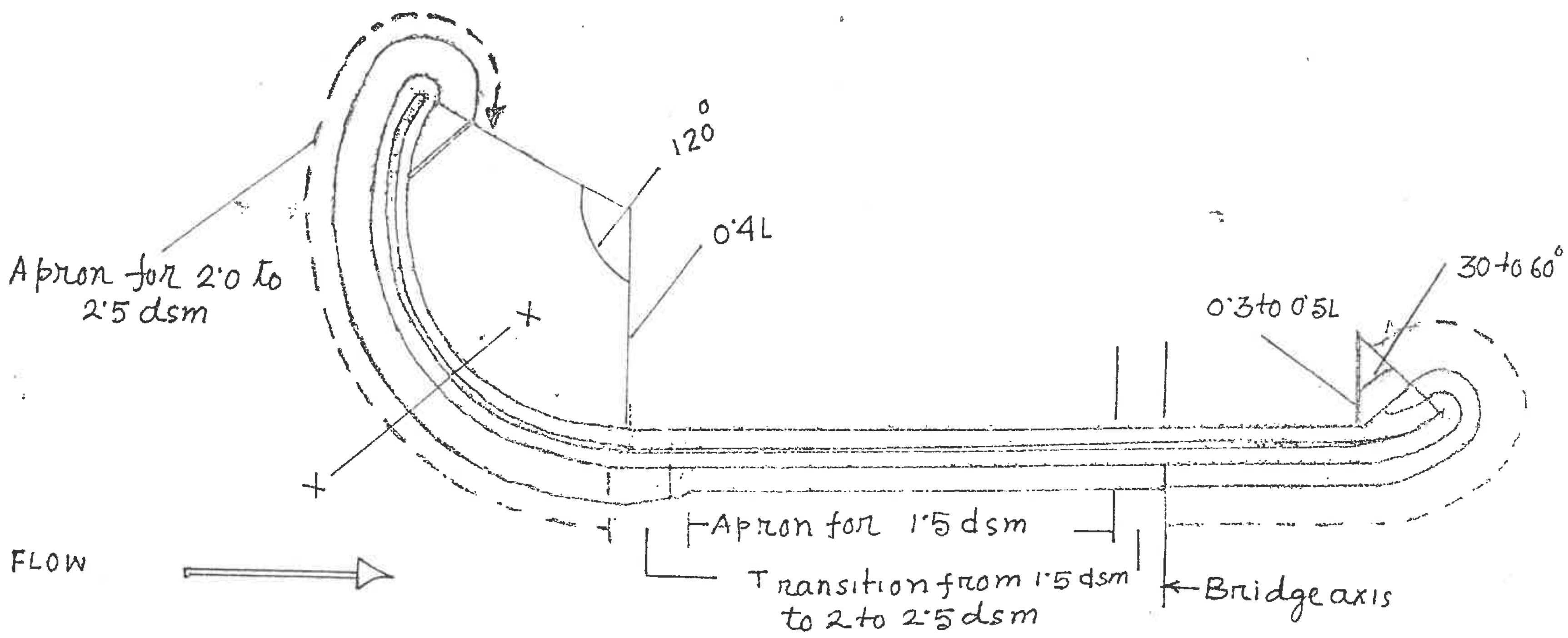
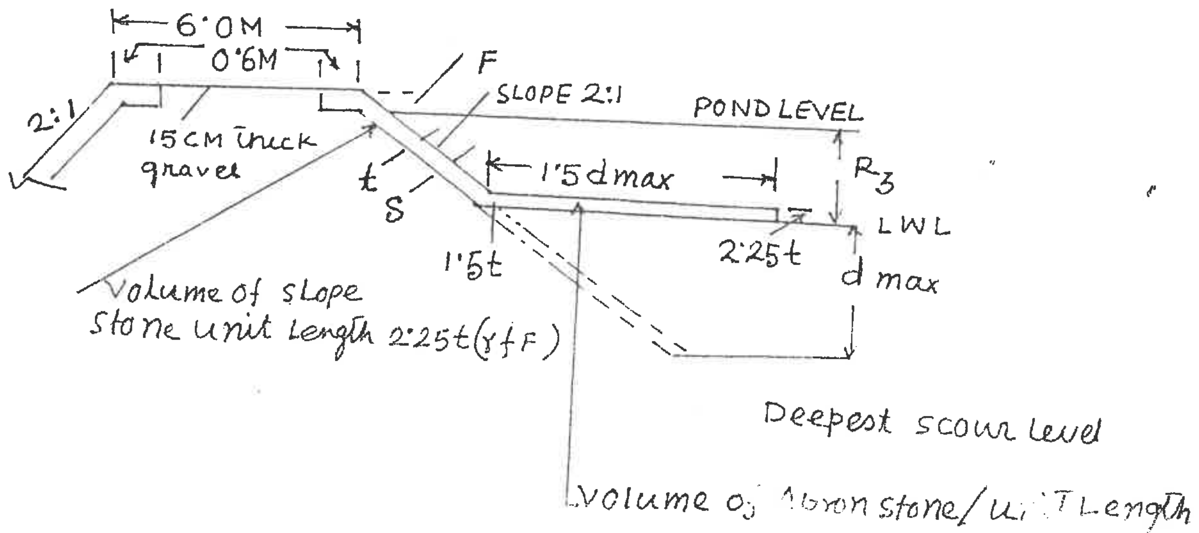

AT PROPOSED ROAD BRIDGE
DISCHARGE INTENSITY
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1
3
5
7
9
11
13
15
17
'19
21
23
25
SPAN NOS-----

FIG-8





LEGEND

F= height of top of guide bund above pond level

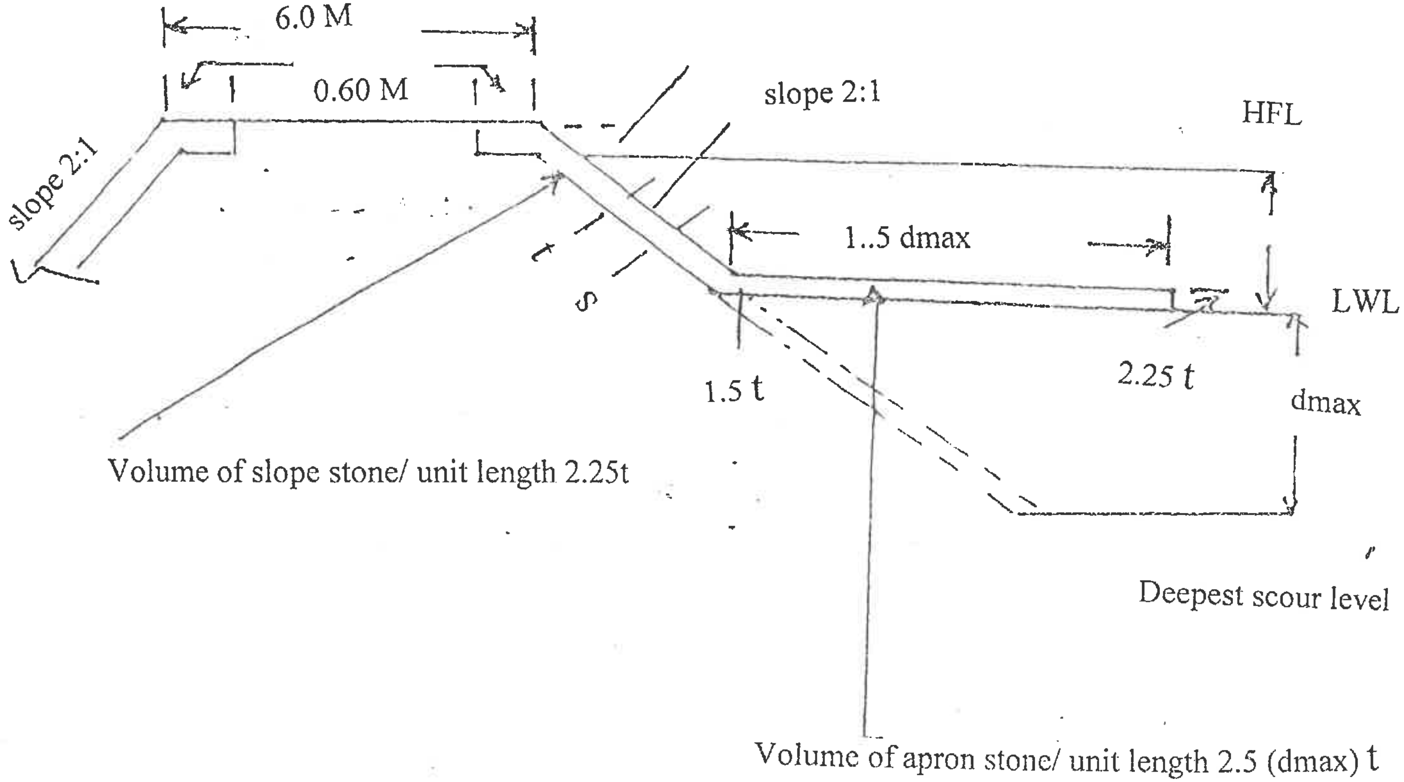
R_3=Rise of flood above LWL at guide bund

