Government of the People's Republic of Bangladesh

Ministry of Irrigation, Water Development and Flood Control
Flood Plan Coordination Organization

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

COMPARTMENTALIZATION PILOT PROJECT (FAP 20)

TANGAIL CPP INTERIM REPORT

ANNEX 4 : MATHEMATICAL MODELLING

(DRAFT)

September 1992

Euroconsult/Lahmeyer International/Bangladesh Engineering & Technological Services/House of Consultants

under assignment to

DIRECTORAAT GENERAAL INTERNATIONALE SAMENWERKING
Government of the Netherlands

and

KREDITANSTALT FÜR WIEDERAUFBAU
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TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

1. Introduction

Mathematical modelling of the Tangail Compartmentalization Pilot Project (CPP) is developed to assess the concept of Compartmentalization in relation to a reference situation.

The reference situation depends on the data availability. Both topographical and hydrological data are available for 1991 and hence 1991 is considered as reference situation.

MIKE11, a commercially available software package which contains a number of process modules developed by the Danish Hydraulic Institute (DHI) is used by the Surface Water Modelling Center of the Water Resources Planning Organization (WARPO) and taken as standard software for unsteady flow simulation.

FAP 20 has three different test areas namely Tangail, Sirajganj and Jamalpur. At present only the Tangail area is subject of this modelling study.

The Tangail compartment is situated (see Figure 1) in the north central region of Bangladesh (in the young Jamuna floodplain). The Dhaleswari river which originates from the Jamuna river is the main source of flooding in this area. The river Lohajang, a distributary of the river Dhaleswari bisects the area, running through Tangail town. In the eastern side of the compartment, the Pungli river flows from North to South and the Dhaleswari - Elanjani forms the western boundary of the project. The southern boundary follows the Silimpur-Karatia-Nathkhola road.

The average elevation of the land is 10.0 m. +PWD. The general slope is towards South. Large depressions/beels are found in SC9, SC14, SC3, SC2 and in Tangail town which are mostly old river beds of the leftover of the Lohajang river.

The Tangail Compartment falls in tropical climate zone. The annual average rainfall is 1550 mm and the maximum temperature is about 35 C. About 80% of the rainfall occur from June to September. During the monsoon period, the most of the area is flooded. The lowest parts are inundated by more than 2.0 m.

2. Related Modelling Activities

In North Central Region the following modelling activities are going on.

North Central Regional Study (FAP-3) model

FAP-3 has completed the modelling study for the whole North Central Region. The CPP falls within their planning unit no 6. The model includes specially Dhaleswari, Pungli, Elanjani and the Lohajang river. The CPP model has collected information about these rivers which are used in the model.

Dhaleswari Mitigation Plan

In connection with the Jamuna Bridge Project (JBP), the northern intake of the Dhaleswari river might be closed. A model was developed to assess the effect of this on the Dhaleswari, Pungli, Elanjani and Lohajung flood regions. Contact has been established with the JBP to use their data regarding the closure for our project purpose.

Kibria Model

The Kibria model was developed for study purpose and has been used as a basis for initial start of the CPP model. It covers the entire Tangail compartment.

Flood Management Modelling FAP 25

The work of flood management modelling will start from October 1992. The MIKE11 model will be integrated with the Digital Elevation Model (DEM) in order to assess and display the flooding depth, duration and spreading.

3. Hydrodynamic Model

3.1 Schematization of the Hydraulic System

A schematization of the model is represented in Figure 1. The CPP model schematization is comprised of 25 channels connected at 13 nodes (node is the meeting point of two or more channels). These channels form the basis of the hydraulic connections. The selection of the channels mainly depends on the following criteria :

- the importance of the channel in terms of flooding.

- the importance of the channel in terms of drainage.

The most important channels that have been included are : Lohajang, Binnafair, Gala, Sadullapur, Deojan, Kumuli, Bhatkura and Jalfai khal. Apart from the Dhaleswari northern intake, the spill channels connecting the Jamuna and Dhaleswari river are represented in the model. The rivers included in the model are shown in Table 1.

The model schematization has been designed such that it can represent all situations from low flow to heavy inundation. This is achieved by making the grid follow the major khal system and including the floodplain section and its associated storage at higher flood levels. The dead storage in the floodplain is centered around the H-point (water level) in the model.

The structures are schematized with H-points immediately upstream and downstream of the structure, and a Q-point at the location of the structure. There are four regulators included in the model.

Table 1 Channels included in the model

River Name	Length Km.	Started from	End at
Dhaleswari	38.0	Jamuna	New Dhaleswari
Pungli	31.5	Dhaleswari	Model boundary
Elangjani	25.0	Dhaleswari	Lohajung
Lohajung	53.0	Dhaleswari	Model boundary
Gala	7.0	Lohajung	Pungli
Binnafair	9.25	Dhaleswari	Lohajung
Dha2	3.5	Dhaleswari	Binnafair
Dha3	2.0	Elangjani	Binnafair
Dha4	4.5	Elangjani	Loh3
Baruha	3.0	Elangjani	Loh3
Jugini	6.0	Lohajung	Binnafair
Gaziabari	2.392	Lohajung	Binnafair
Deojan	4.0	Lohajung	Model boundary
Kumuli	3.0	Lohajung	Model boundary
SD1	4.25	Floodplain	Shadulla
Magur	2.0	SD1	Shadulla
Bally	2.0	Lohajung	Shadulla
Shadulla	6.9	Gala	Jalfai
Rasulpur	4.0	Gala	Shadulla
Jalfai	3.26	Shadulla	Lohajung
Bhatkura	5.59	Shadulla	Lohajung
SD2	5.0	Floodplain	Bhatkura
Malancha	3.01	Dhaleswari	Lohajung
Spill Chan1	6.54	Jamuna	Dhaleswari
Spill Chan2	7.2	Jamuna	Dhaleswari

3.2 Model boundaries

The choice of locations of the external boundaries and of the conditions to impose at these boundaries are crucial for the model set up. The boundaries are selected upon the following factors:

- preferably, discharge boundaries should be applied upstream and water level boundaries downstream.

- The boundaries should be selected at locations where the hydraulic conditions are not affected by the future project condition.

The upstream boundary of the model is extended upto the Dhaleswari offtake. Because discharge data are not available a time dependant water level is used. The downstream boundaries are taken in the Lohajang river upto Mirzapur, in the Pungli river upto the southern border of the project and in the Dhaleswari river upto to the New Dhaleswari river (see Figure 1). These boundaries are placed sufficiently away from the project area to avoid any influence of the proposed structure on boundaries.

Boundaries and type of boundary used are shown below.

Boundary Locations and Types

River Name	Location	Station	Type
Dhaleswari	Upstream	Sirajganj	Water level
Dhaleswari	Downstream	Porabari	Water level
Lohajung	Downstream	Mirjapur	Water level
Pungli	Downstream	G-11	Water level
SD1(Bhatchanda)	Upstream		Q=0.0
SD2(Surooj)	Upstream		Q=0.0
Loh3	Downstream	G-7	Water level
Loh4	Downstream	G-12	Water level

3.3 Data requirement for the Hydrodynamic Model

The following data are required for model calibration:

- Surface water data
- Topography data

Surface Water

In order to have a comprehensive picture of the flooding and draining pattern of Tangail Compartment, 14 water level measuring stations were installed in May 1991. All the gauges were connected with a fixed reference level. (PWD bench mark).

In 1992, an additional 20 gauges were installed to obtain hydrographs in both floodplain and river. Figure 2 and Figure 3 shows the location of the water level stations of 1991 and 1992 respectively.

Topography

All the schematized channels were surveyed from November 1991 onwards and the collected channel cross-sections are used in the model. The relevant cross-sections of Dhaleswari, Elanjani and Pungli rivers have been collected from FAP-3.

The floodplain is most important in the CPP model since it has both a storage and a transport function. The floodplains are included in the model as extensions of channel cross-sections and in some cases as area of static storage or as a mosaic of interlinked flow cells. The floodplains data are collected from the water development map 8 inch to a mile scale with 1 ft. contour interval from 1964. The maps were used to prepare area-elevation curves for every Sub-Compartment.

The number of cross-sections used in different channels are shown in Table 2.

Table 2 Number of cross-sections used in the model.

Name of the River	No. of Cross-section Used
Dhaleswari	9
Pungli	7
Lohajang	27
Elanjani	7
Loh1 (Jugini khal)	5
Binnafair	16
Dha2 (Fatehpur khal)	6
Loh2 (Gaziabari)	8
Dha3 (Indra Belta)	3
Dha4 (Belta Sarai)	6
Baruha	5
Loh3 (Deojan)	7
Loh4 (Kumuli)	4
Shadulla	11
Rasulpur	5
SD1 (Bhatchanda Khal)	4
SD2 (Surooj Khal)	3
Magur	1
Jalfai	8
Bhatkura	6
Bally	9
Spill Channel 1	3
Spill Channel 2	3
Malancah	6
Gala	6

3.4 Calibration of Hydrodynamic model

The calibration is the process of adjusting the model parameter so that it can simulate the river stage and discharge realistically. The CPP model is calibrated against the 1991 condition starting from May upto November. The four structures along the Dhalesawri river are included in the model. There are 261 water level point and 198 discharge points throughout the model.

In the calibration, the river and floodplain roughness coefficient are an important parameter. In the model, Chezy's roughness coefficient is used. Generally the roughness coefficient in the floodplain is taken twice the value used in the river. With rising water levels, roughness coefficients are decreasing for both floodplain and river sections. The proper description of conveyance of the river and floodplain cross-sections is most important. The conveyance is the measure of the channel to pass a certain discharge with a defined 'energy' gradient.

The overall calibration shows good agreement between measured and computed data. The results are shown in Appendix 4.1.

4. Rainfall-Runoff Model (NAM)

The rainfall-runoff model (NAM) is conceptual than deterministic. The complex hydrological processes are simplified to a few key parameters; the runoff generated by direct overland flow, interflow from the surface storage zone and baseflow from the upper groundwater zone. The numerical values of the parameters which determine the runoff rates are adjusted during the calibration over one or more hydrological years. Moreover, the parameter selections are based on the previous modelling experience in this area.

4.1 Catchment Delineation

The catchment area delineation is based on the existing infra-structure such as roads, embankment and on the draining and flooding pattern. For rainfall-runoff modelling, the CPP area is divided into 16 catchments including Tangail town (see Figure 4). These areas are called Sub-compartment. These sub-compartments are again sub-divided into smaller parts called floodcells to have better distribution of the runoff. The sub-compartment areas are given in Table 3.

Apart from the Sub-compartments, the Lohajung floodplain is also included in the model studies.

Table 3 : Sub-compartment Area

Subcompartment No	Area in Ha.
SC1	687
SC2	1281
SC3	630
SC4	419
SC5	752
SC6	242
SC7	359
SC8	904
SC9	606
SC10	487
SC11	1126
SC12	1019
SC13	426
SC14	1143
SC15	690
Lohajung Floodplain	1970
Tangail Town	260
Total	13001

4.2 Data Requirement for the NAM Model

The model is based on the following data on catchment characteristics.

a) soil type and associated soil characteristics of each NAM sub-compartment.

b) land use data.

c) effective root depth for the different crop type.

d) depth of river beds relative to average ground level.

Rainfall

The main input to the model is daily rainfall. For the CPP area rainfall station R-2 Atia, Tangail (see Figure 2) is used in the calibration.

Evapotranspiration

Monthly data for potential evapotranspiration, Ep, are used in the model. As the variations in Ep from year to year are small as compared to the variation in rainfall, average monthly data are sufficient, time series are not used. The spatial variation of Ep is relatively small. Therefore, Mymensingh data are used in the model.

Groundwater

Groundwater level data are necessary for a selected number of wells for the calibration of the rainfall-runoff model (NAM). Data have been collected from the following stations (see Figure 2):

Groundwater level stations

No of Station	Name of Station	Data Collected
TA03	Fatehpur/Tangail	1987-91
TA08	Panchelachine/Tangail	1987-91
TA09	Aditangail/Tangail	1987-91
TA35	Akurtakur/Tangail	1987-91
TA39	Suruj/Tangail	1987-91

In addition, the specific yield for the upper unconfined aquifer is required for each catchment.

4.3 Assessment of Parameter Values

There are three types of parameters used in the model. The first type are based on the catchment characteristics e.g. soil type, cropping pattern, topography and channel geometry. The second type has some fixed range as the model is lumped conceptual. The third category is assessed during the calibration. The range of parameter values used in the model are shown in Table 4.

Calibration was made for the full monsoon and premonsoon period (May - November, 1991) with the emphasis on the rising part of the groundwater table. As shown in Figure 5 for the Sub-compartment no 16 the groundwater table typically rises in the period May - July and remains at or just below the ground surface during the subsequent rainy season. The rising part is most informative with regards to the specific yield (Sy), the maximum lower zone storage (Lmax) and the threshold value for groundwater flow (CL_G). During

August -October the emphasis is on the calibration of the overland flow coefficient (CQ_{OF}) and the threshold value for overland flow (CL_{OF}). Figure 6 presents the measured groundwater in comparion with the computed groundwater in SC1.

Table 4 Parameters used in the Rainfall-runoff model

Parameter	Range of values
CQ_{OF}	0.6 - 0.85
CL_{OF}	0.7 - 0.85
CQ_{IF}	500-1000
CL_{IF}	0.0
CL_{G}	0.0 - 0.50
$GWLF_{1}$	1.65 - 3.0
$GWLF_{0}$	2.0 - 4.0
S_{Y}	0.04 - 0.065
CK_{1} & CK_{2}	24 -48
CK_{BF}	360 - 1440

where

CQ_{OF} : overland flow runoff coefficient
CL_{OF} : overland flow threshold coefficient
CQ_{IF} : interflow drainage coefficient
CL_{IF} : interflow threshold coefficient
CL_{G} : groundwater recharge threshold coefficient
$GWLF_{1}$: capillary flux parameter
$GWLF_{0}$: zero baseflow level
S_{Y} : specific yield
CK_{1} & CK_{2} : time constant for overland flow routing
CK_{BF} : time constant for baseflow recession

5. Selection of Simulation Years

The selection of the simulation year is specially important as the modelling will not be performed for a statistical range of years (for example a model run for 25 years). The assessment of the most relevant years for the modelling is based on the probability of hydrological events and subsequently checked by the probability of damage resulting from hydrological events. Damage in this situation are of two types i.e. infra-structural and agricultural damage.

- Infrastructural damage; it is predominately determined by the level of the flood and only slightly by the duration, the timing, the speed of rise and the sediment load of the flood. The yearly maximum event is a typical indicator for the potential damage.

- Agricultural damage; 5 qualities are equally important for the potential agricultural damage as follows.

- Flood level
- Timing of the flood
- Speed of rise of a flood
- Flood duration
- Sediment load of a flood

The yearly maximum flood level is not the only indicator for the potential damage.

Since FAP 20 has to test the concept of compartmentalization in its broadest sense it is considered most suitable to do the selection of the simulation years for the model on the basis of the potential agricultural damage and to complement this by an assessment of the annual peak waterlevel as an indicator for the possible infrastructural damage.

In order to get an estimate of the potential agricultural damage in the compartment the following method has been used:

- The maximum 3-day mean waterlevel per decade has been assessed for the Jugini waterlevel station (at the mouth of the Lohajang) from 1952 onwards. (see Appendix 4.1)

- The flooded area within the compartment has been related to the waterlevel at Jugini. This assessment is based on the modelling data for 1991 monsoon season. Details are given in Appendix 4.1. The following gives a summery:

LEVEL AT JUGINI (m. -PWD)	AREA APPROXIMATELY FLOODED
10.3	20 %
10.9	50 %
11.6	80 %

The potential damage to the rice crops is given an index for each crop and each year based on these waterlevels and the following assumptions:

50% of the area is cropped with Boro that is harvested from mid May to mid June. Damage starts when the water level rises above 10.4 + 0.3 m -PWD (land level + crop height) before mid June. The damage index ranges from 0 to 50% maximum (the floodlevel rises above 11.7 + 0.3 m. +PWD before mid May).

- 5% of the area (high & medium land) is cropped with T. Aus that is harvested before mid July. Damage starts when the waterlevel rises above 11.0 + 0.7 m PWD before mid July. The damage index ranges from 0 to 50% (the flood level rises above 11.7+0.7 m +PWD before June)

- 30% of the area (high & medium land) is cropped with B. Aus that is harvested before early July. Damage starts when the water level rises above 11.0+0.6 m PWD before early July. The damage index ranges from 0 to 30% (The flood level rises above 11.7+0.6 m PWD before June).

- 5% of the area (high land) is cropped with T. Aman HYV which is planted from mid July to late August. This crop is damaged or can not be planted when the waterlevel stays above 11.7+0.3 m PWD beyond late August (max index is then 5%).

- 5% of the area (high land) is cropped with T. Aman local variety. The planting period is identical with the HYV, the maximum floodlevel is 11.7+0.7 m PWD (max damage index is then 5%).

- 35% of the area is cropped with DW Aman. Damage is related to:

a) waterlevel rises above 10 cm/day over 3 days or more during any period.
b) inundation before end of May (crop not yet settled).

c) floodlevel above 12.5 m +PWD during any period (1 in 4 year max flood level) resulting in low yield due to excessive vegetative growth (10% reduction per 0.1 m above 12.5 m PWD)

The maximum damage index for DW Aman is 35 %.

The maximum potential damage index is 130%. Appendix 4.1 presents the potential damage index as based on the above assumptions for the years from 1952 to 1991.

The last step in this methodology is the rating of the years as per the frequency of occurrence of a specific potential agricultural damage index.

For the modelling the following years have been analyzed according to the above procedures:

- 1987.
  - Premonsoon: waterlevel less than 10.4 m; normal rainfall (560 mm up to 30/6); dry.
  - Monsoon: waterlevel +11.7 m from lll7 to ll9; normal rainfall (1000 mm from 1/7 to 30/9); **wet**.

- Postmonsoon: no significant rainfall; **normal**.

- 1989.
    - Premonsoon: waterlevel around 10.4 m; normal rainfall (600 mm up to 30/6); dry.
    - Monsoon: waterlevel allways below 11.7 m; modest rainfall (600 mm from 1/7 to 30/9); dry.
    - Postmonsoon: significant rainfall (230 mm after 1 10); **normal**.

- 1991.
    - Premonsoon: level + 11.0 m with max rise of 80, 90 and 70 cm/3days during I6, II6 and III6; abundant rainfall (850 mm up to 30/6); potentially harmful.
    - Monsoon: waterlevel around 11.7 m; abundant rainfall (1300 mm from 1/7 up to 30/9); wet.
    - Postmonsoon: significant rainfall (200 mm after 1/10); **normal**.

With respect to the infra-structural damage the year 1987 presents a 1 in 10 year peak value.

Therefore the following years have been selected and the summery of the selected for model simulation. The summary of the selected years for for simulations are shown in the Table 5.

Table 5 Summery of the Selected years for simulation.

Year	Pre-Monsoon	Monsoon	Post-Monsoon	Return Period
1987	dry	wet, highpeak	normal	1:10
1989	dry	dry	normal	N.A.
1991	potentially harmful	wet	normal	1:3

6. Model Application

The calibrated model is primarily used to assess the development activities. The CPP is supposed to test the concept of the Compartmentalization concept and in this respect the following features are identified for testing :-

- Main inlet structure on the Lohajung river;
- Peripheral protection;
- Improvement of existing structures;
- Drainage improvement;
- Water management in Sub-Compartment.

Out of these features, 10 scenarios were developed. These 10 scenarios are tested with the help of the model. The scenarios are shown in Table 6. The results of these scenarios are available for 1991 situation. Out of these 10 scenarios, 4 scenarios (2, 3, 5 and 7) have been selected for further analysis.

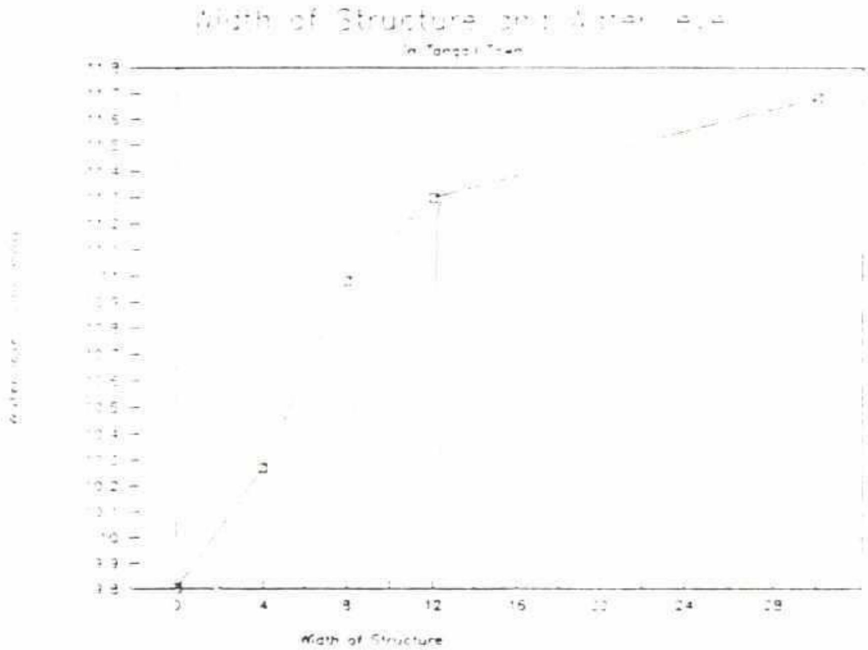
In this report only scenario number 3 is presented for detailed analysis.

Table 6 Options tested by the model

Model run No	Features
1	No intervention (existing situation)
2	Drainage improvement only
3	TOR inlet gated 8 vent & 3 gated Structure
4	TOR inlet gated 4 vent & 3 gated structure
5	TOR inlet throttle & 3 gated structure
6	TOR inlet throttle & 3 gated structure
7	TOR inlet 4 vent & 3 gated & 3 outlet str.
8	FAP inlet gated 8 vent & 4 gates
9	FAP inlet throttle & 4 Throttle
10	TOR inlet throttle & 3 throttle & Lohjang Sub-Compartment interventions.

Selection of Structure size

One of the key element of the modelling work has been assessment of an appropriate dimensioning of the main inlet in the Lohajang. The following curve presents the impact of the number of open vents on the downstream waterlevel. The sharp increase between 4 and 8 vents justifies the selection of an 8 vent structure. (Note: vent size = 1.52 * 3.0 m).



Structure size and the effect on water level near Tangail town

Output Processing

The output of the MIKE11 are composed of water levels and discharges in alternate points along a channel. Discharge and water level is not available in the same point. For sub-compartment analysis, a water level point is selected in such a way that it represents the flooding pattern of the sub-compartment.

A computer program for processing the results of the various simulation has been developed in order to determine the distribution of flooded areas for each sub-compartment.

For each sub-compartment, the selected water level point is used to calculate the respective areas of various categories of level:

* F0 unflooded land or land inundated to a depth less then 30 cm.

* F1 land inundated to a depth of 30 to 90 cm.

* F2 land inundated to a depth of 90 to 180 cm.

* F3 land inundated to a depth of 180 to 300 cm.

* F4 land inundated to a depth of more than 300 cm.

7. Implementation Alternatives

One of the primary objectives of the hydraulic studies is to assist the study team in assessing the impacts of the project development in the 'with' and 'without' project analysis. Also the effect of gated and ungated (throttling) structures were tested. In this section the detail of the selected scenario is presented and the description of the 'without' and 'with' project situation are presented below.

The without and with project situation are simulated for 1987 and 1989 also.

Without Project Situation

The without project situation is the existing situation. There are four existing minor inlet structures along the Dhaleswari-Elanjani river. The compartment area is bounded by the existing embankment as shown in the Figure 5. The water level of both 'without' and 'with' project situation are shown for each Sub-compartment.

1991

The 1991 situation is the calibration year. The simulated water level and discharge in key locations are shown in Appendix 4.3.

1987

1987 was a very wet year and the simulated water level and discharge in key locations are shown in Appendix 4.4.

1989

1989 is a dry year and the simulated water level and discharges in key locations are shown in Annex 4.5.

The simulation for 1987 and 1989 differs from 1991 on the following point:

- the Surroj khal (SC1) has open connection to the Pungli during 1987 and 1989.

- the Kumuli khal has been extended upto the Lohajang river at Birkushia (SC15) during 1987 and 1989.

These modifications have resulted in quite dramatic changes in the flood level in SC1 to SC4 and SC15.

With Project Situation

The with project situation is consists of the following features (shown in Figure 4) :-

- Peripheral Embankment.
- Main inlet in the Lohajang river mouth.
- Medium size inlet in Khorda Jugini, Sadullahpur and Rasulpur khal.
- Improvement of the existing four regulators along the Dhaleswari and Elanjani river.
- Improved drainage channels inside the project area.

Operation procedures have been such that all agtes are closed at an inside water level of approximately 11.00 M. +PWD at Jugini.

From the modelling point of view, the development option is divided into two phase namely i) peripheral control and ii) peripheral control and Lohajang and Sub-compartment interventions. In both the cases the drainage improvement is included. The modelling for Sub-compartment interventions or the internal water management doesnot yet give satisfactorily results and is therefore not presented.

1991

The comparison of the without and the with project are given in Appendix 4.3.

1987

The comparison of the without and the with project are given in Appendix 4.4.

1989

The comparison of the without and the with project are given in Appendix 4.5.

Structural Information

The following structures (main and the medium size regulators shown in Figure 4) are proposed as peripherial protection along the proposed embankment of the project.

Only the important features of the structures are summarized below

Important features of the structures

River/Khal Name	No of vents	Vent size (m)	Sill level m. +PWD
Lohajung	8	1.52*3.0	9.50
Jugini	1	1.52*1.83	10.62
Shadullapur	2	1.52*3.0	9.50
Rasulpur	1	1.52*1.83	9.22
Baruha	2	1.52*3.0	9.70

Discussion on the Results

The results presented in the Appendices are the comparison of with and without project situation. The Sub-compartments can be categorized in to three classes :-

- sub-compartments are directly influenced by the Lohajung river inlet structure
- sub-compartments influenced by the Sadullapur and Rasulpur structure;
- sub-compartments influenced by the backwater effect of the Lohajang - Elanajani confluence.

In the first category, in the sub-compartments SC9, SC10, SC11 and SC12, control in Lohajang river has considerable impact. SC13 is influnced by the Baruha river. SC14 receives water both from Lohajang river and South and hence shows little difference in without and with situation. In SC15, SC2, SC3 and SC4 backwater effect is felt. With the improved drainage channel, more water is entering from the Lohajang river. Regulating the Sadullapur and Rasulpur channels, the reduction in water level are observed in SC8, SC7, SC6 and SC5.

The backwater effect in the Lohajang river near Karatia is shown in Figure 7 (1991 situation).

8. Future Programme

The present model gives enough detail to study the peripheral control. In order to study internal interventions with a detailed water management of the CPP area, the model needs to be modified. Running the model under DOS is problematic as it cannot open more than 12 files simultanouesly with several control structures.

Moreover the external interventions such as Dhaleswari Northern Intake Closure and the Brahmaputra Left Bank Embankment (BLE) will affect the CPP area. In view of this, the following changes are proposed:

1) Splitting the Model:

It is proposed to divide the CPP model into two sub-model. The Sub-model 1 will be consists of SC9, SC10, SC11, SC12, SC13, SC14, SC15 and Sub-model 2 will be consists of SC1, SC2, SC3, SC4, SC5, SC6, SC7, SC8, SC16 and E1. The main reasons for doing this divisions are as follows:-

- to study water management in detail.
- to include more channels and structures.
- to avoid DOS limitations.

2) Construction of Brahmaputra Left Bank Embankment (BLE):

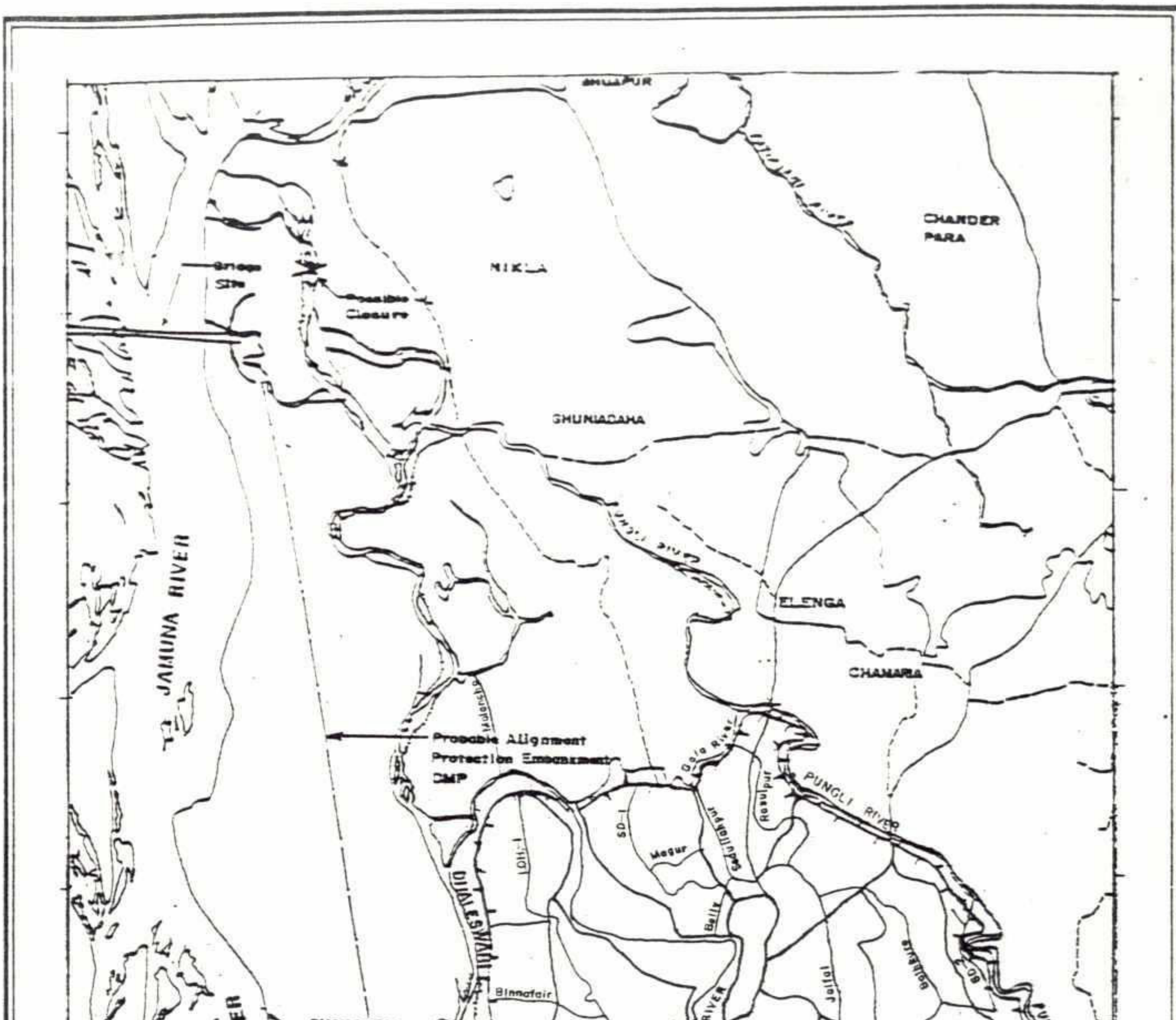
The effect of the BLE will be studied and in relation to this the water management will be checked.

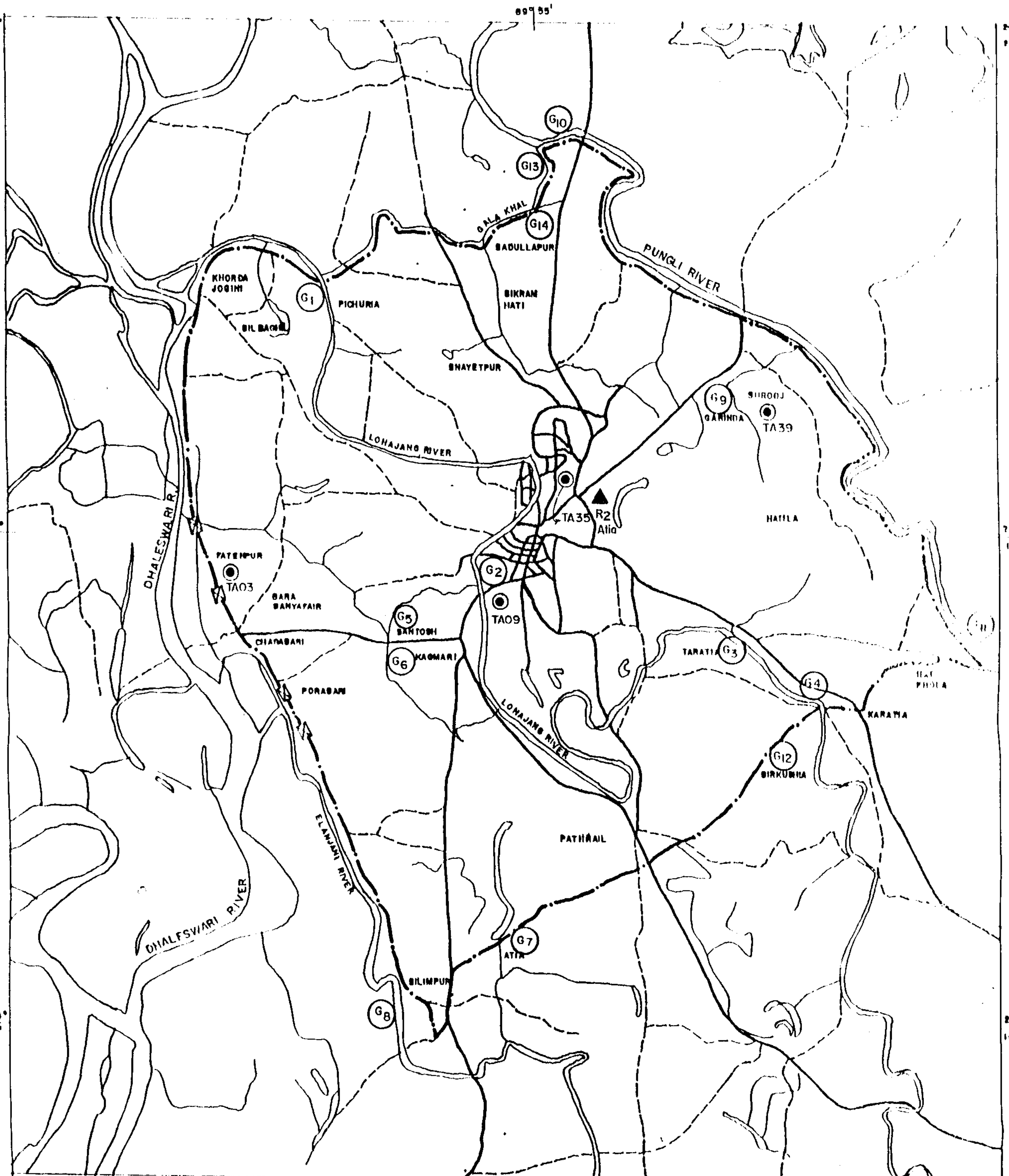
3) Dhaleswari Northern Intake Closure

The Northern intake of the Dhaleswari will be closed if Jamuna Bridge is constructed. The impact of the closure will be studied.

4) Refining the Model by real time monitoring

The main model will be updated for 1992 situation and this model will provide necessary boundary conditions for the sub-models. This will continue as per proposed programme of the Inception Report.


