

Chapter -1: Tapi Basin

1.1 Introduction

Tapi Division, Surat under Hydrological Observation Circle, CWC, Gandhinagar is conducting hydrological observations in the catchments of Tapi River and its tributaries at 18 stations, out of which nine (9) are under Flood Forecasting scheme, three (3) under National Network scheme and six (6) are under 80 - Key Hydrological Observation scheme.

Basin Map of Tapi River, showing CWC sites is enclosed as **plate-1**

The gauge & discharge data of five (5) stations, viz. Tapi at Burhanpur, Purna at Gopalkheda, Purna at Yerli, Tapi at Gidhade and Tapi at Sarangkhedha are included in this book. From administrative consideration, the basin is divided into three zones viz Upper Tapi Zone, Middle Tapi Zone and Lower Tapi Zone each having one Sub-division viz. Upper Tapi Sub-Division, Bhusawal, Middle Tapi Sub-Division, Dhule and Lower Tapi Sub-Division, Surat respectively under the Tapi Division, Surat. Salient features of existing sites in Tapi basin are given in **Table-1**.

1.2 Geographical setting of Tapi Basin

The Tapi Basin is situated in the northern part of the Deccan Plateau and extends over an area of 65145 sqkm which is nearly 2% of the total geographical area of the country. Nearly 80% of the basin lies in the State of Maharashtra. The basin lies between east longitudes of 72° 38' to 78° 17' and north latitudes of 20° 05' to 22° 03'. It is bound in the north by the Satpura range in the east by the Mahadeo hills, in the south by the Ajanta range and Satmala hills and in the west by the Arabian Sea. The river is bound on the three sides by the hill ranges. The Tapi River along with its tributaries flows over the plains of Vidharbha, Khandesh and Gujarat and over large areas in the state of Maharashtra and a small area in Madhya Pradesh and Gujarat.

The basin has an elongated shape with a maximum length of 587 km from east to west and the maximum width of 210 km from north to south. Perimeter of the basin is about 1840 km. The State wise distribution of the drainage area is given in the **table-2**. There are two well defined physical regions, in the basin, viz hilly region and plains; the hilly regions comprising Satpura, Satmalas, Mahadeo, Ajanta and Gawilgarh hills are well forested. The plain covers the Khandesh areas which are broad and fertile suitable for cultivation primarily. The basin consists of black soils; The coastal plains of Gujarat are composed of alluvial clays with a layer of black soil

above. The culturable area of the basin is about 4.29 Mha which is 2.2% of the total culturable area of the country. The forest cover is about 25% of the area in the basin.

Physiographically, the area is a basaltic landscape with major physiographic units of plateau lands, escarpments, hills, piedmont plains, colluvio-alluvial plains and valley plains.

The entire Tapi basin can be divided in three sub basins: Upper Tapi Basin up to Hathnur (confluence of Purna with the main Tapi (29,430 sq km), Middle Tapi Basin from Hathnur up to the Sarangkhedha gauging site (28,970 sqkm), and the Lower Tapi Basin from Sarangkhedha up to Sea (6,745 sq km). The annual rainfall for the upper, middle and lower Tapi basins for an average year is 931.90 mm, 713.05 mm and 1407.9 mm respectively.

Table-1: Salient features of CWC sites of River Tapi at a Glance

SL. No.	Name of Site	River	Code No.	Status	Scheme	Catchment area (Km ²)	Latitude (N) D M S	Longitude (E) D M S
1	2	3	4	5	6	7	8	9
1	Teska	Tapi	NA	GRF	FF	1486	21° 49' 00"	77° 46' 05"
2	Burhanpur	Tapi	010217002	GDSQ RF	NNW	8487	21° 17' 12"	76 °13' 18"
3	Dedtalai	Tapi	010217002	GRF	80K	6660	21° 31' 00"	76° 45' 24"
4	Hathnur	Tapi	010217006	GRF	FF	29430	21° 04' 35"	75° 56' 43"
5	Bhusawal	Tapi	010217007	GRF	FF	32478	21° 03' 54"	75° 46'56"
6	Lakhpuri	Purna	010217003	GRF	80K	3560	20°50' 49'	77° 21' 41"
7	Gopalkhedha	Purna	010217004	GDSQ RF	80K	9500	20° 52' 35"	76° 59' 14"
8	Yerli	Purna	010217005	GDSRF	NNW	16517	20° 56' 11"	76° 28' 27"
9	Chikaldhara	NA	NA	RF	FF	NA	21°24' 04"	77° 19' 46"
10	Girna dam	Girna	010217008	GRF	FF	4729	20° 28' 42"	74° 42' 55"
11	Dahigaon weir	Girna	010217009	GRF	FF	8599	20° 50' 05"	75° 25' 26 "
12	Savkheda	Tapi	010217011	GRF	NNW	48136	21° 08' 53"	75° 30' 54"
13	Morane	Panjhira	010217013	GRF	80 K	1933	20° 54' 32"	74° 42' 47"
14	Gidhade	Tapi	010217014	GDRF	FF	54750	21° 17' 45"	74° 48' 45"
15	Sarangkheda	Tapi	010217015	GDSQ RF	80 K	58400	21° 25' 55"	74 ° 31' 37"
16	Ukai	Tapi	010217016	GRF	FF	62225	21° 14' 55"	73° 35' 25"
17	Ghala	Tapi	010217018	GRF	80 K	63325	21° 17' 53"	73° 01' 43"

18	Surat	Tapi	010217019	G	FF	63973	21° 11' 49"	72° 46' 04"
19	Shegaon	Tapi	Telemetry	RF	--	--	20° 47' 46"	76° 08' 00"
20	Chiklod	Tapi/ Bokar	Telemetry	RF	--	--	21° 20' 06"	76° 00' 23"
21	Sagbara	Tapi	Telemetry	RF	--	--	21° 32' 35"	73° 47' 42"
22	Khetia	Tapi	Telemetry	RF	--	--	21° 39' 00"	74° 42' 06"
23	Nandurbar	Tapi	Telemetry	RF	--	--	21° 21' 37"	74° 14' 18"
24	Nizampur	Tapi	Telemetry	RF	--	--	21° 06' 49"	74° 19' 47"

1.3 The River System

1.3.1 Tapi River

The Tapi River (Hindi ताप्ती , Marathi तापी, Gujarati: તાપ્તી) ancient original name Tapi River (Sanskrit: तापी), is a river in central India. It is one of the major rivers of peninsular India with a length of around 724 km. The Tapi River originates in the Betul district from a place called Multai. It is one of only three rivers in peninsular India that run from east to west - the others being the Narmada River and the Mahi River. The Tapi is the second largest westward draining inter-state river basin. It covers a large area in the State of Maharashtra besides areas in the states of Madhya Pradesh and Gujarat.

The Tapi River drains an area of 65145 sq km out of which nearly 80 percent lies in Maharashtra. The State wise distribution of the drainage area is shown in **Table 2**.

Table-2: State wise distribution of drainage area

Sl. No	Name of State	Drainage area (sqkm)	Percentage of total
1	Madhya Pradesh	9,804	15.0
2	Maharashtra	51,504	79.1
3	Gujarat	3,837	5.9
Total		65,145	100.0

For the first 282 Km., the river flows in Madhya Pradesh, out of which 54 Km form the common boundary with Maharashtra State. It flows for 228 Km in Maharashtra before entering Gujarat. Traversing a length of 214 Km in Gujarat, the Tapi joins Arabian sea in Gulf of Cambay after flowing past the Surat city. The river receives

tidal influence for a length of about 20 Km upstream from mouth i.e. up to Singanapore weir.

The Tapi receives several tributaries on both banks. There are 14 major tributaries having a length more than 50 Km. On the right bank 4 tributaries namely, the Vaki, the Gomai, the Arunavati and the Aner join the Tapi. On the left bank, 10 important tributaries namely the Nesu, the Arunavati, the Buray, the Panjhra, the Bori, the Girna, the Vaghur, the Purna, the Mona and the Sipna drain into the main channel. The drainage system on the left bank of the Tapi is therefore, more extensive as compared to the right bank area.

The Purna and the Girna, the two important left bank tributaries together account for nearly 45 percent of the total catchment area of the Tapi. The Purna is one of the principal tributaries of the Tapi, starts in Betul district in Gawilgar hills of the Satpura range and mostly drains through three districts of Vidharbha namely Amravati, Akola and Buldhana. The Girna another Major tributary rises in the Western Ghats and drains Nasik and Jalgaon districts of Maharashtra.

1.3.2 Major Tributaries of the Tapi River System

Purna River

Purna, is one of the tributaries of Tapi, joins from the left. The Purna is the principal affluent of the Tapi. It is the main artery of a network of rivers and streams draining Akola, Amravati and Buldana districts of Maharashtra and Betul district of Madhya Pradesh. It is the only river in the upper Tapi Basin, which has a perennial flow. Rising in the Gawilgarh hills at an elevation of 900 m., North latitude $21^{\circ} 38' 00''$ and East longitude $77^{\circ} 36' 00''$, the Purna flows first in a South westerly direction for about 60 km through hills and forests before it enters the Purna plains. Flowing in a generally westerly direction for a length of 274 Km, the Purna joins the Tapi north west of Edalabad. The Man is the main left bank tributaries of Purna, and Chandrabhaga and Wan are the principal right bank tributaries. Thus Purna drains a total area of 18, 929 Sq.km.

Girna River

The Girna River is a river in Maharashtra state of southern India. It originates at Kem peak in the Western Ghats range of Nashik District with a latitude of $21^{\circ} 7' 60''$ N and a longitude of $75^{\circ} 19' 0''$ E, and flows east across Nashik and Jalgaon districts, swinging north in Jalgaon District to join the Tapi River. The dams on the river are Chanakapur and Girana Dam. The name Girna derives from the name of Goddess Giraja (Parvati). A 100 sq km area around Girna River has an approximate population

of 979337 (0.009793 persons per square meter) and an average elevation of 246 meters above the sea. The basin of the Girna lies on the Deccan Plateau, and its valley has fertile soils which are intensively farmed.

Gomai

Gomai River is tributary of Tapti River. It originates in Satpura Mountain Range and merge in Tapi River around 2 km east of Prakasha. Gomai river itself has many small tributary rivers like Susri river (passing by Sultanpur), Tipria river (passing by Mandane), Umri river, Sukhi river

Panzara

The Panzara-Kan or Panjhra is a river in Khandesh region of Maharashtra state of India. It is a tributary of the Tapi River. Panjhra River originates just few kilometers from a small town Pimpalher, Tal-Sakri in Dhule District. One small reservoir named Latipada dam is constructed just after its origin.

Pedhi.

The only important left bank tributary of the Purna is the Pedhi. It rises in the low hills near Rithpur and receives a number of small affluent both from the east and the west, the chief on the west being the Naghira river.

Arna.

The first of the principal right bank affluent of the Purna is the Arna which emerges from the Satpuda hills in Betul district and flows in a south and south-easterly direction passing by Sirasgaon to join the Purna just below Deurwada.

1.3.3. Tapi Basin as per the Watershed Atlas of India

As per the watershed atlas of India, Published by Department of Agriculture and cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990),

The sub-catchments from 5C1A to 5C5B pertain to Tapi Basin as shown in **plate-3**.

1.3.3.1 Sub-catchment -5C1A (5C1A1 to 5C1A4)

This catchment is situated in the Surat district of Gujarat drained by lower Tapi River near to its confluence with and some small tributary like Ver and Anjana. The catchment area of this sub catchment is 2140 sq.km.

1.3.3.2 Sub-catchment 5C1B (5C1B1 to 5C1B4)

This Catchment is situated in the plain region of Surat and Bharuch District of Gujarat drained by Kim, Sena, Kini and Ghanta River. The total catchment area of this Catchment is 2580 sq.km

1.3.3.3 Sub-catchment -5C2A (5C2A1 to 5C2A7)

This catchment is situated in the hilly and plane region of Gujarat, Maharashtra State and Madhya Pradesh (MP) drained by small tributaries such as Godada nadi, Dadan khadi, Dudhi, khadi, Kanji nadi, Dehli nadi, Vatkaada nadi, Valhari nadi, Vaki, Gomai, Umri, Lendi-Kordi, covered under Bharuch and Surat districts in Gujarat, Dhulia in Maharashtra and Khargone in MP with the catchment area of 3890 sq.km.

1.3.3.4 Sub-catchment 5C2B (5C2B1 to 5C2B7)

This catchment is situated in the hilly and plain region of Maharashtra State and Madhya Pradesh drained by small tributaries such as Arunavati, Aner, Dhudkheda, Guli Bhaurak, Mor and Suki on the Right Bank of Tapi River. The total catchment area of this catchment is 4890 sq.km.

1.3.3.5 Sub-catchment - 5C3A (5C3A1 to 5C3A5)

This is situated in the plain region of Gujarat and Maharashtra State, drained by Main tributaries such as Rangavali, Nesu, Kordi, Shivrud, Bhad and Amravti in Sub-catchment on the Left Bank of Tapi River. The total catchment area of this Catchment is 3200 sq.km.

1.3.3.6 Sub-catchment- 5C3B (5C3B1 to 5C3B8)

This is situated in the plain region of Maharashtra State, drained by Buray, Sur, Pan, Panjhara, Kanehr, Mokti, Hinasan, Jamkheri Kan, Bori Chikli, Sugran and Kanoli covered under Dhulia, Jalgaon and Nasik district and falls in the Subcatchment on the Left Bank of Tapi River. The total catchment area of this catchment is 6480 sq.km.

1.3.3.7 Sub-catchment- 5C3C (5C3C1 to 5C3C9)

This is situated in the plain region of Maharashtra State, drained by Anjani, Gira, Bahula, Tittut, Nanyad, Panjhari, Sukhi, Masam, Kanjari, Aram and Punand in sub-catchment on the Left Bank of Tapi River covered most of the part of Jalgaon Nasik, Aurangabad and Dhulia. The total catchment area of this catchment is 10100 sq.km

1.3.3.8 Sub-catchment-5C3D (5C3D1 to 5C3D4)

This is situated in the plain region of Maharashtra State, drained by Main tributaries such as Vaghursur, Kag, Khadki, Koka and Bhogavati in the sub-catchment on the Left Bank of Tapi River. The total catchment area of this catchment is 2800 sq.km

1.3.2.9 Sub-catchment -5C4A (5C4A1 to 5C3A6)

This sub catchment is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Nalganga, Biswa, Ghan nadi, Mas, Nirgana and Mun. Catchment area of this sub-catchment is 5950 sq.km.

1.3.3.10 Sub-catchment -5C4B (5C3B1 to 5C3B6)

This sub-catchment is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Ban, Shahnur and Bodli km. Catchment area of this sub- catchment is 4020 sq.km

1.3.3.11 Sub-catchment -5C4C (5C4C1 to 5C4C6)

This is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Murna, Purna, Katapurna, Uma and Pedhi Catchment area of this sub-catchment is 5950 sq.km.

1.3.3.12 Sub-catchment -5C4D (5C4D1 to 5C3D4)

This Sub Catchment area is situated in the plain region of Maharashtra State, drained by the Tributaries of Purna River such as Chanrabhaga, Sapna, and Arna. The total catchment area is 3370 sq.km

1.3.3.13 Sub-catchment -5C5A (5C5A1 to 5C5A8)

This Catchment is situated in the plain and hills region of Maharashtra and Madhya Pradesh State, drained by the Bokad river, Mona river, Utaoli, Tapi and Garg. The total catchment area is 4650 sq.km.

1.3.3.14 Sub-catchment - 5C5B (5C5B1 to 5C1B8)

This Catchment is situated in the plain and hills region of Maharashtra and Madhya Pradesh State, drained by Sipna, Kharpra, Dahsana, Khandu, Baki, Betul and Ambora in Sub-catchment. The total catchment area of this sub-catchment is 5980 sq.km.

***Source:** Watershed Atlas of India, Department of Agriculture and Cooperation, Ministry of agriculture, Krishi Bhavan New Delhi (1990).*

Table–3: General information of main River /Tributaries of Tapi River Basin

Sl. No .	Name of River / tributary	Bank	Elevation of source above m.s.l. [m]	Length [km]	Catchment area [km ²]	% of total area
1.	2.	3.	4.	5.	6.	7.
1	Tapi		752	724	22522	34.57
2	Gomai	Right	600	58	1148	1.76
3	Arunavati	Right	450	53	935	1.44
4	Buray	Left	600	64	1419	2.18
5	Panjhra	Left	600	138	3257	5.00
6	Bori	Left	600	130	2580	3.96
7	Aner	Right	600	94	1702	2.61
8	Girna	Left	900	260	10061	15.44
9	Waghur	Left	751	96	2592	3.98
10	Purna	Left	900	274	18929	29.06
				TOTAL	65145	100

1.4 The Climate

The climate of the Tapi Basin is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season in the upper and middle part of basin but the lower part of the Tapi River Basin shows variation in temperature, rainfall, humidity and other climatic parameters.

The year may be divided into four periods. The winter from December to February, the summer from March to May, the south-west monsoon season from June to September and the post-monsoon period from the October to November

1.4.1 Temperature

Temperature of Tapi basin is like any other part of central India, the temperature is maximum in the month of May and minimum in the month of December to January. In general, upper and middle part of Tapi basin record lower temperature as compared to the lower Tapi basin where the influence of the sea is prominent, and temperature fluctuation is lower than the upper and middle basin.

The temperature profile in the basin is given in the **table-4**.

Table-4: Temperature profile of Tapi basin (Mean Monthly Maximum Temperature (°C))

Month	Mean Monthly Maximum Temperature (°C)										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jun-12	38.9	40.6	32.3	37.6	35.4	38.4	38.7	34.1	30.5	37.7	39.5
Jul-12	31.5	31.6	27.9	32.9	31.2	31.7	30.8	29.7	28.5	31.1	32.4
Aug-12	29.1	26.9	26.1	28.2	29.9	29.5	29.8	27.9	28.4	29.8	32.9
Sep-12	31.7	32.1	28.0	29.8	32.1	32.9	32.1	27.6	29.1	31.7	33.4
Oct-12	34.3	34.5	28.0	30.4	32.1	35.7	34.9	30.6	31.5	35.7	38.8
Nov-12	31.5	32.3	27.7	29.0	31.2	31.7	32.1	27.9	29.1	33.3	35.7
Dec-12	30.5	31.5	25.3	27.8	30.1	32.0	31.8	24.2	27.1	31.9	33.7
Jan-13	29.5	29.9	27.5	23.5	30.9	30.6	29.7	20.0	26.6	30.4	No data
Feb-13	31.5	31.9	26.5	26.4	31.3	32.3	32.3	24.1	29.6	32.1	34.5
Mar-13	37.8	No data	27.9	31.1	37.4	38.4	38.4	29.9	34.8	38.0	38.3
Apr-13	40.8	No data	31.9	37.3	43.2	41.1	41.5	31.9	36.4	40.3	40.8
May-13	41.8	42.5	32.4	43.0	45.0	45.1	43.7	34.0	37.8	41.7	43.0
Annual Mean	34.2	33.4	28.5	31.4	34.2	35.0	34.7	28.5	30.8	34.5	34.6

Table-4: Temperature profile of Tapi basin (Mean Monthly Minimum Temperature (°C))

Month	Mean Monthly Minimum Temperature (°C)										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jun-12	26.9	25.6	25.4	27.1	27.4	28.0	27.0	24.1	27.7	26.1	26.6
Jul-12	24.4	24.2	23.8	24.3	26.4	25.4	24.5	27.5	25.7	24.1	25.5
Aug-12	23.6	23.6	24.3	23.4	23.4	24.5	23.8	26.3	24.4	23.6	25.0
Sep-12	23.1	23.4	25.4	24.1	23.2	24.2	23.9	26.2	23.4	23.1	26.0
Oct-12	21.4	18.8	25.0	23.4	21.0	21.1	21.1	27.2	21.0	20.6	22.4
Nov-12	16.2	12.8	21.5	21.2	14.3	15.7	16.0	22.8	14.8	14.6	15.2
Dec-12	14.9	11.5	15.8	17.1	12.0	13.5	14.5	19.8	13.5	13.5	13.9
Jan-13	13.4	11.5	16.9	11.5	9.8	12.6	12.8	16.3	12.5	12.2	12.5
Feb-13	17.3	15.8	19.9	18.4	14.1	17.1	17.1	20.5	17.2	15.6	16.3
Mar-13	20.1	No data	20.3	16.7	19.7	19.5	19.6	24.7	20.0	18.3	13.7
Apr-13	24.8	No data	25.4	19.2	24.2	25.5	23.8	26.3	26.1	22.7	15.7
May-13	27.9	27.2	24.5	25.6	29.3	30.5	26.6	28.9	27.6	26.1	19.1
Annual Mean	21.2	19.4	22.4	21.0	20.4	21.5	20.9	24.2	21.2	20.0	19.3

1.4.2 Rainfall

The south west monsoon sets in the Tapi basin in the middle of June and withdraws by mid October. About 90 percent of total rainfall is received during the monsoon months, of which 50% is received during July and August. The Tapi River basin shows different climatic characteristics due to the variation of topography from upper to lower part of basin.

The average rainfall in the Tapi basin is 863.5 mm. Basin wise variations of rainfall are shown in **table-5** and average rainfall recorded at various sites is given under **table- 6**.

Table-5: 10 years' Average Monsoon rainfall

Sr. No.	Name of Sub Basin	Bank	Length in Km	Catchment Area (sqkm)	% with reference to total area.	10 years average of Monsoon rainfall (mm) from 2003-2012
1.	Upper Tapi up to Hathnur	Main	290	10471	16.1	961.5
2.	Purna	Left	274	18929	29.1	667.6
3.	Middle Tapi, Hathnur to Ukai excluding Girna.	Main	305	22734	34.9	784.4
4.	Girna	Left	260	10061	15.4	618.5
5.	Lower Tapi-from Ukai to confluence to sea near Surat	Main	129	2920	4.5	1394.8

Table -6: Rainfall at sites in Tapi Basin

Average Annual Rainfall for the period 1980-2011							
Sl No	Name of Site	District	Seasonal Average Rainfall (mm)				Total Annual Average Rainfall
			Winter monsoon	Pre monsoon	South-West monsoon	Post monsoon	
			(Jan-Feb)	(Mar-May)	(June-Sept)	(Oct-Dec)	
1	Teska	Betul (MP)	0.0	0.0	967.9	0.0	967.9
2	Lakhpuri	Akola (MS)	15.7	22.0	640.1	76.9	754.7
3	Chikhaldara	Amarawati (MS)	12.6	28.0	1288.5	106.0	1435.0
4	Gopalkheda	Akola (MS)	14.2	17.7	618.6	54.3	704.7
5	Dedtalai	Burhanpur (MP)	10.5	17.3	816.3	46.3	890.3
6	Burhanpur	Burhanpur (MP)	10.6	27.4	763.0	66.2	867.2
7	Yerli	Buldana (MS)	12.4	17.1	615.8	77.3	722.6
8	Hathnur-Dam	Jalgaon (MS)	8.6	20.4	587.8	58.4	675.3
9	Bhusawal	Jalgaon (MS)	7.0	17.4	632.5	95.3	752.1
10	Girna	Nasik (MS)	5.0	44	461.8	32.4	543.2
11	Dahigaon	Jalgaon (MS)	8.4	4	425.2	25.6	463.2
12	Savkheda	Jalgaon (MS)	6.8	2.2	477.6	32.1	518.7

13	Morane	Dhule(MS)	5.6	6.8	486.6	45.3	544.3
14	Gidhade	Dhule(MS)	9.1	27.6	625	20	681.7
15	Sarangkheda	Nandurbar (MS)	8.2	18	623	29.7	678.9

1.4.3 Wind

Wind speed profile of the basin, based on data collected, is given in **table-7**. The average monthly wind speed in the Tapi basin varies between about 15 km/h and 1.2 km/h. In the pre and post monsoon period, the wind speed is generally higher. The predominant wind direction is NW followed by SW and W. **Table-7** shows wind data of Tapi basin.

Table-7: Wind speed and direction profile of Tapi Basin-2011

Month	Average wind Speed km/h									
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-12	3.60	2.80	2.90	0.90	2.20	1.7	1.2	7	0.5	1.1
Feb-12	4.10	3.80	2.00	1.30	3.30	1.6	2.1	2.8	0.5	1.3
Mar-12	3.90	4.80	2.80	3.90	3.70	1.6	2.5	3.5	1.2	1.7
Apr-12	4.60	6.10	4.50	1.90	4.80	1.8	3.7	4.8	2.1	2.5
May-12	7.50	12.70	9.00	25.10	8.30	3.8	8.6	8.5	7	4.9
Jun-12	8.10	15.30	11.40	12.90	9.10	6.5	8.6	6.1	5.4	4.2
Jul-12	4.60	9.30	7.20	3.50	6.40	3.5	5.3	3.7	2.9	2.3
Aug-12	3.10	6.80	4.40	3.70	5.10	3.0	5.3	2.2	1.8	1.4
Sep-12	3.10	4.50	2.70	1.90	4.30	1.7	2.8	2	1.2	1
Oct-12	2.20	3.00	2.00	1.30	2.30	1.1	1.3	1.8	0.5	0.8
Nov-12	4.30	3.30	2.50	1.90	2.20	13.5	1.2	1.7	1	0.8
Dec-12	4.60	3.10	1.80	1.80	1.80	1.2	1.1	1.2	0.7	0.9
Annual Mean	4.48	6.29	4.43	5.01	4.46	3.4	3.6	3.8	2.1	1.9

Dominant Wind Direction

Month	Dominant Direction									
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-12	E	E	E	E	E	E	W	S	SE	W
Feb-12	E	E	E	W	W	E	N	E	S	N
Mar-12	E	E	E	W	W	E	E	E	S	E
Apr-12	E	W	E	S	E	SE	W	E	SE	N
May-12	S	W	W	E	W	SW	E	E	W	W
Jun-12	S	E	W	W	W	W	E	E	NW	S
Jul-12	S	E	W	W	W	SW	E	E	NW	E
Aug-12	S	NW	W	W	E	SW	W	W	S	W
Sep-12	S	W	W	E	W	SW	W	W	S	S
Oct-12	E	E	W	E	E	E	W	W	SE	S
Nov-12	E	E	W	W	E	E	E	E	SE	S
Dec-12	NE	E	W	W	E	E	E	E	SE	W

1.4.4 Humidity

The morning relative humidity in the basin varies between 92.4% to 34.6% and the evening relative humidity is between 85.8% to 25.4% depending upon the season. Humidity is maximum during the monsoon months and is around 80% to 90%. In winter months of December and January, relative humidity comes down to around 30%. Variation in relative humidity between upper, middle and lower section of basin is not very pronounced except in the vicinity of coastal areas. The relative humidity at various stations of CWC in the Tapi basin is given in **Table-8**.

Table-8: Relative Humidity Data for Tapi basin

Month	% Morning Humidity										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-12	70.6	73.3	69.7	68.1	69.1	74.5	79.1	NA	NA	NA	NA
Feb-12	55.7	64.2	69.8	71.9	56.4	53.2	64.4	NA	NA	NA	NA
Mar-12	39.1	44.9	46.8	46.2	39.3	34.1	52.8	NA	NA	NA	NA
Apr-12	40.3	45.1	47.0	32.6	37.8	34.7	53.2	NA	NA	NA	NA
May-12	53.1	56.8	45.7	25.0	39.4	37.7	62.2	NA	NA	NA	NA
Jun-12	63.0	70.6	59.7	60.8	61.0	61.5	74.2	NA	NA	NA	NA
Jul-12	81.7	86.1	80.9	78.6	85.8	84.2	89.6	NA	NA	NA	NA
Aug-12	83.9	88.9	85.2	79.8	88.4	89.0	90.6	NA	NA	NA	NA
Sep-12	80.8	85.4	82.8	82.9	84.0	89.5	90.3	NA	NA	NA	NA
Oct-12	64.5	79.5	75.0	69.6	75.9	77.5	79.3	NA	NA	NA	NA
Nov-12	62.6	77.3	56.9	54.9	63.9	65.9	78.2	NA	NA	NA	NA
Dec-12	65.0	73.9	71.8	50.4	59.5	72.9	76.4	NA	NA	NA	NA
Annual Mean	63.4	70.5	65.9	60.1	63.4	64.6	74.2	NA	NA	NA	NA

Month	% Evening Humidity										
Location / Name of Site	Bhusawal	Yerli	Hathnur	Dedtalai	Gopalkheda	Lakhpuri	Burhanpur	Savkheda	Morane	Gidhade	Sarangkheda
Jan-12	41.6	34.6	67.6	72.1	61.9	60.0	49.0	NA	NA	NA	NA
Feb-12	29.5	30.9	69.2	69.7	34.3	28.9	46.2	NA	NA	NA	NA
Mar-12	18.5	29.4	50.2	49.8	32.3	17.1	33.5	NA	NA	NA	NA
Apr-12	20.7	21.4	47.3	21.9	29.7	26.8	35.6	NA	NA	NA	NA
May-12	25.6	47.9	49.6	21.3	43.5	21.6	35.8	NA	NA	NA	NA
Jun-12	48.2	45.5	56.3	45.7	52.4	44.1	58.8	NA	NA	NA	NA
Jul-12	72.3	73.0	75.7	72.4	77.6	76.1	81.7	NA	NA	NA	NA
Aug-12	75.3	80.5	82.5	80.2	85.3	83.2	82.7	NA	NA	NA	NA
Sep-12	72.0	72.5	80.7	82.5	75.3	75.4	75.9	NA	NA	NA	NA
Oct-12	47.5	55.5	75.6	71.3	68.6	57.3	57.5	NA	NA	NA	NA
Nov-12	40.4	37.3	65.2	57.5	50.3	47.2	46.6	NA	NA	NA	NA
Dec-12	38.9	38.2	80.5	46.9	55.3	49.5	49.7	NA	NA	NA	NA
Annual Mean	44.2	47.2	66.7	57.6	55.5	48.9	54.4	NA	NA	NA	NA

1.5 Geology

Trap Rocks

Deccan traps cover maximum part of this basin, These trap rocks are the result of outpouring of enormous lava flows which spread over vast areas of Western, Central and Southern India at the end of mesozoic era. They came through long narrow fissures and cracks in the earth crust and spread out as nearly horizontal sheets. They are called 'plateau basalt', because they form a flat-topped plateau. Due to the step-like or terraced appearance on the slope of hills they are also known as 'trap'. These volcanic rocks assume a considerable thickness ranging from a few hundred feet in the south to a couple of thousand feet in the north. The individual thickness of flow varies from a few feet up to a 100 feet or more. A bore-hole at Bhusawal 1211 feet deep, revealed 29 flows, the average being 40 feet In the high hills consisting of several flows, the individual flows can easily be demarcated by their distinct flow lines along which a thin growth of grass is noticed. The lavas are generally horizontal in disposition but at places they dip at very small angles. The traps that are commonly found in the plateau or cliff faces are compact and harder, often characterized by vertical prismatic or columnar jointing. They are dark grey or dark greenish grey to brownish grey in color. The amygdaloidal variety, which is greenish to purplish in color and comparatively softer, generally forms the slopes and valley floors. They contain innumerable cavities which are usually filled with secondary minerals such as quartz, chaledony, agate, jasper, rock crystal, Zeolites and calcite: The ash or Scoriaceous beds and red bole beds are sometimes noticed. The main minerals constituent in the trap rocks are abundant in Labradorite and Enstatite-augite with varying proportion of interstitial glass which on alteration gives rise to secondary minerals like Palagonite, Chlorophaete Iddingsite, etc. Sometimes Porphyritic basalt is seen showing Phenocrysts of Felspars and glassy matters. Magnetite occurs as minute discreet grains amidst other minerals as well as in the glassy groundmass. In a few cases, olivine is also present.

The other formations found in the basin are Alluvium , lower Gondwana, Cuddapah system Bijwara series and granites gneiss. Most of the area of Tapi basin falling in the Maharashtra state is full of cuts and valleys, land on the right side of the basin lying on southern slopes of Satpura hills consist of black soils the soil cover is deep and rock is found at greater depths. Lands on the left of the basin on northern slopes of Sahyadri consists mainly of dykes and red Murrum soil and are rocky in most parts.

The stratigraphic sequence of Tapi basin is tabulated **table-9**.

Table-9: Stratigraphic sequence

Formation	Age
Soil, river alluvia, calcareous Kankar and sands, etc.	Recent.
Conglomerates	Sub-recent.
Trap dykes	Cretaceous Eocene
Deccan basalt flows with inter-trappean Beds, ash beds.	
Erosional Unconformity :	
Upper Gondwana sandstones	Lower cretaceous.

Source : *Cultural.maharashtra.gov.in/english/gazetteer*

Tectonics and Sedimentation in Tapi Basin

The Late Cenozoic period in the Central Indian Tectonic Zone (CITZ) was marked by several episodes of crustal adjustments which are reflected in terms of various tectonic landforms, repeated adjustments in the drainage systems and sedimentation pattern in the Tapi basin which is a half graben structure. The northern margin of the basin is bound by ENE-WSW trending Tapi Fault Zone (TFZ) while the southern margin gradually merges with the Ajanta-Buldhana plateau.

The Tapi in the initial eastern part runs along a narrow intermontane valley carved into the lower middle level plateau of the south Satpuras. The course of the river is dominantly straight to sinuous with resistant channel boundaries and coarse bed material. Here, majority of the fluvial deposition has been in the form of overbank deposits with restricted flood plain development. The river here flows through a fault controlled valley cut into Deccan Traps and the river terraces on either bank are unpaired. The episode of faulting appears to have been preceded by a high rainfall phase and development of ash associated red paleosol horizon. Post uplift sedimentation in this part of the basin has been in form of buff coloured slack water deposits, dominantly finer grained during uppermost part of Late Pleistocene. Possible inset of transient arid phase (~LGM) had led to preservation of lithified grit beds. The last phase of sedimentation in this part of the basin is in form of grey silt bearing inset terraces of Holocene period derived

from older sediments. This phase appears to have witnessed a major episode of faulting as evident by presence of massive, meter scale bank collapse structures in the sediments. At present the river has set into a denudational phase, engaging into deep incision of its older sediment package and intense undercutting of the exposed sections. Intense vertical erosive activity influenced by slow tectonic uplift is manifest in form of fresh scarp sections, presence of giant pot holes and talus scree and block falls from the sections along the river course. The imprints of ongoing tectonic activity in this part have been in the form of tilting, crushing and brecciation of Deccan Traps and alignment of hot and cold springs along the river course.