dmax= maximum scour depth for calculation of apron stone

t = thicknes of slope stone

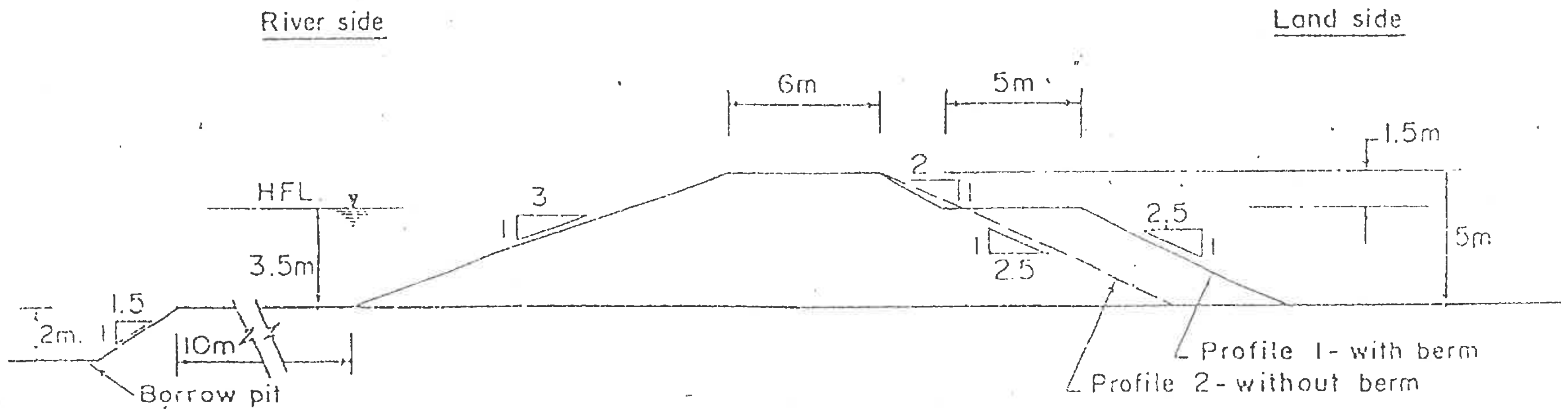
s = thickness of filter

DR G NO-6 Typical section of guide bund



LEGEND
F= free board,1.5m above HFL
R_3=Rise of flood above LWL at channel closing dyke
dmax= maximum scour depth below HFL calculation of apron stone
t = thicknes of slope stone
s = thickness of filter

DRG NO-8 Typical section of channel closing dyke



(Scale : 1 : 250)

Design Section of Embankment.

DRG NO – 9

Table -1

WATER LEVEL OBSERVATION

Location of Gauge site	DISCHARGE IN CUMEC											
	10000		8000		6000		5000		4000		2000	
	Proto WL in meter	Model WL in meter	Proto WL in meter	Model WL in meter	Proto WL in meter	Model WL in meter	Proto WL in meter	Model WL in meter	Proto WL in meter	Model WL in meter	Proto WL in meter	Model WL in meter
NH-52 crossing (G_1)	80.89	80.78	80.03	78.91	77.60	77.48	77.05	76.93	76.70	76.58	76.10	75.99
Over c/s-8 (L/B), Tarajan Village (G_2)	79.99	79.87	79.13	79.01	76.70	76.58	76.14	76.03	75.80	75.69	75.20	75.10
Over c/s-38 (R/B), Chowkiding (G_3)	73.88	73.76	73.02	72.90	70.62	70.51	70.10	69.98	69.70	69.59	69.12	69.00
Over c/s 64 (R/B), Sirwoni Village (G_4)	68.93	68.81	68.07	67.95	65.60	65.49	65.20	65.10	64.68	64.58	64.20	64.10

Table-2

DISCHARGE DISTRIBUTION AND DISCHARGE INTENSITIES AT PROPOSED ROAD BRIDGE (FOR Q=10000M^3/S

SPAN NO	DEPTH (m)	VELOCITY (m/s)	DISCHARGE INTENSITY (m^3/m/s)	DISCHARGE %	REMARK
1	4.7	1.20	5.64	2.60	Road Bridge No of span-25 Span width-48m (c/c) Clear span-45.75m Pier width-2.25m Overall warerway-1200m HFL at RL 73.76m (model) Data given in column 2 & 3 are average values observed in model. Plot of % Discharge Intensities are shown in Fig-7
2	4.90	1.20	5.88	2.70	
3	7.1	1.10	7.81	3.60	
4	7.2	1.20	8.64	3.90	
5	7.1	1.25	8.87	4.10	
6	6.3	1.40	8.82	4.10	
7	6.0	1.47	8.82	4.10	
8	6.3	1.55	9.80	4.50	
9	6.1	1.60	9.76	4.50	
10	5.8	1.56	9.00	4.20	
11	5.9	1.70	10.03	4.60	
12	6.0	1.50	9.00	4.14	
13	6.20	1.55	9.60	4.40	
14	5.0	1.65	8.25	3.80	
15	5.3	1.70	9.00	4.10	
16	5.4	2.10	11.34	5.10	
17	4.6	2.20	10.12	4.65	
18	6.8	1.60	10.88	5.00	
19	10.4	1.50	15.60	7.20	
20	7.6	1.40	10.64	4.90	
21	5.4	1.60	8.64	3.90	
22	4.4	1.50	6.60	3.00	
23	4.2	1.40	5.88	2.70	
24	4.3	1.20	5.16	2.40	
25	4.3	1.20	5.00	2.30	

Table-3

DISCHARGE DISTRIBUTION AND DISCHARGE INTENSITIES AT PROPOSED ROAD BRIDGE (FOR $Q=8000M^3/S$

SPAN NO	DEPTH (m)	VELOCITY (m/s)	DISCHARGE INTENSITY ($m^3/m/s$)	DISCHARGE %	REMARK
1	2.3	1.2	2.76	1.57	Road Bridge No of span-25 Span width-48m (c/c) Clear span-45.75m Pier width-2.25m Overall warerway-1200m HFL at RL 73.76m (model) Data given in column 2 & 3 are average values observed in model. Plot of % Discharge Intensities are shown in Fig-8
2	5.9	1.2	7.10	4.1	
3	5.4	1.6	8.64	4.9	
4	5.1	1.8	9.18	5.2	
5	4.7	1.8	8.46	4.8	
6	3.9	1.5	5.58	3.3	
7	3.6	1.4	5.00	2.8	
8	3.9	1.6	6.20	3.5	
9	3.7	1.5	5.50	3.2	
10	3.4	1.4	4.76	2.71	
11	3.5	2.2	7.70	4.4	
12	5.6	2.5	14.00	8.0	
13	4.5	2.4	10.80	6.2	
14	2.6	2.3	5.98	3.4	
15	2.9	2.2	6.40	3.6	
16	3.0	2.1	6.30	3.6	
17	2.2	1.9	4.20	2.4	
18	4.4	1.9	8.40	4.7	
19	6.0	2.7	16.20	9.2	
20	5.2	2.6	13.50	7.7	
21	3.0	2.6	7.80	4.4	
22	2.2	2.1	4.62	2.6	
23	2.0	1.6	3.20	1.8	
24	2.6	1.4	3.60	2.1	
25	1.9	1.2	2.30	1.3	

Table -4

WATER LEVELS AND VELOCITIES ALONG GUIDE BUNDS FOR Q=10000 M^3/S (MODEL DATA)

LOCATION NO/cross-section	WATER LEVEL (m)	VELOCITY (m/s)	DISCHARGE INTENSITY ($m^3/s/m$)	REMARK	
RIGHT GUIDE BUND					
1/31	75.09	0.35	1.10	Afflux bund	Note: *Design discharge-10000m^3/s *Data given in column 2 and 3 are average values observed in model at NEHARI *Refer Fig- 9 for location of data points
2/32	74.90	1.80	8.20	U/S Head	
3/33	74.71	2.70	16.30		
4/34	74.53	2.60	14.40		
5/35	74.34	2.35	10.87		
6/37	73.95	2.40	12.28	U/S of Proposed bridge	
7/38	73.76	2.20	13.93		
8/43	72.81	1.60	8.20	D/S Head	
9/44	72.62	0.40	1.05	Approach bank	
LEFT GUIDE BUND					
9/32	74.86	0.30	1.15	Afflux bund	
10/33	74.66	1.85	9.20	U/S Head	
11/35	74.29	2.60	13.20		
12/36	74.14	2.40	12.28		
13/37	73.91	1.70	11.20	U/S of Proposed bridge	
14/38	73.72	1.60	9.90	BCL	
15/39	73.56	1.40	6.60	D/S Head	

Table-5

WATER LEVELS ALONG JIABHARALI RIVER U/S OF PROPOSED ROAD BRIDGE FOR Q= 10000 CUM/S (MODEL DATA)