NIKLA
CHANDER PARA
Bridge Site
Possible Closure
GHUNIADAHA
JAMUNA RIVER
ELENGA
CHAMARIA
Probable Alignment
Protection Embankment
CMP
PUNGLI RIVER
Gola River
SD-1
Magur
LOH-1
DHALESWARI
Binnafair
CHAUBARIA
DHA-2
LOH-2
DHA-3
LOHAJANG RIVER
TANGAIL
KARATIA
RIVER
DHA-4
LOH-3
Baruna
LOH-4
PORABARI
DELDUAR
DHALESWARI
ELASIN
LEGEND
Existing Embankment/Raised Road (Project Boundary)
Highway
Local Road
River & Khal
Bridge
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD/FLOOD PLAN COORDINATION ORGANIZATION
COMPARTMENTALIZATION PILOT PROJECT
FAP-20
SCHEMATIZATION
CONSULTANTS:
Euroconsult, Lahmeyer Int., Bets Ltd., HCL.
Drawn by:
Checked by:
Fig. No. 1



1991 PROGRAMME

LEGEND:

- PROJECT BOUNDARY
- HIGHWAYS
- LOCAL ROAD
- RIVER & KHAL
- GAUGE LOCATION (G6)
- RAINFALL STATION ▲
- GROUND WATER MEASURMENT STATION ◉

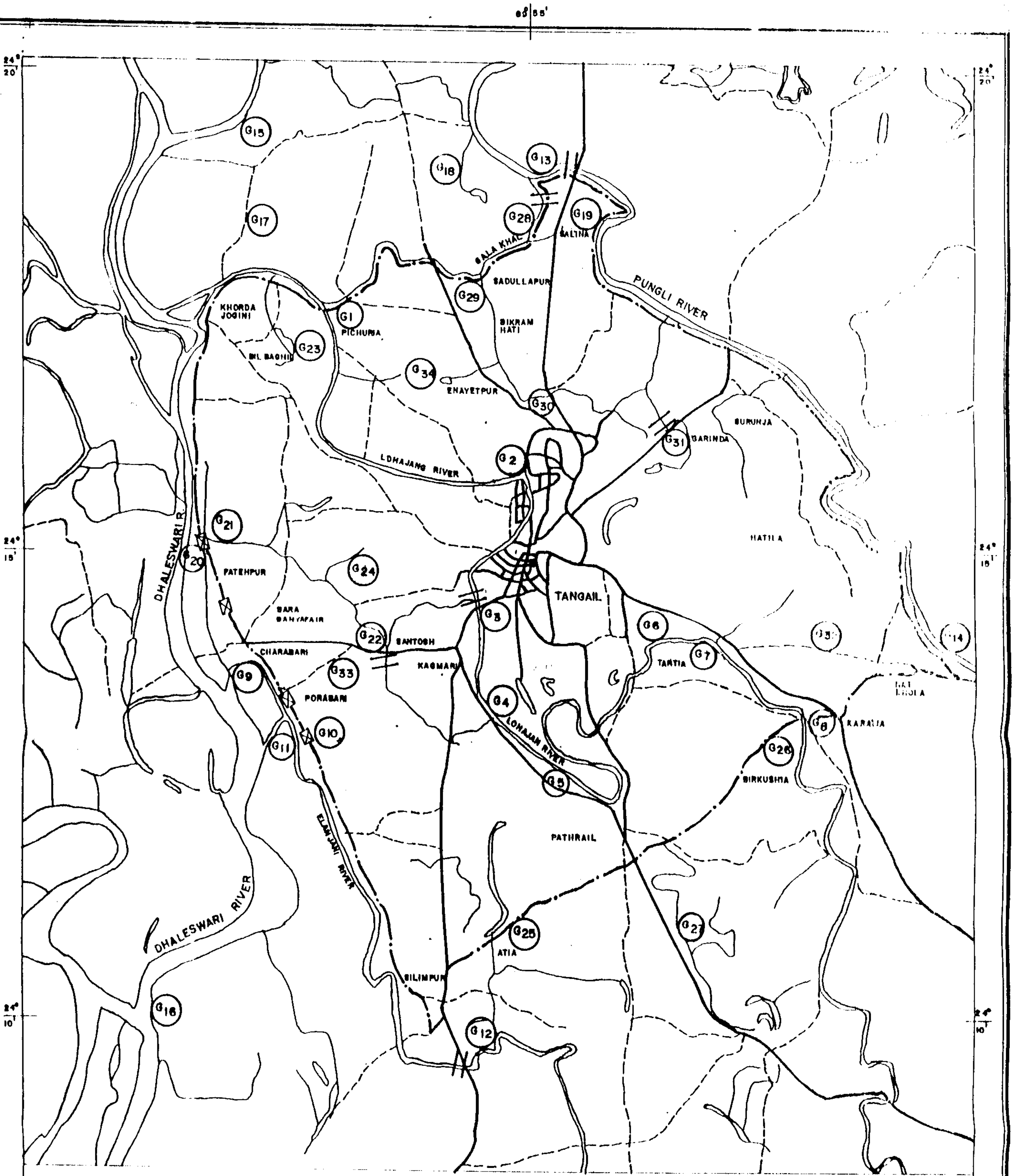
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANIZATION

COMPARTMENTALIZATION PILOT PROJECT
FAP 20

LOCATION OF WATER LEVEL MEASURING STATIONS,1991

Consultants: Euroconsult, Lahmeyer Int., Bets Ltd, HCL

Drawn by: K. Rahman	Checked by:	Fig./Drg No.
Date:	Date:	2



LEGEND:-

PROJECT BOUNDARY	
HIGHWAYS	
LOCAL ROAD	
RIVER & KHAL	
GAUGE LOCATION	G21
DISCHARGE MEASURMENT LOCATION	

1992 PROGRAMME

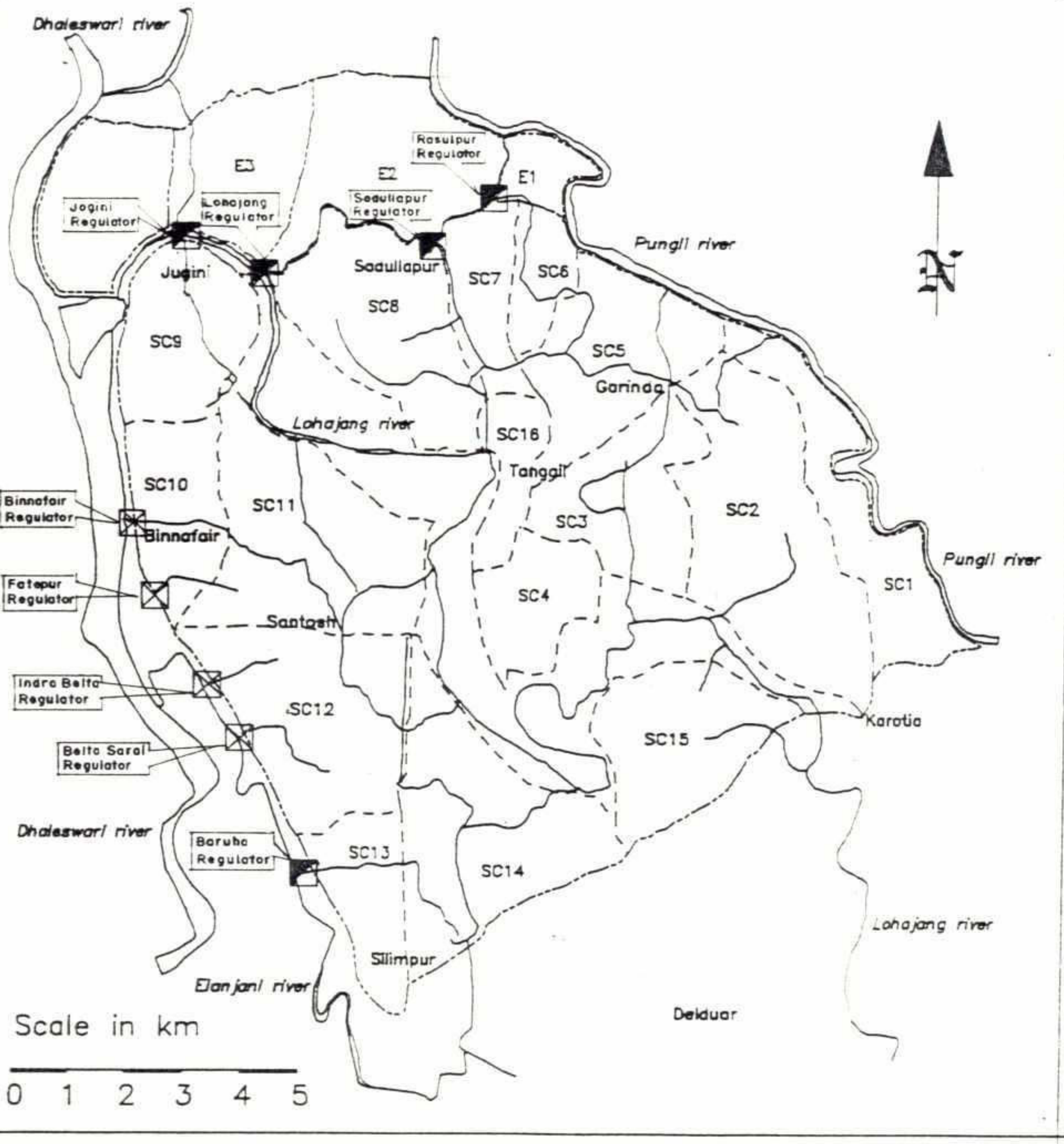
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANIZATION

COMPARTMENTALIZATION PILOT PROJECT
FAP 20

LOCATION OF WATER LEVEL MEASURING STATIONS, 1992

Consultants: Euroconsult Lahmeyer Int, Bets Ltd, HCL.

Drawn by: K. Rahman	Checked by:	Fig/Drg No.
Date:	Date:	3



LEGEND

————	Compartment boundary
- - - - - -	Sub-compartment boundary
————	Waterway

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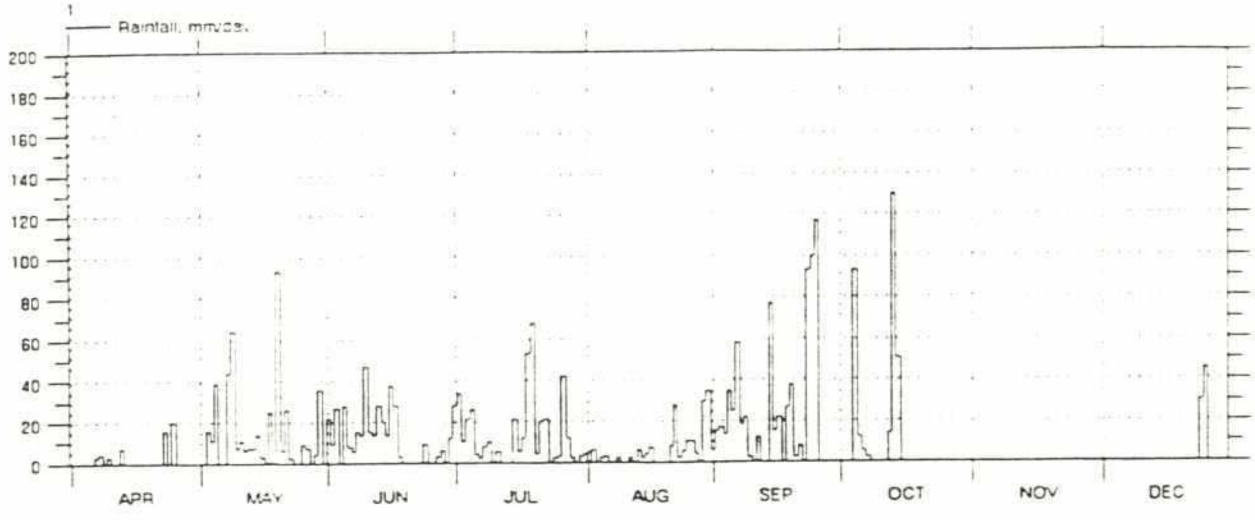
FAP 20

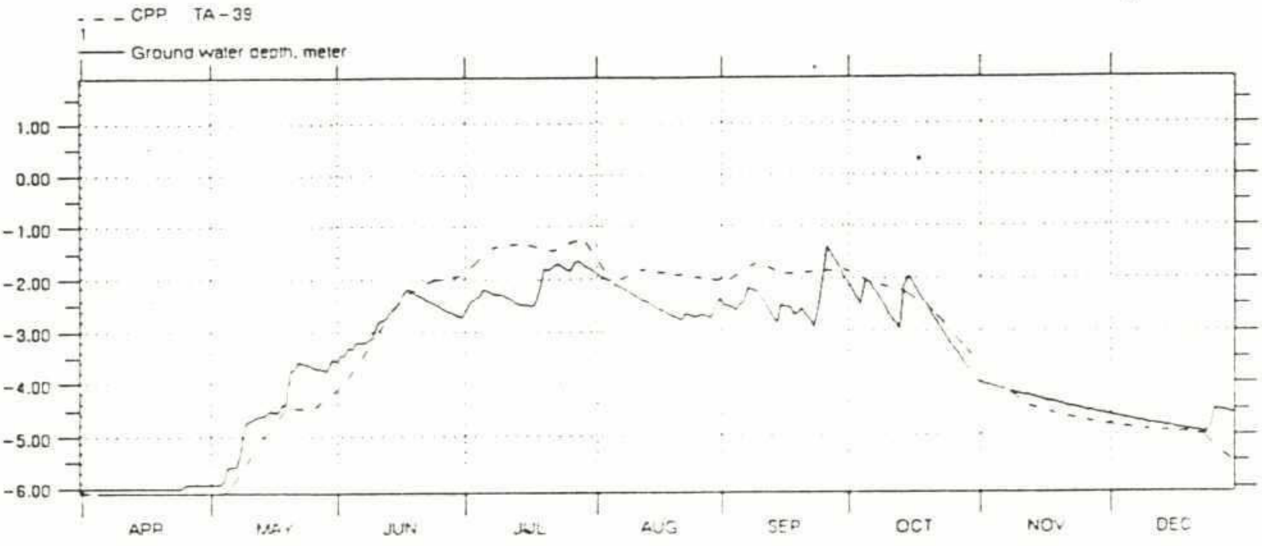
TANGAIL CPP AREA

Consultant: Euroconsult, Lahmeyer Int., Bots Ltd, HCL

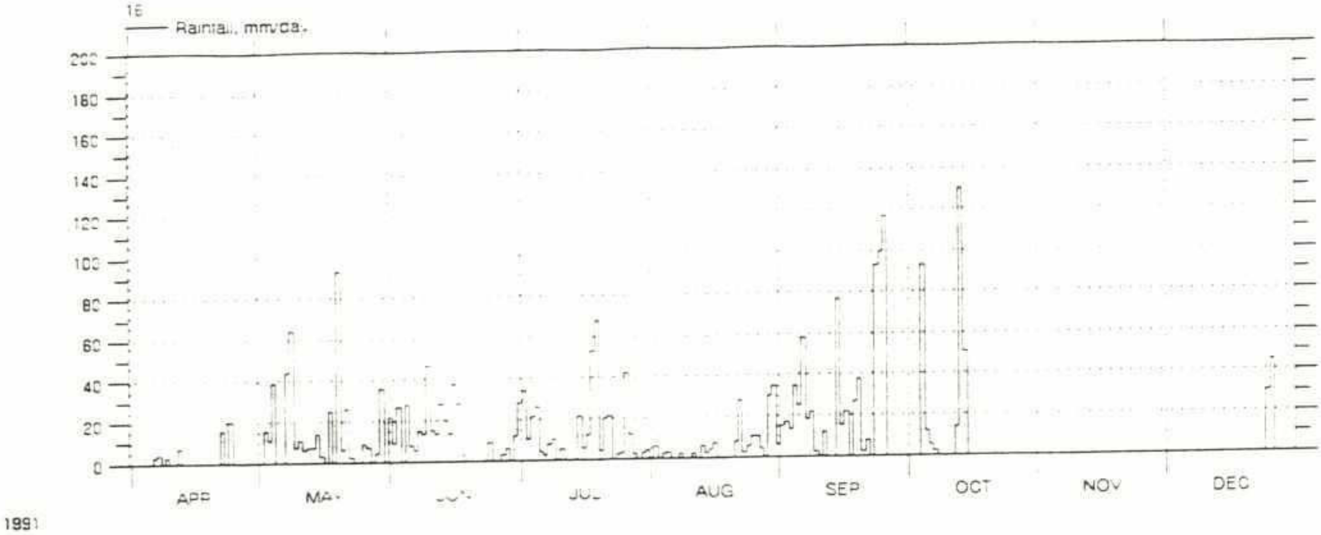
Drawn by	Checked by:	Figure/Drawing No
Date	Date	4

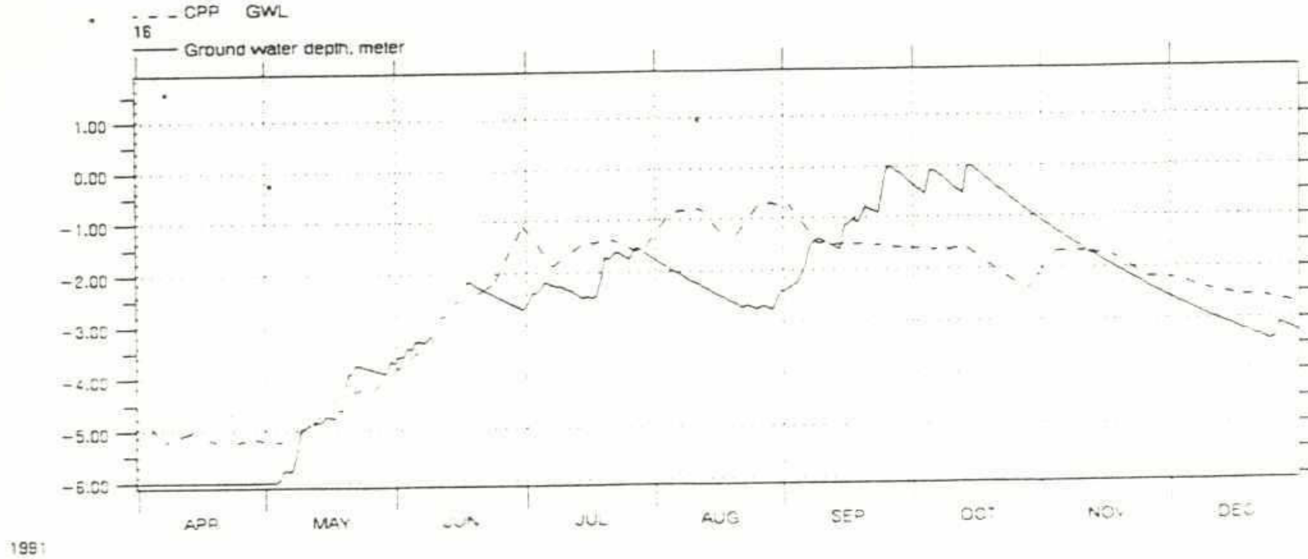
Note: Source for geo-data: FAP19.





SWMC	Compartmentalization Pilot Project Tangail Compartment Groundwater table of SC1 compared with TA39 Surooj	
DATA FILE : CPPRR91.NSF RESULT FILE : RRTEST.NOF	BOUNDARY FILE : CPPRR91.BSF CALCULATED : 28 - SEP - 1992, 11:22	NAM Figure : 5





SWMC	Compartmentalization Pilot Project Tangail Compartment Groundwater table of SC16 compared with TA35 AkurTakur

NAM

DATA FILE : CPPRR91.NSF RESULT FILE : RRTEST.NOF	BOUNDARY FILE : CPPRR91.BSF CALCULATED : 28 – SEP – 1992, 10:27	Figure 6

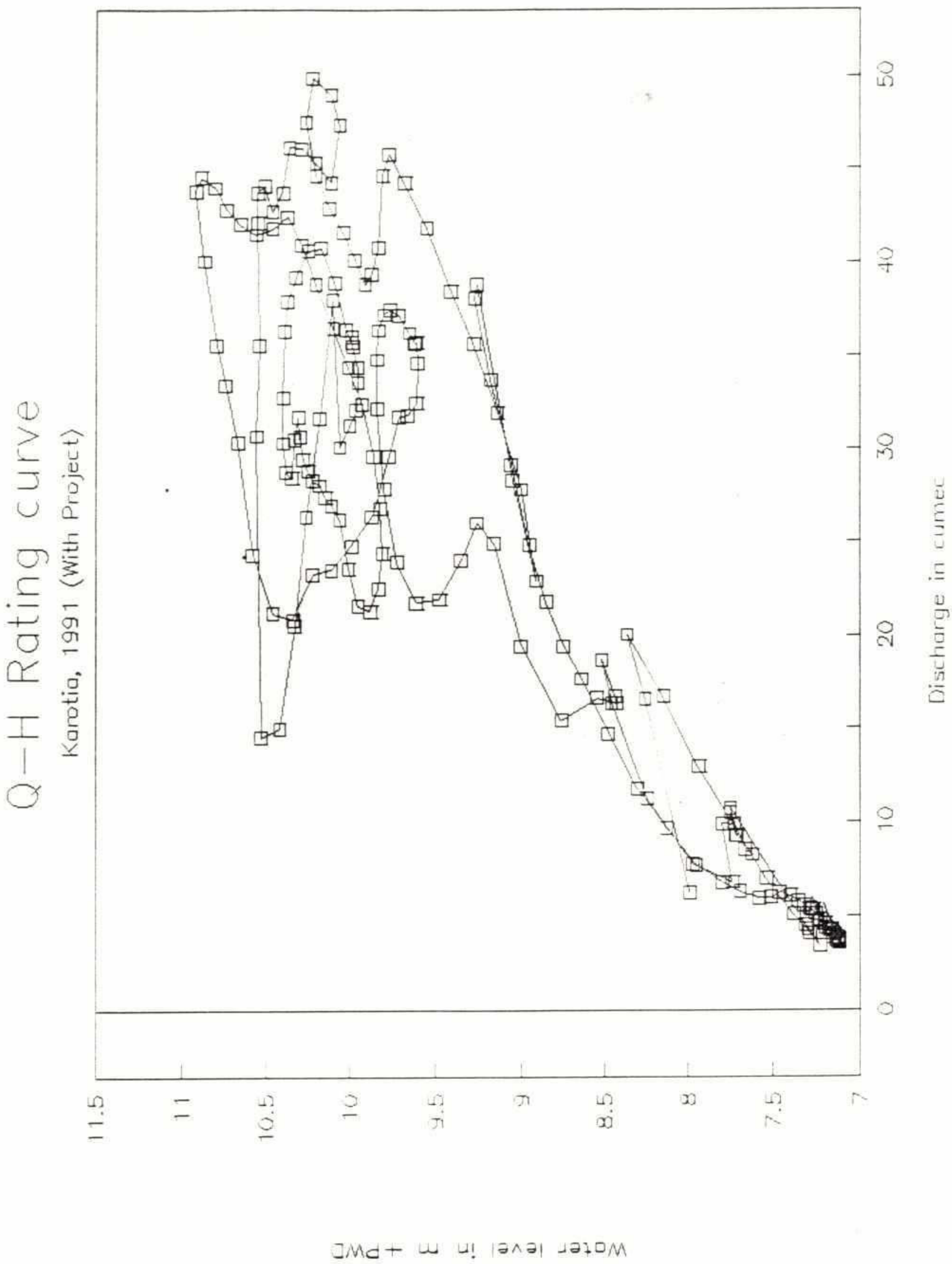


Figure 7 Q-H rating curve in Lohajang river near Karatia

Appendix 4.1

Table 4.1.1 Maximum 3 day mean waterlevel per decade at Jugini station.

Table 4.1.2 Sub-compartmental waterlevels related to Jugini station waterlevel during 1991 monsoon.

Table 4.1.3 Approximate relation between the flooded area in the Tangail compartment and the waterlevel at Jugini gauging station.

Table 4.1.4 Potential Damage Index for 1952 to 1991.

TABLE 4.1.1.

Maximum 3 day mean waterlevel per decade at Jugini station.

YEAR	14	114	1114	15	115	1115	16	116	1116	17	117	1117	18	118	1118	19	119	1119	110	1110	11110	111	1111	11111	112	1112	11112	MAX
52					7.08	9.37	10.20	9.69	10.42	11.29	12.16	11.96	10.72	10.98	11.92	12.16	12.16	12.13	11.93	11.42	11.27	9.79	8.70					12.16
53					7.17	9.48	10.29	10.18	10.42	11.39	11.87	12.22	12.23	11.92	11.31	11.30	12.05	11.99	11.54	11.51	9.66	8.18	7.81					12.23
54					9.66	10.26	10.47	11.56	12.20	12.33	12.11	12.78	12.89	12.64	12.69	12.64	11.76	11.46	11.66	11.53	10.80	9.43	8.34					12.89
55					8.59	9.33	9.91	10.34	11.31	11.77	12.11	12.69	13.00	12.95	12.59	11.80	12.03	11.90	10.91	10.52	10.27	10.23	9.33					13.00
56					10.49	11.29	10.22	12.01	12.31	12.20	11.37	11.76	11.46	11.38	12.21	12.23	12.20	12.13	10.44	10.54	10.59	9.43	9.18	8.43				12.31
57	7.08	7.14	8.77	9.04	9.80	10.36		10.12	11.72	11.80	11.94	12.38	12.73	12.77	12.18	11.48	11.01	11.11	11.19	10.39	9.61	8.91	8.20	7.56	7.23	6.97	6.74	12.77
58	6.26	7.34	7.60	9.61	10.25	10.55	10.76	9.65	11.25	11.47	11.43	11.35	12.30	12.61	12.87	12.82	12.12	12.09	11.48	11.47	11.17	9.61	8.78	8.12	7.66	7.33	7.02	12.87
59																												
60																												
61																												
62																												
63																												
64	7.65	8.24	8.49	9.29	9.51	8.89	9.60	10.75	11.76	11.90	12.16	12.54	12.86	12.64	12.00	12.05	12.16	12.08	11.48	10.64	10.00	9.73	8.90	8.25	7.82	7.51	7.32	12.86
65	6.91	7.13	8.08	8.29	9.32	9.35	10.80	11.01	11.21	11.58	11.66	11.62	11.92	12.53	12.35	11.82	11.95	11.91	11.13	10.15	9.10	8.90	8.71	8.25	7.75	7.42	7.12	12.53
66	6.46	7.02	7.72	7.63	8.22	8.79	10.41	12.06	10.99	11.98	12.00	11.94	12.11	12.25	12.75	12.76	12.31	11.87	10.65	10.47	9.23	8.58	7.96	7.72	7.54	7.30	7.03	12.76
67	6.82	6.77	6.99	7.81	8.69	8.70	9.73	10.35	11.34	11.72	12.44	12.39	11.66	11.72	11.71	11.14	11.12	11.79	11.49	11.04	10.24	8.94	8.34	7.92	7.59	7.33	7.11	12.44
68	7.15	7.39	8.03	8.28	8.84	9.76	10.42	10.63	12.10	12.06	12.18	12.62	12.51	11.91	11.84	11.86	11.35	11.84	12.32	11.82	10.09	8.94	8.44	7.94	7.58	7.25	6.96	12.62
69	6.58	6.66	7.85	8.08	7.67	9.66	9.39	11.15	11.46	11.42	12.05	12.23	11.69	11.67	11.97	11.96	11.74	11.21	10.44	9.49	8.84	8.21	7.72	7.48	7.28	7.04	6.85	12.23
70	7.64	7.51	7.90	9.20	10.31	10.27	10.17	10.57	11.59	11.39	12.00	12.48	12.43	12.13	11.71	11.08	11.14	11.77	11.79	11.02	9.44	9.14	8.12	7.49	7.07	6.65	6.34	12.48
71	6.00	6.09	6.61	6.71	7.51	7.37	8.78	11.13	11.15	11.22	11.62	11.48	11.54	12.04	12.08	11.89	10.97	10.74	10.94	10.99	10.28	9.04	8.14	7.45	6.73	6.36	6.20	12.08
72	5.90	6.24	6.24	8.22	8.40	9.29	9.61	9.55	11.06	10.94	10.49	11.86	12.02	11.18	10.45	11.20	11.24	10.62	10.36	9.26	8.87	8.17	7.47	6.85	6.45	6.23	6.15	12.02
73	5.81	6.73	7.65	7.30	9.24	9.07	9.55	11.47	11.93	11.64	10.39	11.50	12.23	12.24	11.39	10.14	11.72	11.70	10.18	10.51	9.28	7.80	7.01	6.54	6.30	6.25	6.16	12.24
74	5.98	6.11	6.76	7.40	8.62	8.48	9.82	9.75	11.12	11.36	11.55	12.05	12.44	12.24	11.40	12.32	11.56	11.28	10.99	9.98	8.98	8.38	7.20	6.34	6.05	5.93	5.86	12.44
75	5.64	5.64	5.90	6.63	6.64	7.86	8.26	9.20	10.19	10.57	11.03	11.81	11.79	11.08	10.93	11.25	11.38	11.12	10.24	10.10	9.79	8.35	7.36	6.72	6.46	6.39	6.33	11.81
76	6.11	6.11	6.25	7.09	7.18	7.22	8.69	10.67	10.50	11.59	11.29	10.96	10.90	11.07	11.47	11.23	10.65	10.47	10.11	9.31	8.73	8.17	7.43	7.12	6.84	6.73	6.45	11.59
77	6.71	8.04	7.79	9.51	9.02	9.24	10.67	10.84	10.90	10.50	11.47	11.55	11.65	12.08	12.20	11.97	11.05	10.96	10.87	10.89	9.25	8.18	7.71	7.24	6.79	6.62	6.56	12.20
78	6.38	6.37	6.47	6.76	7.00	8.59	8.33	10.09	11.41	11.38	10.94	11.22	11.30	11.35	11.09	9.95	10.89	10.88	10.39	9.06	8.62	7.43	7.04	6.96	6.91	6.88	6.86	11.41
79																												
80																												
81	6.58	6.69	6.69	6.66	6.79	6.89	8.50	7.97	9.71	11.55	11.32	11.60	11.76	11.27	11.64	11.65	11.22	11.10	9.89	9.56	8.27	7.35	7.24	7.18	7.15	7.13	7.09	11.76
82																												
83	6.98	7.01	6.99	7.44	8.00	9.11	9.02	9.77	10.67	11.42	11.38	11.56	11.68	10.99	11.32	11.20	12.51	12.19	11.64	10.52	10.26	9.10	8.20	7.65	7.50	7.45	7.41	12.51
84	7.21	7.55	7.50	7.92	8.44	10.09	9.92	11.16	11.28	11.37	12.44	12.50	12.52	11.66	10.78	11.53	12.80	12.76	11.17	9.67	9.93	9.15	8.03	7.59	7.49	7.42	7.37	12.80
85	7.10	7.17	7.74	8.62	8.31	7.98	11.10	10.44	10.76	11.37	11.84	12.40	12.31	10.70	11.64	11.70	11.78	10.77	10.92	10.08	9.69	8.59	8.01	7.55	7.28	7.22	7.17	12.40
86	6.93	6.91	7.61	7.78	7.89	7.68	7.90	8.65	10.40	10.73	10.54	11.22	11.53	11.07	11.13	11.33	11.56	11.71	10.67	10.66	9.94	8.77	8.01	7.61	6.95	6.78	6.73	11.71
87	6.40	6.57	6.69	6.69	6.76	7.50	7.83	9.28	9.88	10.95	10.95	12.40	12.41	12.95	12.63	11.92	11.95	11.64	11.41	10.10	9.05	8.40	7.79	7.35	7.23	7.17	7.12	12.95
88	6.84	6.82	6.87	6.97	8.61	9.98	10.16	9.53	9.97	12.10	12.43	11.72	11.73	11.84	13.41	13.38	12.42	10.81	10.46	10.54	9.33	8.48	7.89	7.79				13.41
89	7.38	7.36	7.45	7.46	7.65	9.30	9.25	10.51	10.53	11.60	11.47	11.48	11.13	10.68	11.12	11.11	11.19	11.46	11.12	10.45	9.79	8.95	8.16	7.81	7.71	7.64	7.60	11.60
90	7.45	7.45	8.18	8.28	8.42	9.11	10.36	10.87	11.04	10.75	11.40	11.93	11.86	11.35	11.24	11.23	10.88	11.32	11.41	11.42	9.99	8.78	8.25	8.05	7.97	7.92	7.88	11.93
91	7.62	7.55	7.56	8.31	9.56	9.26	9.85	10.90	11.35	11.73	12.39	11.77	11.40	11.68	11.65	11.61	11.99	11.14	10.80	9.91	9.87	8.96	8.67	8.65	8.63	8.61	8.69	12.39
1/2Y	6.63	6.85	7.23	7.74	8.25	8.89	9.53	10.22	10.95	11.40	11.54	11.86	11.87	11.69	11.69	11.56	11.56	11.41	10.90	10.35	9.58	8.64	7.97	7.47	7.14	6.96	6.83	12.28
1/5Y	7.15	7.39	7.87	8.54	9.21	9.82	10.31	11.03	11.54	11.80	12.05	12.29	12.37	12.28	12.29	12.19	12.05	11.90	11.43	10.99	10.21	9.22	8.49	7.96	7.64	7.48	7.37	12.70
1/10Y	7.49	7.75	8.30	9.08	9.86	10.43	10.83	11.57	11.93	12.06	12.39	12.57	12.71	12.67	12.68	12.60	12.37	12.22	11.77	11.42	10.63	9.61	8.84	8.29	7.98	7.82	7.72	12.98
1/20Y	7.82	8.10	8.71	9.59	10.47	11.01	11.33	12.08	12.30	12.32	12.71	12.84	13.03	13.04	13.06	12.99	12.68	12.53	12.10	11.82	11.04	9.98	9.17	8.60	8.31	8.15	8.07	13.24

TABLE 4.1.2. pg 1.