The Tapi River after traversing this intermontane valley descends onto the foothills which has a different set up of tectonic landforms and sedimentation history. Here the river course is having dominantly wide and open meander bends with occasional presence of point bars and channel bars. This part represents the deeper part of the basin and sedimentation here has been under the influence of two regional scale faults: Tapi North Fault (TNF) traversing the lower plateau parts of the Satpura ranges and its margin and Tapi River Fault (TRF) which as the name suggests, runs along the course of the Tapi river and has governed the sedimentation pattern in the basin. Several first order transverse tributaries emerge from the Satpura foothills and join the Tapi River course in this stretch. Chronological data supports that the sedimentation in this part of the basin was initiated at least during middle Pleistocene. Episodic uplift of the reactivated segments of old crustal scale discontinuities has provided loci for sedimentation in the basin. The flood plain (red palaeosol) sediments of this part also show signatures of high rainfall phase caused by intensification of monsoon and episodic uplift of the northern footwall block of TNF. Climatic amelioration caused development of multiple bedded calcrete horizons and flash flood deposit. Rejuvenation of the main river and its tributaries has also introduced channel deposits along the river courses at a later phase possibly during upper part of Late Pleistocene. The youngest Holocene deposit occur as inset terraces along the river course. The sedimentary pile in this part is appreciably thick and the base rock/Quaternary contact is not seen along the river course except for the parts which have witnessed contemporary uplift along TRF.

Both TNF and TRF have been active during the deposition of sediments in this part of the basin. The imprints of TNF activity have been in the form of zones of high

geothermal gradient, accelerated denudation even along the juvenile first order streams and deformation of sediments. TRF on the other hand, has preserved the evidences of active tectonic activity in the form of paleoliquefaction features, deformation of sediments, development of coalesced colonies of potholes resulting from intense scouring of the Deccan Trap base rock along the uplifted segments of the TRF and development of alluvial fans. The episodic faulting in the basin created the depocentre for initiation of sedimentation and seismicity in the basin.

(Source: Snigdha Ghatak, Mriganka Ghatak, Tectono-climatic controls on fluvial sedimentation of upper and middle reaches of Tapi River basin, Central India, 2011, Second National Working Group Meeting, Geological Survey Of India)

Purna Basin

Part of the basin is covered by rocks of the Deccan volcanics of Cretaceous-Eocene age, and a few alluvium patches of the Purna and Penganga basin, respectively. The trap rocks are usually fine to coarse-grained, dark grey to greenish-black basalts of vesicular and massive types. The hard compact massive flows are generally noticed on the hill tops, *e.g.*, Melghat section whereas comparatively soft and amygdular varieties usually occupy the flanks of the hill or valley floors. Spheroidal exfoliation is a characteristic feature of weathering in the traps. Besides vertical and inclined jointing, columnar jointing is also well seen in more massive types. The vesicular and non-vesicular flows are at places separated by thin beds of ash or scoriae, but typical inter-trappean sedimentary rocks have not been recognised in the area. The amygdular varieties of flows carry secondary minerals like zeolites (mostly heulandite), calcite and chalcedony. No dykes have been found associated with the trap flows in the district where a lava pile of approximately 800 metres is preserved.

Alluvium

The Purna valley alluvium occupies an extensive stretch of low lying ground between Paturda and the confluence of Purna river with that of Tapi in Jalgaon district. In the river valleys and where superficial rain-wash has accumulated, a mixture of black cotton soil associated with sub-recent conglomeratic formation or light brown laterite material is noticeable at places, but otherwise, there is little variation in the nature and extent of soil or any variety of geological interest. The alluvium of the plains is usually of considerable depth. Much on the alluvium produces effervescence of sodium salts. Majority of the wells sunk in the area have brackish water.

Source : Cultural.maharashtra.gov.in/english/gazetteer

1.6 Soil

The soil in the Tapi basin up to Ukai Dam can be broadly classified in to three groups.

1. Coarse shallow soils
2. Medium black soils
3. Deep black soils.

The area covered by these three group of soils in the basin is given in **table-10**.

Table-10: Types of Soil in Tapi basin

sl. no.	Type of soil	Districts covered
1	Coarse shallow soils	Betul, Khandwa, Khargon, Amrawati, Akola, Buldhana, Jalgaon, Dhule, Aurangabad and Nasik
2	Medium black soils	Khandwa, Amrawati, Akola, Buldhana, Jalgaon, Dhule, and Nasik
3	Deep black soils.	Amrawati, Akola, Buldhana, Jalgaon, Dhule, Nasik, Surat and Bharuch

Coarse shallow soils

These soils have developed primarily from the basaltic Deccan trap and have been considerably affected by natural processes of weathering and erosion. Their depth is generally between 25cm to 50 cm and seldom more, their texture from surface to sub surface varies from silty loam to clay. Their organic matter content is usually poor and they are moderately drained.

Medium black soils

These soils have developed from Deccan traps and cover the largest area of the basin. Their depth is generally between 50cm to 1m. these soils contain higher lime reserve and are alkaline in reaction. These soils are fair in their contents of phosphates and potash but low in organic matter and nitrogen.

Deep black soils

These soils are found along the Purna river and in the middle and lower reaches of Tapi River. These soils have originated primarily from decomposition of trap rocks of hilly ranges. The depth of this soil varies from 1m to 6m. The soil have very high clay content Montmorillonite predominating and not easily workable during monsoon. The soil reaction varies from neutral to alkaline.

Source: [Hydrology and Water Resources of India, Water Science and Technology Library](#) Volume 57, 2007, pp 561-595 Tapi, Sabarmati and Mahi Basins, [Sharad K. Jain, Pushpendra K. Agarwal, Vijay P. Singh](#) (http://link.springer.com/chapter/10.1007%2F1-4020-5180-8_12)

1.7 Forest

The Tapi basin exhibits two distinct geographical regions, viz., the plain regions in the east and south-east and the hilly regions of the Satpura ranges in north and north-west. The plain region is extensively cultivated and forests appear only in dotted, scattered patches. The hilly region is an extensive block of compact forests and contains an abundance of rich teak trees. The percentage of the forest area to total area in the Tapi basin is approximately 25% of the total area, and is unevenly distributed.

Tree Forests

These include the forests of producing big-size teak and timber of other type.

Minor Forests

These include the forests in the plain regions, which are capable of producing small-size timber poles of teak, etc. These forests also supply fire-wood, thorns and grass and serve as good pastures for grazing the cattle.

Babul Bans.

These are artificially created forests of Babul (*Acacia arabica*) in the cultivated plain tracts and lie dotted over the area.

Ramnas and Pasture Forests

These include open forests with sparse tree growth and lie mostly in the plain regions, where an intense demand exists for grass and grazing.

Utilization

The forests are managed under regular working plans, the object being the supply of large-size timber for commercial use. The minor forests like Babul Bans and the Ramnas and pasture lands are being maintained to supply the local demand for small-size timber, fuel, grass and grazing.

Forest Produce

The major forest produce is timber. The minor forest produce constitutes various items, such as bamboo, fuel, Rosha grass, fodder grass, minerals, horns and hides, Tendu leaves and gum.

Forest Trees

The most useful trees and plants found in these forests, are given below: -

Teak (Tectona grandis), Tiwas (Ougenia dalbergioides), Shisham (Dalbergia latifolia), Bija (Pterocarpus marsupium), Haldu (Adina cordifolia), Saj (Terminalia tomentosa), Dhawda (Anogeissus latifolia), Dhaman (Grewia tiliaefolia), Semal (Bombax malabaricum; Silk cotton tree), Sivan (Gmelina arborea), Kusum (Schleichera trijuga), Kalam (Stephegyne parvifolia), Kahu (Terminalia arjuna), Landia (Lagerstroemia parviflora), Harra (Terminalia chebula), Bhormal (Hymenodictyon excelsum), Salai (Boswellia serrata), Moyan (Odina nodosa), Kekda (Garuga pinnata), Maharukh (Ailanthus excelsa), Moha (Madhuca latifolia), Tendu (Diospyros melanoxylon)

Achar (Buchanania lanzan), Aonla (Emblica officinalis) Beheda (Terminalia belerica), Bhilawa (Semecarpus anacardium) Amba (Mangifera indica) Bor (Zizyphus jujuba) Palas (Butea frondosa) Babul (Acacia arabica) Khair (Acacia catechu), Anjan (Hardwickia binata), Jamun (Eugenia jambolana), Bhosa (Bauhinia racemosa), Rohan (Soyamida febrifuga), Amaltas (Cassia fistula), Bel (Aegle marmelos), Kumbhi (Careya arborea), Gular (Ficus species), Dahi-palas (Cordia), Mokha (Schrebera swietenoides), Bhirra (Chloroxylon swietenia), Hiwar (Acacia leucophloea), Kulu (Sterculia urens), Gongal (Cochlospermum gossypium) Dudhi (Wrightia tinctoria), Arang (Kydia calycina) Pangra (Exythrina Indica), Bamboos (Dendrocalamus strictus).

Source: cultural.maharashtra.gov.in/english/gazetteer

1.8 Major/ Medium/Multipurpose/Irrigation projects

At present there are 28 Major and Medium Irrigation schemes completed and 2 projects are in under construction in the form of reservoirs or weirs in the Tapi catchment. List of the name of the completed, under construction and ongoing Projects are given in **Table. 11,12 and 13** respectively.

Table -11: Major/ Medium/Multipurpose/Irrigation Projects (completed)

Sl.No	Name of project	River	Status	Capacity (MCM)	
				Gross	Live
1.	Girna Project	Girna	Medium	608.450	523.55
2.	Dahigaon	Girna			
3.	Manyad Project	Manyad	Medium	53.95	40.27
4.	Bori Project	Bori	Medium	40.31	25.15
5.	Hathnur	Tapi	Medium	388.000	255.00
6.	Suki	Suki	Medium	50.16	39.85
7.	Abhora	Boked Nalla	Medium	7.440	6.020
8.	Boker Bari	Boker Bari Nala	Medium	7.090	6.54
9.	Agnawati	Agnawati	Medium	3.740	2.76
10.	Titur	Titur	Pick up bandhara.		
11.	Tondapur	Khadki Nalla	Medium	6.304	4.636
12.	Aner Project	Aner	Medium	103.230	56.38

13.	Karwand Proj.	Arunawati	Medium	33.840	31.15
14.	Panjhra Project	Panjhra	Medium	43.410	35.63
15.	Malangaon	Kan	Medium	13.020	11.35
16.	Kanholi	Kanholi	Medium	11.79	8.450
17.	Burai	Burai	Medium	21.330	14.21
18.	Arunawati	Arunawati	Mediu	27.780	14.97
19.	Rangawali	Rangawali	Medium	15.020	12.89
20.	Nagasakya	Panzar	Medium	15.620	11.240
21.	Haran Bari	Mousam	Medium	34.780	--
22.	Ukai	Tapi	Major	8510	7092
23.	Kakrapar	Tapi	Major	51.51	36.57
24.	Lakhigav	Dhakani	Medium	38.80	37.41
25.	Ver	Ver	Medium	4.90	4.61
26.	Sulwada Barrage	Tapi	Medium	65.06	64.642
27.	Sarangkheda Barrage	Tapi	Medium	92.20	91.82
28.	Prakasha Barrage	Tapi	Medium	63.64	62.11
29.	Kate Purna	Kate Purna	Major	97.670	86.350
30.	Nal ganga	Nal ganga	Major	76.200	69.320
31.	Uma	Uma	Medium	14.000	11.680
32.	Nirguna	Nirguna	Medium	32.290	28.850
33.	Morna	Morna	Medium	44.740	41.460
34.	Gyan ganga	Gyan ganga	Medium	36.260	33.930
35.	Mos	Mos	Medium	17.504	15.140
36.	Paltag	Vishvganga	Medium	9.090	7.510
37.	Man	Man	Medium	39.760	36.830
38.	Thoran	Tributary of Purna	Medium	8.480	7.900

Table -12: Major/ Medium/Multipurpose/Irrigation Projects (Under construction)-Tapi basin

Under Construction projects					
SI No	Name of Project	River	Classification	Gross Capacity (MCM)	Live storage (MCM)
1	Shelgaon Barrage	Tapi	Medium	116.37	110.35
2	Padelsa Dam	Tapi	Medium	420.56	407.59

Table -13: Ongoing Major / Medium Projects- Purna basin

Sl. No	Name of Project	River	Classification	Gross Capacity (MCM)	Live storage (MCM)
1	Ghungshi Project	Purna	Medium	17.444	17.269
2	Purna Barrage II (Ner Dhamna)	Purna	Medium	8.1743	8.1126
3	Jigaon Project	Purna	Medium	736.579	296.726

1.9 Important Projects in Tapi Basin

The salient features of the important projects, namely Hathnur Dam of Upper Tapi Project, Kakrapar weir and Ukai Dam of Ukai Project, Girna Dam and Dahigaon Weir of Girna Project, are as follows:

1.9.1 Hathnur Dam (Maharashtra)

This is the first stage of Upper Tapi Project. It consists of 717 m long Ogee shaped gated overflow weir in the centre with 1863 m long earthen embankment on either side constructed across the river Tapi near Hathnur village in Jalgaon district of Maharashtra State. It is having a live storage capacity of 255 MCM to irrigate 3, 78, 384 hectares of land in Raver, Yawal and Chopda talukas of Jalgaon district by a right bank canal of 95 km length.

1.9.2 Kakrapar Weir (Gujarat)

The project comprises of an Ogee shaped masonry pick up weir constructed across the Tapi River near Kakrapar in Surat district of Gujarat. The weir was constructed at a cost of Rs.20.61 crores. The weir is 621 m long and 14m high. Two canals take off from either bank to irrigate an area of 2.28 lakh ha. This project was commissioned in the year 1954 as stage -- I of the Ukai project.

1.9.3 Ukai Dam (Gujarat)

This is stage - II of the multipurpose Ukai Project. It consists of 4928 m long and 68.6 m high composite earth - cum - masonry dam across the Tapi River near Ukai village in Surat district of Gujarat State. It includes a spillway with power dam constructed on the left bank. Two canals take off from either bank to irrigate an

area of 1.58 lakh ha. The power house has an installed capacity of 4 units of 75 MW each.

1.9.4 Girna Dam (Maharashtra)

It is constructed across river Girna, a tributary of river Tapi near Panzan village in Nandgaon taluka of Nasik district. This is a multipurpose scheme, main purpose being irrigation and subsidiary power generation (power generation yet to be started). This is a composite dam having total length of 963.17 m, masonry dam with gated spillway for a length of 426.72 m and earthen dam of length of 536.45 m respectively.

1.9.5 Dahigam Weir (Maharashtra)

It is constructed across river Girna near Dahigaon village in Pachora Taluka of Jalgaon district of Maharashtra. It consists of a Ogee shaped Weir having a length of 422.76m and a maximum height of 8.82m. It irrigates an area of 57797 ha land through left bank canal of 45.06 Km. length.

Chapter-2: Stream flow Data

2.1 Methodology

Gauge Measurement

Water level or stage of the river is measured as its elevation above the G.T.S. datum. Water level measurement is conducted by reading non - recording gauges as specified in IS: 4080-1967. Series of vertical staff gauges have been fixed at three sections at every Site. The gauge posts are generally of wood or concrete with cut at water face arrangements and fixed securely in vertical position by anchoring them in M - 150 concrete base of suitable size. Enameled vertical gauge plates with metric markings are fixed on the gauge posts so that gauges can be read to an accuracy of 0.005 m.

Out of three gauge lines the central one is used as Station Gauge line and the readings of other two lines are used for calculation of water surface slope. During non-monsoon season gauges are read thrice daily (0800, 1300 and 1800 hrs.) and during monsoon gauges are read hourly, at the station gauge line.

Discharge Observation

Discharges are observed once a day starting from 0800 hours at all the sites by area - velocity method, except on Sundays and holidays. For non-observation days, the discharges are computed from the stage and discharge relation prepared, from the observed data for that water year.

The stream width is divided into 15 to 25 segments based on the degree of accuracy as outlined in IS: 1192-1981. The width of the river is measured by steel metallic tape or wire/ nylon rope stretched across the river width with markings indicated thereon when the river width and depth permitted wading. For large width and deep flow conditions segmentation is done using simple trigonometric method for which pivot point and segment blocks have been constructed at each site.

The depth is measured by using sounding rod 3 to 6 metres long adopting specifications given in IS: 3912-1966. When the river flow is very deep and swift, lead lines / echo sounders are used. Necessary Air and Wet line corrections are made to the sounding observations as provided in IS: 1192-1981. The velocity is measured as per IS: 3918 - 1966 by using a cup type current meter conforming to specifications given in IS: 3910-1966.

The current meter is lowered at the requisite depth (0.6d) in a vertical at every segment by suspension equipment as specified in IS: 6064-1971.

In high velocities, boats fitted with power engines or motor launches are used. Drift is measured and corrections for the same are made. Where observations by boat or launch are not possible, measurement of velocity is conducted from bridge or cable way. When the above procedures are not possible then velocity is measured by float observations. The observations are recorded in a standard format for calculation of total river flow.

Equipment used for observation

Table-14: List of equipment used in observation

Sl. No	Name of Equipment	By Wading	By Bridge	By Boat	By Float
1	Current Meter	√	√	√	X
2	Pigmy Current Meter	√	X	X	X
3	Stop Watch	√	√	√	√
4	Wading Rod	√	X	X	X
5	Nylon rope & tag	√	X	X	X
6	Measuring Tape	√	X	X	X
7	Protractor	√	√	√	X
8	Ranging Rod	√	X	√	X
9	Sounding Rod	√	X	√	X
10	Automatic Battery Counter	√	√	√	X
11	Thermometer	√	√	√	√
12	Prismatic Compass	X	X	X	√
13	Balloon	X	X	X	√
14	Sounding Cable with fish weight	X	√	√	X
15	Echo Sounder	X	X	√	X

Morphology: No significant morphological changes have been observed at sites.

Narrative description /special information on hydrological conditions is as Under

- a) SRRG information for important G and D sites during flood period: - One Self recording rain gauge and one Ordinary rain gauge are available at sites.
- b) Flood Hydrograph details enclosed in data part.
- c) Extent of flooding:- No unprecedented flood experienced during 2012-13
- d) Breaching of embankments and other structures, if any: - There had been no incident of major breaches during 2012-13

e) Substantial changes in river morphology: - Study of river cross sections of last few years indicates that there is no appreciable change in the river morphology at sites.

f) Drought / Water scarcity: - Water scarcity is not experienced and hence no drought in this zone.

2.2 Data Availability of Existing Sites

Table-15: Data availability of existing sites

Sl.No	Station Name	River	Station Code No.	Type	Data available	
					From	To
1	Burhanpur	Tapi	010217002	GDSQRF		
				Gauge	16.06.1972	Contd...
				Discharge	14.09.1972	-do-
				Sediment	23.12.1972	-do-
				W Q	01.06.1977	-do-
				RF	15.06.1970	-do-
2	Gopalkheda	Purna	010217004	GDSQ RF		
				G	17.02.1977	-do-
				D	17.02.1977	-do-
				S	30.07.1979	-do-
				WQ	01.08.1979	-do-
				RF	01.01.1980	-do-
3	Yerli	Purna	010217005	GDSRF		
				G	11.11.1971	-do-
				D	01.03.1972	-do-
				S	09.04.1973	-do-
				RF	04.09.1979	-do-
				WQ	01.06.1977	31/05/05
4	Gidhade	Tapi	01 02 17014	GDRF		
				G	15.06.1969	
				D	19.06.1990	-do-
				RF	03.07.1971	-do-
				WQ	01.09.1990	31/05/05
5	Sarangkheda	Tapi	0102 17015	GDSQRF	--	
				G	29.07.1976	Contd..
				D	19.10.1977	-do-
				S	13.07.1984	-do-
				WQ.	01.01.1980	-do-
				RF	15.06.1986	-do-

2.2.1 Availability of Data of closed sites and sites with reduced Status

Table-16: Availability of data of closed site

Sl. No	Station Name	River / Tributary	Station Code No.	Type	Data available	
					From	To
1	Dedtalai	Tapi	0102 17001	GDSRFQ		
				Gauge	06.01.77	Contd..
				Discharge	12.12.77	31.05.05
				Sediment	24.01.84	31.05.05
				Water Qly.	01.08.79	31.05.05
				RF	11.08.84	Contd..
2	Lakhpuri	Tapi/Purna	0102 17003	GDRFQ		
				Gauge	16.02.77	Contd..
				Discharge	18.02.77	31.05.05
				Water Qly	03.11.86	31.05.05
				Rainfall	01.09.81	Contd..
3	Savkheda	Tapi	0102 17011	GDSRFQ		
				Gauge	06.04.72	Contd..
				Discharge	10.04.72	31.05.05
				Sediment	01.11.72	31.05.05
				Water Qty.	01.06.77	31.05.05
				RF	01.01.85	Contd..
4	Morane	Tapi/ Panjhra	0102 17012	GDRFQ		
				Gauge	17.07.76	Contd...
				Discharge	02.11.77	31.05.05
				W. Quality	01.09.90	31.05.05
				RF	01.11.91	Contd
5	Dapuri	Tapi/ Girna	0102 17010	GDSRFQ		
				Gauge	21.09.71	31.05.05
				Discharge	21.01.72	31.05.05
				Silt	01.07.73	31.05.05
				WQ	01.06.77	31.05.05
				RF	01.06.85	31.05.05
6	Malkheda	Tapi/ Bori	0102 17012	GDQRF		
				Gauge	17.07.76	31.05.05
				Discharge	02.11.77	31.05.05
				W Qly.	01.09.90	31.05.05
				RF	01.06.87	31.05.05
7	Ghala	Tapi	01 02 17 018	GDRFQ		
				Gauge	15.08.77	Contd..
				Discharge	01.06.78	31.05.05
				Water Qty.	01.08.83	31.05.05
				RF	01.06.78	Contd..
8	Kakrapar	Tapi	0102 17017	GRF		
				Gauge	01.06.69	15.10.04
				Rainfall	01.06.69	15.10.04

2.3 Explanatory notes

The explanatory notes given here-under are designed to assist in the interpretation of hydrological parameters contained in the data presented. The notes are, therefore, applicable in so far as the data presented in this book.

- i] Water year covers the period from June 1st of the one calendar year to May 31st of the next calendar year and includes one complete hydrological cycle.
- ii] Discharge is given in cubic metre per second.
- iii] Discharges given are observed daily discharges.
- iv] Discharges are expressed as 0.000 when river bed is dry and also when there is stagnation of water i.e. velocity is observed as NIL.
- v] Discharges indicated with asterisk (*) mark are Estimated discharges as per rating curve equation corresponding to stage at 0800 hours of that day. Discharges indicated with (#) marks are estimated discharges of the discarded points.
- vi] The Zero of Gauge is a datum level / R. L. fixed for a given site, which is kept 1 or 2 m lower than the lowest water level recorded in a perennial stream. In a non- perennial stream, it is kept 1 or 2 m lower than the lowest bed level of the stream.
- Vii] Discharges are rounded off to:
 - a] Nearest full integer when more than 1000.
 - b] Nearest first decimal figures when between 100 and 1000
 - c] Nearest two decimal figures when between 10 and 100
 - d] Nearest three decimal figures when less than 10.
- Viii] Maximum and minimum discharges are taken from the observed daily flows.
- ix] Runoff in mm is the notional depth of water in millimetres over the catchment area equivalent to annual runoff calculated at the discharge measurement station. It is computed using the relation

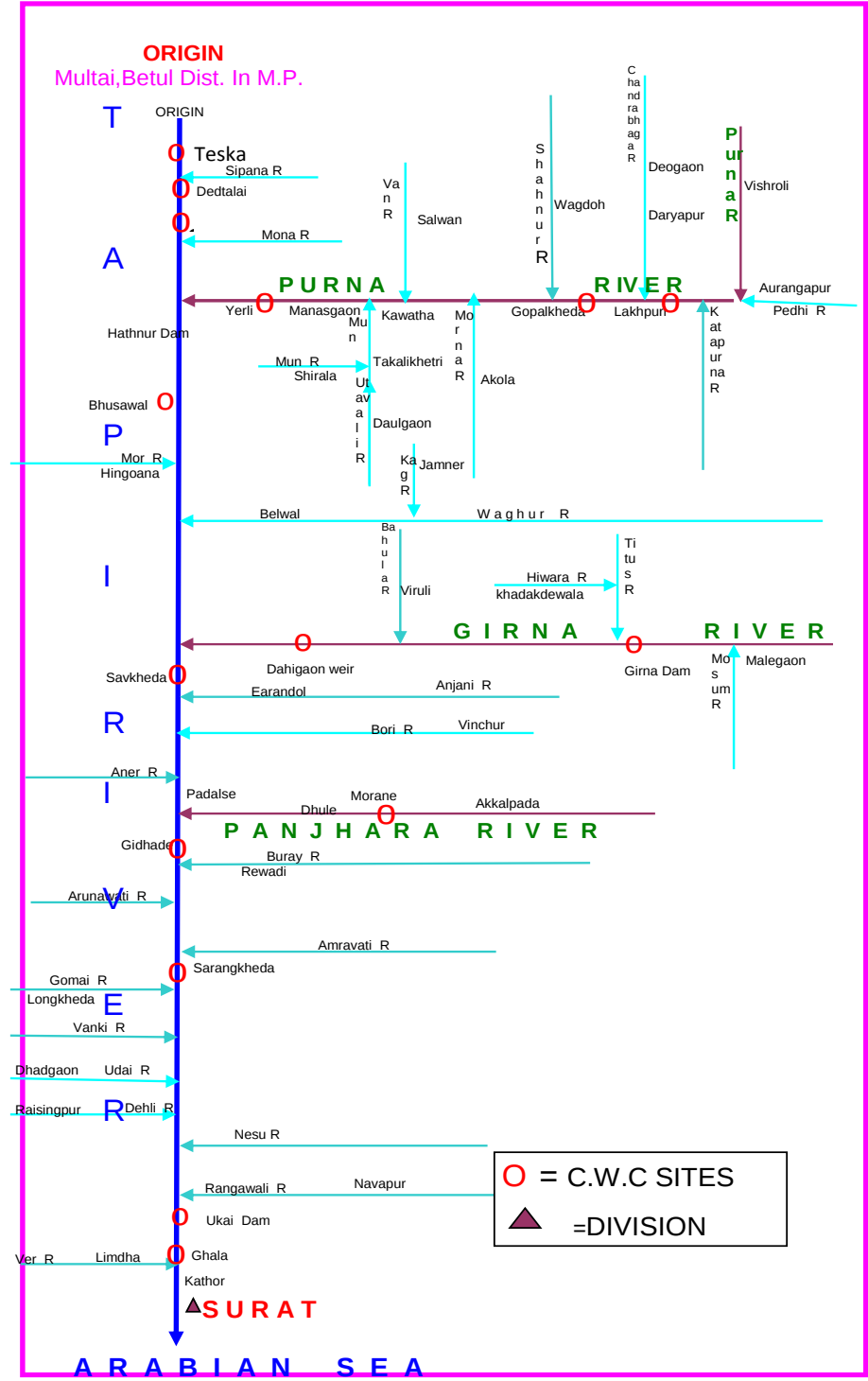
$$\text{Runoff (mm)} = \frac{\text{Annual runoff (mm}^3\text{)} \times 1000}{\text{Catchment area (km}^2\text{)}}$$

- x] Peak and lowest flow correspond to the highest and lowest water levels recorded during the period of record.
- xi] Measuring authority refers to the field division responsible for the operation of the gauging station.
- xii] The gauging station code number is a unique NINE digit number, which facilitates storage and retrieval of flow data in data banks. The first two digits are identifier of measuring authority, third and fourth digits represent Basin / Zone and fifth and sixth digit refer to independent river Basins in the zone, seven eight and nine digits indicate site numbers.
- xiii] The month and the year from which data available in the data banks is indicated against record available

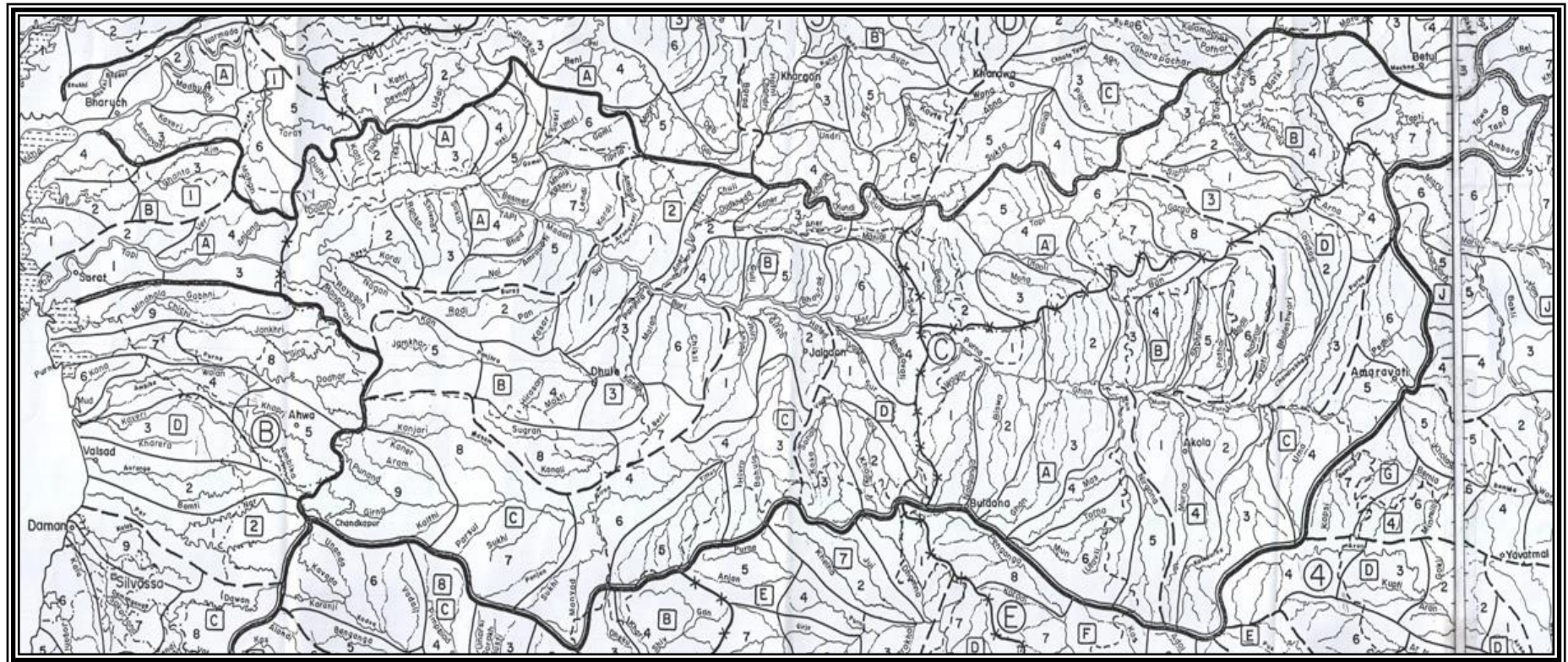
Plate no-1



Plate-2



Watershed Map of Tapi River Basin (As per Watershed Atlas of India Published by: Department of Agriculture and Cooperation, Ministry of Agriculture, Krishi Bhavan New Delhi (1990))



Chapter-3 Hydrological data

3.1 Burhanpur

3.1.1 History sheet

Site	:	Tapi at Burhanpur	Code	:	01 02 17 002
State	:	Madhya Pradesh	District	:	Khandwa
Basin	:	Tapi	Independent River	:	-
Tributary	:		Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	
Division	:	Tapi Division Surat	Sub-Division	:	Upper Tapi Bhusawal
Drainage Area	:	8487 sq km	Bank	:	Right
Latitude	:	21°17'12"	Longitude	:	76°30'18"
Zero of Gauge (m)	:	213 (msl)	16/06/1972		
		Opening Date	Closing Date		
Gauge	:	16/06/1972			
Discharge	:	14/09/1972			
Sediment	:	23/12/1972			
Water Quality	:	01/06/1977			

Annual Maximum / Minimum observed discharge with corresponding Water Level (m)

Year	Maximum			Minimum		
	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1973-1974	6330	226.112	27/08/1973	1.100	215.120	04/06/1973
1974-1975	2015	220.908	13/08/1974	0.900	214.990	19/05/1975
1975-1976	6117	224.890	12/08/1975	0.800	215.085	22/05/1976
1976-1977	3745	224.435	03/09/1976	0.000	215.085	28/02/1977
1977-1978	3893	223.000	14/09/1977	0.720	214.960	28/05/1978
1978-1979	26683	239.500	29/08/1978	1.000	214.990	01/06/1978
1979-1980	12100	233.950	10/08/1979	0.400	214.970	16/05/1980
1980-1981	5379	224.780	06/08/1980	0.800	214.980	31/05/1981
1981-1982	13259	230.100	10/08/1981	0.800	214.970	16/06/1981
1982-1983	1120	219.190	12/09/1982	0.300	215.030	09/05/1983
1983-1984	3687	222.200	01/09/1983	0.300	215.030	12/06/1983
1984-1985	11305	230.975	19/08/1984	0.100	215.010	10/06/1984
1985-1986	1875	220.500	14/08/1985	0.100	214.890	31/05/1986
1986-1987	4837	223.800	15/08/1986	0.000	214.860	11/05/1987
1987-1988	1160	219.000	18/06/1987	0.200	214.920	31/01/1988
1988-1989	4707	222.825	22/07/1988	0.000	214.780	02/05/1989
1989-1990	3435	221.400	19/08/1989	0.050	214.920	08/03/1990
1990-1991	8959	226.100	23/08/1990	0.000	214.870	15/05/1991
1991-1992	8246	232.450	31/07/1991	0.000	214.700	23/04/1992
1992-1993	4694	224.600	17/08/1992	0.000	214.550	05/05/1993
1993-1994	8268	223.800	16/06/1993	0.000	214.500	12/06/1993
1994-1995	17027	233.600	06/09/1994	0.000	214.800	05/06/1994
1995-1996	6630	226.500	03/09/1995	0.000	214.730	31/05/1996
1996-1997	2742	220.800	28/07/1996	0.136	215.030	16/05/1997
1997-1998	12339	229.350	26/07/1997	0.000	214.700	29/05/1998
1998-1999	25261	238.000	15/09/1998	0.000	214.700	13/06/1998
1999-2000	8649	227.800	10/08/1999	0.111	214.750	30/05/2000
2000-2001	1403	219.000	20/07/2000	0.000	215.620	17/05/2001
2001-2002	6664	225.050	15/08/2001	0.000	215.280	31/05/2002
2002-2003	5300	225.500	06/09/2002	0.000	215.170	25/05/2003
2003-2004	5130	224.600	28/07/2003	0.000	214.950	14/06/2003
2004-2005	5197	225.130	23/08/2004	0.000	215.320	09/05/2005
2005-2006	4098	224.060	15/09/2005	0.000	214.500	13/06/2005
2006-2007	3825	224.075	08/08/2006	0.000	215.900	01/06/2006
2007-2008	32686	236.800	08/07/2007	0.000	214.920	01/06/2007
2008-2009	3797	223.050	05/08/2008	0.000	215.220	01/05/2009
2009-2010	2810	222.500	23/07/2009	0.000	215.320	01/06/2009
2010-2011	2803	223.950	09/09/2010	0.000	216.000	24/01/2011
2011-2012	5965	225.475	27/08/2011	0.000	215.790	12/06/2011
2012-2013	8613	228.250	06/09/2012	0.00	215.29	27/05/2013