'O' RD, NH-52 Bridge, c/s no-4

SL NO	GAUGE LOCATIONS		WATER LEVELS (M)	REMARK
	Cross-section no	Chain age in metre	Waterway 1200m	
1	4.	0	80.06	NH-52 bridge 'O' RD (L/B)
2	8	1320	79.84	Tarajan village(L/B)
3	11	2220	79.27	
4	15	3420	78.51	Samdhara Village(L/B)
5	27	7020	75.86	
6	34	9120	75.50	
7	38	10,200	73.76	BCL
8	39	10,500	73.57	Downstream Of Bridge

* Gauge locations are shown in Fig-*9
Water level data given in column 4 are average values observed in model
Accuracy of water level measurements in model is +- 0.10m

REFERENCES

1. River Mechanics, Vol-II- *HSIEN WENSHE IV*
2. Hydraulic Model Studies for Flood Control-CBI Journal XVI No.3, - *JOGLIKA, D.V.*
3. Mechanics of Sediment Transportation and Alluvial Stream Problems,2nd Edition,1985- *GARDE,R.J. and Ranga Raju, K.G.*
4. Rating Curve Analysis-Report No. DP-2- (1982-83), *NIH, Roorkee.*
5. Flood Estimation Report-*C.W.C .(1984)*
6. Annual Report (Tech) –*C.W.P.R.S.,, Pune,1950.*
7. Morphological Studies of River Brahmaputra, *N.E.C., Shillong.*
8. Morphological Studies for River Brahmaputraat Neemati Kalabari Reach-Technical Report-3688 , *C.W.P.R.S., Pune.*
9. Master Plan of River Brahmaputra (Mainstream)- *Brahmaputra Board.*
10. River Training Studies of Brahmaputra River-Master Plan Report (Main)- *William Halcrow & Partners Ltd., -under B.W.D.B.*
11. Analysis of Alluvial Bed Forms , *Mercer, A.G. , Colorado State University.*
12. State of Art on Spurs, *C.W.P.R.S., Pune.*
13. *Morphological Study of River Brahmaputra at Nagaghuli –Maijan-Oakland area of Dibrugarh Town, Assam (Report No-3590), C.W.P.R.S., Pune.*
14. Remote Sensing Aided Idealization of Space-Time Variant behaviour of Chanel Geometry of River Brahmaputra , *Deptt. Of W.R.D & Management, I.I.T., Rookee, (March-2005).*
15. Erosion Problem of Majuli Island, *Brahmaputra Board.*
16. Modeling of Fluvial Processes, *Gessler, Colorado State University.*
17. River Behaviour Management and Training (Publication No. 204-1989), Vol-I, *C.B.I.P.*
18. Final Report on Physical Model Study of River Brahmaputra covering Phulbari Reach, *N.E.H.A.R.I.*
19. Final Report on Physical Model Study of River Brahmaputra covering Kaniajan Area, *W.R.D.,Govt. of Assam.*