Subcompartmental waterlevels related to Jugini station waterlevel during 1991 monsoon.
(based on model run base situation)

month	date	sc1	sc2	sc3	sc4	sc5	sc6	sc7	sc8	sc9	sc10	sc11	sc12	sc13	sc14	sc15	sc16
6	14	-0.61	-0.61	-0.56	-0.57	-0.45	-0.38	0.1	0.03	0.61	0.61	0.4	-0.31	-0.44	-0.39	-0.68	-0.27
6	15	-0.81	-0.81	-0.78	-0.77	-0.66	-0.6	-0.05	-0.21	0.37	0.37	0.16	-0.46	-0.58	-0.58	-0.94	-0.36
6	16	-1.19	-1.19	-1.17	-1.14	-1.04	-0.98	-0.17	-0.52	0.01	-0.01	-0.26	-0.71	-0.79	-0.97	-1.26	-0.47
6	17	-1.29	-1.29	-1.29	-1.22	-1.06	-1	-0.07	-0.39	-0.05	-0.07	-0.32	-0.63	-0.79	-1.06	-1.37	-0.31
6	18	1.23	1.23	1.22	1.16	0.97	0.87	0.02	-0.19	0.07	0.06	-0.22	0.55	-0.79	1.03	1.4	0.24
6	19	1.31	1.31	1.3	1.24	0.99	0.89	0.04	-0.22	0.07	0.06	-0.3	-0.6	0.87	1.14	1.52	0.29
6	20	-1.52	-1.52	-1.51	-1.44	-1.14	-1.01	-0.1	-0.32	0	-0.01	-0.42	-0.7	-1.01	-1.34	-1.78	-0.38
6	21	-1.67	-1.67	-1.67	-1.56	-1.17	-0.99	-0.04	-0.27	0.08	0.06	-0.41	-0.69	-1.12	-1.48	-2.02	-0.39
6	22	-1.74	-1.74	-1.75	-1.62	-0.98	-0.91	-0.13	-0.27	0.2	0.19	-0.38	-0.7	-1.21	-1.58	-2.21	-0.42
6	23	-1.67	-1.67	-1.67	-1.55	-0.88	-0.81	-0.11	-0.22	0.33	0.33	-0.29	-0.63	-1.22	-1.57	-2.23	-0.35
6	24	-1.48	-1.48	-1.48	-1.4	-0.75	-0.63	-0.03	-0.12	0.41	0.41	-0.19	-0.53	-1.16	-1.45	-2.18	-0.26
6	25	-1.29	-1.29	-1.28	-1.24	-0.59	-0.54	0.07	-0.02	0.46	0.46	-0.11	-0.44	-1.08	-1.33	-2.01	-0.18
6	26	-1.16	-1.16	-1.15	-1.13	-0.48	-0.44	0.14	0.07	0.48	0.48	-0.07	-0.39	-1.01	-1.22	-1.87	-0.13
6	27	-1.05	-1.05	-1.04	-1.05	-0.34	-0.33	0.19	0.12	0.49	0.49	-0.05	-0.35	-0.93	-1.07	-1.8	-0.1
6	28	-0.96	-0.96	-0.95	-0.97	-0.3	-0.24	0.24	0.16	0.49	0.49	-0.02	-0.33	-0.88	-1.04	-1.63	-0.08
6	29	-0.88	-0.88	-0.86	-0.9	0.23	-0.12	0.25	0.22	0.49	0.49	-0.01	-0.31	-0.82	-0.95	-1.51	-0.06
6	30	-0.81	-0.81	-0.8	-0.84	-0.35	-0.3	0.24	0.2	0.48	0.49	0.01	-0.29	-0.76	-0.88	-1.4	-0.04
7	1	-0.81	-0.81	-0.79	-0.82	-0.35	-0.28	0.27	0.2	0.48	0.48	0.02	-0.28	-0.71	-0.82	-1.27	-0.03
7	2	-0.85	-0.85	-0.83	-0.85	-0.42	-0.32	0.23	0.14	0.44	0.44	0	-0.32	-0.72	-0.82	-1.27	-0.07
7	3	-0.87	-0.87	-0.85	-0.86	-0.43	-0.33	0.22	0.14	0.43	0.43	0.01	-0.32	-0.73	-0.84	-1.28	-0.07
7	4	-0.91	-0.91	-0.89	-0.9	-0.48	-0.37	0.19	0.1	0.4	0.4	-0.04	-0.36	-0.75	-0.88	-1.29	-0.1
7	5	-1.13	-1.13	-1.11	-1.09	-0.69	-0.56	0.06	-0.07	0.28	0.27	-0.2	-0.51	-0.86	-1.01	-1.49	-0.25
7	6	-1.24	-1.24	-1.23	-1.2	-0.73	-0.64	0.08	-0.1	0.29	0.28	-0.22	-0.54	-0.95	-1.14	-1.57	-0.26
7	7	-1.35	-1.35	-1.34	-1.29	-0.74	-0.66	0.07	-0.09	0.33	0.32	-0.23	-0.55	-1.03	-1.26	-1.72	-0.27
7	8	1.53	1.53	1.52	1.46	0.85	0.77	0.07	0.2	0.29	0.29	0.32	0.65	1.18	1.45	1.92	0.36
7	9	1.67	1.67	1.67	1.59	0.88	0.83	0.17	-0.29	0.3	0.29	-0.35	-0.7	-1.3	1.61	2.06	0.42
7	10	-1.72	1.72	-1.72	1.64	-0.9	-0.89	-0.22	-0.32	0.34	0.33	-0.33	-0.69	-1.39	-1.7	-2.2	-0.42
7	11	-1.75	-1.75	-1.75	-1.68	-0.95	-0.89	-0.25	-0.35	0.35	0.34	-0.34	-0.72	-1.47	-1.78	-2.3	-0.44
7	12	-1.77	-1.77	-1.77	-1.72	-0.94	-0.92	-0.29	-0.36	0.34	0.34	-0.34	-0.74	-1.52	-1.81	-2.34	-0.46
7	13	-1.86	-1.86	-1.86	-1.81	-1.04	-1	-0.33	-0.41	0.32	0.31	-0.38	-0.8	-1.62	-1.89	-2.46	-0.51
7	14	1.89	-1.89	-1.88	-1.83	1.01	-0.97	-0.32	-0.38	0.34	0.34	-0.37	-0.81	-1.66	-1.89	-2.48	-0.5
7	15	1.83	1.83	1.83	1.8	0.94	0.9	-0.29	-0.34	0.36	0.36	-0.36	-0.81	-1.64	-1.81	-2.41	-0.49
7	16	1.73	1.73	-1.72	1.72	0.84	-0.81	-0.23	-0.26	0.38	0.38	-0.32	-0.76	-1.56	-1.68	-2.27	-0.45
7	17	-1.66	-1.66	-1.65	-1.67	-0.8	-0.77	-0.18	-0.23	0.38	0.38	-0.32	-0.75	-1.51	-1.62	-2.19	-0.45
7	18	1.61	1.61	-1.6	1.62	0.77	0.74	-0.15	-0.21	0.39	0.39	-0.31	-0.74	-1.46	-1.55	-2.06	-0.44
7	19	1.53	1.53	1.52	1.51	0.76	0.73	-0.2	-0.22	0.35	0.35	-0.29	-0.75	-1.34	-1.39	1.79	0.46
7	20	1.32	1.32	1.31	-1.37	0.63	0.6	-0.1	-0.13	0.38	0.39	-0.21	-0.66	-1.27	-1.34	-1.63	-0.39
7	21	-1.15	-1.15	-1.15	-1.21	-0.51	-0.48	0	-0.03	0.42	0.42	-0.17	-0.55	-1.13	-1.21	-1.45	-0.3
7	22	-1.09	-1.09	-1.08	-1.14	-0.5	-0.47	0	-0.03	0.39	0.39	-0.17	-0.52	-1.07	-1.15	-1.36	-0.29
7	23	-1.09	-1.09	1.09	-1.13	0.55	0.53	-0.04	-0.09	0.34	0.35	-0.2	-0.54	-1.03	-1.1	-1.34	-0.32
7	24	-1.05	-1.05	1.05	-1.08	0.54	-0.52	-0.04	-0.07	0.36	0.36	-0.18	-0.5	-0.97	-1.04	-1.31	-0.28
7	25	-0.97	0.97	0.96	-1	-0.48	-0.46	0.03	-0.02	0.38	0.38	-0.13	-0.42	-0.89	-0.96	-1.24	-0.21
7	26	-0.8	-0.8	-0.79	-0.81	-0.34	-0.31	0.17	0.12	0.46	0.46	-0.01	-0.3	-0.72	-0.78	-1.04	-0.09
7	27	-0.75	-0.75	-0.74	-0.77	-0.32	-0.29	0.2	0.13	0.43	0.43	0	-0.31	-0.68	-0.75	-0.99	-0.1
7	28	-0.7	-0.7	-0.69	-0.72	-0.28	-0.23	0.22	0.19	0.43	0.43	0	-0.29	-0.65	-0.71	-0.93	-0.08
7	29	-0.65	-0.65	-0.64	-0.68	-0.25	-0.22	0.24	0.16	0.43	0.43	0	-0.28	-0.61	-0.67	-0.89	-0.08
7	30	-0.63	-0.63	-0.62	-0.65	-0.27	-0.26	0.14	0.1	0.43	0.43	0	-0.28	-0.58	-0.64	-0.85	-0.08

TABLE 4.1.2. pg 2.

Subcompartmental waterlevels related to Jugini station waterlevel during 1991 monsoon.
(based on model run base situation)

month	date	sc1	sc2	sc3	sc4	sc5	sc6	sc7	sc8	sc9	sc10	sc11	sc12	sc13	sc14	sc15	sc16
7	31	-0.66	-0.66	-0.64	-0.66	-0.35	-0.35	0.09	0.02	0.39	0.4	-0.03	-0.31	-0.56	-0.62	-0.86	-0.11
8	1	-0.68	-0.68	-0.67	-0.68	-0.43	-0.41	0.06	-0.03	0.37	0.37	-0.05	-0.34	-0.57	-0.64	-0.89	-0.12
8	2	-0.79	-0.79	-0.77	-0.77	-0.57	-0.54	0	-0.12	0.3	0.3	-0.13	-0.41	-0.62	-0.72	-0.99	-0.19
8	3	-0.97	-0.97	-0.96	-0.95	-0.76	-0.74	0.08	-0.25	0.19	0.19	-0.25	-0.53	-0.73	-0.87	-1.17	-0.28
8	4	-1.16	-1.16	-1.15	-1.12	-0.93	-0.9	-0.15	-0.35	0.12	0.11	-0.33	-0.62	-0.84	-1.04	-1.36	-0.35
8	5	-1.41	-1.41	-1.4	-1.35	-1.08	-1.06	-0.19	-0.45	0.05	0.04	-0.43	-0.72	-1	-1.26	-1.65	-0.44
8	6	-1.59	-1.59	-1.58	-1.5	-1.09	-1.09	-0.17	-0.42	0.11	0.1	-0.43	-0.74	-1.13	-1.42	-1.89	-0.46
8	7	-1.67	-1.67	-1.67	-1.57	-1.02	-1.04	-0.24	-0.41	0.2	0.2	-0.39	-0.73	-1.21	-1.52	-2.04	-0.46
8	8	-1.63	-1.63	-1.63	-1.54	-0.94	-0.92	-0.2	-0.33	0.29	0.28	-0.31	-0.65	-1.23	-1.53	-2.08	-0.39
8	9	-1.58	-1.58	-1.57	-1.49	-0.83	-0.85	-0.18	-0.29	0.31	0.31	-0.29	-0.63	-1.2	-1.39	-2.11	-0.37
8	10	-1.56	-1.56	-1.55	-1.5	-0.87	-0.85	-0.21	-0.31	0.3	0.3	-0.3	-0.65	-1.26	-1.54	-2.13	-0.39
8	11	-1.56	-1.56	-1.55	-1.51	-0.87	-0.86	-0.23	-0.33	0.3	0.3	-0.31	-0.65	-1.28	-1.55	-2.14	-0.41
8	12	-1.57	-1.57	-1.56	-1.52	-0.87	-0.87	-0.25	-0.34	0.3	0.29	-0.31	-0.67	-1.3	-1.55	-2.16	-0.42
8	13	-1.59	-1.59	-1.58	-1.55	-0.9	-0.89	-0.28	-0.37	0.29	0.28	-0.33	-0.69	-1.33	-1.58	-2.18	-0.44
8	14	-1.59	-1.59	-1.59	-1.55	-0.9	-0.89	-0.29	-0.38	0.28	0.28	-0.33	-0.69	-1.34	-1.58	-2.19	-0.45
8	15	-1.59	-1.59	-1.58	-1.55	-0.9	-0.88	-0.29	-0.37	0.28	0.28	-0.33	-0.7	-1.35	-1.59	-2.17	-0.45
8	16	-1.54	-1.54	-1.53	-1.51	-0.92	-0.84	-0.27	-0.35	0.29	0.29	-0.31	-0.67	-1.31	-1.52	-2.11	-0.43
8	17	-1.51	-1.51	-1.5	-1.49	-0.8	-0.82	-0.26	-0.34	0.29	0.29	-0.31	-0.67	-1.3	-1.5	-2.07	-0.43
8	18	-1.57	-1.57	-1.56	-1.55	-0.9	-0.88	-0.31	-0.39	0.26	0.26	-0.35	-0.71	-1.34	-1.56	-2.11	-0.47
8	19	-1.65	-1.65	-1.64	-1.62	-0.95	-0.95	-0.36	-0.44	0.23	0.23	-0.38	-0.76	-1.39	-1.62	-2.17	-0.51
8	20	-1.64	-1.64	-1.63	-1.6	-0.91	-0.93	-0.33	-0.41	0.27	0.27	-0.34	-0.73	-1.39	-1.61	-2.16	-0.48
8	21	-1.58	-1.58	-1.58	-1.55	-0.92	-0.88	-0.29	-0.36	0.29	0.29	-0.31	-0.7	-1.35	-1.57	-2.11	-0.45
8	22	-1.5	-1.5	-1.49	-1.48	-0.83	-0.82	-0.25	-0.32	0.3	0.3	-0.29	-0.66	-1.29	-1.49	-2.01	-0.42
8	23	-1.41	-1.41	-1.4	-1.4	-0.77	-0.75	-0.2	-0.27	0.32	0.32	-0.25	-0.62	-1.22	-1.39	-1.91	-0.38
8	24	-1.3	-1.3	-1.29	-1.3	-0.69	-0.67	-0.14	-0.2	0.34	0.34	-0.22	-0.56	-1.14	-1.3	-1.79	-0.33
8	25	-1.15	-1.15	-1.15	-1.16	-0.55	-0.54	-0.03	-0.1	0.39	0.39	-0.14	-0.47	-1.02	-1.17	-1.6	-0.23
8	26	-0.99	-0.99	-0.98	-1	-0.47	-0.42	0.06	0.01	0.43	0.43	-0.07	-0.38	-0.87	-0.98	-1.4	-0.15
8	27	-0.93	-0.93	-0.92	-0.94	-0.42	-0.41	0.06	-0.01	0.39	0.4	-0.08	-0.39	-0.81	-0.9	-1.31	-0.17
8	28	-0.95	-0.95	-0.94	-0.97	-0.51	-0.48	0.01	-0.07	0.34	0.34	-0.14	-0.45	-0.85	-0.99	-1.31	-0.22
8	29	-1.06	-1.06	-1.05	-1.06	-0.68	-0.6	-0.08	-0.18	0.27	0.27	-0.22	-0.53	-0.87	-0.99	-1.41	-0.29
8	30	-1.12	-1.12	-1.11	-1.09	-0.7	-0.69	-0.11	-0.23	0.26	0.26	-0.22	-0.55	-0.87	-0.99	-1.5	-0.31
8	31	-1.16	-1.16	-1.15	-1.13	-0.75	-0.73	0.14	-0.25	0.25	0.25	-0.22	-0.56	-0.9	-1.03	-1.55	-0.33
9	1	-1.11	-1.11	-1.1	-1.08	-0.63	-0.67	-0.08	-0.19	0.3	0.3	-0.18	-0.51	-0.87	-1.02	-1.5	-0.27
9	2	-1.18	-1.18	-1.17	-1.15	-0.75	-0.74	-0.13	-0.25	0.25	0.25	-0.24	-0.57	-0.91	-1.06	-1.57	-0.33
9	3	-1.24	-1.24	-1.23	-1.19	-0.81	-0.79	-0.12	-0.27	0.26	0.25	-0.25	-0.59	-0.94	-1.09	-1.63	-0.34
9	4	-1.31	-1.31	-1.3	-1.26	-0.85	-0.82	-0.15	-0.29	0.24	0.24	-0.28	-0.61	-0.99	-1.16	-1.71	-0.36
9	5	-1.38	-1.38	-1.37	-1.33	-0.86	-0.85	-0.17	-0.31	0.24	0.24	-0.28	-0.63	-1.05	-1.24	-1.74	-0.38
9	6	-1.44	-1.44	-1.43	-1.39	-0.88	-0.86	-0.2	-0.33	0.24	0.24	-0.3	-0.66	-1.11	-1.32	-1.81	-0.41
9	7	-1.43	-1.43	-1.43	-1.38	-0.86	-0.84	-0.22	-0.32	0.25	0.25	-0.27	-0.64	-1.13	-1.28	-1.71	-0.4
9	8	-1.38	-1.38	-1.38	-1.34	-0.81	-0.79	-0.19	-0.29	0.27	0.27	-0.27	-0.62	-1.12	-1.29	-1.69	-0.38
9	9	-1.43	-1.43	-1.42	-1.4	-0.85	-0.83	-0.22	-0.32	0.25	0.24	-0.31	-0.66	-1.17	-1.36	-1.8	-0.42
9	10	-1.66	-1.66	-1.65	-1.62	-1.05	-1.03	-0.41	-0.51	0.15	0.15	-0.44	-0.81	-1.37	-1.61	-2.07	-0.57
9	11	-1.86	-1.86	-1.86	-1.8	-1.19	-1.18	-0.53	-0.64	0.14	0.13	-0.49	-0.9	-1.52	-1.81	-2.3	-0.65
9	12	-1.92	-1.92	-1.91	-1.85	-1.18	-1.18	-0.54	-0.63	0.17	0.17	-0.45	-0.89	-1.58	-1.88	-2.41	-0.64
9	13	-1.85	-1.85	-1.84	-1.8	-1.11	-1.08	-0.47	-0.54	0.22	0.21	-0.4	-0.84	-1.58	-1.85	-2.38	-0.59
9	14	-1.7	-1.7	-1.69	-1.67	-0.95	-0.94	-0.37	-0.42	0.25	0.25	-0.34	-0.77	-1.48	-1.7	-2.2	-0.52
9	15	-1.51	-1.51	-1.5	-1.51	-0.81	-0.8	-0.26	-0.31	0.29	0.29	-0.25	-0.69	-1.33	-1.47	-1.91	-0.45

TABLE 4.1.2. pg 3.

Subcompartmental waterlevels related to Jugini station waterlevel during 1991 monsoon.
(based on model run base situation)

month	date	sc1	sc2	sc3	sc4	sc5	sc6	sc7	sc8	sc9	sc10	sc11	sc12	sc13	sc14	sc15	sc16
9	16	-1.37	-1.37	-1.36	-1.39	-0.72	-0.71	-0.2	-0.25	0.29	0.29	-0.26	-0.64	-1.25	-1.38	-1.76	-0.41
9	17	-1.33	-1.33	-1.32	-1.34	-0.75	-0.72	-0.22	-0.27	0.27	0.27	-0.27	-0.64	-1.19	-1.3	-1.66	-0.42
9	18	-1.32	-1.32	-1.31	-1.34	-0.76	-0.74	-0.22	-0.28	0.26	0.26	-0.29	-0.63	-1.2	-1.36	-1.62	-0.41
9	19	-1.27	-1.27	-1.26	-1.28	-0.69	-0.69	-0.17	-0.24	0.29	0.29	-0.24	-0.59	-1.13	-1.26	-1.58	-0.36
9	20	-1.15	-1.15	-1.14	-1.17	-0.6	-0.57	-0.09	-0.14	0.33	0.34	-0.16	-0.5	-1.03	-1.14	-1.47	-0.28
9	21	-1.04	-1.03	-1.03	-1.05	-0.49	-0.48	-0.01	-0.07	0.36	0.36	-0.14	-0.45	-0.94	-1.04	-1.35	-0.23
Summary																	
max		-0.61	-0.61	-0.56	-0.57	0.23	-0.12	0.27	0.22	0.61	0.61	0.4	-0.28	-0.44	-0.39	-0.68	-0.03
min		-1.92	-1.92	-1.91	-1.85	-1.19	-1.18	-0.54	-0.64	-0.05	-0.07	-0.49	-0.9	-1.66	-1.89	-2.48	-0.65
mean		-1.31	-1.31	-1.30	-1.28	-0.74	-0.71	-0.10	-0.20	0.31	0.30	-0.23	-0.58	-1.08	-1.26	-1.72	-0.33

TABLE 4.1.3.

Approximate relation between the flooded area in the Tangail compartment and the waterlevel at Jugini gauging station.

SUB-COMPARTMENT	WATER LEVEL IN SUB-COMPARTMENT BY % FLOODED AREA			LEVEL DIF. IN M BETWEEN JUGINI & SUB-COMPTMT	WATER LEVEL AT JUGINI BY % FLOODED AREA / SUB-COMPMT		
	20 %	50 %	80 %		20 %	50 %	80 %
1	9	9.6	10.4	1.3	10.3	10.9	11.7
2	8.9	9.3	9.9	1.3	10.2	10.6	11.2
3	9.1	9.5	9.9	1.3	10.4	10.8	11.2
4	9.3	9.8	10.4	1.3	10.6	11.1	11.7
5	9.2	10	10.7	0.7	9.9	10.7	11.4
6	9.8	10.3	11	0.7	10.5	11	11.7
7	10.1	10.5	11.1	0.1	10.2	10.6	11.2
8	9.9	10.5	11.5	0.2	10.1	10.7	11.7
9	10.7	11.5	12.1	-0.3	10.4	11.2	11.8
10	10.2	11.1	11.8	-0.3	9.9	10.8	11.5
11	9	9.6	10.4	0.2	9.2	9.8	10.6
12	9.5	10.2	11.2	0.6	10.1	10.8	11.8
13	10	10.7	11.4	1.1	11.1	11.8	12.5
14	9.4	9.9	10.5	1.3	10.7	11.2	11.8
15	9.1	9.7	10.3	1.7	10.8	11.4	12
MEAN VALUE AT JUGINI IN MPWD:					10.3	10.9	11.6

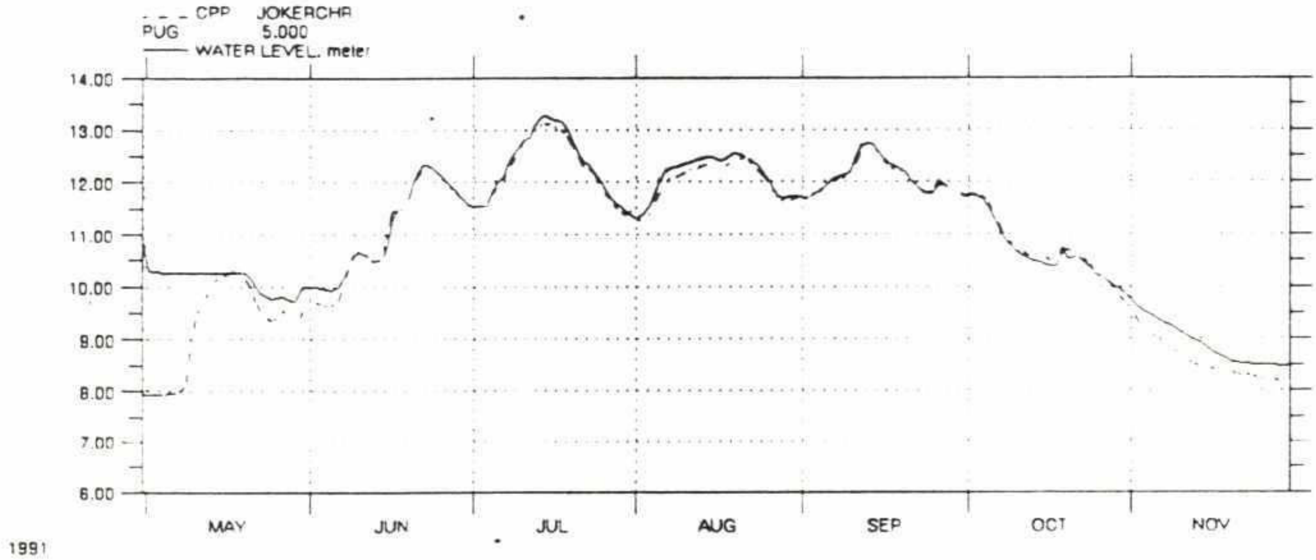
TABLE 4.1.4.: POTENTIAL DAMAGE INDEX FOR 1952 TO 1991.

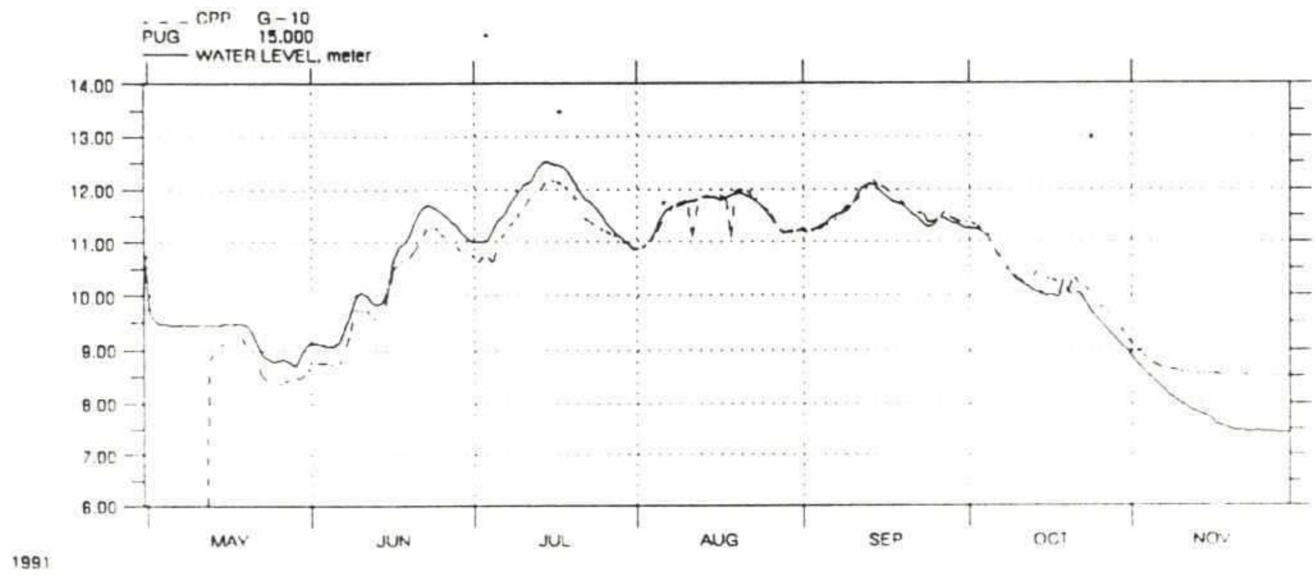
YEAR	BORO	T AUS	B AUS	T AMAN	DW AMAN	TOTAL	RATING	EXC PROB	RETURN PERIOD
	50	5	30	10	35	130		%	YEARS
1952	0	0	0	0	0	0	24	75%	1
1953	0	0	0	0	0	0	24	75%	1
1954	17	2	15	10	14	58	2	6%	16
1955	0	0	0	10	18	28	5	16%	6
1956	35	2	20	5	20	82	1	3%	32
1957	0	1	3	2	9	15	12	38%	3
1958	0	0	0	10	13	23	8	25%	4
1959									
1960									
1961									
1962									
1963									
1964	0	1	4	5	13	23	8	25%	4
1965	5	0	0	7	0	12	13	41%	2
1966	17	2	10	10	9	48	3	9%	11
1967	0	1	0	0	0	1	23	72%	1
1968	0	2	12	0	4	18	10	31%	3
1969	4	1	0	0	0	5	20	63%	2
1970	0	1	0	7	0	8	17	53%	2
1971	5	0	0	2	0	7	18	56%	2
1972	0	0	0	0	0	0	24	75%	1
1973	8	2	5	2	0	17	11	34%	3
1974	0	0	0	9	0	9	16	50%	2
1975	0	0	0	0	0	0	24	75%	1
1976	0	0	0	0	0	0	24	75%	1
1977	2	0	0	5	0	7	18	56%	2
1978	0	0	0	0	0	0	24	75%	1
1979									
1980									
1981	0	0	0	0	0	0	24	75%	1
1982									
1983	0	0	0	10	0	10	15	47%	2
1984	5	1	0	10	11	27	6	19%	5
1985	11	0	0	0	0	11	14	44%	2
1986	0	0	0	0	0	0	24	75%	1
1987	0	0	0	10	16	26	7	22%	5
1988	0	2	3	10	32	47	4	13%	8
1989	0	0	0	0	0	0	24	75%	1
1990	2	0	0	0	0	2	22	69%	1
1991	2	1	0	0	0	3	21	66%	2

Appendix 4.2

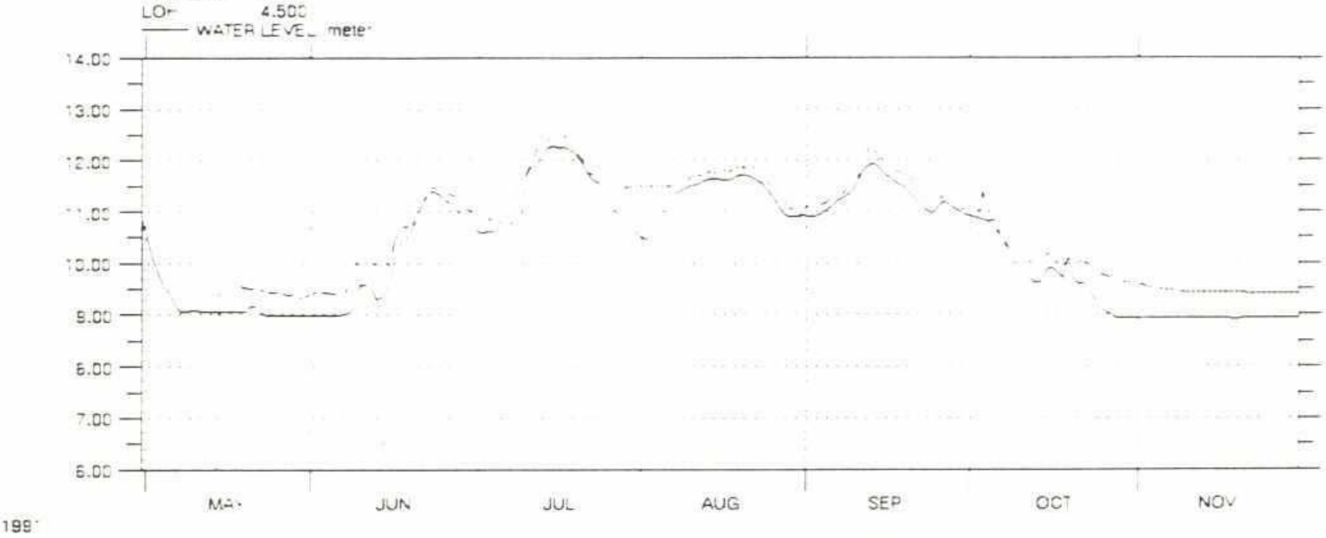
Comparison of calibrated and measured water level at diffrent locations.

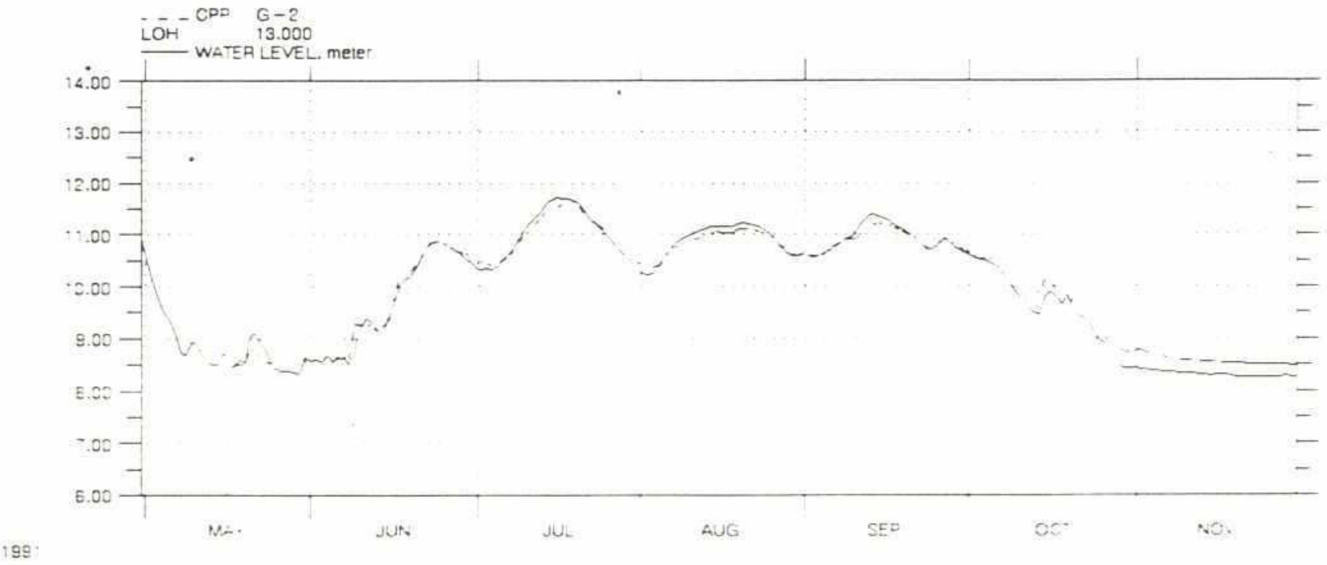
Computed Discharges at key locations.





SWMC	Compartmentalization Pilot Project Tangail Compartment, FAP 20 Measured and Computed water levels	
DATA FILE : BASE.RDF RESULT FILE : BASE.RRF	BOUNDARY FILE : CPP.BSF CALCULATED : 14-MAY-1992, 12:05	MIKE 11 Dwg no





SWMC

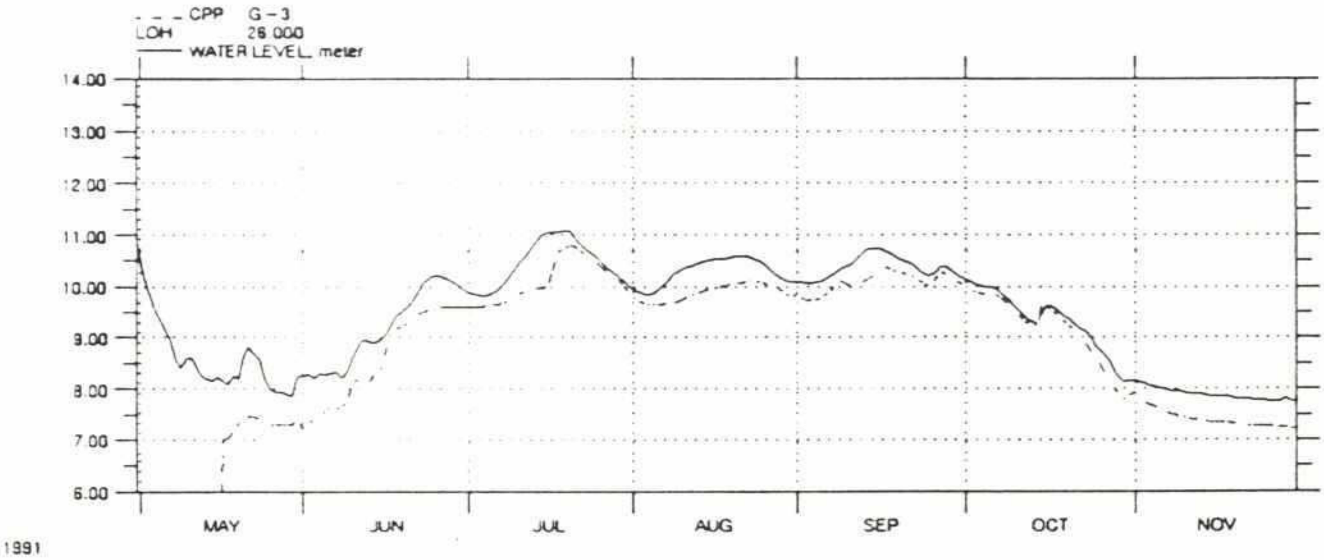
Compartmentalization Pilot Project
Tangail Compartment, FAP 20
Measured and Computed water levels

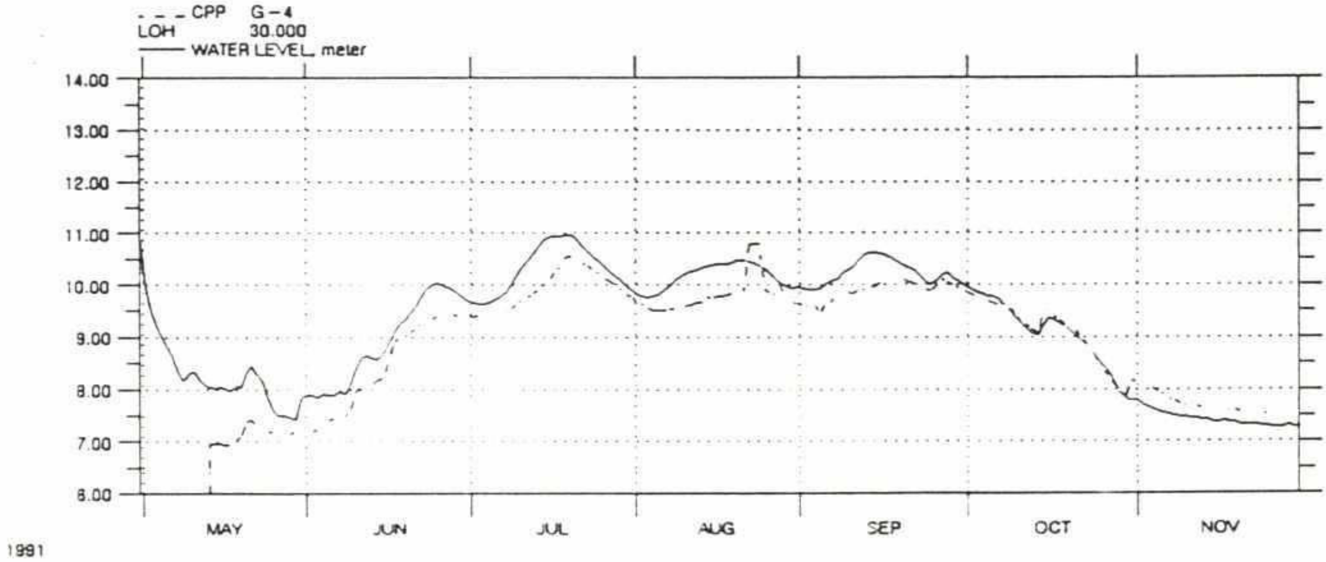
MIKE 11

DATA FILE : BASE.RDF
RESULT FILE : BASE.RRF

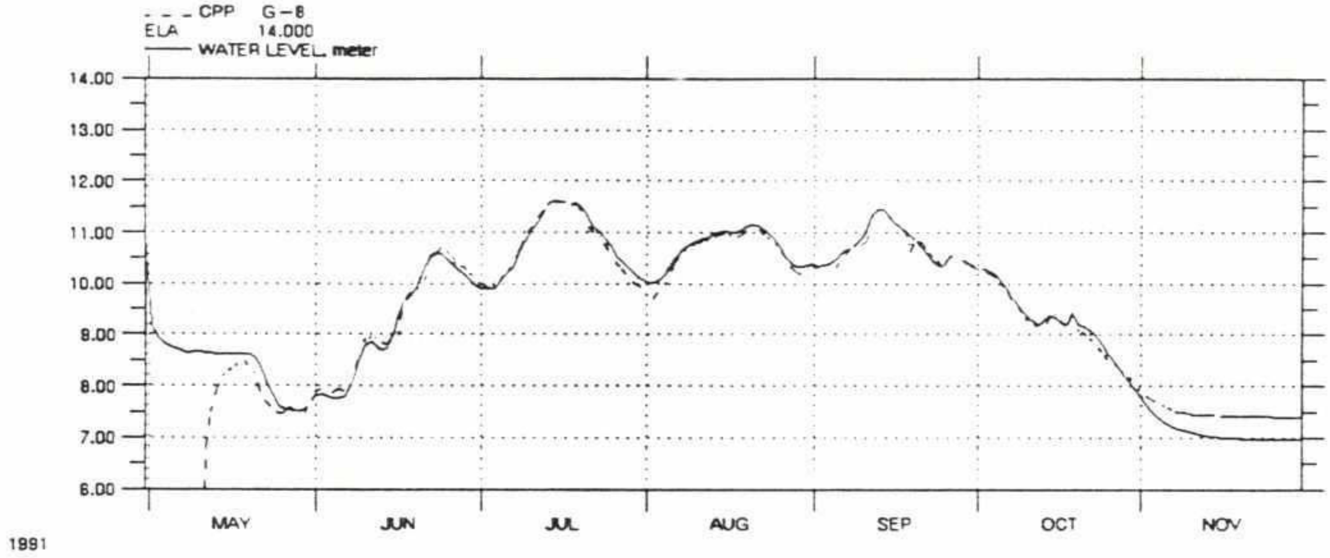
BOUNDARY FILE : CPP.BSF
CALCULATED : 14 - MAY - 1992, 12:05