3.1.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1973	227.075	15/07/1973	03:00:00
1974	221.750	13/08/1974	02:00:00
1975	225.850	11/09/1975	20:00:00
1976	224.850	03/09/1976	08:00:00
1977	223.325	14/09/1977	15:00:00
1978	239.500	29/08/1978	18:00:00
1979	233.172	10/08/1979	09:00:00
1980	227.350	06/08/1980	14:00:00
1981	229.800	10/08/1981	00:00:00
1982	218.100	12/09/1982	00:00:00
1983	222.250	02/09/1983	17:00:00
1984	230.600	19/08/1984	02:00:00
1985	219.500	14/08/1985	00:00:00
1986	225.200	15/08/1986	00:00:00
1987	219.600	21/08/1987	06:00:00
1988	223.950	03/10/1988	07:00:00
1989	222.990	23/08/1989	21:00:00
1990	232.150	23/08/1990	17:00:00
1991	233.350	31/07/1991	05:00:00
1992	225.850	16/08/1992	21:00:00
1993	230.200	16/07/1993	22:00:00
1994	236.700	06/09/1994	17:00:00
1995	226.600	03/09/1995	10:00:00
1996	223.600	26/07/1996	19:00:00
1997	229.500	26/07/1997	10:00:00
1998	238.800	15/09/1988	12:00:00
1999	229.800	10/08/1999	03:00:00
2000	223.200	19/07/2000	15:00:00
2001	229.900	15/08/2001	23:00:00
2002	227.800	06/09/2002	01:00:00
2003	228.450	28/07/2003	02:00:00
2004	226.500	23/08/2004	05:00:00
2005	224.400	02/08/2005	13:00:00
2006	225.700	06/08/2006	22:00:00
2007	239.950	08/07/2007	17:00:00
2008	227.000	05/08/2008	21:00:00
2009	225.700	23/07/2009	01:00:00
2010	225.300	30/07/2010	19:00:00
2011	226.100	27/08/2011	09:00:00
2012	238.000	05/09/2012	23:00:00

3.1.3 Summary of Data

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Upper Tapi Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	215.070	0.000	215.810	10.18 *	220.000	1329	218.825	956.0	216.810	222.1	216.080	30.55
2	215.050	0.000	216.650	137.0	220.300	1445	218.650	875.7	216.750	166.4 *	216.060	28.30
3	215.020	0.000	216.350	105.6	218.675	833.4	220.300	1509	216.855	222.8	216.050	28.74
4	215.000	0.000	216.545	127.1	218.080	617.5	219.400	1149	216.810	219.4	216.050	30.73 *
5	214.990	0.000	216.475	115.4	217.790	502.2 *	221.175	3011	216.790	210.9	216.050	26.50
6	214.970	0.000	216.290	109.1	217.550	392.5	228.250	8613	216.780	200.5	216.050	26.12
7	214.950	0.000	216.000	34.44	224.500	3869 #	221.725	2286	216.720	158.1 *	216.040	25.17
8	214.940	0.000	218.400	722.0 *	223.000	2966 #	220.050	1385	216.690	158.2	216.030	24.07
9	214.930	0.000	216.550	131.3	219.775	1264	219.100	1073	216.640	151.0	216.030	24.06
10	214.920	0.000	217.810	466.6	218.600	799.1 *	218.900	967.3	216.620	140.4	216.020	22.22
11	214.910	0.000	216.830	218.2	218.440	745.3	223.200	3082 #	216.520	120.2	216.000	21.92
12	214.900	0.000	216.685	148.6	222.500	2681 #	220.200	1413	216.490	118.4	215.980	21.94
13	214.880	0.000	216.550	142.1	219.950	1298	218.910	967.4	216.450	113.7	215.970	22.53 *
14	214.800	0.000	216.480	133.7	219.060	1041	218.300	707.9	216.430	89.62 *	215.960	19.89
15	214.750	0.000	216.400	83.73 *	218.550	779.6 *	218.100	628.6	216.410	71.53	215.940	17.27
16	214.700	0.000	216.150	64.95	218.140	618.7	217.980	568.1 *	216.400	70.73	215.920	15.36
17	214.700	0.000	216.100	52.92	217.825	480.0	217.695	471.0	216.370	76.30	215.900	14.96
18	214.840	0.000	216.070	51.42	217.600	450.5	217.520	407.7	216.350	75.04	215.890	15.69 *
19	219.300	1086 #	216.040	45.27	217.560	425.7 *	217.350	345.8	216.320	69.37	215.870	14.22
20	216.835	233.9	216.010	41.25	217.500	406.4 *	217.250	329.4	216.300	65.42	215.850	13.71
21	216.380	112.6	216.010	41.51	218.875	895.6	217.230	317.1	216.290	63.98 *	215.830	12.95

22	216.200	79.67	216.000	25.44 *	218.625	842.5	217.150	297.4	216.280	52.73	215.820	12.47
23	216.140	63.47	224.200	3683 #	218.850	962.9	217.550	422.5 *	216.260	48.89	215.810	12.05
24	216.110	39.20 *	226.700	5314 #	218.050	586.1	217.250	333.4	216.250	57.42 *	215.780	12.50
25	215.960	29.60	219.225	1089	217.740	485.0 #	217.920	533.7	216.240	46.56	215.760	7.390 *
26	215.930	26.53	218.200	617.2	217.630	448.6 *	217.100	275.2	216.220	44.01	215.740	11.82
27	215.830	15.55	217.600	431.2	217.775	522.7	216.990	251.1	216.200	49.96 *	215.700	11.49
28	215.830	15.33	221.925	2293	219.550	1175	217.310	354.8	216.180	47.10 *	215.680	3.910 *
29	215.810	14.64	222.600	2738 *	218.410	759.6	217.050	264.8	216.150	36.35	215.660	3.700 #
30	215.810	12.48	220.465	1471	218.400	722.0 #	216.900	211.5 *	216.120	35.11	215.660	3.700 #
31			219.640	1233	218.650	815.4			216.100	32.91		
<u>Ten-Daily Mean</u>												
I Ten-Daily	214.984	0.000	216.688	195.9	219.827	1402	220.637	2183	216.747	185.0	216.046	26.65
II Ten-Daily	215.462	132.0	216.331	98.21	218.712	892.6	218.650	892.1	216.404	87.04	215.928	17.75
III Ten-Daily	216.000	40.90	220.233	1721	218.414	746.8	217.245	326.1	216.208	46.82	215.744	9.199
<u>Monthly</u>												
Min.	214.700	0.000	215.810	10.18	217.500	392.5	216.900	211.5	216.100	32.91	215.660	3.700
Max.	219.300	1086	226.700	5314	224.500	3869	228.250	8613	216.855	222.8	216.080	30.73
Mean	215.482	57.63	217.831	705.7	218.966	1005	218.844	1134	216.445	104.4	215.906	17.86

Annual Runoff in MCM = 8033 Annual Runoff in mm = 946

Peak Observed Discharge = 8613 cumecs on 06/09/2012 Corres. Water Level :228.25 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2012 Corres. Water Level :215.07 m

Note: River in pooling condition i.e. negligible flow during 1/6 to 18/06/2012, and from 02-04-13 to 30-04-13

**Q: observed/ computed discharge in cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated**

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Upper Tapi Bhusawal

Day	Dec			Jan		Feb		Mar		Apr		May	
	W.L	Q		WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	215.660	3.698	#	215.700	4.102	215.600	2.125	215.660	2.336	215.400	0.000 *	215.330	0.000
2	215.700	5.270	*	215.700	4.076	215.600	1.901	215.650	2.127	215.400	0.000 *	215.330	0.000
3	215.780	11.23		215.690	3.654	215.600	1.882 *	215.650	3.350 *	215.390	0.000	215.330	0.000
4	215.780	10.72		215.690	3.450	215.650	2.185	215.650	2.165	215.390	0.000	215.320	0.000
5	215.780	10.59		215.680	3.321	215.650	2.254	215.640	1.983	215.390	0.000	215.320	0.000
6	215.780	9.818		215.670	4.060 *	215.650	2.224	215.620	1.978	215.380	0.000	215.310	0.000
7	215.770	9.242		215.640	2.946	215.650	2.068	215.620	1.948	215.380	0.000	215.310	0.000
8	215.770	8.848		215.640	2.839	215.650	1.977	215.610	1.861	215.380	0.000	215.310	0.000
9	215.640	3.021	*	215.640	2.551	215.650	2.135	215.600	1.806	215.380	0.000	215.310	0.000
10	215.770	7.014		215.630	2.543	215.650	3.350 *	215.590	1.640 *	215.380	0.000	215.310	0.000
11	215.770	4.871		215.630	2.465	215.650	1.967	215.570	1.292	215.380	0.000	215.310	0.000
12	215.770	4.606		215.630	2.434	215.650	1.962	215.560	1.240	215.380	0.000	215.310	0.000
13	215.770	5.340		215.630	2.710 *	216.000	26.80 #	215.560	1.162	215.380	0.000	215.310	0.000
14	215.770	6.234		215.630	2.746	215.900	17.66 #	215.560	1.117	215.380	0.000	215.310	0.000
15	215.770	6.141		215.630	2.693	215.880	16.00 #	215.560	1.106	215.380	0.000	215.300	0.000
16	215.630	2.710	*	215.630	2.644	215.780	9.320 #	215.560	1.067	215.380	0.000	215.300	0.000
17	215.760	5.762		215.630	2.605	215.730	6.640 *	215.560	1.020 *	215.380	0.000	215.300	0.000
18	215.750	5.594		215.620	2.541	215.730	2.601	215.560	1.155	215.370	0.000	215.300	0.000
19	215.750	5.278		215.620	2.551	215.730	2.575	215.550	1.086	215.370	0.000	215.300	0.000
20	215.750	5.231		215.620	2.410 *	215.730	2.575	215.550	1.183	215.370	0.000	215.300	0.000
21	215.740	4.992		215.620	2.494	215.710	2.451	215.550	1.097	215.370	0.000	215.300	0.000

22	215.740	4.829		215.620	2.420	215.710	2.445	215.550	1.106	215.370	0.000	215.300	0.000
23	215.730	6.640	*	215.610	2.389	215.710	2.358	215.540	1.077	215.370	0.000	215.300	0.000
24	215.730	4.665		215.610	2.350	215.690	4.850	*	215.530	0.550	*	215.370	0.000
25	215.610	2.140	*	215.610	2.140	*	215.680	2.299	215.500	0.230	*	215.360	0.000
26	215.730	4.587		215.610	2.140	*	215.680	2.296	215.500	0.230	*	215.350	0.000
27	215.720	4.430		215.610	2.140	*	215.670	2.343	215.430	0.000	*	215.350	0.000
28	215.710	4.354		215.610	2.318		215.670	2.204	215.420	0.000	*	215.350	0.000
29	215.710	4.245		215.600	2.217				215.420	0.000	*	215.350	0.000
30	215.600	1.882	*	215.600	2.214				215.400	0.000	*	215.340	0.000
31	215.710	4.151		215.600	2.155				215.400	0.000	*		215.280
Ten-Daily Mean													
I Ten-Daily	215.743	7.945		215.668	3.354	215.635	2.210	215.629	2.119	215.387	0.000	215.318	0.000
II Ten-Daily	215.749	5.177		215.627	2.580	215.778	8.810	215.559	1.143	215.377	0.000	215.304	0.000
III Ten-Daily	215.703	4.265		215.609	2.271	215.690	2.656	215.476	0.390	215.358	0.000	215.290	0.000
Monthly													
Min.	215.600	1.882		215.600	2.140	215.600	1.882	215.400	0.000	215.340	0.000	215.280	0.000
Max.	215.780	11.23		215.700	4.102	216.000	26.80	215.660	3.350	215.400	0.000	215.330	0.000
Mean	215.731	5.746		215.634	2.72	215.702	4.695	215.552	1.191	215.374	0.000	215.304	0.000

Peak Computed Discharge = 2738 cumecs on 29/07/2012

Corres. Water Level :222.6 m

Lowest Computed Discharge = 0.000 cumecs on 27/03/2013

Corres. Water Level :215.43 m

Note: River in pooling condition i.e. negligible flow during 1/6 to 18/06/2012, and from 27-03-13 to 31-05-13

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge #Discarded and estimated

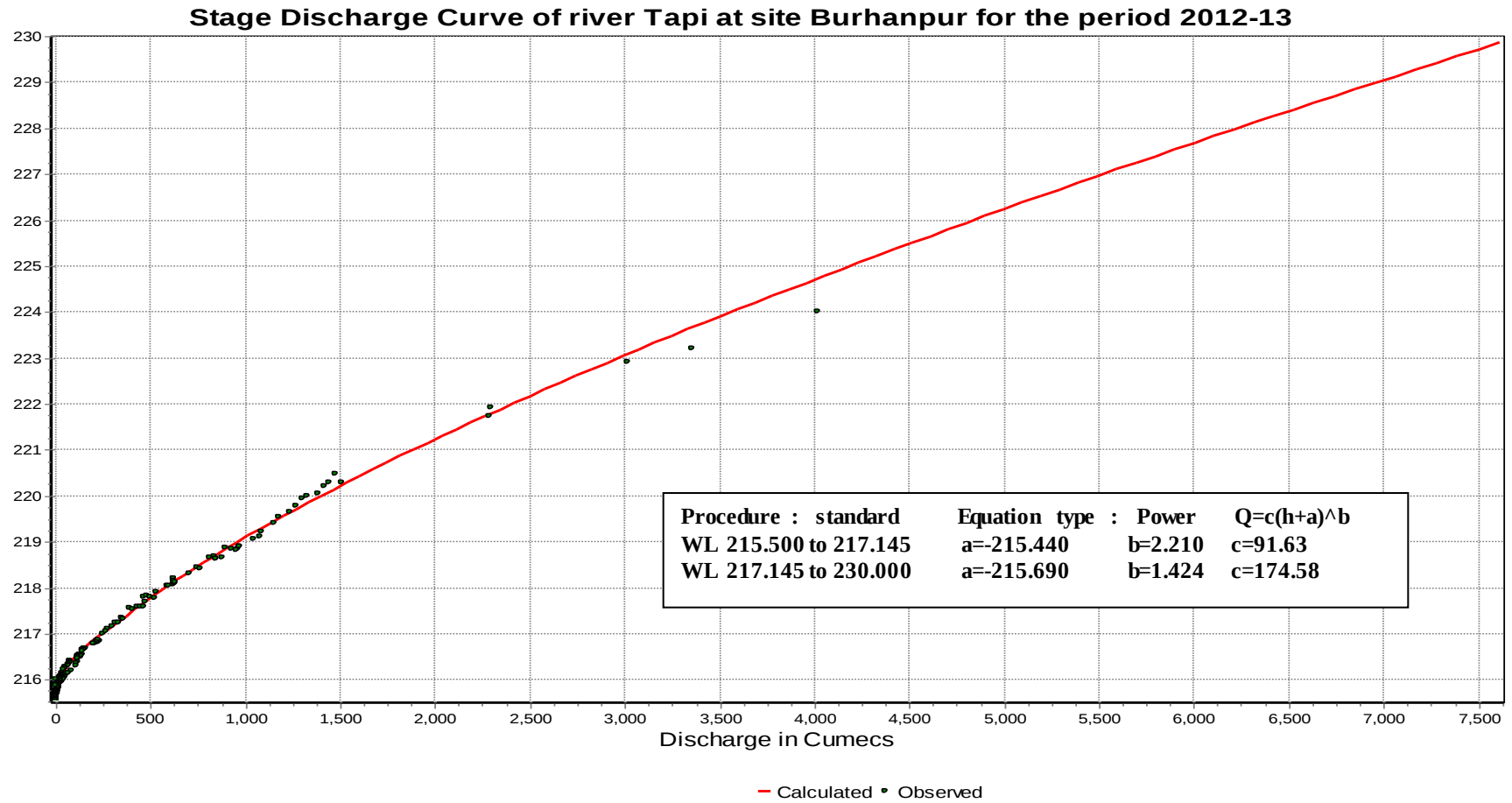
3.1.4 Stage Discharge Curve

Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Upper Tapi Bhusawal



3.1.5 Annual Runoff

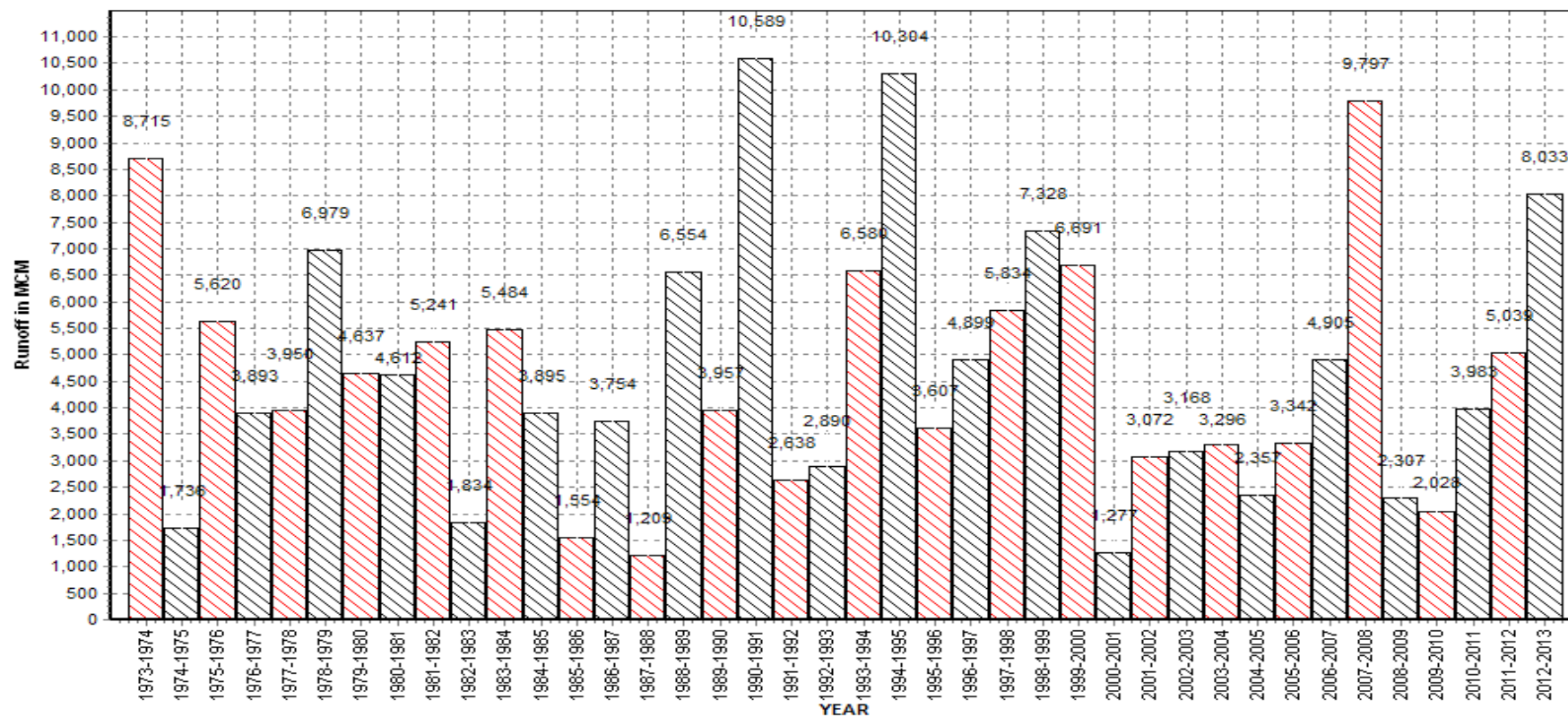
Annual Runoff for the period 1973-2013

Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Upper Tapi Bhusawal



3.1.6 Monthly average Runoff

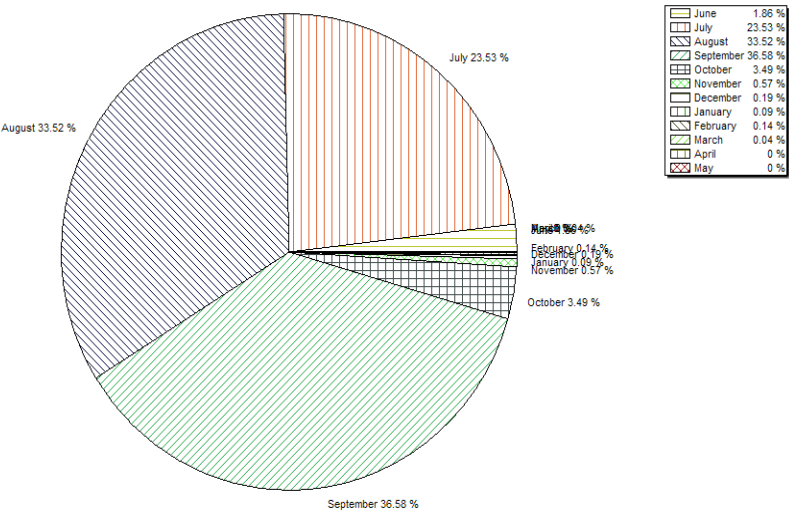
Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

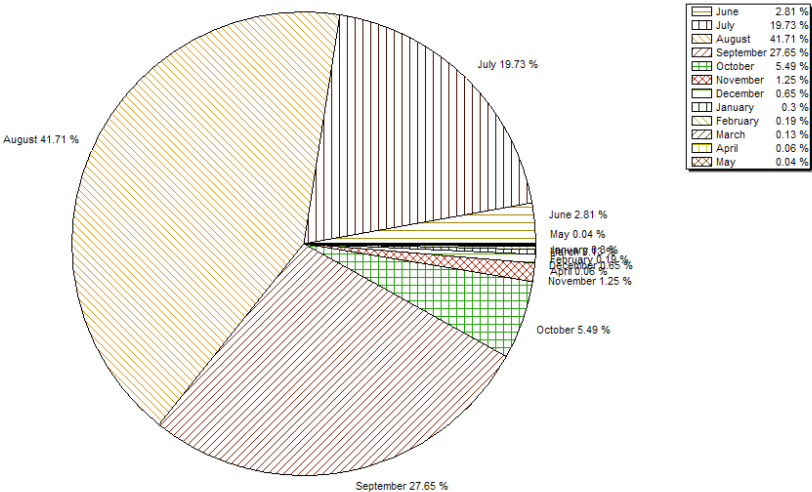
Local River: Tapi

Sub Division: Upper Tapi Bhusawal

Monthly Average Runoff Based on period 1971-2013



Monthly Runoff Based on period 2012-2013



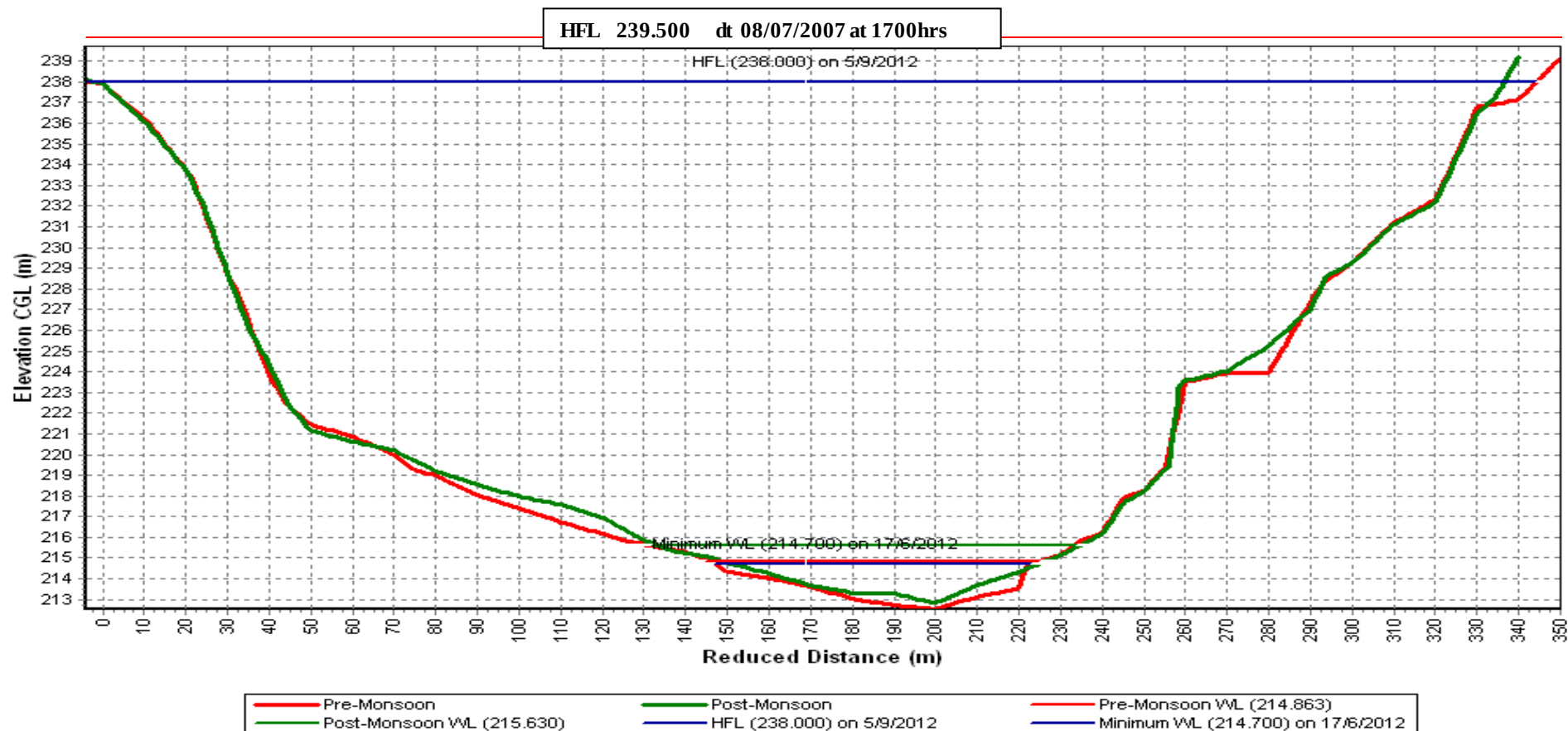
3.1.7 Superimposed cross section

Station Name: Tapi at Burhanpur (01 02 17 002)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Upper Tapi Bhusawal



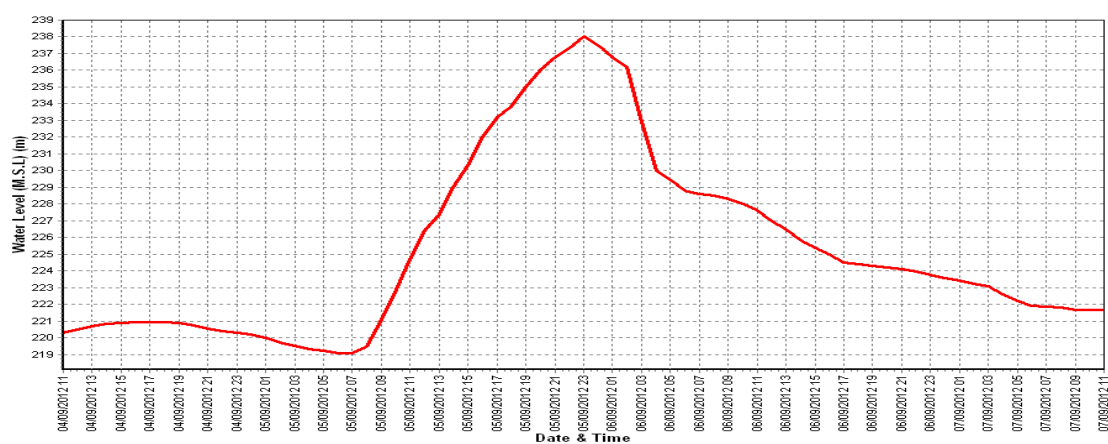
3.1.8 WL vs Time Graph of I, II, III peak

Station Name: Tapi at Burhanpur (01 02 17 002)
River: Tapi

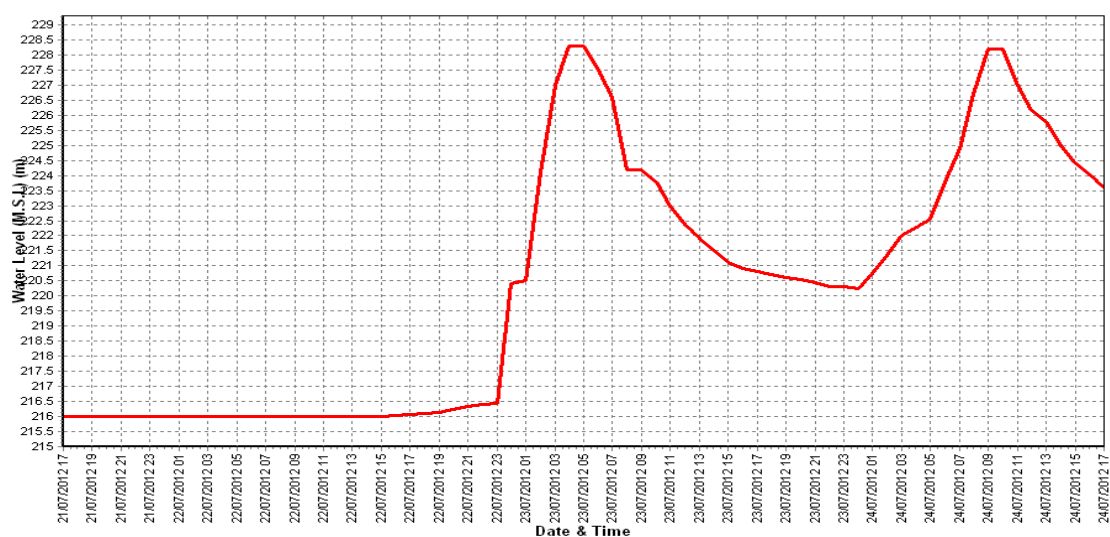
Division: Tapi Division Surat
Sub Division: Upper Tapi Bhusawal

Local

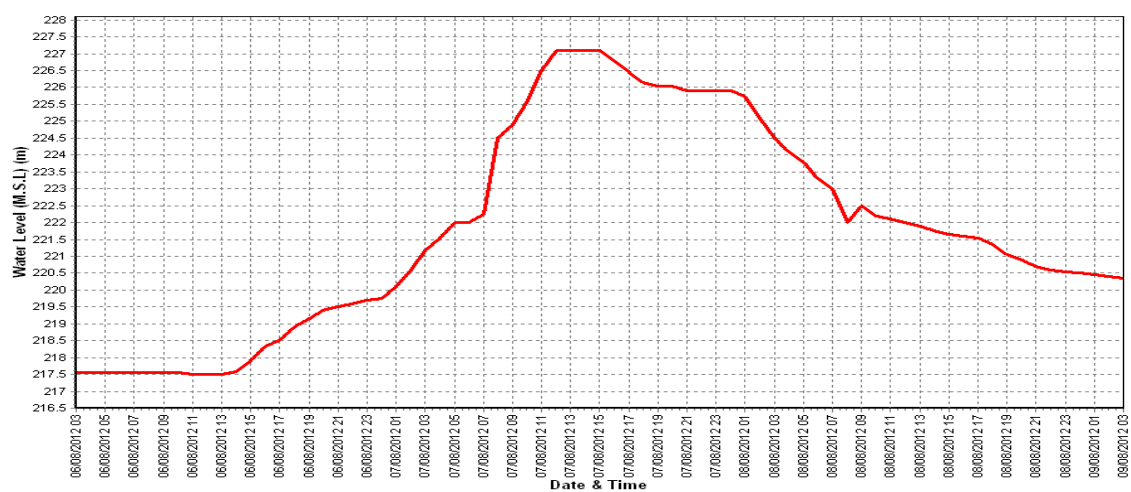
Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (II) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



3.2 Gopalkheda

3.2.2 History sheet

Site	: Purna at Gopalkheda	Code	: 01 02 17 004
State	: Maharashtra	District	Akola
Basin	: Tapi	Independent River	: Tapi
Tributary	: Purna	Sub Tributary	:
Sub-Sub Tributary	:	Local River	:
Division	: Tapi Division : Surat	Sub-Division	: Upper Tapi Bhusawal
Drainage Area	: 9500 sq km	Bank	: Left
Latitude	: 20°52'35"	Longitude	: 76°59'14"
Zero of Gauge (m)	: 236 (msl)	17/02/1977	
	Opening Date	Closing Date	
Gauge	: 17/02/1977		
Discharge	: 17/02/1977		
Sediment	: 30/07/1979		
Water Quality	: 01/08/1979		

Annual Maximum / Minimum discharge with corresponding Water Level (above msl)

	Maximum			Minimum		
Year	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1977-1978	133.9	81.532	26/11/1977	0.300	80.420	11/06/1977
1978-1979	2105	250.327	30/08/1978	0.196	237.120	12/05/1979
1979-1980	1872	252.100	10/08/1979	0.000	237.100	18/05/1980
1980-1981	529.3	243.920	17/08/1980	0.200	237.150	01/06/1980
1981-1982	2881	249.680	10/08/1981	0.200	237.020	02/06/1981
1982-1983	358.9	242.240	21/07/1982	0.000	236.860	15/04/1983
1983-1984	1630	248.970	12/08/1983	0.400	236.905	14/06/1983
1984-1985	712.0	245.310	19/08/1984	0.300	237.045	15/02/1985
1985-1986	437.0	242.100	27/06/1985	0.100	237.050	06/01/1986
1986-1987	2192	247.595	15/08/1986	0.200	236.920	14/06/1986
1987-1988	444.1	241.170	21/08/1987	0.000	236.960	21/07/1987
1988-1989	2700	251.450	03/10/1988	0.993	237.170	11/04/1989
1989-1990	565.3	243.800	24/08/1989	0.000	237.170	05/04/1990
1990-1991	1419	248.050	17/08/1990	0.240	236.660	05/03/1991
1991-1992	1341	246.525	31/07/1991	0.000	237.040	26/01/1992
1992-1993	1329	248.650	22/08/1992	0.213	236.470	17/03/1993
1993-1994	189.5	239.090	17/07/1993	0.000	237.300	26/05/1994
1994-1995	2976	250.690	07/09/1994	0.000	237.340	11/05/1995
1995-1996	970.8	245.188	25/07/1995	0.000	237.300	21/04/1996
1996-1997	736.8	243.000	08/09/1996	0.000	236.890	03/05/1997
1997-1998	1313	246.100	01/12/1997	0.000	236.200	24/05/1998
1998-1999	2521	249.955	16/09/1998	0.049	236.410	12/04/1999
1999-2000	1840	249.275	10/08/1999	0.047	236.450	10/04/2000
2000-2001	1020	247.325	20/07/2000	0.000	236.300	10/05/2001
2001-2002	767.7	244.085	15/06/2001	0.087	236.310	24/12/2001
2002-2003	1910	246.700	03/09/2002	0.000	236.300	20/07/2002
2003-2004	200.4	239.500	29/07/2003	0.010	237.600	04/12/2003
2004-2005	292.8	239.700	06/08/2004	0.000	236.220	21/06/2004
2005-2006	1953	247.925	02/08/2005	0.000	236.270	24/06/2005
2006-2007	4124	251.600	07/08/2006	0.430	236.260	18/07/2006
2007-2008	3608	251.100	09/07/2007	0.020	236.110	09/05/2008
2008-2009	256.5	239.740	22/09/2008	0.109	236.150	07/07/2008
2009-2010	286.4	239.675	08/07/2009	0.000	237.160	19/08/2009
2010-2011	1293	245.345	01/08/2010	0.000	237.250	13/05/2011
2011-2012	768.2	243.380	29/08/2011	0.000	237.620	22/01/2011
2012-2013	2515	250.000	07/09/2012	0.000	R-Dry	04/06/2012