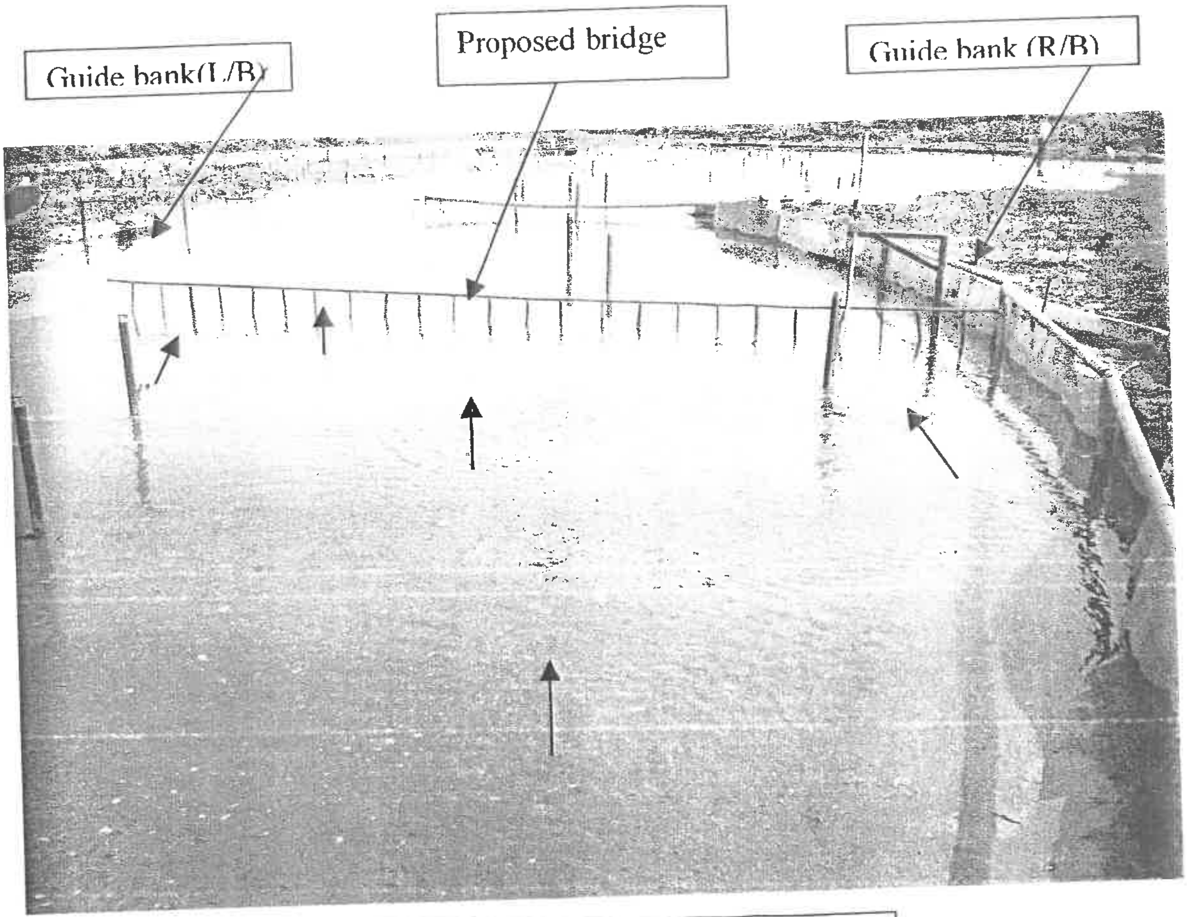


Photo-5 :- Flow across proposed bridge looking upstream

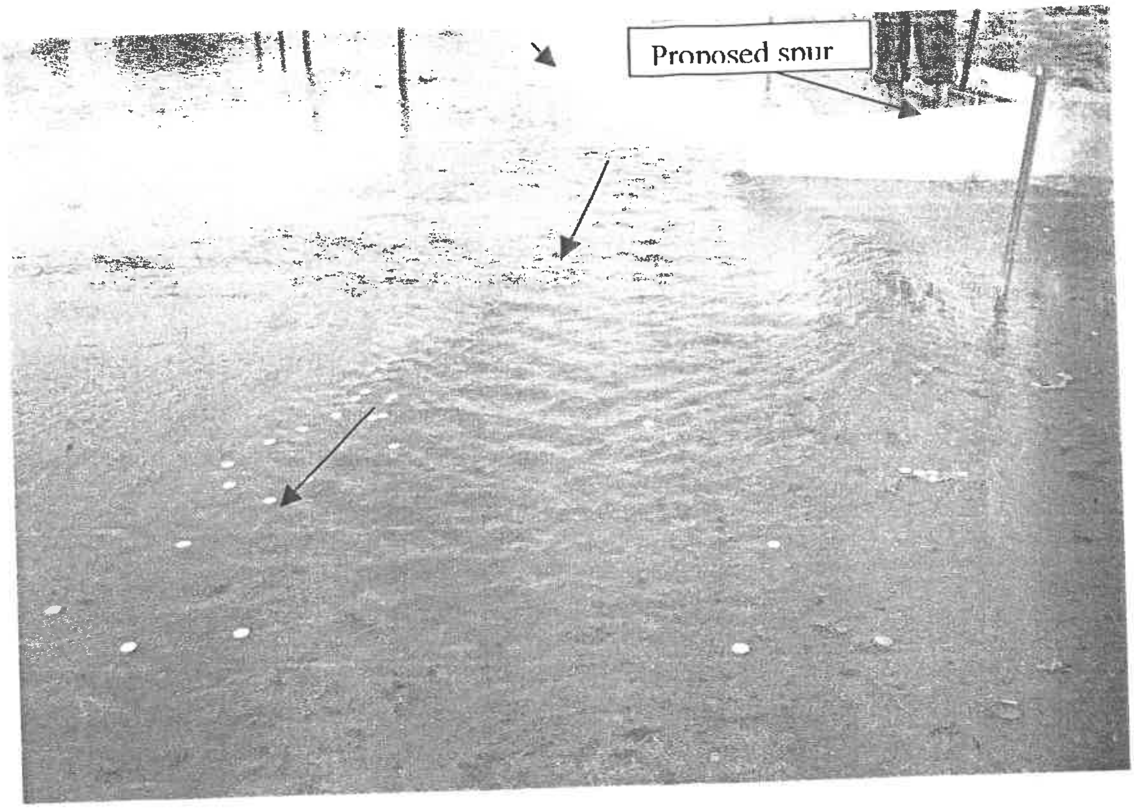


Photo-6 :- Flow along proposed spurs looking downstream

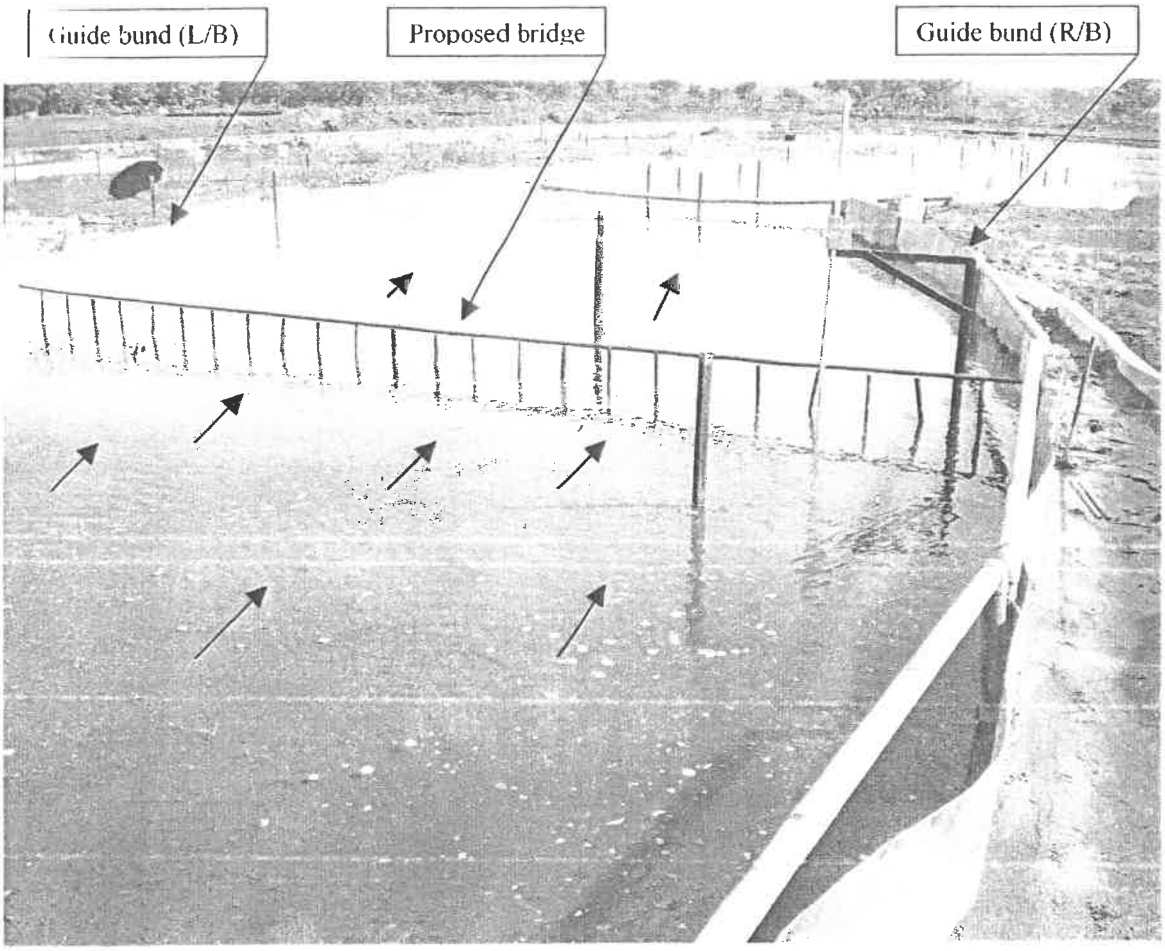


