

# Chapter 5

## Water resources and hydrology

### 5.1 General

Planning for water resources development in a basin requires careful assessment of the available water resources and reasonable needs of the basin in the foreseeable future for various purposes such as drinking, irrigation, hydro-power, industries, navigation etc. Hydrological studies are carried out to assess the available quantity of water in a given basin. This chapter deals with the assessment of water balance in the Pennar basin up to the Somasila dam site, in the basins lying enroute the link alignment, in the Cauvery basin up to the Grand Anicut site and simulation study at Somasila reservoir.

### 5.2 Hydrologic Information about the region

#### 5.2.1 Pennar basin

##### 5.2.1.1 Rainfall

The catchment receives rainfall, both during the south-west and north-east monsoon. The rainfall during the non-monsoon period is not significant. The normal rainfall over the basin varies from 550 to 900 mm.

##### 5.2.1.2 Temperature

The Pennar basin experiences cool and hot weather. In the cool weather, the temperature falls as one advances from Nellore towards Kurnool. The mean daily maximum and mean daily minimum temperature are 34.6° C and 15.2° C respectively at Cuddapah and Arogyavaram. During hot weather, the mean daily maximum and the mean daily minimum temperature at representative places like Cuddapah and Arogyavaram are from 40.9°C and 16.9°C respectively.

##### 5.2.1.3 Relative humidity

In general, the humidity is high during the monsoon period and moderate during the non-monsoon period. The relative humidity in the catchment ranges from 21% to 84%.

#### **5.2.1.4 Wind speed**

Wind velocity is generally low to moderate and increases in monsoon season. The catchment is influenced by winds from south-west and north-west during the period from May to September and from north-east and south-east during the period from October to April. The average wind speed in the catchment varies from 4.3 km/hr to 21.3 km/hr.

#### **5.2.1.5 Cloud cover**

Generally, sky is heavily clouded during the monsoon period. During the post-monsoon period, the cloud cover decreases and the rest of the year, the sky is clear or partially clouded. The cloud cover in the catchment ranges from 1.3 oktas to 7.1 oktas.

### **5.2.2 Area covered by the streams between Pennar and Palar basins**

#### **5.2.2.1 Rainfall**

The basin receives most of the rainfall from the south-west and north-east monsoons. The annual rainfall of the basin varies from 596 mm to 1684 mm.

#### **5.2.2.2 Temperature**

The temperature in the upper reaches of the basin is lesser than that of the coastal plains in the summer season. For most of the period it is very hot and sultry near the coastal plains. The mean daily maximum and minimum temperature recorded at Chennai IMD observatory are 37.6 °C and 20.3 °C respectively with maximum of 45.8 °C recorded on 21.05.1910 and minimum of 13.0 °C recorded on 29.01.1905.

#### **5.2.2.3 Wind speed**

The monthly mean maximum and minimum wind speed data observed at the Chennai IMD observatory are 16.4 km/hr and 9.0 km/hr respectively.

#### **5.2.2.4 Relative humidity**

The relative humidity is high during the monsoon in the month of December and low in the non-monsoon period in the month of May. The coastal plains have more humidity than the upper reaches. The monthly

mean maximum and minimum relative humidity values of Chennai IMD observatory are 84% and 58% respectively.

#### **5.2.2.5 Cloud cover**

The sky is heavily clouded during the monsoon period and during the cyclone depressions. During the remaining part of the year the sky is clear and moderately clouded during afternoons. The maximum and minimum monthly cloud cover data at Chennai IMD observatory are 7.1 oktas and 1.9 oktas respectively.

### **5.2.3 Palar basin**

#### **5.2.3.1 Rainfall**

The basin receives most of the rainfall from the south-west and north-east monsoons. The annual rainfall of the basin varies from 547 mm to 1229 mm.

