CS-6

RATING CURVES FOR GAUGING SITES ON NARMADA RIVER

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CONTENTS

LIST OF SYMBOLS

K	-	Section factor
A	-	Area of cross section
R	-	Hydraulic radius
G	-	Gauge height above a datum L
Q	-	Discharge
a	-	Multiplying parameter
e	-	Sub tracting parameter
b	-	Index parameter
n	-	Manning's coefficient
H	-	Depth of flow
Hr,Hor	-	Horizontal
Ver	-	Vertical
W	-	Width of the cross section
S	-	Bed slope
L	-	Arbitrary datum
ZG	-	Zero of gauge in(m)

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ABSTRACT

For improving the present practice of establishing stage and discharge relations, a methodology using information about physical features are suggested and explained in the user manual. This methodology has been applied to the data of gauging stations in the Narmada basin. The river Narmada situated in Central India, is a west flowing river, rising near Amarkantak in Maikala range of Madhya Pradesh. There are seven important discharge sites where measurement of discharge are carried out using current meters and some times floats. For the purpose of design flood studies in Narmada basin, discharge values at hourly intervals were needed at the gauging sites. The case study described herein ralates the stage and discharge data for all the seven sites (Manot,Jamtara,Bermanghat,Houshangabad, Mortakka,Mandleshwar and Garudeshwar). At all the seven sites daily discharges are observed using current meters (or floats) and Water levels are observed hourly. In order to compute hourly discharge the relationship between stage and discharge have been established.

A relationship of the form $Q = a(G - e)^b$

where, G,Q are stage and discharge respectively and a,b, and e are parameters defining the relation, is used alongwith a least squares methods for estimation of parameters. This equation is compared with Manning's equation.

$$Q = \frac{1}{n} (AR)^{2/3} (S)^{1/2}$$

where A is area, R is hydraulic radius, n is a constant and S is the bed slope. This results in the following approximation, $a = (1/n)\ W\ S^{1/2}$ where W is the width. The hydraulic radius is approximately equal to (G-e) for wide channel, where 'e' is the bottom of the channel elevation. The value of 'b' is equal to 1.6 to 1.7. The physically based estimates of a,b, and e are obtained prior to using computer programme for rating,using least squares. These are used as a guide to interpret and select the parameters for rating relationship.

Superimposed cross section plot of these sites revealed that there is a gradual increase in the cross sectional area from site Manot to Bermanghat. There is a sudden increase in cross sectional area at the site Houshangabad, but further downstream is not that large. The reach at Houshangabad will act as a natural regulator of flood. The cross section of all the sites are analysed and conveyance are calculated and plotted along with discharge. A simple plot of measured discharge are also made to remove obvious errors. A double log plot made for the discharge observed at all the sites exhibited a single ration curve within the channel portion for all the sites except for Mandleshwar. The analysis of data pertaining to the site Mandleshwar showed the requirement of two rating curves within the channel portion, one curve for lower discharges and the other for high discharges. The following is the table of parameters defining the rating curve for different sites:

Site	Parameters			Datum (m)
	a	b	e	
Manot	99.467	1.769	0.5	86.0
Jamtara	85.046	1.795	2.3	360.0
Bermanghat	98.428	1.73	4.0	306.0
Houshangabad	173.183	1.858	1.9	282.0
Mortakka	605.09	1.54	2.6	150.0
Mandleshwar	331.209	1.715	0.9	138.0
Garudeshwar	250.0	1.66	1.7	12.0

The plots comparing the curves supplied by field organisations and the presently established are also made.

1.0 INTRODUCTION

Establishment of a steady state relationship between stage and discharge forms an important aspects of hydrologic analysis. This steady state relation is an important tool in hydrologic analysis which replaces the well known hydraulic equation of momentum and provides means to convert the stage observations at a particular river site to discharges for direct use in hydrologic models. A brief description of the methodology is being given in this report dealing with application of the methodology to data of different gauging sites of the river Narmada **viz.,**

1. Manot site
2. Jamtara site
3. Bermanghat site
4. Hoshangabad site
5. Mortakka site
6. Mandleshwar site
7. Garudeshwar site

The location of each of the above on the river Narmada is shown in figure 1. The rating relationship established for each of the above sites are in table 17.

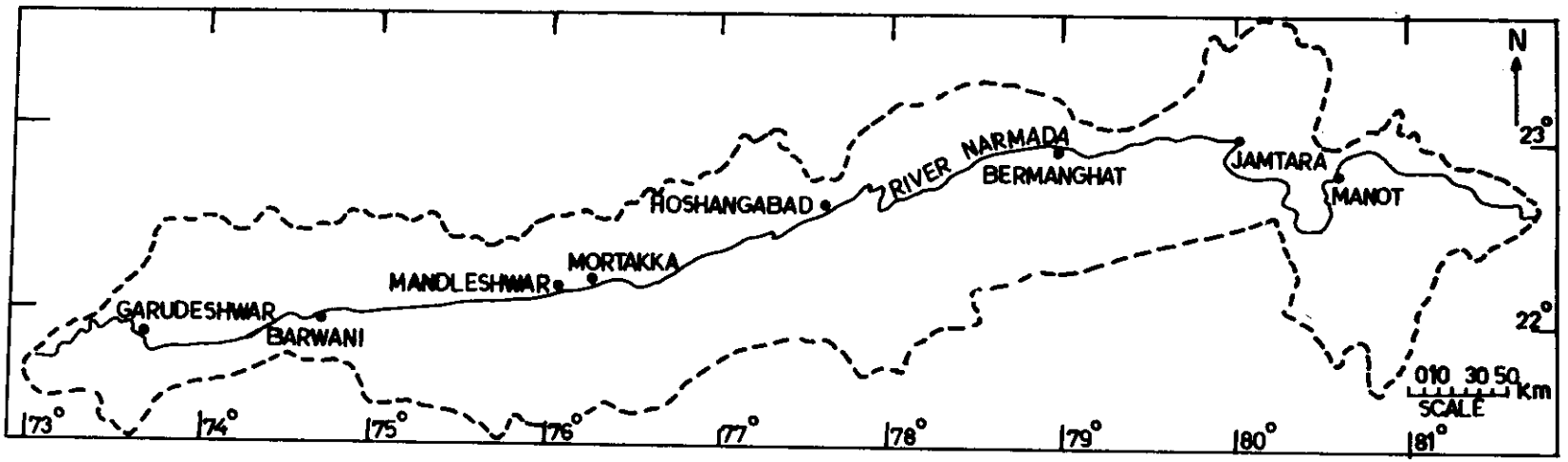

Figure 1 - Index Map showing gauging site of the river Narmada

2.0 REVIEW

The rating curve for a gauging station is a graphical depiction of the relation between stage and discharge. For each station rating curve establishment presents individual problems based on the control characteristics for the station.

2.1 Principle

The relation of stage to discharge is usually controlled by a section or reach of channel downstream from the gauge. A section control may be natural or man made. It may be a rock across the channel or a riffle or a weir. Section controls are effective only at low discharges. A channel control consists of all the physical features of the channel which include slope, roughness, alignment, constriction, expansion etc. Knowledge of these features are important where judgement in interpolating and extrapolating of measurements is involved and where there are only limited measurements available.

Hiranandani and Chitale observed in their book stream gauging (1964) that gauge discharge curves could show up a loop when there exists a low weir on a river. Mistry et.al (1984) in an analysis of few small rivers of Gujarat State found that generation of a process called water hammer starting near the junction with sea water is responsible for a looped rating curve. They also observed that in long rivers the looped rating curves are caused by flatening gradient in the case of falling stage. Dawdy noted discontinuity in depth discharge

relation of many alluvial streams. The significance of various regimes of flow to stage-discharge relation has been realised after Colby (1960). Relatively stable channel section will have a steady state rating. This means that there is only one discharge corresponding to a stage.

3.0 STATEMENT OF THE PROBLEM

To use the established rating curve with appropriate interpolation technique to convert the continuous stage records to discharge records for use in hydrologic analysis, including extension if possible, and to establish a physically meaningful rating curve from the observed daily gauge and discharge data.

4.0 DESCRIPTION OF STUDY AREA

The river Narmada, situated in the Central India is a west flowing river, rising near Amarkantak in Madhya Pradesh at elevation of about 900 m. in Maikala range.

4.1 The River

The river Narmada has several falls in the head reaches. The river drops by 24 m at Kapildhara fall, 8 km from the source and 4.6 m drop at Dudhara falls very near to the former. Close to Jabalapur the river drops 15 m at Dhaundhara falls after flowing through 404 km from the source. After travelling 464 km the river Narmada enters the upper fertile plains. The river drops again 12 m both at Nandhar,806 km from the source and at Dhardi, 853 km from the source, while its journey in the middle plains. A drop of about 6.7 m at Sahasradhara can be seen at 966 km from the source. After the middle plains the river enteres the lower hilly regions and flows through gorge. Emerging from the gorge the river enteres the lower plains and meanders till it reaches Broach. Beyond Broad the valley widens into an estuary and enters the Gulf of Gambay.

In its 1312 km journey the river Narmada receives flows from number of tributaries. Some of the major tributaries are Burhner, Banjar,Sher Shakkar,Tawa,Chhota Tawa,Kundi.

The Narmada Basin is bounded on the North by Vindhyas, on the east by Maikala range on the south by the Satpuras and on the west by the Arabian sea. The hilly regions are well

forested. The upper, middle and lower plains are broad and fertile areas well suited for cultivation.

So far as the main river is concerned there are seven important discharge sites as marked in the figure 1. Observations are reported to be carried out daily with current meters. In case of high floods floats are used.

4.2 Cross Section

A superimposed cross section plot of all the gauging sites considered is shown in figure 2. The data is plotted with respect to a common reference in rectangular coordinates. The Central vertical line at the middle of channel width is made to coincide with Y-axis. The X-axis is based on the zero of gauge reference given in the cross section. The X-axis represents the sloping bed. It can be seen the cross section of the river gradually increases from upstream site Manot to Bermanghat. Soon of after the site Bermanghat. Soon after the site Bermanghat the river width has a sudden expansion at Hoshangabad. The cross section at Mortakka, downstream of Hoshangabad is not wider. From this typical construction in nature, the Hoshangabad reach is expected to act as a regulator of flood flow, storing huge flood and releasing through narrow reaches. Because of this a large reduction in peak of flood, flow is expected at Hoshangabad. The river has an expansion from Mortakka to Mandelshwar. But further downstream there seems to have reduction in the cross section at Garudeshwar. The following table shows salient features of these cross sections of the river Narmada.

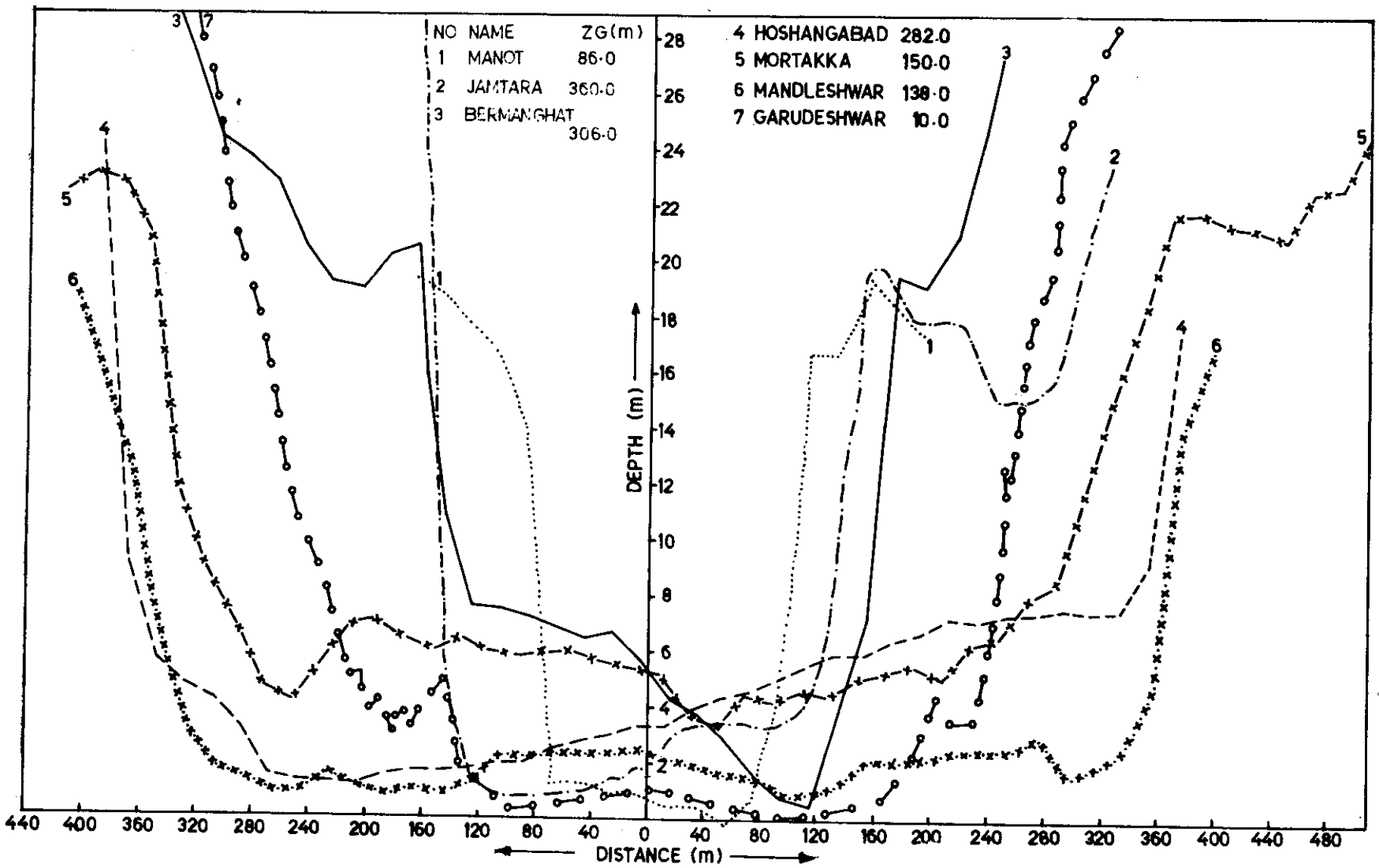

Figure 2 - Comparison of cross section of differeng gauging sites

Table 1- Salient features of the cross sections of the river Narmada

No.	Name	Zero of gauge (m)	Width (m)	Channel slope	Area m^2 at 15 m depth
1.	Manot	442	170	.00125	2592
2.	Jamtara	360	280	.00033	3715
3.	Bermanghat	306	320	.00038	3140
4.	Hoshangabad	282	700	.00023	8831
5.	Mortakka	150	670	.00053	6291
6.	Mandleshwar	138	600	.00046	10064
7.	Garudeshwar	10	500	.0001	6682

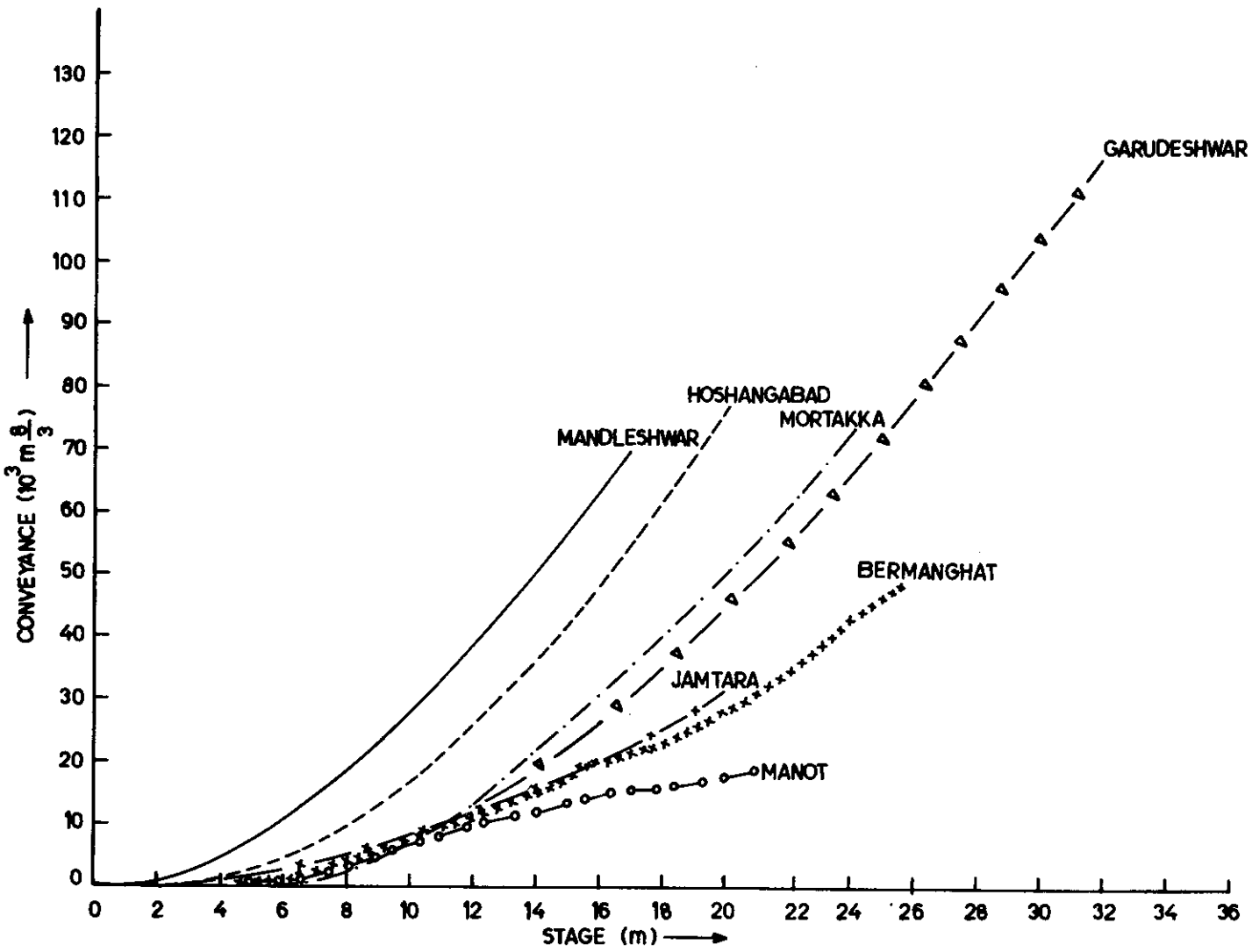

Figure - 3 Comparison of conveyance of differeng gauging sites

5.0 AVAILABILITY OF DATA

The following table provides the information on the data connected with establishment of relation between stage and discharge of various sites under study:

Table 2 - Available Data

Site	Cross section for the years	Daily gauge for the years	Rating curve for the years
Manot	1978	1977 to 1980	1978
Jamtara	1978 - 1979	1968 to 1980	1971 to 1973 and 1975 to 1979
Bermanghat	1978 - 1979	1972 to 1977 and 1980	1972 to 1978
Hoshangabad	1973 to 1979	1972 to 1978	1973 to 1978
Mortakka	1978	1968 to 1978 and 1980	1978 - 1979
Mandleshwar	1979	1971 to 1980	1972 to 1978
Garudeshwar	1973 to 1979	1972 to 1978	1973 to 1978

It has been noticed that under a particular name of the site the gauging will be operational at various cross sections at various time. Many times these cross sections are very much apart from each other. Hence the data under the same site name contains mixed information . However, proper care has been taken to separate them and use in this study.

6.0 METHODOLOGY

Three cases have been studied and reported earlier. Depending on the need a choice can be made out of the three cases viz:

i) Interpolation ii) Conveyance analysis iii) Rating analysis based on least square methods and physical verification.

6.1 Interpolation Methods

This method is possible only when a rating curve is available. These rating curves are graphical display of stage and discharge in steady state conditions normally prepared by people incharge of measurements. If rating curve has been drawn well guided by the observed and plotted points and if the extension of the curve is minimal considering the stages to be converted, preparation of rating table is taken up. The rating table is simply a representation of rating curve in a discrete form. An equal interval table is prepared. Discrete values of discharges corresponding to the stages are read from the curve and entered in the table. The table is smoothened to ensure that the rating curve is really represented in the rating table to be monotonic curve. Preparation of a difference table is taken up to smoothen it. Discharges are interpolated using this smoothened table. Out of the various interpolation methods used second order Hermition interpolation appear to be best suited in comparison to the other two

techniques namely linear and cubic spline.

6.2 Conveyance Analysis

In this case of (i) if it is found that the extension of the curve is not minimal the extension of the curve is first carried out. The cross section of the river is needed. River cross sections are defined by geometric coordinates. The section factor as defined by

$$K = AR^{2/3}$$

where A is the area and R is hydraulic radius, K is taken to be representing the conveyance taking 'n' to be unity.

The plot between conveyance and discharge is made. If a straightline could be drawn, it is extended considering the curve for stage Vs conveyance. A rating table is prepared and interpolation techniques are used. If the curve resulted in conveyance analysis could not be extended the next method is adopted. Care should be taken in the case of composite sections while computing conveyance.

6.3 Rating analysis Based on Least Squares Method and Physical Analysis

This analysis is started with measured daily gauge and discharge data of a particular site. A simple plot on ordinary graphsheet will help to eliminate obvious errors in the data.

An equation of the form

$$Q = a\ (G - e)^b$$

where Q is the discharge , (m^3/S)

G is the stage elevation, (m)

e is the zero of gauge and (m)

a and b are the coefficients, if fit into the data using least square techniques. It may be noted that a number of different set of coefficients are possibly fit the given data. Hence a choice of the coefficients is made in accordance with physical verification and according to double log plot .

7.0 ANALYSIS

The previously described method of establishing rating curves which is physically meaningful has been applied to the seven gauging sites of the river Narmada, viz, 1) Manot , 2) Jamtara 3)Bermanghat 4) Hoshangabad 5) Mortakka 6) Mandeleshwar 7) Garudeshwar

The details are given below:

7.1 Site : Manot

The gauging site Manot is situated on river Narmada near the confluence of left side tributary Burner at about 248 km from the source Amarkantak.

For the development of rating curve the cross-section data of the year 1978 and daily gauge and discharge data for 1977-78 with ZG = 86.0 m have been used in the present study as given in Appendix I.