Photo-7:- Flow pattern across proposed bridge looking upstream

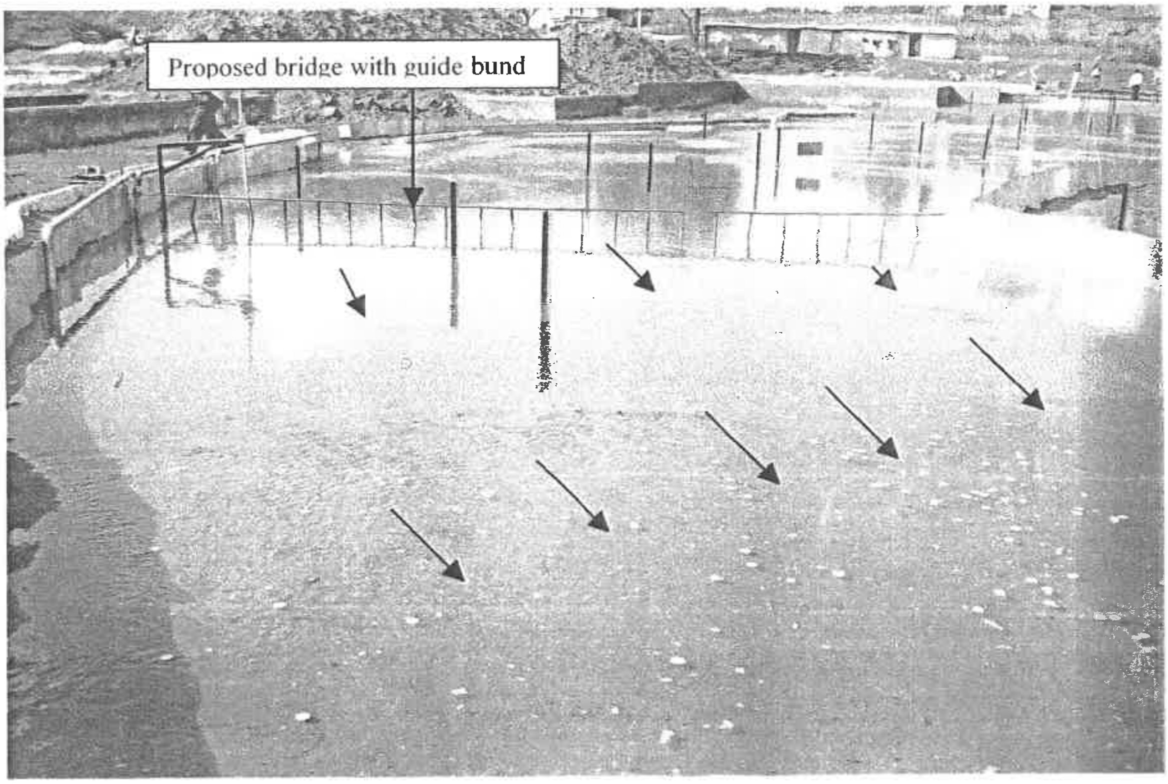


Photo-8:- Flow pattern across proposed bridge looking down stream

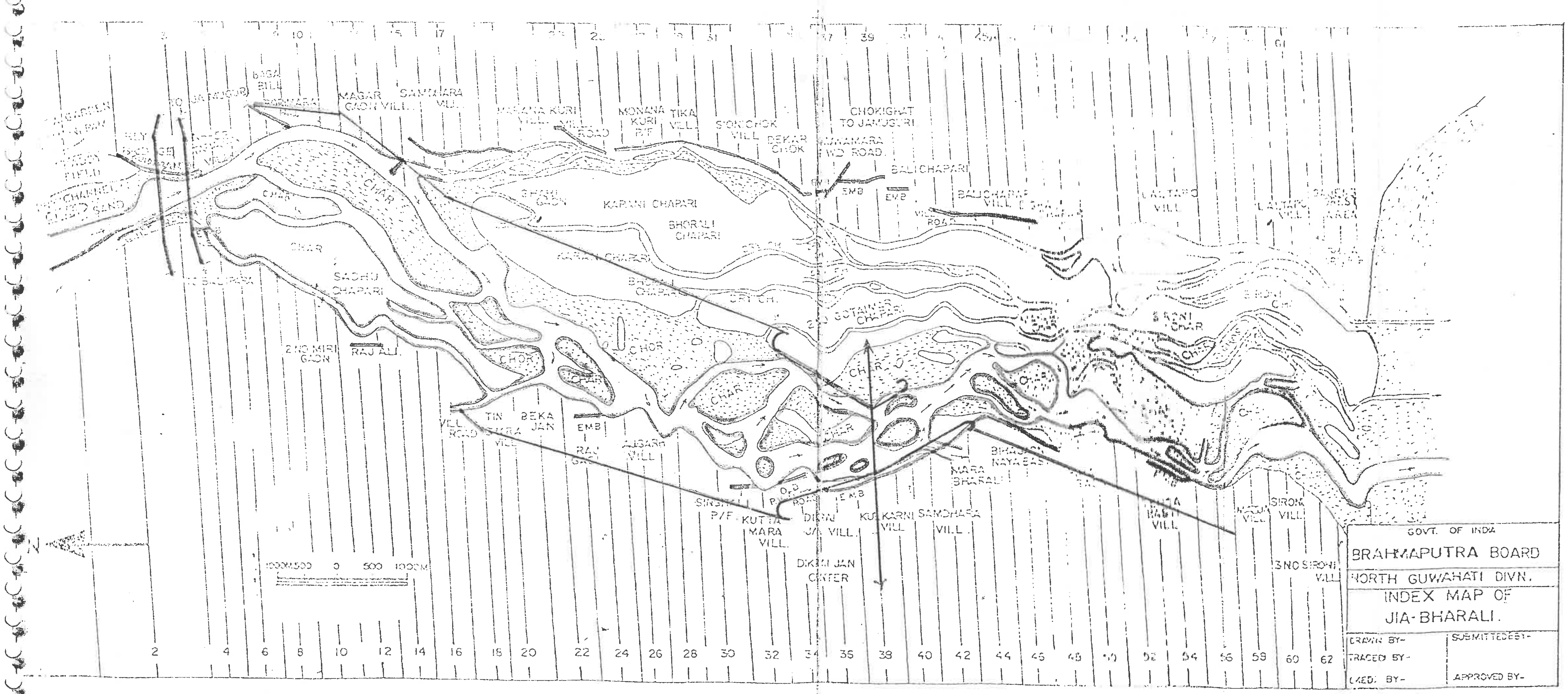