3.2.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1977	241.200	25/11/1977	08:00:00
1978	250.405	30/08/1978	08:00:00
1979	252.100	10/08/1979	08:00:00
1980	247.010	17/08/1980	17:00:00
1981	249.770	10/08/1981	09:00:00
1982	242.940	22/07/1982	16:00:00
1983	249.130	12/08/1983	11:00:00
1984	245.980	19/08/1984	16:00:00
1985	246.000	26/06/1985	18:00:00
1986	247.730	15/08/1986	11:00:00
1987	241.990	21/08/1987	08:00:00
1988	252.000	03/10/1988	14:00:00
1989	244.700	24/08/1989	01:00:00
1990	251.000	25/07/1990	06:00:00
1991	248.350	31/07/1991	15:00:00
1992	248.650	22/08/1992	07:00:00
1993	239.780	16/07/1993	17:00:00
1994	250.750	07/09/1994	10:00:00
1995	245.350	25/07/1995	11:00:00
1996	243.240	08/09/1996	06:00:00
1997	246.250	30/11/1997	18:00:00
1998	250.150	16/09/1998	16:00:00
1999	249.590	10/08/1999	15:00:00
2000	247.400	20/07/2000	09:00:00
2001	244.300	15/06/2001	06:00:00
2002	249.550	03/09/2002	23:00:00
2003	241.900	28/07/2003	18:00:00
2004	242.050	05/08/2004	23:00:00
2005	250.800	01/08/2005	21:00:00
2006	251.600	07/08/2006	06:00:00
2007	251.270	09/07/2007	04:00:00
2008	241.150	21/09/2008	20:00:00
2009	241.880	08/07/2009	15:00:00
2010	246.580	31/07/2010	18:00:00
2011	244.550	06/09/2011	02:00:00
2012	250.160	07/09/2012	05:00:00

3.2.3 Summary of Data

Stage Discharge data for the period 2012 to 2013

Station Name: Purna at Gopalkheda (01 02 17 004)

Division : Tapi Division Surat

Local River: Purna

Sub Division: Upper Tapi Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	236.300	0.000	236.290	0.490 *	238.375	105.2	241.475	506.2	237.460	43.75	236.600	6.741
2	236.280	0.000	238.750	137.7	240.075	269.5	238.370	105.5 *	237.190	27.57 *	236.580	6.487
3	236.230	0.000	237.405	45.10	238.625	125.3	237.840	66.15	237.250	29.53	236.570	6.272
4	River Dry	0.000	236.895	12.40	237.890	66.72 *	240.355	332.7	238.500	122.7	236.550	4.700 *
5		0.000	236.665	8.147	237.540	46.24 *	243.775	907.8	237.825	70.58	236.530	5.376
6		0.000	236.600	4.001	237.570	47.82	248.350	2021 #	237.710	57.53	236.520	5.171
7		0.000	237.110	29.01	238.285	98.36	250.000	2515 #	237.250	30.48 *	236.510	5.080
8		0.000	238.250	95.71 *	238.610	121.5	244.800	1117 #	236.980	14.56	236.510	5.046
9		0.000	237.320	38.25	238.375	110.2	240.900	398.4	236.950	13.51	236.500	4.849
10		0.000	236.700	9.676	238.050	80.29 *	239.070	164.7	236.920	13.63	236.490	4.428
11		0.000	237.415	46.66	237.950	73.96	239.985	258.0	236.890	12.67 *	236.490	3.420 *
12		0.000	236.810	10.43	238.350	103.8 *	243.010	729.1	236.890	12.76	236.480	4.197
13		0.000	236.765	9.772	239.360	197.8	239.450	223.3	236.870	12.64	236.470	3.030 *
14		0.000	236.720	9.585	238.565	119.4	238.450	113.3	236.860	13.81 *	236.460	3.508
15		0.000	236.680	8.030 *	237.820	63.97 *	238.370	104.5	236.790	11.68	236.440	3.115
16		0.000	236.650	7.709	237.835	62.36	238.340	103.0 *	236.780	11.47	236.440	3.071
17		0.000	236.550	3.031	237.495	43.99	238.400	108.1	236.770	11.45	236.440	3.019
18	236.270	0.000	236.480	1.955	237.450	41.72	238.200	91.04	236.760	11.30	236.430	2.320 *
19	237.700	56.08 *	236.560	3.112	237.420	39.39 *	237.810	64.32	236.750	10.84	236.430	2.887
20	238.725	131.8	236.465	1.828	237.240	29.99 *	237.630	54.59	236.740	10.13	236.400	2.667

21	237.465	48.07	236.420	1.515	237.125	18.12	237.515	47.16	236.730	9.510 *	236.380	2.417
22	236.670	8.220	236.410	1.990 *	237.110	16.70	237.450	42.20	236.700	9.300	236.370	2.335
23	236.585	3.844	237.725	60.44	237.205	26.56	239.310	195.4 *	236.690	8.985	236.370	2.338
24	236.570	5.170 *	239.630	221.9	238.300	101.1	238.675	134.0	236.670	7.750 *	236.370	2.229
25	236.510	2.604	237.700	56.80	237.590	49.69	237.530	48.41	236.670	8.613	236.360	1.260 *
26	236.475	1.991	237.380	41.57	237.140	25.24 *	237.730	59.29	236.660	8.193	236.360	0.936
27	236.420	1.287	237.240	30.55	236.940	13.83	237.390	38.60	236.650	7.200 *	236.360	0.000
28	236.335	0.234	237.665	52.51	237.825	62.32	237.440	41.35	236.640	6.930 *	236.360	0.000
29	236.320	0.780 *	241.805	561.9	238.290	101.2	237.375	37.51	236.640	7.466	236.330	0.000
30	236.310	0.680 *	237.910	70.43	237.525	47.30	237.350	35.61 *	236.630	7.001	236.330	0.000
31			237.680	53.53	238.700	135.4			236.620	7.017		
Ten-Daily Mean												
I Ten-Daily	236.270	0.000	237.198	38.05	238.340	107.1	242.493	813.5	237.403	42.39	236.536	5.415
II Ten-Daily	237.565	18.78	236.710	10.21	237.948	77.64	238.965	184.9	236.810	11.87	236.448	3.123
III Ten-Daily	236.566	7.289	237.960	104.8	237.614	54.31	237.777	67.96	236.664	7.997	236.359	1.151
Monthly												
Min.	236.230	0.000	236.290	0.490	236.940	13.83	237.350	35.61	236.620	6.930	236.330	0.000
Max.	238.725	131.8	241.805	561.9	240.075	269.5	250.000	2515	238.500	122.7	236.600	6.741
Mean	236.698	8.691	237.311	52.77	237.956	78.87	239.745	355.4	236.950	20.34	236.448	3.23

Annual Runoff in MCM = 1359 Annual Runoff in mm = 143

Peak Observed Discharge = 2515 cumecs on 07/09/2012

Corres. Water Level :250 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2012

Corres. Water Level :236.3m

Note: 01/ to 03/06/12 river in pooling Condition, River dry from 4/6 to 17/06/12, River in polling condition / negligible flow condition, submergence effect of temporary bund at 80m D/S of S/G line from 26/11/2012 to 31/01/2013 .

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge #Discarded and estimated

Stage Discharge data for the period 2012 to 2013

Station Name: Purna at Gopalkheda (01 02 17 004)

Division : Tapi Division Surat

Local River: Purna

Sub Division: Upper Tapi Bhusawal

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	236.330	0.000	237.540	0.000	237.550	0.000	237.530	0.000	237.450	0.000	237.570	0.000
2	236.330	0.000	237.540	0.000	237.550	0.000	237.530	0.000	237.400	0.000	237.570	0.000
3	236.320	0.000	237.520	0.000	237.550	0.000	237.530	0.000	237.400	0.000	237.560	0.000
4	236.320	0.000	237.520	0.000	237.540	0.000	237.530	0.000	237.400	0.000	237.550	0.000
5	236.320	0.000	237.500	0.000	237.600	0.000	237.530	0.000	237.400	0.000	237.540	0.000
6	236.320	0.000	237.490	0.000	237.600	0.000	237.520	0.000	237.400	0.000	237.540	0.000
7	236.320	0.000	237.490	0.000	237.600	0.000	237.550	0.000	237.400	0.000	237.520	0.000
8	236.310	0.000	237.480	0.000	237.600	0.000	237.550	0.000	237.400	0.000	237.500	0.000
9	236.310	0.000	237.470	0.000	237.580	0.000	237.550	0.000	237.380	0.000	237.490	0.000
10	236.310	0.000	237.450	0.000	237.580	0.000	237.550	0.000	237.380	0.000	237.480	0.000
11	236.440	0.000	237.500	0.000	237.600	0.000	237.540	0.000	237.360	0.000	237.480	0.000
12	236.440	0.000	237.520	0.000	237.600	0.000	237.540	0.000	237.360	0.000	237.480	0.000
13	236.440	0.000	237.520	0.000	237.620	0.000	237.520	0.000	237.350	0.000	237.480	0.000
14	236.430	0.000	237.500	0.000	237.610	0.000	237.520	0.000	237.450	0.000	237.500	0.000
15	236.430	0.000	237.520	0.000	237.650	0.000	237.520	0.000	237.520	0.000	237.510	0.000
16	236.430	0.000	237.520	0.000	237.640	0.000	237.510	0.000	237.540	0.000	237.520	0.000
17	236.420	0.000	237.510	0.000	237.640	0.000	237.510	0.000	237.580	0.000	237.510	0.000
18	236.420	0.000	237.510	0.000	237.640	0.000	237.510	0.000	237.600	0.000	237.490	0.000
19	236.420	0.000	237.600	0.000	237.640	0.000	237.510	0.000	237.600	0.000	237.480	0.000
20	236.420	0.000	237.590	0.000	237.570	0.000	237.510	0.000	237.610	0.000	237.470	0.000
21	236.440	0.000	237.590	0.000	237.570	0.000	237.520	0.000	237.610	0.000	237.470	0.000

22	236.470	0.000	237.580	0.000	237.550	0.000	237.530	0.000	237.640	0.000	237.450	0.000
23	236.480	0.000	237.520	0.000	237.540	0.000	237.530	0.000	237.640	0.000	237.430	0.000
24	236.840	0.000	237.510	0.000	237.520	0.000	237.580	0.000	237.620	0.000	237.410	0.000
25	236.970	0.000	237.510	0.000	237.500	0.000	237.500	0.000	237.620	0.000	237.390	0.000
26	237.750	0.000	237.500	0.000	237.500	0.000	237.570	0.000	237.600	0.000	237.380	0.000
27	237.800	0.000	237.540	0.000	237.500	0.000	237.590	0.000	237.600	0.000	237.370	0.000
28	237.740	0.000	237.550	0.000	237.550	0.000	237.600	0.000	237.600	0.000	237.350	0.000
29	237.650	0.000	237.550	0.000			237.600	0.000	237.580	0.000	237.340	0.000
30	237.600	0.000	237.550	0.000			237.550	0.000	237.580	0.000	237.320	0.000
31	237.550	0.000	237.550	0.000			237.500	0.000			237.300	0.000
Ten-Daily Mean												
I Ten-Daily	236.319	0.000	237.500	0.000	237.575	0.000	237.537	0.000	237.401	0.000	237.532	0.000
II Ten-Daily	236.429	0.000	237.529	0.000	237.621	0.000	237.519	0.000	237.497	0.000	237.492	0.000
III Ten-Daily	237.208	0.000	237.541	0.000	237.529	0.000	237.552	0.000	237.609	0.000	237.383	0.000
Monthly												
Min.	236.310	0.000	237.450	0.000	237.500	0.000	237.500	0.000	237.350	0.000	237.300	0.000
Max.	237.800	0.000	237.600	0.000	237.650	0.000	237.600	0.000	237.640	0.000	237.570	0.000
Mean	236.670	0.000	237.524	0.000	237.578	0.000	237.536	0.000	237.502	0.000	237.466	0.000

Peak Computed Discharge = 195.4 cumecs on 23/09/2012

Corres. Water Level :239.31 m

Lowest Computed Discharge = 0.490 cumecs on 01/07/2012

Corres. Water Level :236.29 m

Note: 01/ to 03/06/12 river in pooling Condition, River dry from 4/6 to 17/06/12, River in polling condition / negligible flow condition, submergence effect of temporary bund at 80m D/S of S/G line from 26/11/2012 to 31/01/2013 .

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge #Discarded and estimated

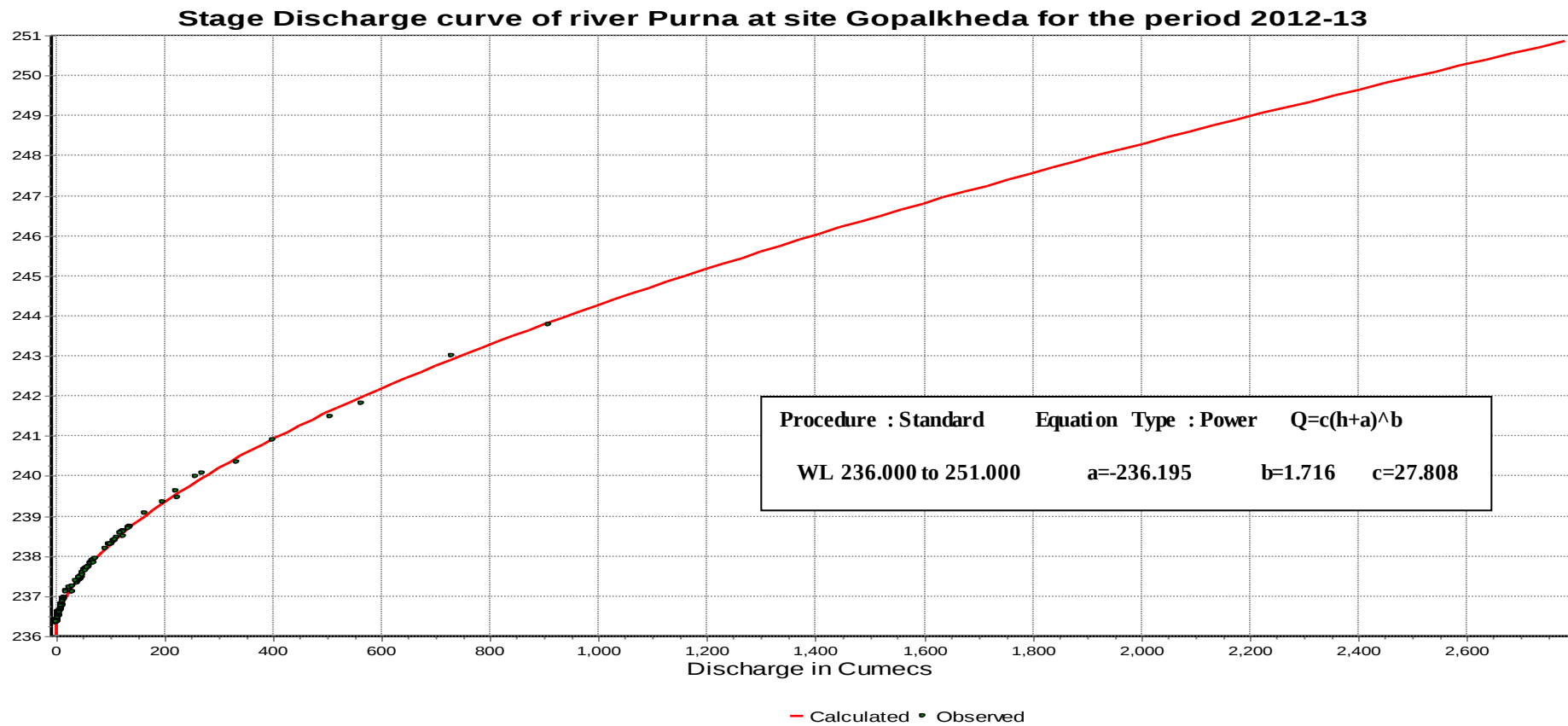
3.2.4 Stage Discharge Curve

Station Name: Purna at Gopalkheda (01 02 17 004)

Division : Tapi Division Surat

Local River: Purna

Sub Division: Upper Tapi Bhusawal



3.2.5

Annual runoff

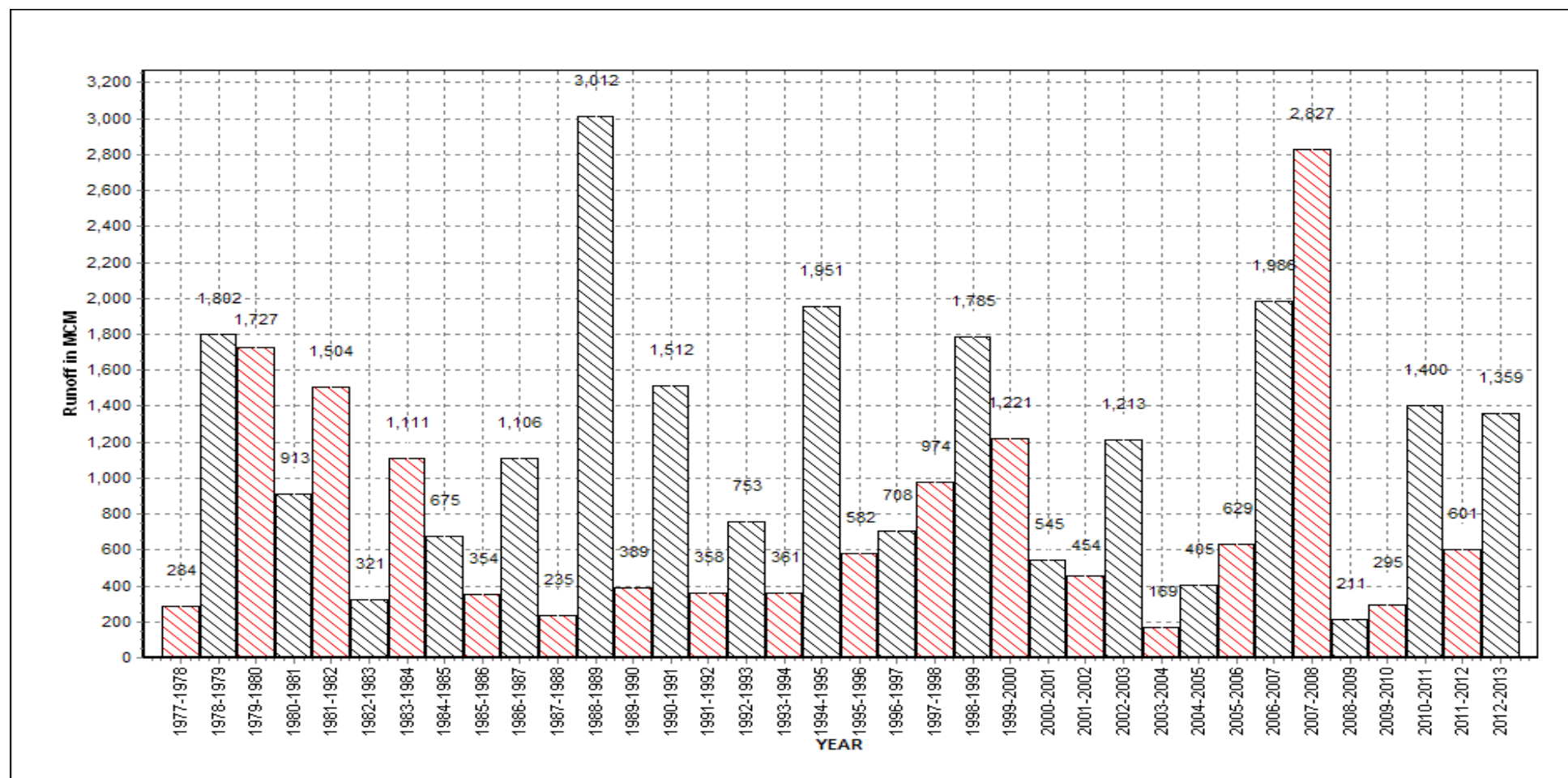
Annual Runoff for the period 1977-2013

Station Name: Purna at Gopalkheda (01 02 17 004)

Division : Tapi Division Surat

Local River: Purna

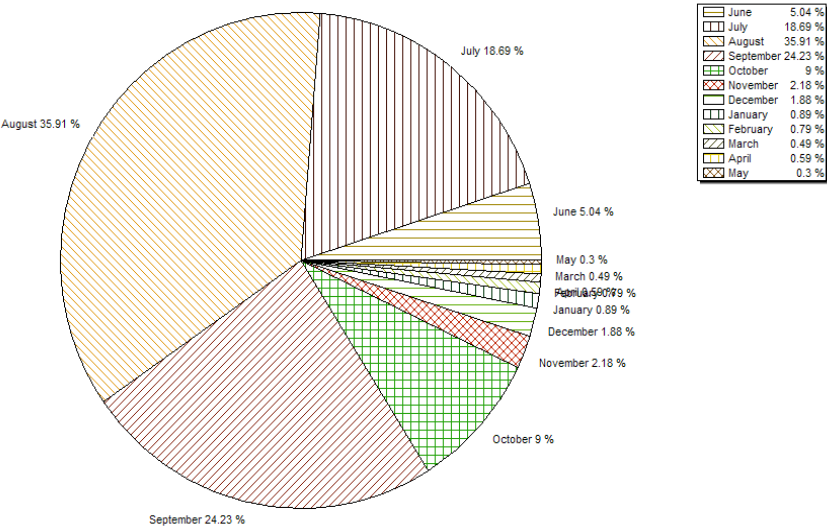
Sub Division: Upper Tapi Bhusawal



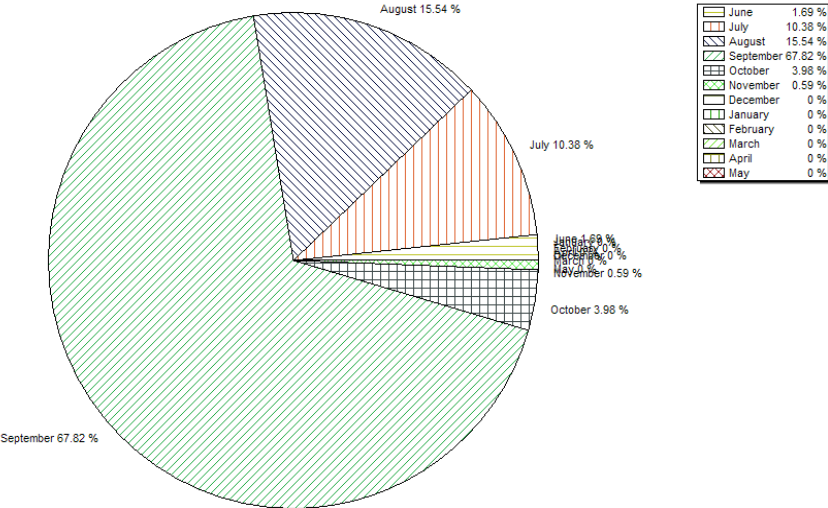
3.2.6 Monthly average Runoff

Station Name: Purna at Gopalkheda (01 02 17 004) Division : Tapi Division Surat Local River: Purna Sub Division: Upper Tapi Bhusawal

Monthly Average Runoff Based on period 1977-2013



Monthly Runoff Based on period 2012-2013



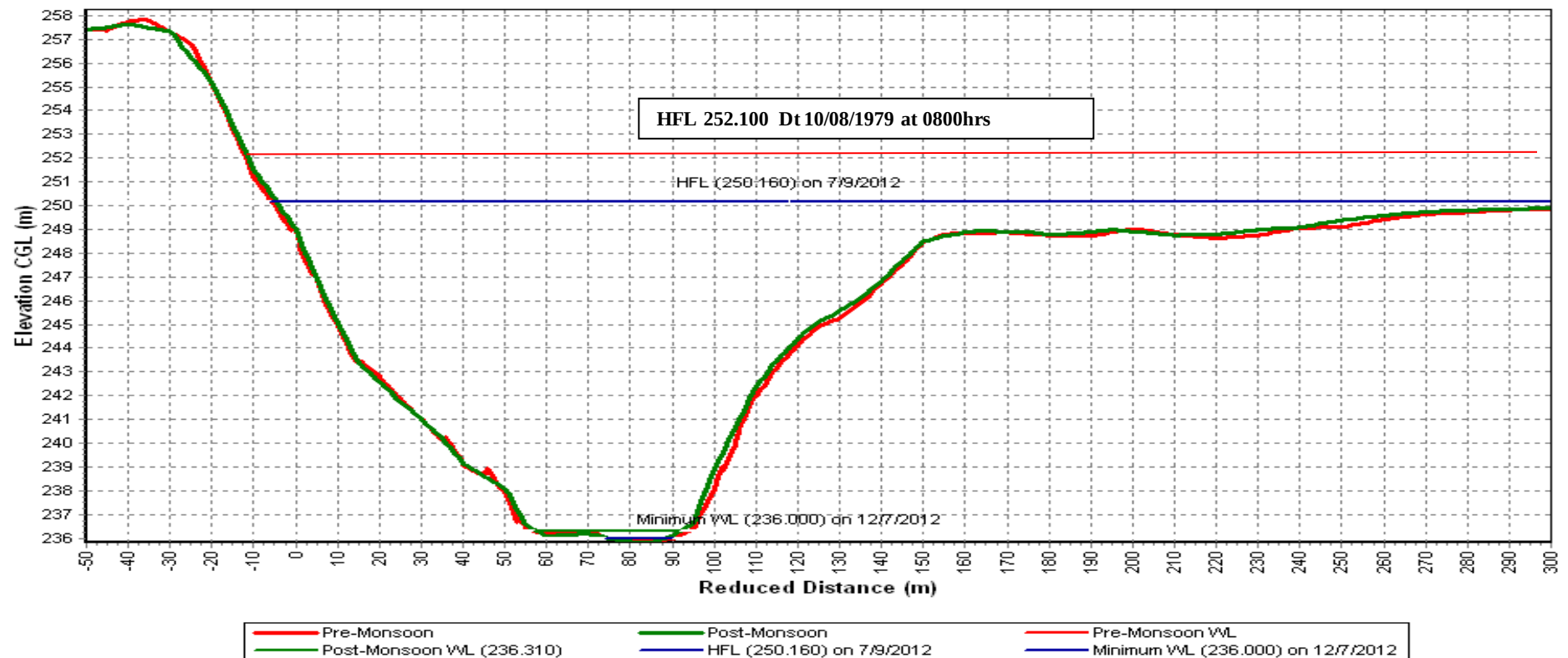
3.2.7 Superimposed cross section

Station Name: Purna at Gopalkheda (01 02 17 004)

Division : Tapi Division Surat

Local River: Purna

Sub Division: Upper Tapi Bhusawal

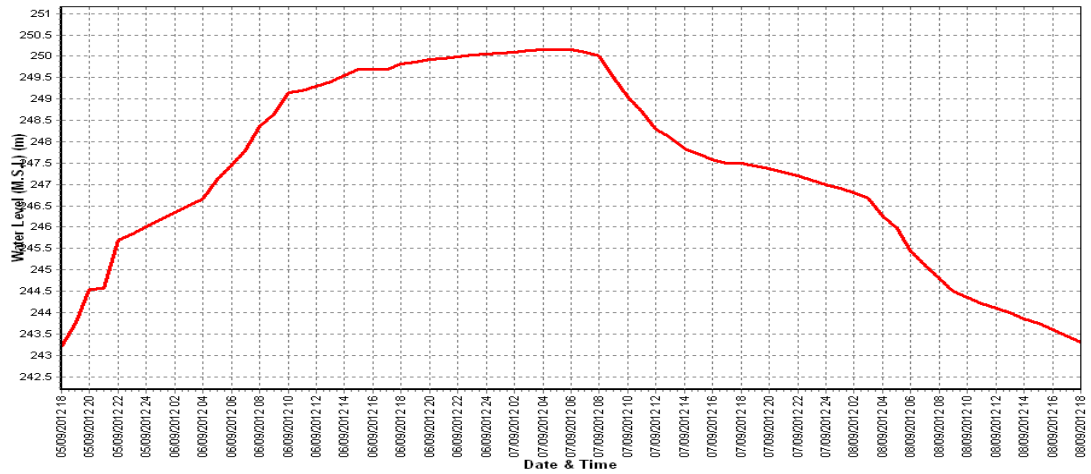


3.2.8 WL vs Time graph of highest I, II, III peak

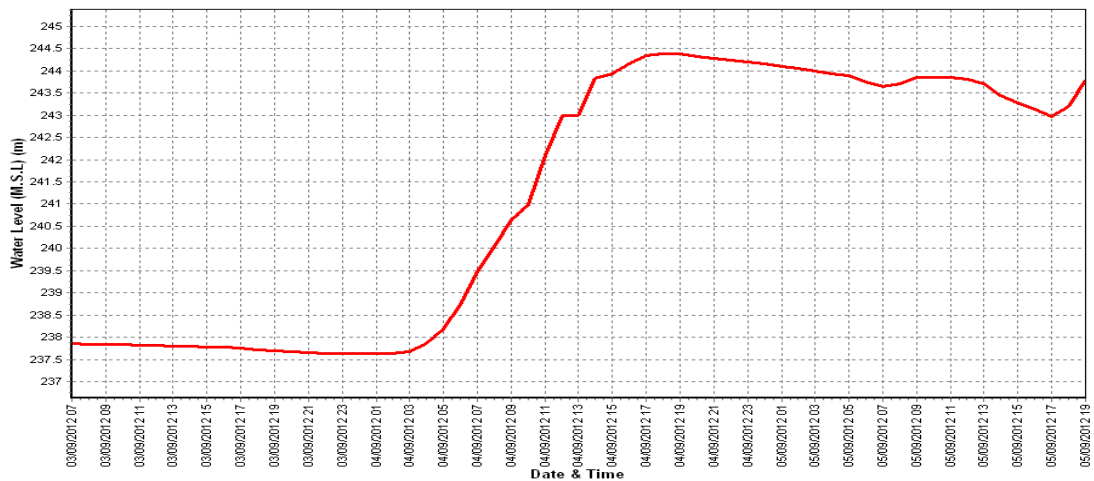
Station Name: Purna at Gopalkheda (01 02 17 004)
Local River: Purna

Division : Tapi Division Surat
Sub Division: Upper Tapi Bhusawal

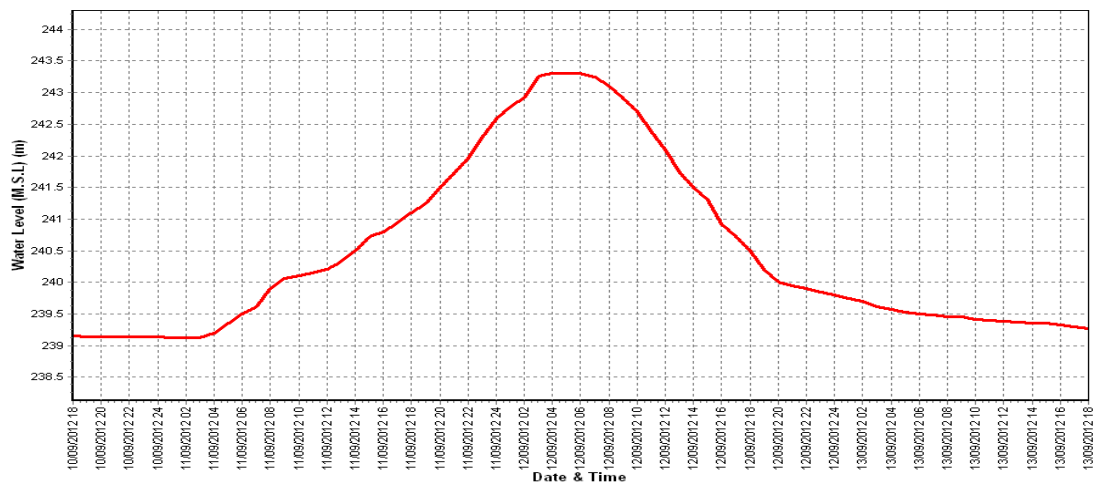
Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (II) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (III) flood peak during the water year 2012-13



3.3. Yerli

3.3.1 HISTORY SHEET

Site	: Purna at Yerli	Code	: 01 02 17 005
State	: Maharashtra	District	Buldhana
Basin	: Tapi	Independent River	: Tapi
Tributary	: Purna	Sub Tributary	: -
Sub-Sub Tributary	: Tapi Division	Local River	:
Division	: Surat	Sub-Division	: Upper Tapi Bhusawal
Drainage Area	: 16517 sq km	Bank	: Left
Latitude	: 20°56'11"	Longitude	: 76°28'27"
Zero of Gauge (m)	: 213 (msl)	11/11/1971	
	Opening Date	Closing Date	
Gauge	: 11/11/1971		
Discharge	: 01/03/1972		
Sediment	: 09/04/1973		
Water			
Quality	: 01/06/1977	31/05/2005	

Annual Maximum / Minimum discharge with corresponding Water Level (above msl)