On the basis of physical information provided by the river cross-section, a conveyance analysis using GEDA programme has been made. The output from this programme provides hydraulic radius and other hydraulic elements as a function of depth of flow (elevation). The cross-section of river Narmada at Manot has been plotted as shown in figure 4 and the stage elevation, conveyance and discharge are plotted as indicated in figure 5. It is seen from figure 5 that the conveyance changes at a uniform rate upto stage of 101 meter or so, and it is,therefore, expected that rating curve would also have

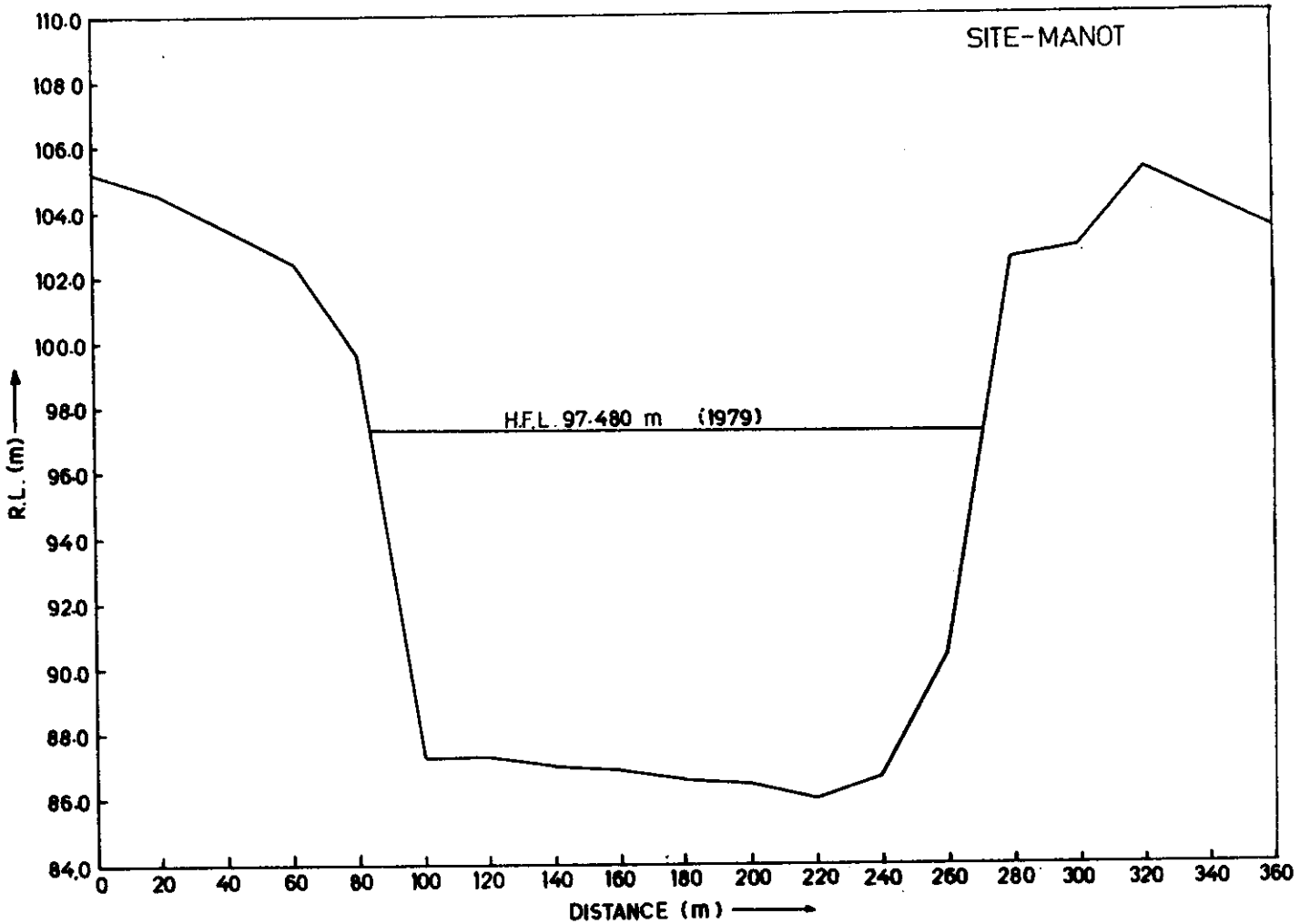

Figure 4 - Cross - section of river Narmada at Manot

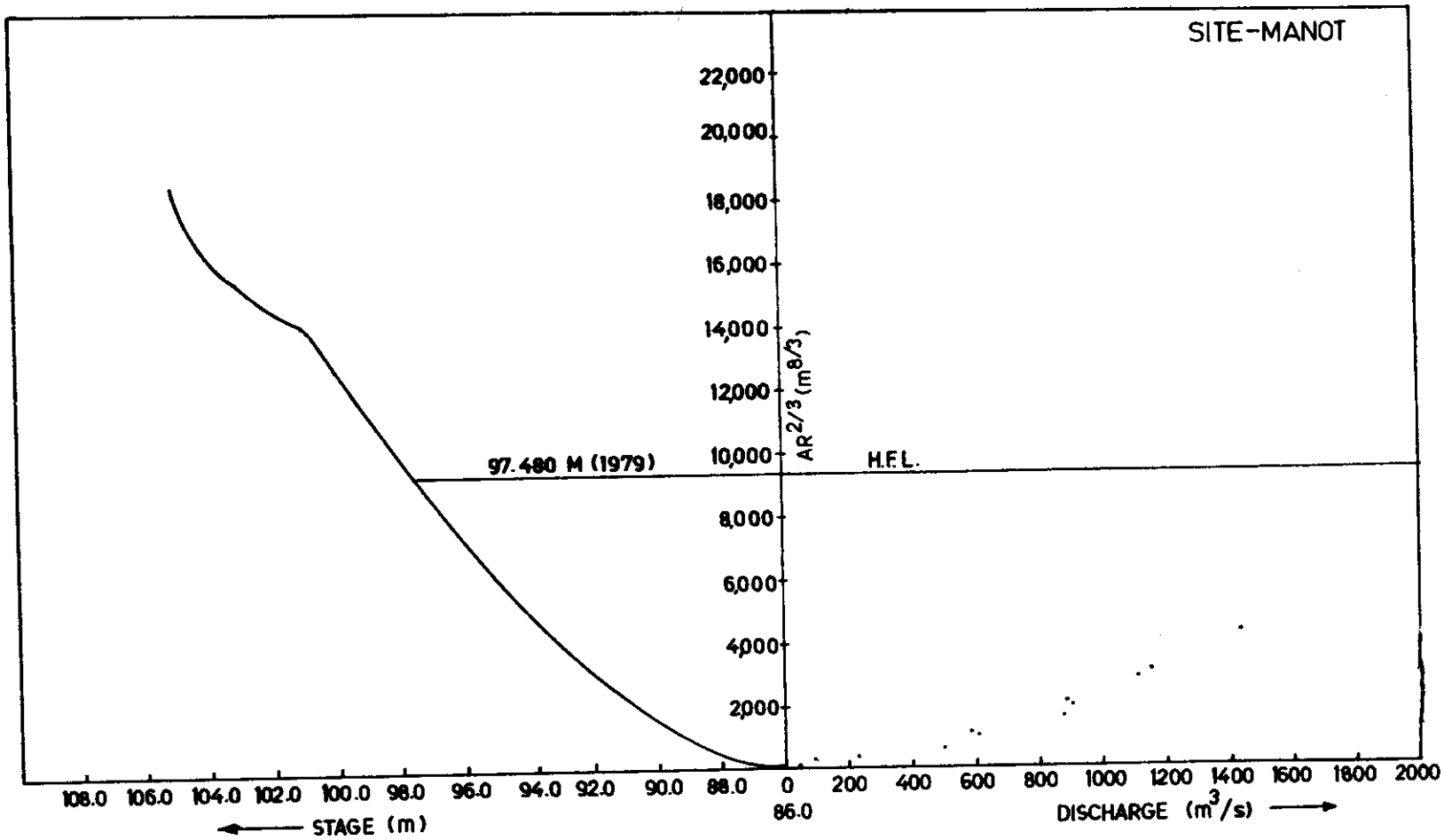

Figure - 5 Plot of the conveyance,Q, and stage for Manot site

similar behaviour upto this level assuming Manning's n remains constant.

An equation of the form

$$Q = a\ (G - e\ )^{b}$$

where,

Q is the discharge at the gauging site

G is the stage elevation, a,b,e are the parameters defining the relation.

The details of analysis made are given below:

A. Physical Verification

Width of the channel (at the channel top)	170.0 m
Slope of the bottom (as per longitudinal section)	0.00125
$S^{1/2}$	0.0353
n (assumed)	0.035
$a = \frac{1}{n}\ W\ S^{1/2}$	= 170.0 approximately
b = 1.7	(assuming parabolic shape)
e = 0.5	(effective bottom level)

B. Double Log Plot

Adopting a shift of e = 0.5 in the observed stages a plot of stage and discharge has been made in the double log as shown in figure 6. A straight line has been fitted through these points. The value of the coefficients a,b,e obtained are as follows :

a = 100.0

b = 1.78

e = 0.5

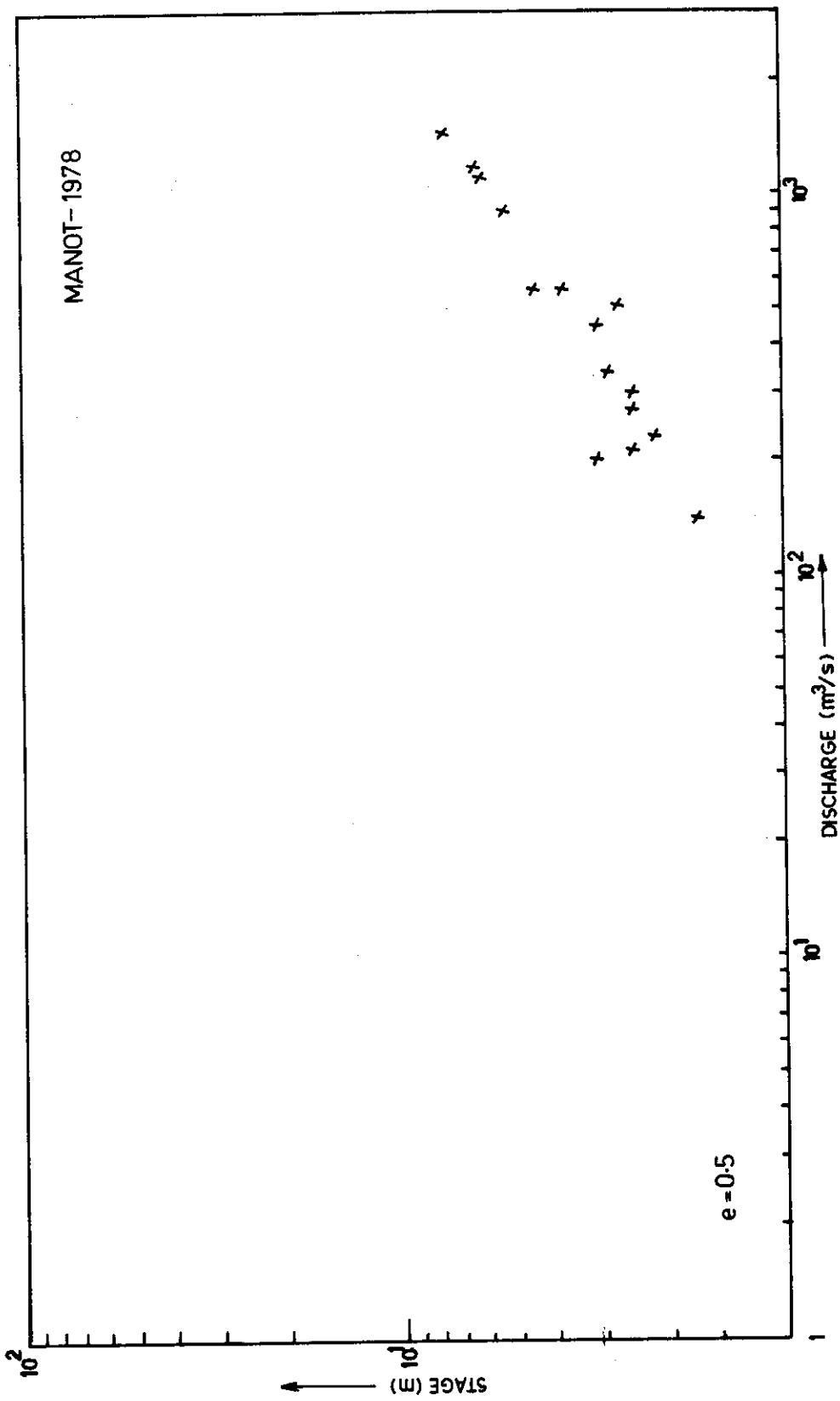

Figure 6 - Double log plot between discharge and stage for Manot site

C. Rating Analysis

The daily gauge and discharge of the year 1977,1978 were used for analysis. Least square technique is applied using 34 data points. The following are the relevant extract from the computer results.

Table 3 - Trial Parameters for the Manot Site

Trial No.	a	b	e	Sum of squared error	Remarks
1	66.739	0.3	2.04	194023	
2	81.688	0.4	1.906	193058	Computer chosen best
3.	99.467	0.5	1.769	193713	Finally selected basis on the physical verification

Although the second set of values are chosen by the computer based on the least square criterion, however,because of the relatively higher value of b = 1.906 as compared with value obtained by physical verification and double log analysis, the third set of parameters were finally selected for conversion of stages, viz. a = 99.467, b =0.5, e = 1.769. Comparison the rating adopted and the rating curve supplied by field organisation(CWC) is shown in figure 7. It appears that for higher values of Q, points plotted in CWC curve are linearly interpolated points.

The following relationship was finally adopted

$$Q = 99.467\ (G - 0.5)^{1.769}$$

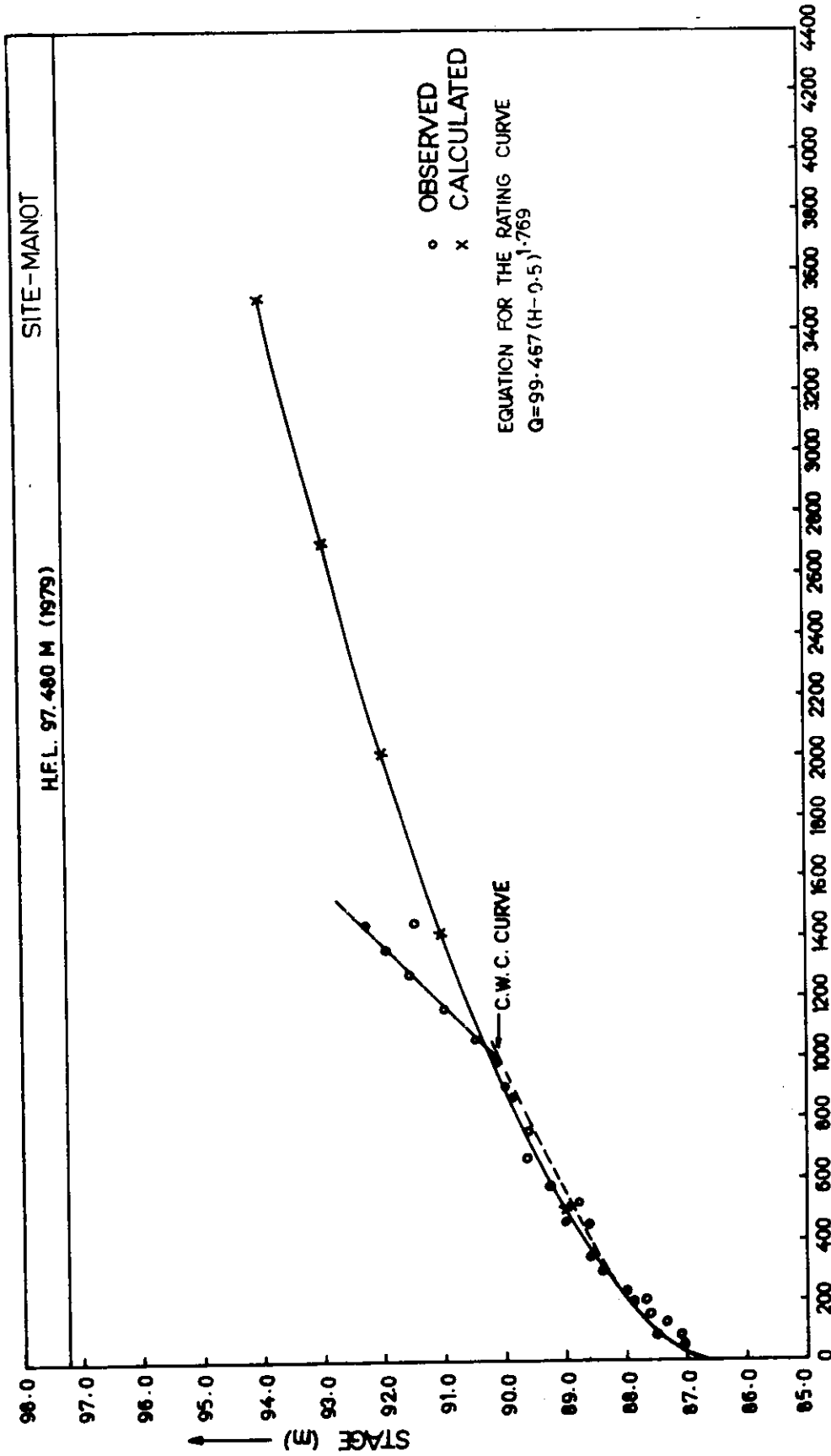

Figure 7 - Comparison of established and C.W.C. rating curves for Manot

where,

G is stage in m above a datum = 86.0 m

Q is discharge on m^3/sec

PROFORMA

Site	:	MANOT
River	:	Narmada
Type of data	:	Rating curve (graphical)
Source	:	CWC/Bhopal gauging Division
Year	:	1977 and 1978
Scale	:	Hr 1 cm = 20 m^3/sec Ver 1 cm = 0.2 m
Zero of gauge	:	86.0 m
Remarks	:	1. The curve is drawn well guided by the points in the region 86 m to 89,2 m 2. The stage conversion needs the curve upto 97.485 m. 3. Plot of available higher range values indicates an error. The values might have been extrapolated linearly.

Type of data	:	Cross section
Year	:	Not indicated
Remarks	:	1. The cross section is defined by 19 coordinates. The lowest level is defined by 220 m, 86.1 m. 2. Both the left over bank and right over bank are not defined.

where,

G is stage in m above a datum = 86.0 m

Q is discharge on m^3/sec

PROFORMA

Site	:	MANOT
River	:	Narmada
Type of data	:	Rating curve (graphical)
Source	:	CWC/Bhopal gauging Division
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Zero of gauge	:	86.0 m
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Type of data	:	Cross section
Year	:	Not indicated
Remarks	:	1. The cross section is defined by 19 coordinates. The lowest level is defined by 220 m, 86.1 m. 2. Both the left over bank and right over bank are not defined.

7.2 Site : Jamtara

This gauging site on the main river Narmada is located at 399 KM away from the source Amarkantak Bargi dam is 19 km upstream of Jamtara. A measurement site at a railway bridge was established in the year 1949. This gauge site has a zero of gauge 361.567 (m) and was operated by Western gauging division CWC until the year 1970 and there after by Central Flood Forecasting Division(CFFD). The Western gauging division started taking measurements at a downstream site having zero of gauge 360.0 m. The table 4 given below shows the different zero of gauge seen alongwith the data indicating the frequent shifts in the gauging site both upstream and downstream and different agencies involved.

Table 4 - Different zero of gauge at Jamtara

Period	Zero of gauge (m)	Source and Remarks
Feb.1949 - June 1949	359.69	CWC statistical Dte.
July 1949- Nov.1949	364.88	-do-
1.12.1949 - 20.1.50	359.69	-do-
20.1.50 - 10.3.50	363.38	Bargi site
11.3.50 - 31.12.67	361.57	Jamtara site
Nov.1971-onward	360.00	Jamtara site
1949 - 1967	361.57	Seen from Rating curves
1971 - 1980	361.57	daily gauge and discharge data
1972 - 1978	360.00	Rating curve from Western Gauging
1971 - 1977	360.00	Daily gauge and discharge
1971 - 1979	360.00	Hourly data

Data pertaining to the site having zero of gauge 360.0 m were taken for analysis. The cross section data of the year 1978 as shown in figure 8 were used for conveyance analysis. The details of the cross section and rating curve supplied are given in a proforma. The output of the program GEDA with above input data are used to compute conveyances. These conveyances as a function of depth and also as a function of discharge are shown graphically in figure 9. It can be seen from the figure 9 that the conveyance changes uniformally upto the height of 380 m or so and it is ,therefore, expected that the stage and discharge would also have similar behaviour upto this level atleast, assuming Mannings n remains constant.

An equation of the form

$$Q = a\ (G-e)^{b}$$

where,

Q is the discharge at the gauging site

G is the stage elevation,

a,b,e are the parameters defining the relation is assumed.

The details of the analysis carried are given below:

A. Physical verification

Width of the channel (at the channel top)	280.0 m
Slope (from the longitudinal section)	0.00033
$S^{1/2}$	0.018
n (assumed)	0.036
$a = \frac{1}{n}\ WS^{1/2}$	140.0