FIG -5 LOCATION AND ALIGNMENT OF BRIDGE , GUIDE BUNDS AND AFFLUX BUND / EMBANKMENT

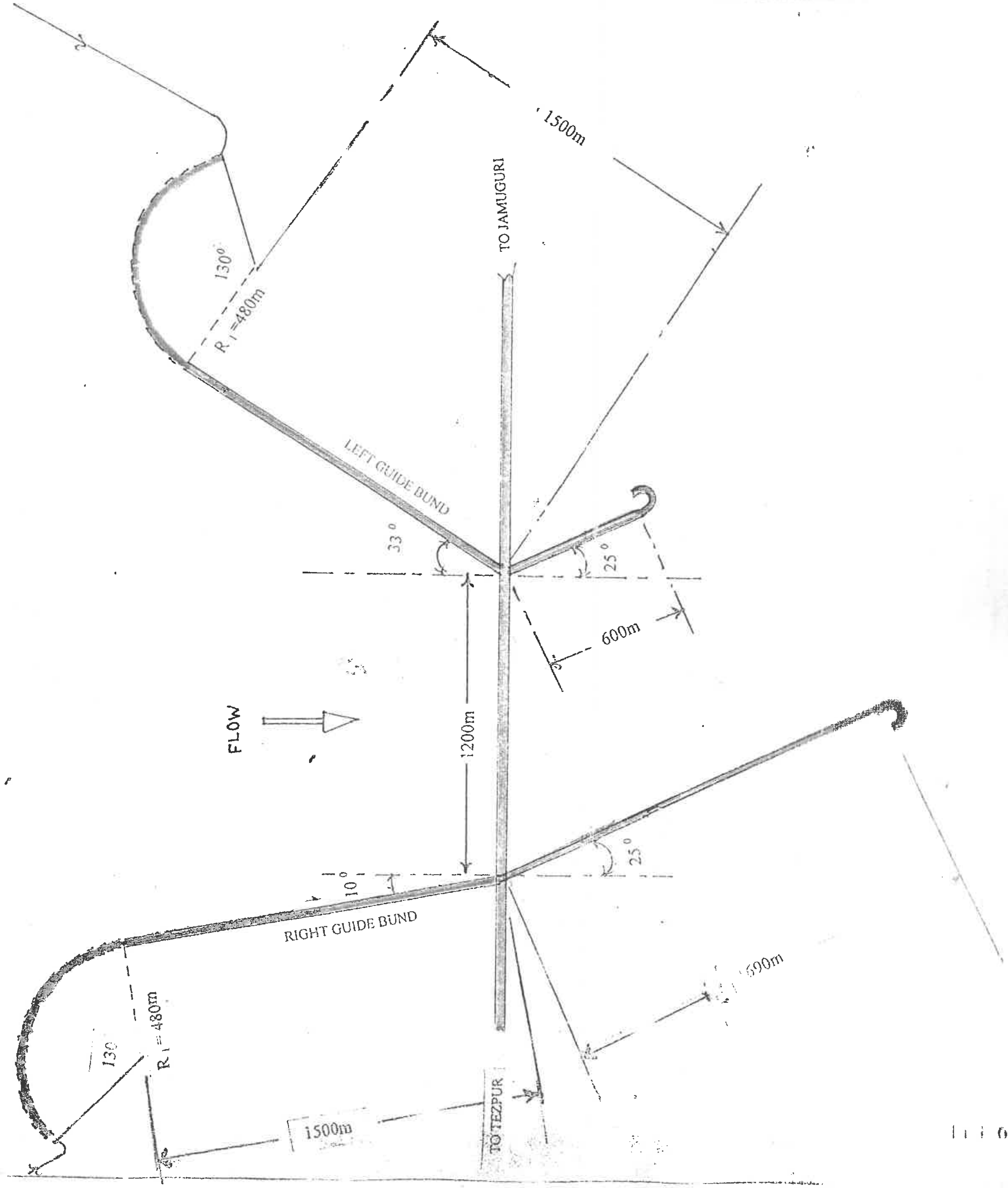


FIG 6 LAYOUT PLAN OF GUIDE BUND

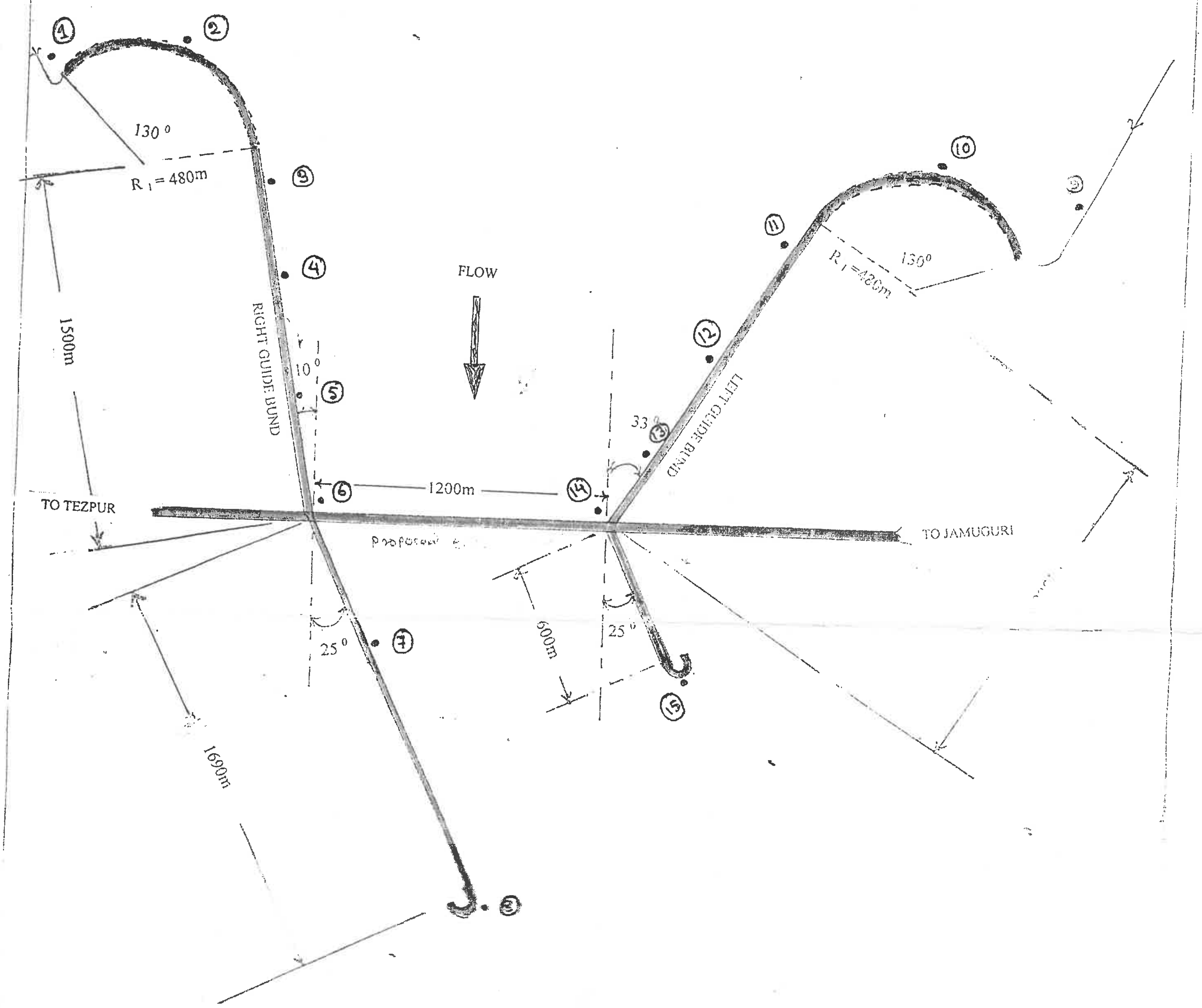
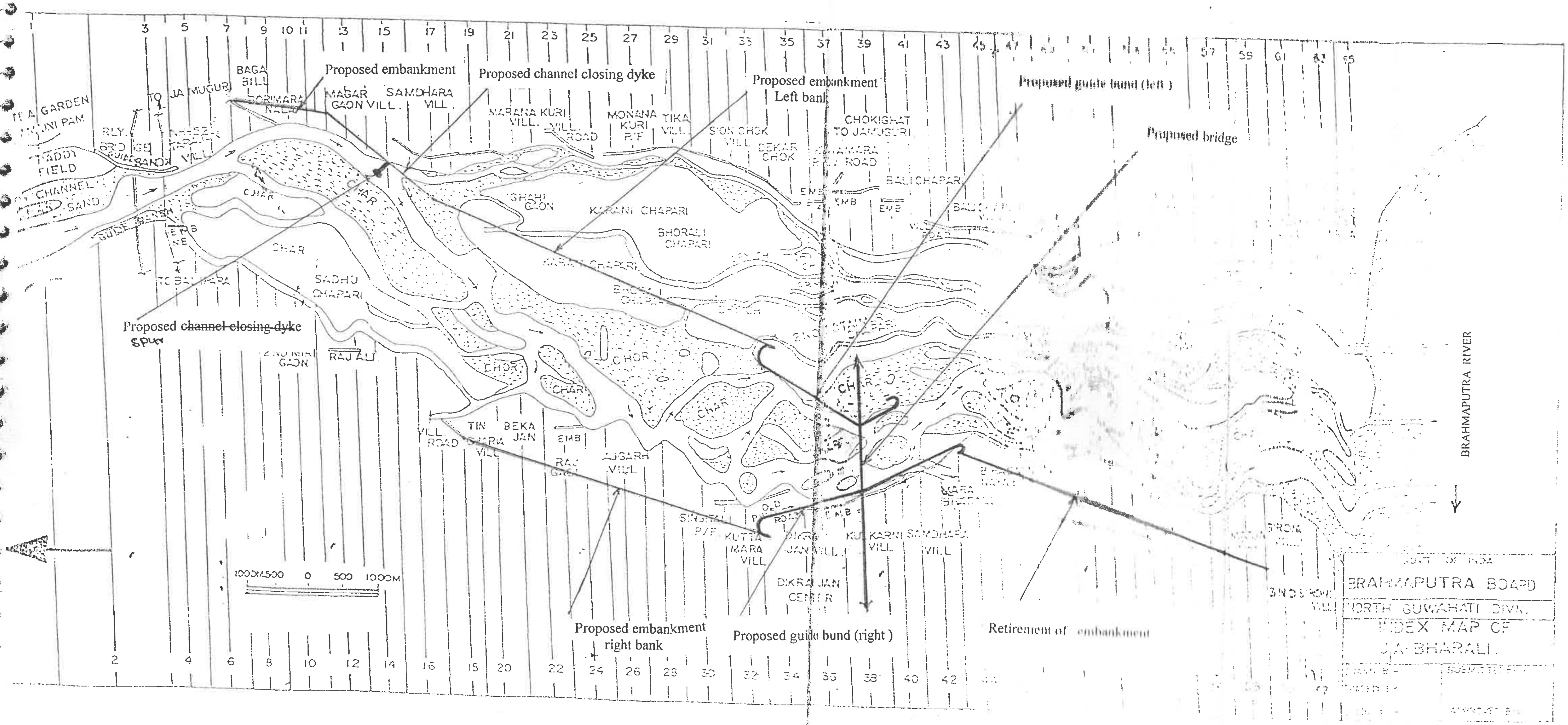
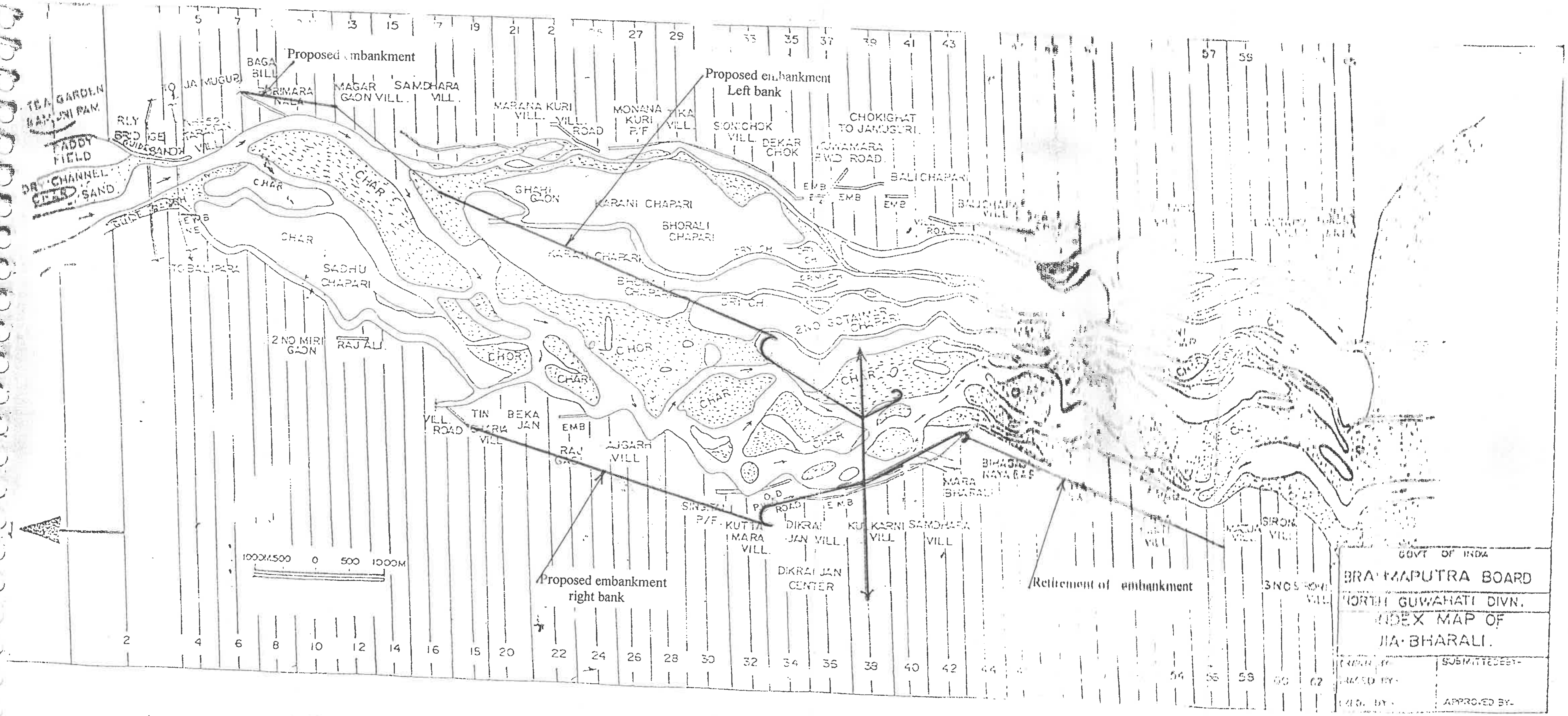