Year	Maximum			Minimum		
	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1973-1974	3060	226.210	28/08/1973	0.000	228.370	27/08/1973
1974-1975	2005	220.882	13/08/1974	0.200	214.400	28/05/1975
1975-1976	2493	222.883	05/09/1975	0.200	214.580	13/05/1976
1976-1977	2580	222.800	04/09/1976	0.200	214.630	02/06/1976
1977-1978	1885	220.965	14/06/1977	0.500	214.553	12/06/1977
1978-1979	4154	225.200	31/08/1978	1.200	214.805	29/05/1979
1979-1980	10380	230.510	11/08/1979	0.916	214.785	14/06/1979
1980-1981	1842	221.532	18/08/1980	1.200	214.815	31/05/1981
1981-1982	3350	224.780	11/08/1981	0.800	214.755	02/06/1981
1982-1983	651.6	219.485	21/07/1982	0.100	214.650	20/04/1983
1983-1984	6055	229.850	12/08/1983	1.243	214.695	31/05/1984
1984-1985	1611	220.595	10/10/1984	0.000	214.475	26/05/1985
1985-1986	3146	223.650	27/06/1985	0.000	214.570	30/05/1986
1986-1987	3073	224.240	07/08/1986	0.100	214.610	01/06/1986
1987-1988	1122	219.825	21/08/1987	0.000	214.620	21/04/1988
1988-1989	6700	228.500	04/10/1988	0.000	214.360	07/06/1988
1989-1990	1298	220.780	24/08/1989	0.000	214.730	17/05/1990
1990-1991	4501	227.150	25/07/1990	0.000	214.880	11/05/1991
1991-1992	1480	221.540	01/08/1991	0.000	214.730	03/03/1992
1992-1993	1974	222.445	22/08/1992	0.000	214.435	17/06/1992
1993-1994	2269	223.820	16/07/1993	0.000	214.650	07/05/1994
1994-1995	3785	225.550	08/09/1994	0.000	214.600	10/06/1994
1995-1996	1538	221.510	03/09/1995	0.000	214.600	16/04/1996
1996-1997	747.2	219.650	24/10/1996	0.000	214.655	23/04/1997
1997-1998	1294	221.350	01/12/1997	0.000	214.600	16/05/1998
1998-1999	3059	224.710	17/09/1998	0.000	214.550	22/05/1999
1999-2000	3020	224.150	11/08/1999	0.000	214.700	30/04/2000
2000-2001	680.0	220.200	20/07/2000	0.000	214.620	27/11/2000
2001-2002	1659	222.260	15/06/2001	0.000	214.600	18/05/2002
2002-2003	2750	225.870	04/09/2002	0.000	214.580	03/02/2003
2003-2004	443.4	218.095	29/09/2003	0.000	214.580	04/06/2003
2004-2005	407.8	217.425	06/08/2004	0.000	214.620	07/03/2005
2005-2006	3046	224.550	02/08/2005	0.000	214.690	07/06/2005
2006-2007	8703	233.540	07/08/2006	0.000	214.600	03/03/2007
2007-2008	3132	225.615	02/07/2007	0.000	214.620	18/05/2008
2008-2009	542.8	218.645	22/09/2008	0.000	214.410	23/04/2009
2009-2010	369.0	217.395	04/09/2009	0.000	River Dry	04/11/2009
2010-2011	1757	223.005	01/08/2010	0.257	214.760	31/12/2010
2011-2012	989.3	219.000	06/09/2012	0.000	214.970	01/06/2011
2012-2013	2348	223.750	08/09/2012	0.000	River Dry	01/06/12

3.3.2 Annual Maximum flood peak

Year	Highest Flood Level (m)	Date	Hour
1972	224.895	19/08/1972	14:00:00
1973	220.990	13/08/1973	06:00:00
1974	220.990	13/08/1974	06:00:00
1975	222.990	05/09/1975	07:00:00
1976	223.040	04/09/1976	01:00:00
1977	221.250	28/06/1977	20:00:00
1978	225.330	31/08/1978	04:00:00
1979	230.670	11/08/1979	03:00:00
1980	222.200	17/08/1980	15:00:00
1981	224.950	11/08/1981	01:00:00
1982	220.600	20/07/1982	22:00:00
1983	229.870	12/08/1983	09:00:00
1984	220.710	10/10/1984	10:00:00
1985	223.750	27/06/1985	14:00:00
1986	225.200	07/08/1986	00:00:00
1987	219.860	21/08/1987	09:00:00
1988	228.850	04/10/1988	12:00:00
1989	223.340	21/07/1989	21:00:00
1990	228.100	25/07/1990	19:00:00
1991	221.540	01/08/1991	07:00:00
1992	222.655	22/08/1992	19:00:00
1993	223.920	16/07/1993	06:00:00
1994	225.600	08/09/1994	12:00:00
1995	221.520	03/09/1995	09:00:00
1996	219.820	08/09/1996	21:00:00
1997	221.350	01/12/1997	08:00:00
1998	224.730	17/09/1998	11:00:00
1999	224.390	11/08/1999	13:00:00
2000	221.130	20/07/2000	21:00:00
2001	222.530	15/06/2001	10:00:00
2002	226.060	26/08/2002	04:00:00
2003	218.320	09/08/2003	03:00:00
2004	218.120	06/08/2004	14:00:00
2005	225.600	02/08/2005	20:00:00
2006	233.700	07/08/2006	12:00:00
2007	226.930	09/07/2007	23:00:00
2008	218.670	22/09/2008	09:00:00
2009	217.700	04/09/2009	02:00:00
2010	224.000	31/07/2010	22:00:00
2011	220.600	13/07/2011	15:00:00
2012	224.07	07/09/2012	22:00:00

3.3.3 Summary of Data

Stage Discharge data for the period 2012 to 2013

Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

Local River:

Sub Division: Upper Tapi, Bhusawal

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	River Dry	0.000	215.320	74.00 *	215.800	131.6	218.175	612.5	214.980	46.85	214.640	6.190
2		0.000	214.680	9.800 *	216.050	188.3	216.300	224.4 *	214.910	28.57 *	214.630	6.142
3		0.000	214.670	9.140 #	216.400	270.7	215.910	152.1	215.005	43.29	214.630	5.828
4		0.000	214.845	35.07	215.750	111.8	216.175	253.7	215.325	77.89	214.700	11.18 *
5		0.000	214.740	6.296	215.500	97.80 *	219.275	905.0	215.810	122.9	214.730	13.35 *
6		0.000	214.720	4.911	215.160	69.70	221.200	1475 #	215.690	112.3	214.820	20.52 *
7		0.000	214.690	4.538	215.450	88.16	223.410	2224 #	215.200	59.40 *	214.720	12.62 *
8		0.000	215.010	38.42 *	215.700	101.5	223.750	2348 #	214.990	30.67	214.650	7.850 *
9		0.000	215.650	110.6	216.000	165.8	219.100	859.0 *	214.910	31.85	214.630	6.620 *
10		0.000	215.000	45.13	215.570	107.5 *	216.550	293.3	214.860	25.90	214.550	2.430 *
11		0.000	215.830	116.9	215.600	93.32	216.550	292.5	214.840	28.64	214.500	0.590 *
12		0.000	214.850	33.27	215.840	1488 *	218.470	689.5	214.810	26.58	214.500	0.590 *
13		0.000	214.820	30.19	216.480	291.8	217.345	424.6	214.800	21.17	214.500	0.590 *
14		0.000	214.770	27.54	216.105	179.7	216.370	257.6	214.790	18.03 *	214.490	0.330 *
15		0.000	214.680	9.800 *	215.920	160.3 *	216.180	228.9	214.755	15.19	214.490	0.330 *
16		0.000	214.630	3.515	215.750	107.3	216.000	173.2 *	214.710	14.12	214.490	0.330 *
17		0.000	214.600	4.920 *	215.550	86.96	216.070	216.1	214.700	11.18 *	214.490	0.330 *
18		0.000	214.580	3.840 *	215.350	74.45	215.750	117.8	214.690	13.77	214.490	0.330 *
19	215.800	148.4	214.550	2.420 *	215.340	76.58 *	215.690	113.9	214.690	13.12	214.490	0.330 *
20	216.210	230.1	214.520	1.230 *	215.300	71.54 *	215.505	97.06	214.690	12.63	214.490	0.330 *

21	215.100	45.76	214.500	0.590 *	215.000	52.31	215.320	78.11	214.680	9.805 *	214.480	0.120 *
22	214.730	17.75	214.490	0.330 *	215.500	80.04	215.395	88.29	214.680	11.40	214.480	0.120 *
23	214.660	13.56	214.540	2.000 *	215.080	57.21	216.410	244.2 *	214.670	9.137 *	214.480	0.120 *
24	214.590	4.360 *	215.390	74.15	215.900	166.3	215.875	153.8	214.670	9.137 *	214.480	0.120 *
25	214.530	1.602 *	216.135	208.6	215.525	72.83	215.510	97.79	214.670	9.137 *	214.480	0.120 *
26	214.480	0.120 *	215.750	114.0	215.180	57.07 *	215.530	106.2	214.670	9.137 *	214.480	0.120 *
27	214.460	0.000 *	215.060	47.21	215.150	68.18	215.400	82.43	214.670	9.137 *	214.480	0.120 *
28	214.440	0.000 *	214.600	4.900 #	215.200	69.45	215.270	73.07	214.660	8.480 *	214.480	0.120 *
29	214.430	0.000 *	217.650	499.0 *	216.120	182.1	215.220	66.91	214.650	6.678	214.470	0.000 *
30	214.430	0.000 *	215.960	181.4	215.665	104.1	215.000	37.40 *	214.650	6.598	214.470	0.000 *
31			215.525	107.5	215.795	124.0			214.640	6.351		
<u>Ten-Daily Mean</u>												
I Ten-Daily		0.000	214.933	33.79	215.738	133.3	218.984	934.7	215.168	57.96	214.670	9.273
II Ten-Daily	216.005	37.85	214.783	23.36	215.723	263.0	216.393	261.1	214.747	17.44	214.493	0.408
III Ten-Daily	214.585	8.315	215.418	112.7	215.465	93.96	215.493	102.8	214.665	8.636	214.478	0.096
<u>Monthly</u>												
Min.	214.430	0.000	214.490	0.330	215.000	52.31	215.000	37.40	214.640	6.351	214.470	0.000
Max.	216.210	230.1	217.650	499.0	216.480	1488	223.750	2348	215.810	122.9	214.820	20.52
Mean	214.822	15.39	215.057	58.43	215.636	161.2	216.957	432.9	214.854	27.39	214.547	3.259

Annual Runoff in MCM = 1832 Annual Runoff in mm = 111

Peak Observed Discharge = 2348 cumecs on 08/09/2012 Corres. Water Level :223.75 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2012

Note:River Dry from 01/06/2012 to 18/06/12, From 23/10 to 28/10 Q suspended due to shortage of staff , river in pooling condition from 04-11-2012 to 31/01/2013.River remained dry from 01/02/2013 to 31/05/2013

**Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated**

Stage Discharge data for the period 2012 to 2013

Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

Local River:

Sub Division: Upper Tapi, Bhusawal

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	214.470	0.000 *	214.300	0.000	River Dry	0.000	River Dry	0.000	River Dry	0.000	River Dry	0.000
2	214.470	0.000 *	214.330	0.000		0.000		0.000		0.000		0.000
3	214.460	0.000 *	214.330	0.000		0.000		0.000		0.000		0.000
4	214.460	0.000 *	214.330	0.000		0.000		0.000		0.000		0.000
5	214.460	0.000 *	214.320	0.000		0.000		0.000		0.000		0.000
6	214.460	0.000 *	214.320	0.000		0.000		0.000		0.000		0.000
7	214.460	0.000 *	214.310	0.000		0.000		0.000		0.000		0.000
8	214.460	0.000 *	214.310	0.000		0.000		0.000		0.000		0.000
9	214.450	0.000 *	214.310	0.000		0.000		0.000		0.000		0.000
10	214.450	0.000 *	214.310	0.000		0.000		0.000		0.000		0.000
11	214.450	0.000 *	214.300	0.000		0.000		0.000		0.000		0.000
12	214.430	0.000 *	214.300	0.000		0.000		0.000		0.000		0.000
13	214.430	0.000 *	214.300	0.000		0.000		0.000		0.000		0.000
14	214.420	0.000	214.300	0.000		0.000		0.000		0.000		0.000
15	214.410	0.000	214.300	0.000		0.000		0.000		0.000		0.000
16	214.410	0.000	214.300	0.000		0.000		0.000		0.000		0.000
17	214.400	0.000	214.300	0.000		0.000		0.000		0.000		0.000
18	214.390	0.000	214.300	0.000		0.000		0.000		0.000		0.000
19	214.390	0.000	214.280	0.000		0.000		0.000		0.000		0.000
20	214.380	0.000	214.280	0.000		0.000		0.000		0.000		0.000
21	214.380	0.000	214.260	0.000		0.000		0.000		0.000		0.000
22	214.370	0.000	214.260	0.000		0.000		0.000		0.000		0.000

23	214.370	0.000	214.250	0.000		0.000		0.000		0.000		0.000
24	214.360	0.000	214.250	0.000		0.000		0.000		0.000		0.000
25	214.360	0.000	214.250	0.000		0.000		0.000		0.000		0.000
26	214.350	0.000	214.250	0.000		0.000		0.000		0.000		0.000
27	214.350	0.000	214.250	0.000		0.000		0.000		0.000		0.000
28	214.340	0.000	214.230	0.000		0.000		0.000		0.000		0.000
29	214.340	0.000	214.230	0.000				0.000		0.000		0.000
30	214.340	0.000	214.230	0.000				0.000		0.000		0.000
31	214.340	0.000	214.230	0.000				0.000				0.000
Ten-Daily Mean												
I Ten-Daily	214.460	0.000	214.317	0.000		0.000		0.000		0.000		0.000
II Ten-Daily	214.411	0.000	214.296	0.000		0.000		0.000		0.000		0.000
III Ten-Daily	214.355	0.000	214.245	0.000		0.000		0.000		0.000		0.000
Monthly												
Min.	214.340	0.000	214.230	0.000		0.000		0.000		0.000		0.000
Max.	214.470	0.000	214.330	0.000		0.000		0.000		0.000		0.000
Mean	214.407	0.000	214.285	0.000		0.000		0.000		0.000		0.000

Peak Computed Discharge = 1488 cumecs on 12/08/2012

Corres. Water Level :215.84 m

Lowest Computed Discharge = 0.000 cumecs on 27/06/2012

Corres. Water Level :214.46 m

Note:River Dry from 01/06/2012 to 18/06/12, From 23/10 to 28/10 Q suspended due to shortage of staff , river in pooling condition from 04-11-2012 to 31/01/2013.River remained dry from 01/02/2013 to 31/05/2013

**Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated**

3.3.4 Stage Discharge Curve

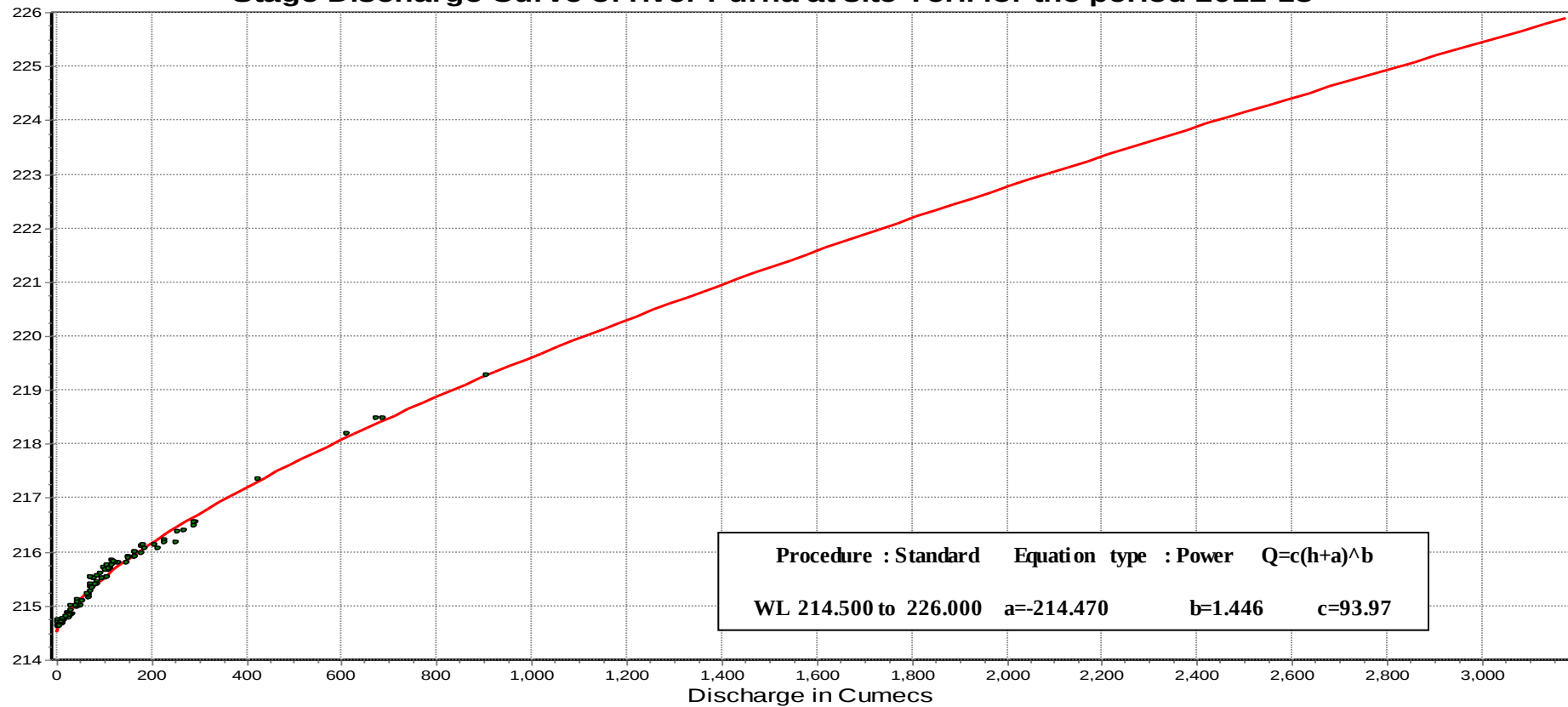
Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

Local River: Purna

Sub Division: Upper Tapi, Bhusawal

Stage Discharge Curve of river Purna at site Yerli for the period 2012-13



— Calculated • Observed

3.3.5 Annual runoff

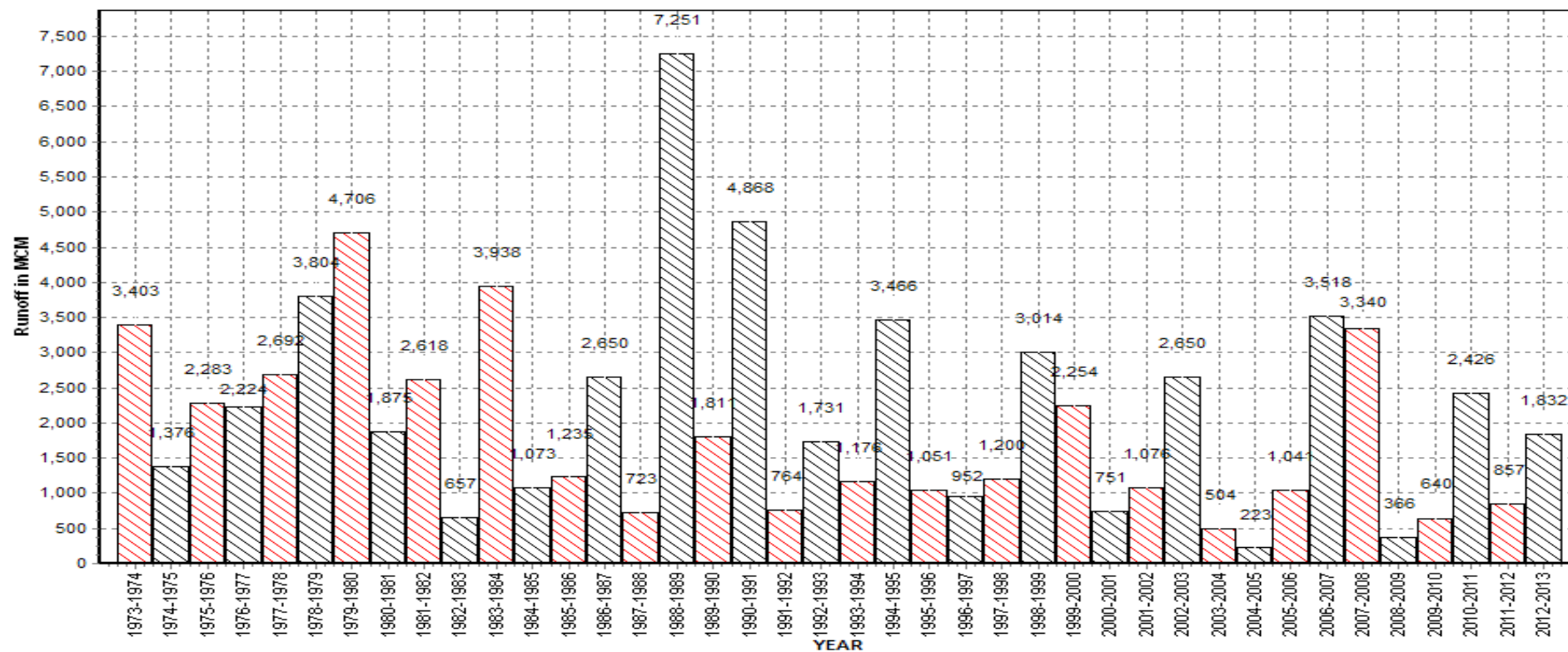
Annual Runoff for the period 1973-2013

Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

Local River: Purna

Sub Division: Upper Tapi, Bhusawal



3.3.6 Monthly average Runoff

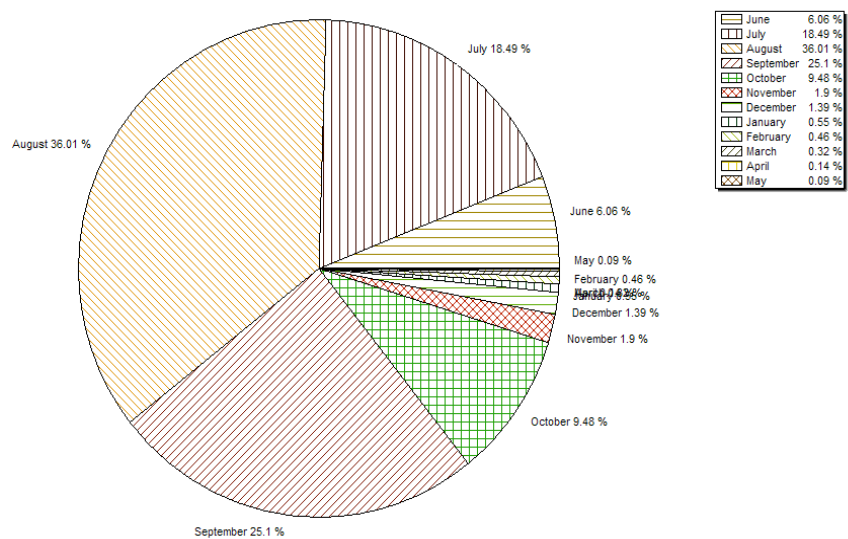
Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

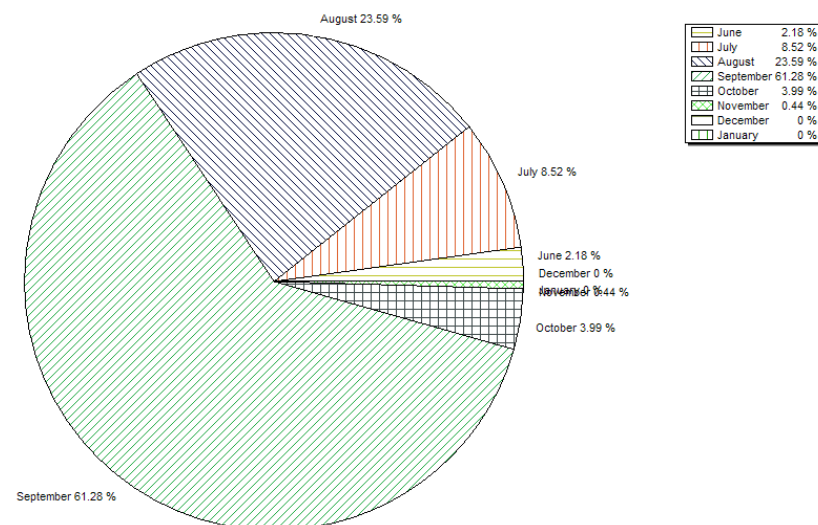
Local River:Purna

Sub Division: Upper Tapi, Bhusawal

Monthly Average Runoff Based on period 1973-2013



Monthly Runoff Based on period 2012-2013



3.3.7 Superimposed cross section

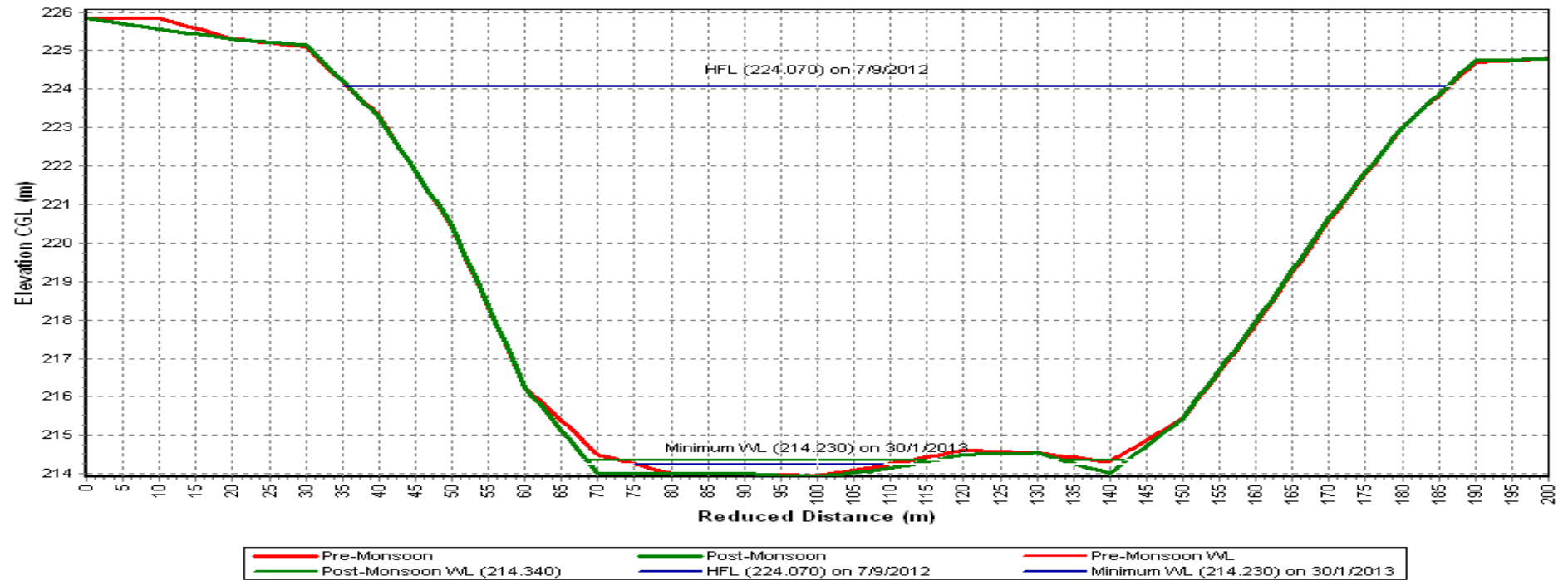
Station Name: Purna at Yerli (01 02 17 005)

Division: Tapi Division, Surat

Local River: Purna

Sub Division: Upper Tapi, Bhusawal

HFL 229.870 Dt 12/08/1983 at 09:00 hrs

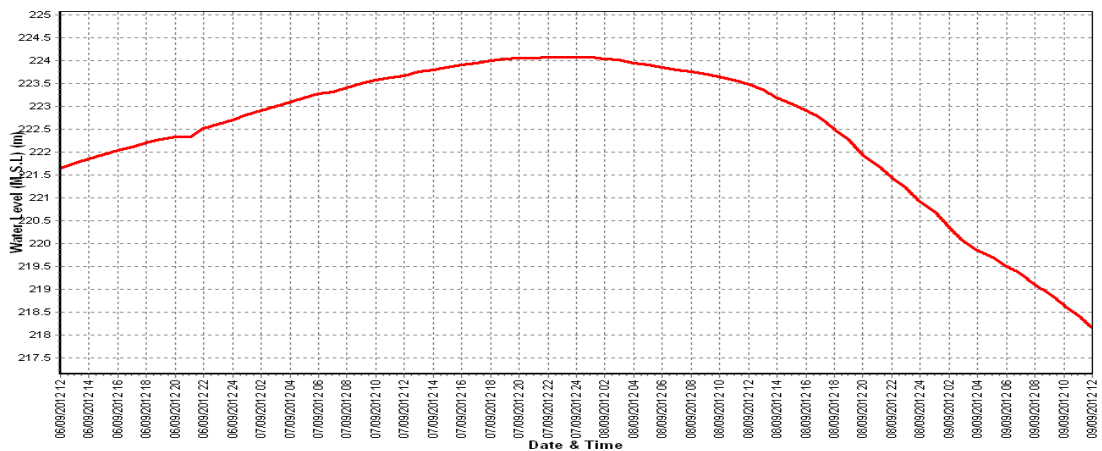


3.3. WL vs Time graph of highest I, II, III peak

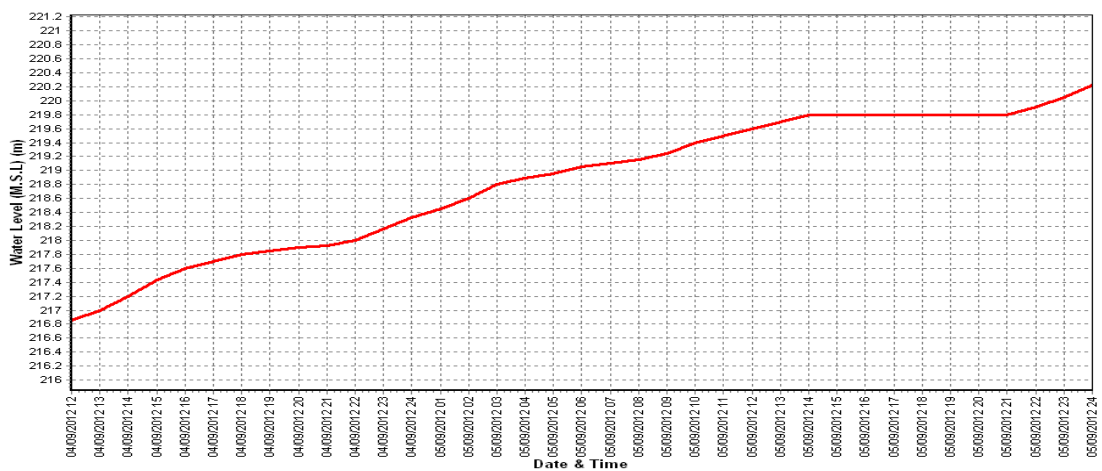
Station Name: Purna at Yerli (01 02 17 005)
Local River: Purna

Division: Tapi Division, Surat
Sub Division: Upper Tapi, Bhusawal

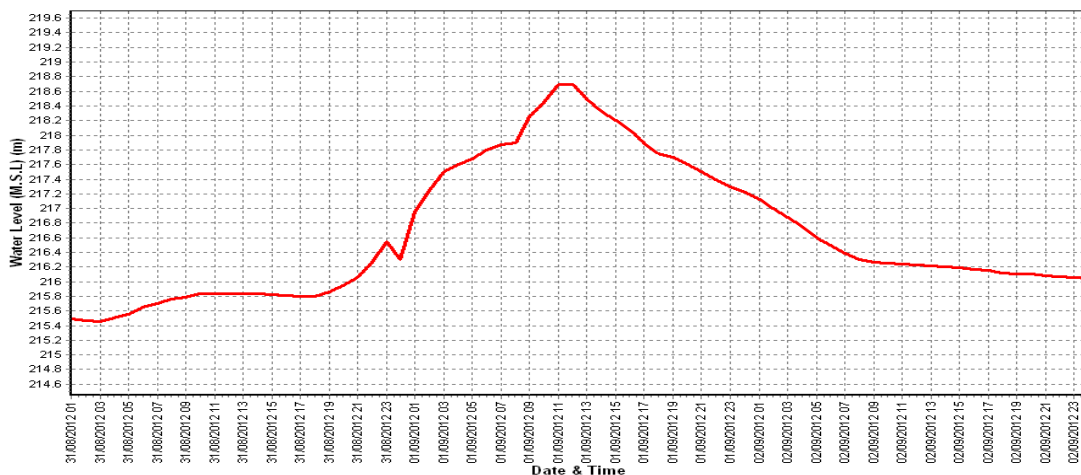
Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



3.4. Gidhade

3.4.1 History Sheet

Site : Gidhade Code : 01 02 17 014

State : Maharashtra District : Dhule

Basin : Tapi Independent River : Tapi

Tributary : - Sub Tributary :

Sub-Sub
Tributary : Local River : Tapi
Middle Tapi

Division : Surat Sub-Division : Dhule

Drainage
Area : 54750 sq
km Bank : Right

Latitude : 21°17'45" Longitude : 74°48'45"

Zero of
Gauge
(m) : 119 (msl) 15/06/1969

Opening
Date Closing Date

Gauge : 15/06/1969

Discharge : 19/06/1990

Sediment :
Water
Quality : 01/09/1990 31/05/2005

Annual Maximum / Minimum discharge with corresponding Water Level (msl)

	Maximum			Minimum		
Year	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1991-1992	7680	131.300	01/08/1991	0.000	122.100	01/04/1992
1992-1993	4224	129.175	18/08/1992	0.000	River Dry	15/03/1993
1993-1994	8018	132.250	17/07/1993	0.000	River Dry	26/03/1994
1994-1995	15068	136.775	07/09/1994	0.000	River Dry	12/06/1994
1995-1996	4981	130.705	04/09/1995	0.000	River Dry	06/02/1996
1996-1997	2681	127.880	28/07/1996	0.000	River Dry	08/8/1997
1997-1998	4516	130.825	27/07/1997	0.000	River Dry	24/03/1998
1998-1999	17578	137.805	16/09/1998	0.000	River Dry	15/04/1999
1999-2000	6267	131.050	11/08/1999	0.000	River Dry	02/04/2000
2000-2001	2541	126.925	20/07/2000	0.000	River Dry	30/04/2001
2001-2002	5063	130.250	16/08/2001	0.000	River Dry	29/01/2002
2002-2003	7361	132.900	03/09/2002	0.000	River Dry	27/12/2002
2003-2004	4180	129.150	25/08/2003	0.000	River Dry	26/03/2004
2004-2005	3218	129.225	06/08/2004	0.000	River Dry	14/12/2004
2005-2006	3697	128.700	03/08/2005	0.000	River Dry	02/12/2005
2006-2007	20898	141.650	08/08/2006	0.000	River Dry	03/01/2007
2007-2008	10684	135.690	09/07/2007	0.000	121.560	25/06/2007
2008-2009	3670	128.900	06/08/2008	33.270	122.340	26/08/2008
2009-2010	5735	131.190	04/09/2009	0.000	123.350	13/08/2009
2010-2011	4134	129.200	10/09/2010	32.16	122.335	22/07/2010
2011-2012	3639	128.475	30/08/2011	0.000	Pooling effect	NA
2012-2013	8117	133.350	07/09/2012	0.000	129.100	01/06/12