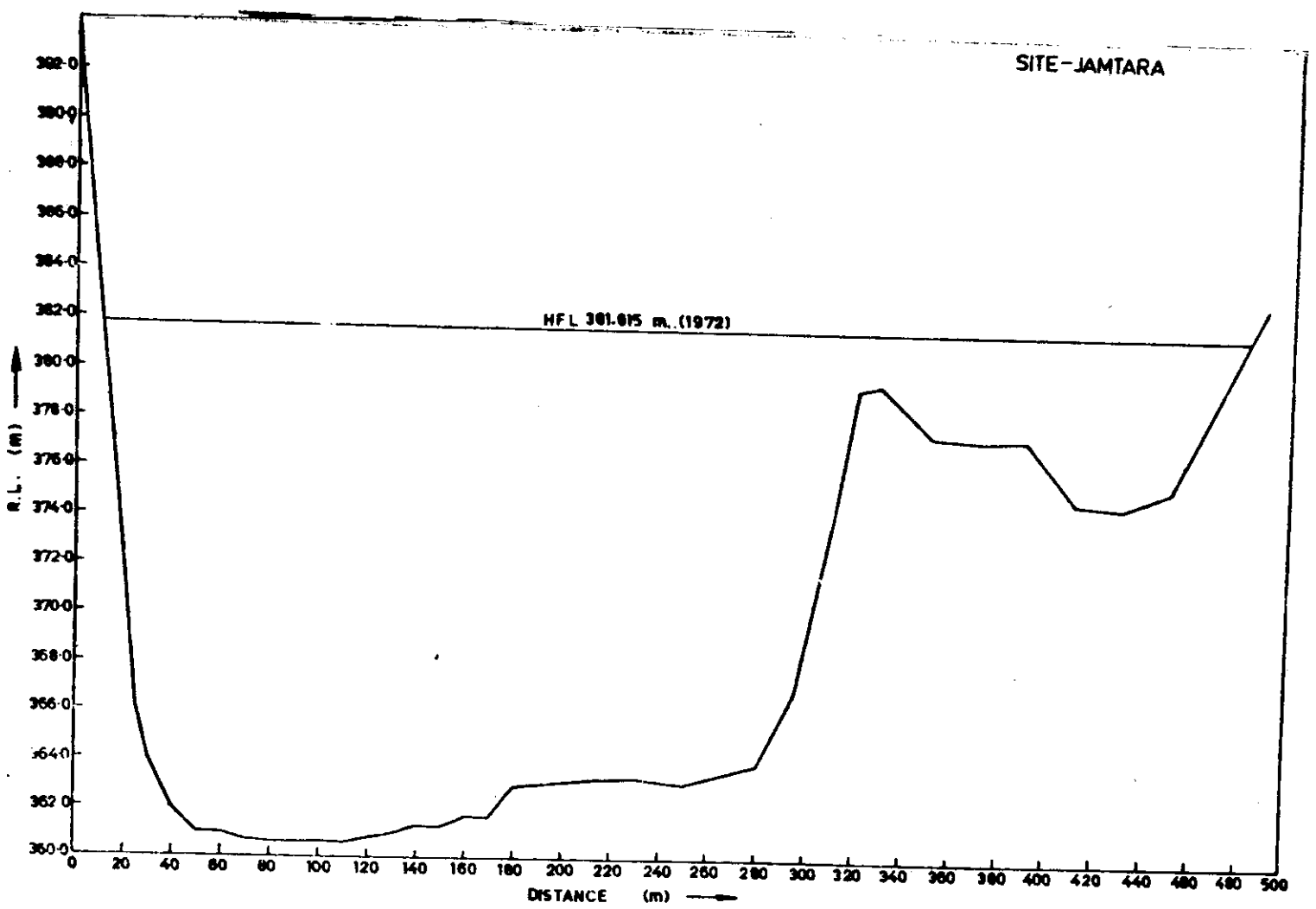

Figure 8 - Cross-section of the river Narmada at Jamtara

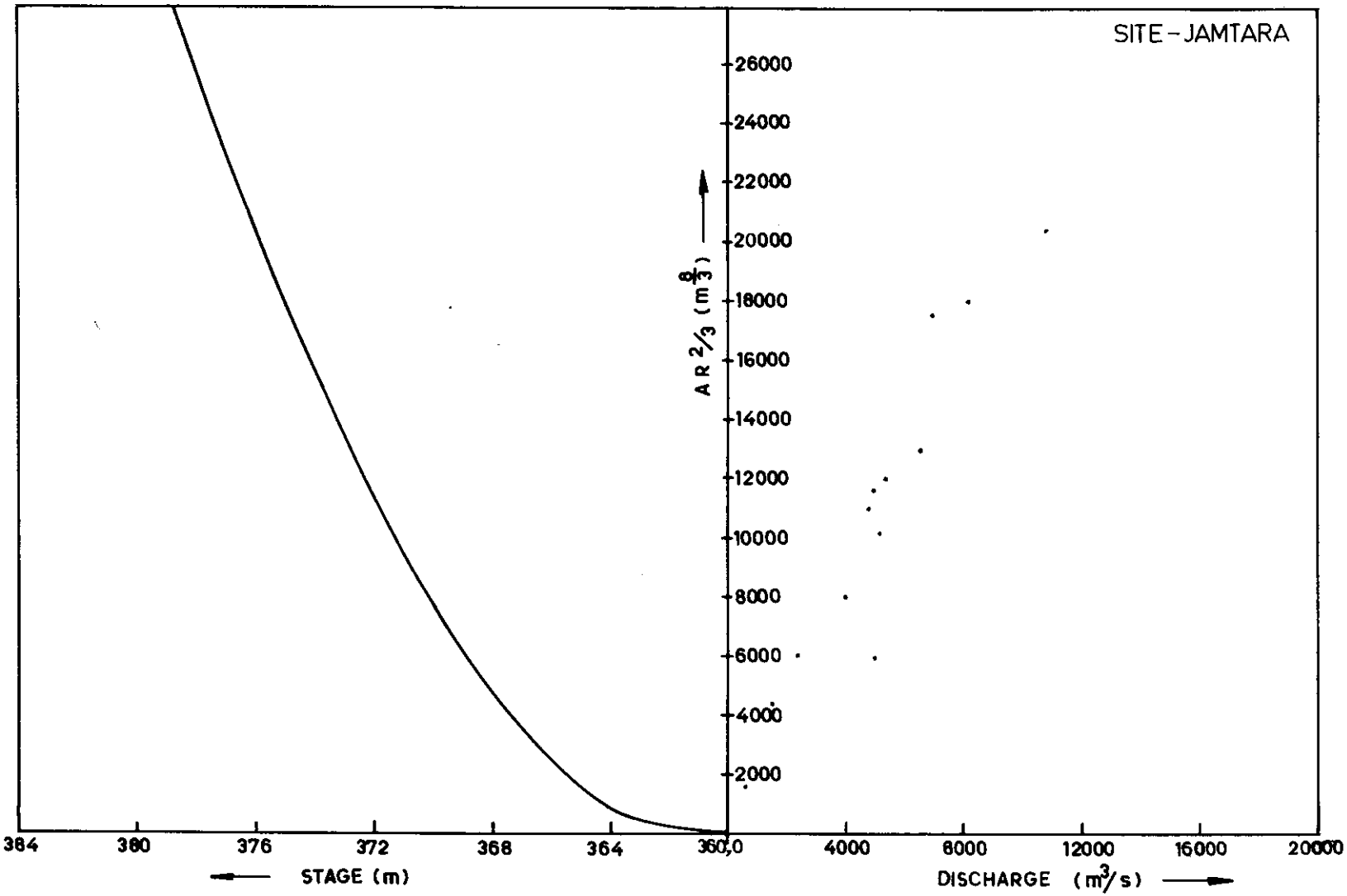

Figure -9 Plot of the conveyance ,Q, and stage for Jamtara site

b = 1.7 (assuming a parabolic shape)

e = 2.0 (effective bottom elevation)

Double log analysis

Stage elevations are reduced by 362.0 m and a plot is made on a double log as shown in figure 10. using the stage and discharge data. A straight line fit is made. The following parameters are obtained from the plot.

a = 70

b = 2.04

e = 2.0

Remarks: Double log plot showed a S shaped curve indicating a channel control like a falls this aspect was not investigated in the present study.

Rating analysis

The daily gauge and discharge data pertaining to the year 1972 to 1977 were used. In total about 255 pairs were used while applying the least square techniques. The following table gives the extract of computer results:

Table 5 - Trial Parameters for the Jamtara site

Trial No.	a	b	e	Sum of squared error	Remarks
1	76.275	1.837	2.2	Not printed out	-
2	85.046	1.795	2.3		Computer choice as the best
3	94.858	1.753	2.4		

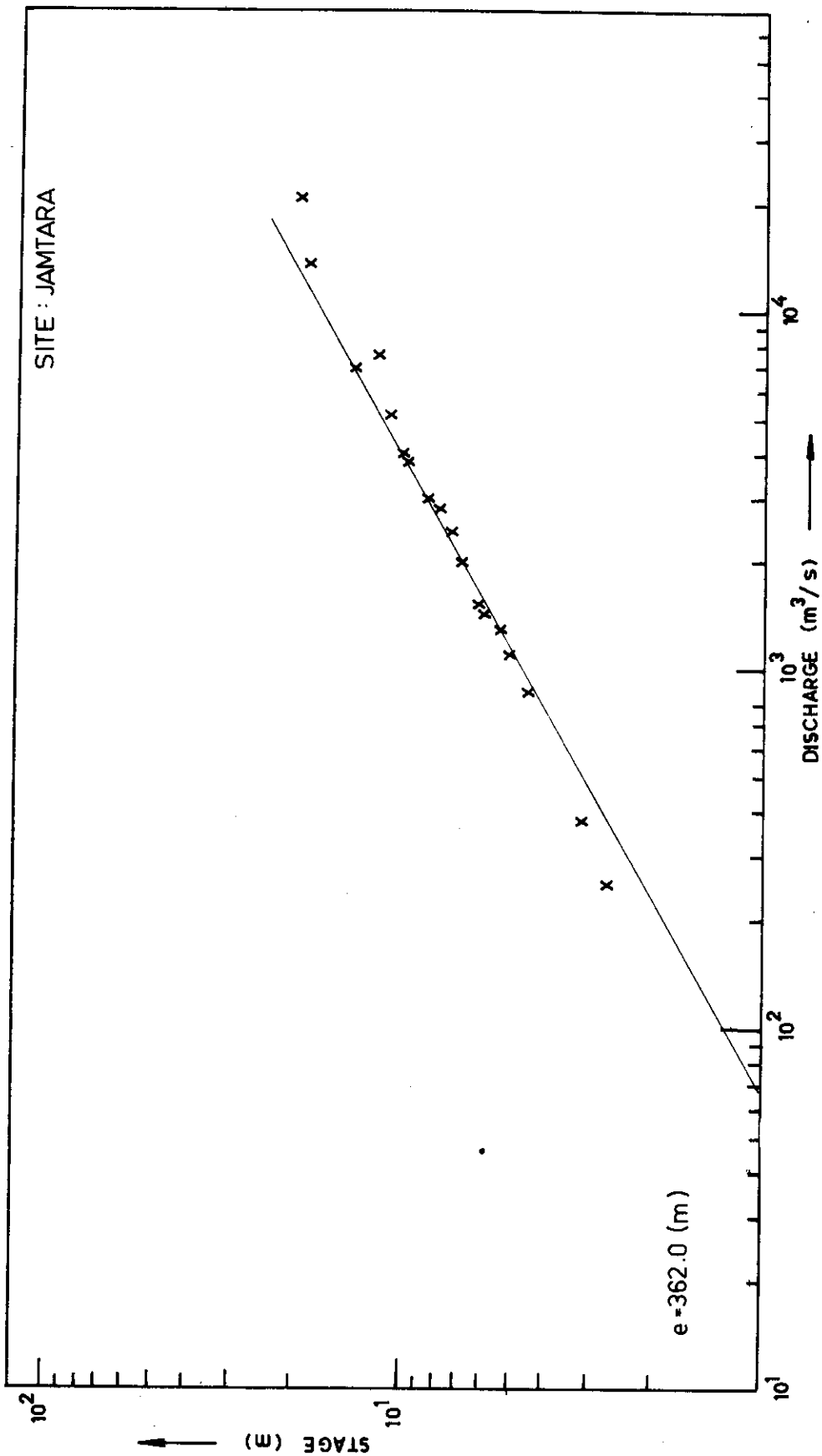

Figure 10 - Double log plot between discharge and stage for Jamtara site

The computer choice of the parameters viz., a = 85.046 b = 1.795 and e = 2.3 is taken as final for conversion of stages since these value are comparable with the ones obtained in other two analyses.

A comprison of rating curve used in NIH with the rating curve supplied by field organisation (CWC) is shown in figure 11. If extended CWC curve would over estimate the discharges in comparison to those given by the presently established rating curve.

The relationship finally adopted is the following:

$$Q = 85.046 \ (G - 2.3)^{1.795}$$

where,

G is the stage above zero of gauge in m

Q is the discharge in m^3/sec

PROFORMA

Site	:	JAMTARA
River	:	Narmada
Type of data	:	Rating curve (graphical)
Source	:	CWC Bhopal Division
Year	:	1978
Range	:	360.0 m to 370.5 m
Zero of the gauge	:	360.0 m
Remarks	:	1. The curve is drawn well guided by the plotted points
		2. The stage coversion needs upto 375.875 M to be converted, hence an extension of 5 m is involved.

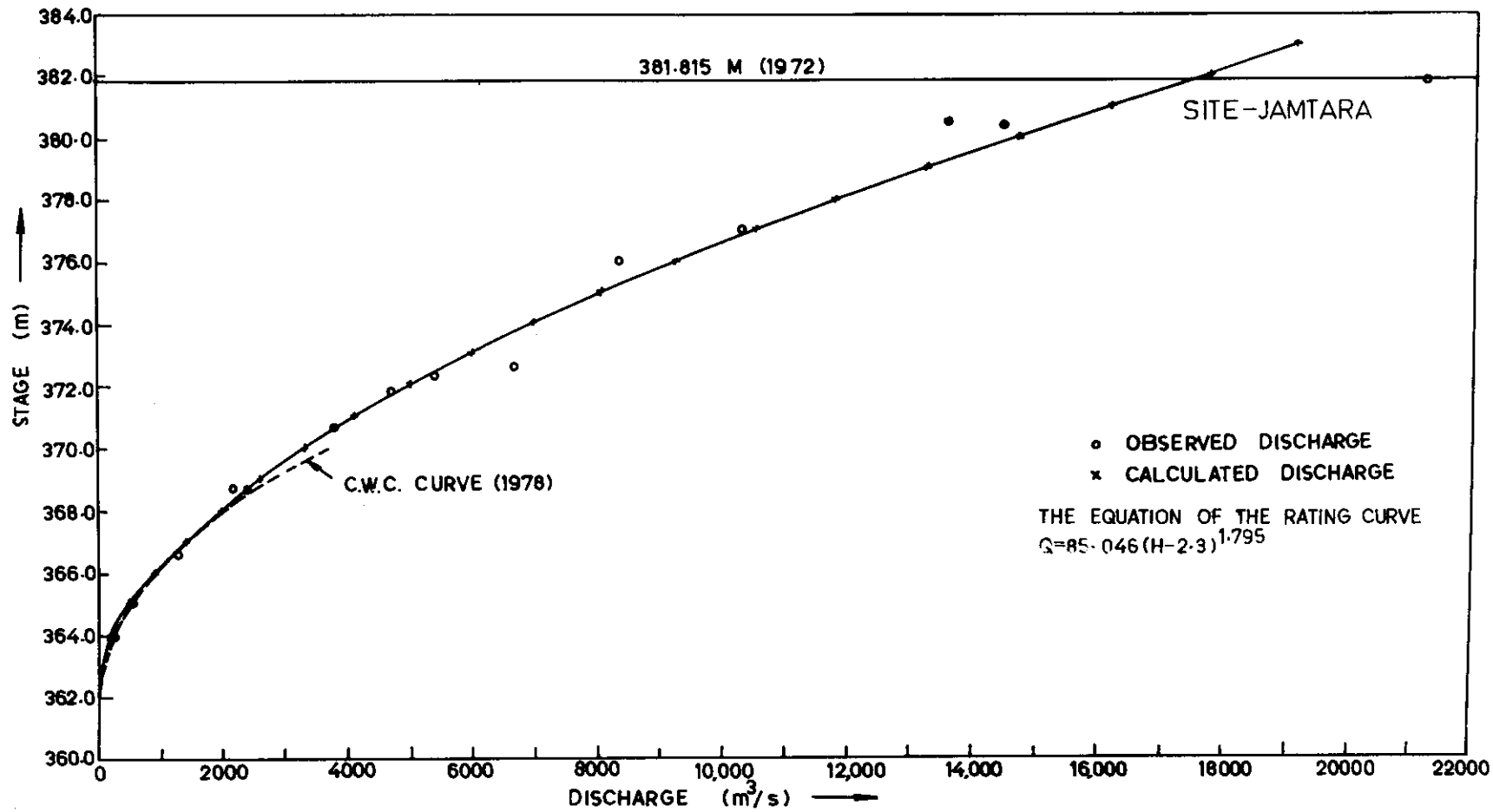

Figure 11 - Comparison of established and C.W.C. rating curves for Jamtara

Type of data	:	Cross section (graphical)
Year	:	1979
Remarks	:	1. The cross section is defined by 41 co-ordinates covering 490 m width. The lowest level is defined by 90 m, 361.025 m.
		2. The section is a composite one.
		3. The left over bank is not defined while right over bank is in sufficiently defined.

7.3 Bermanghat

This gauging site is situated at about 510 km from the source and just 10 km downstream of the confluence of the tributary Sher. This site is in M.P.State. Table 6 below gives the zero of gauge of this site as mentioned in data supplied.

Table 6 - Different zero of gauges at Bermanghat

Year	Zero of gauge(m)	Source and Remarks
1978	306.0	Rating curves
1971 to 1978	306.0	Daily gauge and discharge (CWC)
1976	315.85	Cross section
1978	318.7	Cross section
1979	306.0	Cross section
1980	306.0	Hourly stages

On the basis of geometrical information provided in the cross section pertaining to the year 1979, as shown in figure 12, the conveyance analysis was carried out. The output from the program which are hydraulic elements like area, $R^{2/3}$ etc. These were used to compute conveyance . Conveyance , as function of stage and discharge as a function of conveyance, were plotted as shown in figure 13. It can be found that the conveance of this cross section varies uniformly upto a stage of 324.0 m. Hence it can also be expected that the rating curve would also have similar behaviour this elevation assuming that

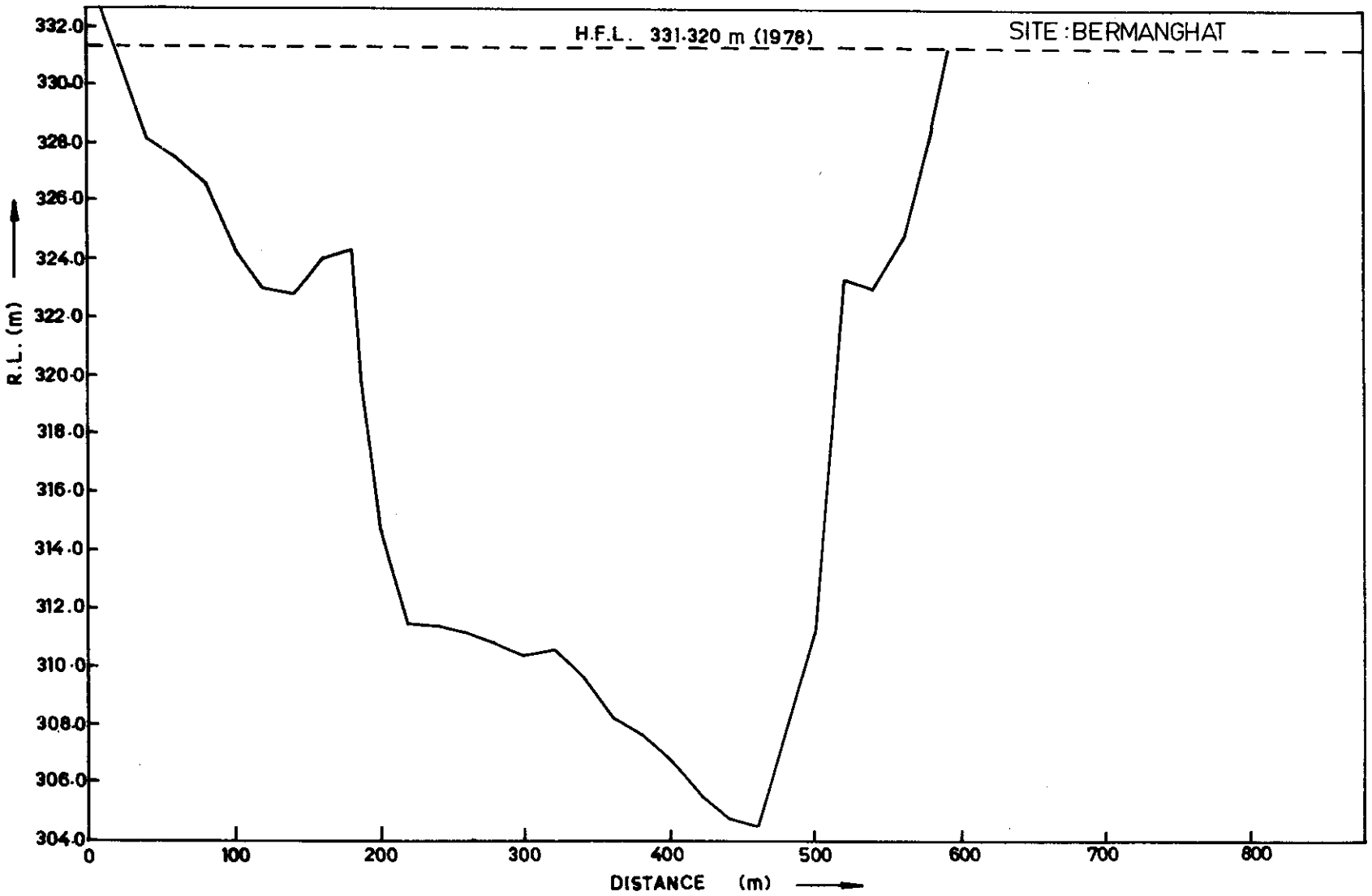

Figure 12 - Cross section of the river Narmada and Bermanghat site

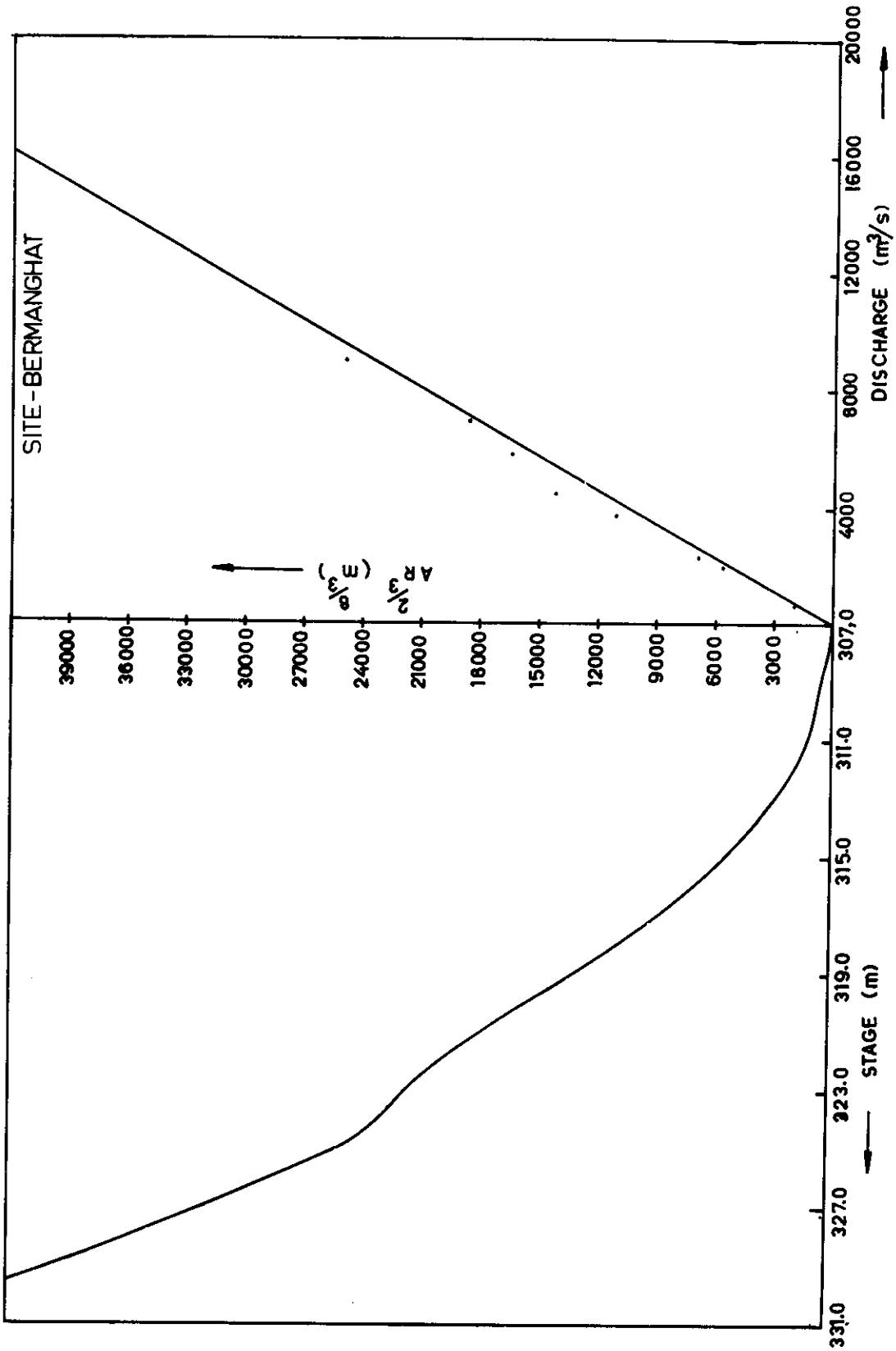

Figure 13 - Plot of the conveyance,Q, and stage for Bermanghat site

Manning's 'n' remains constant.

For the devellpment of the relationship an equation of the following general form is assumed :

$$Q = a\ (G - e)^b$$

where,

Q is the discharge in (m^3/S),

G is the stage elevation in (m), and

a,b,e are the coefficients defining the relation. The following are the details of the analysis; carried out:

A. Physical analysis

Width ---------- 320 m
(from the cross section)

Slope ---------- .00038
(from the longitudinal section)

$S^{1/2}$ ---------- .019

n ----------.038
(assumed)

$a = \frac{1}{n} W S^{1/2}$ ---------- 160

b = 1.7 (A parabolic cross sectional shape)

e = 4.0 m (effective bottom)

B. Double Log Plot

The stage elevations are reduced by 310 m and a plot of stage and discharge on a double log sheet is made as shown in figure 14 A straight line could be drawn through most of the points as shown.