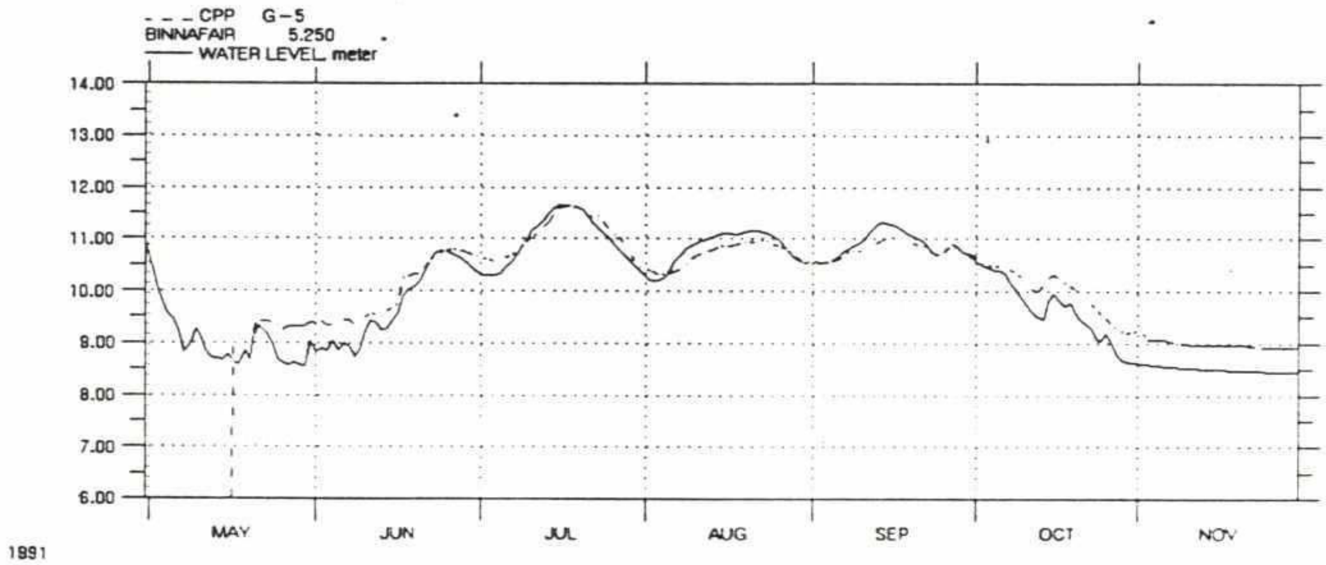
Dwg no:



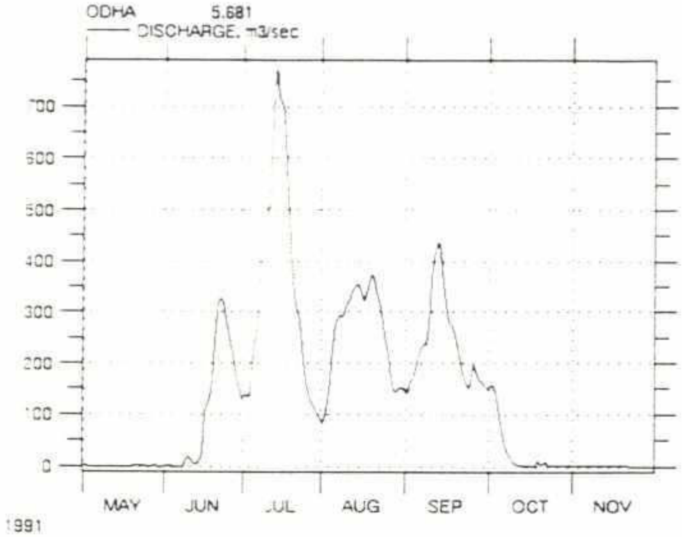


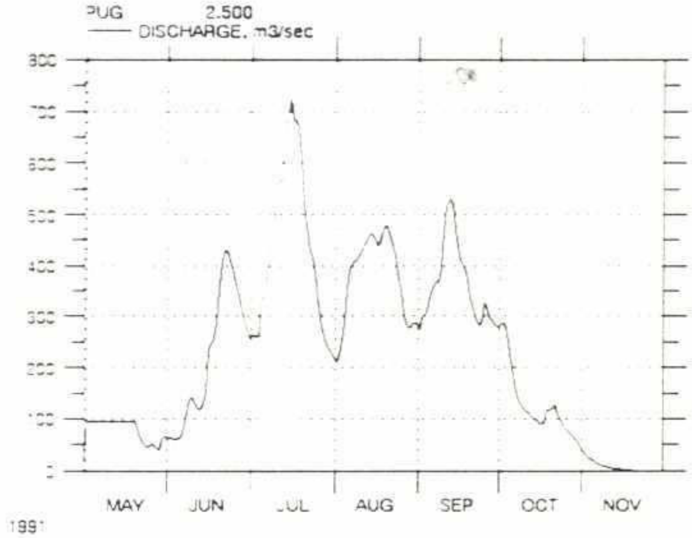
SWMC	Compartmentalization Pilot Project Tangail Compartment, FAP 20 Measured and Computed water levels	
DATA FILE : BASE.RDF RESULT FILE : BASE.RRF	BOUNDARY FILE : CPP.BSF CALCULATED : 14-MAY-1992, 12:05	**MIKE 11** Dwg no.:

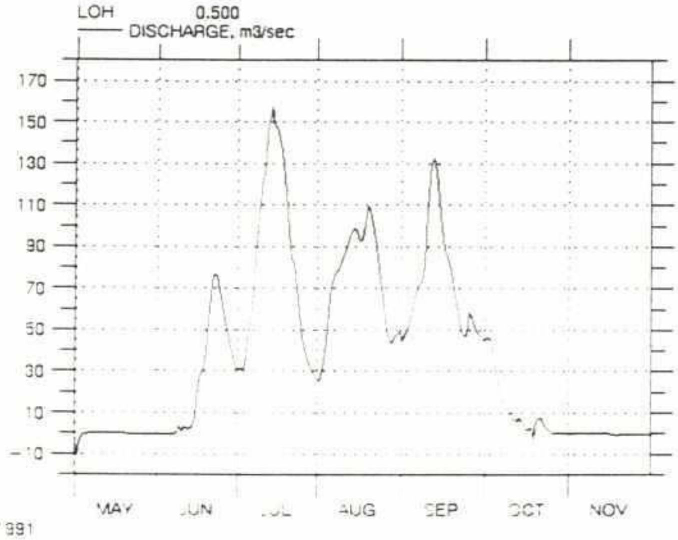


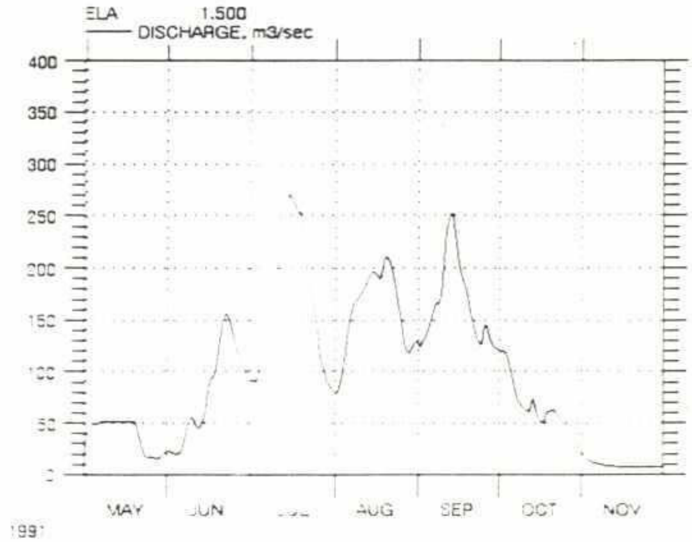


SWMC	Compartmentalization Pilot Project Tangail Compartment, FAP 20 Measured and Computed water levels	
DATA FILE : BASE.RDF RESULT FILE : BASE.RRF	BOUNDARY FILE : CPP.BSF CALCULATED : 14 – MAY – 1992, 12:05	MIKE 11 Dwg no.:









S W M C

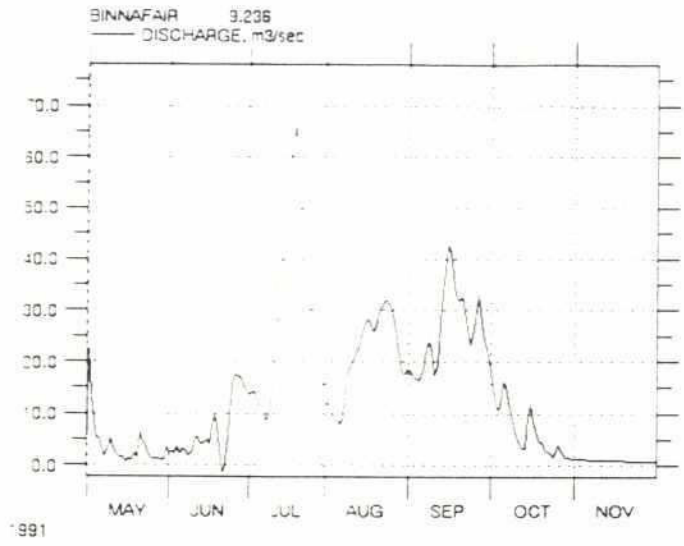
Compartmentalization Pilot Project
Tangail Compartment, FAP 20
Computed discharges

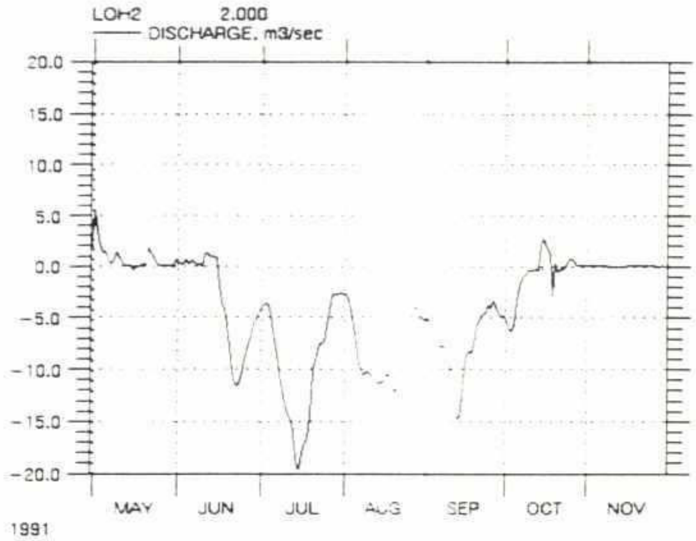
MIKE 11

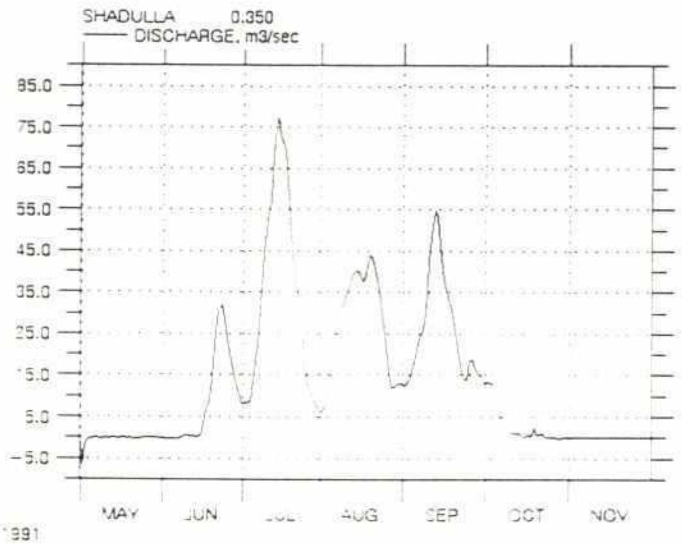
Dwg no.:

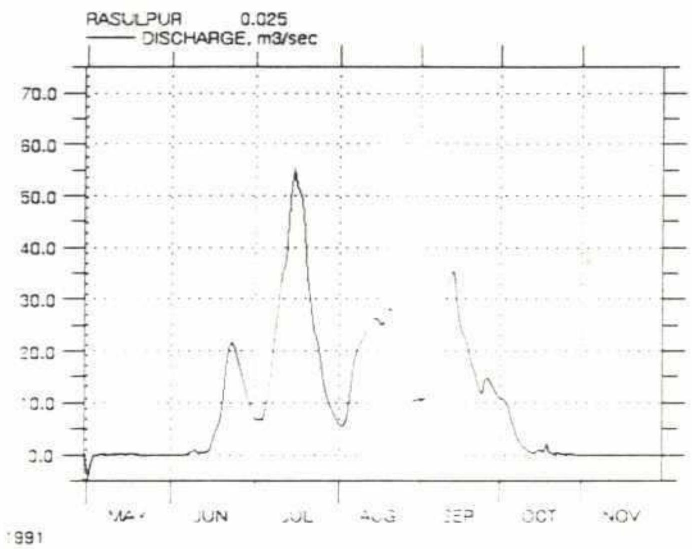
DATA FILE : BASE.RDF
RESULT FILE : BASE.RRF

BOUNDARY FILE : CPP BSF
CALCULATED : 14 – MAY – 1992, 12:05









S W M C

Compartmentalization Pilot Project
Tangail Compartment, FAP 20
Computed discharges

MIKE 11

DATA FILE : BASE.RDF
RESULT FILE : BASE.RRF

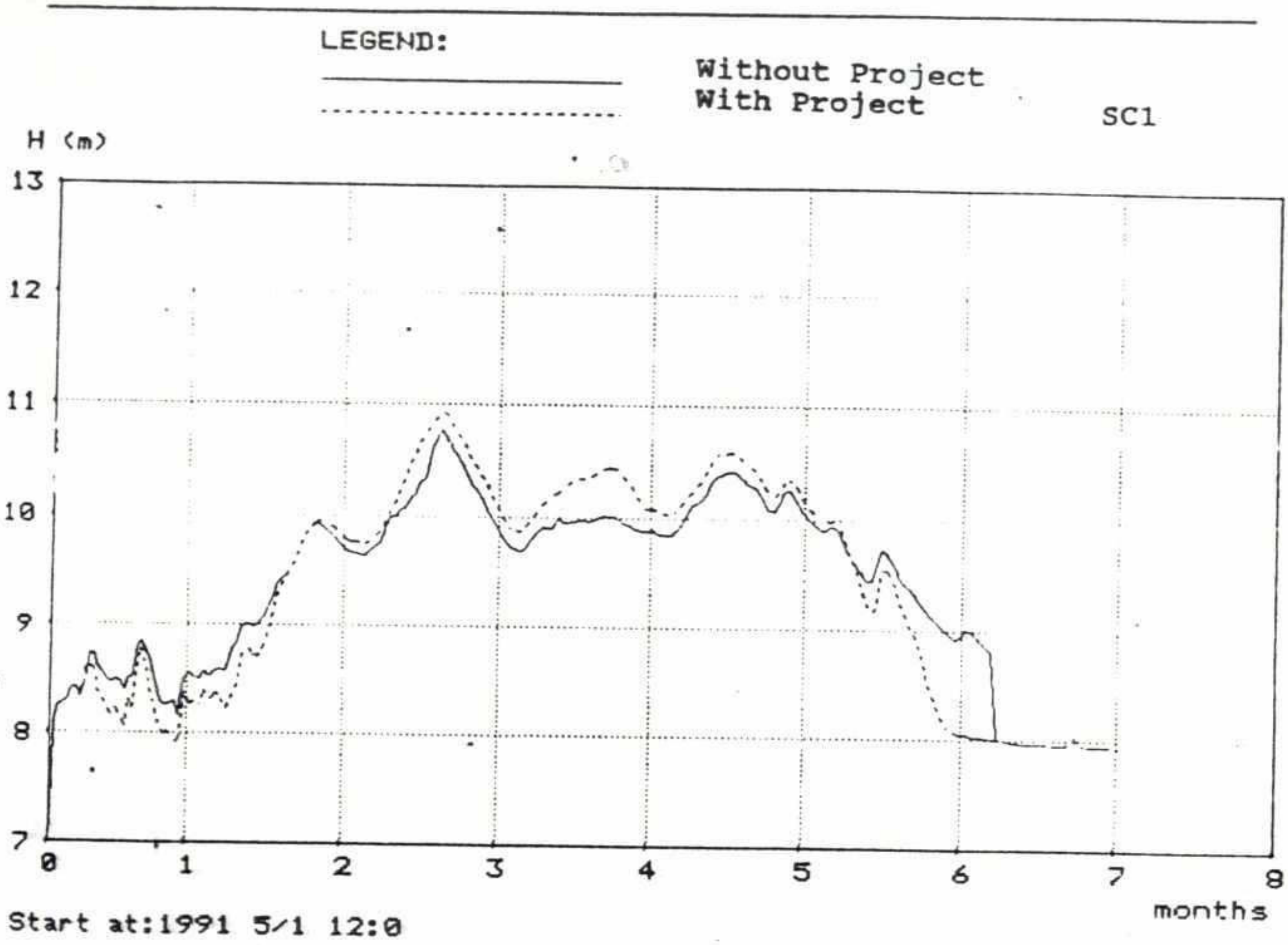
BOUNDARY FILE : CPP.BSF
CALCULATED : 14 – MAY – 1992, 12:05

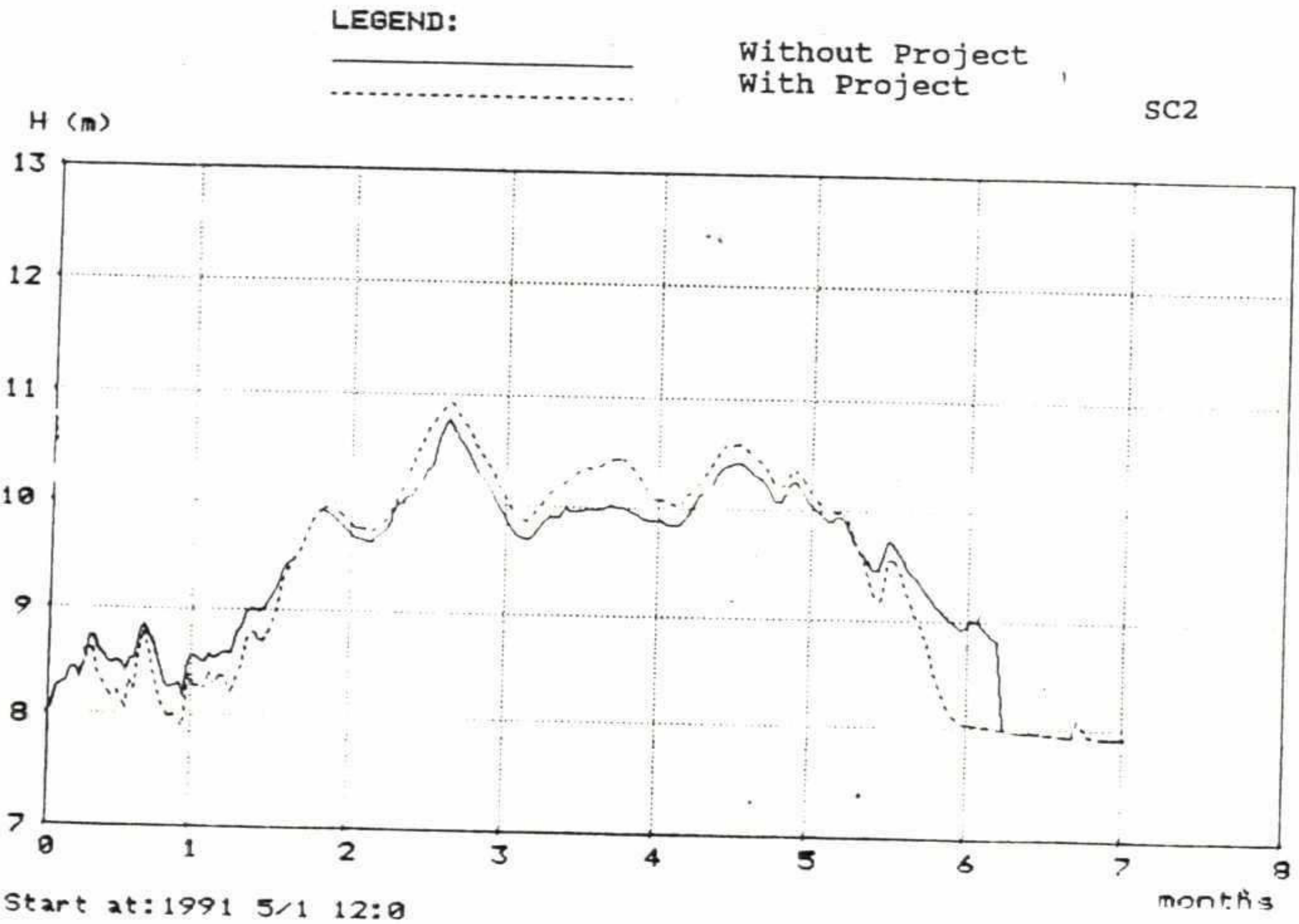
Dwg no.:

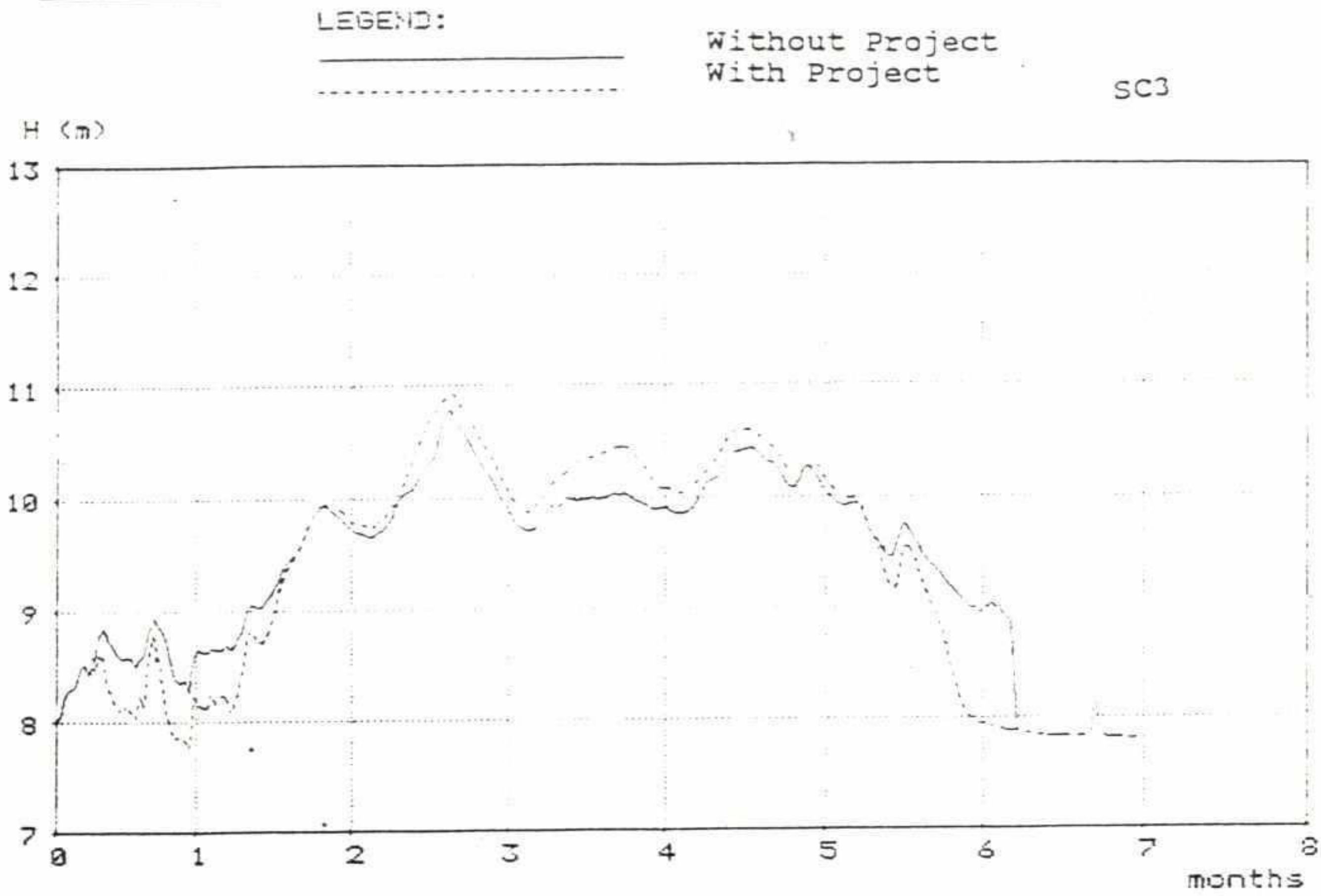
Appendix 4.3

1991 Simulated water levels of Without and With Project situation in SC1 to SC15.

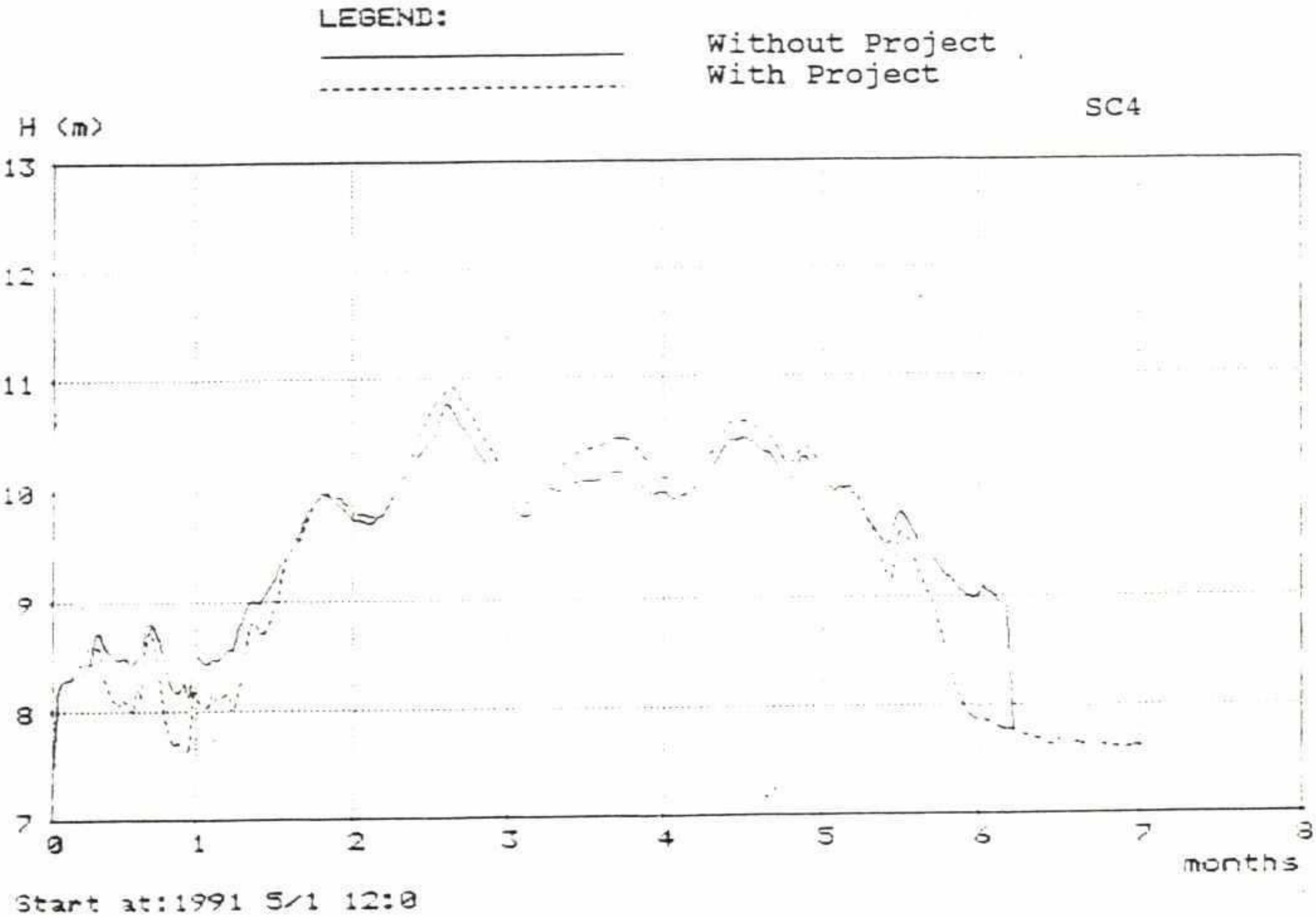
86


LEGEND:
Without Project
With Project
SC1
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1991 5/1 12:0


LEGEND:
Without Project
With Project
SC2
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1991 5/1 12:0



Start at:1991 5/1 12:0

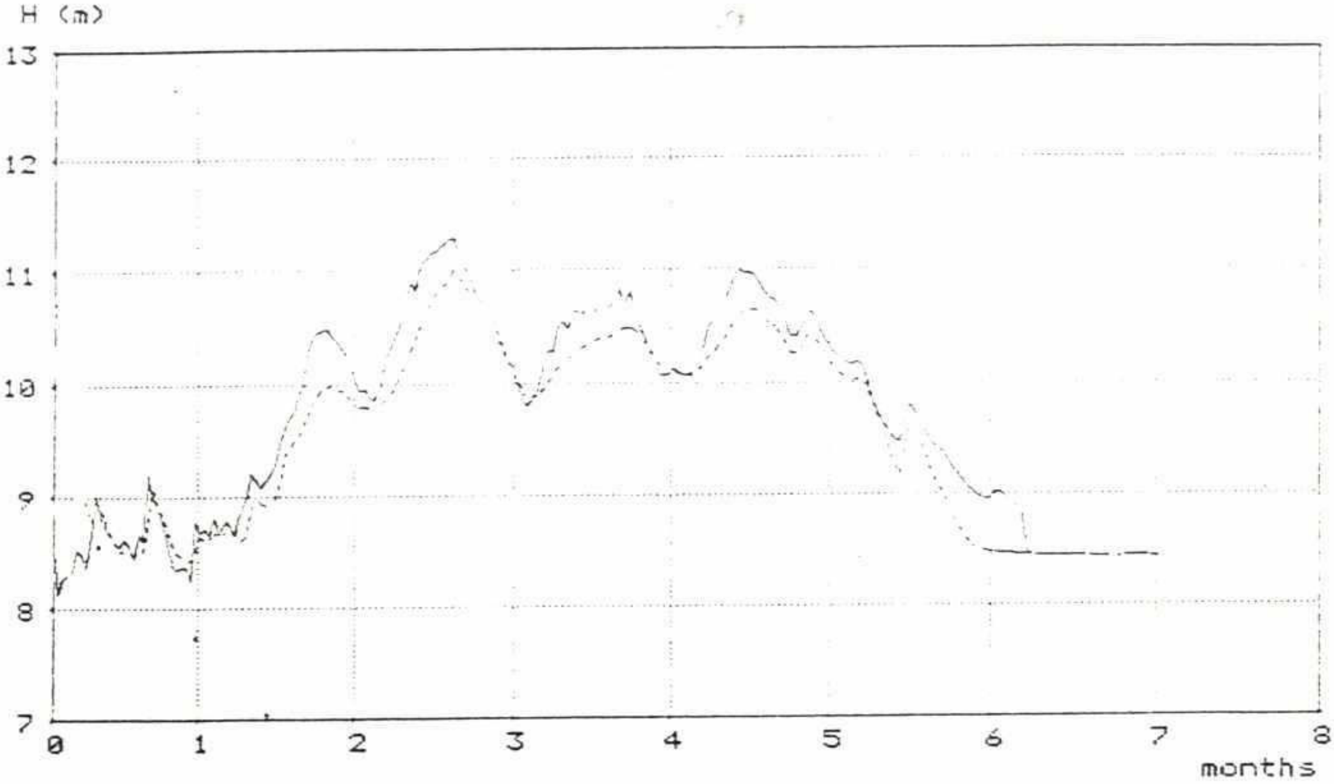


Start at:1991 5/1 12:0

LEGEND:

Without Project
With Project

SC5

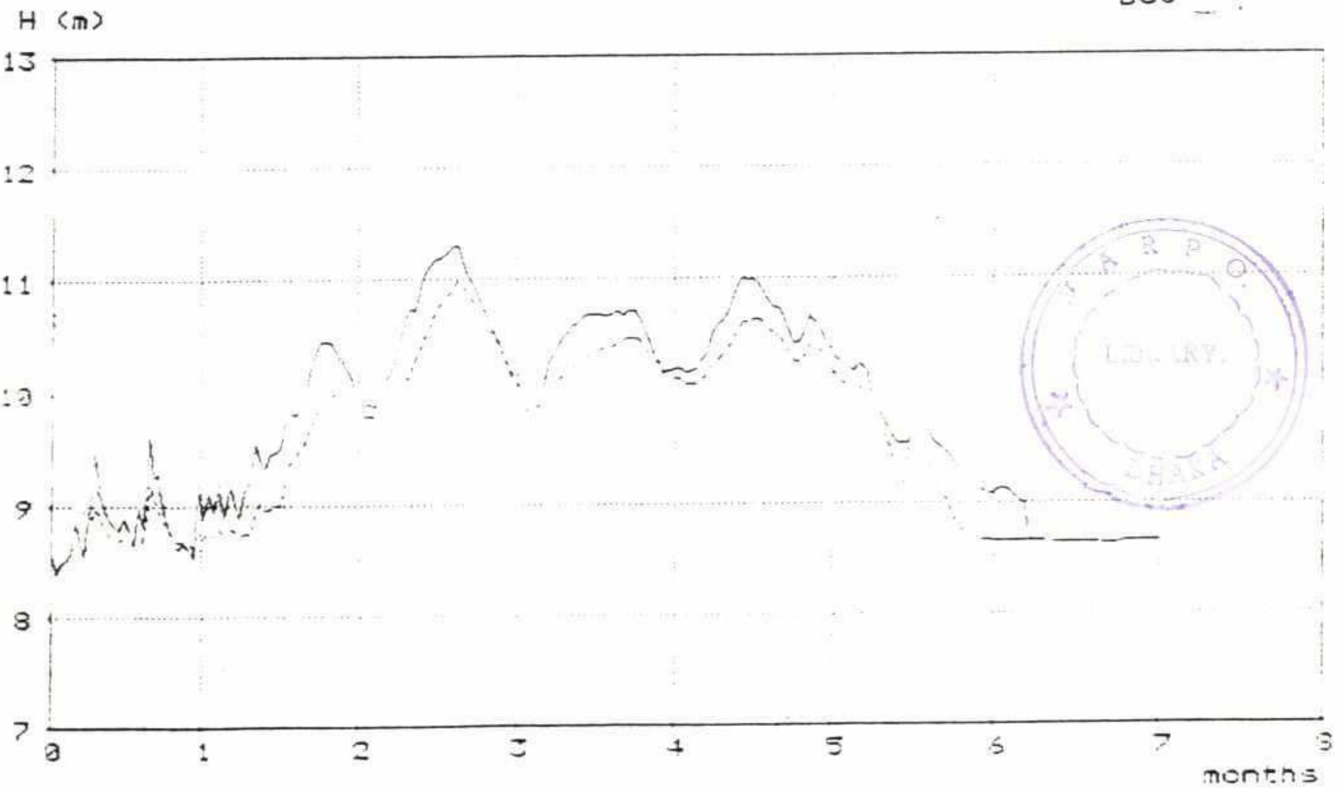


Start at:1991 5/1 12:0

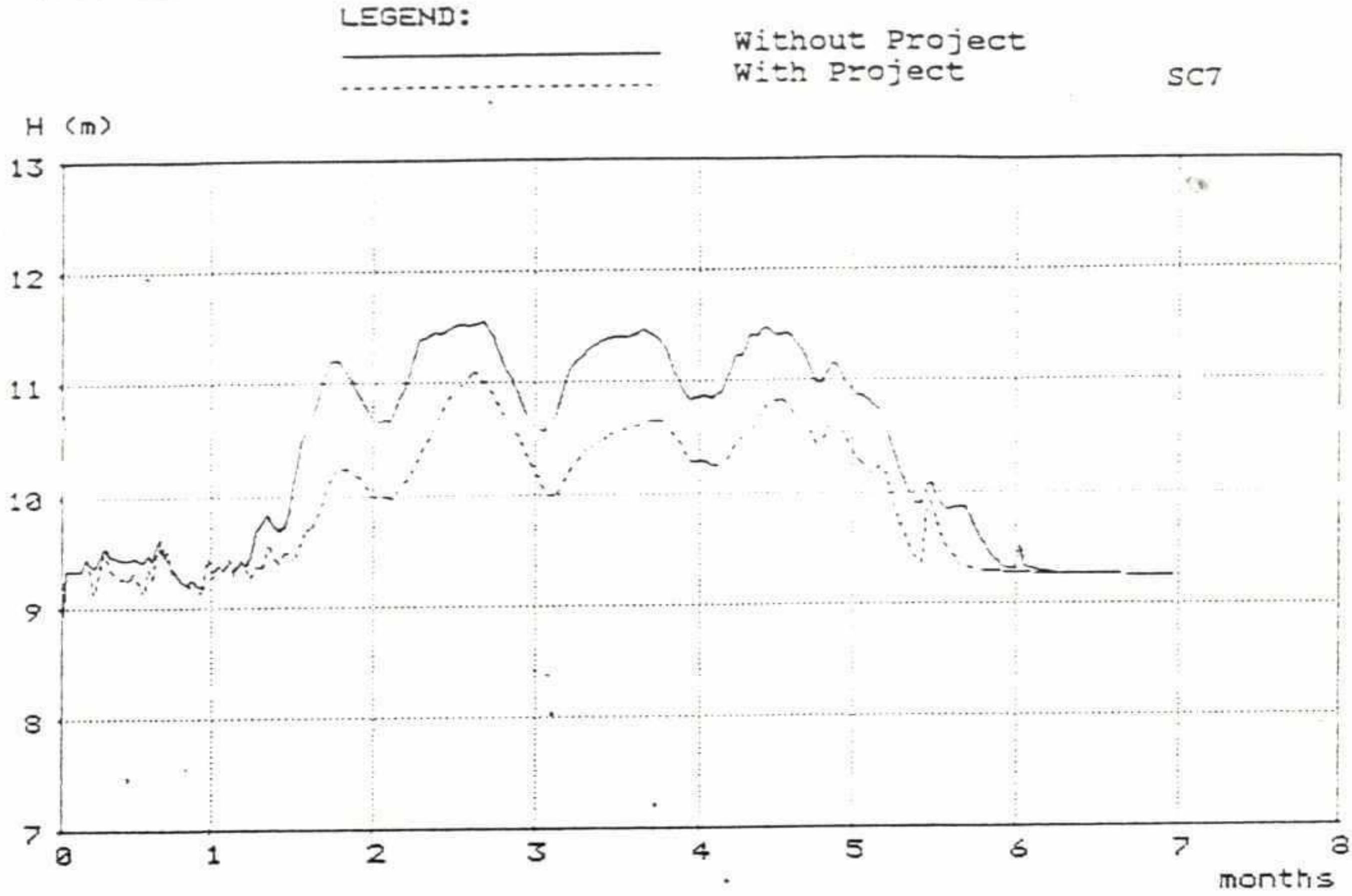
LEGEND:

Without Project
With Project

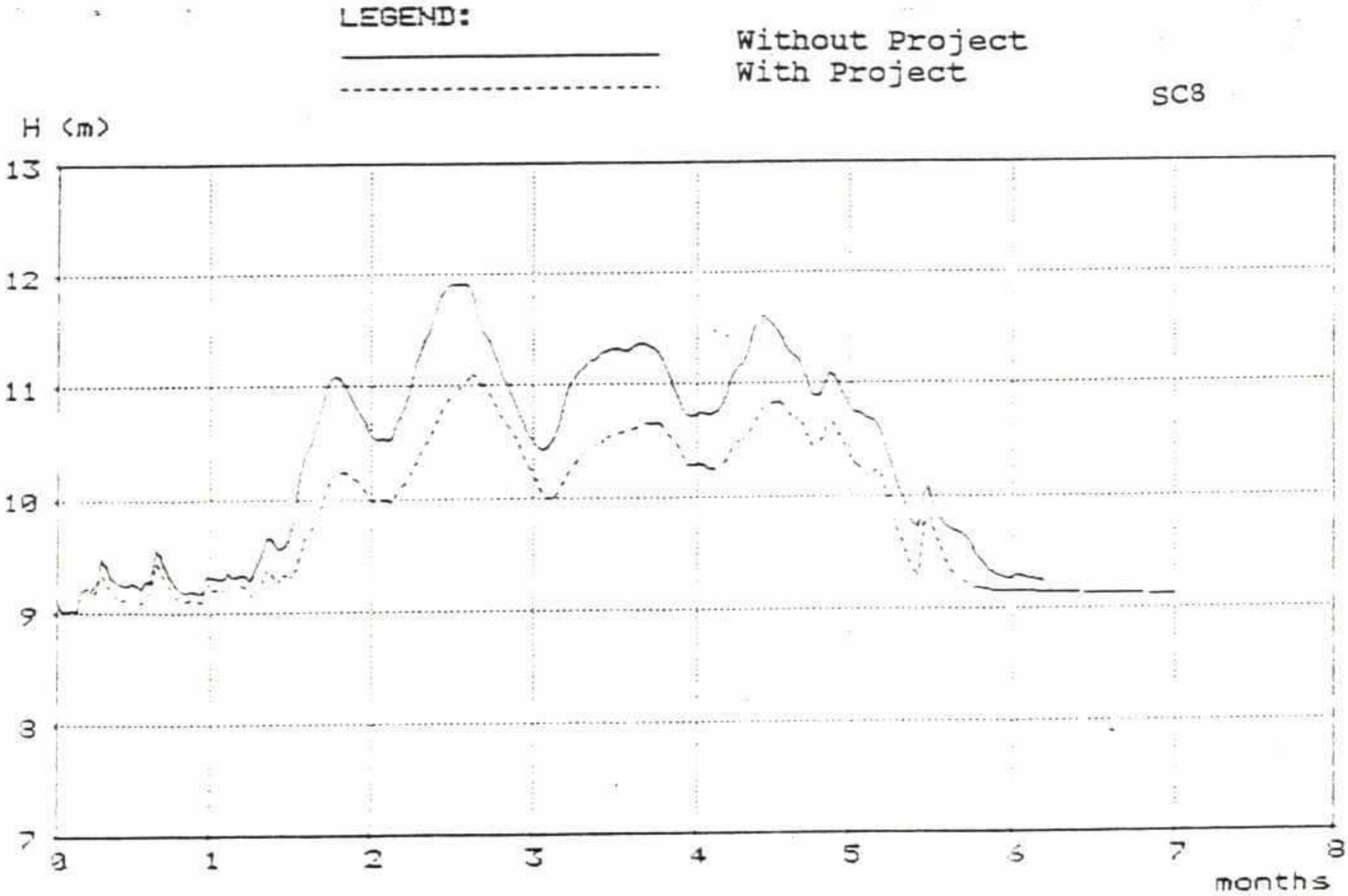
SC6



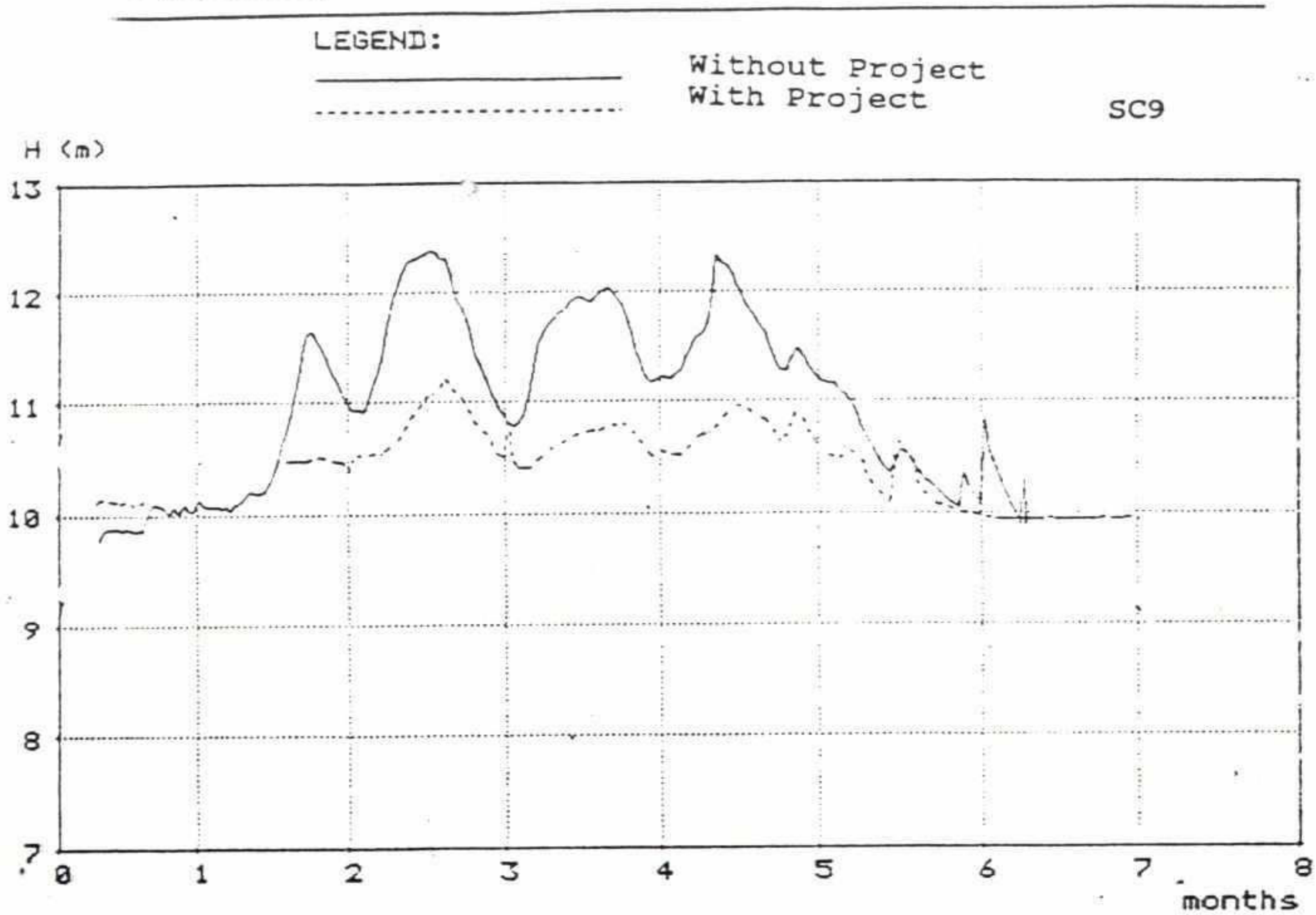
Start at:1991 5/1 12:0



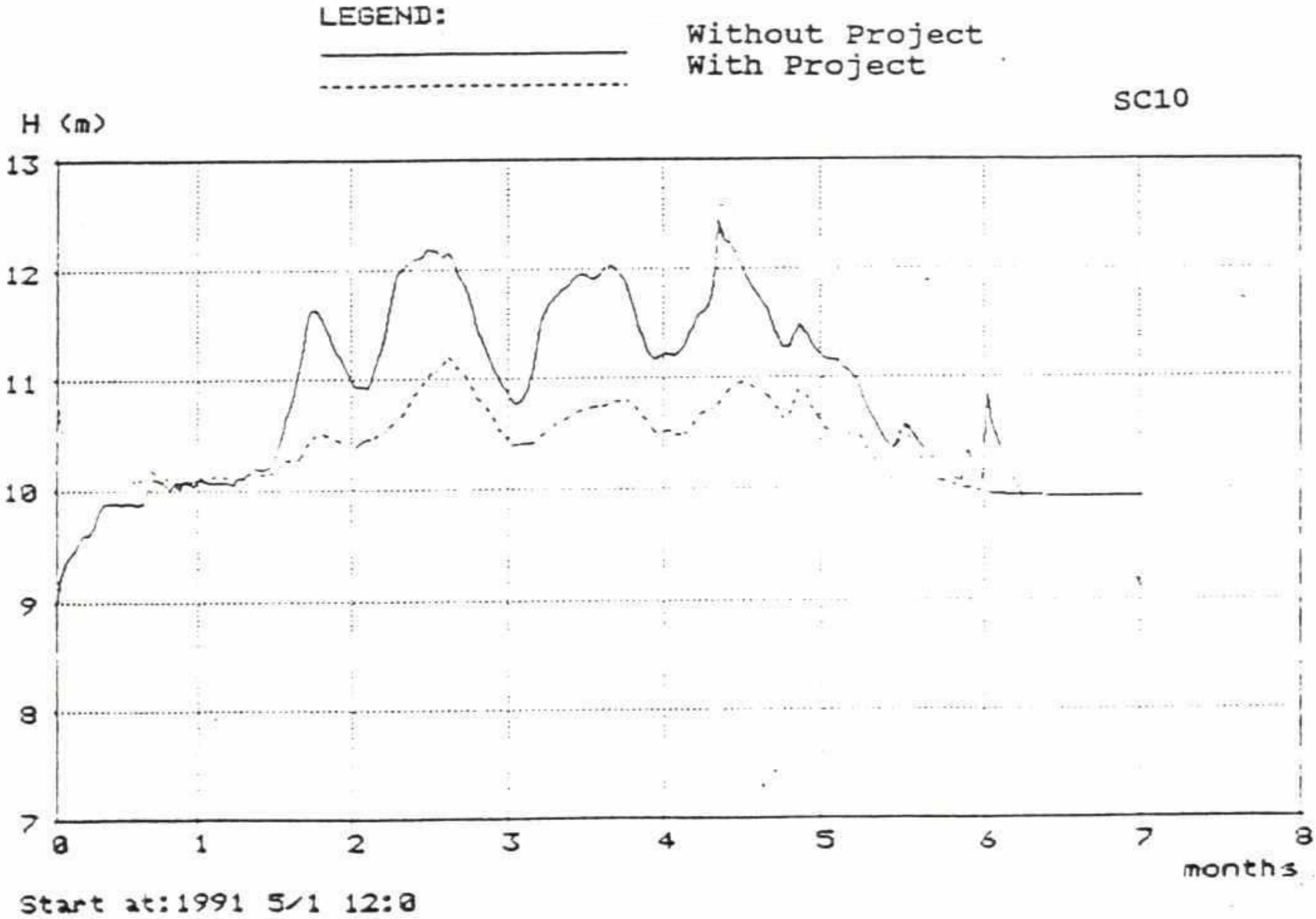
Start at:1991 5/1 12:0



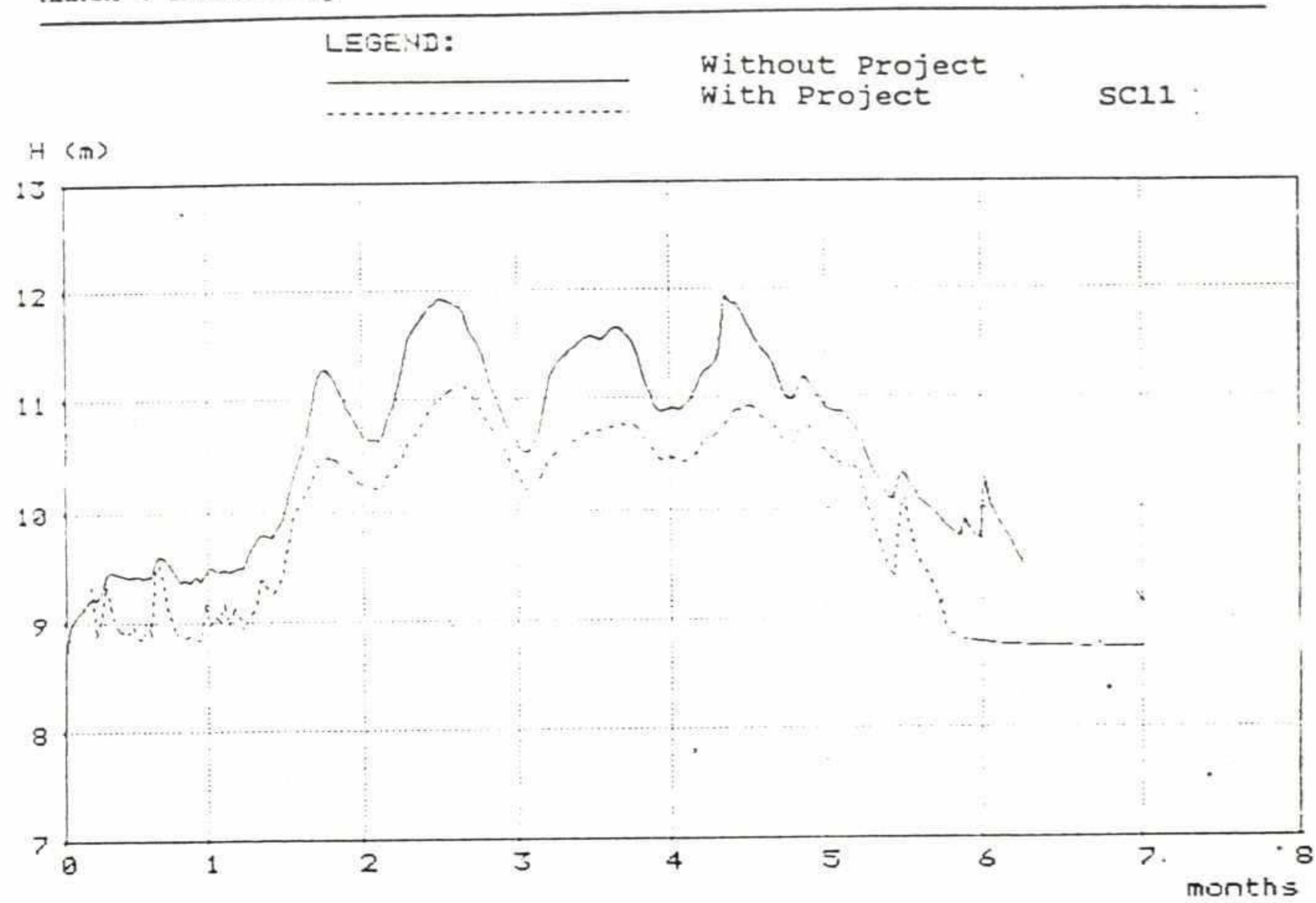
Start at:1991 5/1 12:0



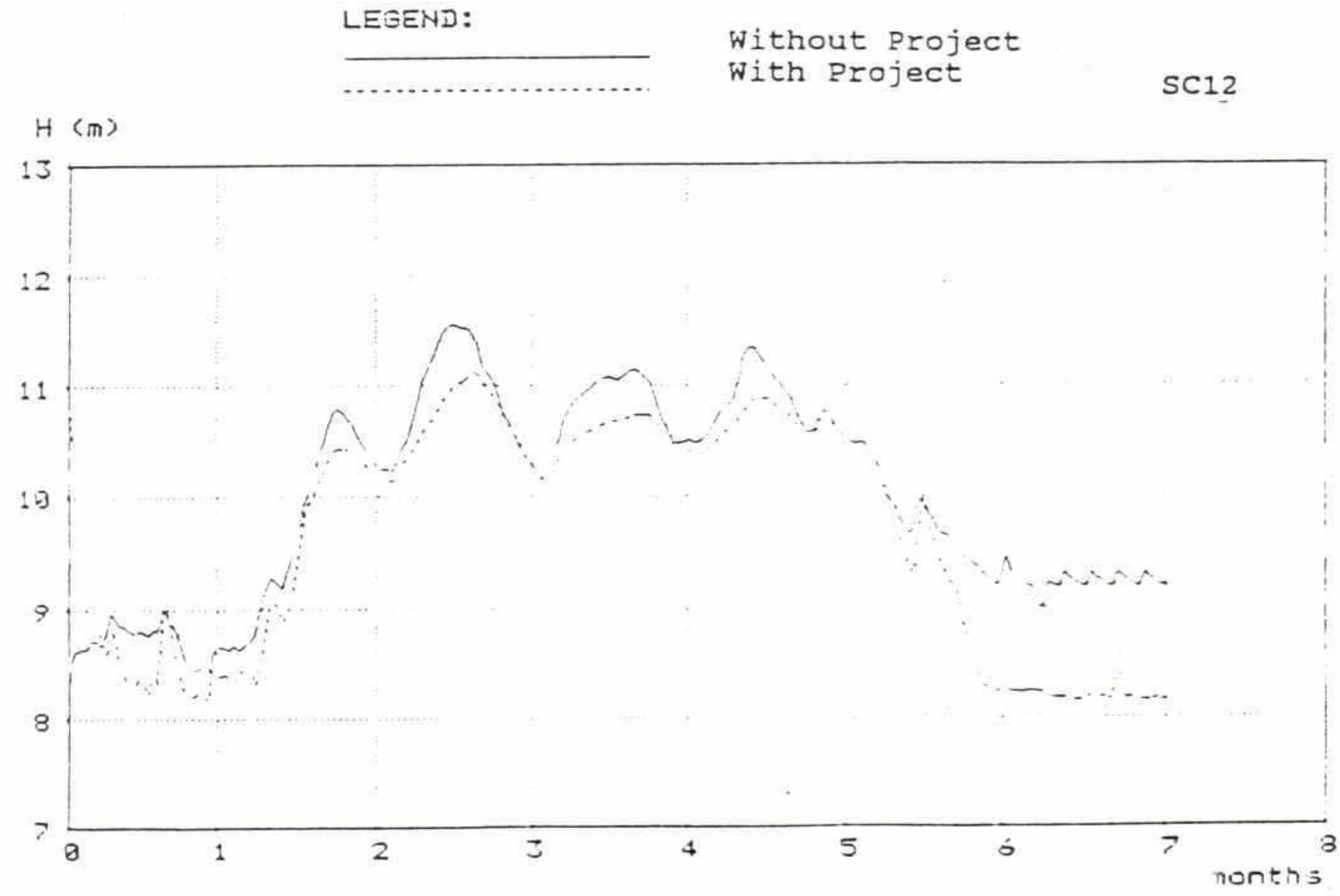
Start at:1991 5/1 12:0



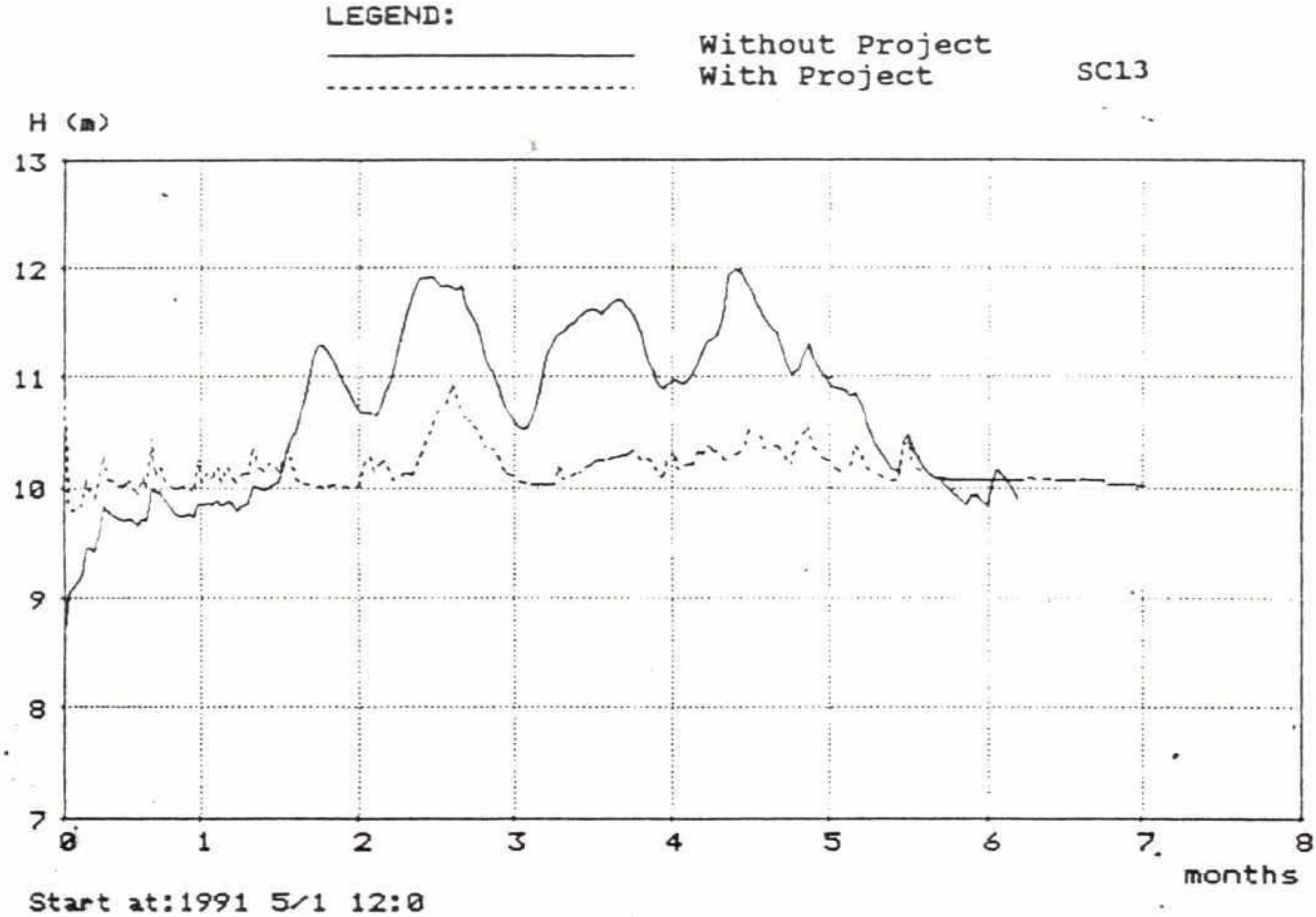
Start at:1991 5/1 12:0

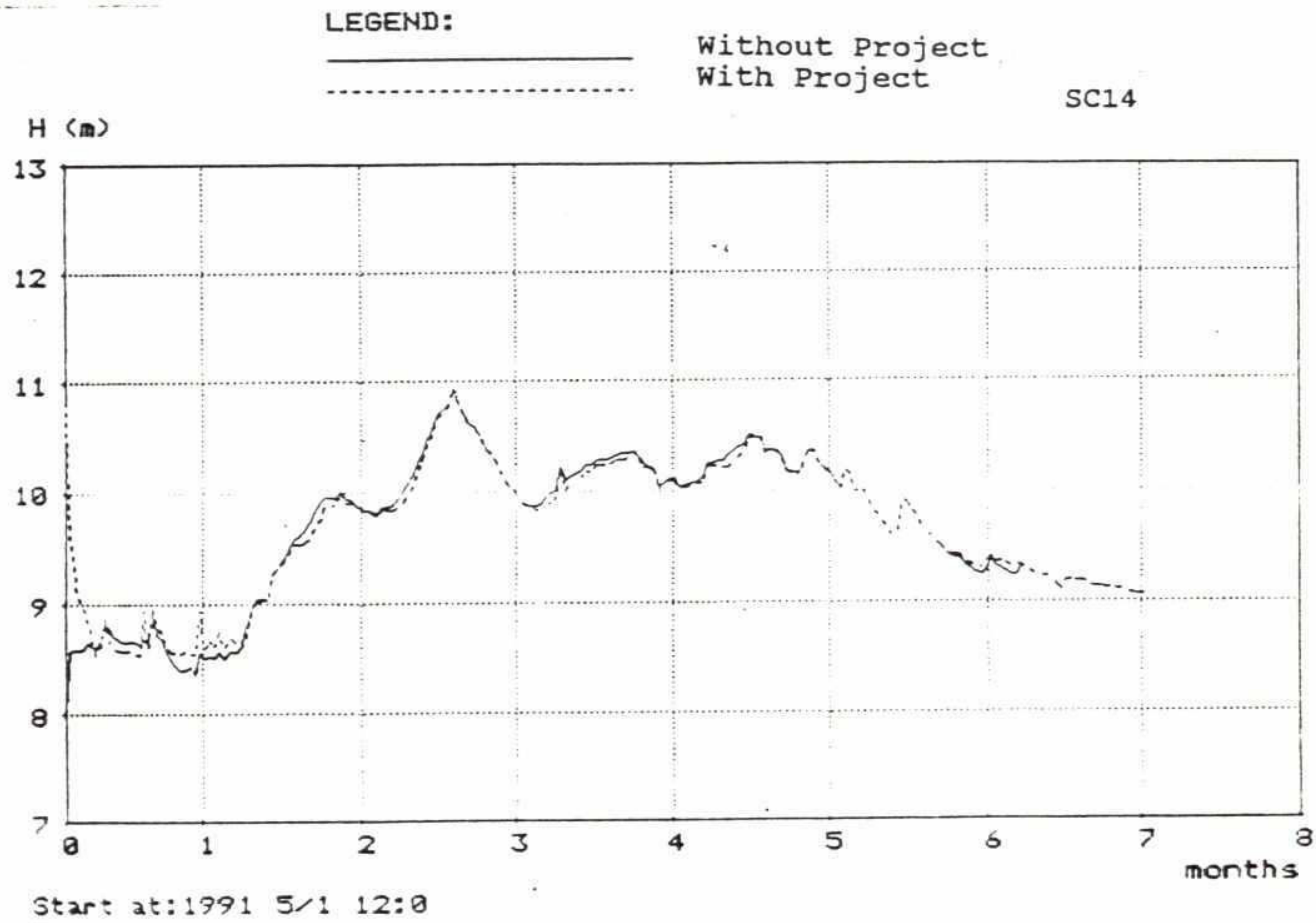


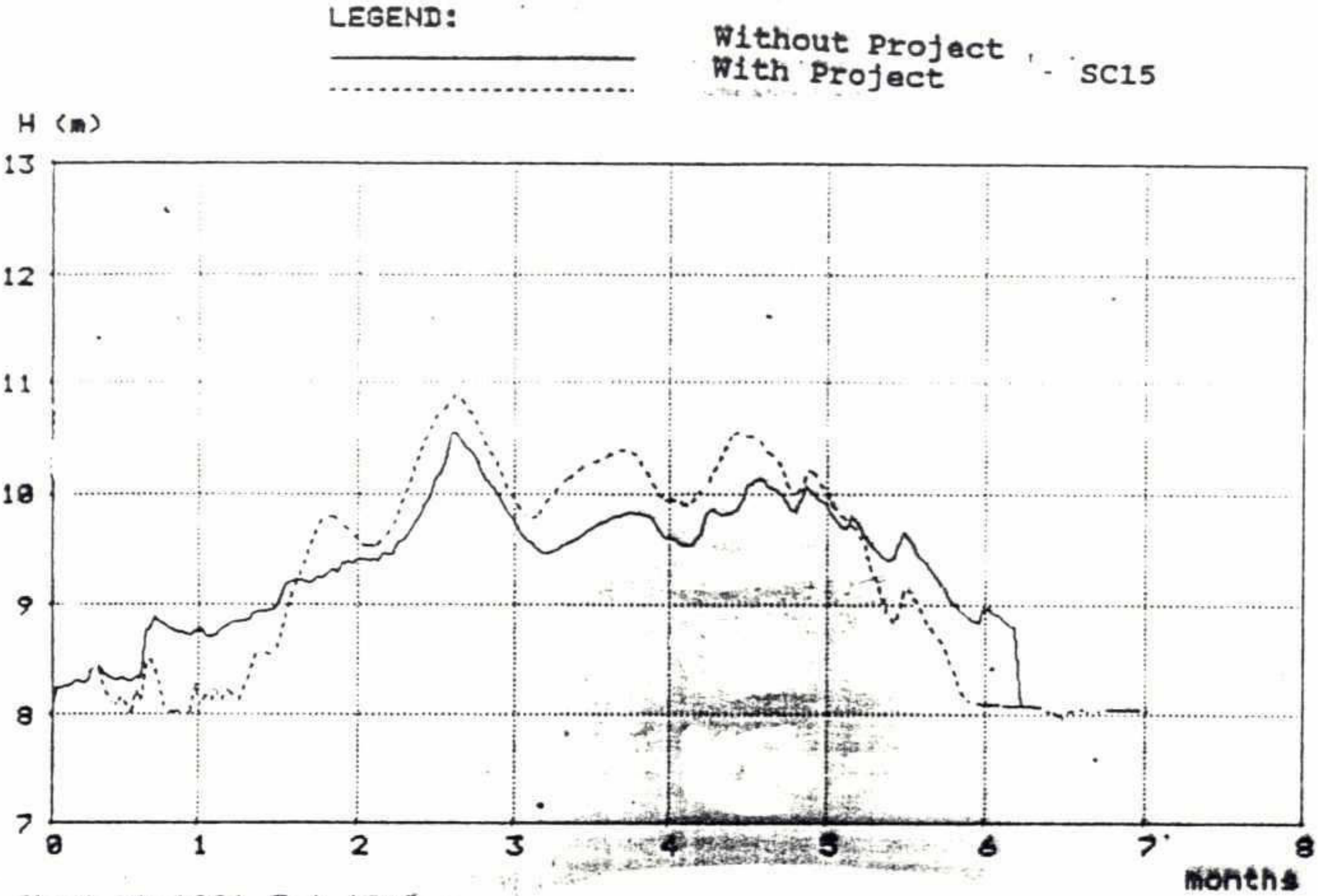
Start at:1991 5/1 12:0



Start at:1991 5/


LEGEND:
Without Project
With Project
SC13
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1991 5/1 12:0

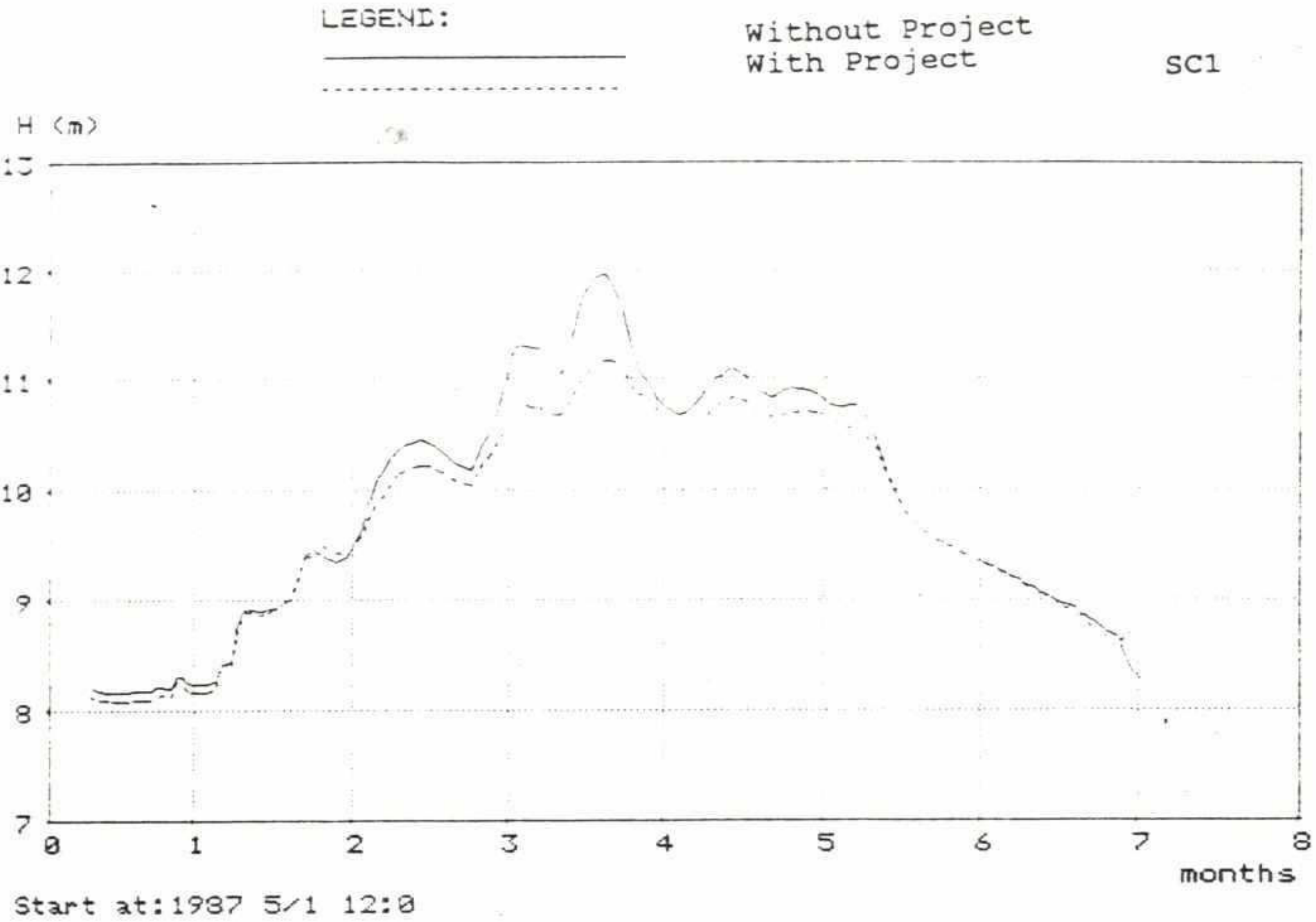

LEGEND:
Without Project
With Project
SC14
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1991 5/1 12:0