#### **5.2.3.2 Temperature**

The monthly mean daily temperature observed at Vellore IMD observatory, located in the Central region of the basin, ranges from 18.2<sup>0</sup> C in the month of January to 38.4<sup>0</sup> C in the month of May. The annual mean temperature varies from 22.8<sup>0</sup> C to 33.1<sup>0</sup> C with maximum of 44.4<sup>0</sup> C recorded on 18.5.1906 and minimum of 11.70 C recorded on 31.1.1946.

#### **5.2.3.3 Relative humidity**

The relative humidity is high during the north-east monsoon and low in the non-monsoon. The coastal plains and uplands have more humidity than at the upper reaches. The mean relative humidity varies from 39% in the month of April to 85% in the months of December and January as observed at Vellore IMD observatory.

#### **5.2.3.4 Wind speed**

Winds are generally moderate with some increase in force in monsoon months. From May to September winds are generally south-westerly to westerly and on afternoons north-westerly. In October, wind blows from the north-east or east and these predominate in the period from November to January. Thereafter there is a gradual clockwise shift of

the wind direction, particularly in the mornings till April, when winds are mainly south-westerly to westerly in mornings and between north-east and south-east in the afternoons. The monthly mean maximum and minimum wind speed data observed are 9.9 km/hr and 4.9 km/hr at the Vellore IMD observatory.

#### **5.2.3.5 Cloud cover**

The sky is heavily clouded during the monsoon period and cyclonic depressions. In the remaining part of the year, the sky is clear and moderately clouded during afternoons. The maximum and minimum monthly cloud cover data at Vellore IMD observatory are 6.6 oktas and 2.6 oktas respectively.

### **5.2.4 Area covered by the streams between Palar and Cauvery basins**

#### **5.2.4.1 Rainfall**

This basin receives most of the rainfall from the south-west and north-east monsoons. The annual rainfall of the basin varies from 553 mm to 1315 mm.

#### **2.5.4.2 Temperature**

Three IMD observatories are located in this basin at Cuddalore, Kallakurichchi and Bangalore. The monthly mean daily maximum temperature are 36.9<sup>0</sup> C in June, 38.4<sup>0</sup> C in May and 33.4<sup>0</sup> C in April and the monthly mean daily minimum temperature are 20.8<sup>0</sup> C in January, 20.4<sup>0</sup> C in February and 15.0<sup>0</sup> C in January as recorded at Cuddalore, Kallakurichchi and Bangalore observatories respectively.

#### **5.2.4.3 Relative humidity**

The mean relative humidity varies between 24% to 86% at Bangalore IMD observatory; 40% to 77% at Kallakurichchi IMD observatory and 60% to 84% at Cuddalore IMD observatory.

#### **5.2.4.4 Wind speed**

The maximum normal wind speed recorded at Cuddalore and Bangalore are 12.6 km/hr and 17.5 km/hr in the months of May and July

respectively. The minimum normal wind speed of 7.4 km/hr and 8.2 km/hr was recorded in the month of October at both the stations.

#### **5.2.4.5 Cloud cover**

The sky is very cloudy during the monsoon season and is lightly clouded in non-monsoon season. The monthly normals of cloud amount varies from 2.8 oktas to 7.6 oktas at Bangalore IMD observatory; from 2.5 oktas to 6.3 oktas at Kallakurichchi IMD observatory and from 2.9 oktas to 6.5 oktas at Cuddalore IMD observatory.

### **5.2.5 Cauvery Basin**

#### **5.2.5.1 Rainfall**

The western side of the catchment mainly experiences the south-west monsoon from June to September and the eastern side gets most of the rain during north – east monsoon from October to December. The rainfall during the non-monsoon period is not significant. The annual rainfall over the catchment varies from 574 mm to 3345 mm.

#### **5.2.5.2 Temperature**

The climate of the catchment remains dry except in the monsoon months. The mean daily maximum temperature in the basin varies from 19.5°C to 33.7°C and the mean daily minimum temperature varies from 9.1° C to 25.2° C.

#### **5.2.5.3 Relative Humidity**

The mean relative humidity is high during the monsoon period and comparatively low during the post-monsoon period. In summer, the weather is dry and the humidity is low. The relative humidity in the basin ranges from 49% to 86%.