The following coefficients are optioned from the plot:

a = 150
b = 1.34
e = 4.0

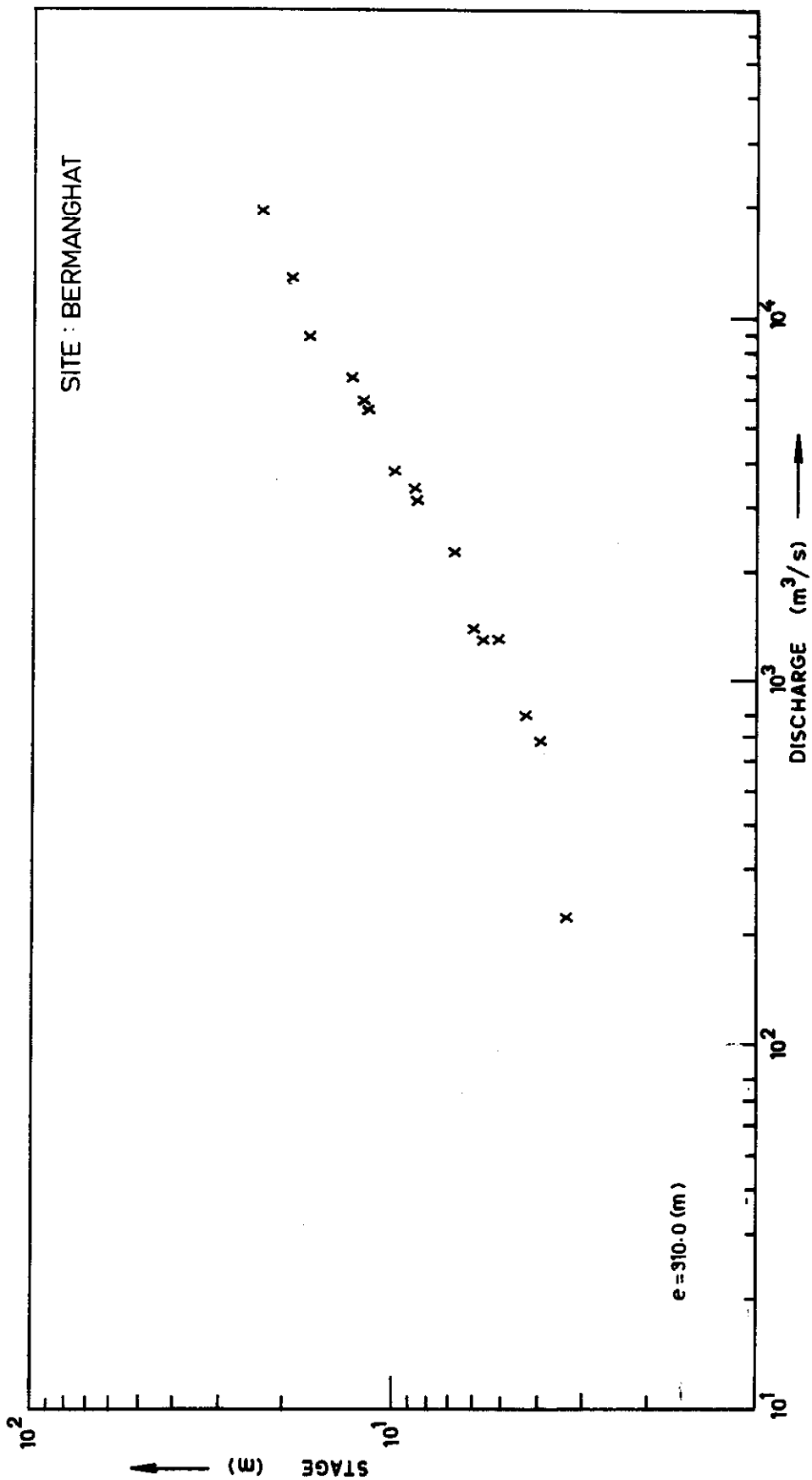

Figure 14 - Double log plot between discharge and stage for Bermanghat site

(C) Rating analysis

The daily gauge and discharge data pertaining to 1973, 1976 and 1977 (ZG = 306.0 m) were used. In total 177 pair of values were used in the Least Square technique. The relevant extract from the computer output is given in table 7.

Table 7 - Trial Parameters for the Bermanghat site

Sl.No.	a	b	e	Sum of squared error 10^6	Remark
1	88.758	1.769	3.0	22.978	-
2	98.428	1.73	4.0	22.816	computer selected set
3	165.566	1.53	4.5	23.32	

The computer chosen second set of parameters is selected for final conversion based on least sum of squares errors and also because of this closeness to the earlier analysis based on physical characteristics.

For the purpose of comparison the rating curve supplied (CWC curve) and our presently established curve are plotted on figure 15. It is seen that the CWC curve is uniformly under estimating the discharge.

The following relationship has been finally adopted:

$$Q = 98.428\ (G - 4.0)^{1.73}$$

where,

G is stage in (m) above zero gauge

Q is the discharge in m^3/sec

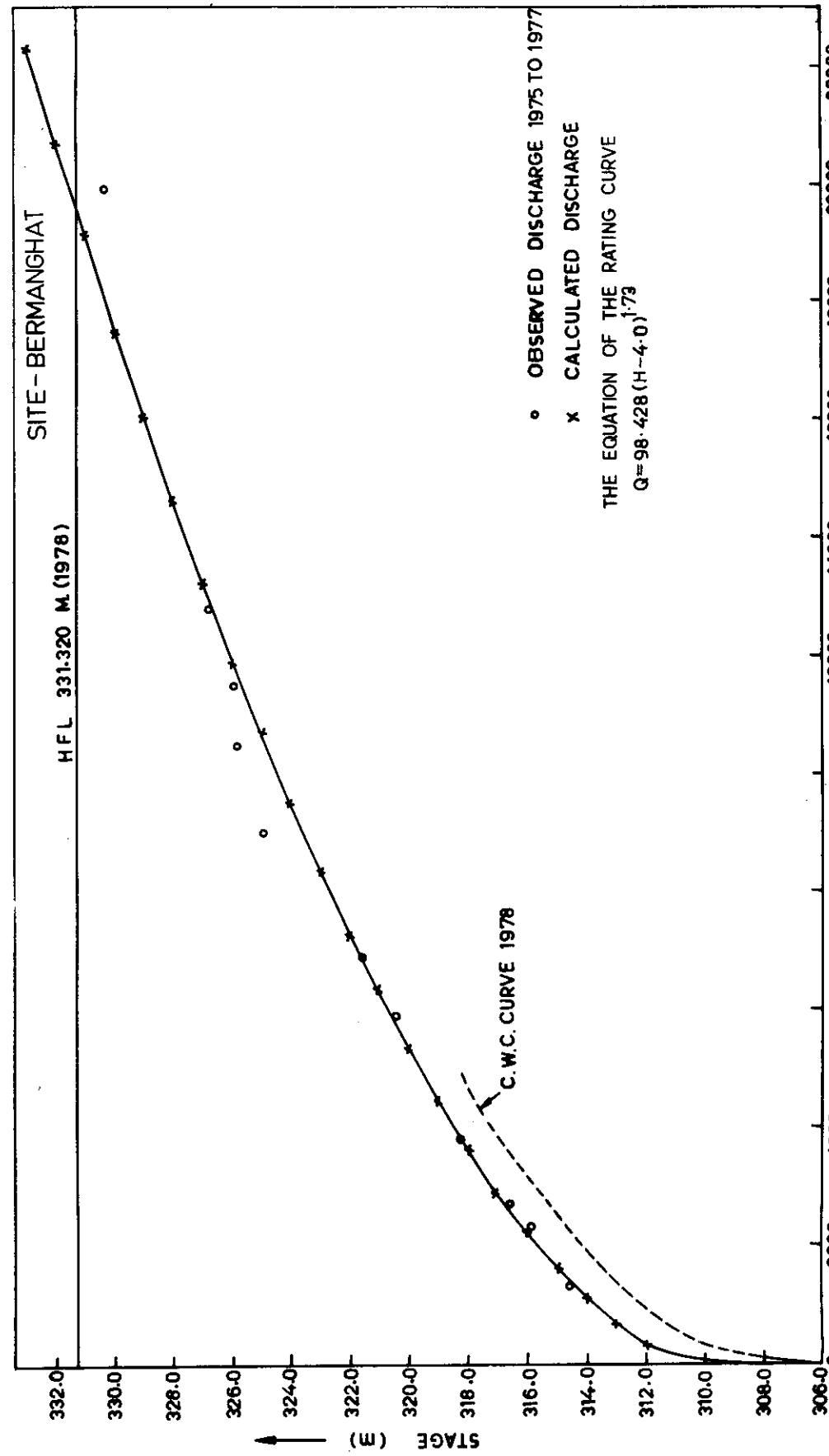

Figure 15- Comparison of established and C.W.C.rating curves for Bermanghat

PROFORMA

Site	:	Bermanghat
River	:	Rating curve (graphical)
Type of data	:	CWC/Western gauging Division
Year	:	1978
Scale	:	Hor. 1 cm = 100 m^3/sec
		Ver. 1 cm = 1.0 m
Zero of gauge	:	306.0 m,
Remarks	:	1. The curve covers 306.0 m to 318.0 m
		2. Drawn well guided by the plotted points .
Type of data	:	Cross section (graphical)
Year	:	1978
Remarks	:	1. The cross section is defined by 60 co-ordinates covering 540 m, The lowest level is 280 m, 304-465 m.
		2. Both left over bank and right over bank are not defined.

7.4 Site : Hoshangabad

This gauging site Hoshangabad is situated at about 650 km from the source. This gauging site is operated by CWC from 21.5.72. The zero of gauge as found from the data are given below:

Table 8 - Different zero of gauges at Hoshangabad

Years	Zero of gauge (m)	Source and Remarks
1978	282.0	Daily gauge and discharge data
1979 1980	282.0	Hourly data

For the development of rating curve the cross section data of the year 1978 and daily gauge and discharge data for the years 1972,1973 and 1978 have been used in the present study.

On the basis of physical information provided by the river cross-section a conveyance analysis using GEDA program has been made. The output from this program provides hydraulic radius and other hydraulic elements as a function of depth of flow (elevation). The cross section of river Narmada at Hoshangabad has been plotted as shown in figure 16 and the stage elevation conveyance and discharge are plotted as indicated in figure 17. It is seen from figure 17 that the conveyance changes at a uniform rate upto stage of 303 m or so and it is therefore expected that the rating curve would also have

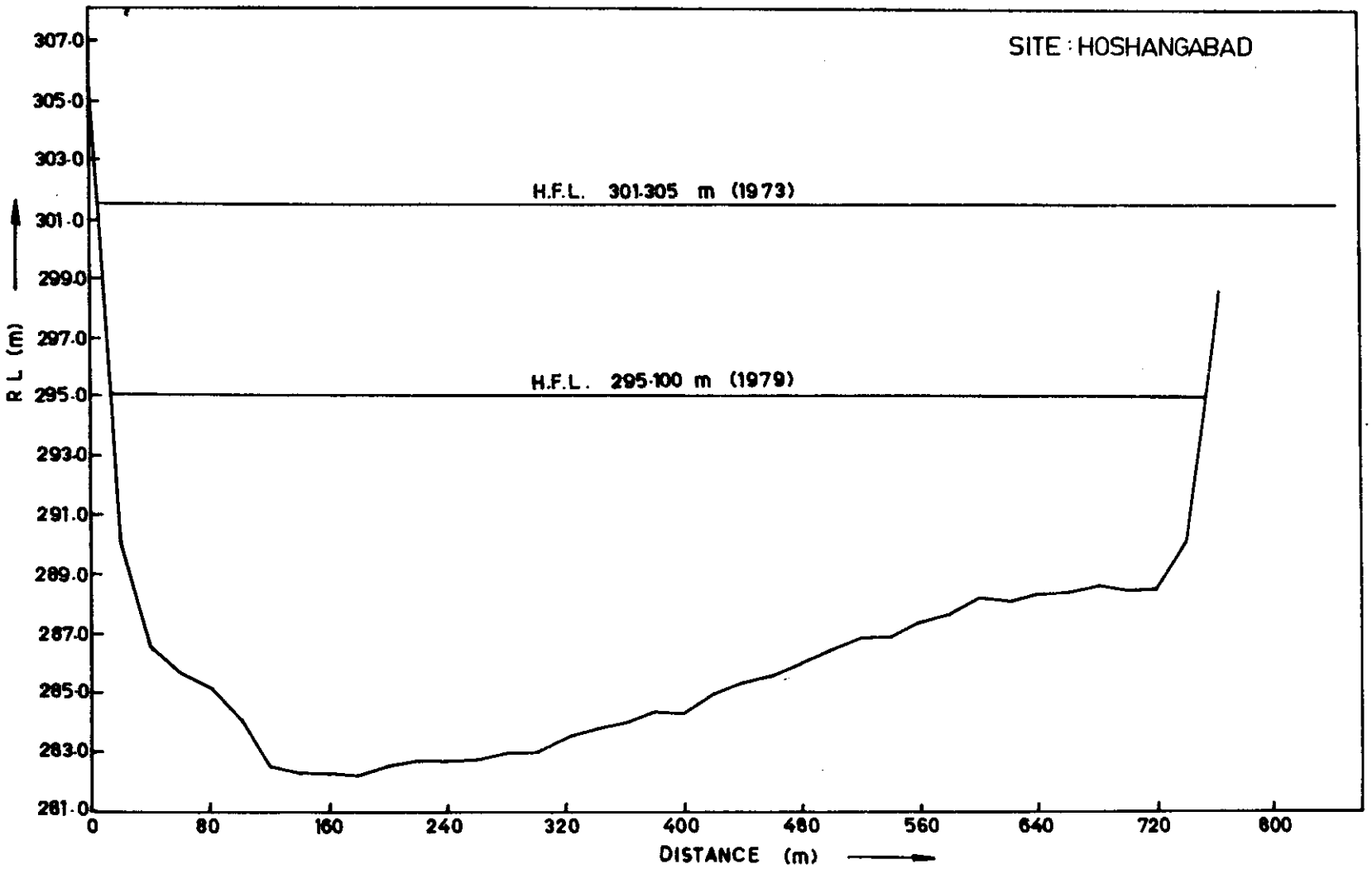

Figure 16 - Cross section of the river Narmada at Hoshangabad

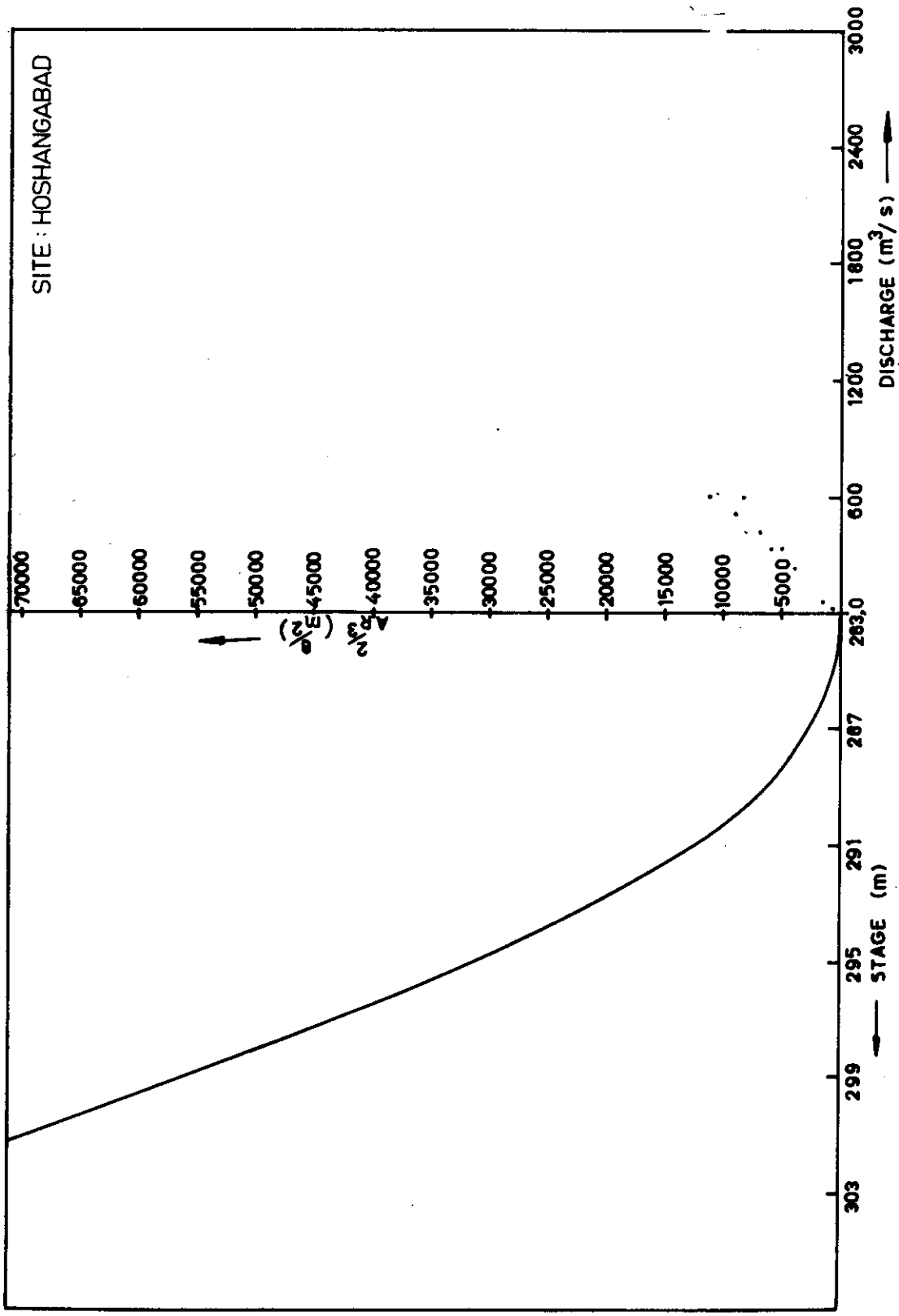

Figure 17 - Plot of the conveyance, Q and stage for Hoshangabad site

similar behaviour upto this level assuming Manning's 'n' remaining the same

An equation of the form

$$Q = a\ (G-e)^b$$

where,

Q is the discharge at the gaugint site,

G is the stage elevation, and

a,b,e are the parameters defining the relation. The details of analysis made are given below;

A. Physical Verification

Width of the channel (at the channel portion) ----------700 m

Slope S (as per longitudinal section) ----------0.00023

$S^{1/2}$ ----------0.0151

$n_{(assumed)}$ ----------0.036

$a = \frac{1}{n} W S^{1/2}$ ----------294

b = 1.7 (assuming a parabolic shape)

e = 0.0 m (effective bottom level)

B. Double Log Plot

Adopting a shift of 283.9 m in the stage elevation (i.e. h =G -283,9) a plot is made of observed stage(h) and discharge in double log as shown in figure 18. A straight line has been fitted through these points. The value of coefficients obtained are as follows:

a= 170

b= 2.0

e= 1.9 above zero of gauge)

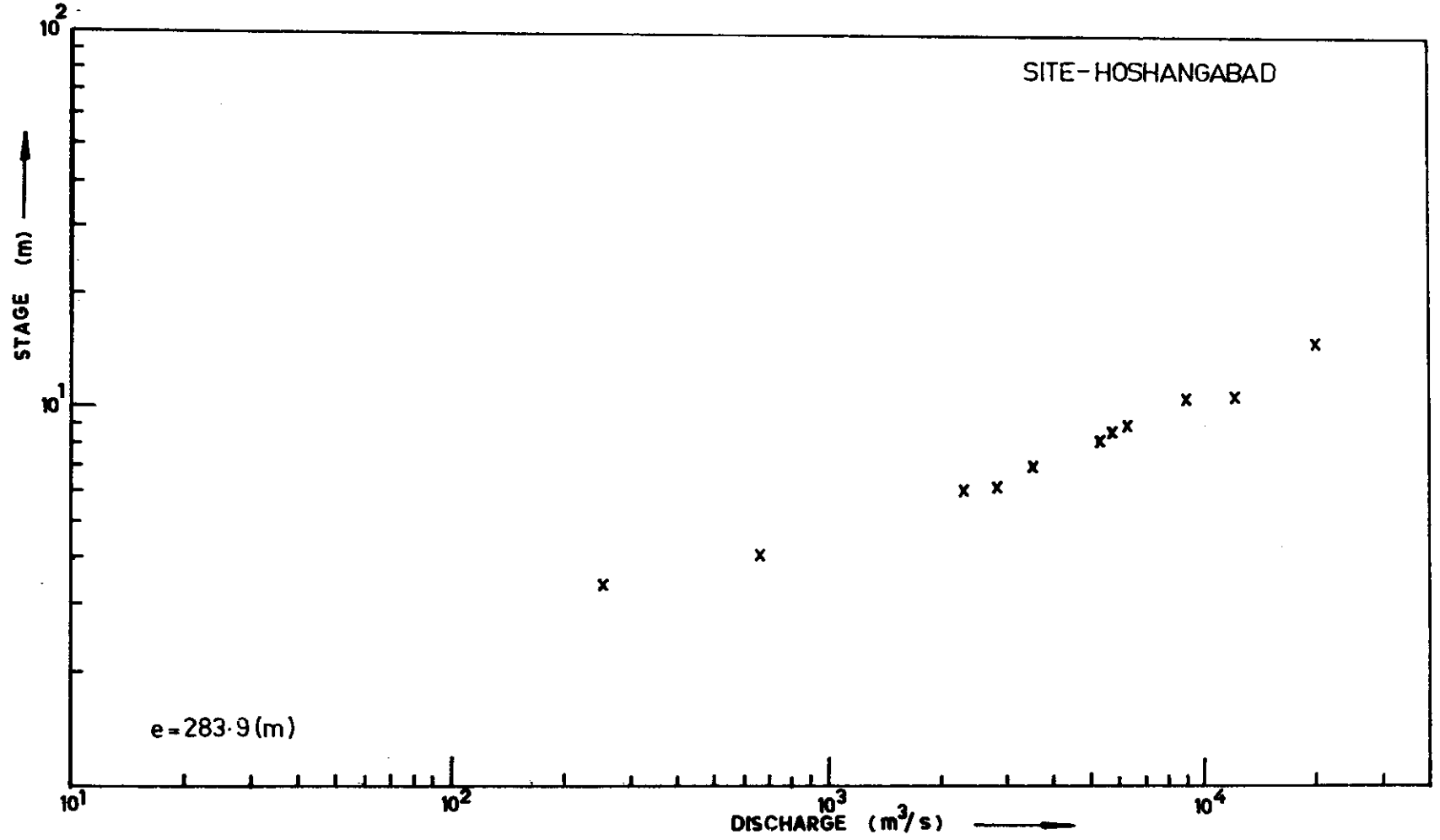

Figure 18 - Double log plot between discharge and stage for Hoshangabad site

C. Rating Analysis

The daily gauge and discharge of the year 1972,1973 and 1978 were used for analysis. Least square technique is applied using 325 data points. The following are the relevant computer results:

Table 9 - Trial Parameters for the Hoshangabad site

Sl.No.	a	b	e	Sum of squared error	Remarks
1	149.756	1.924	1 .8	55916604	
2	173.183	1.858	1 .9	48690932	Computer chosen best
3	200.28	1.791	2 .0	49299792	

The computer chosen second set based on the minimum error criterion is also comparable with the physical analysis, double log analysis and hence they are selected for conversion of stages into discharges.