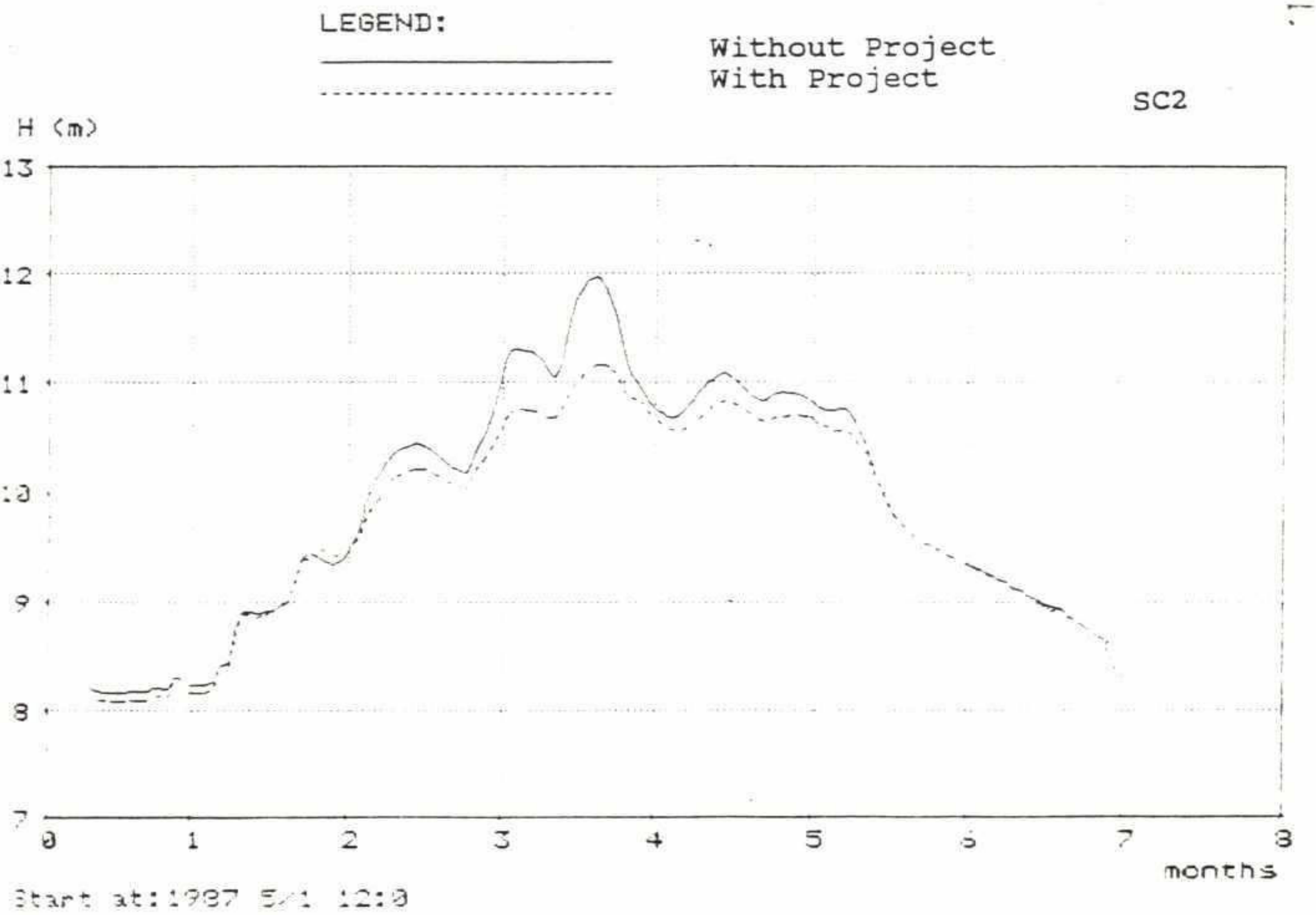


Start at:1991 5/1 12:0

Appendix 4.4

1987 Simulated water levels of Without and With Project situation in SC1 to SC15.

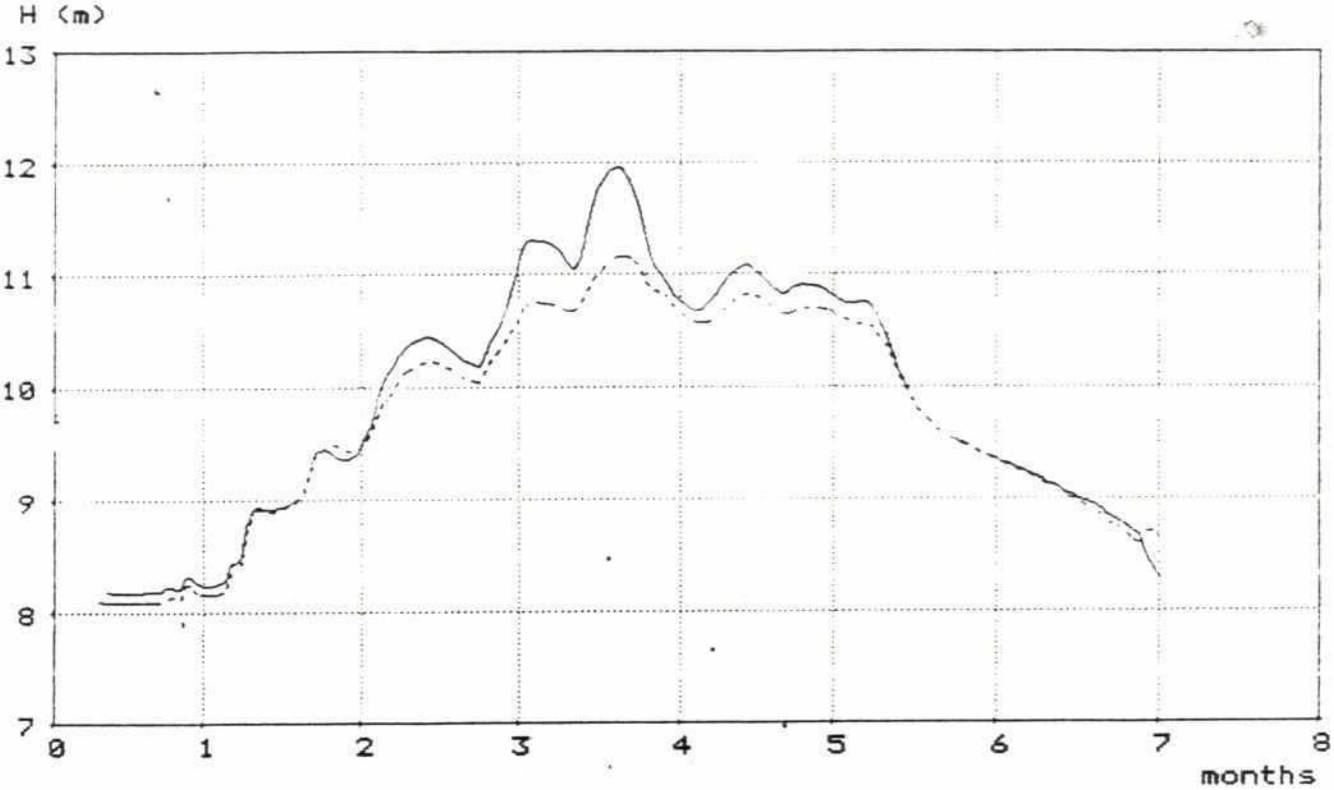

LEGEND:
Without Project
With Project
SC1
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1987 5/1 12:0


LEGEND:
Without Project
With Project
SC2
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1987 5/1 12:0

LEGEND:

Without Project
With Project

SC3

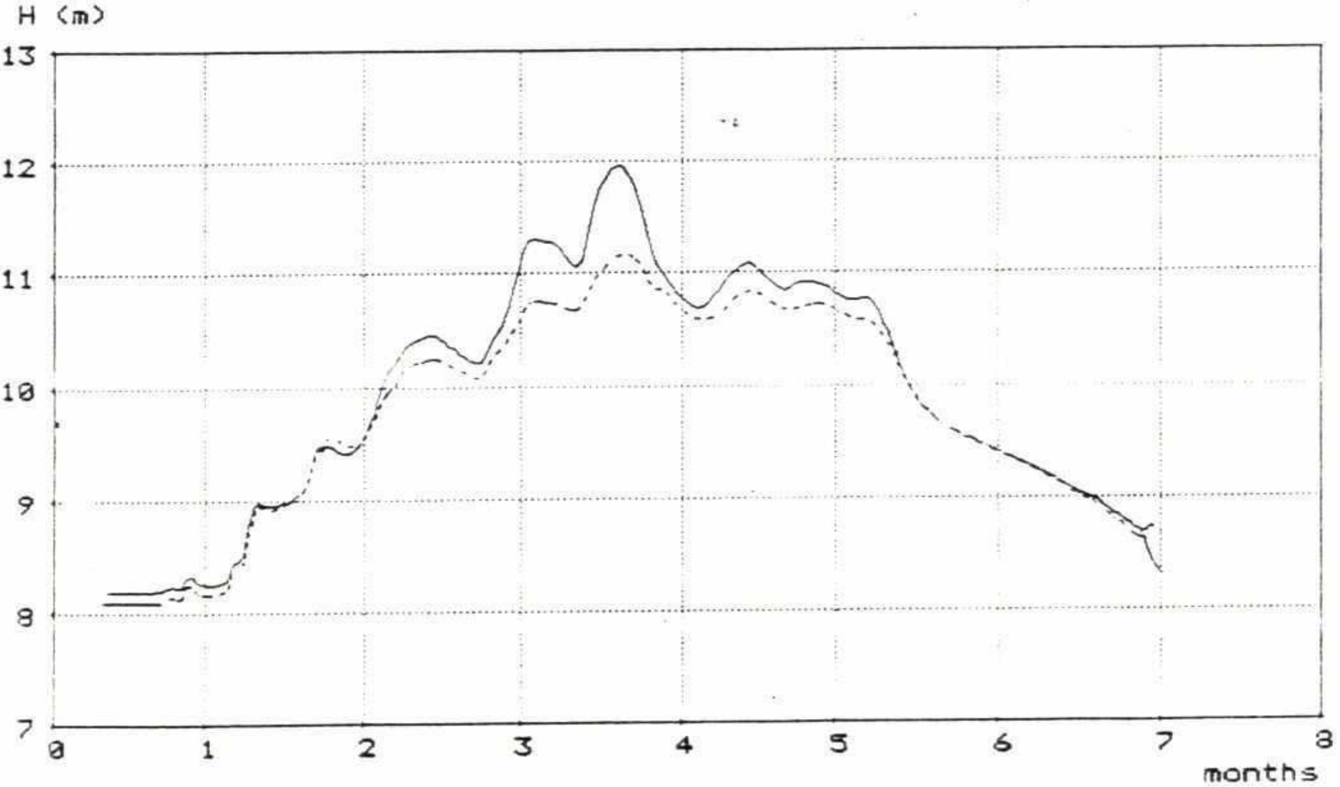


Start at:1987 5/1 12:0

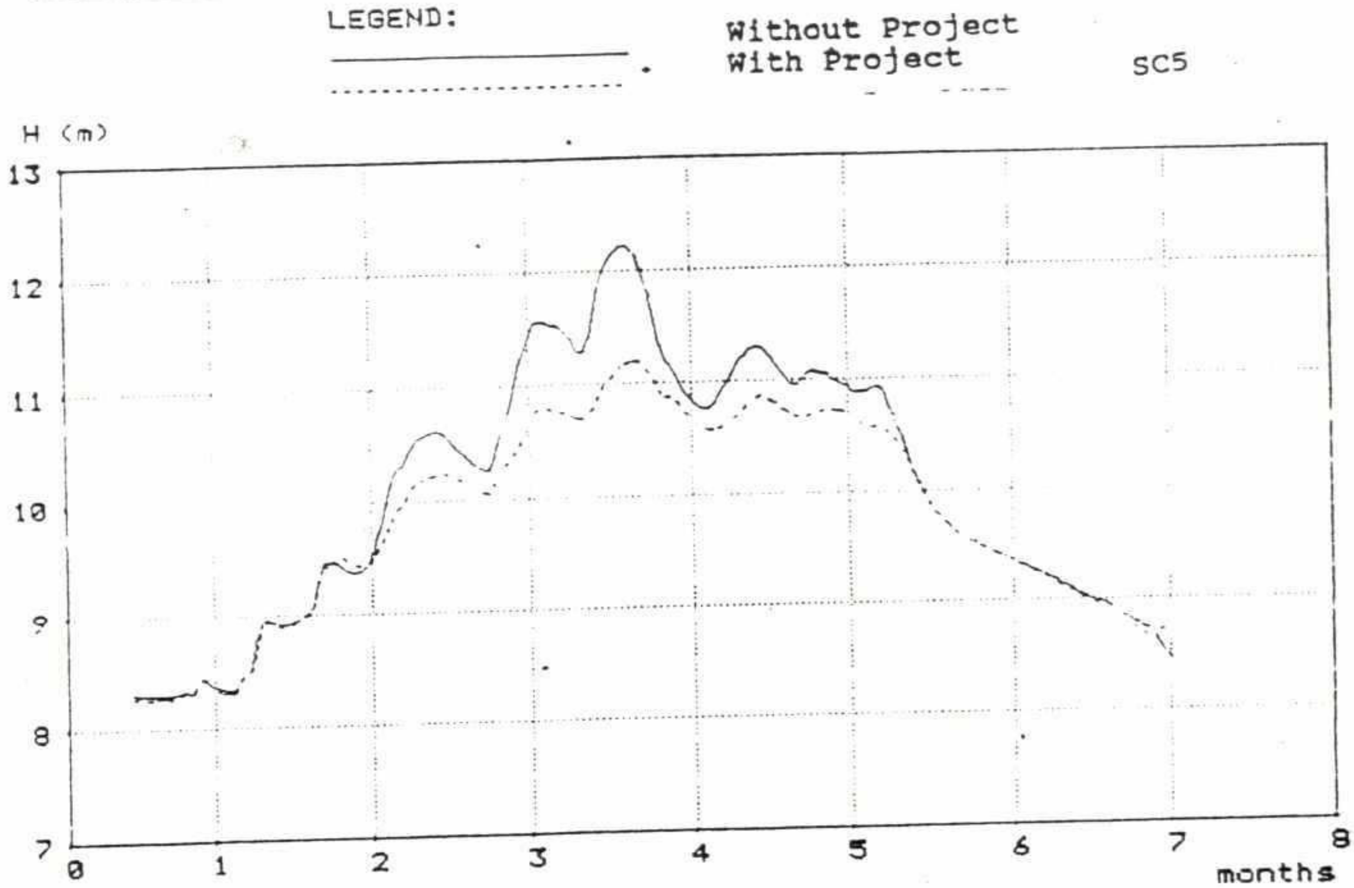
LEGEND:

Without Project
With Project

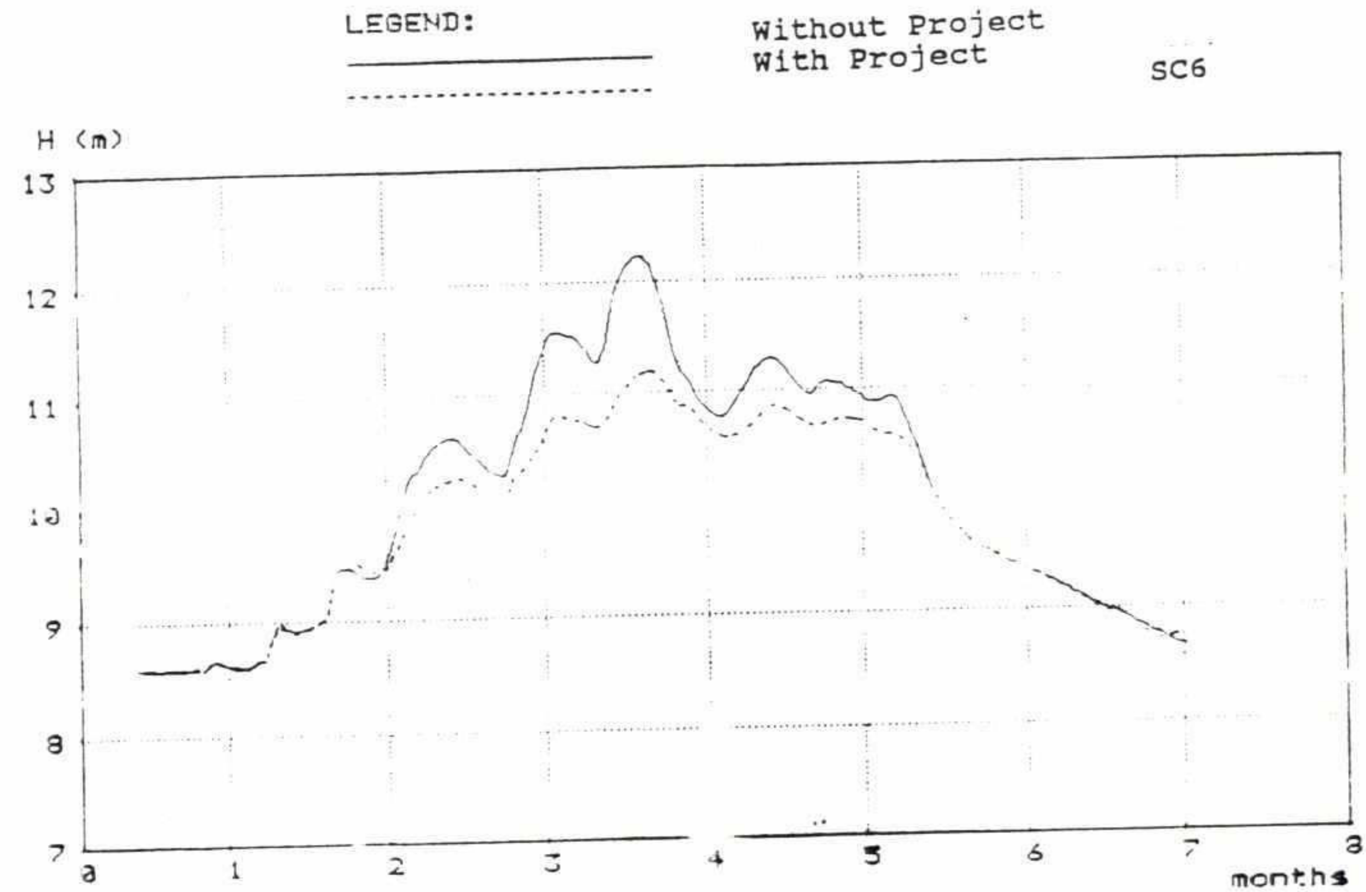
SC4



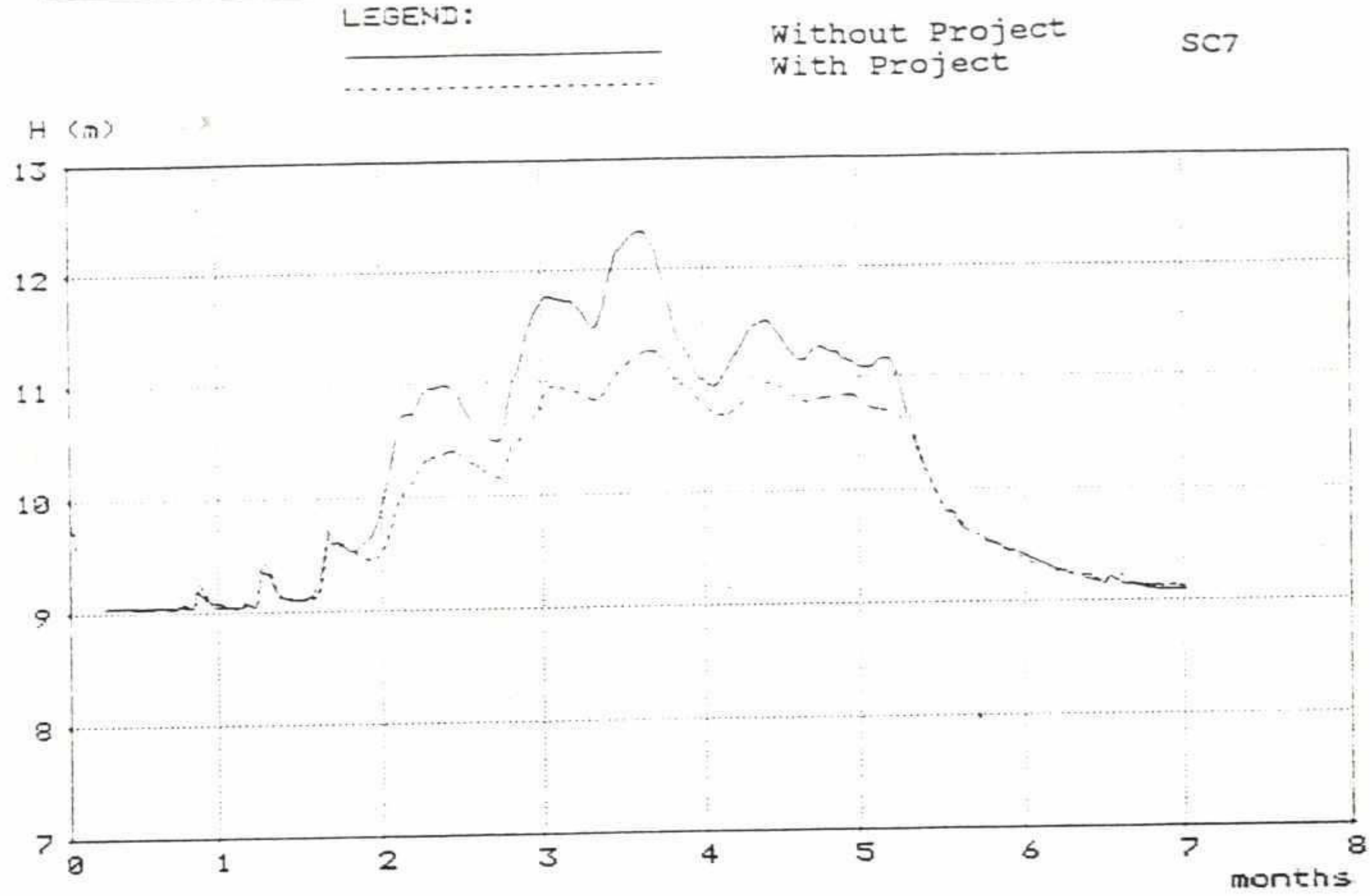
Start at:1987 5/1 12:0



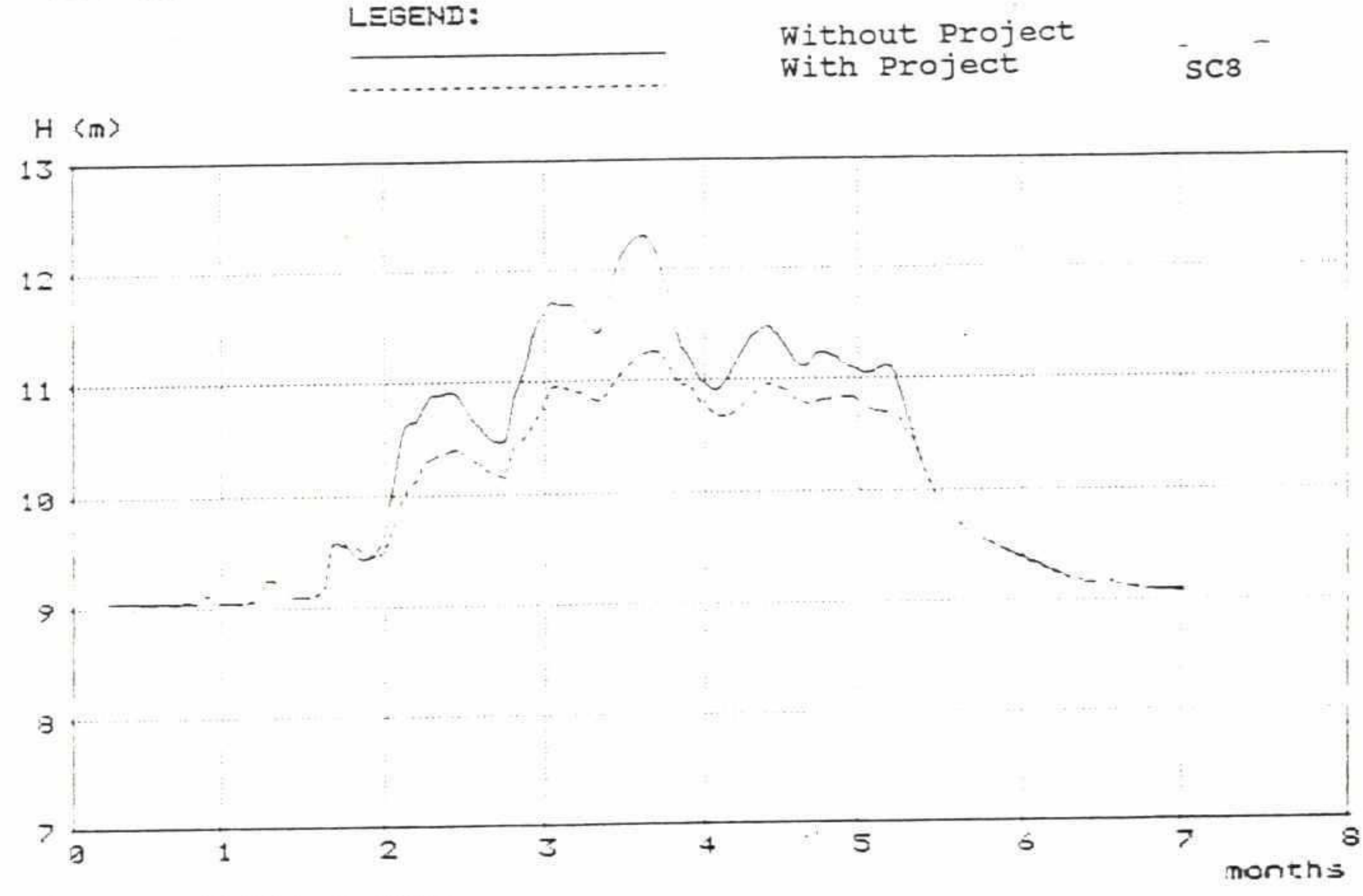
Start at:1987 5/1 12:0



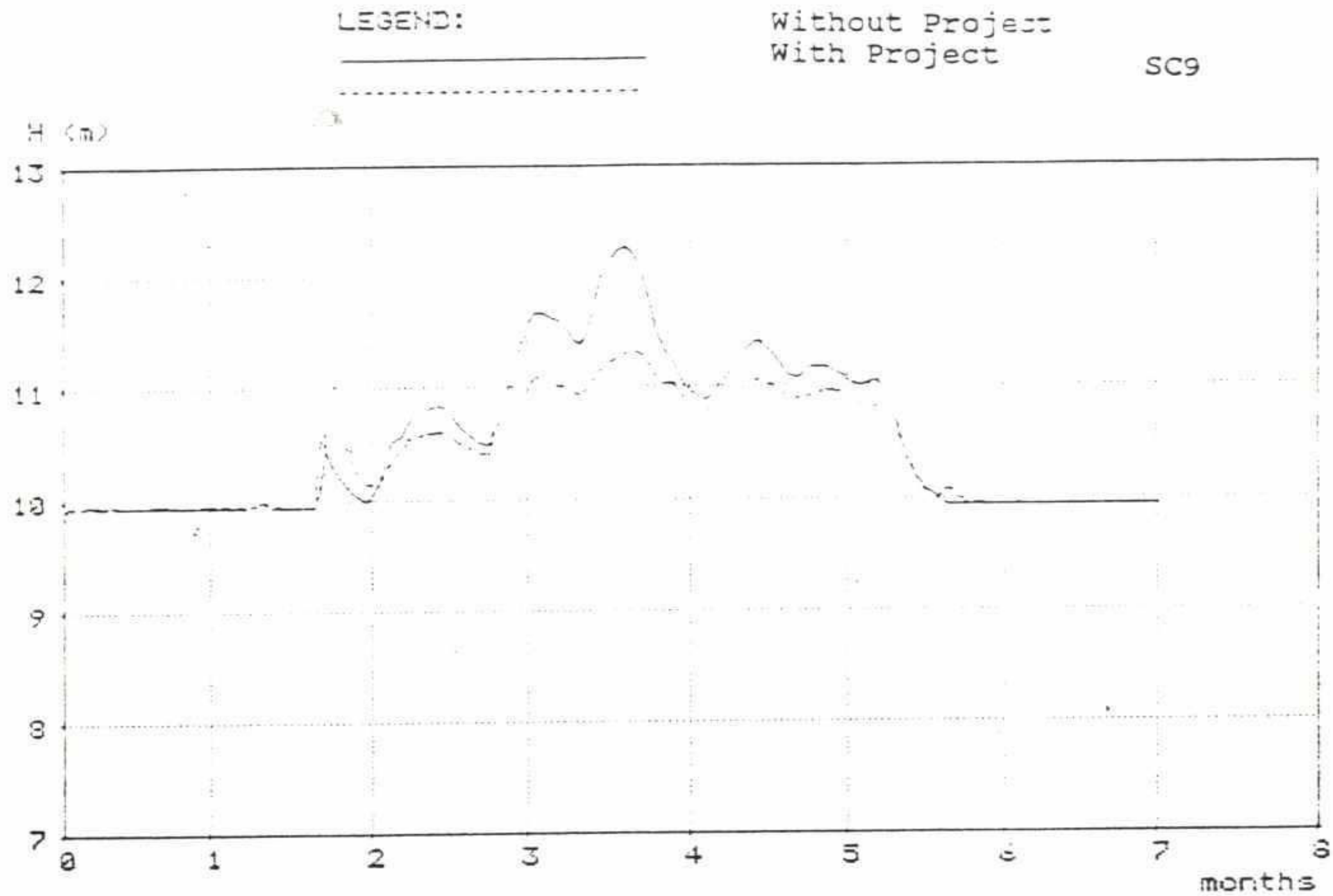
Start at:1987 5/1 12:0



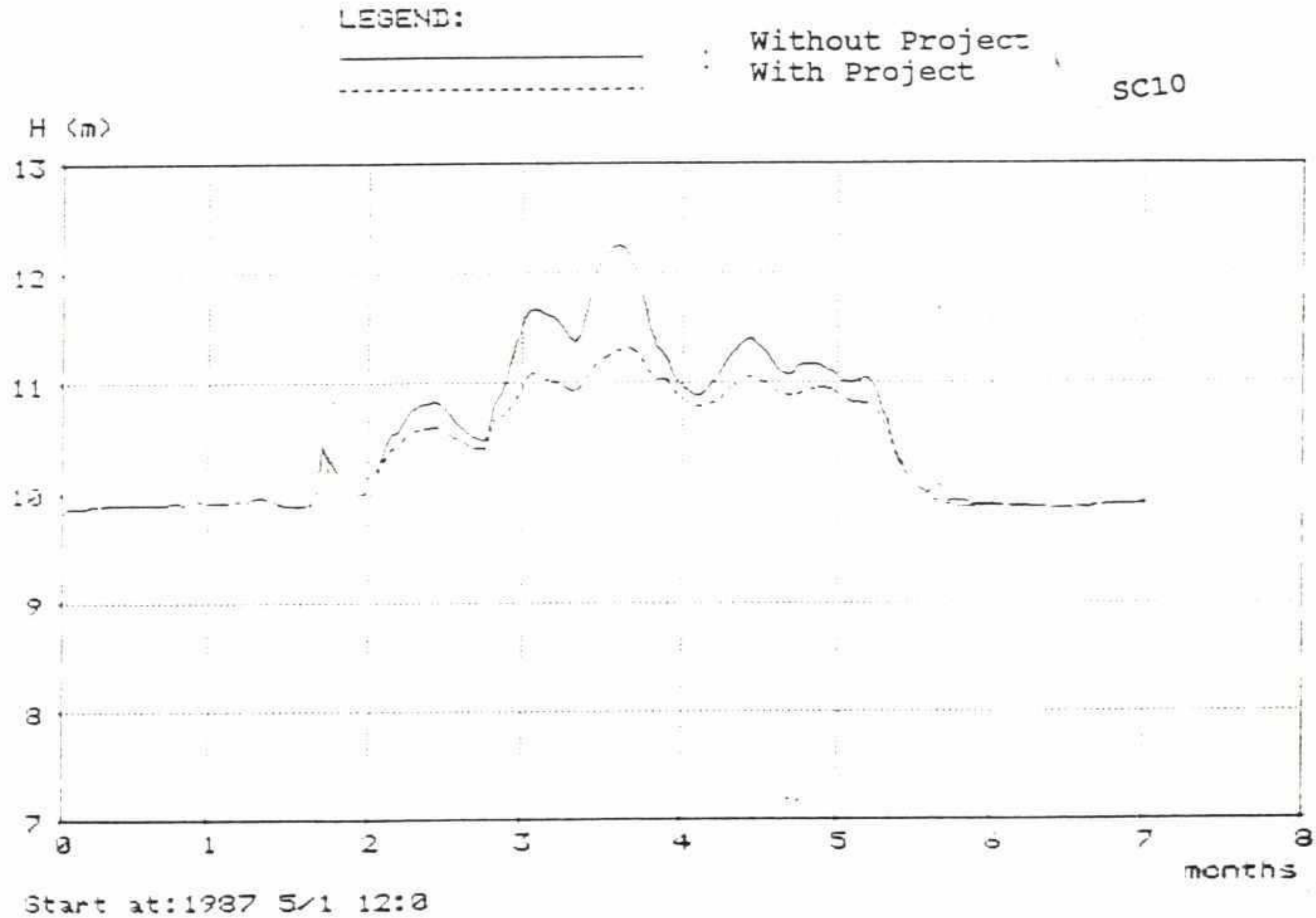
Start at:1987 5/1 12:0



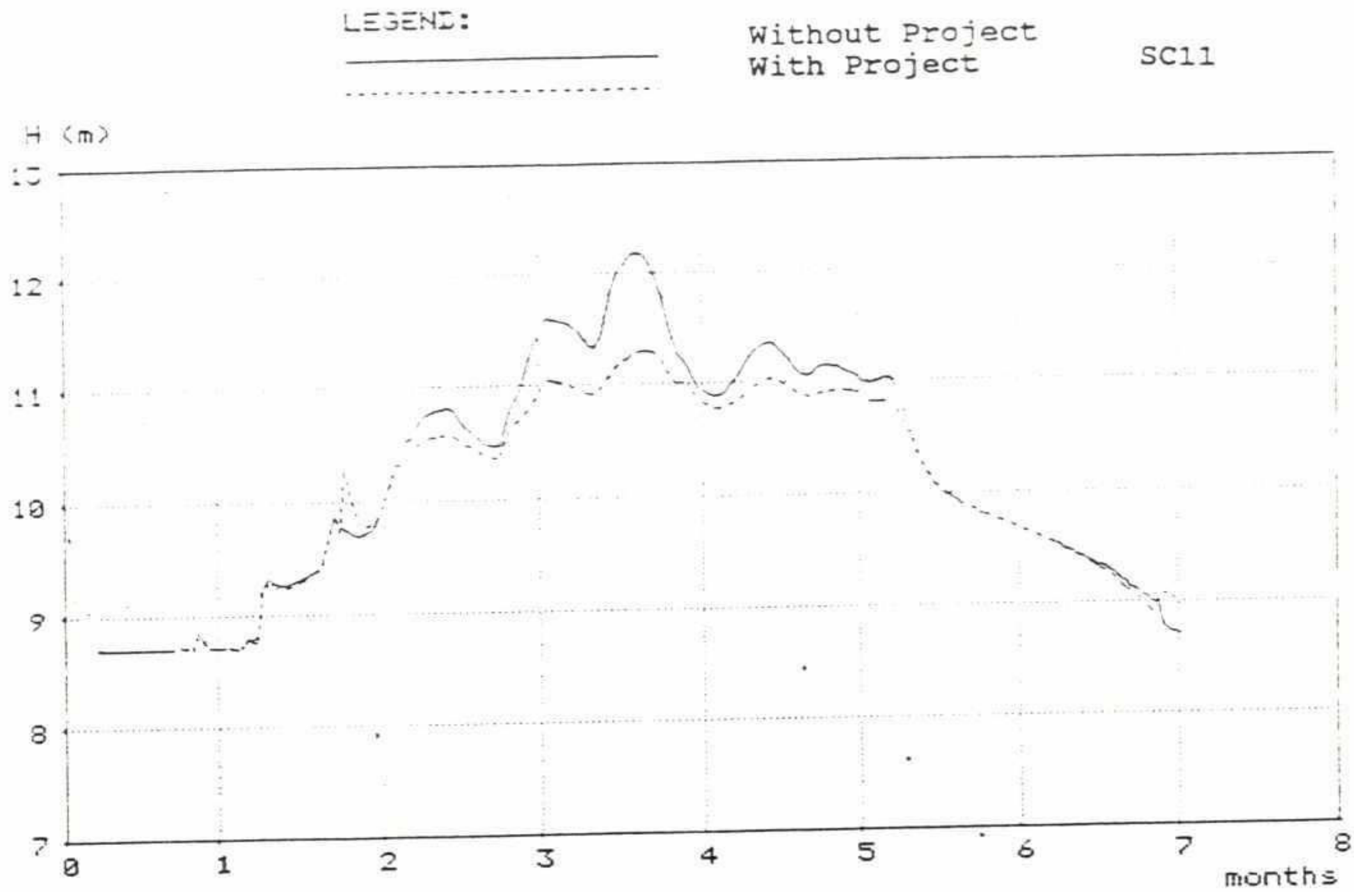
Start at:1987 5/1 12:0



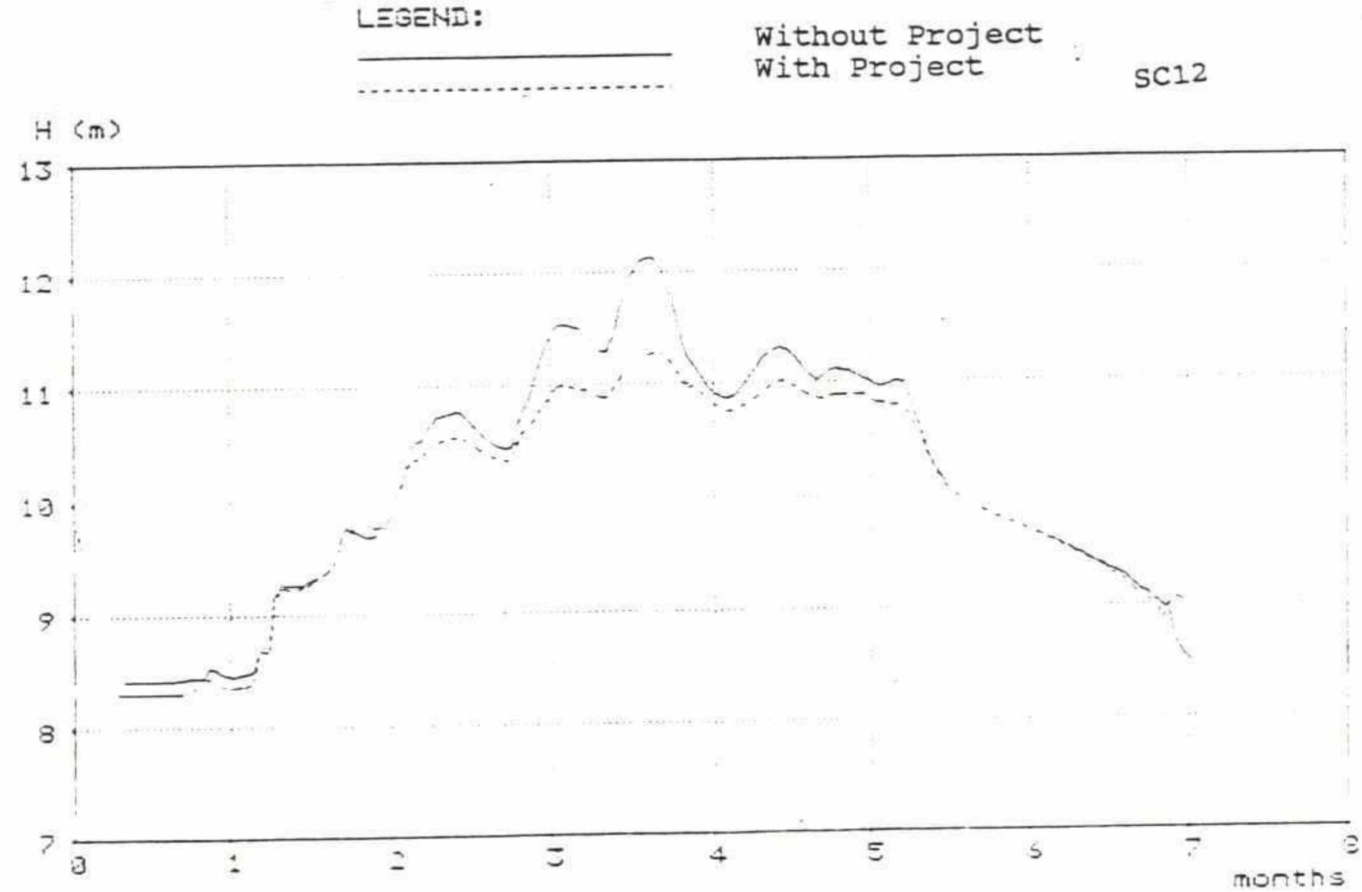
Start at:1987 5/1 12:0



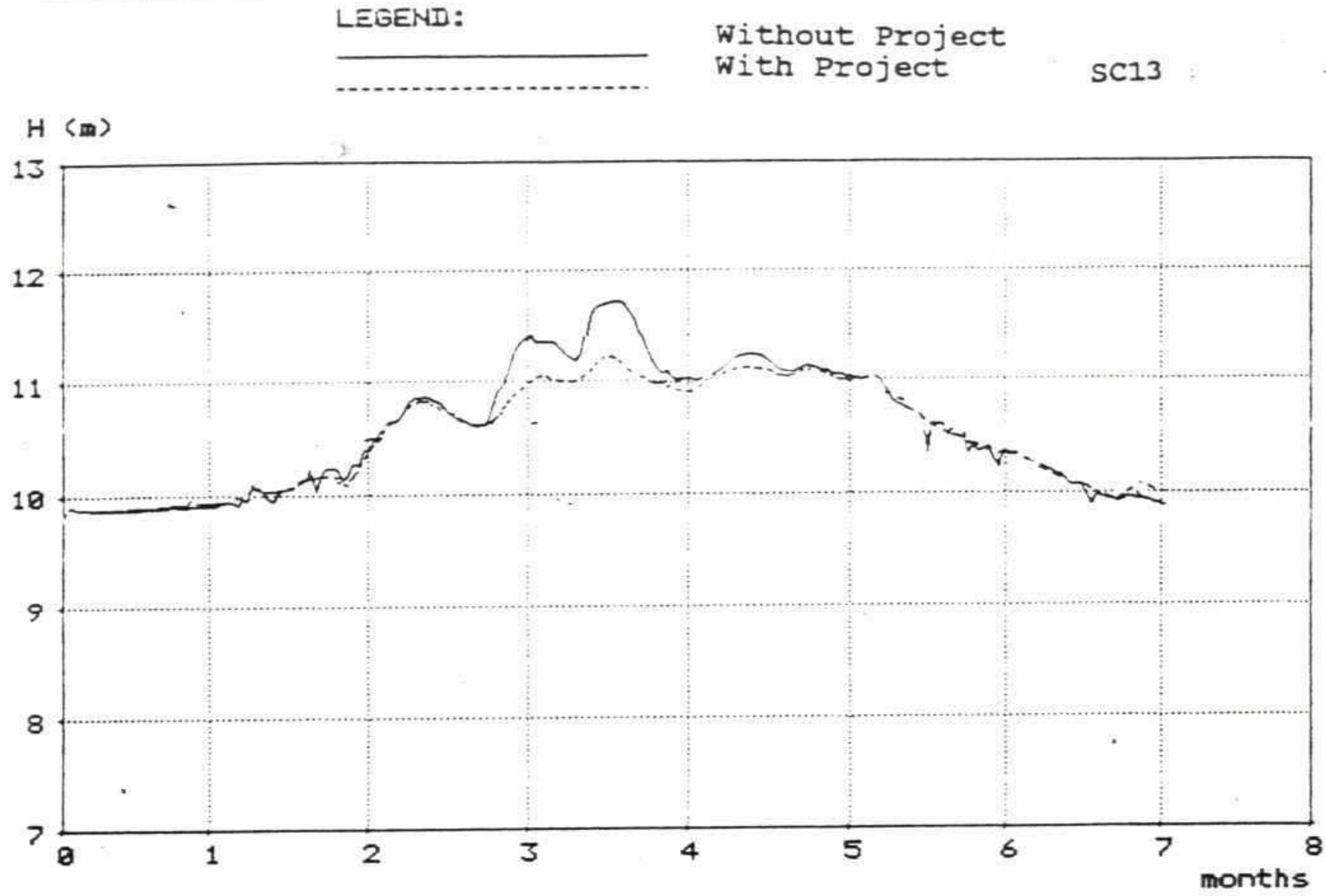
Start at:1987 5/1 12:0



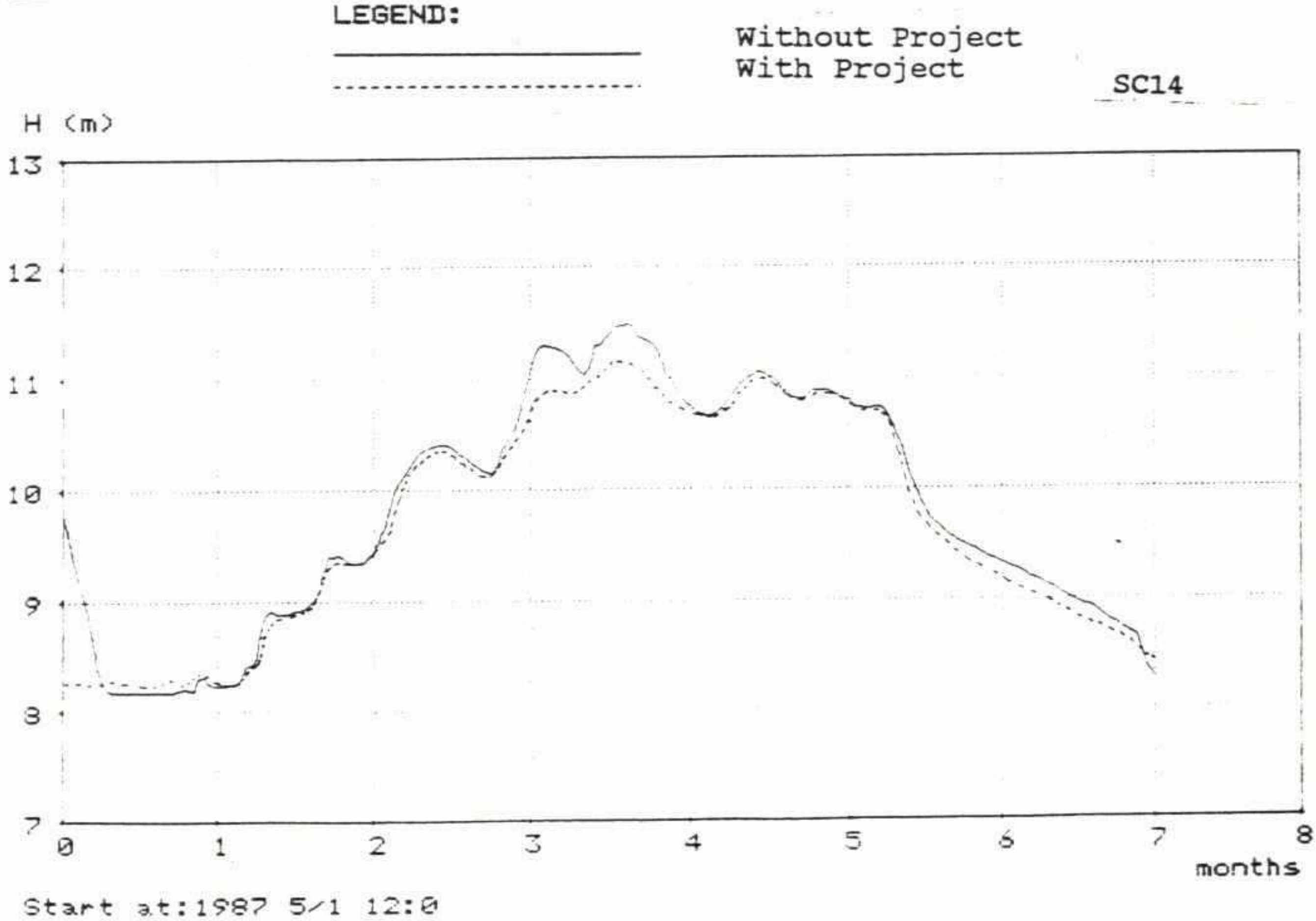
Start at:1987 5/1 12:0



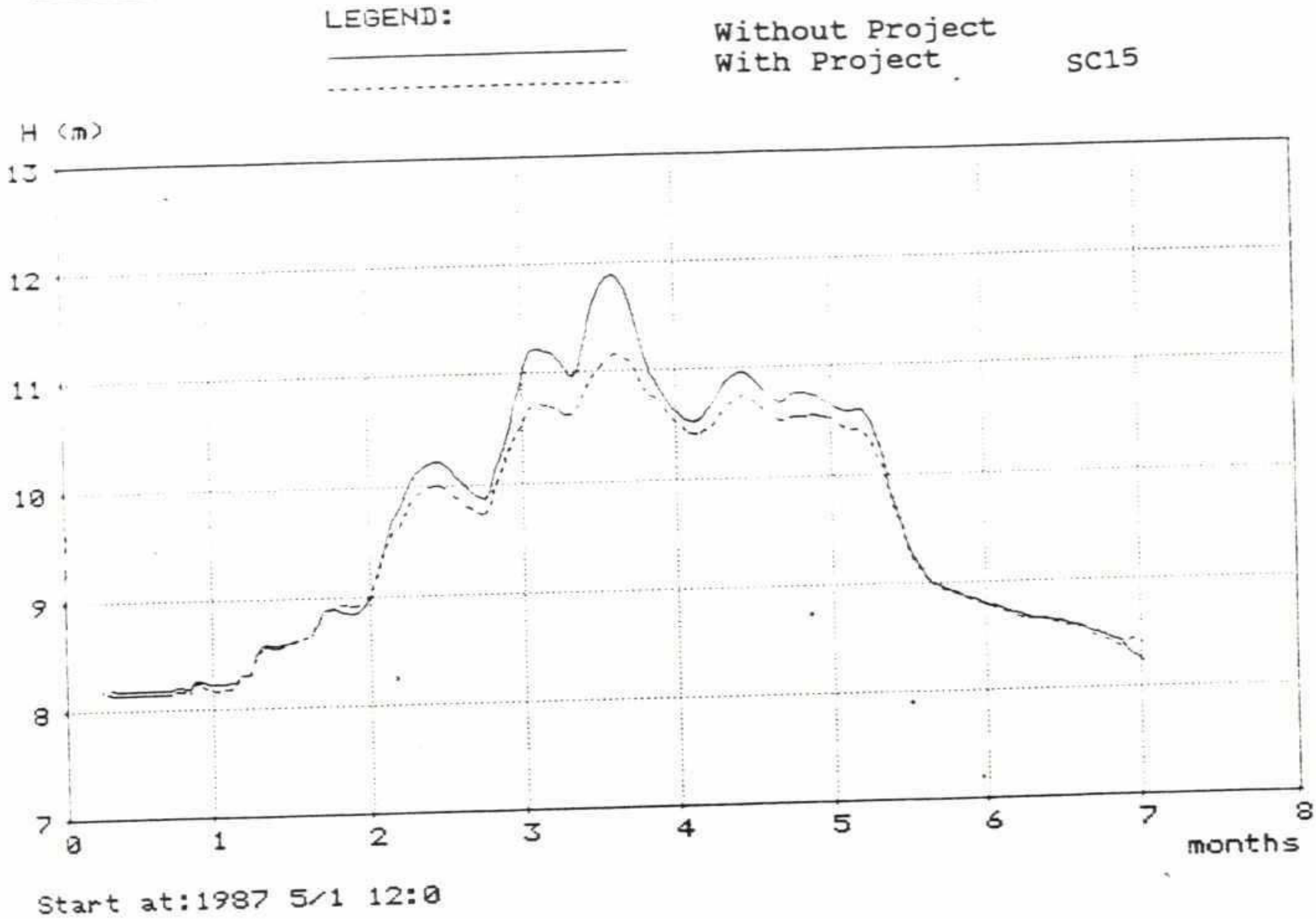
Start at:1987 5/1 12:0



Start at:1987 5/1 12:0

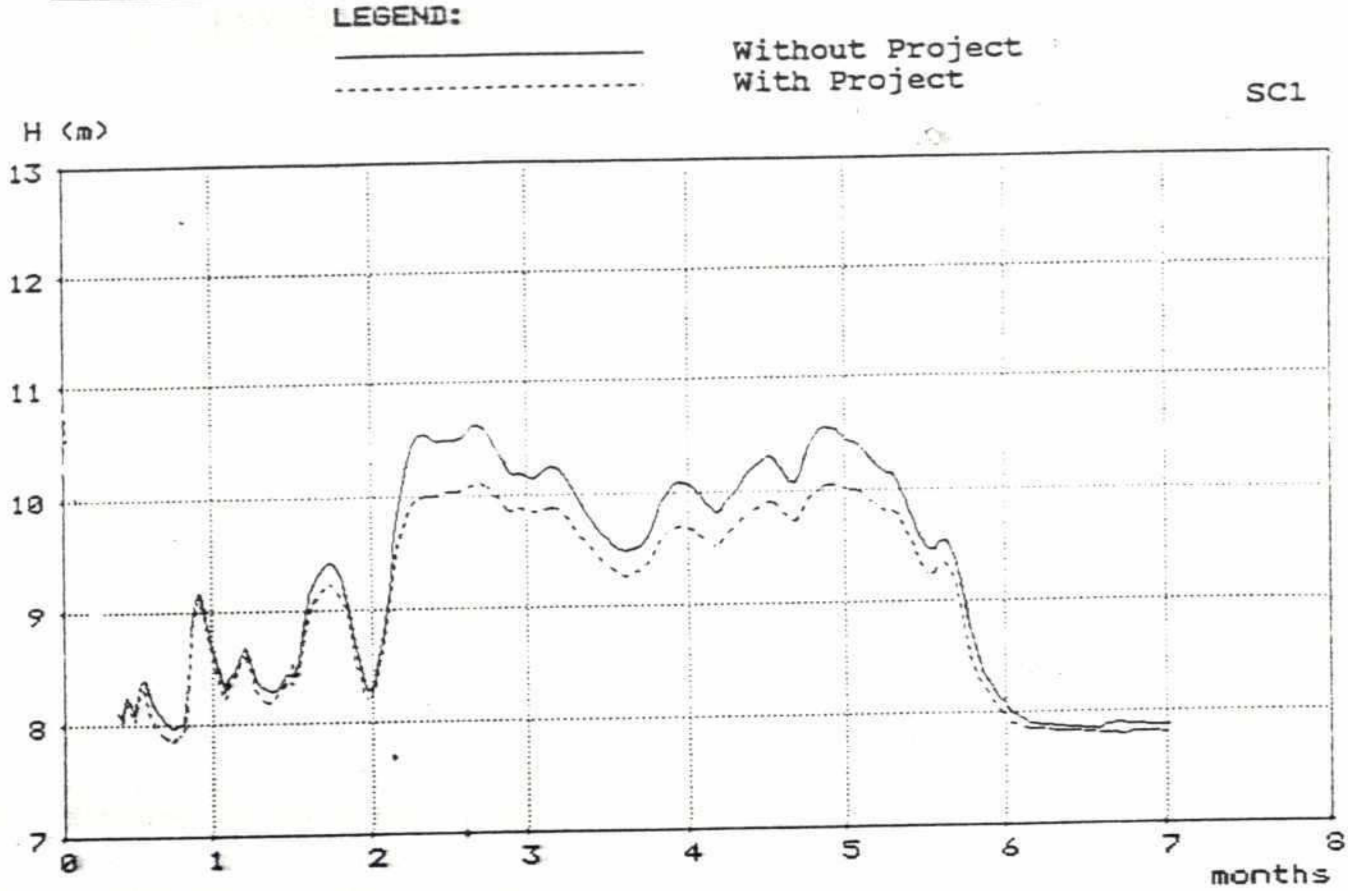


Start at:1987 5/1 12:0

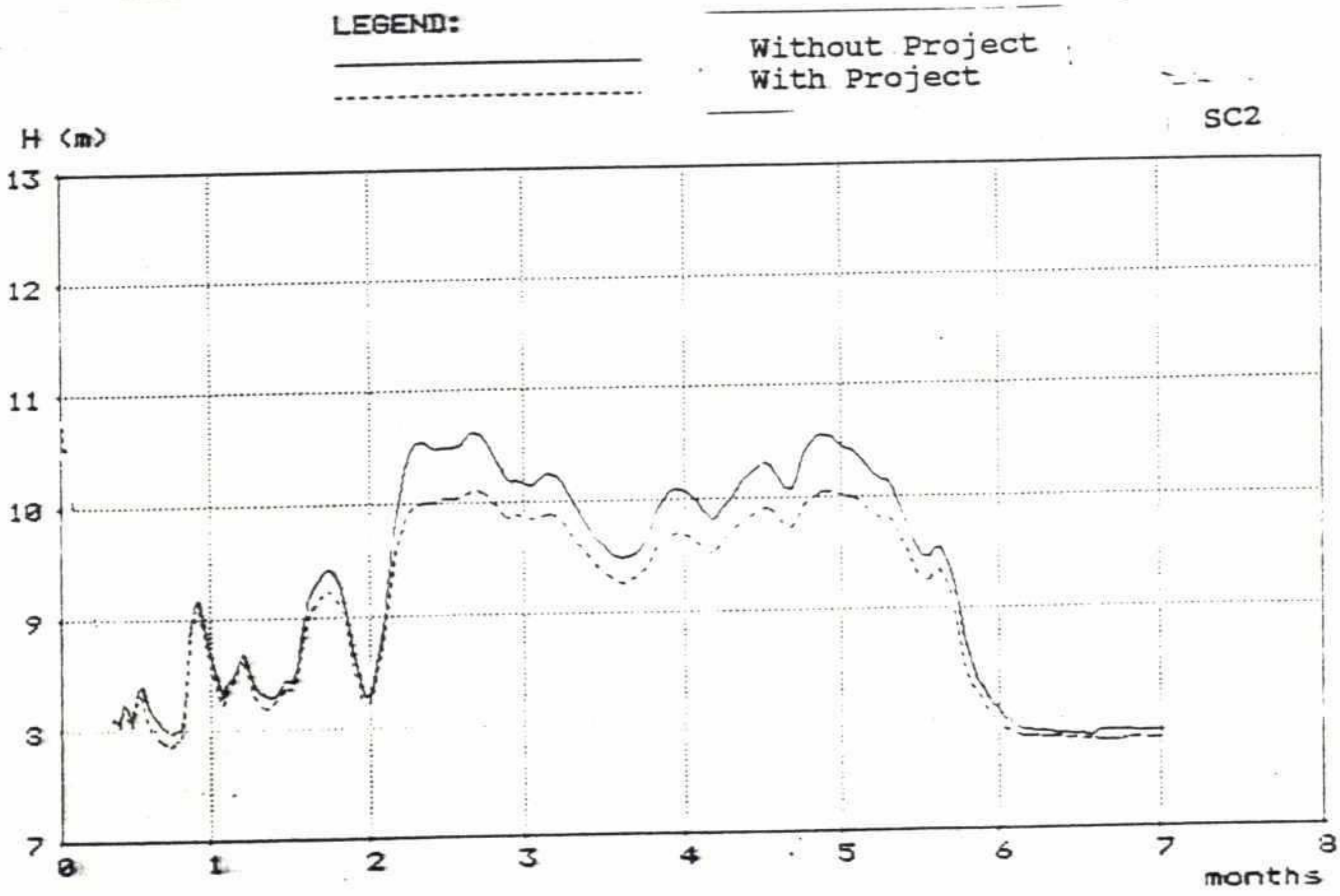

LEGEND:
Without Project
With Project
SC15
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1987 5/1 12:0

Appendix 4.5

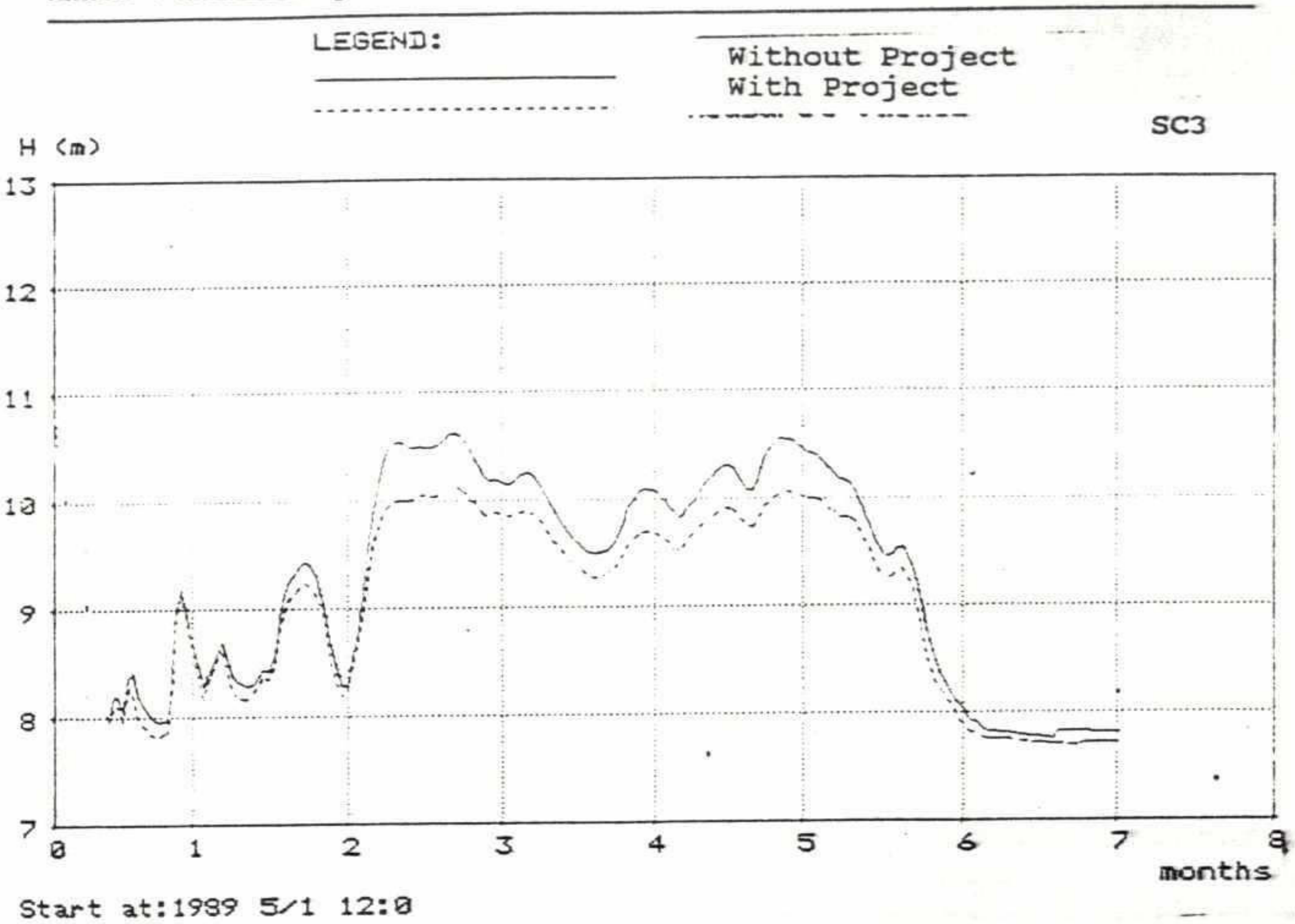
1989 Simulated water levels of Without and With Project situation in SC1 to SC15.

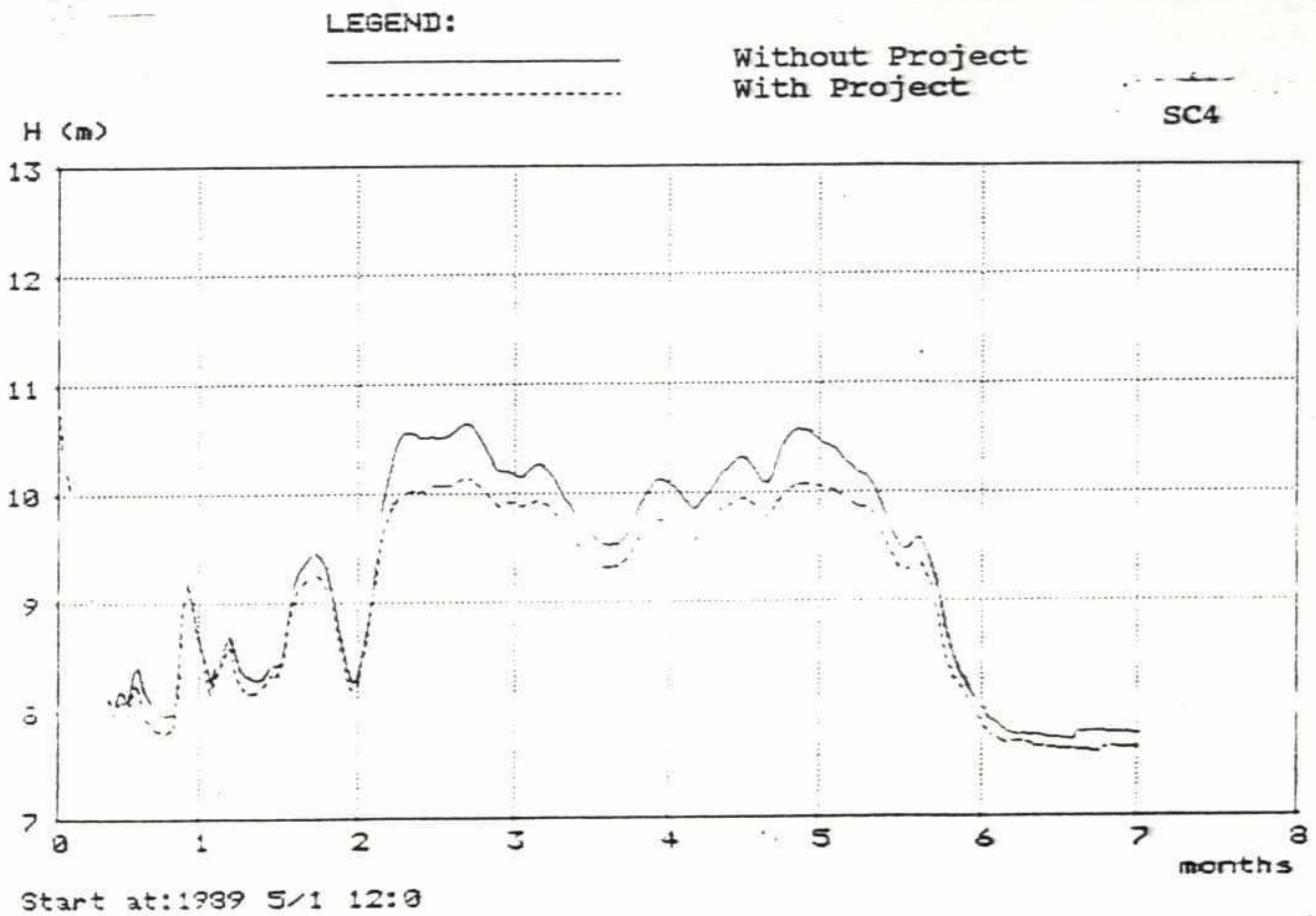


Start at:1989 5/1 12:0

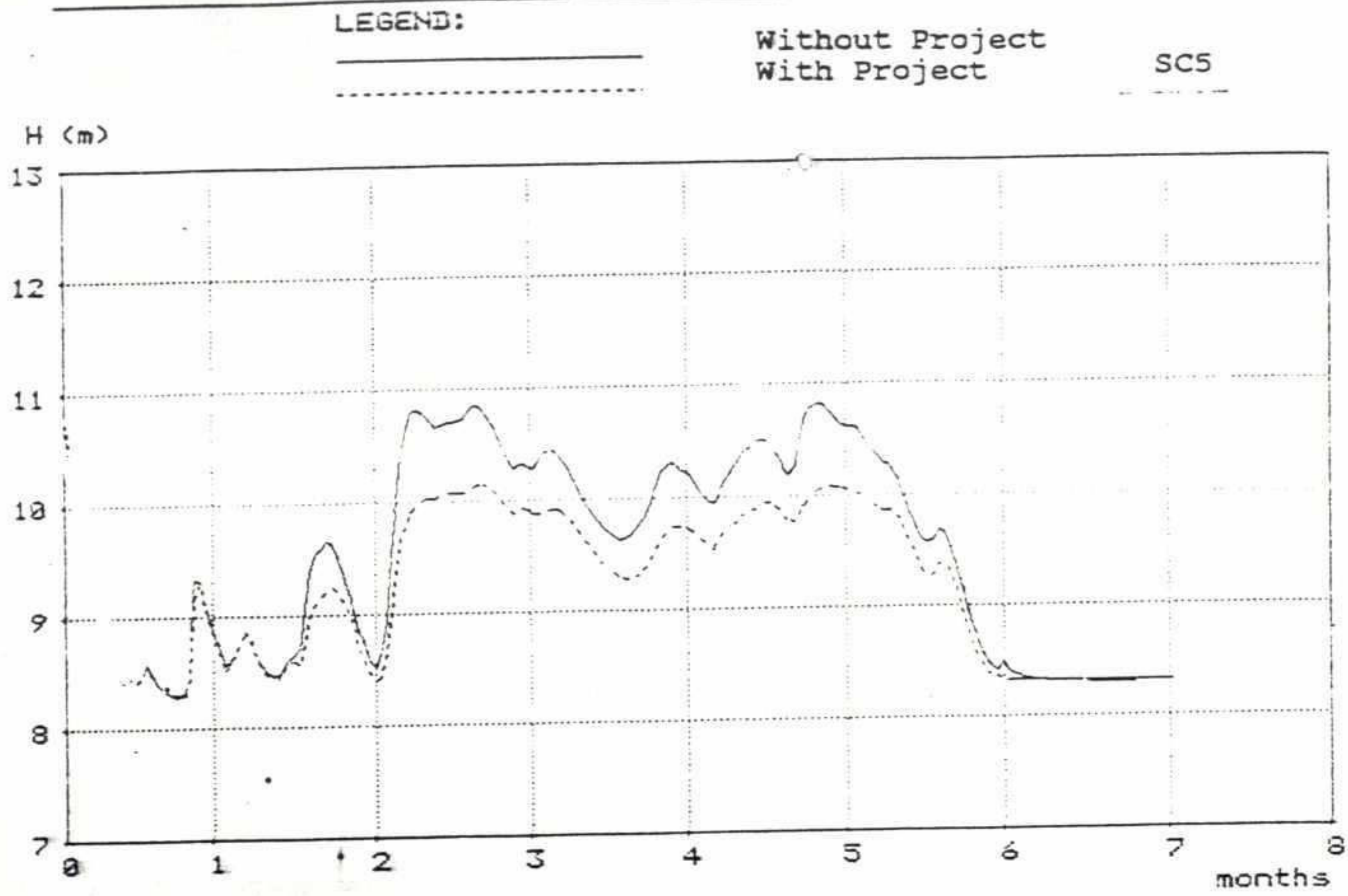


Start at:1989 5/1 12:0

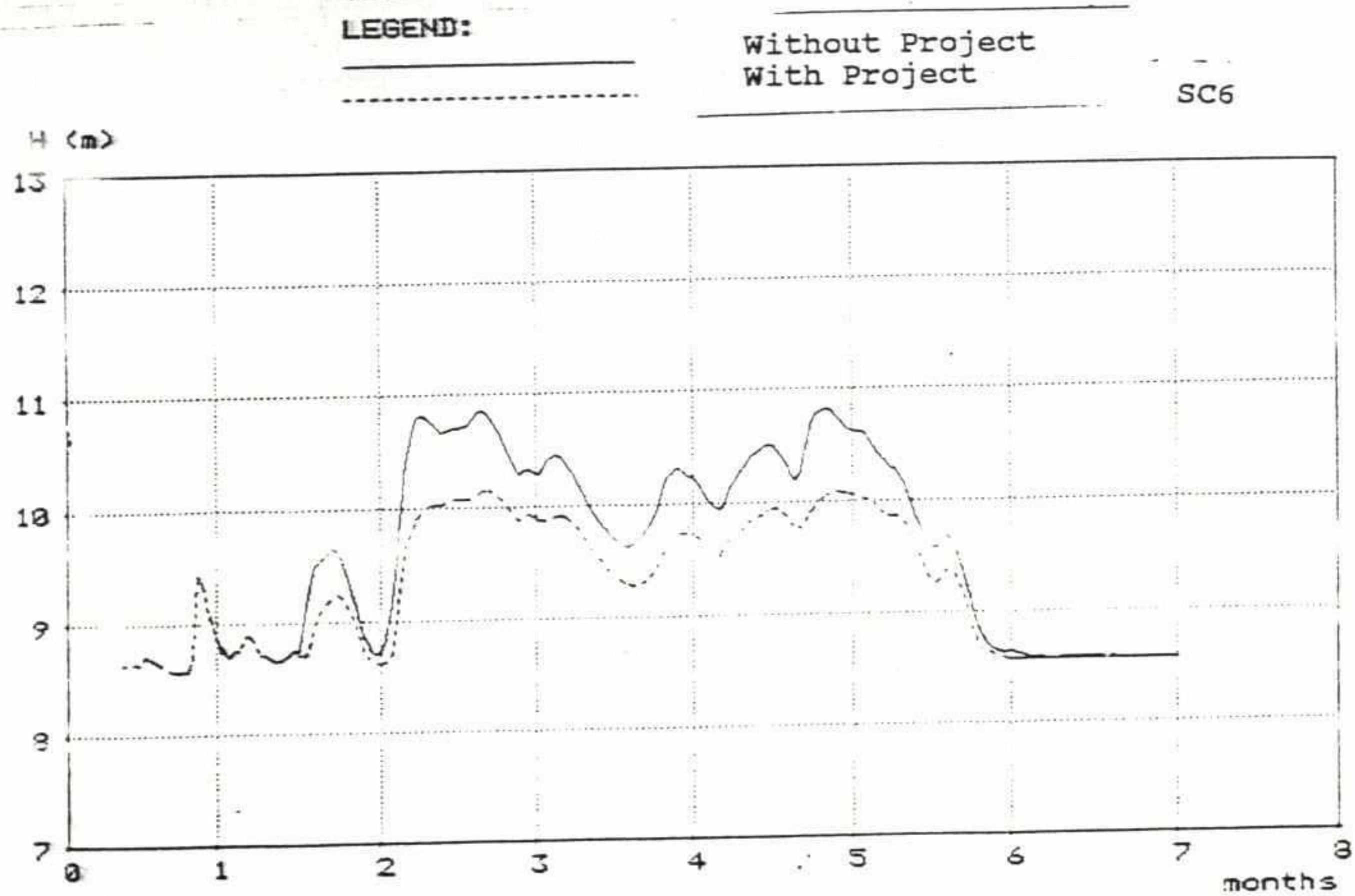

LEGEND:
Without Project
With Project
SC3
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1989 5/1 12:0