#### **5.2.5.4 Wind Speed**

Winds blow mainly from the directions between the south – west and north – west during the south – west monsoon season. In the post monsoon season, wind blows mainly in the north easterly or easterly direction. During the rest of the year, wind blows from the direction between north and east. The mean wind speed in the basin varies from 5.4 km/hr to 18.9 km/hr.

#### 5.2.5.5 Cloud Cover

Sky is generally heavily clouded during the monsoon season. During the post-monsoon months, cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the basin varies from 4.1 to 5.3 oktas.

### 5.3 Methodology used in computing water balance

#### 5.3.1 Surface water availability

Observed flow data at the terminal G&D site and the rainfall observed at various raingauge stations in and around the catchment of a sub-basin are collected. To these observed flows, year-wise upstream utilisations are added to get virgin yields. Weighted rainfall for the catchment up to the G&D site and for the whole sub-basin are worked out. Using these virgin flows and weighted rainfall up to the G&D site, a rainfall -runoff relationship (linear/non-linear) is developed by statistical methods. Using the best fit equation and weighted rainfall for the entire sub-basin, monsoon yields are computed. To the monsoon yields, non-monsoon yields are added for arriving at annual gross yields for the entire sub-basin. The annual gross yields thus arrived at are arranged in descending order, from which 50% and 75% dependable annual gross yields are obtained.

The overall surface water available in a sub-basin is arrived at by summing up the yield (at 50% and 75% dependabilities separately), and imports and by deducting the exports, if any, from the sub-basin.

#### 5.3.2 Water requirement

The requirements of water at the ultimate stage for various uses viz. irrigation, domestic, industrial and hydro-power are worked out as follows:

**Irrigation needs:** The requirements for irrigation are worked out for all the existing, ongoing and proposed major, medium and minor projects in a sub-basin. For this purpose, all the projects planned by the states as per their master plans are considered. The designed annual utilisation is considered for the existing and ongoing projects. The requirements for future projects are determined by adopting intensities of irrigation as 150%, 125% and 100% for major, medium and minor projects

respectively. For assessing the crop water requirements by climatological approach, the potential evapotranspiration values for various stations as given in the IMD scientific report No.136 (1971) are adopted. In the case of a deficit basin, if the ultimate annual irrigation considering all the existing, ongoing and future major, medium and minor projects works out to less than 30% of the maximum culturable area of the sub-basin, the requirements are calculated by increasing the annual irrigation to 30% of the maximum culturable area of the sub-basin. And in the case of a surplus basin, the annual irrigation at the ultimate stage is increased to 60% of the maximum culturable area. 50% of such increased annual irrigation is considered to be under future medium projects and the remaining 50% under future minor schemes.

**Domestic needs:** The requirement of water for domestic consumption by the rural and urban human population and for the livestock is estimated by projecting the rural, urban human population and the livestock of the catchment to 2025 AD using the available census data. Per capita water requirement of 70 litres, 200 litres and 50 litres per day is considered for the rural human population, urban human population and livestock population respectively as per the recommendations of the Ministry of Works and Housing in their manual "Water Supply and Treatment". The requirement of 50% of the rural human population and of the entire livestock is considered to be met from groundwater and the requirement for the remaining 50% of rural population and the entire urban population is considered to be met from surface water. However, in the water balance reports being revised now, the population projections are made to 2050 AD instead of 2025 AD.

**Industrial needs:** In the absence of relevant data to estimate precisely the industrial water needs, industrial requirement is taken to be equivalent to the total domestic requirement for human population and livestock. The entire industrial requirement is considered to be met from surface water.

**Hydropower needs: Requirement** for the hydropower is taken to be the evaporation losses at the reservoirs of hydroelectric projects. Wherever the evaporation data of the projects is available, the same is made use of and wherever the data is not available, the same is worked out from the water spread area of the reservoir, assuming suitable evaporation values.