A comparison of rating curve used in NIH with the CWC rating curve supplied in shown in figure 19. The CWC curves will be over-estimating the discharge between stages approximately 290 m to 294 m.

The relationship finally adopted is the following:

$$Q = 173.183\ (G-1.9)^{1.858}$$

where,

G is the stage above zero of gauge in m , and

Q is the discharg in m^3/sec.

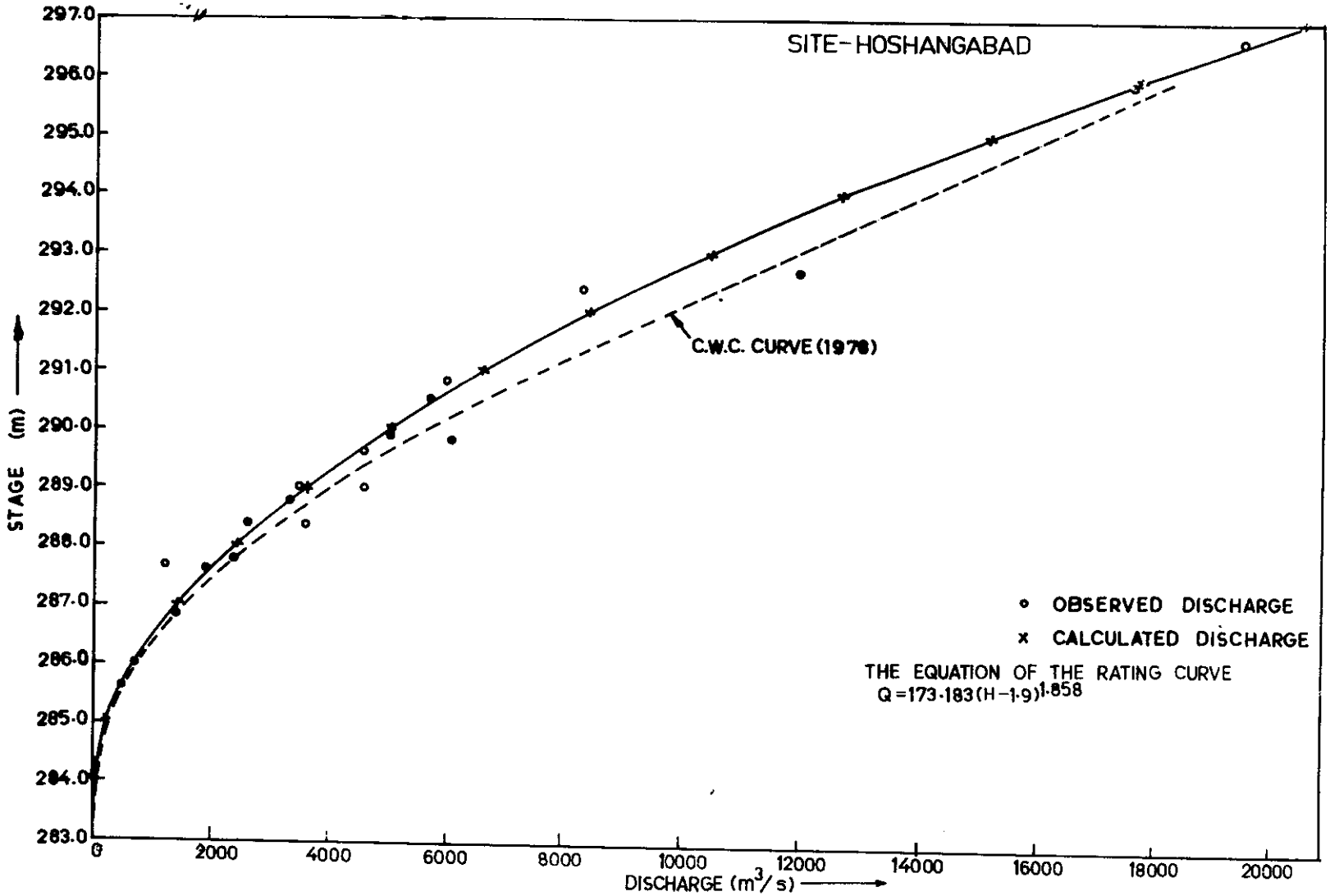

Figure 19 - Comparison of established and C.W.C.rating curves for Hoshangabad

Site	:	Hoshangabad
River	:	Narmada
I Type of data	:	Rating curve (graphical)
Source	:	CWC/Western gauging Division
Year	:	1973
Scale	:	Hor. 1 cm = 500 m^3/sec
		Ver. 1 cm = 1 m
Zero of the gauge	:	282.0 m
Remark	:	The range covered is from 282.0 m to 296.0 m
II Type of data	:	cross section (graphical)
Year	:	1979
Remark	:	1. The cross section is defined by 47 co-ordinates covering a width of 753 m
		2. The lowest level is defined by the co-ordinate (160 m,281.92 m)

7.5 Site : Mortakka

The gauging site Mortakka is situated on the main river upstream of the dam at Maheshwar dam at about 886 km from the source. The Narmada tribunal report says that daily observations are made with float at a section 3000 ft. downstream of a railway bridge on Western Railway line between Khandwa to Indore.

The zero of gauge as found from various data are given in the table below:

Table 10 - Different zero of gauges of Mortakka

Year	Zero of gauge(m)	Source and Remarks
1969 to 1975	152.961	Rating curve (CFFD)
1979	150.0(datum)	Cross-section supplied by Govt. of M.P.
1968 to 1970	152.4	Daily gauge and discharge
1973	152.4	CWC
1978	152.4	CWC

For the purpose of establishing a rating curve the cross sectional data pertaining to the year 1979 and the daily gauge and discharge data pertaining the year 1980 were used.

A. Physical Verification

Width of the channel (at the channel portion) ---------- 670 m

Slope S ----------0.00053

$S^{1/2}$ ----------0.023

n ----------0.03

$a = \frac{1}{n} W S^{1/2}$ ---------- 616.4

e (effective bottom) ---------- 0.8 m above datum 153.0 m

b = (Assuming a parabolic shape to cross section) 1.7

B. Stage elevation are reduced by 155.6 m and a plot is made on a double log as shown in figure 22. Using the osbserved stage and discharge data. A straight line is fitted through the plotted points. The following parameters are obtained from the plot

a = 950

b = 1.23

e = 155.6 m or (2.6 m above the zero of gauge)

Since the other stage and discharge data for different years do not pertain to the site for which stage measurements are available.

The cross section used is as shown in figure 20. Analysis of this cross section of this site is done by a computer program GEDA which takes geometric co-ordinates and the output of which include the hydraulic elements like $R^{2/3}$ etc. These were used to compute the conveyance. These conveyance as a function of stage and also as a function of discharge are shown graphically in figure 21. It can be seen from figure 21 that the conveyance changes uniformly upto the height of 172 m or so and it is ,therefore, expected that the stage and discharge would also have similar behaviour upto this level assuming a constant Manning's 'n'.

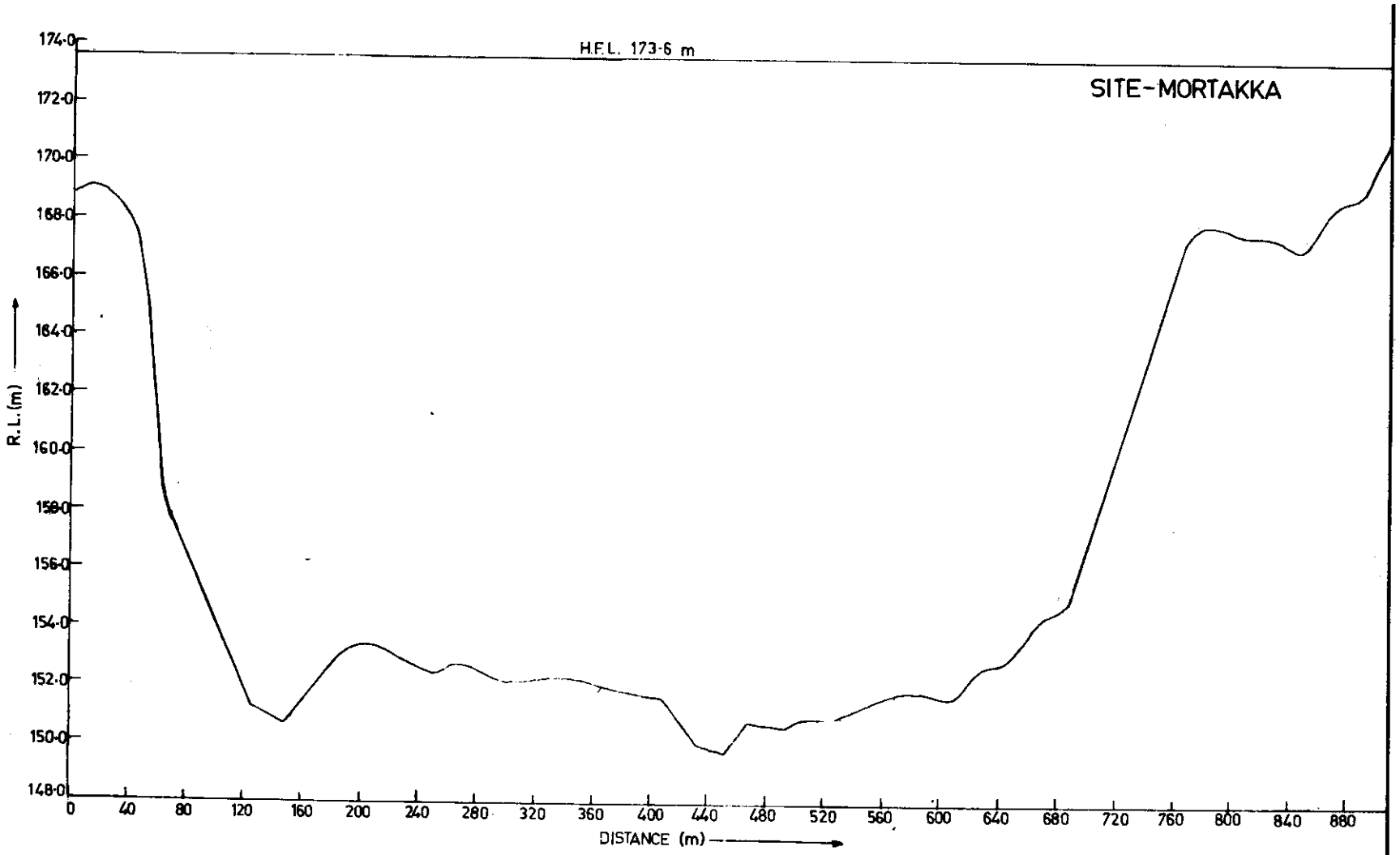

Figure 20 - Cross section of the river Narmada at Mortakka

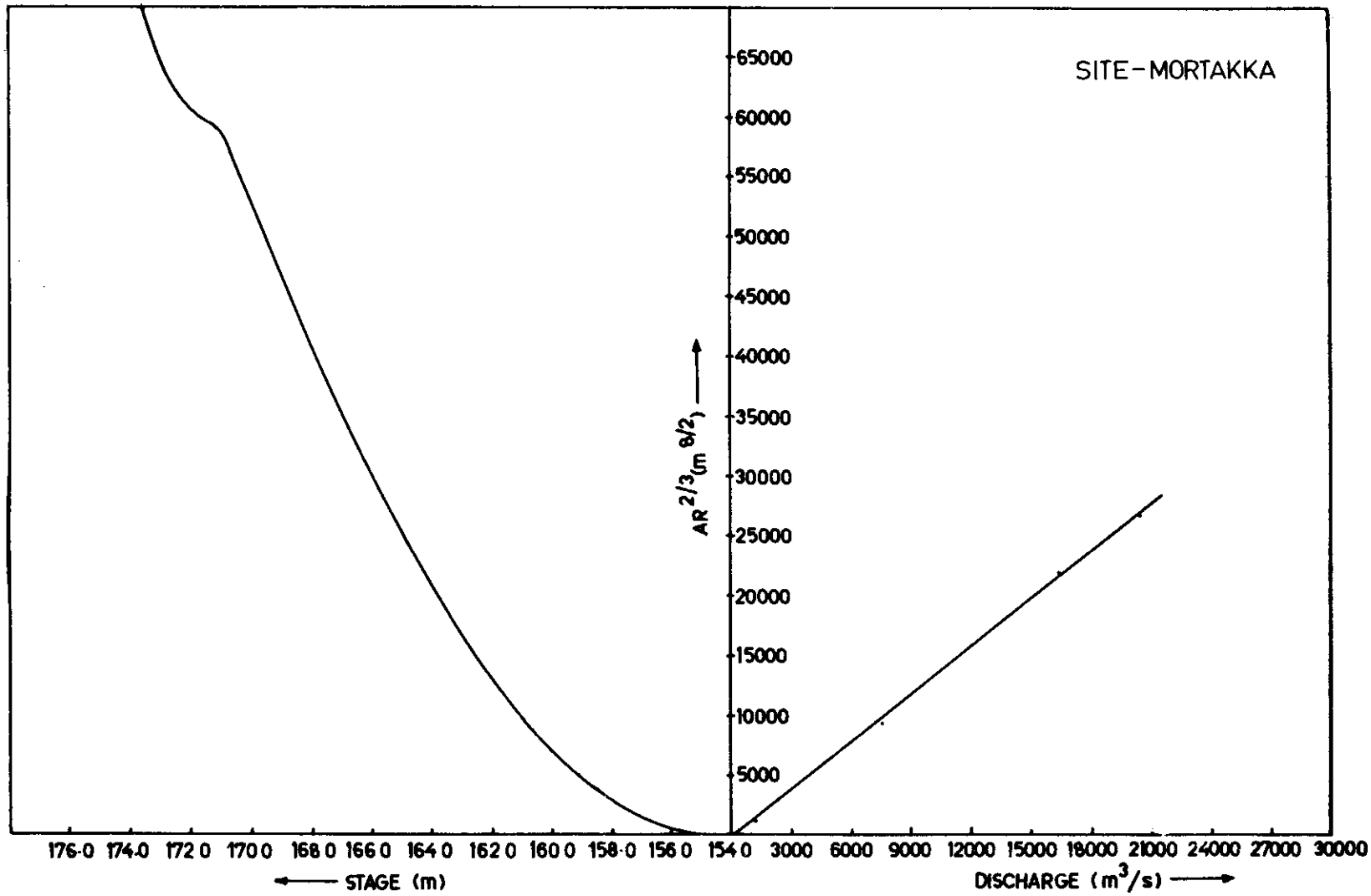

Figure 21 - Plot of conveyance,Q,stage for Mortakka site

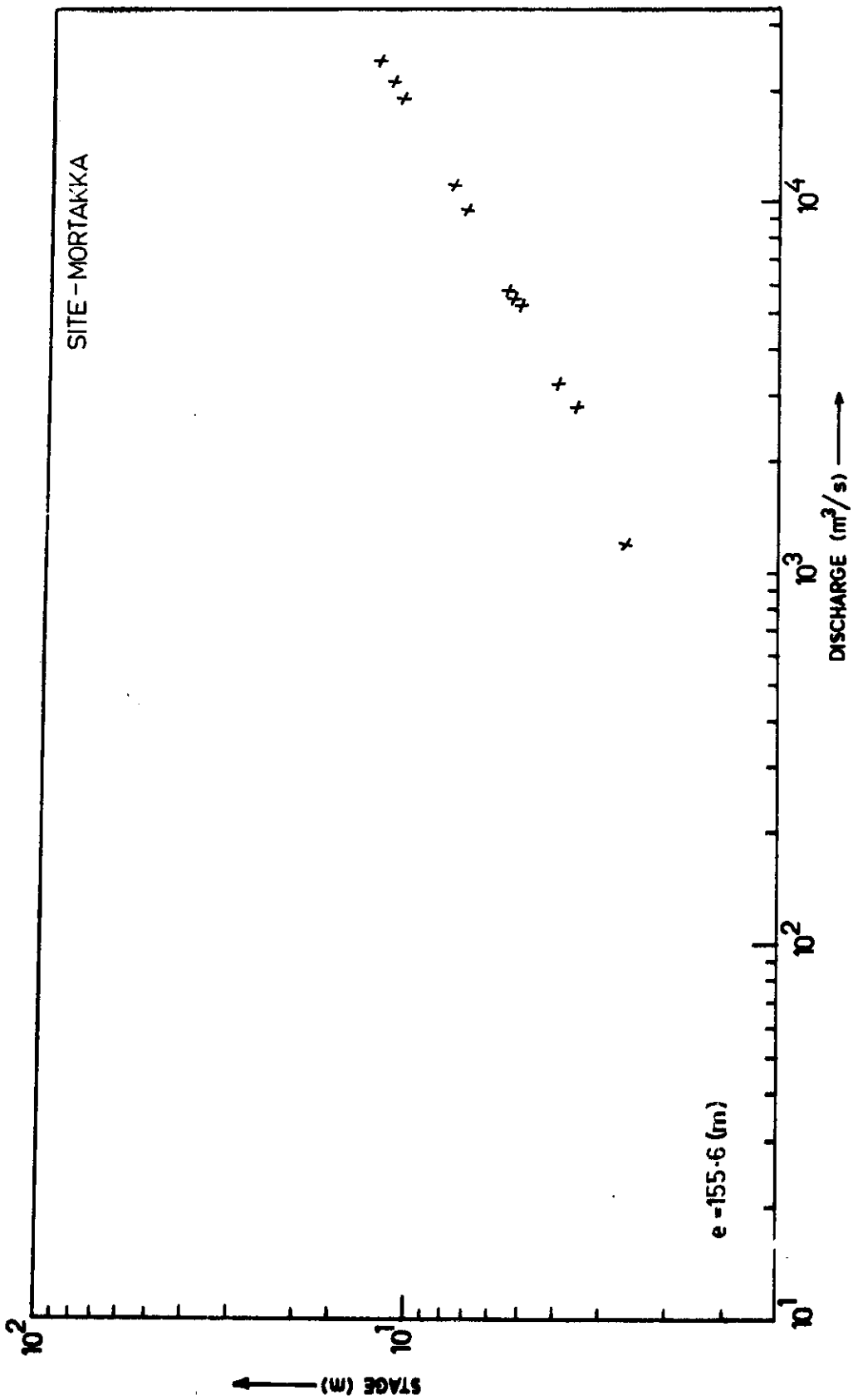

Figure 22 - Double log plot of discharge,stage for Mortakka site

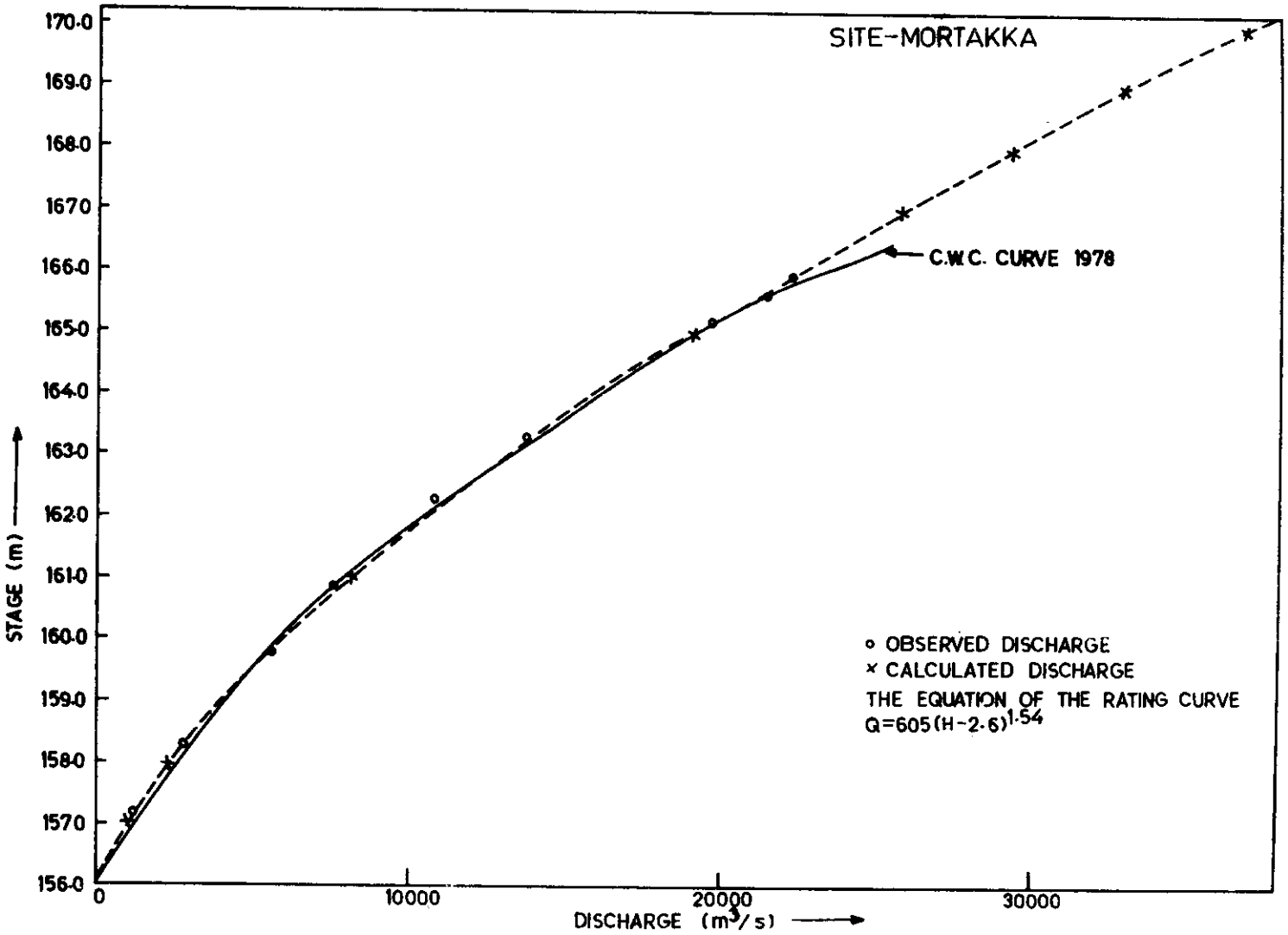

Figure 23 - Comparison of established and C.W.C. rating curves for Mortakka site

C. Rating analysis

An equation of the following form is assumed:

$Q = a\ (G-e)^b$

where,

Q is the discharge in (m^3/sec.);

G is the stage in (m) above a datum = 153.0 m

a,e,b are coefficients defining the relationship

After the detailed analysis carried out on the daily gauge and discharge data pertaining to the years 1978 and 1980, the following relationship is adopted.

$Q = 605.099\ (G-2.6)^{1.54}$

The trial parameters worked out in the computation are given in table 11 as an extract of the computer output.