FIG-9 OBSERVATION OF WATER LEVELS AND VELOCITIES ALONG GUIDE BUND

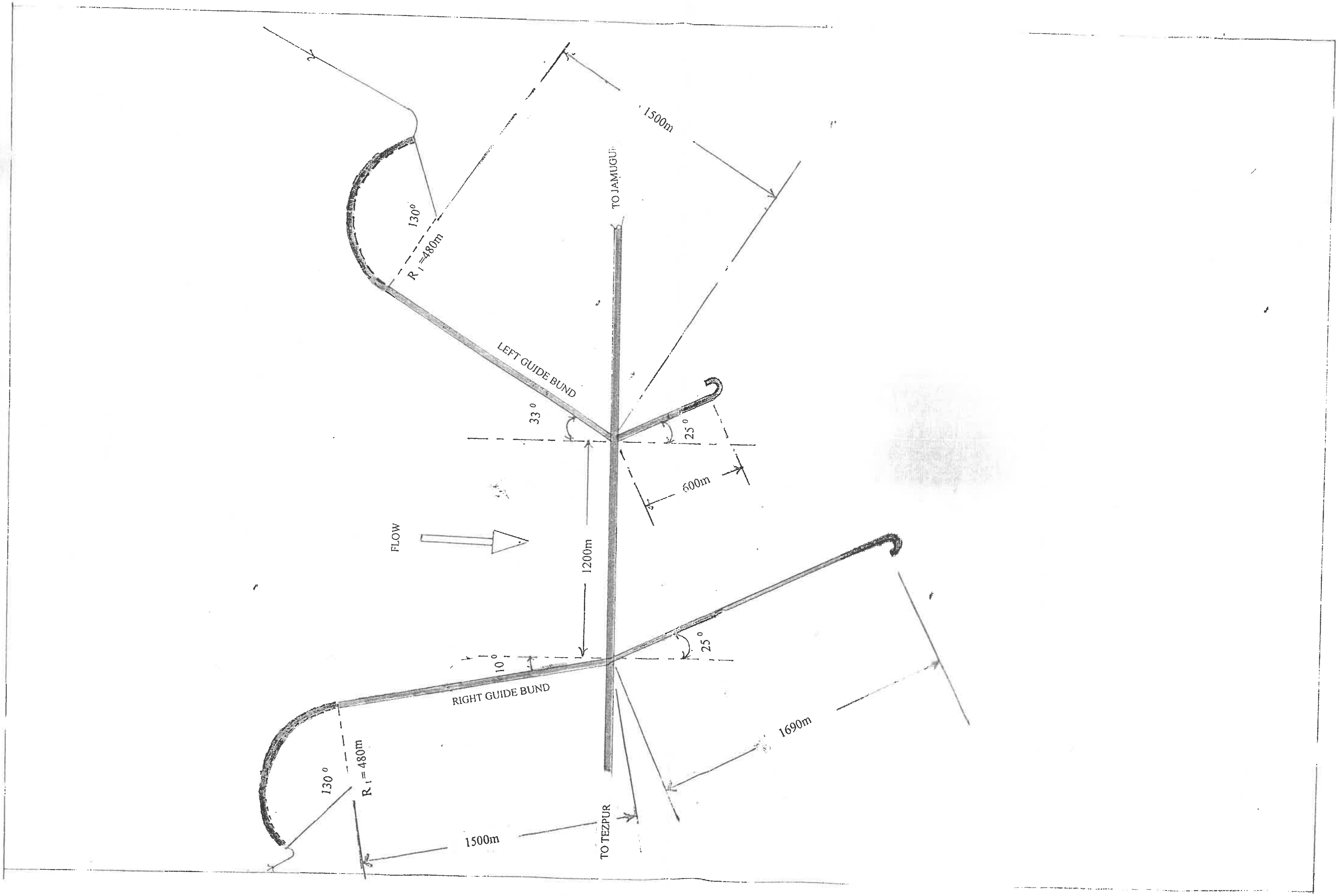


PROPOSED STRUCTURE

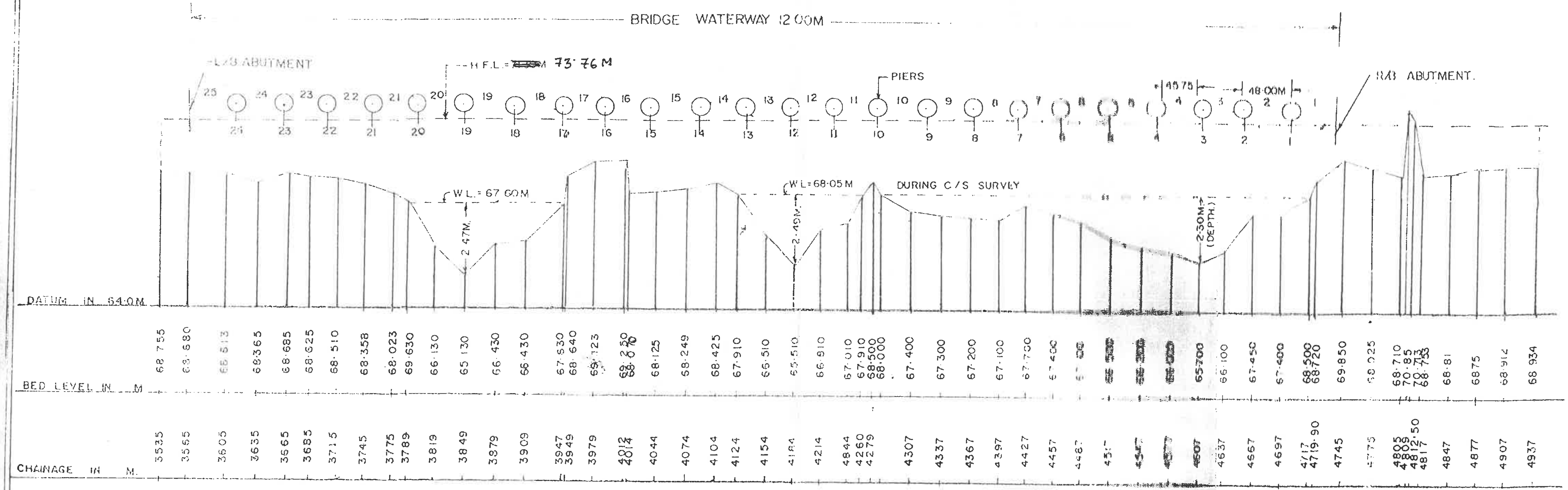
DRG NO – 1


Proposed embankment
Proposed embankment
Left bank
Proposed embankment
right bank
Retirement of embankment
TEA GARDEN
PADDY FIELD
DRY CHANNEL
SAND
RLY BRIDGE
CHAR
SADHU CHAPARI
2 NO MIRI GAON
RAJ ALI
MAGAR GAON VILL.
SAMDHARA VILL.
MONANA KURI
KARANI CHAPARI
BHORALI CHAPARI
GHAHI GAON
CHOKIGHAT TO JAMUGURI
BALI CHAPARI
2 NO SOTAIMER CHAPARI
TO BALIPARA
TIN SUKIA VILL.
BEKA JAN
EMB
AJGARH VILL.
VILL. ROAD
KUTTA MARA VILL.
DIKRAI JAN VILL.
KULKARNI VILL
SAMDHARA VILL
DIKRAI JAN CENTER
MARA BHARALI
1000M 500 0 500 1000M
GOVT OF INDIA
BRAHMAPUTRA BOARD
NORTH GUWAHATI DIVN.
INDEX MAP OF
JIA-BHARALI.
SUBMITTED BY-
APPROVED BY-

DRG NO-3



DRG NO- 4 DETAILS OF POSITION AND SPECIFICATION OF GUIDE BUND AND ALIGNMENT OF BRIDGE



C.S. NO - 38.

CHAUKIGHAT TO KULKARANI VILL

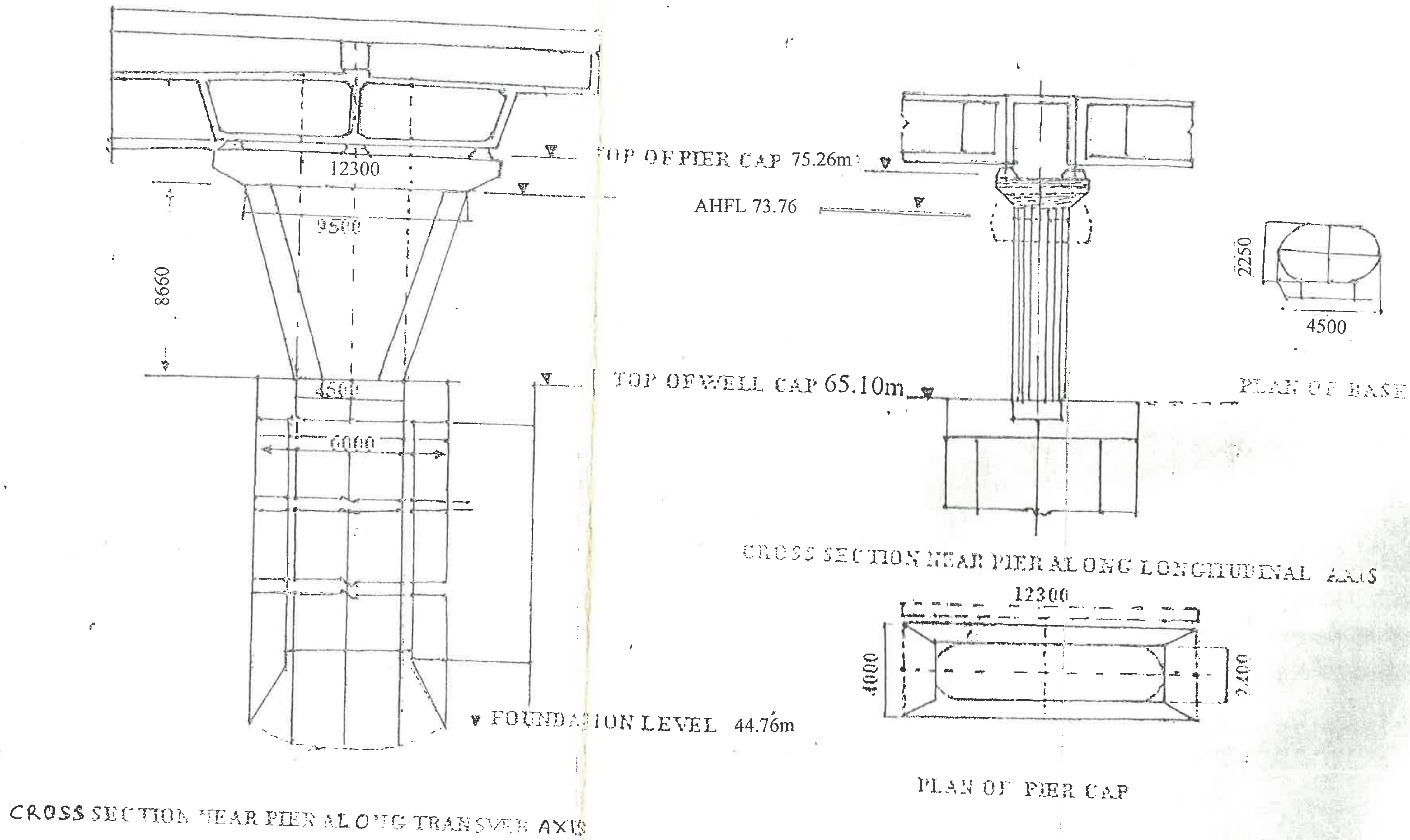
SCALE — H = 1CM. = 30M; V = 1CM = 1M.