3.4.2 Annual Maximum flood peak

Station Name: Tapi at Gidhade (01 02 17 014)
Local River:Tapi

Division: Tapi division Surat
Sub Division: Middle Tapi Sub Division Dhule

Year	Highest Flood Level (m)	Date	Hour
1970	134.650	20/08/1970	11:00:00
1971	128.200	24/07/1971	22:00:00
1972	135.650	19/08/1972	10:00:00
1973	134.300	28/08/1973	02:00:00
1974	128.750	13/08/1974	21:00:00
1975	130.950	05/09/1975	23:00:00
1976	130.300	04/09/1976	23:00:00
1977	129.275	03/09/1977	21:00:00
1978	138.075	30/08/1978	17:00:00
1979	137.650	11/08/1979	07:00:00
1980	130.860	07/08/1980	09:00:00
1981	134.000	11/08/1981	04:00:00
1982	127.140	20/06/1982	19:00:00
1983	131.020	13/08/1983	13:00:00
1984	133.000	19/08/1984	22:00:00
1985	126.650	03/08/1985	16:00:00
1986	130.450	16/08/1986	09:00:00
1987	126.300	22/08/1987	06:00:00
1988	131.740	04/10/1988	05:00:00
1989	131.640	20/08/1989	03:00:00
1990	135.240	17/08/1990	14:00:00
1991	133.500	01/08/1991	01:00:00
1992	129.580	03/09/1992	19:00:00
1993	132.550	17/07/1993	16:00:00
1994	138.820	07/09/1994	23:00:00
1995	131.150	03/09/1995	23:00:00
1996	128.450	28/07/1996	03:00:00
1997	131.850	27/07/1997	04:00:00
1998	137.890	16/09/1998	12:00:00
1999	132.060	11/08/1999	02:00:00
2000	128.620	13/07/2000	18:00:00
2001	131.510	16/08/2001	16:00:00
2002	133.550	26/08/2002	00:00:00
2003	131.900	24/08/2003	21:00:00
2004	129.450	24/08/2004	03:00:00
2005	129.250	02/08/2005	19:00:00
2006	142.950	07/08/2006	15:00:00
2007	136.240	09/07/2007	16:00:00
2008	131.590	16/10/2008	00:00:00
2009	132.760	03/10/2009	09:00:00
2010	130.000	10/09/2010	10:00:00
2011	132.680	08/10/2011	18:00:00
2012	135.60	06/09/2012	22:00:00

3.4.3 Summary of Data

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Gidhade (01 02 17 014)

Division: Tapi Division Surat

Local River:Tapi

Sub Division: Middle Tapi Sub Division Dhule

Day	Jun		Jul		Aug		Sep		Oct		Nov			
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q		
1	129.100	0.000	129.160	0.000	*	125.000	1014	125.400	1196	128.400	0.000	132.800	0.000	
2	129.080	0.000	129.180	0.000	*	125.000	1012	125.100	1076	*	130.100	0.000	132.760	0.000
3	129.070	0.000	129.060	0.000	*	125.300	1123	124.340	710.4	131.400	0.000	132.740	0.000	
4	129.060	0.000	128.960	0.000	*	124.300	775.2	125.300	1161	131.580	0.000	132.720	0.000	
5	129.040	0.000	127.840	0.000	*	124.240	671.0	*	125.975	1679	131.380	0.000	132.700	0.000
6	129.020	0.000	127.340	0.000	*	123.880	518.2	133.300	7804	131.500	0.000	132.700	0.000	
7	129.000	0.000	126.460	0.000	*	123.700	458.7	133.350	8117	132.200	0.000	132.680	0.000	
8	128.980	0.000	125.800	0.000	*	129.950	4452	128.600	3454	132.200	0.000	132.680	0.000	
9	128.960	0.000	123.900	0.000	*	125.970	1541	127.550	2607	131.780	0.000	132.680	0.000	
10	128.940	0.000	124.050	558.2	#	125.300	1187	*	125.700	1435	131.640	0.000	132.680	0.000
11	128.900	0.000	124.000	536.4	#	124.500	817.7	124.930	1006	131.920	0.000	132.680	0.000	
12	128.880	0.000	123.080	137.0		124.740	886.0	*	128.350	3414	132.300	0.000	132.680	0.000
13	128.860	0.000	123.100	150.1		127.400	2345	125.810	1503	132.760	0.000	132.680	0.000	
14	128.840	0.000	125.000	0.000		125.200	1085	124.700	906.4	132.680	0.000	132.680	0.000	
15	128.820	0.000	123.800	0.000		125.000	1022	*	124.225	669.6	132.380	0.000	132.660	0.000
16	128.800	0.000	124.860	0.000		124.050	560.4	123.620	381.1	*	132.620	0.000	132.660	0.000
17	128.780	0.000	125.720	0.000		123.800	486.8	123.900	541.5	132.600	0.000	132.660	0.000	
18	128.760	0.000	126.440	0.000		123.800	470.2	124.350	738.0	132.500	0.000	132.660	0.000	
19	128.720	0.000	125.900	0.000		123.800	452.5	*	123.770	456.2	132.680	0.000	132.640	0.000
20	128.680	0.000	125.000	0.000		123.500	335.9	*	123.550	368.9	132.720	0.000	132.640	0.000

21	128.250	0.000	124.960	0.000	123.740	428.2	123.380	272.4	132.720	0.000	132.620	0.000
22	128.120	0.000	126.300	1793 *	125.175	1026	123.040	189.8	132.740	0.000	132.620	0.000
23	128.200	0.000	126.200	1729 #	123.900	509.0	123.400	299.7 *	132.740	0.000	132.600	0.000
24	129.320	0.000 *	127.900	2508	124.290	673.7	124.500	750.6	132.760	0.000	132.600	0.000
25	128.980	0.000 *	129.250	4017	123.360	280.7	123.230	234.5	132.780	0.000	132.580	0.000
26	128.980	0.000 *	124.750	904.5	123.560	358.3	123.100	216.1	132.780	0.000	132.560	0.000
27	129.040	0.000 *	124.250	687.6	123.580	374.9	123.160	228.2	132.800	0.000	132.540	0.000
28	129.060	0.000 *	123.200	262.8	128.350	3386	123.160	221.4	132.800	0.000	132.520	0.000
29	129.040	0.000 *	129.250	4035	125.150	1085	123.280	226.4	132.800	0.000	132.500	0.000
30	129.120	0.000 *	126.400	1885	123.520	356.3	123.660	396.6 *	132.800	0.000	132.500	0.000
31			125.380	1204	124.780	939.7			132.800	0.000		
Ten-Daily Mean												
I Ten-Daily	129.025	0.000	127.175	55.82	125.264	1275	127.462	2924	131.218	0.000	132.714	0.000
II Ten-Daily	128.804	0.000	124.690	82.35	124.579	846.2	124.720	998.5	132.516	0.000	132.664	0.000
III Ten-Daily	128.811	0.000	126.167	1730	124.491	856.2	123.391	303.6	132.775	0.000	132.564	0.000
Monthly												
Min.	128.120	0.000	123.080	0.000	123.360	280.7	123.040	189.8	128.400	0.000	132.500	0.000
Max.	129.320	0.000	129.250	4035	129.950	4452	133.350	8117	132.800	0.000	132.800	0.000
Mean	128.880	0.000	126.016	658.300	124.769	988.100	125.191	1409.000	132.189	0.000	132.647	0.000

Annual Runoff in MCM = 8061 Annual Runoff in mm = 147

Peak Observed Discharge = 8117 cumecs on 07/09/2012 Corres. Water Level :133.35 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2012 Corres. Water Level :129.1 m

Note: River remained in no flow w.e.f. 01.06 to 23.06.12 , / negligible flow condition from 24/06/12 to 09/07/2012 and 14/07/2012 to 22/07/2012 & no flow 1/10/2012 to 31/05/2013No release or negligible release during this period from existing barrage in D/S of site .

**Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated**

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Gidhade (01 02 17 014)

Division: Tapi Division Surat

Local River: Tapi

Sub Division: Middle Tapi Sub Division Dhule

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	132.480	0.000	131.860	0.000	131.540	0.000	130.920	0.000	130.260	0.000	129.670	0.000
2	132.470	0.000	131.840	0.000	131.510	0.000	130.900	0.000	130.230	0.000	129.660	0.000
3	132.460	0.000	131.830	0.000	131.480	0.000	130.880	0.000	130.200	0.000	129.650	0.000
4	132.440	0.000	131.820	0.000	131.460	0.000	130.860	0.000	130.180	0.000	129.640	0.000
5	132.430	0.000	131.800	0.000	131.440	0.000	130.840	0.000	130.160	0.000	129.630	0.000
6	132.420	0.000	131.800	0.000	131.420	0.000	130.820	0.000	130.130	0.000	129.620	0.000
7	132.400	0.000	131.780	0.000	131.420	0.000	130.800	0.000	130.100	0.000	129.600	0.000
8	132.380	0.000	131.760	0.000	131.380	0.000	130.780	0.000	130.080	0.000	129.580	0.000
9	132.360	0.000	131.760	0.000	131.360	0.000	130.760	0.000	130.050	0.000	129.560	0.000
10	132.340	0.000	131.750	0.000	131.340	0.000	130.740	0.000	130.020	0.000	129.540	0.000
11	132.320	0.000	131.740	0.000	131.300	0.000	130.720	0.000	130.000	0.000	129.520	0.000
12	132.300	0.000	131.740	0.000	131.280	0.000	130.700	0.000	129.980	0.000	129.500	0.000
13	132.280	0.000	131.740	0.000	131.260	0.000	130.680	0.000	129.980	0.000	129.480	0.000
14	132.260	0.000	131.730	0.000	131.240	0.000	130.660	0.000	129.970	0.000	129.460	0.000
15	132.240	0.000	131.720	0.000	131.220	0.000	130.640	0.000	129.970	0.000	129.450	0.000
16	132.240	0.000	131.700	0.000	131.200	0.000	130.620	0.000	129.960	0.000	129.400	0.000
17	132.220	0.000	131.700	0.000	131.180	0.000	130.600	0.000	129.940	0.000	129.360	0.000
18	132.200	0.000	131.700	0.000	131.160	0.000	130.580	0.000	129.920	0.000	129.320	0.000
19	132.180	0.000	131.690	0.000	131.140	0.000	130.560	0.000	129.900	0.000	129.300	0.000
20	132.160	0.000	131.670	0.000	131.120	0.000	130.540	0.000	129.880	0.000	129.280	0.000
21	132.120	0.000	131.660	0.000	131.100	0.000	130.520	0.000	129.860	0.000	129.240	0.000

22	132.080	0.000	131.650	0.000	131.080	0.000	130.500	0.000	129.840	0.000	129.200	0.000
23	132.040	0.000	131.650	0.000	131.060	0.000	130.480	0.000	129.820	0.000	129.160	0.000
24	132.000	0.000	131.640	0.000	131.040	0.000	130.460	0.000	129.800	0.000	129.120	0.000
25	132.000	0.000	131.620	0.000	131.020	0.000	130.450	0.000	129.780	0.000	129.080	0.000
26	131.980	0.000	131.620	0.000	131.000	0.000	130.420	0.000	129.760	0.000	129.040	0.000
27	131.960	0.000	131.600	0.000	130.960	0.000	130.400	0.000	129.730	0.000	129.000	0.000
28	131.940	0.000	131.600	0.000	130.940	0.000	130.380	0.000	129.700	0.000	128.960	0.000
29	131.920	0.000	131.580	0.000			130.360	0.000	129.680	0.000	128.920	0.000
30	131.900	0.000	131.580	0.000			130.330	0.000	129.680	0.000	128.880	0.000
31	131.880	0.000	131.560	0.000			130.300	0.000			128.840	0.000
Ten-Daily Mean												
I Ten-Daily	132.418	0.000	131.800	0.000	131.435	0.000	130.830	0.000	130.141	0.000	129.615	0.000
II Ten-Daily	132.240	0.000	131.713	0.000	131.210	0.000	130.630	0.000	129.950	0.000	129.407	0.000
III Ten-Daily	131.984	0.000	131.615	0.000	131.025	0.000	130.418	0.000	129.765	0.000	129.040	0.000
Monthly												
Min.	131.880	0.000	131.560	0.000	130.940	0.000	130.300	0.000	129.680	0.000	128.840	0.000
Max.	132.480	0.000	131.860	0.000	131.540	0.000	130.920	0.000	130.260	0.000	129.670	0.000
Mean	132.206	0.000	131.706	0.000	131.238	0.000	130.619	0.000	129.952	0.000	129.344	0.000

Peak Computed Discharge = 1793 cumecs on 22/07/2012

Corres. Water Level :126.3 m

Lowest Computed Discharge = 0.000 cumecs on 24/06/2012

Corres. Water Level :129.32 m

Note: River remained in no flow w.e.f. 01.06 to 23.06.12 , / negligible flow condition from 24/06/12 to 09/07/2012 and 14/07/2012 to 22/07/2012 & no flow 1/10/2012 to 31/05/2013 No release or negligible release during this period from existing barrage in D/S of site .

Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge #Discarded and estimated

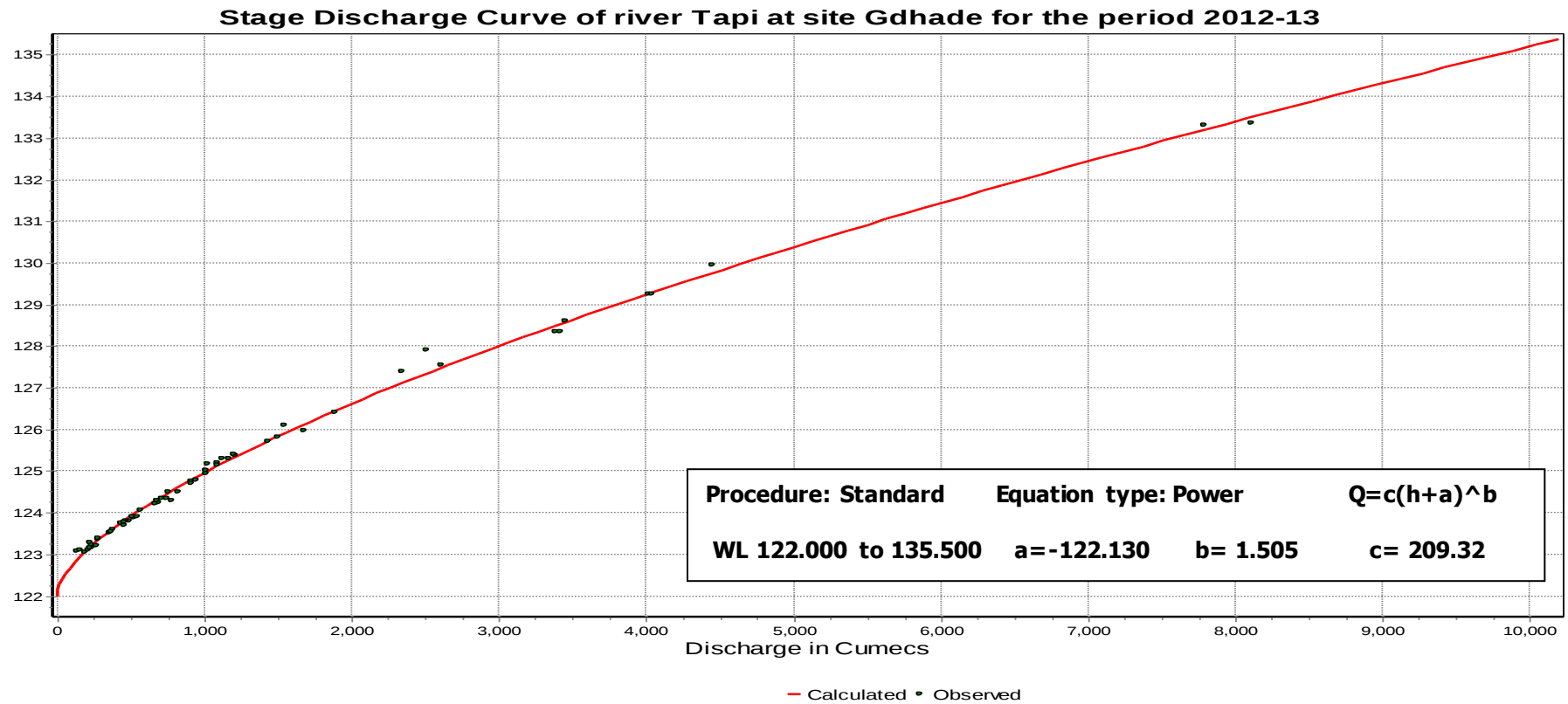
3.4.4 Stage Discharge Curve

Station Name: Tapi at Gidhade (01 02 17 014)

Division: Tapi Division Surat

Local River:Tapi

Sub Division: Middle Tapi Sub Division Dhule



3.4.5 Annual Runoff

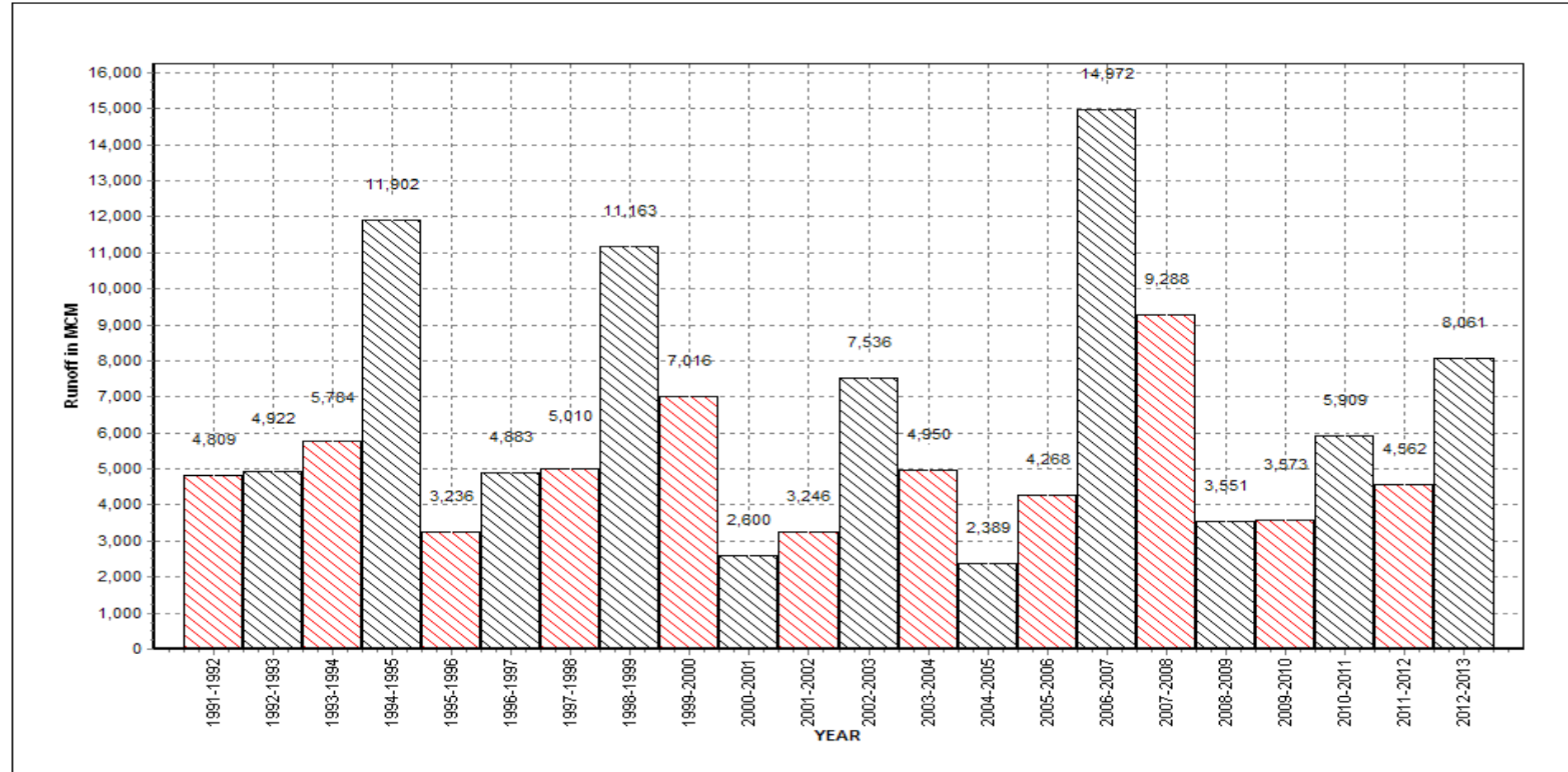
Annual Runoff for the period 1991 to 2013

Station Name: Tapi at Gidhade (01 02 17 014)

Division: Tapi Division Surat

Local River:Tapi

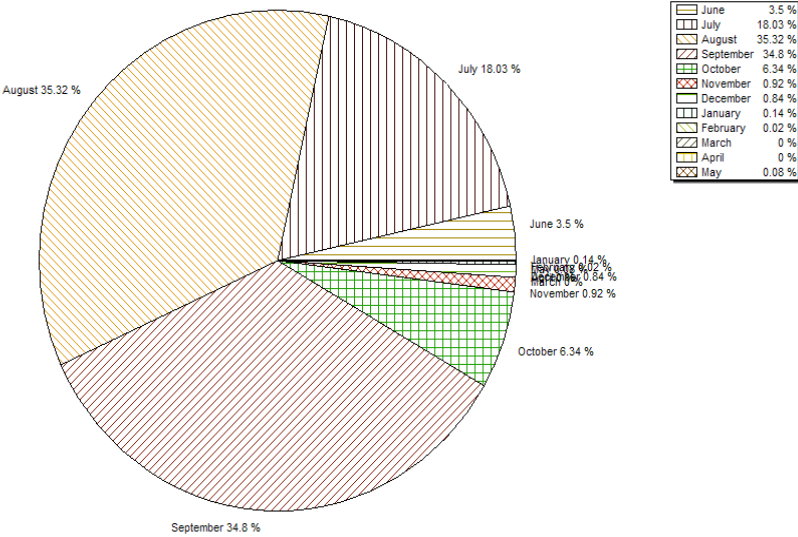
Sub Division: Middle Tapi Sub Division Dhule



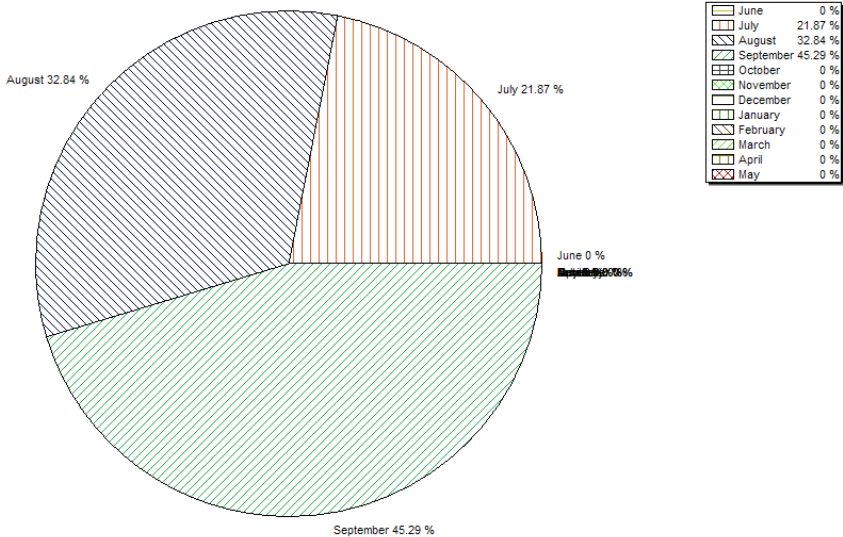
3.4.6 Monthly average Runoff

Station Name: Tapi at Gidhade (01 02 17 014) Division: Tapi Division Surat Local River:Tapi Sub Division: Middle Tapi Sub Division Dhule

Monthly Average Runoff Based on period 1991-2013



Monthly Runoff Based on period 2012-2013



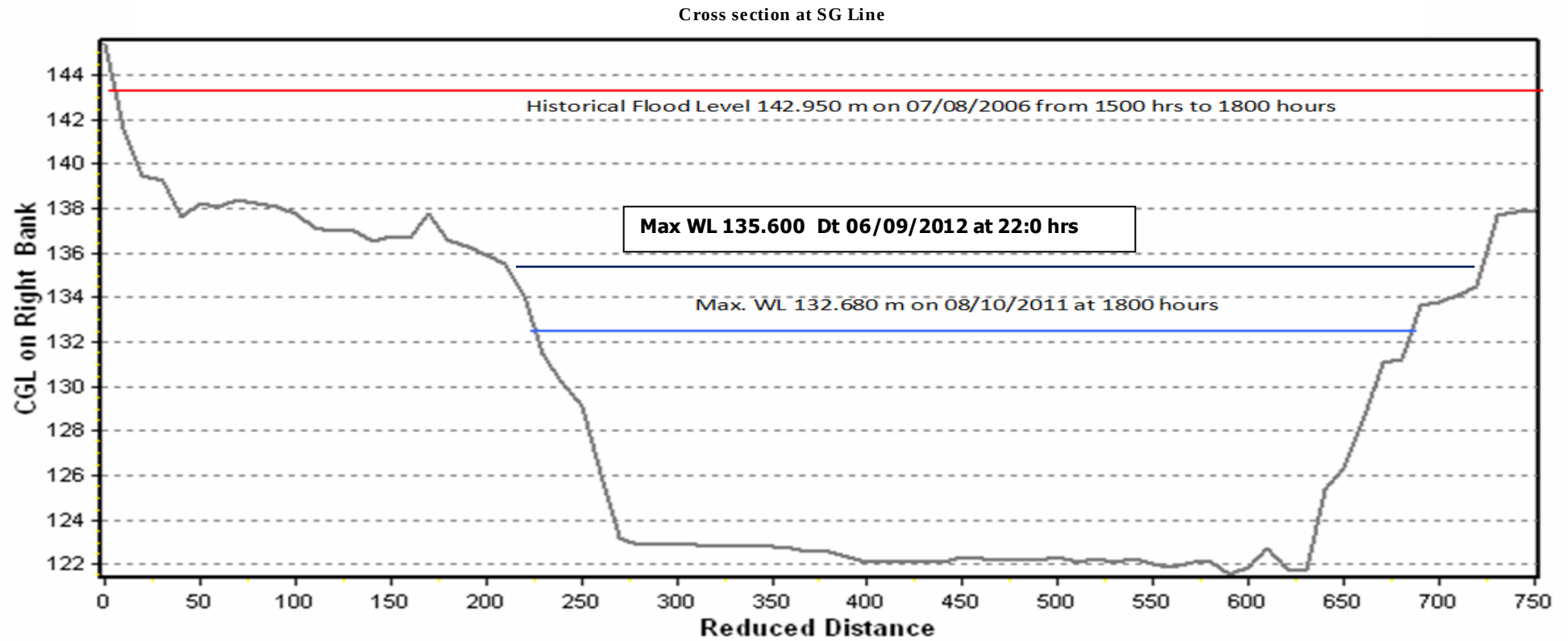
3.4.7

Superimposed cross section

Station Name: Tapi at Gidhade (01 02 17 014)

Division: Tapi Division, Surat Local River:Tapi

Sub Division: Middle Tapi, Dhule



___ Pre monsoon 08/07/2011

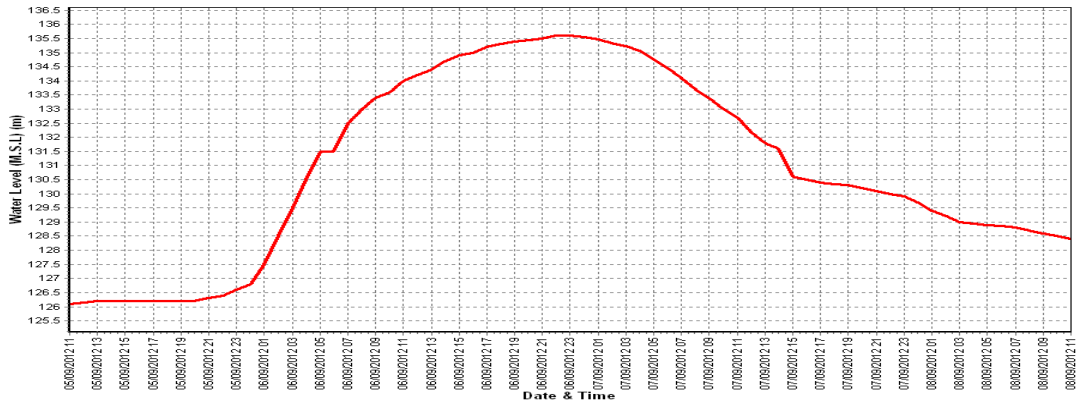
Pre and post monsoon cross section at site have not been taken due to submergence of SG line (Due to storage in Sulwade barrage)

3.4.8 WL vs Time Graph of I,II,III peak

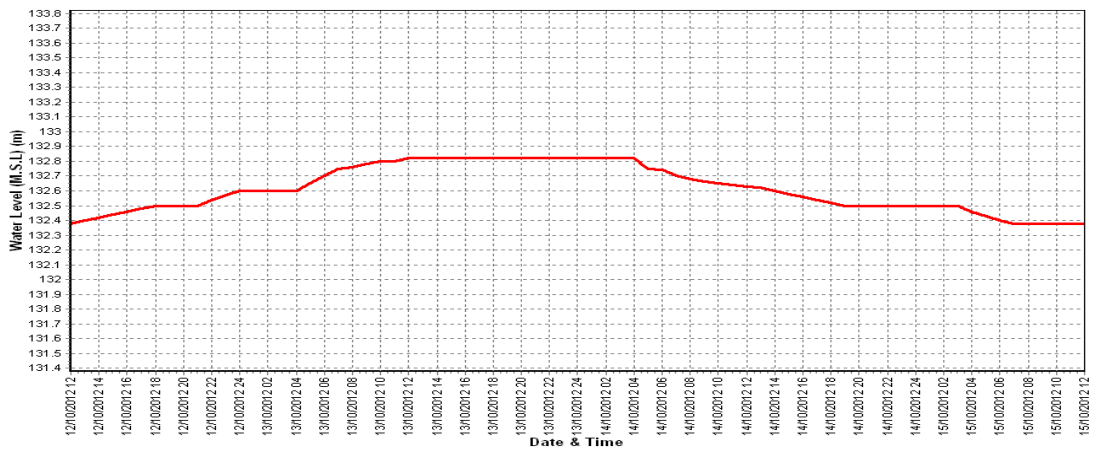
Station Name: Tapi at Gidhade (01 02 17 014)
Local River:Tapi

Division: Tapi Division Surat
Sub Division: Middle Tapi Sub Division Dhule

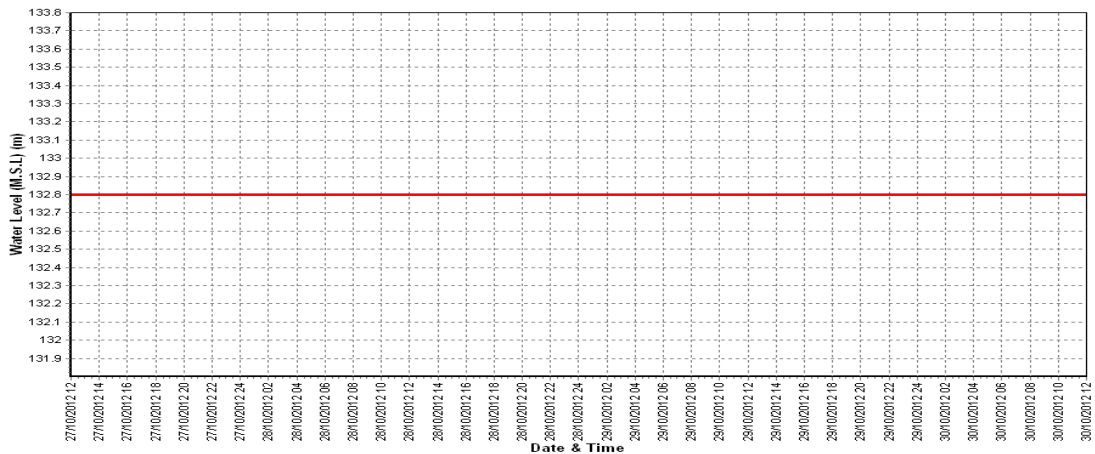
Water level vs Time Graph of Highest (I) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (II) flood peak during the water year 2012-13



Water level vs Time Graph of Highest (III) flood peak during the water year 2012-13



3.5 Sarangkhedda

3.5.1 History Sheet

Site	:	SARANGKHEDA	Code	:	01 02 17 015
State	:	Maharashtra	District	:	Nandurbar
Basin	:	Tapi	Independent River	:	Tapi
Tributary	:	-	Sub Tributary	:	
Sub-Sub Tributary	:		Local River	:	Tapi
Division	:	Tapi Division Surat	Sub-Division	:	Middle Tapi Dhule
Drainage Area	:	58400 sq km	Bank	:	Right
Latitude	:	21°25'55"	Longitude	:	74°31'37"
Zero of Gauge (m)	:	108 (msl)		:	21/09/1971
		Opening Date		:	Closing Date
Gauge	:	29/07/1976			
Discharge	:	19/10/1977			
Sediment	:	13/07/1984			
Water Quality	:	01/01/1980			

**Annual Maximum / Minimum discharge with corresponding Water Level
(above msl)**

Year	Maximum			Minimum		
	Q (cumec)	WL (m)	Date	Q (cumec)	WL (m)	Date
1977-1978	600.0	111.610	27/11/1977	0.000	109.400	08/07/1977
1978-1979	13819	121.500	30/08/1978	6.400	109.450	01/06/1978
1979-1980	15000	122.725	11/08/1979	5.000	109.795	03/06/1979
1980-1981	5403	117.010	07/08/1980	5.500	109.730	19/05/1981
1981-1982	11375	119.985	11/08/1981	5.400	109.760	16/06/1981
1982-1983	1714	113.498	21/06/1982	2.500	109.570	22/05/1983
1983-1984	9493	117.135	13/08/1983	2.700	109.570	04/06/1983
1984-1985	13750	118.600	20/08/1984	0.700	109.530	07/10/1984
1985-1986	1820	113.570	04/08/1985	1.400	109.615	24/02/1986
1986-1987	7026	117.395	16/08/1986	0.300	109.480	31/05/1987
1987-1988	1604	113.270	22/08/1987	0.000	109.280	03/05/1988
1988-1989	10521	118.145	04/10/1988	0.000	109.280	11/06/1988
1989-1990	9300	118.055	20/08/1989	0.000	River Dry	24/03/1990
1990-1991	11838	120.060	17/08/1990	0.000	River Dry	23/03/1991
1991-1992	7986	118.485	01/08/1991	0.000	River Dry	29/10/1991
1992-1993	5244	116.000	18/08/1992	0.000	River Dry	10/02/1993
1993-1994	8462	118.060	17/07/1993	0.000	River Dry	05/03/1994
1994-1995	15626	122.575	07/09/1994	0.000	River Dry	01/04/1995
1995-1996	6156	117.530	04/09/1995	0.000	River Dry	26/01/1996
1996-1997	3510	114.810	28/07/1996	0.000	River Dry	29/06/1996
1997-1998	7174	117.970	27/07/1997	0.000	River Dry	24/02/1998
1998-1999	21292	123.030	16/09/1998	0.000	River Dry	22/04/1999
1999-2000	6300	118.100	11/08/1999	0.000	River Dry	05/03/2000
2000-2001	3435	114.900	14/07/2000	0.000	River Dry	01/01/2001
2001-2002	4076	115.800	17/08/2001	0.000	River Dry	23/02/2002
2002-2003	9000	119.000	26/08/2002	0.000	River Dry	13/02/2003
2003-2004	7564	117.400	25/08/2003	0.000	River Dry	30/04/2004
2004-2005	5909	115.970	24/08/2004	0.000	River Dry	24/02/2005
2005-2006	4458	116.050	03/08/2005	0.000	River Dry	30/11/2005
2006-2007	23044	126.000	08/08/2006	0.160	109.330	30/01/2007
2007-2008	11827	121.000	09/07/2007	0.000	109.680	03/01/2008
2008-2009	3406	114.900	06/08/2008	0.000	River Dry	05/09/2008
2009-2010	3942	114.850	24/07/2009	0.000	River Dry	01/06/2009
2010-2011	4876	116.450	10/09/2010	7.400	109.900	22/07/2010
2011-2012	4404	116.100	20/06/2011	123.9	110.650	20/06/2011
2012-2013	10481	120.350	07/09/2012	0.000	110.200	04/07/2012