Table 11 - Trial parameters for the Mortakka site

Trial No.	Value of parameters			Remarks
	a	b	e	
1	506.193	1.610	2.4	
2	553.409	1.576	2.5	
3	605.099	1.542	2.6	computer choice
4	661.727	1.507	2.7	

PROFORMA

Site : Mortakka

River : Narmada

Type of data : Rating curve (graphical)

Source	:	Irrigation Deott.,Bhopal,M.P.
Year	:	1979
Scale	:	Hor. km = 500 m^3/sec
		Ver. km = 0.5 m
Zero of gauge	:	150.0 (datum)
Remark	:	The curve covers the range from
		150.0 m to 167.0 m
Type of data	:	Cross section (graphical)
Year	:	1979
Remarks	:	1. The cross section is defined by 97 co-ordinates covering a width of 920 m.
		2. The lowest level is defined by the co-ordinates 460 m,153,325 m.
		3. The HFL is 173.69m and the road level is 169.
		4. The left and right overbanks are not defined.

7.6 Site : Mandleshwar

The gauging site Mandleshwar is situated at about 926 km from the source. The site is operated by CWC since 16.12. 1970. The zero of gauge as mentioned in various data supplied are given below

Table 12 - Different zero of gauges at Mandleshwar

Year	Zero of gauge(m)	Source and remarks
1973	138.0	Hourly stage
1973 to 1978	138.0	Rating curves
1975 to 1980	138.0	Daily gauge and discharge

For the purpose of establishing a rating curve the cross sectional data pertaining to the year 1979 and the observed daily gauge and discharge data pertaining to the years 1975 to 1980 were used for analysis.

On the basis of geometrical informations provided in the cross section pertaining to the year 1979 as shown in figure 24 the conveyance analysis was carried out. In this connection GEDA program was used. The output from the program which are hydraulic elements like Area, $R^{2/3}$. These were used to find conveyance. A plot is made as shown in figure 2 5 giving conveyance, as a function of sta ge and discharge as a function of conveyance. It can be seen that conveyance vary uniformly upto the stage of 155 m and hence it may be expected

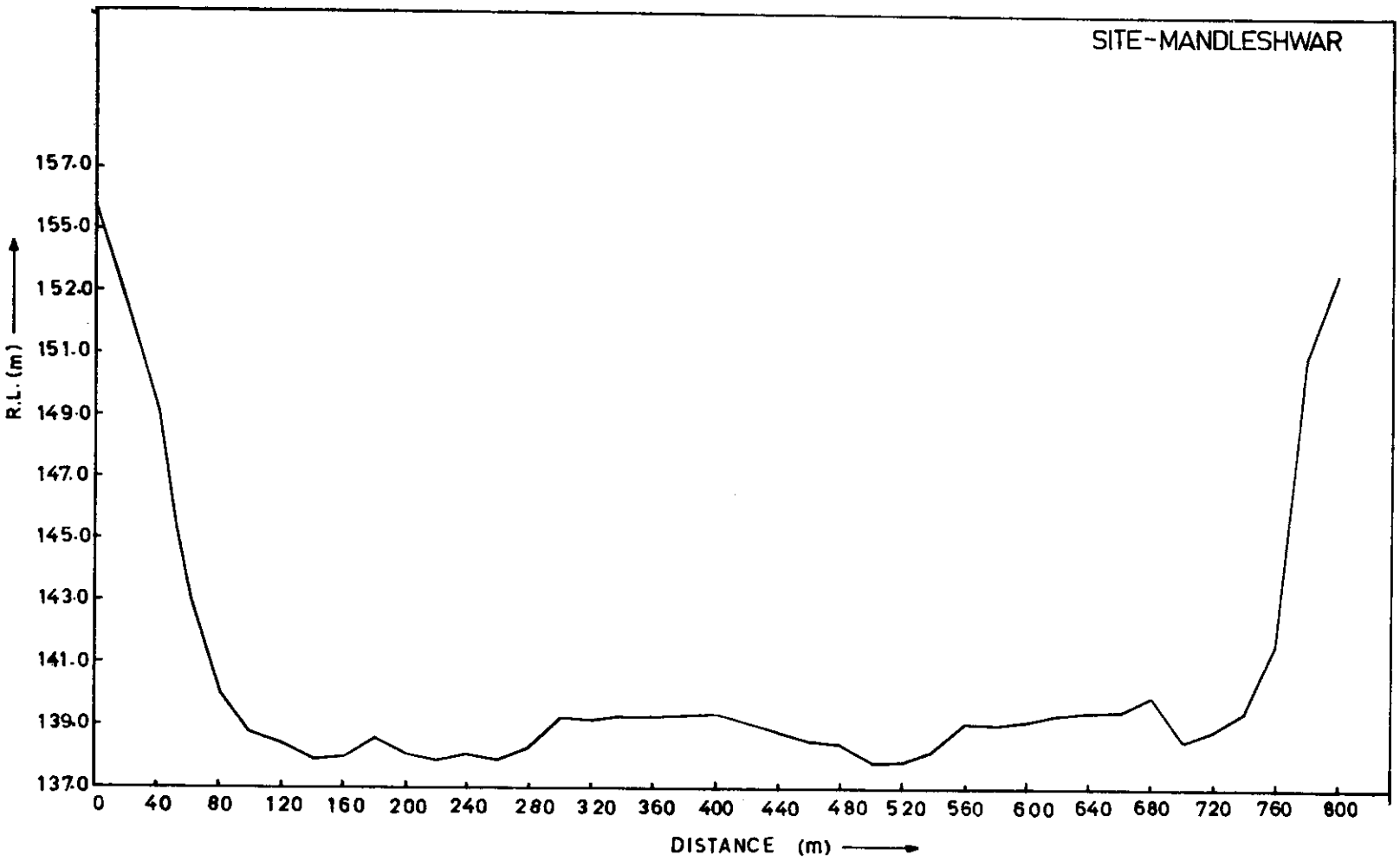

Figure 24 - Cross section of the river Narmada at Mandleshwar site

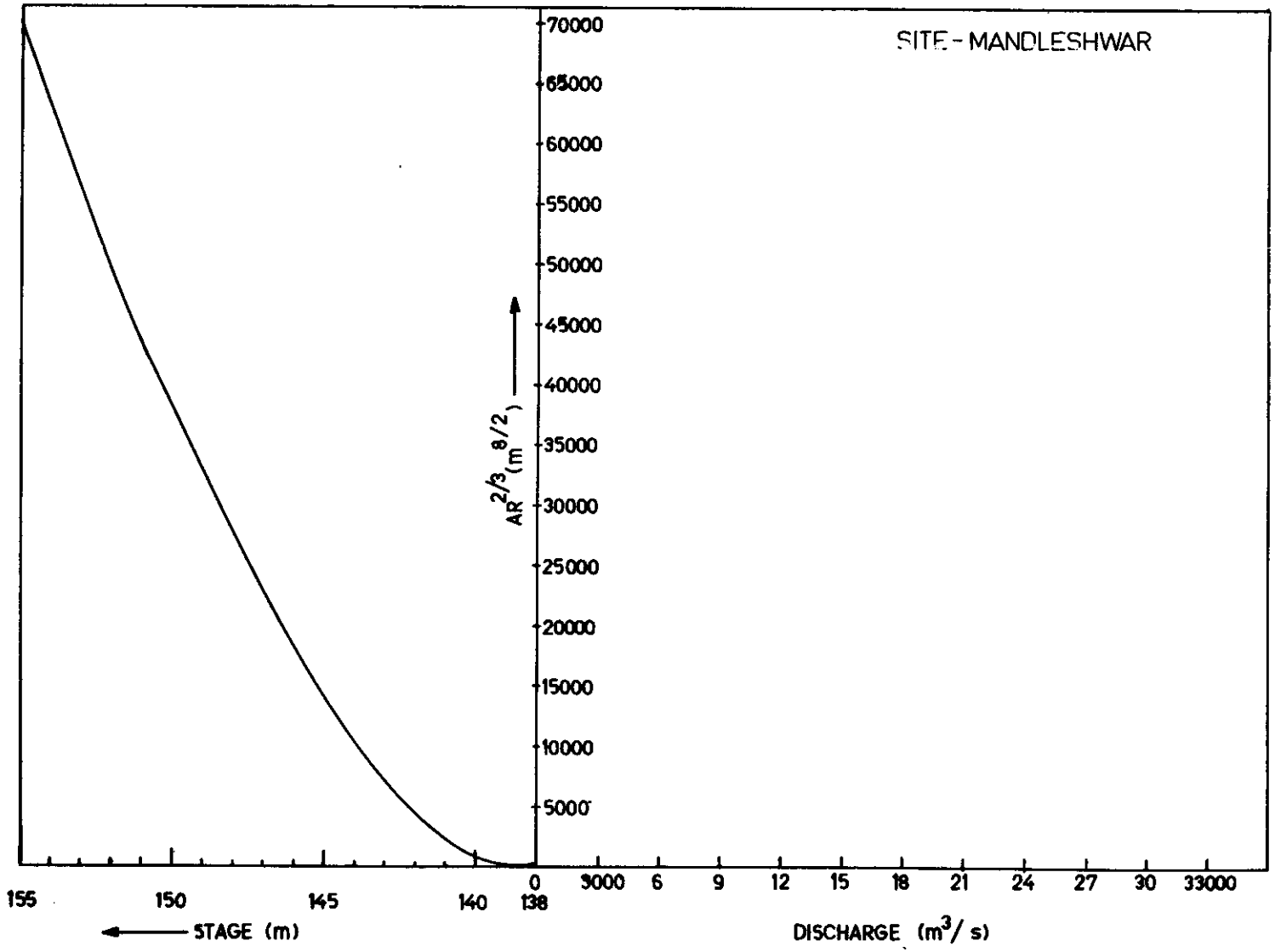

Figure 25 - Plot of conveyance,Q,stage for Mandleshwar site

that the rating curve would also have similar behaviour upto this elevation assuming that Manning's 'n' remains constant.

For the development of the relationship an equation of the following general form is assumed:

$$Q = a\ (G-e)^b$$

where,

Q is the discharge in (m^3/S),

G is the stage elevation in (m) and ,

a,b,and e are the coefficients defining the relation.

The following are the details of the analysis carried out:

A Physical analysis

Width (from the cross section)..... 600 m
(at channel portion)

Slope(obtained from longitudinal section.....0.00046

$S^{1/2}$ 0.0215

n 0.32

$a = \frac{1}{n} W S^{1/2}$ 400.0

e = 13.8.7 m or .7 m abo ve zero of gauge

b = 1.7 (assuming a parabolic shape)

B Double log analysis

The stage elevations are reduced by 138.8 and observed daily gauge and discharge data were plotted in a double log sheet. It is observed that the plotted points showed different patterns. The points below the stage 146 m formed a straight line. The plotted point above 146 m of stage formed another straight line.

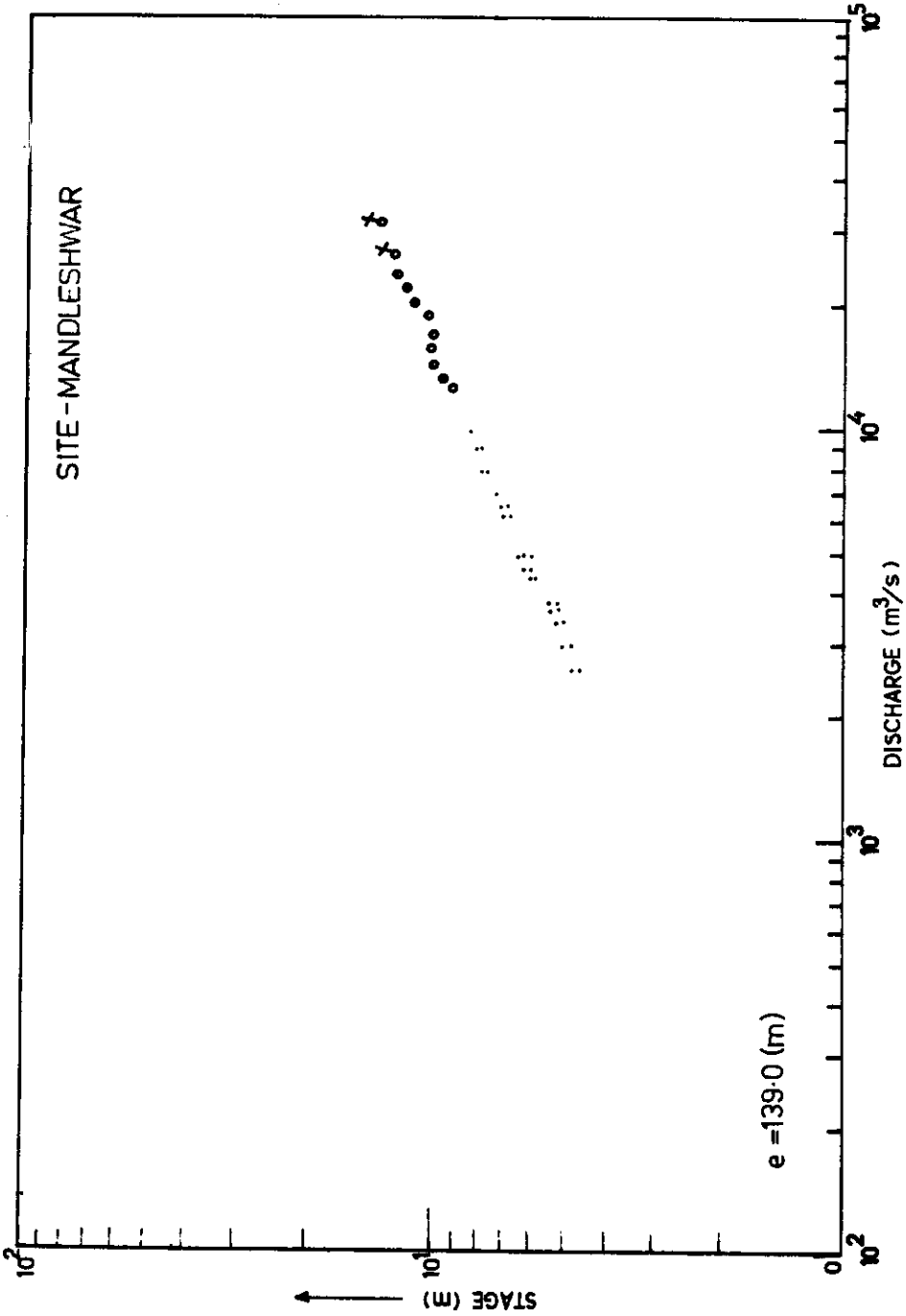

Figure 26 - Double log plot of discharge,stage for Mandleshwar site

The following coefficients are obtained from the plot:

1) upto stage 146.0 m

a = 320 b = 1.938 and e = 138.8

2) Above stage 146.0

a = 500 b = 1.763 and e = 139.0

Q computed by (1) and (2) for stage 146.0 m

Q^1 = 14677.779 m^3/sec

Q^2 = 15448.198 m^3/sec

Q^2-Q^1= 770.42 m^3/sec

This is approximately 4.9% of error which is tolerable.

C Rating analysis

The daily gauge and discharge data pertaining to years 1975 to 1980 were used in this analysis. These data were grouped in two, one containing stages less than or equal to 146.0 m and the other containing stages higher than 146.0 m. For the first set 225 data pairs were used and in the second 36 paris were used. The extract of the computer output are as follows:

Table 13 - Trial Parameters for the Mandleshwar site (for stages upto 146.0 m)

Trial Run	a	b	e	Sum of squared error	Remarks
1	299.76	1.755	0.8	67543736	
2	331.204	1.715	0.9	67525848	computer choice choice
3	365.687	1.675	1.0	67526104	

Table 14 - Trial parameters for the Mandleshwar site (For stages above 146.0 m).

Trial Run	a	b	e	Sum of squared error	Remarks
1	506.739	1.396	1.0	976356416	computer choice
2	528.819	1.384	1.1	976753024	
3	551.803	1.372	1.2	977154304	

The computer chosen set of parameters were selected for final conversion since the physical and to double log analysis are comparable with rating analysis.

For the purpose of comparison the rating curve supplied (CWC) and presently established curves are plotted and shown in figure 27. Both the curves do not differ much for stages below 146.0 m however NIH curve tends to produce under estimated discharge for high stages. This may need further studies.

The following relationship has been finally adopted for stages equal to or less than 146.0or 8 m above zero of gauge.

$$Q = 331.209\ (G-0.9)^{1.715}$$

where,

Q is discharge in m^3/sec

G is stage ab ove zero of gauge

Site : Mandleshwar

River : Narmada

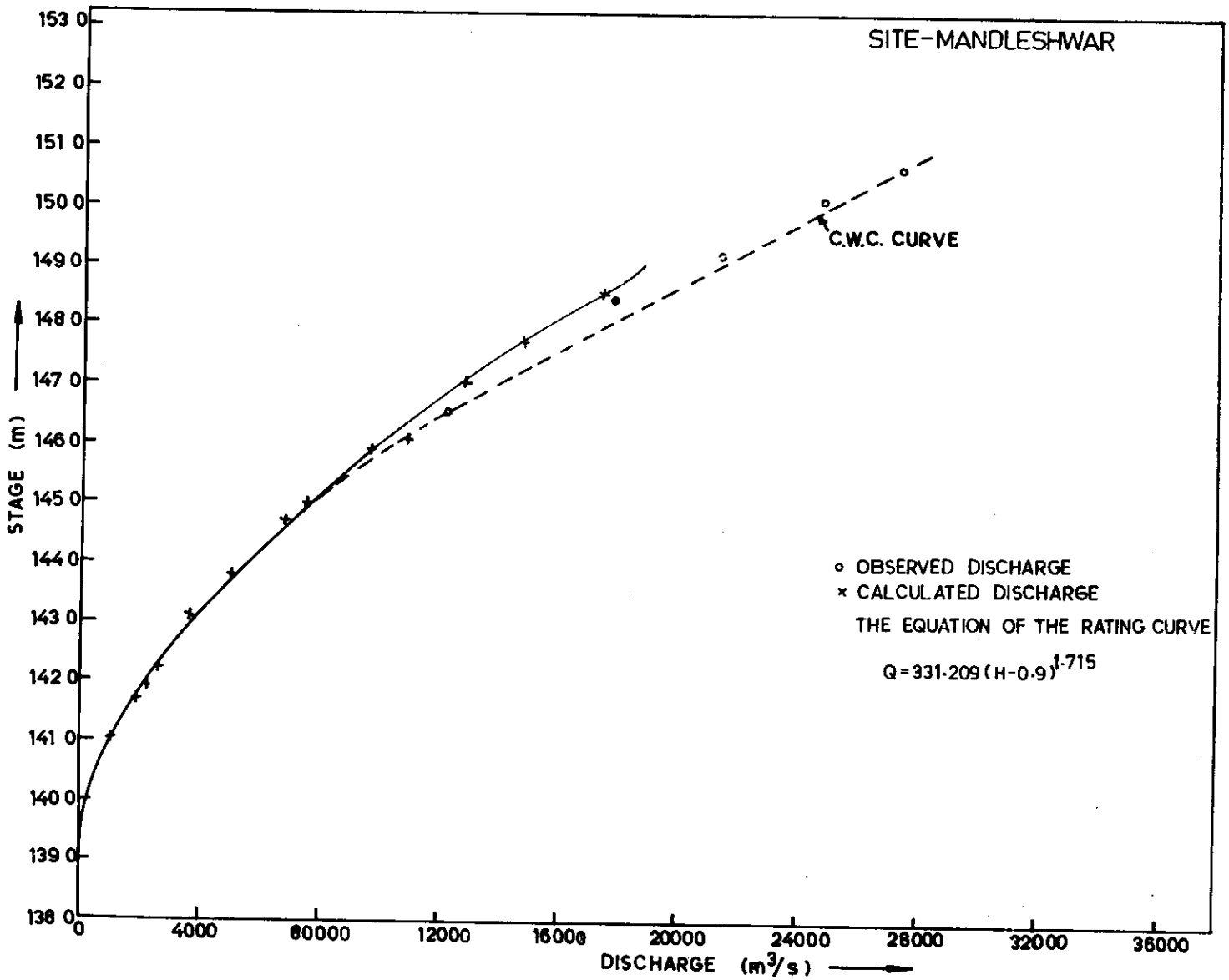

Figure 27 - Comparison of established and C.W.C.rating curves for Mandleshwar site

I Type of data	:	Rating curve(graphical)
Source	:	CWC Bhopal Division
Year	:	1978
Zero of gauge	:	not shown
Remark	:	The range of stage covered in the curve is 138.0 m to 153.0 m
II Type of data	:	Cross section (graphical)
Year	:	1979
Remarks	:	1. The cross section is defined by 41 co-ordinates covering a width of 799.5 m 2. The lowest level is defined by the co-ordinates 520 m,137.88 m. 3. Both left over bank and right bank are not defined.

7.7 Site : Garudeshwar

This gauging site Gardudeshwar is situated at about 1179 km from the source. The zero of gauge as found in the data are given below:

Table 15 - Different zero of gauges at Garudeshwar

Year	Zero of gauge (m)	Source and Remarks
1968 to 1980	12	Hourly stage Rating Curve
1980 1975 1977	10	-do- Supplied by NIC

For the development of rating curve the cross-section data of the year 1978 was used. The daily gauge and discharge for the year 1977 with ZG = 10.0 m were used.

On the basis of physical information provided by the river cross-section a conveyance analysis using GEDA programme has been made. The output from this programme provides hydraulic radius and other hydraulic elements as a function of depth of flow (elevation) . The cross-section of river Narmada at Garudeshwar has been plotted as shown in figure 28, and the stage elevation conveyance and discharge are plotted as indicated in figure 29. It is seen from figure 29 that the conveyance changes at a uniform rate upto stage of 38.0 m or so and it is,therefore, exepected that the rating curve would also have similar behaviour upto this level assuming Manning's 'n' remains the same.