NO OF SPAN = 25.
NO OF PIERS = 24.
SPAN WIDTH = 48.00M C/C
CLEAR = 45.75 M

RIVER CROSS SECTION ALONG PROPOSED BRIDGE AT CHAUKIGH...

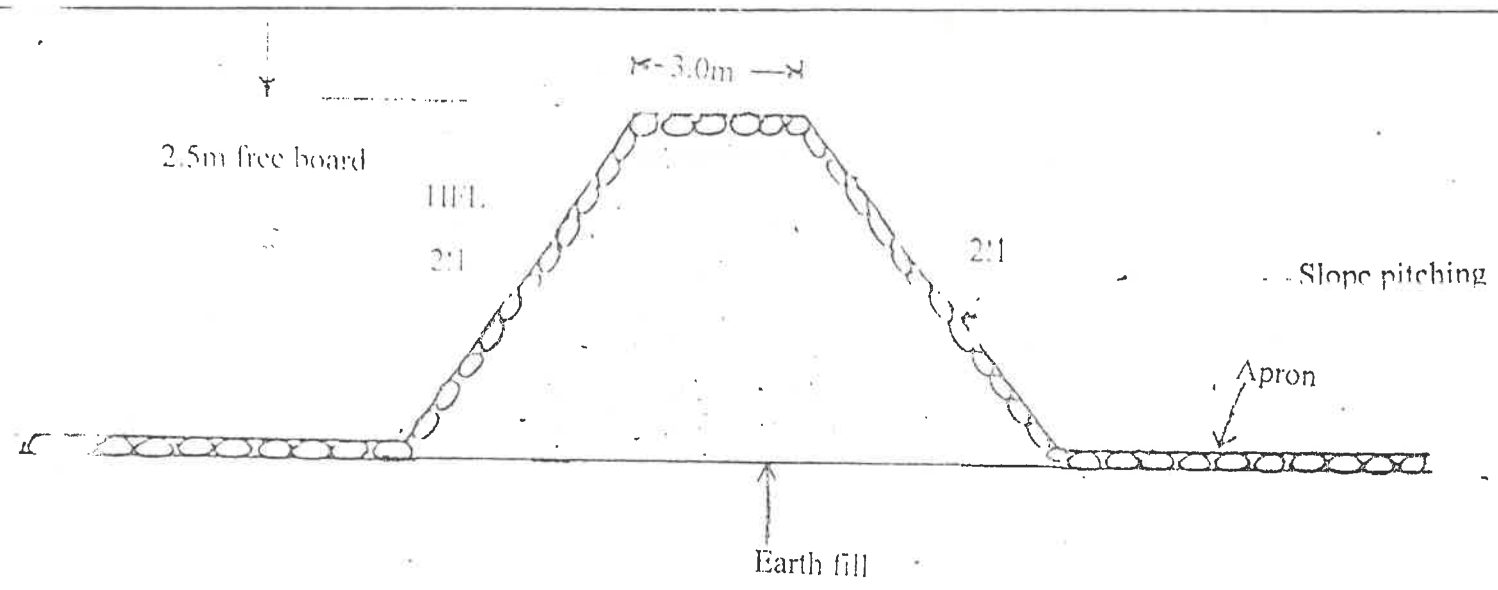
DGR NO-5 DETAILS OF PROPOSED BRIDGE

PROPOSED ROAD BRIDGE ON JIABHARALI RIVER AT CHOUKIGHAT NEAR TEZPUR

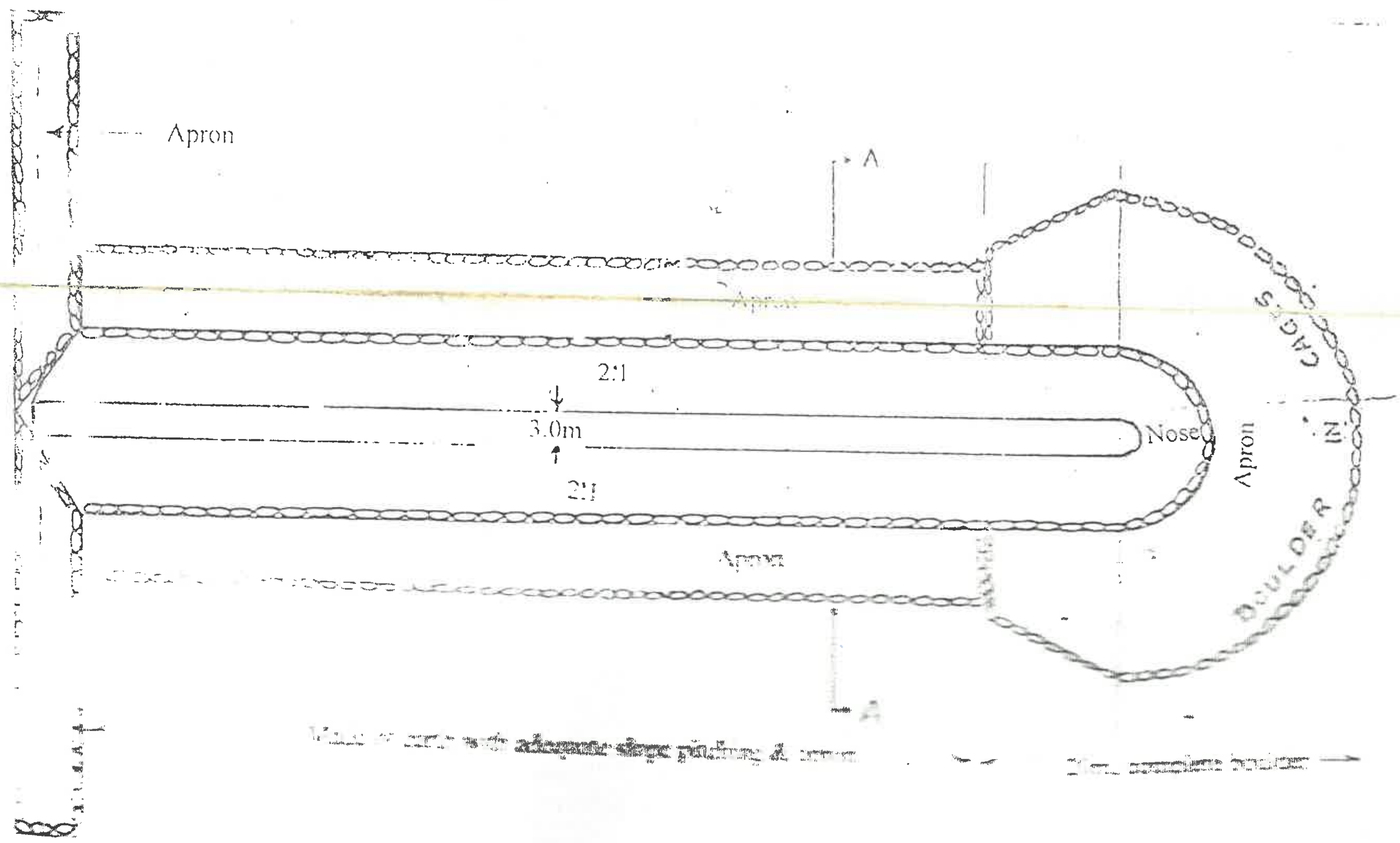


DETAILS OF ROAD BRIDGE PIERS (TENTATIVE)

DRG NO. [illegible]A



Section A-A



Typical section of spur at d/s of c s-5
(Not in scale)

NEHARI
Hydraulic Laboratory
DRG NO - 7