Q: Observed/computed discharge WL: corresponding discharge

3.5.2 Annual Maximum flood peak

Station Name: Tapi at Sarangkhedha (01 02 17 015) Division: Tapi division Surat
Local River: Sub Division: Middle Tapi Dhule

Year	Highest Flood Level (m)	Date	Hour
1977	111.910	27/11/1977	18:00:00
1978	123.340	30/08/1978	22:00:00
1979	122.800	11/08/1979	10:00:00
1980	117.420	07/08/1980	16:00:00
1981	120.000	11/08/1981	09:00:00
1982	114.370	21/06/1982	01:00:00
1983	117.370	13/08/1983	17:00:00
1984	119.120	20/08/1984	03:00:00
1985	114.115	28/06/1985	21:00:00
1986	117.830	16/08/1986	13:00:00
1987	113.510	22/08/1987	11:00:00
1988	118.160	04/10/1988	09:00:00
1989	118.340	20/08/1989	06:00:00
1990	120.700	17/08/1990	17:00:00
1991	119.440	01/08/1991	05:00:00
1992	116.200	03/09/1992	22:00:00
1993	118.730	17/07/1993	18:00:00
1994	123.640	08/09/1994	03:00:00
1995	117.800	03/09/1995	23:00:00
1996	115.070	28/07/1996	17:00:00
1997	118.050	27/07/1997	07:00:00
1998	123.640	16/09/1998	18:00:00
1999	118.280	11/08/1999	00:00:00
2000	115.550	13/07/2000	23:00:00
2001	117.700	16/08/2001	22:00:00
2002	119.900	26/08/2002	04:00:00
2003	118.300	25/08/2003	00:00:00
2004	116.350	06/08/2004	15:00:00
2005	116.300	03/08/2005	03:00:00
2006	127.080	08/08/2006	02:00:00
2007	121.800	09/07/2007	19:00:00
2008	115.650	06/08/2008	14:00:00
2009	117.000	06/09/2009	03:00:00
2010	116.800	10/09/2010	05:00:00
2011	116.400	28/08/2011	08:00:00
2012	121.600	07/09/2012	06:00:00

3.5.3 Summary of Data

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat

Local River:Tapi

Sub Division: Middle Tapi Dhule

Day	Jun		Jul		Aug		Sep		Oct		Nov	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	110.000	0.000	110.000	0.000	112.200	1217	112.900	1616	112.200	0.000	112.300	0.000
2	110.000	0.000	110.000	0.000	112.200	1232	112.000	989.5 *	112.200	0.000	112.300	0.000
3	110.000	0.000	110.000	0.000	113.000	1649 #	111.650	763.4	112.200	0.000	112.300	0.000
4	110.000	0.000	110.200	0.000	111.450	660.9	111.200	614.3	112.200	0.000	112.300	0.000
5	110.000	0.000	110.400	282.2	111.300	615.6 *	112.500	1050	112.300	0.000	112.300	0.000
6	110.000	0.000	110.000	134.7 *	111.100	570.7	118.075	7220	112.300	0.000	112.300	0.000
7	110.000	0.000	110.000	134.7	110.900	483.2	120.350	10481	112.200	0.000	112.300	0.000
8	110.000	0.000	110.000	134.7 *	116.000	4332	115.500	3653	112.300	0.000	112.250	0.000
9	110.000	0.000	110.500	267.7	113.750	2260	114.900	3274 *	112.300	0.000	112.300	0.000
10	110.000	0.000	110.950	440.4	112.550	1335 *	113.150	1933	112.150	0.000	112.300	0.000
11	110.000	0.000	110.800	340.2	111.500	703.4	111.975	1120	112.200	0.000	112.300	0.000
12	110.000	0.000	110.350	225.9	111.700	820.0 *	114.900	3129	112.200	0.000	112.300	0.000
13	110.000	0.000	110.400	247.6	114.750	2928	112.900	1611	112.200	0.000	112.200	0.000
14	110.000	0.000	110.350	229.1	112.150	1240	112.500	1301 #	112.300	0.000	112.200	0.000
15	110.000	0.000	110.250	203.7 *	112.100	1049 *	111.575	767.5	112.300	0.000	112.200	0.000
16	110.000	0.000	109.800	88.47 *	111.450	730.9	110.950	457.5 *	112.300	0.000	112.200	0.000
17	110.000	0.000	109.900	91.16	110.975	535.9	110.800	443.1	112.300	0.000	112.200	0.000
18	110.000	0.000	110.000	95.86	110.850	489.6	111.500	772.4	112.250	0.000	112.200	0.000
19	110.000	0.000	110.000	99.28	110.850	416.0 *	111.100	573.5	112.200	0.000	112.200	0.000
20	110.000	0.000	109.900	90.83	110.800	396.0 *	110.700	432.5	112.200	0.000	112.150	0.000

21	110.000	0.000	109.200	4.490	*	110.500	318.1	110.700	431.2	112.200	0.000	112.150	0.000	
22	110.000	0.000	109.000	0.000	*	113.000	1770	110.700	352.9	112.200	0.000	112.100	0.000	
23	110.000	0.000	109.000	0.000	*	111.100	573.1	111.600	766.6	*	112.400	0.000	112.100	0.000
24	110.000	0.000	115.500	3196		111.400	688.9	112.050	999.6		112.300	0.000	112.100	0.000
25	110.000	0.000	116.450	4416		110.550	338.0	110.700	472.1		112.300	0.000	112.050	0.000
26	110.000	0.000	112.400	1313		110.500	284.4	*	110.900	0.000	112.300	0.000	112.050	0.000
27	110.000	0.000	111.800	795.1		110.500	284.9		111.100	0.000	112.300	0.000	112.050	0.000
28	110.000	0.000	110.750	328.3		110.800	396.0	#	111.600	0.000	112.300	0.000	112.000	0.000
29	110.000	0.000	114.000	2446	*	112.650	1210		112.100	677.1	112.300	0.000	112.000	0.000
30	110.000	0.000	114.300	2299		110.650	353.9		112.300	0.000	112.300	0.000	111.950	0.000
31			113.175	1731		111.250	626.7				112.300	0.000		
Ten-Daily Mean														
I Ten-Daily	110.000	0.000	110.205	139.4		112.445	1435	114.222	3159	112.235	0.000	112.295	0.000	
II Ten-Daily	110.000	0.000	110.175	171.2		111.713	931.0	111.890	1061	112.245	0.000	112.215	0.000	
III Ten-Daily	110.000	0.000	112.325	1503		111.173	622.2	111.375	487.1	112.291	0.000	112.055	0.000	
Monthly														
Min.	110.000	0.000	109.000	0.000		110.500	284.4	110.700	0.000	112.150	0.000	111.950	0.000	
Max.	110.000	0.000	116.450	4416		116.000	4332	120.350	10481	112.400	0.000	112.300	0.000	
Mean	110.000	0	110.948	633.4		111.757	984.1	112.496	1569	112.258	0	112.188	0	

Annual Runoff in MCM = 8298

Annual Runoff in mm = 142

Peak Observed Discharge = 10481 cumecs on 07/09/2012

Corres. Water Level :120.35 m

Lowest Observed Discharge = 0.000 cumecs on 01/06/2012

Corres. Water Level :110 m

All Gates of Barrage closed river in pooling condition from 01-06-12 to 04-07-12, Negligible flow polling condition on 06/7/2012 & 07/07 /2012 and Negligible flow polling condition 16/7/2012 & 21/7/12 to 23/7/2012. Gate closed negligible flow on 26/9/2012 to 28/9 /2012 and Negligible flow All gates closed Negligible flow from 30-9-12

**Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge
#Discarded and estimated**

Stage Discharge data for the period 2012 to 2013

Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat

Local River:Tapi

Sub Division: Middle Tapi Dhule

Day	Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	WL	Q	WL	Q	WL	Q	WL	Q	WL	Q
1	111.950	0.000	111.500	0.000	111.150	0.000	110.800	0.000	110.300	0.000	110.000	0.000
2	111.950	0.000	111.500	0.000	111.150	0.000	110.800	0.000	110.250	0.000	110.000	0.000
3	111.900	0.000	111.500	0.000	111.150	0.000	110.750	0.000	110.250	0.000	110.000	0.000
4	111.900	0.000	111.500	0.000	111.150	0.000	110.750	0.000	110.250	0.000	110.000	0.000
5	111.800	0.000	111.450	0.000	111.150	0.000	110.700	0.000	110.200	0.000	110.000	0.000
6	111.800	0.000	111.450	0.000	111.150	0.000	110.700	0.000	110.200	0.000	110.000	0.000
7	111.750	0.000	111.450	0.000	111.150	0.000	110.700	0.000	110.200	0.000	110.000	0.000
8	111.750	0.000	111.450	0.000	111.150	0.000	110.650	0.000	110.200	0.000	110.000	0.000
9	111.750	0.000	111.400	0.000	111.100	0.000	110.650	0.000	110.150	0.000	110.000	0.000
10	111.700	0.000	111.400	0.000	111.100	0.000	110.650	0.000	110.150	0.000	110.000	0.000
11	111.700	0.000	111.400	0.000	111.100	0.000	110.600	0.000	110.150	0.000	110.000	0.000
12	111.700	0.000	111.400	0.000	111.100	0.000	110.600	0.000	110.100	0.000	110.000	0.000
13	111.700	0.000	111.400	0.000	111.050	0.000	110.600	0.000	110.100	0.000	110.000	0.000
14	111.650	0.000	111.400	0.000	111.050	0.000	110.550	0.000	110.100	0.000	110.000	0.000
15	111.650	0.000	111.400	0.000	111.000	0.000	110.550	0.000	110.100	0.000	110.000	0.000
16	111.600	0.000	111.350	0.000	111.000	0.000	110.550	0.000	110.050	0.000	110.000	0.000
17	111.600	0.000	111.350	0.000	111.000	0.000	110.500	0.000	110.050	0.000	110.000	0.000
18	111.600	0.000	111.300	0.000	111.000	0.000	110.500	0.000	110.050	0.000	110.000	0.000
19	111.550	0.000	111.300	0.000	110.950	0.000	110.500	0.000	110.000	0.000	110.000	0.000
20	111.550	0.000	111.300	0.000	110.950	0.000	110.450	0.000	110.000	0.000	110.000	0.000
21	111.550	0.000	111.300	0.000	110.950	0.000	110.450	0.000	110.000	0.000	110.000	0.000
22	111.550	0.000	111.300	0.000	110.950	0.000	110.450	0.000	110.000	0.000	110.000	0.000

23	111.550	0.000	111.250	0.000	110.950	0.000	110.400	0.000	110.000	0.000	110.000	0.000
24	111.550	0.000	111.250	0.000	110.900	0.000	110.400	0.000	110.000	0.000	110.000	0.000
25	111.550	0.000	111.250	0.000	110.900	0.000	110.400	0.000	110.000	0.000	110.000	0.000
26	111.550	0.000	111.250	0.000	110.900	0.000	110.350	0.000	110.000	0.000	110.000	0.000
27	111.550	0.000	111.250	0.000	110.850	0.000	110.350	0.000	110.000	0.000	110.000	0.000
28	111.550	0.000	111.200	0.000	110.850	0.000	110.350	0.000	110.000	0.000	109.800	0.000
29	111.550	0.000	111.200	0.000			110.350	0.000	110.000	0.000	109.600	0.000
30	111.550	0.000	111.200	0.000			110.300	0.000	110.000	0.000	109.500	0.000
31	111.500	0.000	111.200	0.000			110.300	0.000			109.400	0.000
Ten-Daily Mean												
I Ten-Daily	111.825	0.000	111.460	0.000	111.140	0.000	110.715	0.000	110.215	0.000	110.000	0.000
II Ten-Daily	111.630	0.000	111.360	0.000	111.020	0.000	110.540	0.000	110.070	0.000	110.000	0.000
III Ten-Daily	111.545	0.000	111.241	0.000	110.906	0.000	110.373	0.000	110.000	0.000	109.845	0.000
Monthly												
Min.	111.500	0.000	111.200	0.000	110.850	0.000	110.300	0.000	110.000	0.000	109.400	0.000
Max.	111.950	0.000	111.500	0.000	111.150	0.000	110.800	0.000	110.300	0.000	110.000	0.000
Mean	111.663	0.000	111.350	0.000	111.030	0.000	110.537	0.000	110.095	0.000	109.945	0.000

Peak Computed Discharge = 3274 cumecs on 09/09/2012

Corres. Water Level :114.9 m

Lowest Computed Discharge = 0.000 cumecs on 22/07/2012

Corres. Water Level :109 m

All Gates of Barrage closed river in pooling condition from 01-06-12 to 04-07-12, Negligible flow polling condition on 06/7/2012 & 07/07 /2012 and Negligible flow polling condition 16/7/2012 & 21/7/12 to 23/7/2012. Gate closed negligible flow on 26/9/2012 to 28/9 /2012 and Negligible flow All gates closed Negligible flow from 30-9-12

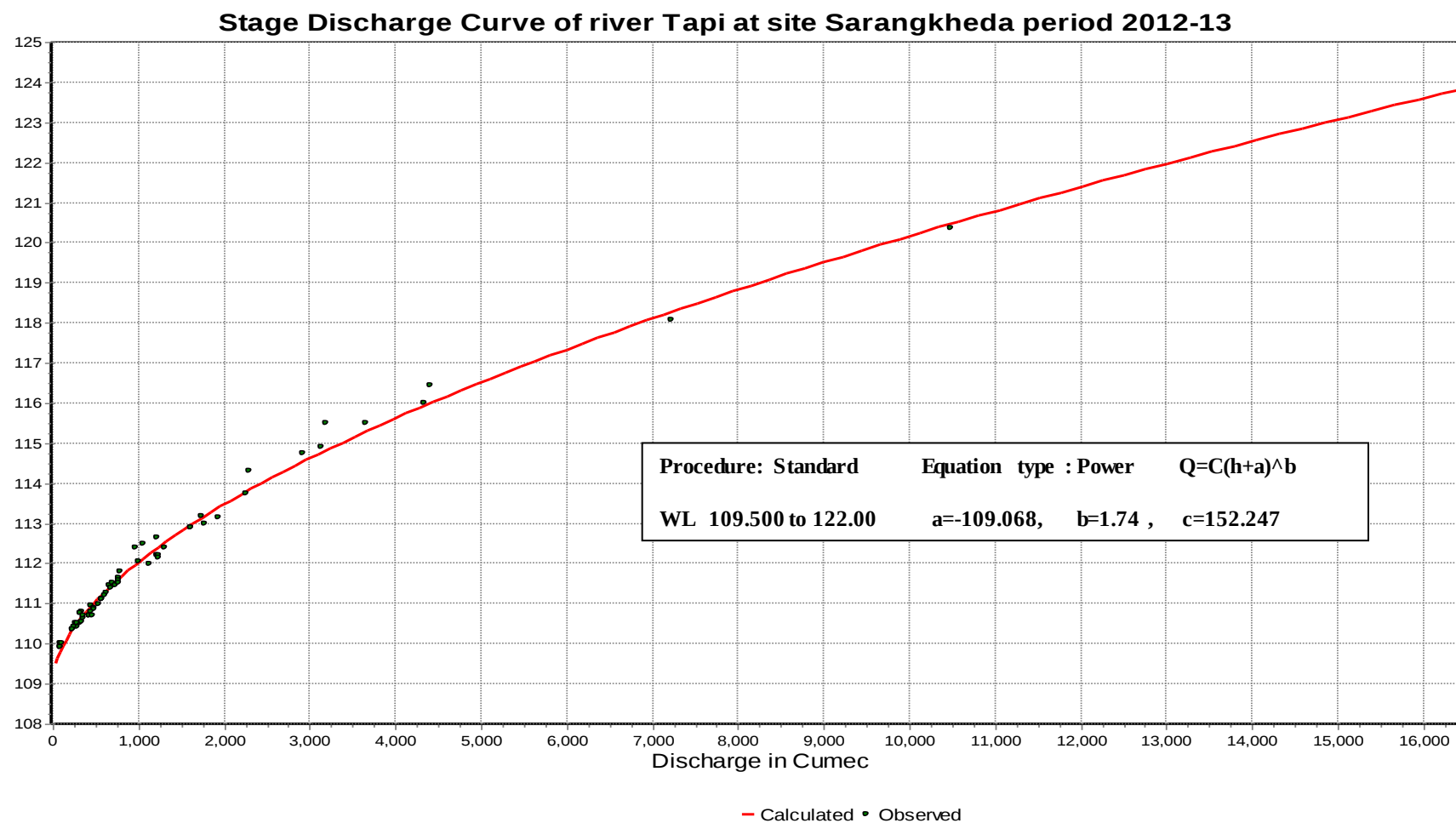
Q: observed/ computed discharge in Cumec, WL: Corresponding Mean Water Level (msl) in m, *: Computed Discharge #Discarded and estimated

3.5.4 Stage Discharge Curve

Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat Local River:Tapi

Sub Division: Middle Tapi Dhule



3.5.5 Annual runoff

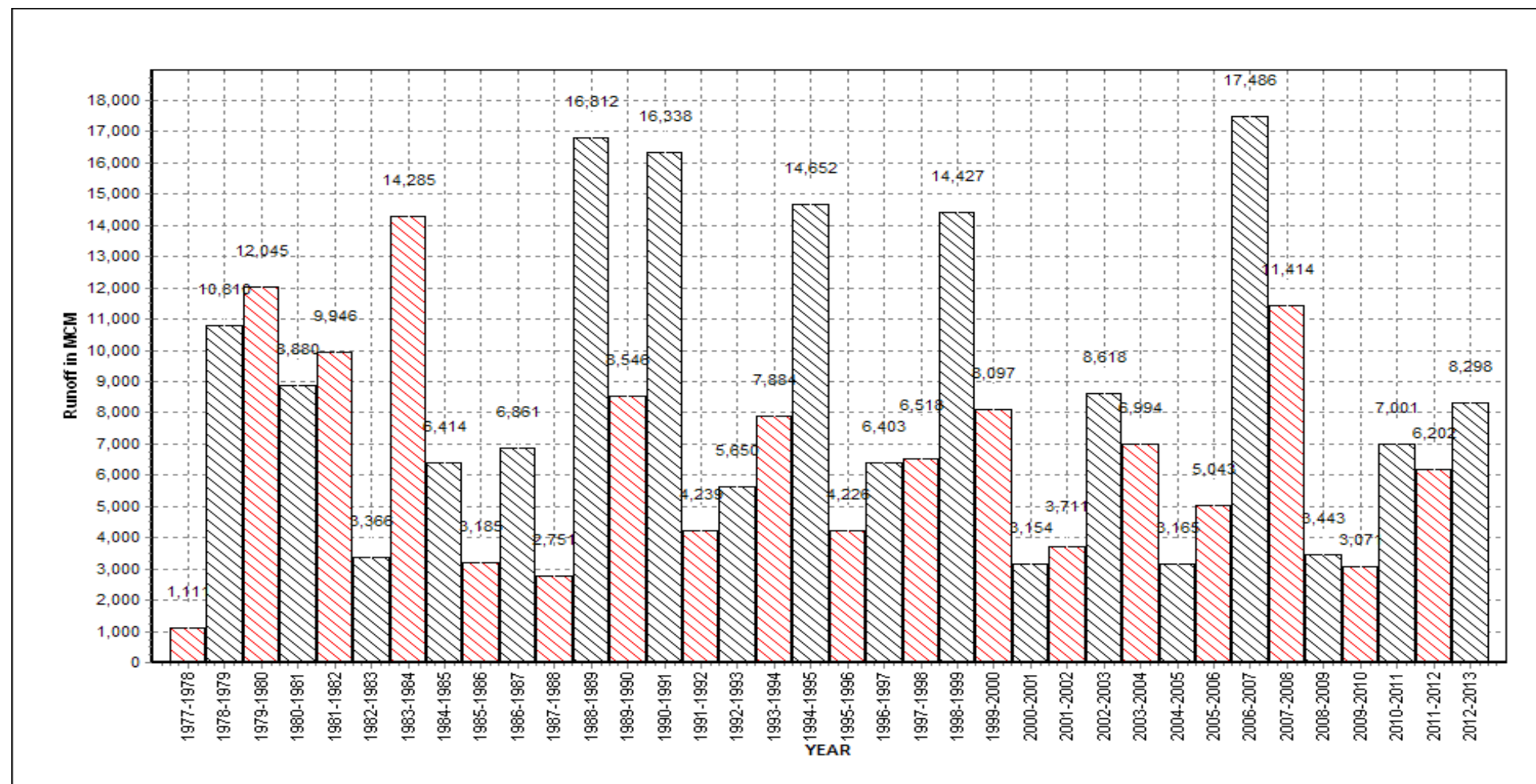
Annual Runoff for the period 1977-2013

Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat

Local River:Tapi

Sub Division: Middle Tapi Dhule



3.5.6 Monthly Average Runoff

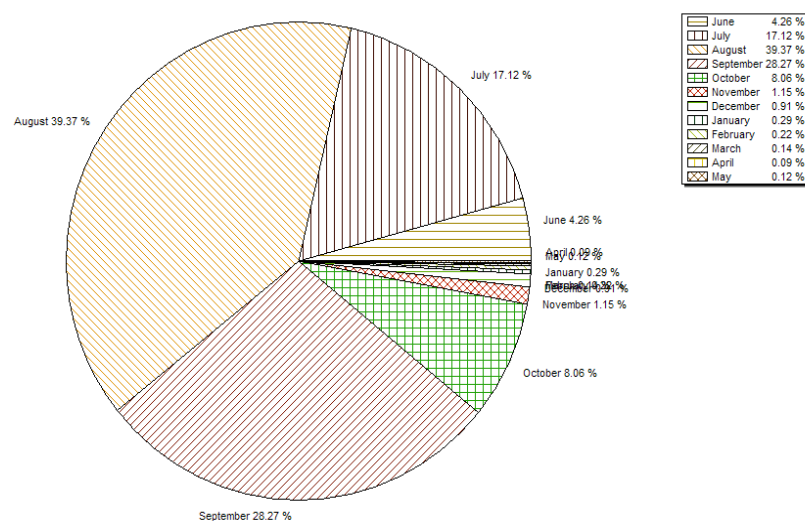
Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat

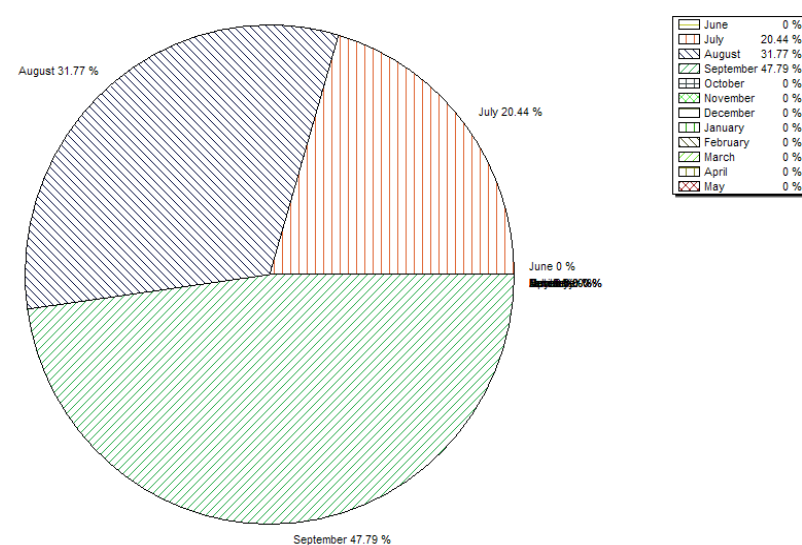
Local River:Tapi

Sub Division: Middle Tapi Dhule

Monthly Average Runoff Based on period 1971-2013



Monthly Runoff Based on period 2012-2013



3.5.7 Superimposed cross section

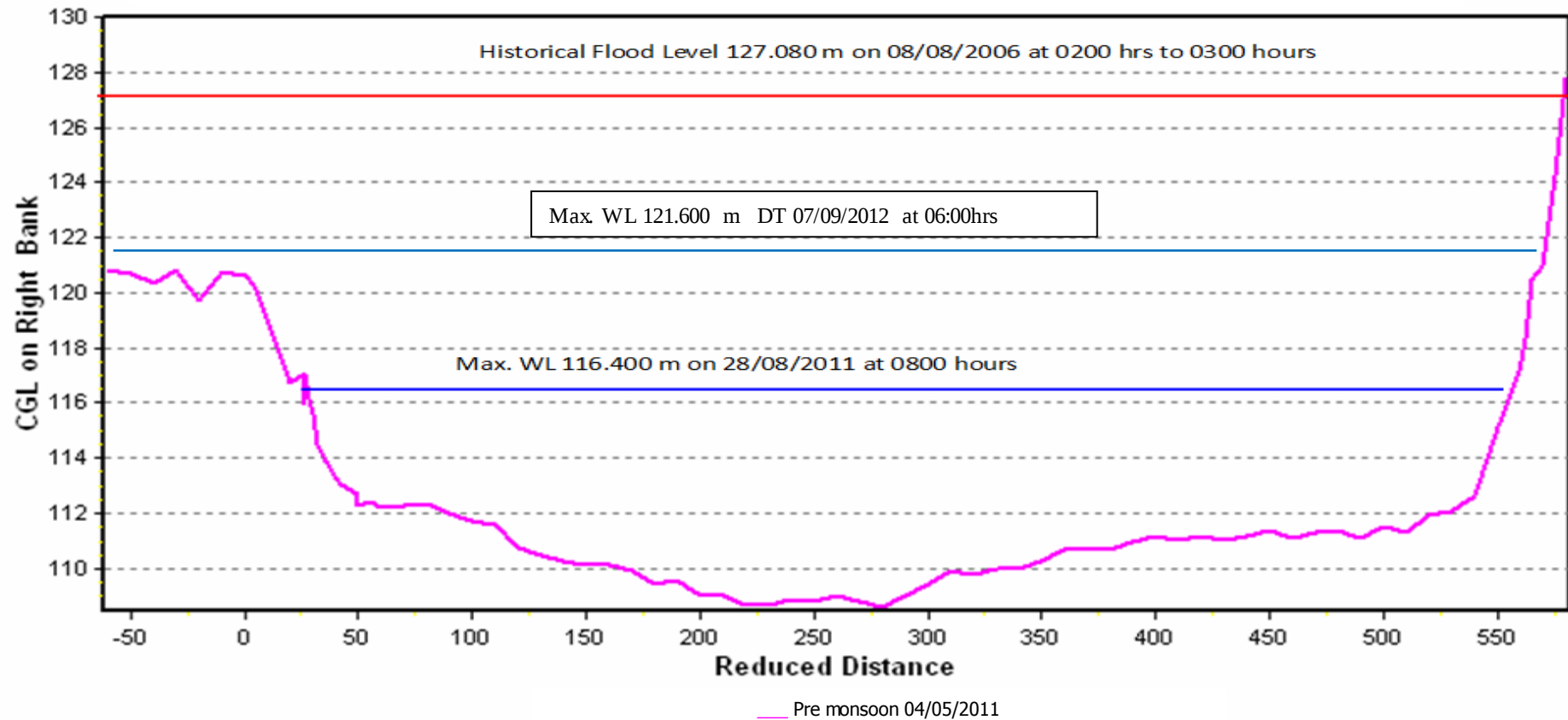
Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division, Surat

Local River :Tapi

Sub Division: Middle Tapi, Dhule

Cross section at SG Line



Pre and post monsoon cross section at site have not been taken due to submergence of SG line (Due to storage in Sarangkhedha barrage)

3.5.8 WL vs Time Graph of I,II,III peak

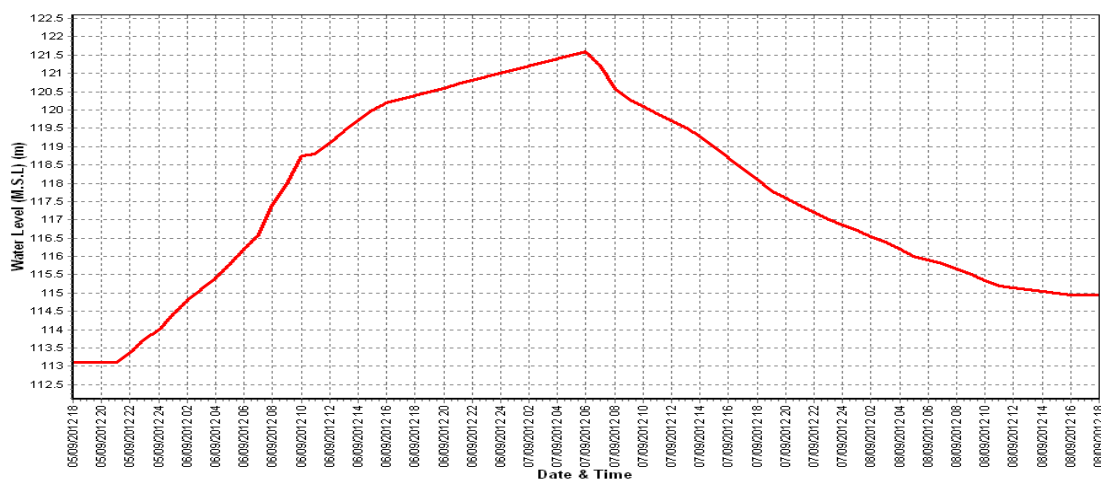
Station Name: Tapi at Sarangkhedha (01 02 17 015)

Division: Tapi Division Surat

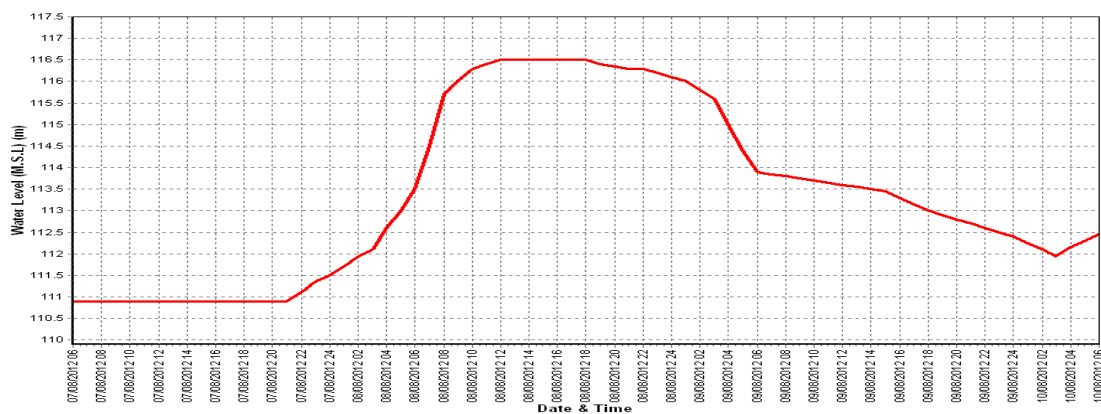
Local River:

Sub Division: Middle Tapi Dhule

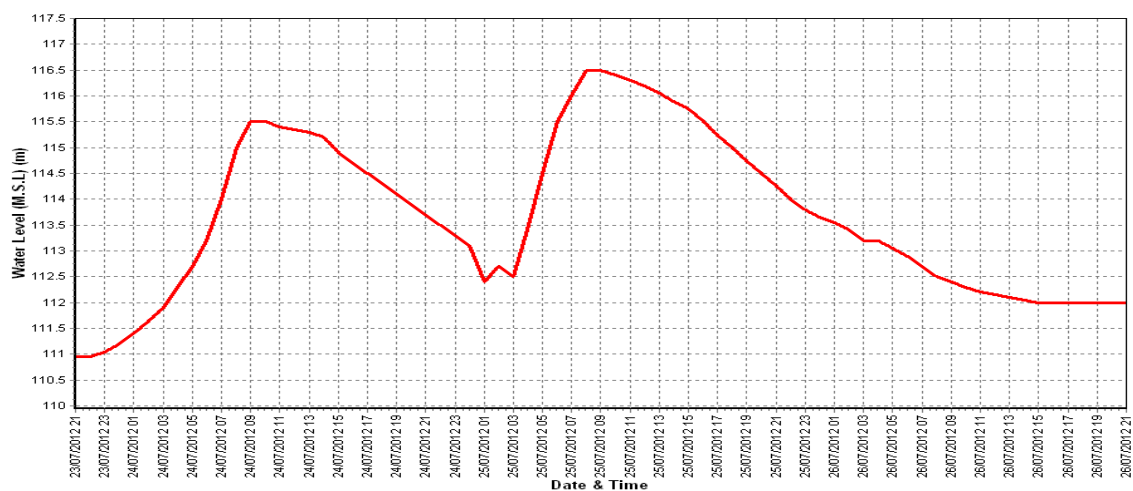
Water Level v/s Time graph of Highest (I) Flood Peak during the water year 2012-13



Water Level v/s Time graph of Highest (II) Flood Peak during the water year 2012-13



Water Level v/s Time graph of Highest (III) Flood Peak during the water year 2012-13



Chapter-4: Trend Analysis

4.1 Introduction

Trends are important indicators of the temporal variability of runoff as computed from observed discharge at site. By analyzing the time sequence of the runoff, we assess the magnitude and significance of the temporal variability. The present surface runoff trend study involves analysis of the temporal variability of data sets on the observed discharges in Tapi basin using available data of existing river gauging stations.