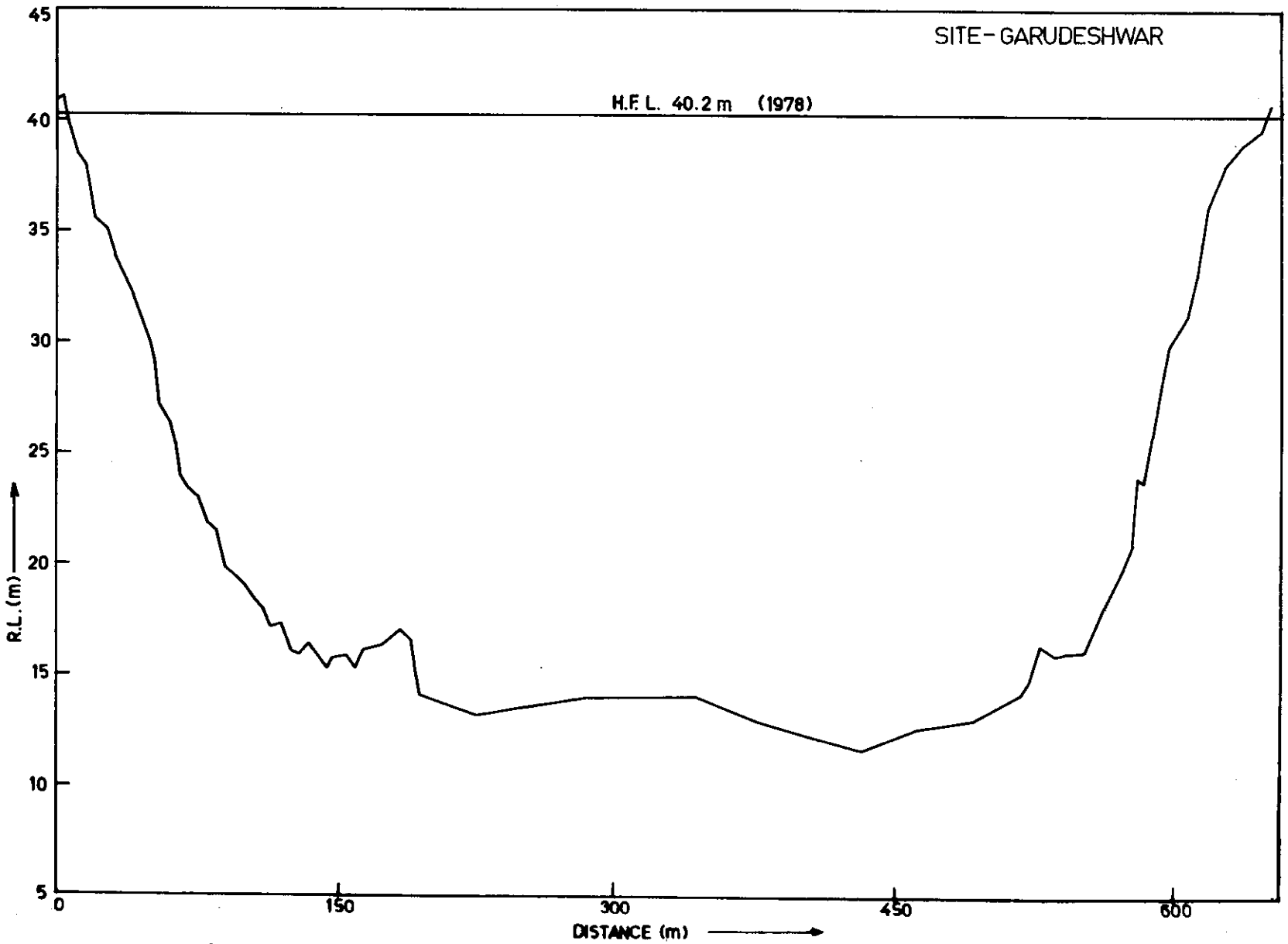

Figure 28 - Cross section of the river Narmada at Garudeshwar

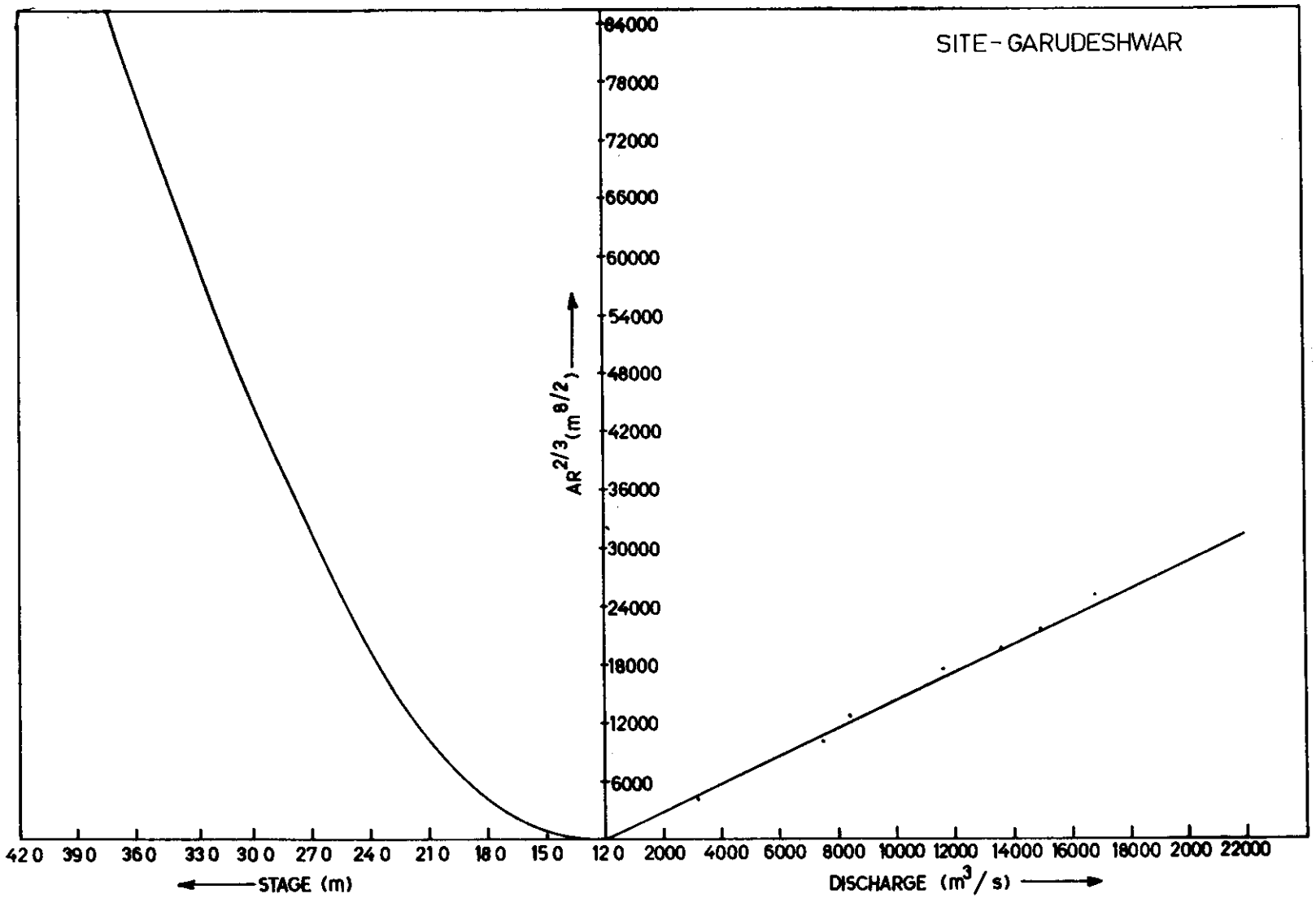

Figure 29 - Plot of conveyance, Q, stage for Garudeshwar

An equation of the form

$Q = a\ (G-e)^b$

where,

Q is the discharge at the gauging site

G is the stage elevation

a,b,e are the parameters defining the relation

The details of analysis made are given below:

A. Physical verification

Width of the river (at the channel portion) ---------- 500 m

Slope S ---------- 0001

$S^{1/2}$ ---------- 0.01

n ---------- 0.02

$a = \frac{1}{n} W S^{1/2} = 250.0$

e = 14.5 m (effective bottom level)

b = 1.7 (assuming a parabolic shape)

B. Double Log Plot

Adopting a shift 13.7 m in the stage elevation, (i.e. h = G-13.7) a plot is made of observed stage(h) and discharge in double log as shown in figure 30. A straight line has been fitted through these points. The value of cofficient obtained are as follows:

a = 250

b = 1.66

e = 13.7

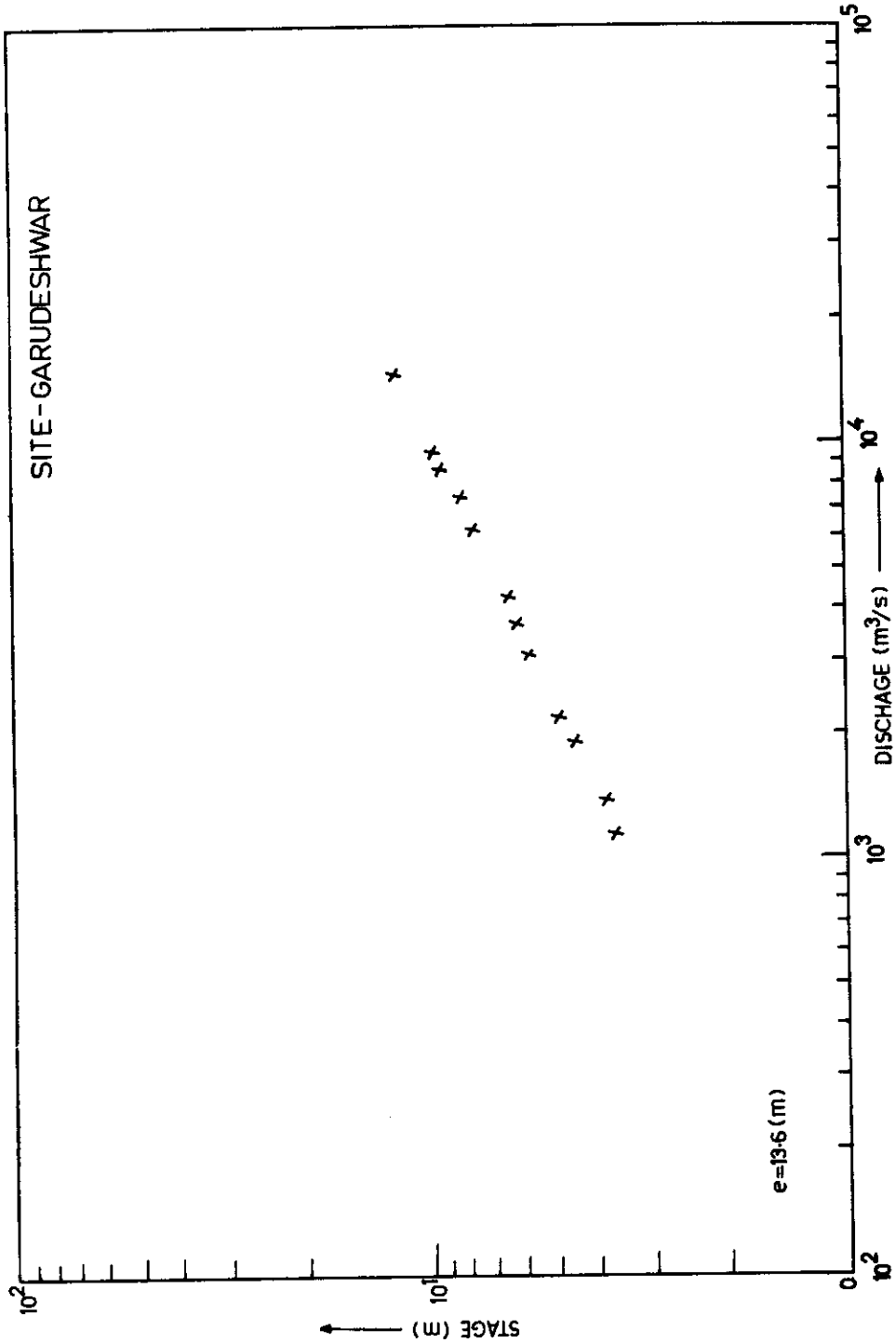

Figure 30 - Double log plot of discharge,stage for Garudeshwar

C. Rating analysis,

The daily gauge and discharge data of the year 1977 were used for analysis. Least square technique is applied using 83 pairs of stage and discharge. The following are the relevant computer results.

Table 16- Trial Parmaeters for the Garudeshwar site

Trial No.	a	b	e	Remarks
1	193.41	1.794	1.5	
2	213.151	1.758	1.6	Computer chosen best
3	234.852	1.721	1.7	

The computer chosen second set based on the minimum error criterion is also comparable with the physical analysis, double log analysis.

A comparison of rating curve used in NIH with the rating curve (CWC) supplied as shown in figure 31. The CWC curve is slightly under estimating the discharge at higher stages approximately above 22.0 m

The relationship finally adopted is the following:

$$Q = 250\ (G-1.70)^{1.66}$$

where,

G is the stage above a datum (12.0 m) and

Q is the discharge in m^3/sec.

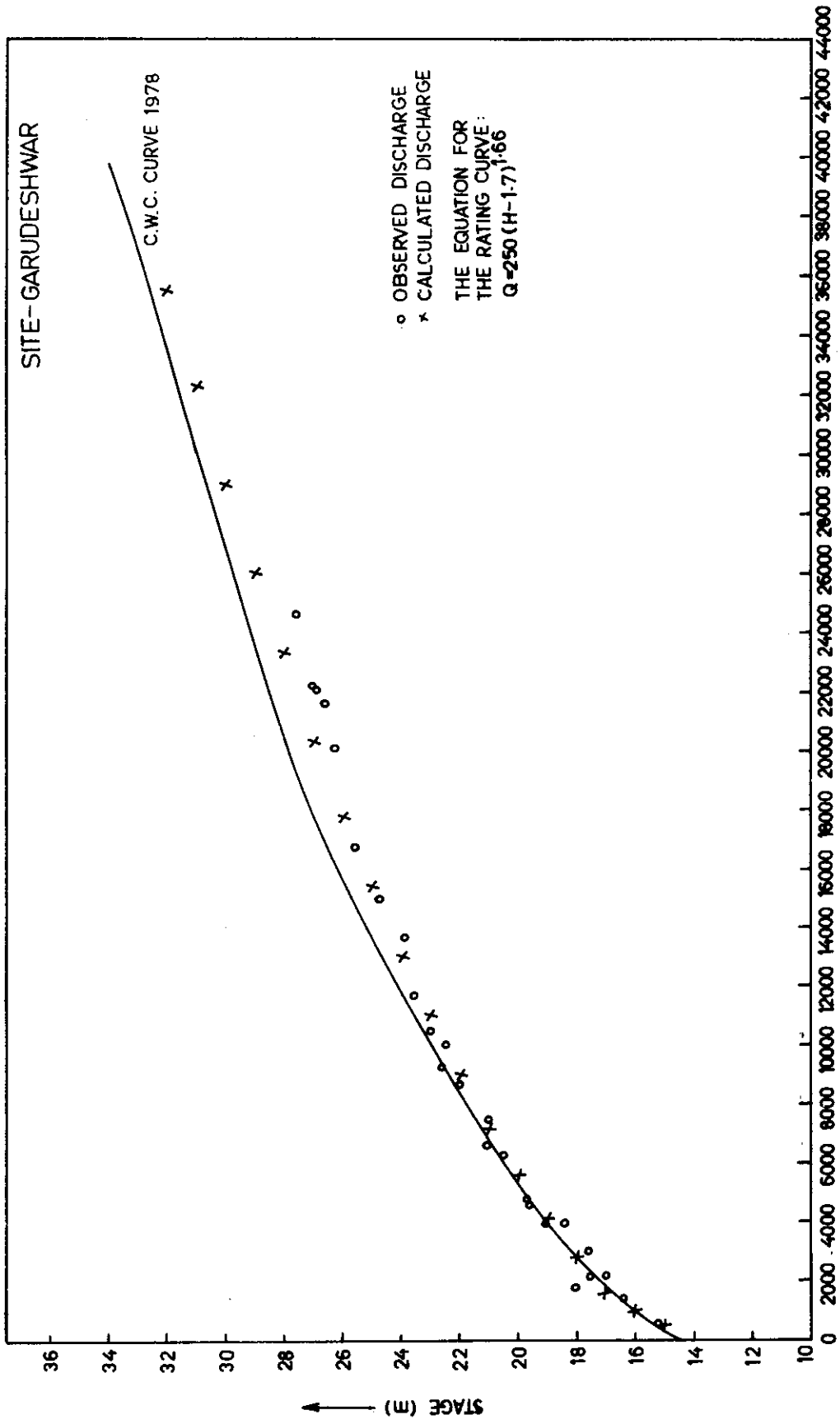

Figure 31 - Comparison of established and C.W.C. rating curves for Garudeshwar

Site	:	Garudeshwar
River	:	Narmada
Type of data	:	Rating curve (graphical)
Source	:	CWC western gauging division
Year	:	1978
Zero of gauge	:	10.0 m
Remark	:	The range covered is from 10.0 m to 34.0 m
Type of data	:	Cross section (graphical)
Year	:	1979
Remark	:	1. The cross section is defined 65 co-ordinates covering 660 m width. 2. The lowest level is defined by the co-ordinates 480.0 m 12.483 m. 3. The left over bank and right over bank are not defined.

8.0 RESULTS

An equation of the form

$Q = a\ (G-e)^b$, where Q is the discharge, G is the stage elevation, a,b,e are the parameters defining the relation, has been used in the establishment stage and discharge relationships in the main river sites. The following is the table of parameters defining the relation between stage and discharge measured at the main river sites:

Table 17- Rating Parameters for the gauging sites of the river Narmada

Sl. No.	Site	Years	Values of parameter a	b	c	Adopted datum(m)
1,	Manot	1977,and 1978	99.467	1.769	0.5	86
2.	Jamtara	1972 to 1977	85.046	1.795	2.3	360
3.	Bermanghat	1973,1975 1976,1977	98.428	1.73	4.0	306
4.	Hoshangabad	1972,1973 1978	173.183	1.858	1.9	282
5.	Mortakka	1980	605.09	1.54	2.6	153
6.	Mandleshwar	1975 to 1980	331.209	1.715	0.9	138
7.	Garudeshwar	1977	250.0	1.66	1.7	12

9.0 CONCLUSIONS

(a) The following information are extracted from the analysis of the cross-section plotted on figure 2. The flow section gradually increases from the upstram site Manot upto Bermanghat. The section at Hoshangabad shows a rapid increase in the section. The river has a narrow section at Garudeshwar. It is understood that the river again widens just after this site, from topo-sheets. As the result of this typical feature, a large flood incident at or upstream of Hoshangabad will be temporarily stored and passed on to the downstream site.

(b) Comparison of conveyance is made approximately. The reaches containing Mandleshwar and Hoshangabad can convey large quality of flow than other sections. They are also expected to have flatter rating curves than other sections. For this analysis a constant Manning's 'n' is assumed.

(c) The rating curves established at National Institute of Hydrology compares very well with curves supplied by CWC specially in the case of Mortakka, Garudeshwar, and Mandleshwar. At the site Bermanghat a depth adjustment will match the two curves well. In all other sites except at Manot the curves agree reasonably well. However, in view of the needed extrapolations the rating curves established through physical reasoning

should be considered superior.

(d) A general comment on the value of parameters computed is important.

The parameter 'a' depends mostly on the width of the river section. From the table it can be seen that Mortakka takes a large value. Although the cross-section at Hoshangabad is wider than Mortakka and Garudeshwar the rating curve has lesser value of 'a' than even Garudeshwar. This is because of the bed slope which is the second important physical feature upon which the parameter 'a' depends. The bed slope at Hoshangabad is 0.00025 and whereas at Garudeshwar is 0.0001.

The parameter'b' depends on the shape of the section. The table 17 shows fairly a constant value. Hence the shape effect of the sections on the rating curve can be taken to be same at all sections.

The parameter 'e' is related to a datum. Its magnitude depends on the datum used.

In all the above analysis it is assumed that the cross-sections at the gauging sites do not change considerably but remains constant.

Further the rating curves could be improved if the information on the variation of roughness coefficients (like the Manning's 'n') are available.

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APPENDIX I

Stage and Discharge Data used for developing rating curves for gauging sites on Narmada River

Site : Manot

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
1	1.050	31.400	20	2.435	279.600
2	1.080	37.500	21	2.640	437.000
3	1.130	43.000	22	2.670	449.800
4	1.730	50.300	23	2.725	488.800
5	1.240	56.500	24	2.770	487.000
6	1.270	70.300	25	2.975	651.000
7	1.320	69.700	26	3.005	271.000
8	1.373	77.800	27	3.095	610.000
9	1.450	89.100	28	3.150	236.000
10	1.495	93.500	29	3.225	596.800
11	1.530	107.000	30	3.240	539.100
12	1.630	121.000	31	3.315	694.000
13	1.870	190.000	32	3.440	741.600
14	1.990	204.000	33	3.585	745.000
15	2.000	208.000	34	3.805	878.000
16	2.110	213.000			
17	2.800	272.000			
18	2.300	300.800			
19	2.325	312.300			

Site: Jamtara

Sl. No.	Stage (m)	Discharge (m^3/S)	Sl. No.	Stage (m)	Discharge (m^3/S)
1	364.975	509.300	29	366.418	1194.100
2	365.680	761.600	30	365.530	353.100
3	364.700	498.500	31	365.258	544.400
4	364.033	266.000	32	365.645	756.900
5	364.192	290.300	33	365.628	701.500
6	364.775	419.200	34	365.193	528.500
7	364.530	374.400	35	364.900	399.900
8	365.640	841.300	36	369.910	3342.900
9	364.700	498.500	37	367.300	1453.900
10	364.185	218.100	38	365.528	534.300
11	363.920	182.300	39	364.545	313.300
12	363.705	132.600	40	364.748	438.000
13	363.635	135.000	41	364.710	390.300
14	372.600	6686.100	42	363.870	155.500
15	374.558	8569.900	43	364.720	406.365
16	368.695	2400.000	44	364.365	308.900
17	366.635	1293.100	45	364.125	228.500
18	365.835	752.200	46	365.513	749.500
19	364.740	498.000	47	365.773	939.900
20	365.495	859.900	48	371.720	4762.500
21	366.625	1158.300	49	367.150	1451.600
22	365.643	868.000	50	365.270	647.900
23	366.683	1192.500	51	366.000	925.000
24	373.870	7669.800	52	375.080	8137.300
25	381.815	21355.100	53	368.800	2207.100
26	371.165	4245.500	54	366.410	1050.800
27	368.593	2330.000	55	365.373	644.400
28	367.643	1499.000	56	364.908	453.300

Contd...