LEGEND:
Without Project
With Project
SC4
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1989 5/1 12:0

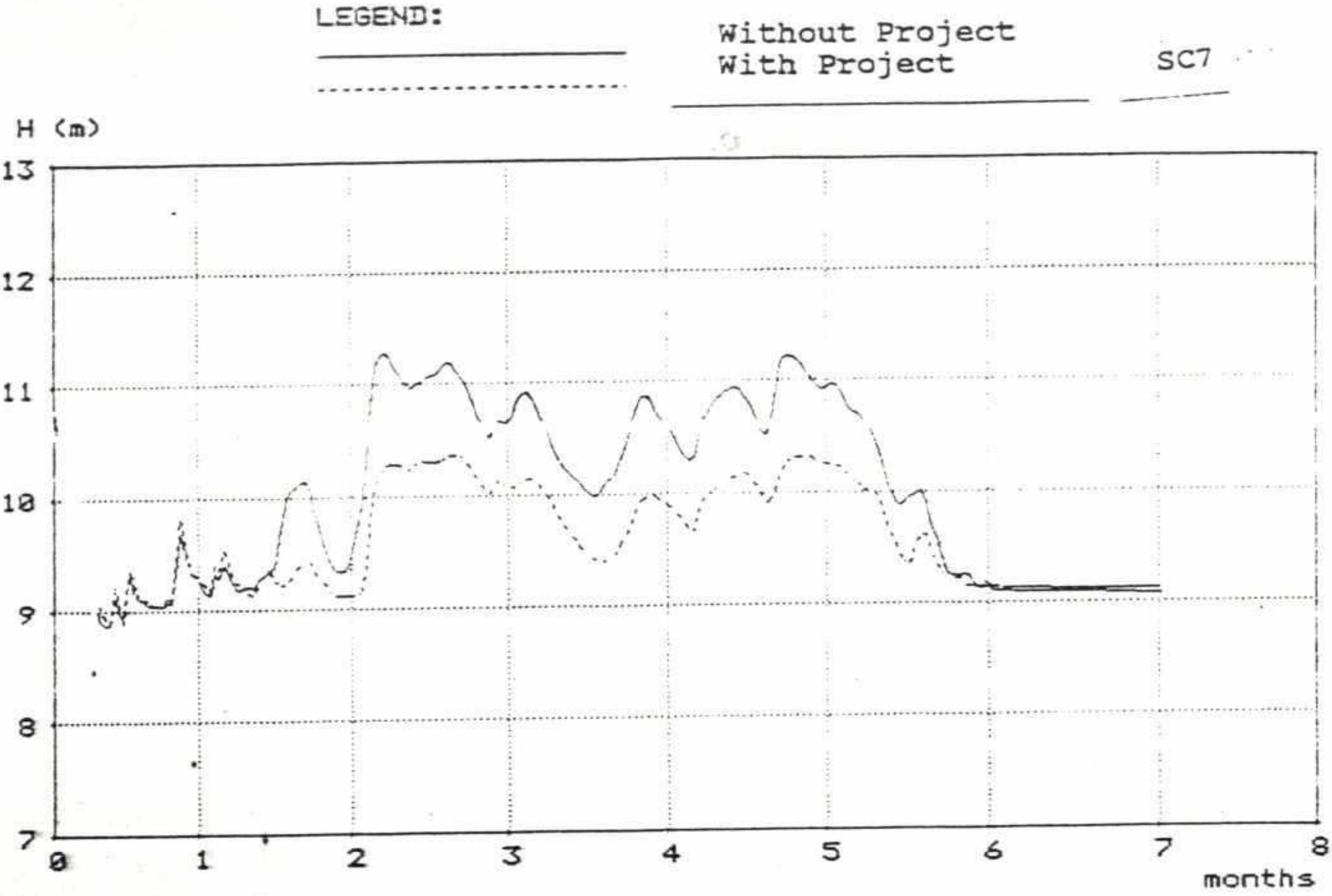
Annex 4 Modelling



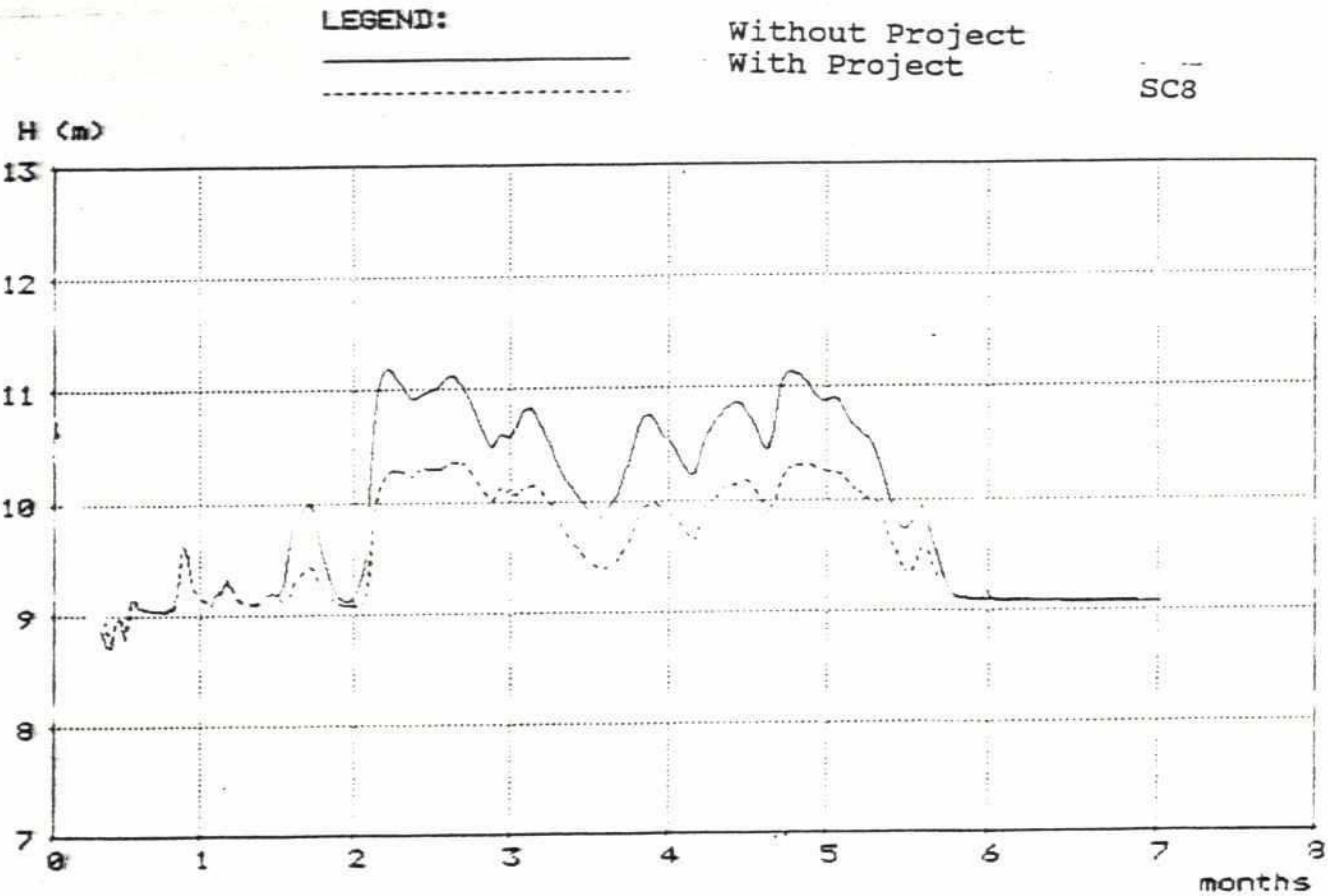
Start at:1989 5/1 12:0



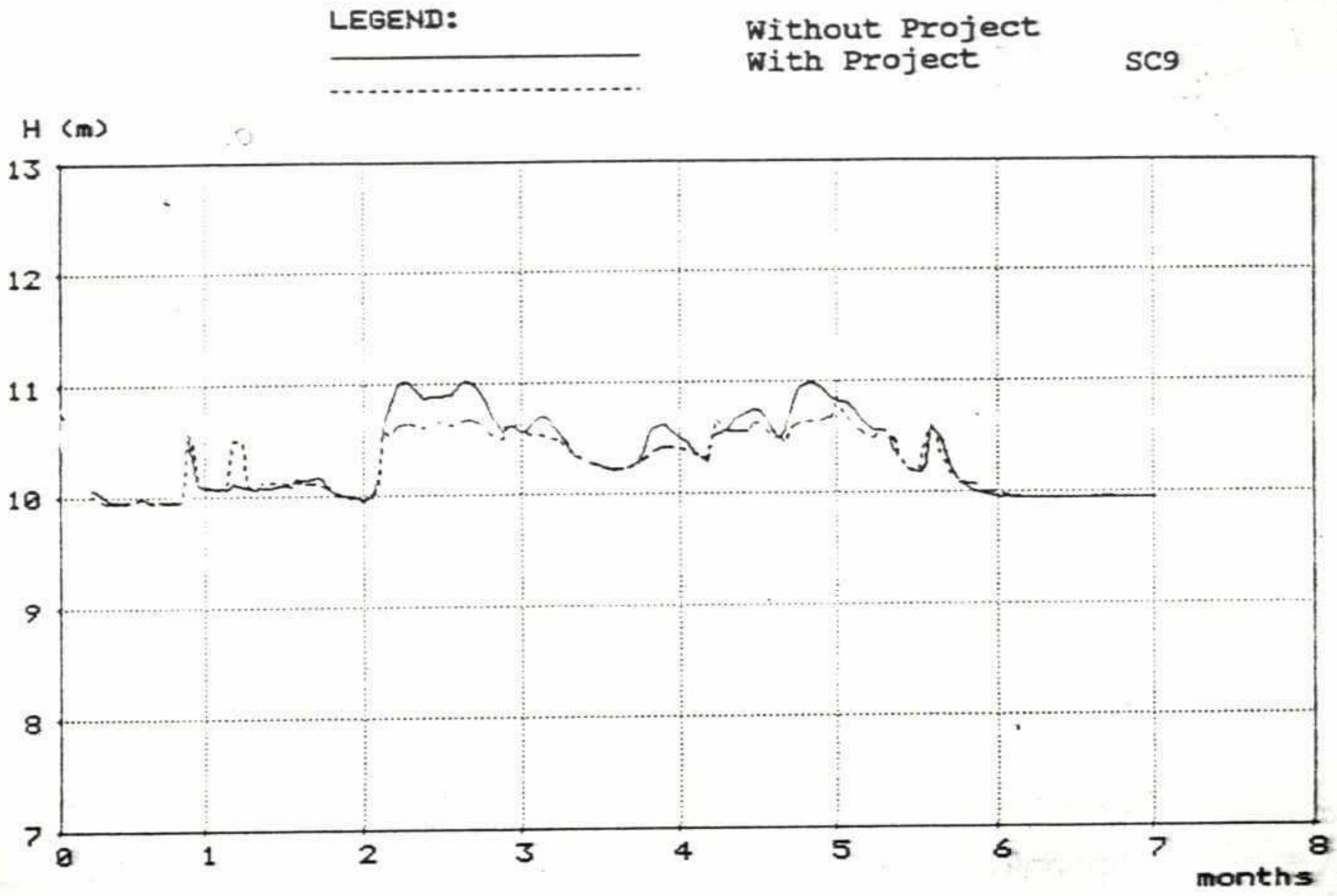
Start at:1989 5/1 12:0



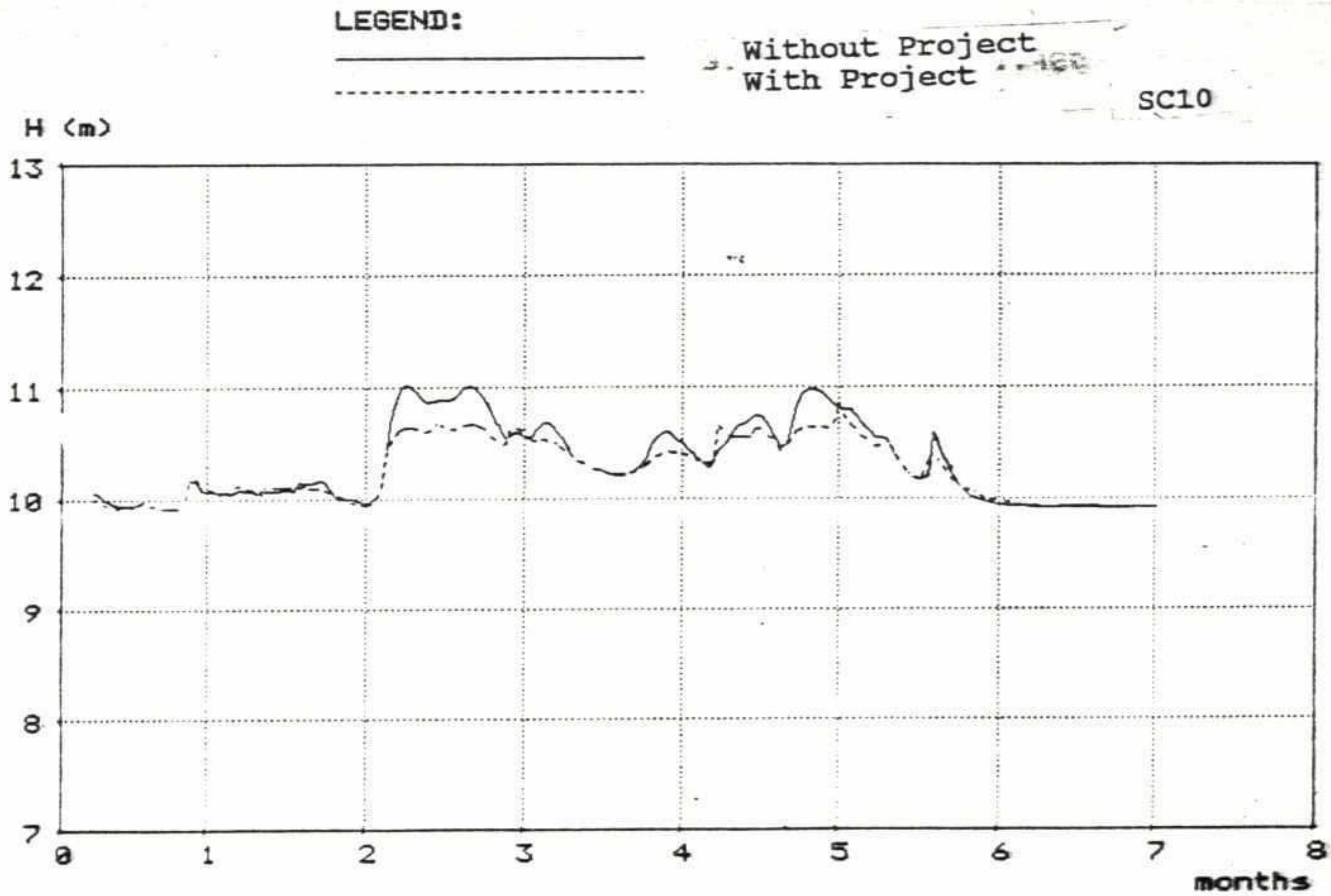
Start at:1989 5/1 12:0



Start at:1989 5/1 12:0



Start at:1989 5/1 12:0

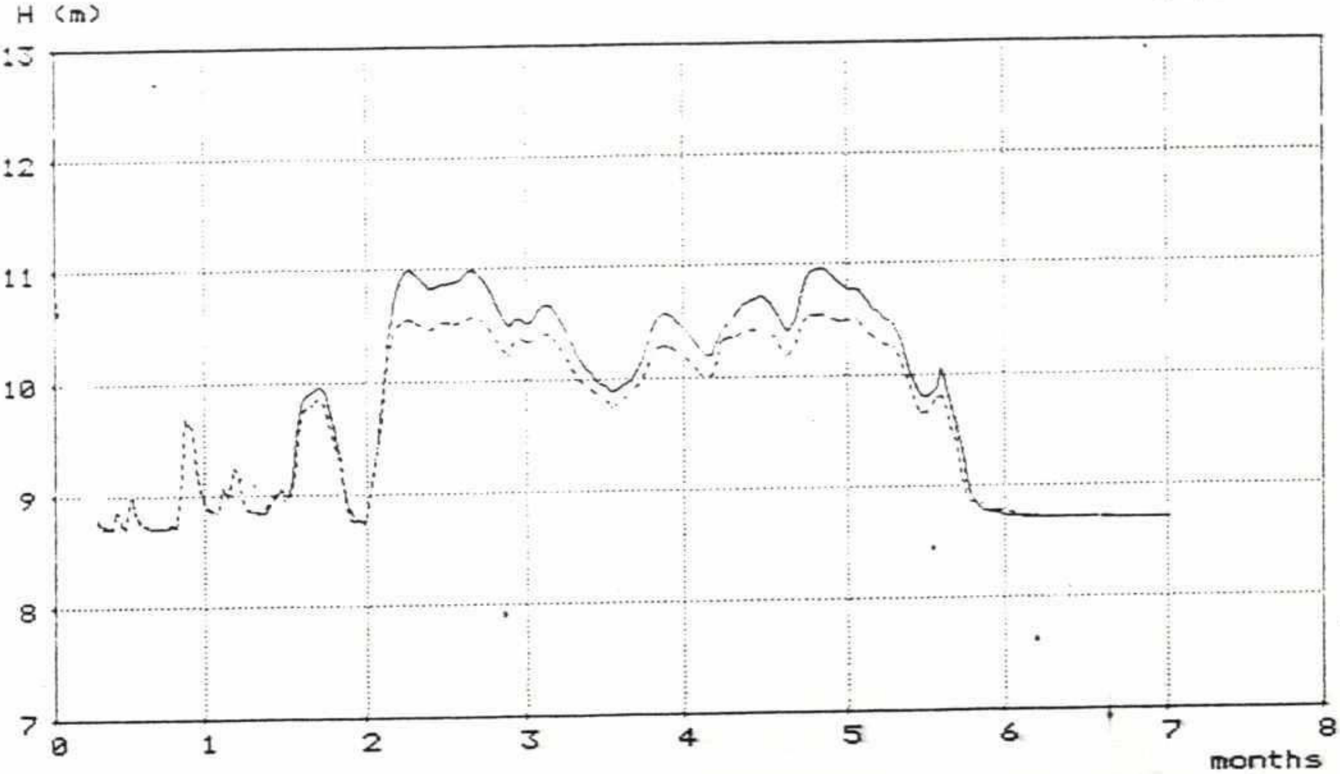


Start at:1989 5/1 12:0

LEGEND:

——— Without Project
------- With Project

SC11

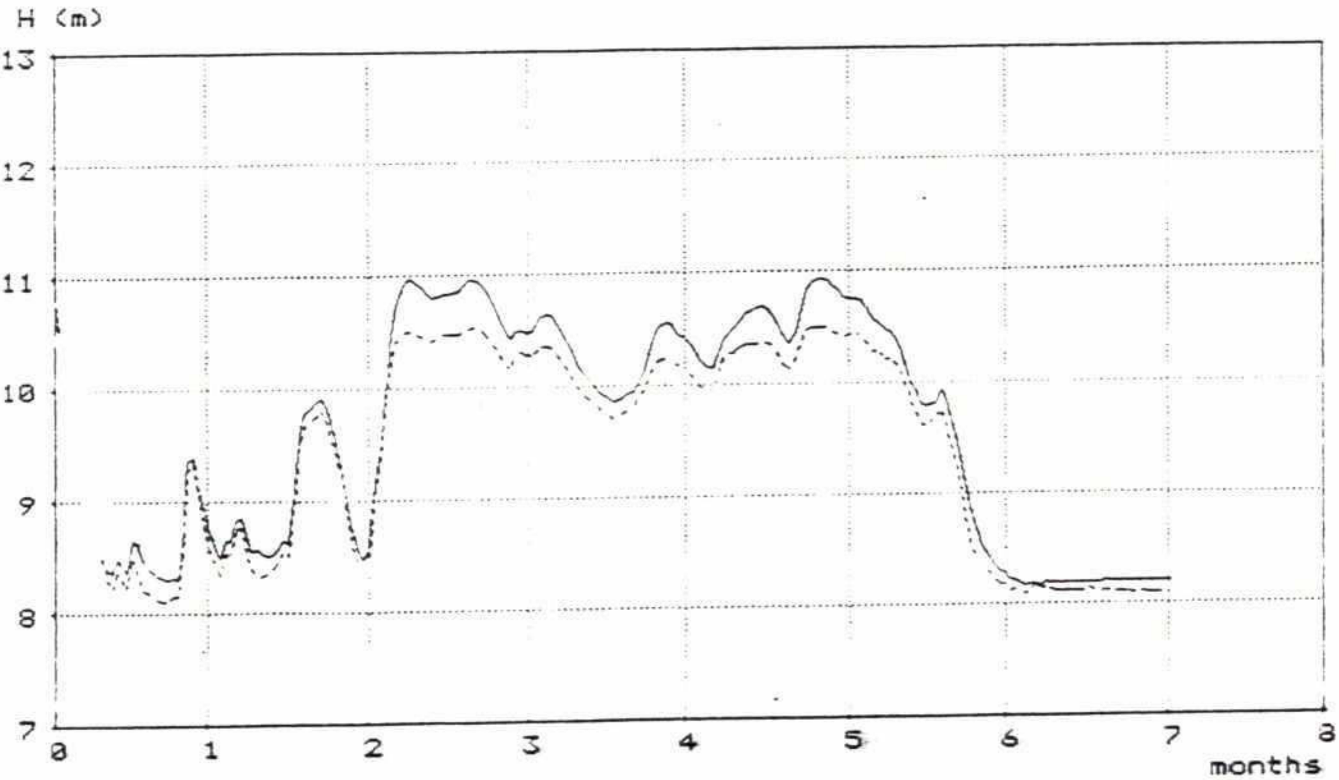


Start at:1989 5/1 12:0

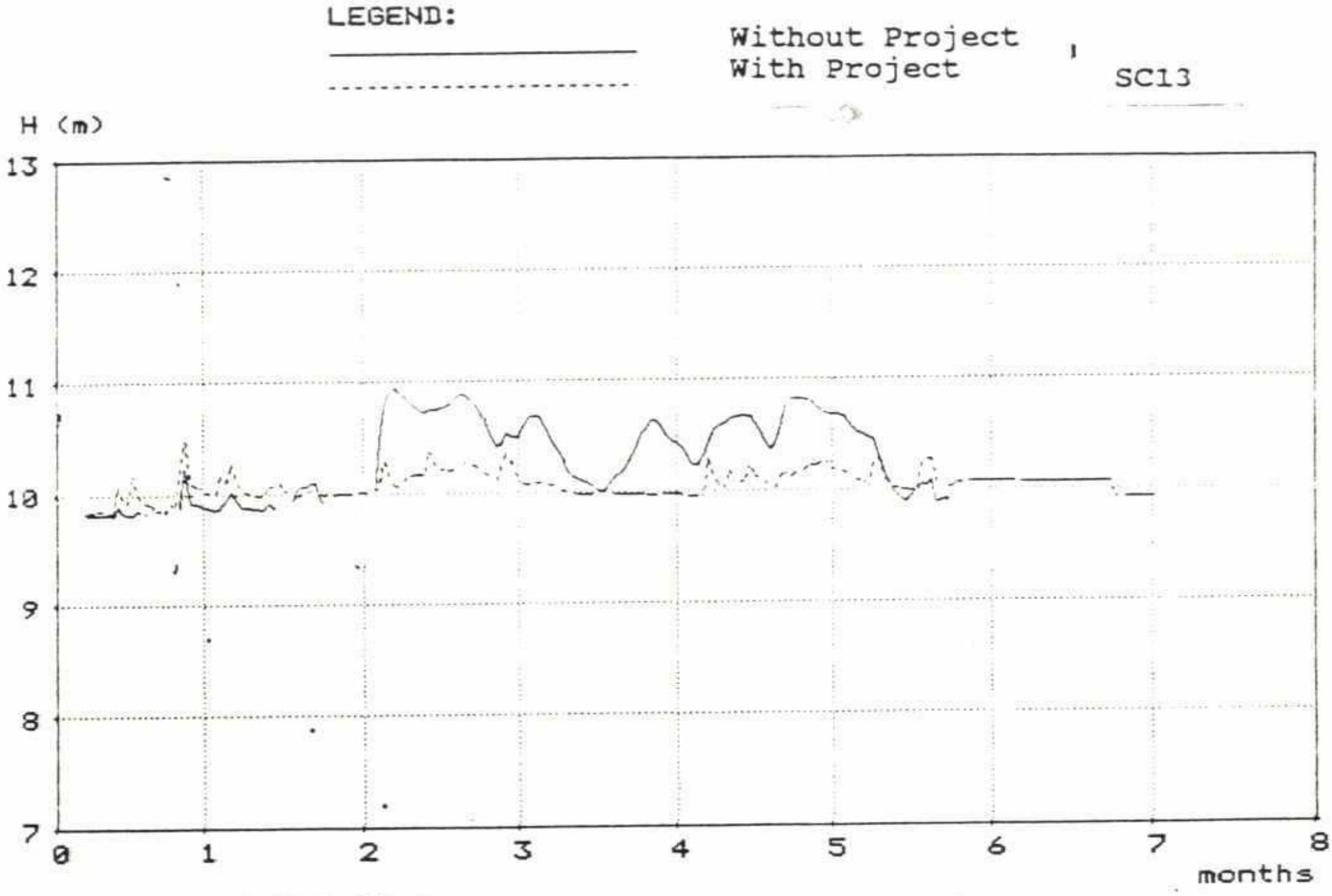
LEGEND:

——— Without Project
------- With Project

SC12



Start at:1989 5/1 12:0



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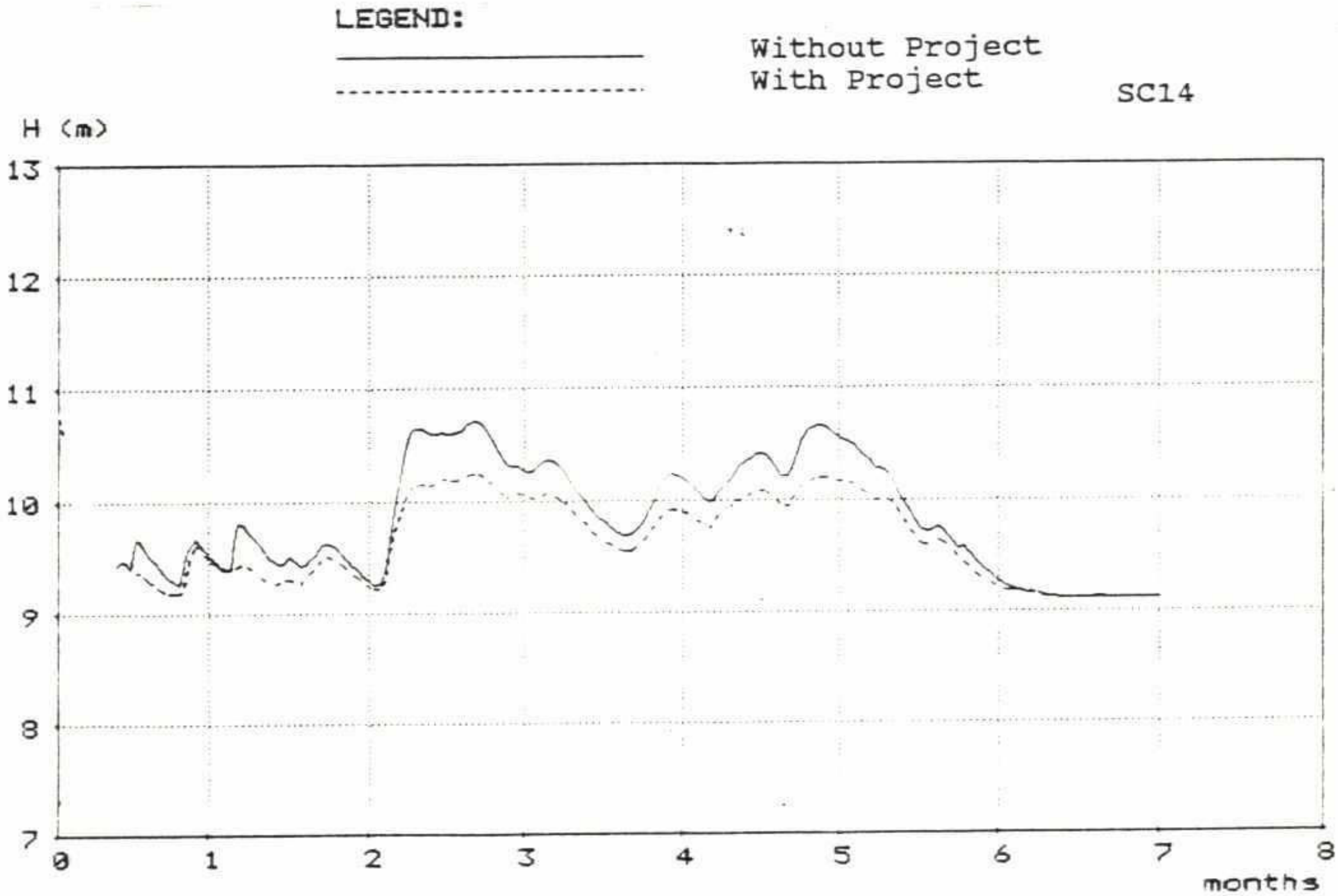

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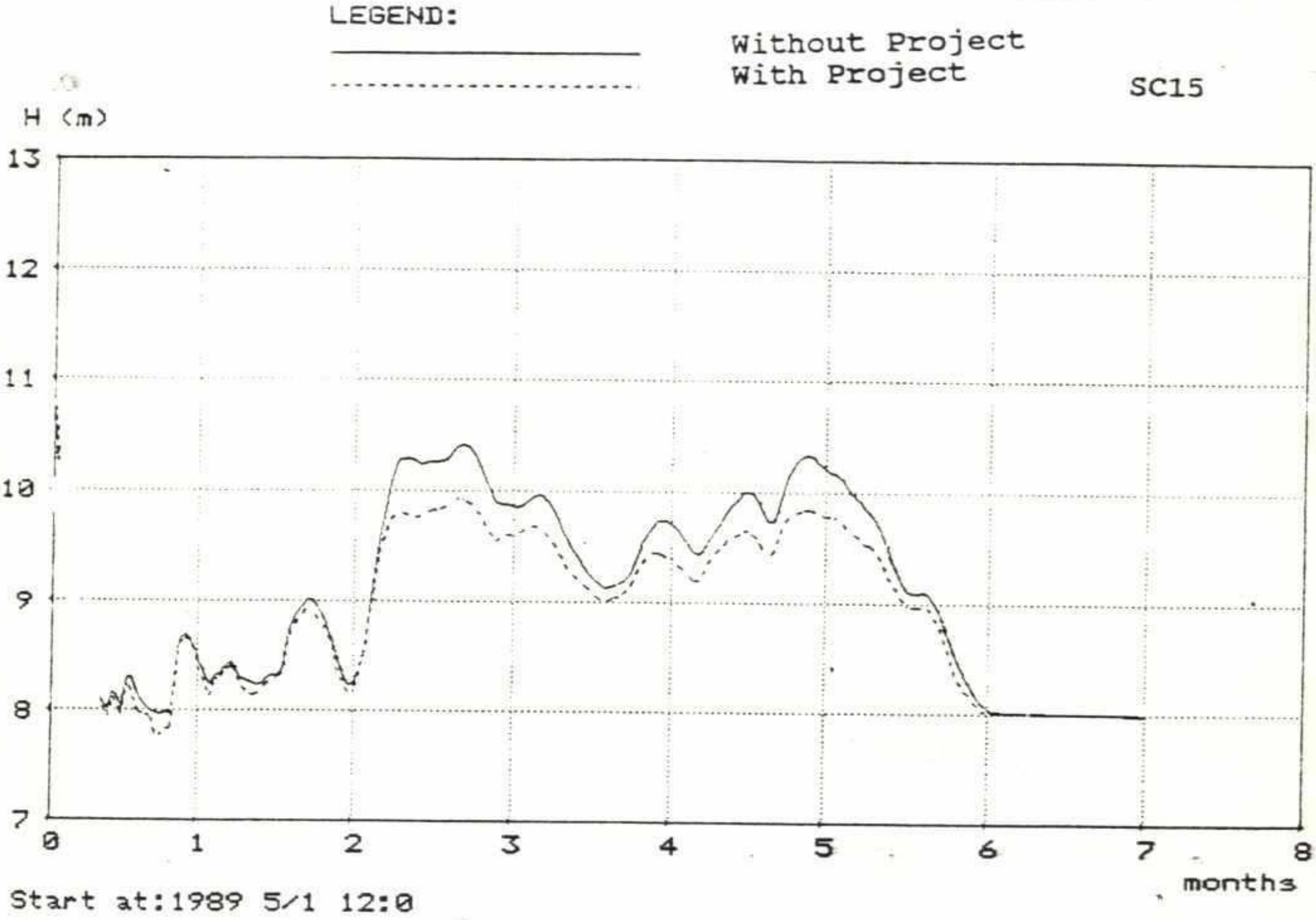
LEGEND:
Without Project
With Project
SC15
H (m)
13
12
11
10
9
8
7
0
1
2
3
4
5
6
7
8
months
Start at:1989 5/1 12:0