4.2 Methodology

In the analysis of the trends of runoff on Tapi River and its major tributary Purna, annual runoff is computed and analysed. The analysis is carried out for five (5) river gauging stations with sufficiently long and continuous data sets that are fairly representatively distributed across Tapi river Basin.

Overall five stations have been considered in this study. The length of the data sets of river gauging station varies from 22 to 40 years. Subsequently, time series are analysed on various statistical parameters, fitting of mathematical equations, observing moving means for various period so as to find out if there are any trends in the annual runoff data.

4.2.1 Time series analysis

Time series is defined as a sequence of values arrayed in order of their occurrence which can be characterized by statistical properties. Time series analysis may be used to test the variability, homogeneity and trend of a stream flow series or simply to give an upright list the characteristics of the series as graphically displayed. Significant movements of time series are the secular, periodic, cyclic and irregular trends. A time series may display a tendency to increase or decrease, over a specified period. Such a series provides an interesting illustration because if the trend is usually predominant, virtually no other movements are discernible.

Various methods exist for analysis of time series such moving averages, residual series, residual mass curves and balance. Trends may also be revealed by determining if observed stream flow follows some mathematical equation as a function of time.

In this chapter, first statistical parameters have been computed for time series data of annual runoff at different sites in Tapi basin. It is also ascertained if

any mathematical equation can be fitted to the time series to assess predictability. Finally, the data is analysed by the method of moving means for various periods.

4.3 Availability of Data

There are 5 G&D sites in Tapi Basin. Availability of annual runoff data for these sites is summarized in **Table-17**.

Table-17: Availability of Data

S. no.	Site	Period of Availability	Years
1.	Burhanpur on Tapi River	1973-74 to 2012-13	40
2.	Yerli on Purna River	1973-74 to 2012-13	40
3.	Gopalkheda On Purna River	1977-78 to 2012-13	36
4.	Gidhade On Tapi River	1990-91 to 2012-13	22
5.	Sarangkheda on Tapi River	1977-78 to 2012-13	36
The data is placed at Annexure-1 and shown in line diagram in Fig- 1 .			

4.4 Analysis

4.4.1 Statistical Analysis

Various statistical parameters of the time series of available data are given below in **Table-18**.

Table-18: Statistical parameters of Annual Runoff series at various sites in Tapi Basin

River Gauging Station	Data length (years)	Mean (MCM)	Median (MCM)	standard deviation (MCM)	Co-efficient of variation
Burhanpur	40	4689.6	3970	2460.34	0.525
Yerli	40	2100.5	1822.0	1483.9	0.706
Gopalkheda	36	1020.4	833	714.6	0.700
Gidhade	22	6074.1	4936	3259.1	0.537
Sarangkheda	36	7806.1	6927.5	4434.3	0.560

4.4.2 Fit characteristics

In order to find out if any mathematical equation represents the time series as a function of time, fitting of various types of equations viz. linear, logarithmic, exponential and polynomial have been attempted. Results of such fits are given in the **Table-19** and shown in **Fig 2 through 6**.

Table-19: Fit Characteristics

S. No.	Station name	Standard Deviation σ (MCM)	Coefficient of variance C_v	Mathematical Fit		R^2
1.	Burhan-Pur	2460.34	0.525	Linear	$y = -1.623x + 7925$	0.00006
				Logarithmic	$y = -3278\ln(x) + 29591$	0.00006
				Exponential	$y = 14669e^{-6E-0x}$	0.00
				Polynomial	$y = 0.791x^2 - 3157.x + 3E+06$	0.001
2.	Yerli	1483.9	0.706	Linear	$y = -38.2 x + 78407$	0.091
				Logarithmic	$y = -7629 \ln(x) + 58172$	0.091
				Exponential	$y = 1E+24e^{-0.02x}$	0.134
				Polynomial	$y = 0.158x^2 + 593.x - 55058$	0.091
3.	Gopal-kheda	714.6	0.700	Linear	$y = 1.312x - 1596$	0.00
				Logarithmic	$y = -2599\ln(x) - 18727$	0.00
				Exponential	$y = 45.01e^{0.001x}$	0.00
				Polynomial	$y = 0.421x^2 - 1678.x + 2E+0.06$	0.003
4.	Gidhade	3259.1	0.537	Linear	$y = 11.73 x - 17422$	0.00
				Logarithmic	$y = 23496\ln(x) - 17253$	0.00
				Exponential	$y = 3034e^{0.000x}$	0.00001
				Polynomial	$y = -0.32 x^2 + 141.4x - 14720$	0.00
5.	Sarang-kheda	4434.3	0.560	Linear	$y = -39.56x + 86724$	0.008
				Logarithmic	$y = -7875 \ln(x) + 60620$	0.008
				Exponential	$y = e^{0.004x}$	-0.000

				Polynomial	$y = -3.1715x^2 - 14780.x + 1E+07$	0.015
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4.4.3 Moving Mean Analysis

In [statistics](#), a moving mean (average), also called rolling average, rolling mean or running average, is a type of [finite impulse response filter](#) used to analyze a set of data points by creating a series of [averages](#) of different subsets of the full data set.

The first element of the moving average is obtained by taking the average of the initial fixed subset of the number series. Then the subset is modified by "shifting forward", that is excluding the first number of the series and including the next number following the original subset in the series. This creates a new subset of numbers, which is averaged. This process is repeated over the entire data series. The plot line connecting all the (fixed) averages is the moving average. A moving average is a set of numbers, each of which is the [average](#) of the corresponding subset of a larger set of data points. A moving average may also use unequal weights for each data value in the subset to emphasize particular values in the subset.

A moving average is commonly used with [time series](#) data to smooth out short-term fluctuations and highlight longer-term trends or cycles.

In the present analysis, moving means have been computed for 3, 5 and 7 year periods for various sites of Tapi River Basin and shown in **Fig-7 through 11**.

4.5 Interpretation

4.5.1 Fitting of various statistical/mathematical models viz linear, logarithmic, exponential and polynomial reveals that values of R^2 range from 0.00 to 0.001 for Burhanpur, from 0.091 to 0.134 for Yerli, from 0.000 to 0.003 for Gopalkheda, from 0.000 to 0.00001 for Gidhade, and 0.00 to 0.015 for Sarangkheda. The values of R^2 are quite close to 0 indicating absence of any significant trend.

4.5.2 As regards the Purna, tributary of river Tapi, a decreasing trend is seen at site Yerli from the plot of moving mean averages from about mid-nineties, which again shows signs of rising by 2010, though no trend is visualized on the upstream site Gopalkheda on Purna. On the main stream Tapi, it may be seen from the moving mean analysis that there does not appear any significant trend as observed from 3 year moving mean. But as we prolong the period of mean, cyclicalness or periodicity

begins to appear. However, in view of the limited length of data series, it may be premature to conclude that there exists a definite cyclic trend in the annual runoff data.

4.6 Conclusion

Statistically speaking, the annual runoff of river Tapi and its tributary Purna, in general, appears to be a random variable; however elements of cyclicalness cannot be ruled out on the strength of moving mean analysis. A longer set of time series data may help identify trends in annual runoff, if any.



Annexure-I: Annual Runoff data at Various Sites in Tapi Basin

(MCM)

Site	Burhanpur	Yerli on	Gopalkheda	Gidhade on	Sarangkheda
Year	on Tapi	Purna	on Purna	Tapi	on Tapi
1973-74	8714	3404			
1974-75	1736	1376			
1975-76	5620	2282			
1976-77	3892	2224			
1977-78	3951	2693	284		1111
1978-79	6979	3804	1802		10810
1979-80	4637	4706	1727		12045
1980-81	4612	1875	913		8880
1981-82	5241	2618	1504		9946
1982-83	1834	657	321		3368
1983-84	5484	3938	1111		14258
1984-85	3895	1074	675		6414
1985-86	1555	1235	354		3185
1986-87	3753	2650	1106		6861
1987-88	1209	723	235		2751
1988-89	6553	7250	3012		16812
1989-90	3957	1812	389		8546
1990-91	10589	4869	1512		16338
1991-92	2638	763	358	4809	4239
1992-93	2889	1731	753	4922	5650
1993-94	6580	1176	361	5784	7884
1994-95	10304	3466	1951	11902	14652
1995-96	3607	1051	582	3236	4226
1996-97	4900	952	708	4883	6403
1997-98	5834	1201	974	5010	6518
1998-99	7328	3014	1785	11163	14427
1999-2000	6691	2254	1221	7016	8097
2000-01	1277	751	545	2600	3154
2001-02	3071	1076	454	3246	3711
2002-03	3168	2649	1213	7536	8618
2003-04	3296	504	1169	4950	6994
2004-05	2357	223	405	2389	3165
2005-06	3342	1040	629	4268	5043
2006-07	4905	3518	1988	14972	17486
2007-08	9797	3340	2827	9288	11414
2008-09	2307	365	211	3551	3443
2009-10	2028	640	295	3573	3071
2010-11	3983	2427	1400	5909	7001
2011-12	5039	857	601	4562	6202
2012-13	8033	1832	1359	8061	8298

Fig 1: Annual Runoff at Various Sites

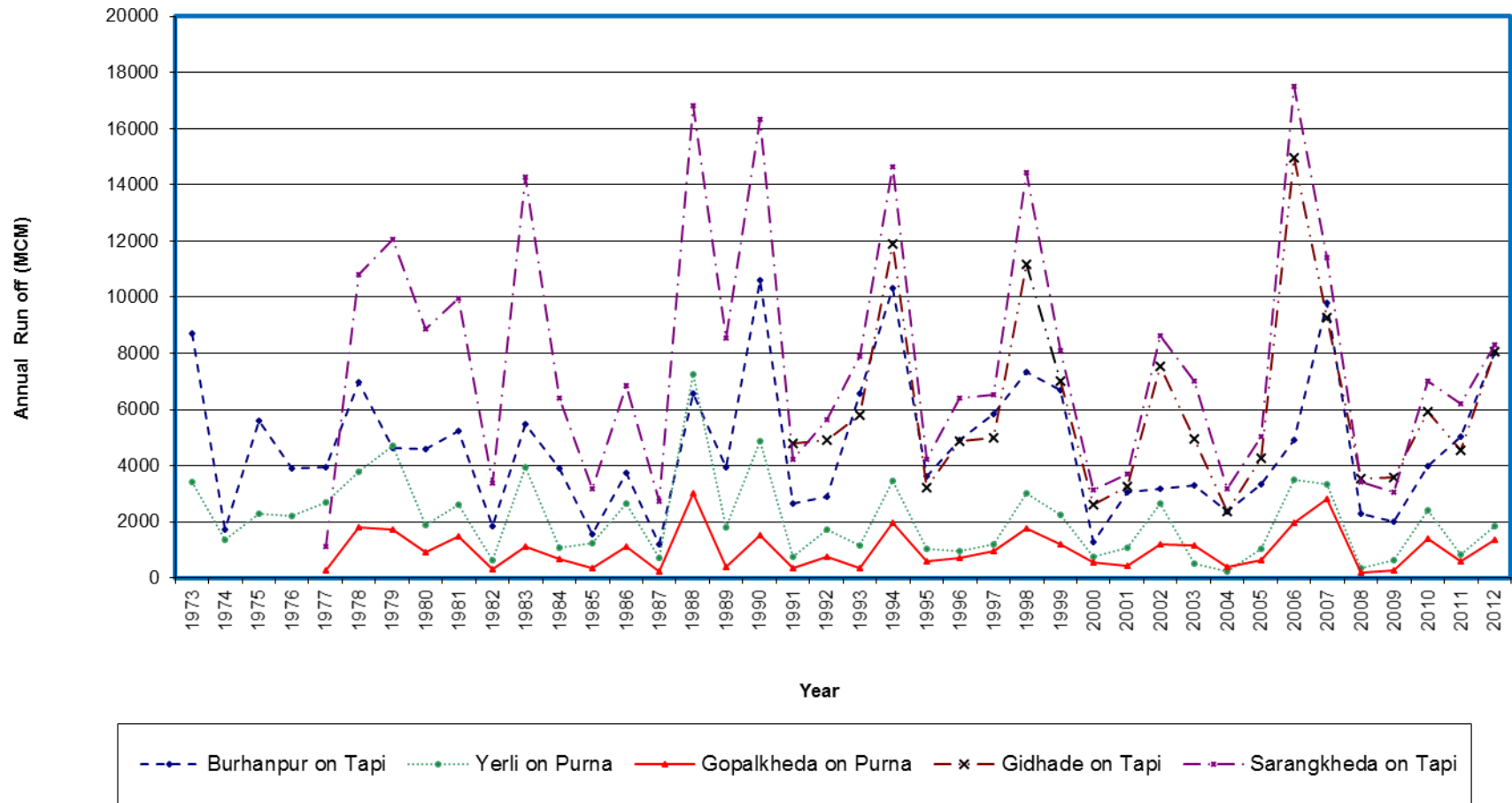


Fig.2: Fit Characteristics at Burhanpur

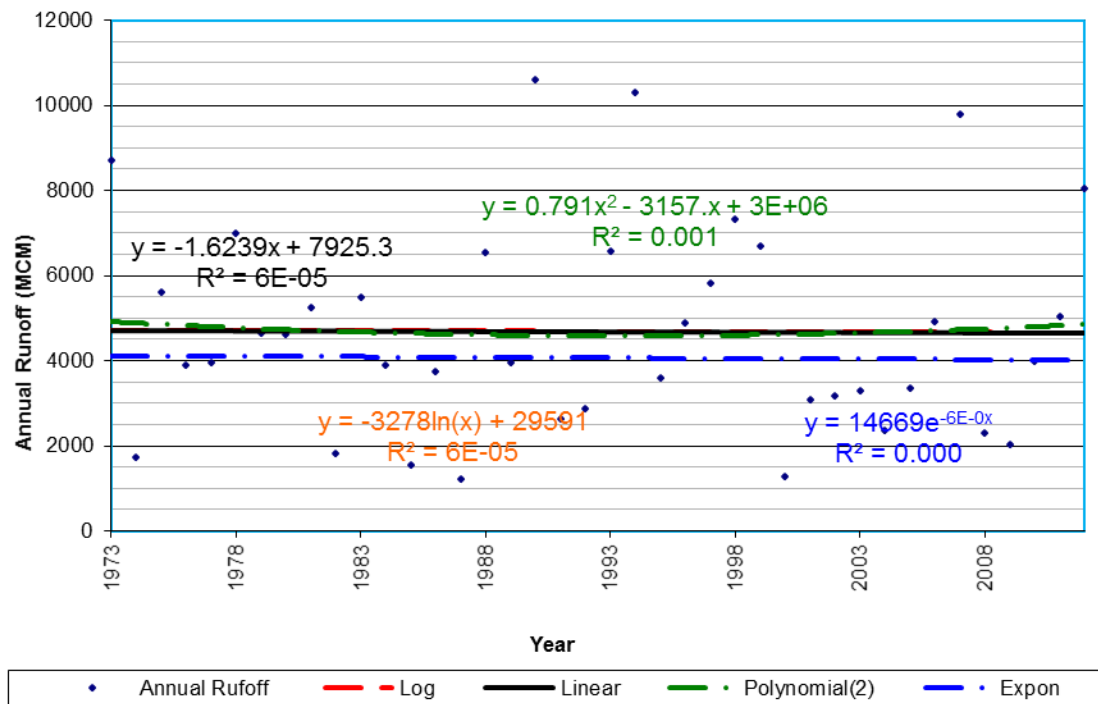


Fig.3: Fit Characteristics at Yerli

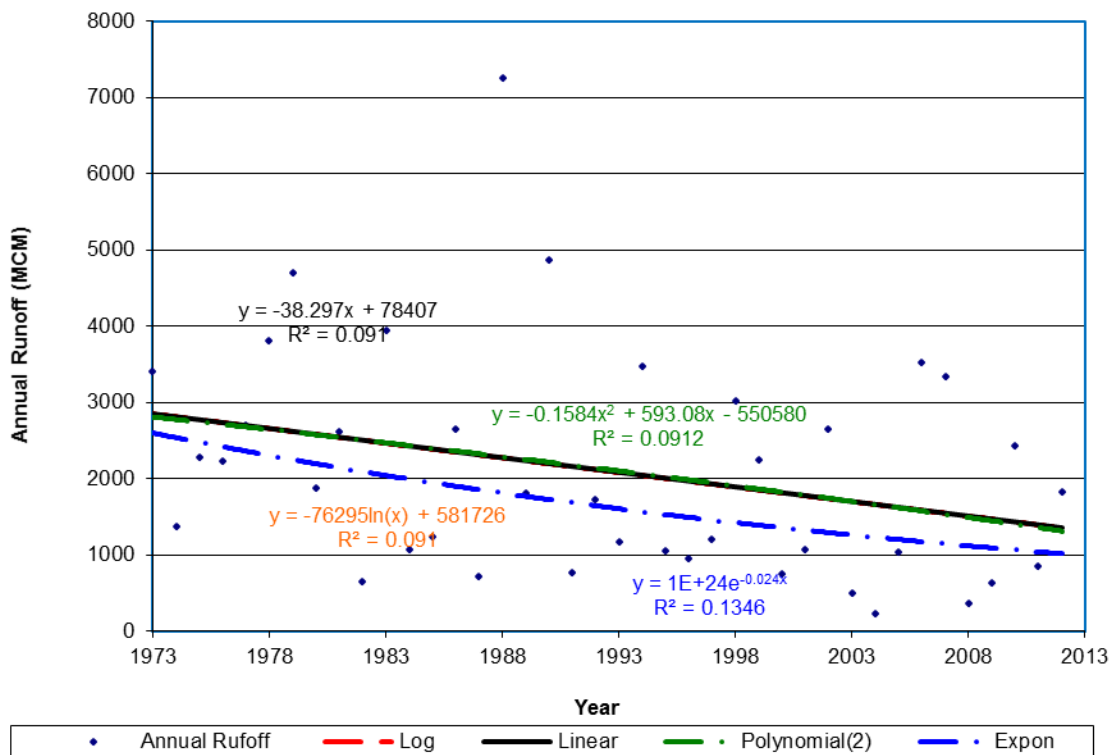


Fig.4: Fit Characteristics at Gopalkheda

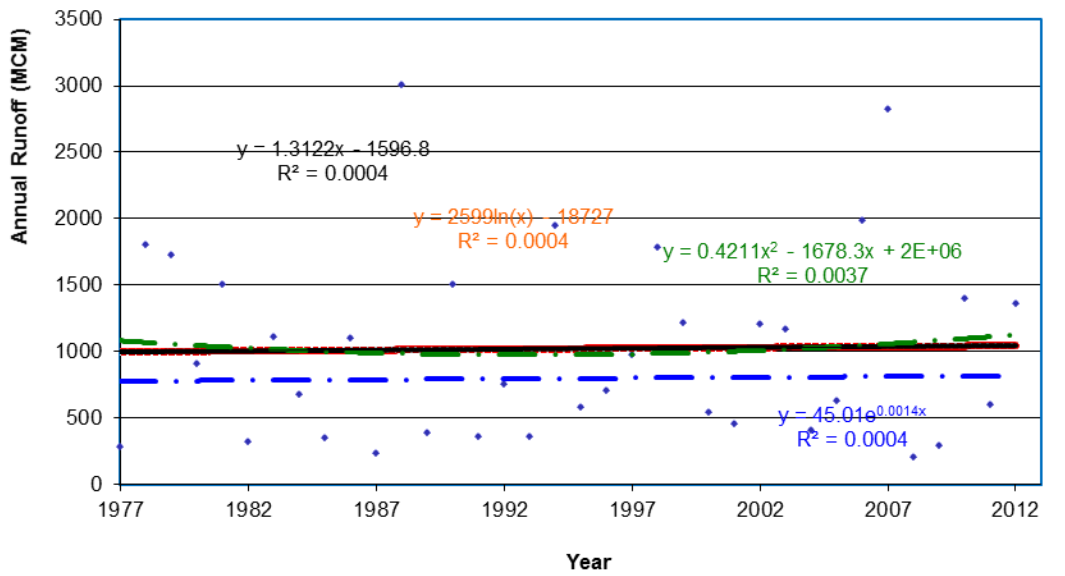


Fig.5: Fit Characteristics at Gidhade

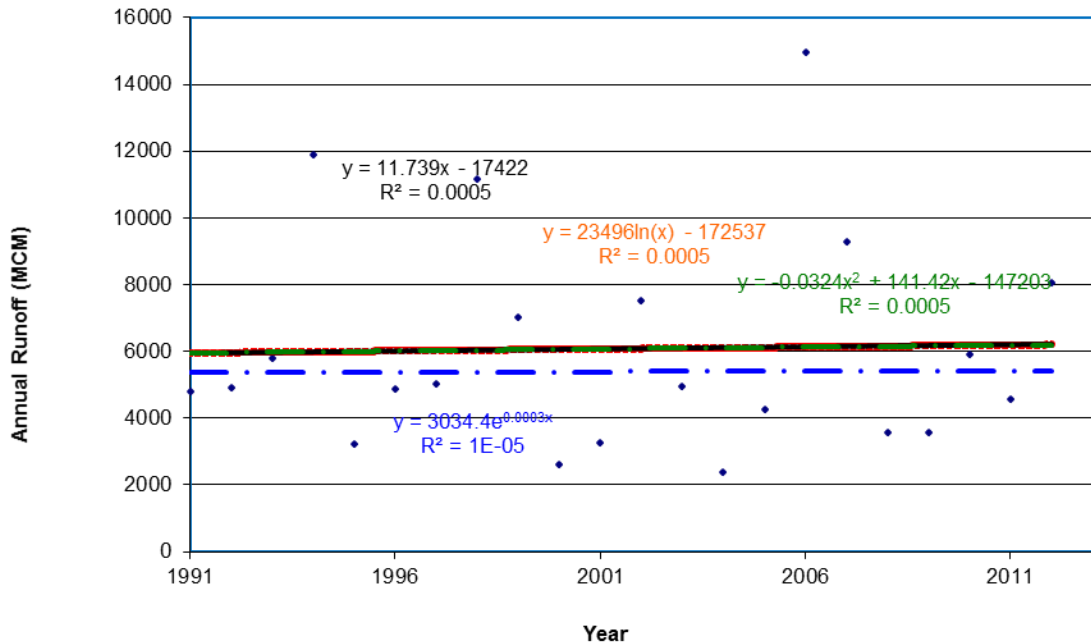


Fig-6: Fit Characteristics at Sarangkhedha

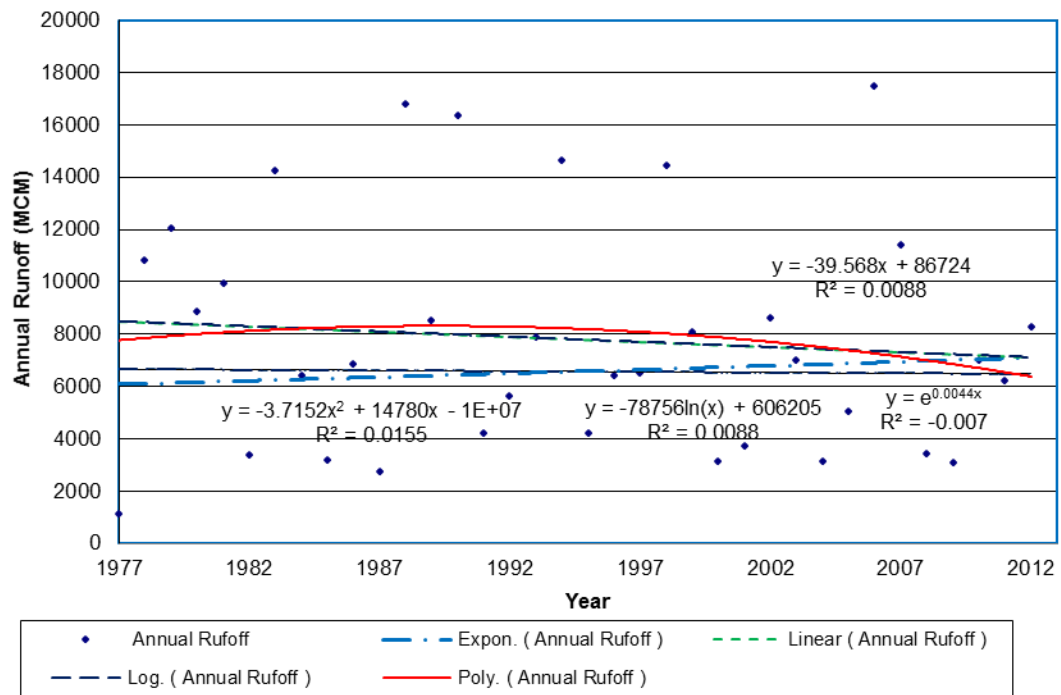


Fig.7: Moving Mean Analysis for Burhanpur

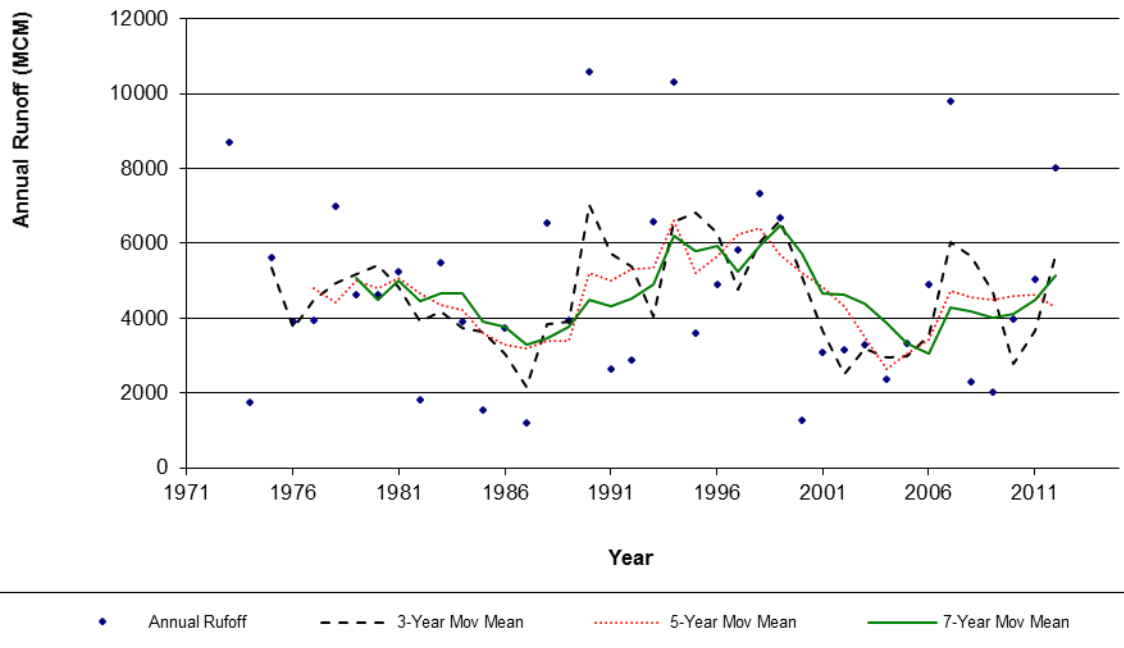


Fig.8: Moving Mean Analysis for Yerli

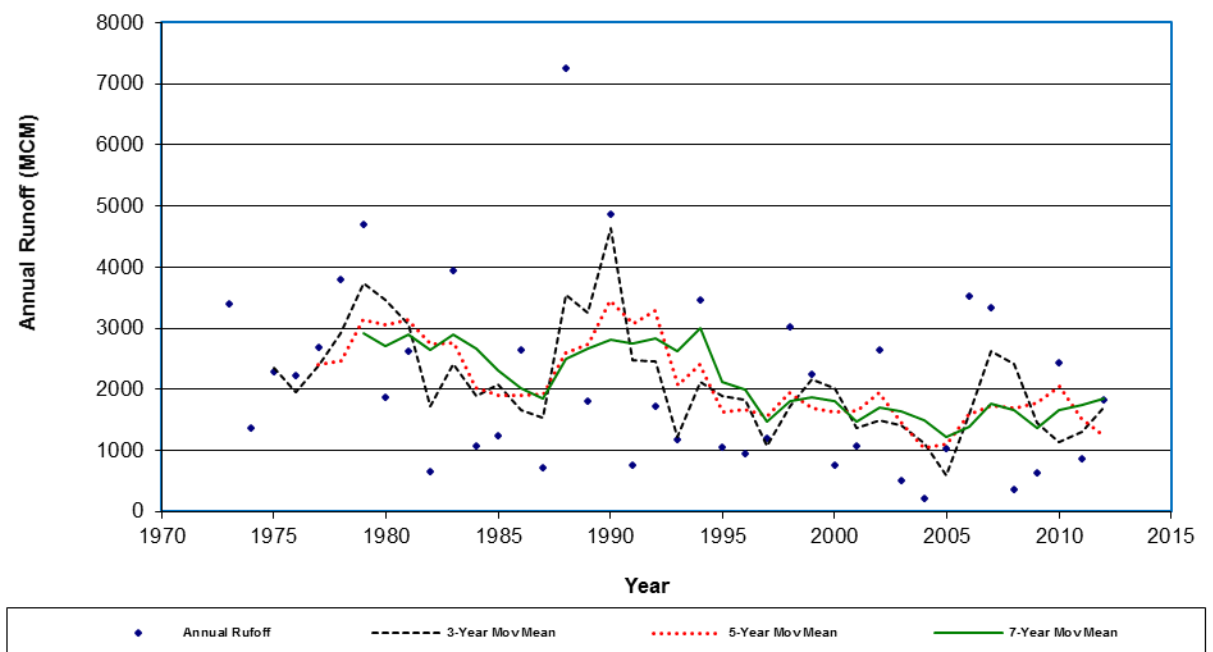


Fig.9: Moving Mean Analysis for Gopalkheda

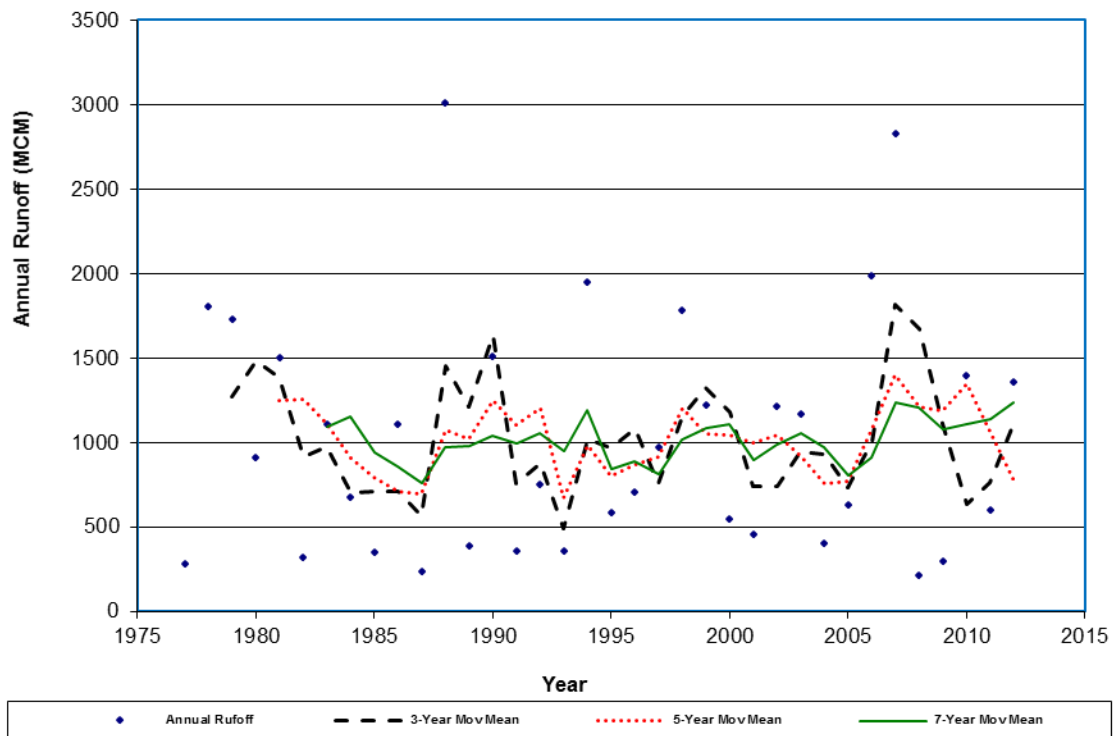


Fig.10: Moving Mean Analysis for Gidhade

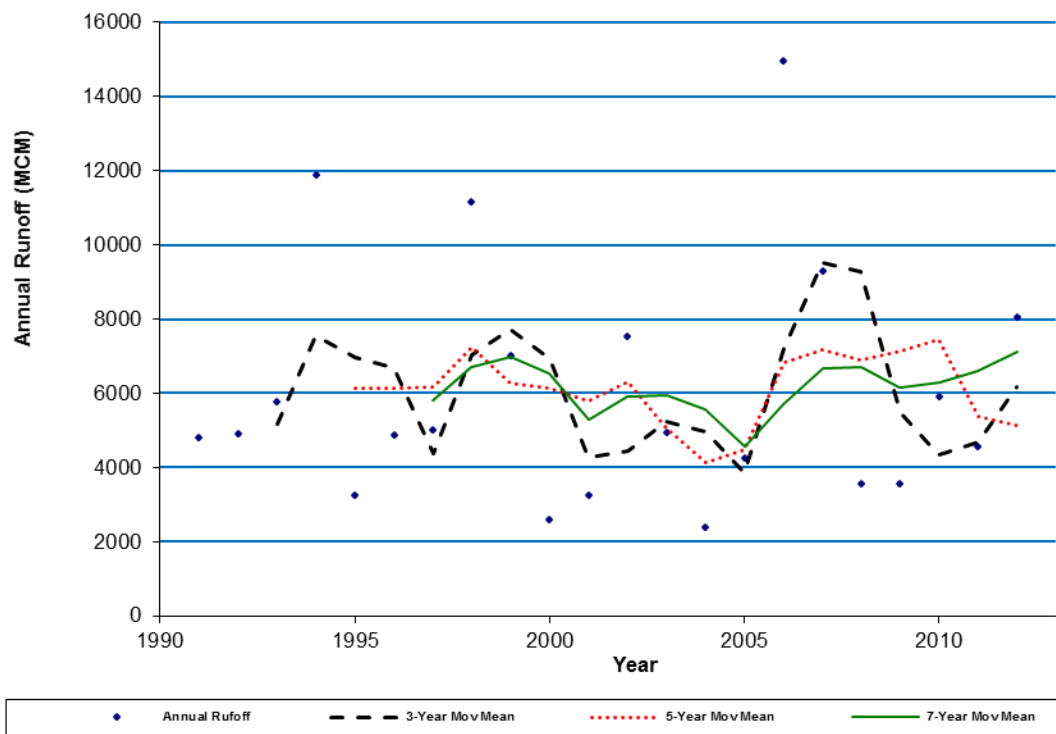


Fig.11: Moving Mean Analysis for Sarangkhedra