Sl. No.	Stage (m)	Discharge (m^3/S)	Sl. No.	Stage (m)	Discharge (m^3/S)
57	364.573	368.700	88	365.045	584.200
58	364.420	336.300	89	365.750	852.100
59	364.335	307.000	90	366.880	1394.500
60	364.290	299.800	91	367.145	1634.800
61	364.365	344.200	92	366.620	1241.700
62	365.200	649.500	93	365.645	807.800
63	365.800	858.000	94	366.100	967.500
64	366.610	1333.400	95	365.755	828.700
65	372.000	5037.500	96	365.863	904.500
66	369.470	2850.000	97	368.635	2416.500
67	366.710	1219.000	98	367.480	1786.100
68	366.250	1037.500	99	364.503	379.300
69	368.835	2257.700	100	364.415	346.900
70	371.430	4898.700	101	364.300	301.100
71	372.285	5396.000	102	364.120	227.300
72	371.035	3907.200	103	364.620	282.500
73	380.510	13715.300	104	364.053	284.000
74	371.900	4682.700	105	363.818	160.800
75	367.250	1458.800	106	364.828	490.600
76	366.525	1088.600	107	366.510	1006.210
77	365.878	813.800	108	370.515	3506.900
78	376.000	8357.300	109	365.745	890.600
79	370.690	3852.700	110	370.253	4038.400
80	369.900	3039.800	111	366.940	1400.000
81	368.135	1971.500	112	366.265	1025.000
82	367.155	1433.500	113	369.670	3200.600
83	366.630	1173.200	114	368.825	2580.000
84	365.970	896.300	115	380.725	13756.600
85	365.560	687.200	116	372.745	5620.000
86	365.450	573.300	117	369.360	2644.100
87	365.808	843.000	118	367.765	1860.000

Sl. No.	Stage (m)	Discharge (m^3/S)	Sl. No.	Stage (m)	Discharge (m^3/S)
119	366.665	1066.900	149	367.770	1636.400
120	366.008	860.000	150	368.520	2073.400
121	365.645	703.900	151	368.638	2236.700
122	365.455	663.500	152	366.655	1229.600
123	366.060	1065.900	153	366.878	1355.500
124	365.992	824.100	154	366.470	1157.900
125	364.838	388.400	155	370.1 8	3365.000
126	364.590	319.900	156	372.245	5300.000
127	364.505	319.800	157	380.413	14574.600
128	364.408	242.100	158	377.813	10451.6000
129	364.268	219.200	159	370.665	3775.000
130	364.338	222.400	160	368.713	2230.300
131	365.163	549.800	161	366.850	1183.600
132	364.820	388.300	162	366.938	1249.500
133	364.343	230.600	163	366.188	905.700
134	366.865	1414.500	164	368.635	2352.600
135	370.350	3584.100	165	366.595	1128.400
136	372.000	4825.600	166	366.838	1264.500
137	367.765	1752.800	167	366.420	1095.800
138	365.945	904.700	168	366.283	1026.500
139	369.630	2950.000	169	366.125	982.100
140	369.120	2751.300	170	368.348	2075.000
141	367.195	1562.400	171	368.980	2401.100
142	365.598	768.000	172	366.178	880.800
143	365.576	746.500	173	365.820	768.200
144	365.250	672.000	174	366.410	1028.700
145	365.875	1021.200	175	366.925	1225.300
146	368.643	2342.900	176	367.443	1523.800
147	373.990	6808.000	177	365.953	917.300
148	370.980	4163.500	178	365.000	510.400

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
179	366.008	928.600	211	365.580	700.000
180	366.010	949.200	212	365.638	753.200
181	365.233	630.200	213	365.903	955.403
182	365.358	713.800	214	369.725	2825.200
183	364.803	344.500	215	367.171	1591.600
184	364.455	356.400	216	366.185	1052.600
185	368.115	2515.300	217	366.498	1176.200
186	367.445	1673.400	218	366.815	1314.900
187	366.305	967.200	219	365.930	837.500
188	365.095	574.100	220	366.550	1393.700
189	364.703	433.000	221	370.780	3678.100
190	364.943	547.900	222	370.260	3573.00
191	366.275	980.400	223	375.205	9099.400
192	367.178	1432.700	224	372.010	4825.000
193	367.300	1556.200	225	368.720	2201.000
194	366.185	941.400	226	368.740	2271.4000
195	365.728	841.400	227	369.373	2548.500
196	367.548	1675.000	228	367.750	1593.700
197	368.143	2107.600	229	366.720	1321.300
198	366.405	1079.300	230	371.140	4000.000
199	365.833	850.100	231	367.470	1378.300
200	365.538	799.100	232	366.295	988.400
201	366.083	883.800	233	365.785	680.600
202	368.523	2105.100	234	365.400	594.600
203	366.690	1170.400	235	365.728	821.700
204	370.880	4104.000	236	366.345	1184.100
205	369.200	2589.600	237	366.500	1261.600
206	367.000	1266.000	238	366.400	1078.600
207	365.545	674.000	239	365.860	820.00
208	370.650	3645.200	240	369.975	3041.30
209	366.773	1352.700	241	367.385	1586.000
210	366.120	1057.000	242	366.890	1508.000

Sl.No.	Stage (m)	Discharge (m^3/S)
243	366.865	1386.000
244	366.235	980.000
245	367.275	1623.200
246	366.315	1000.00
247	366.088	900.00
248	365.495	622.700
249	364.975	480.300
250	364.755	440.600
251	364.675	400.00
252	364.695	426.300
253	368.415	2118.00
254	369.114	2609.00
255	366.925	1383.900
256	366.045	900.00
257	365.263	612.100
258	364.900	480.000
259	364.925	556.500
260	364.545	370.000
261	364.470	368.300
262	365.100	583.300
263	364.995	562.500

Site : BERMANGHAT

S.No.	Stage (m)	Discharge (m^3/sec.)	S.No.	Stage (m)	Discharge (m^3/sec.)
1.	312.885	682.400	31.	312.520	402.50
2.	312.785	646.300	32.	312.750	423.10
3.	313.350	810.900	33.	312.315	433.30
4.	312.510	534.200	34.	311.960	137.40
5.	312.775	628.300	35.	312.437	390.40
6.	314.500	1531 .000	36.	312.305	248.30
7.	318.270	3823.000	37.	311.822	122.300
8.	314.640	1532.700	38.	312.300	197.200
9.	312.875	758.500	39.	312.637	360.200
10.	315.842	2328.700	40.	313.837	993.900
11.	312.320	2255.100	41.	313.867	1090.000
12.	314.980	1697.00	42.	312.910	781.700
13.	315.720	846.900	43.	312.202	176.000
14.	320.000	4763.000	44.	312.632	381.900
15.	325.725	10450.000	45.	312 . 457	384 . 700
16.	330.455	19958.199	46.	312.272	246.200
17.	317.660	3759.100	47.	312.475	396.100
18.	314. 525	1333.800	48.	312.792	467.700
19.	313.412	458.400	49.	314.580	1264.700
20.	312.835	674.800	50	313.540	1867.500
21.	322.610	7100.000	51.	313.130	899.10
22.	325.017	2978.00	52.	312.275	248.30
23.	319.525	4550.00	53.	312.12	168.20
24.	316.650	2348.00	54.	312.285	220.40
25.	315.035	1406.200	55.	311.800	76.000
26.	314.037	1237.600	56.	315.818	2114.600
27.	313.235	898.600	57.	320.020	5783.300
28.	312.720	659.500	58.	321.525	6947.000
29.	312.310	325.200	59.	316.760	2336.300
30.	312.402	343.600	60.	314.049	1035.400

S.No.	Stage (m)	Discharge (m^3/S)	S.No.	Stage (m)	Discharge (m^3/S)
61	316.630	2696.000	91	314.310	1640.00
62	314.938	1655.400	92	312.970	777.00
63	313.310	825.000	93	312.158	373.500
64	313.325	837.000	94	312.750	700.00
65	313.305	820.000	95	313.460	1017.900
66	314.875	1679.400	96	313.210	941.100
67	316.680	2291.300	97	312.400	595.700
68	315.473	2113.600	98	315.440	2374.300
69	325.775	11493.600	99	313.498	978.100
70	320.425	5900.00	100	312.438	447.200
71	317.755	3425.00	101	312.845	879.00
72	315.503	2116.600	102	313.980	1345.200
73	315.625	2278.800	103	312.983	873.800
74	314.440	1242.500	104	312.113	441.900
75	313.735	769.300	105	312.678	677.900
76	313.718	814.200	106	313.003	867.000
77	314.983	1543.100	107	312.988	799.700
78	314.270	1275.00	108	312.090	345.200
79	313.748	824.400	109	315.120	2061.800
80	313.303	699.400	110	314.085	1409.600
81	313.145	540.000	111	313.043	899.100
82	313.668	775.500	112	312.283	414.600
83	315.543	1825.700	113	312.000	318.200
84	314.655	1253.100	114	312.330	434.600
85	313.090	728.00	115	312.018	403.900
86	313.090	708.00	116	312.060	340.00
87	317.585	1511.200	117	312.455	563.100
88	313.875	998.600	118	313.875	1493.100
89	313.675	1007.900	119	319.163	3452.900
90	312.140	197.300	120	313.443	1157.60

Contd...

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	State (m)	Discharge (m^3/S)
121	312.170	440.100	152	316.610	1969.00
122	312.345	555.300	153	313.603	765.00
123	312.718	803.400	154	313.840	1467.200
124	311.985	372.500	155	318.435	4183.600
125	313.875	1200.00	156	318.130	3525.00
126	315.133	1440.100	157	315.410	1600.500
127	312.633	1160.00	158	314.458	1276.500
128	312.600	671.700	159	313.940	1354.400
129	311.818	311.900	160	315.395	1776.600
130	312.175	685.400	161	314.025	1083.900
131	313.300	1342.00	162	314.065	903.00
132	313.190	1280.700	163	313.313	1102.00
133	312.268	618.700	164	312.940	866.100
134	318.200	3924.700	165	312.220	449.000
135	318.693	3912.400	166	312.003	262.000
136	321.050	6199.300	167	312.028	315.100
137	326.838	12755.200	168	315.450	1797.900
138	320.625	5525.000	169	314.968	1309.200
139	316.485	2248.200	170	313.395	875.000
140	318.123	4190.200	171	312.550	520.900
141	317.350	2753.600	172	311.930	350.00
142	315.705	2051.700	173	315.900	1490.00
143	317.435	3075.00	174	315.138	1857.00
144	316.950	2780.00	175	314.175	1554.600
145	314.040	979.700	176	313.455	1043.300
146	312.870	1306.700	177	312.675	584.500
147	312.320	746.900	178	312.075	375.000
148	311.905	566.00			
149	314.938	1792.00			
150	313.965	959.700			
151	312.050	375.00			

Site: Hoshangabad

Sl. No.	Stage (m)	Discharge (m^3/S)	Sl. No.	Stage (m)	Discharge (m^3/S)
1	287.840	2337.600	31	285.050	314.300
2	287.415	1767.500	32	285.010	308.400
3	287.000	1350.300	33	285.130	223.30
4	287.603	1117.200	34	285.160	265.600
5	286.460	1013.300	35	286.123	491.600
6	286.278	755.400	36	285.050	444.800
7	286.128	739.900	37	289.048	3499.300
8	285.995	665.000	38	290.135	4503.200
9	285.883	578.700	39	286.785	1277.100
10	285.813	502.800	40	287.550	1866.900
11	285.838	538.900	41	289.340	4080.000
12	285.930	597.400	42	292.435	8345.800
13	286.060	664.700	43	290.130	5278.800
14	285.925	586.200	44	289.100	3535.300
15	285.720	497.500	45	289.240	5369.000
16	285.600	465.000	46	290.82	6069.000
17	285.508	384.100	47	288.743	3597.000
18	285.438	321.400	48	296.717	19574.10
19	285.400	356.8	49	289.575	4554.40
20	285.360	289.400	50	287.787	2020.00
21	285.		51	287.393	1921.200
22	285.420	355.700	52	286.913	1420.700
23	285.305	305.600	53	286.610	1032.100
24	285.230	258.600	54	286.063	819.400
25	285.255	248.400	55	285.990	762.900
26	285.415	386.900	56	285.860	647.600
27	285.338	312.800	57	285.705	691.900
28	285.178	375.100	58	285.818	684.400
29	285.130	340.200	59	285.885	679.600
30	285.085	306.200	60	286.248	1130.600

Sl. No.	Stage (m)	Discharge (m^3/s)	Sl. No.	Stage (m)	Discharge (m^3/S)
61	286.750	1283.900	91	287.510	2460.200
62	286.860	1480.600	92	287.400	2921.700
63	287.843	2549.500	93	287.313	2894.100
64	287.430	1902.800	94	286.710	1158.100
65	286.990	1539.500	95	287.028	1469.900
66	290.310	5680.900	96	288.370	2358.800
67	290.500	5696.100	97	288.435	2577.000
68	289.270	3068.600	98	288.290	2435.300
69	287.645	2237.900	99	287.630	1940.400
70	287.820	2291.300	100	287.033	1391.100
71	288.700	4389.900	101	286.860	1124.300
72	290.220	4972.300	102	286.860	195.100
73	288.600	3958.700	103	286.715	1160.500
74	288.585	3942.900	104	286.790	1268.200
75	291.407	7039.100	105	286.955	1378.100
76	290.410	5354.600	106	288.095	2517.800
77	289.755	4173.800	107	287.480	1785.900
78	289.568	4109.000	108	287.090	1516.100
79	292.650	12024.600	109	286.780	1219.300
80	300.535	31463.000	110	286.485	917.900
81	289.703	4450.000	111	286.530	918.700
82	289.935	5004.500	112	286.330	730.600
83	295.943	17203.199	113	286.175	722.300
84	289.73	4564.800	114	286.130	782.500
85	288.425	3552.300	115	286.055	599.100
86	287.635	2770.70	116	285.797	455.100
87	287.490	2856.100	117	285.730	503.700
88	287.358	2054.100	118	285.577	437.200
89	287.335	2862.90	119	285.515	454.200
90	287.255	2607.000	120	285.455	384.100

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Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
121	285.385	358.100	151	289.820	588.000
122	285.315	339.600	152	289.870	6074.800
123	285.265	331.600	153	289.175	4411.200
124	285.225	329.100	154	288.645	2875.700
125	285.175	249.300	155	289.203	4964.400
126	285.175	253.300	156	289.350	3113.500
127	285.375	294.800	157	289.07	4639.200
128	285.495	359.400	158	287.500	2208.900
129	285.440	332.800	159	286.770	1915.100
130	285.565	347.800	160	286.110	1240.500
131	285.600	431.500			
132	285.490	370.900			
133	285.305	294.300			
134	285.190				
135	285.09	187.4			
136	285.035	201.200			
137	285.447	357.900			
138	285.899	645.800			
139	285.775	646.400			
140	285.665	557.90			
141	285.650	647.200			
142	285.602	545.300			
143	285.610	512.500			
144	285.630	573.300			
145	288.800	3268.800			
146	288.237	2778.900			
147	286.880	1501.400			
148	287.825	2357.300			
149	288.400	2386.400			
150	288.775	3577.600			

Site:Mortakka

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
1	157.180	1195.000	26	162.310	10944.420
2	157.750	1962.000	27	165.380	20579.711
3	160.750	7378.590	28	166.500	25557.320
4	160.040	5856.656	29	162.700	11787.540
5	158.250	2768.710	30	160.800	7600.470
6	158.180	2644.300	31	159.680	5342.760
7	159.790	5516.482	32	160.020	5912.370
8	159.580	5259.370	33	160.320	6749.950
9	160.240	6330.200	34	158.566	3211.930
10	159.800	5561.139	35	159.700	5285.050
11	160.170	6284.303	36	160.220	6439.160
12	161.920	9550.320	37	161.620	9493.417
13	160.820	7601.430	38	159.970	5890.396
14	159.550	5130.770	39	159.550	5067.780
15	158.360	2878.960	40	159.590	5221.400
16	160.150	6163.320	41	158.940	3927.787
17	159.800	5556.830	42	165.870	22464.490
18	158.920	3828.940	43	165.650	21477.930
19	166.300	24437.061	44	163.330	13891.240
20	164.260	16494.930	45	160.970	7935.030
21	160.950	7914.650	46	160.140	6277.378
22	159.650	5546.410	47	159.270	4677.980
23	158.800	3697.490	48	159.960	5882.345
24	163.380	14526.350	49	160.830	7576.232
25	165.230	19835.529	50	159.740	5474.500

Site:Mandelshwar (Set 1)

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
1	147.505	13559.20	21	147.220	14200.00
2	148.250	16400.00	22	150.100	24844.00
3	147.318	13120.00	23	147.308	13398.30
4	147.558	13942.70	24	149.980	24352.30
5	147.433	13232.20	25	145.180	19185.30
6	146.000	10040.00	26	147.573	13367.80
7	152.685	32213.60	27	149.188	2146.70
8	148.038	18450.00	28	146.455	11871.10
9	147.073	12927.90	29	150.578	27306.90
10	147.305	11738.60	30	150.575	27373.90
11	146.750	12014.30	31	146.460	12312.70
12	147.108	12735.40	32	146.645	13757.72
13	149.940	24300.00	33	151.600	32084.29
14	148.155	14459.70	34	148.118	17305.82
15	147.955	17000.00	35	147.040	14300.00
16	146.350	11500.00	36	149.750	2184.37
17	147.730	16379.50			
18	148.683	19883.30			
19	148.323	17373.10			
20	147.185	13495.00			

Set 2

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
1	142.293	2309.600	31	142.228	2363.100
2	142.243	2480.000	32	143.560	4682.300
3	142.948	3061.100	33	142.768	3140.200
4	142.560	2726.700	34	143.433	4378.000
5	142.164	2592.100	35	142.480	2854.800
6	143.409	4922.000	36	144.865	7853.400
7	142.523	2826.000	37	145.910	9229.100
8	142.283	2520.000	38	145.105	7031.000
9	143.590	4711.000	39	143.670	4345.800
10	142.335	2600.000	40	142.865	3162.300
11	142.083	2273.800	41	142.358	2455.300
12	142.983	3249.500	42	141.915	2065.000
13	143.367	4150.000	43	141.900	2027.400
14	145.830	8989.800	44	141.905	2011.000
15	143.784	5558.000	45	142.628	3044.000
16	143.768	4609.400	46	142.035	2183.200
17	144.943	7145.700	47	141.843	2001.100
18	145.315	8050.00	48	142.458	2592.700
19	144.665	6702.800		142.345	2450.000
20	143.300	3786.500	50	142.623	2829.800
21	144.795	7217.300	51	142.445	2550.000
22	144.660	6618.300	52	142.490	2600.000
23	144.203	5591.500	53	144.398	5453.500
24	145.378	8450.600	54	144.200	5613.800
25	145.039	7980.100	55	143.070	3790.400
26	142.716	3366.600	56	143.113	3301.800
27	141.994	2309.500	57	145.770	8916.300
28	142.215	2348.600	58	145.228	7992.400
29	144.740	6600.00	59	143.883	4831.500
30	142.873	3182.300	60	144.318	5807.200

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Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
61	143.450	4218.100	92	144.333	6965.100
62	143.903	4964.000	93	144.575	6675.500
63	143.893	5005.400	94	144.403	6365.200
64	143.305	4121.400	95	143.803	4870.000
65	143.155	3616.200	96	143.695	4690.800
66	143.178	3616.100	97	143.745	4651.200
67	145.115	7444.300	98	142.825	3404.200
68	144.530	6173.000	99	141.820	2016.800
69	143.488	4326.200	100	144.693	7028.600
70	143.075	3689.000	101	144.733	7242.800
71	142.713	2940.500	102	145.420	9398.300
72	142.500	2565.800	103	145.645	9443.200
73	142.393	2569.700	104	144.765	7157.000
74	145.435	7519.500	105	144.330	6382.000
75	145.243	8208.900	106	143.330	4510.000
76	143.725	4684.000	107	142.790	3493.200
77	142.673	2747.600	108	142.485	2953.000
78	144.330	5911.700	109	142.200	2502.900
79	143.560	4389.700	110	145.163	8223.000
80	142.625	2925 000	111	145.565	4490.600
81	141.990	2119.700	112	142.858	3431.700
82	142.625	3045.500	113	142.438	2878.500
83	142.273	2453.900	114	142.030	2238.900
84	142.150	2421.100	115	143.135	4063.400
85	142.718	3143.400	116	142.620	3289.000
86	142.855	3 53.000	117	142.240	2590.500
87	142.338	2587.400	118	141.990	2302.000
88	142.275	2517.500	119	144.713	7403.300
89	142.118	2215.100	120	144.215	6502.200
90	144.428	6136.900	121	142.288	2749.800
91	145.885	9432.00	122	142.018	2534.600

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
123	142.460	2986.500	155	142.815	3506.100
124	144.520	7108.700	156	142.543	2960.100
125	143.813	5389.400	157	142.345	2660.100
126	143.918	5742.700	158	143.520	4787.200
127	144.480	7127.000	159	145.028	7940.700
128	144.140	6329.300	160	144.220	6201.800
129	143.595	5178.900	161	143.430	4505.200
130	144.268	6409.400	162	142.850	3346.600
131	145.085	7993.400	163	142.480	2859.700
132	143.845	5167.400	164	142.688	3302.700
133	142.878	3495.300	165	142.425	2914.500
134	142.400	2846.300	166	142.268	2679.200
135	141.980	2132.700	167	142.145	2365.900
136	142.005	2456.600	168	141.935	2132.200
137	144.078	5665.700	169	141.688	1925.700
138	143.060	3967.200	170	142.568	2871.800
139	143.605	3164.300	171	142.590	2799.700
140	142.225	2414.500	172	142.330	2504.100
141	141.983	2324.800	173	144.060	5500.000
142	142.010	2415.200	174	143.530	4500.000
143	144.363	6077.100	175	142.330	2340.630
144	144.073	5571.700	176	142.260	2591.430
145	143.573	4346.300	177	144.745	7494.320
146	143.168	3847.300	178	144.175	5396.170
147	143.138	3861.800	179	142.605	2948.480
148	143.038	3787.500	180	141.925	2202.490
149	142.593	3022.800	181	144.630	6815.260
150	142.400	2700.000	182	142.330	4249.710
151	142.318	2686.200	183	142.655	3000.00
152	145.183	8913.900	184	142.090	2732.150
153	143.893	5274.700	185	144.435	6978.110
154	143.238	4130.500	186	144.510	7068.360

Sl. No.	Stage (m)	Discharge (m3/S)	Sl. No.	Stage (m)	Discharge (m3/S)
187	143.250	4600.000	219	142.470	4465.980
188	141.870	2194.560	220	141.815	3758.604
189	143.070	3770.954	221	141.815	2052.645
190	143.265	3750.988	222	141.900	2800.000
191	143.322	3723.426	223	141.712	2550.000
192	142.172	3000.00	224	142.240	3678.403
193	141.687	2346.082	225	142.412	2910.227
194	142.223	2200.00	226	142.157	2577.330
195	141.876	2000.00			
196	142.532	3600.00			
197	142.980	3102.993			
198	143.457	6072.030			
199	143.455	5119.192			
200	143.125	4749.190			
201	142.935	3700.00			
202	145.395	6699.902			
203	143.635	6394.403			
204	144.495	4500.00			
205	145.616	9927.823			
206	144.325	7017.327			
207	143.800	5824.280			
208	143.797	5000.000			
209	143.000	4927.813			
210	142.495	3953.804			
211	142.120	3000.00			
212	142.030	3000.00			
213	143.527	4600.00			
214	143.100	4600.00			
215	143.295	4600.00			
216	143.145	4600.00			
217	142.925	4600.00			
218	143.001	3852.986			

Site:Garudeshwar

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
1.	12.470	2213.00	22.	17.30	1941.20
2.	22.040	8700.00	23.	11.00	1876.10
3.	22.540	9995.50	24.	16.68	1610.10
4.	21.020	7468.60	25.	16.34	1407.30
5.	17.500	2350.00	26.	16.21	1188.30
6.	17.630	2480.00	27.	25.61	16845.00
7.	17.270	2117.30	28.	24.74	14950.00
8.	20.460	6150.00	29.	20.71	6461.90
9.	19.550	4840.60	30.	21.19	7485.90
10.	18.410	3231.10	31.	20.77	6709.50
11.	17.100	1900.00	32.	20.03	5709.90
12.	16.900	2044.90	33.	20.00	5696.80
13.	16.860	1569.20	34.	19.93	5279.30
14.	16.850	1663.30	35.	18.88	3732.20
15.	16.740	1514.60	36.	17.89	2867.90
16.	16.430	1376.80	37.	17.52	2481.8
17.	16.200	1247.80	38.	17.30	2103.1
18.	17.140	1875.00	39.	17.02	1884.0
19.	18.20	3150.00	40.	16.65	1486.10
20.	17.73	2600.00	41.	16.64	1451.80
21.	17.49	2221.40	42.	21.14	7150.00

Sl.No.	Stage (m)	Discharge (m^3/S)	Sl.No.	Stage (m)	Discharge (m^3/S)
43	24.130	13741.600	66	16.320	1351.700
44	23.580	11738.700	67	16.200	1120.600
45	22.040	8882.700	68	16.150	1084.800
46	22.300	9640.700	69	16.210	1192.000
47	22.950	10556.100	70	16.660	1552.500
48	24.810	15100.000	71	16.610	1476.600
49	20.350	6171.700	72	16.590	1448.400
50	18.540	3447.500	73	19.000	3974.600
51	18.190	3082.900	74	18.480	3370.000
52	17.710	2572.200	75	18.000	2861.100
53	17.520	2270.500	76	17.580	2458.700
54	23.890	13782.900	77	17.200	2051.100
55	21.590	8489.200	78	16.640	1463.600
56	19.050	4328.500	79	16.510	1394.100
57	18.550	3652.900	80	16.380	1154.500
58	18.280	3417.500	81	16.300	1134.500
59	17.770	2854.600	82	16.240	1115.200
60	17.480	2350.000	83	16.160	1036.800
61	17.250	2188.000			
62	17.020	2028.500			
63	16.850	1609.400			
64	16.700	1546.600			
65	16.550	1342.500			