### **5.3.3 Regeneration**

The regeneration is considered as (a) 10% of the net utilisation for irrigation from all the existing, ongoing and future identified major and medium projects, and (b) 80% of the domestic and industrial uses to be met from the surface water.

### **5.3.4 Water balance**

The total water requirement of a sub-basin, worked out on the methodology outlined above, is deducted from the overall surface water availability at 75% and 50% dependabilities to determine the water balances (surplus/deficit) at those dependabilities respectively.

## **5.4 Surplus water availability**

### **5.4.1 Hydrological and water balance studies of Pennar basin up to Somasila project**

The Pennar basin has been divided into 4 sub-basins for the purpose of hydrological studies. These are (1) Upper Pennar (from source to the confluence of river Chitravati including the catchments of Jayamangali and Chitravati) (2) Middle Pennar (from the confluence of Chitravati to the confluence of Papagni including the catchment of Kunderu and Papagni), (3) Lower Pennar (from the confluence of Papagni to the confluence of Cheyyeru), and (4) Pennar delta (from the confluence of Cheyyeru to the sea). The catchment area of Pennar basin up to Somasila project includes catchments of the three upper sub-basins viz. Upper Pennar, Middle Pennar, Lower Pennar and part of Pennar delta sub-basin up to Somasila project.

The catchment extends over an area of 50493 km<sup>2</sup>, which works out to 91.5% of the total catchment area of the Pennar basin and lies in the States of Karnataka (6937 km<sup>2</sup>) and Andhra Pradesh (43556 km<sup>2</sup>). The hydrological studies in respect of all the above sub-basins have been carried out by NWDA and the annual yield series of each sub-basin have been developed.

The gross annual yields of the catchment of Pennar basin up to Somasila project for the period from 1901-02 to 1989-90 have been arrived at by adding the gross annual yields of the three upper sub-basins and of the part catchment of Pennar delta sub-basin up to Somasila project. By arranging the combined annual yield series in descending order, the 75%



and 50% dependable annual gross yields of the catchment have been found to be 1892 Mm<sup>3</sup> and 3242 Mm<sup>3</sup> respectively.

Surface water needs for irrigation have been assessed by considering the ultimate annual irrigation. The surface water requirement for irrigation from all the existing, ongoing and future major, medium and minor projects is given in Table 5.1.

**Table 5.1**  
**Ultimate irrigation and surface water requirement in the catchment of Pennar basin up to Somasila project**

Project Category/State	Annual irrigation (ha)			Annual utilisation (Mm <sup>3</sup> )		
	In basin	Import	Total	In basin	Import	Total
<b>Existing</b>						
Andhra Pradesh	176036	138525	314561	1392	1379	2771
Karnataka	28842	-	28842	201	-	201
<b>Ongoing</b>						
Andhra Pradesh	51400	223904	275304	399	1615	2014
Karnataka	21414	-	21414	152	-	152
<b>Proposed</b>						
Andhra Pradesh	85435	-	85435	852	-	852
Karnataka	3112	37191	40303	33	394	427
<b>Additional Area to cover 30% of CCA</b>						
Andhra Pradesh	134473	-	134473	1291	-	1291
Karnataka	16647	-	16647	160	-	160
<b>Total</b>	<b>517359</b>	<b>399620</b>	<b>916979</b>	<b>4480</b>	<b>3388</b>	<b>7868</b>

The requirement of water for domestic use in the rural and urban areas and for livestock has been computed by projecting the rural and urban population and livestock to 2025 AD. The total domestic water needs are assessed to be 799 Mm<sup>3</sup>. Details are given in Table 5.2.

**Table 5.2**  
**Domestic water requirement by 2025 AD of Pennar basin up to Somasila project**

Category	Population in thousands	Per capita daily needs (Litres)	Water requirement (Mm <sup>3</sup> )
Rural	12186	70	311
Urban	4308	200	314
Live stock	9573	50	174
<b>Total</b>			<b>799</b>

The urban population water requirement and 50% of the rural population water requirement is proposed to be met from the surface water resources. 80% of domestic water use to be met from surface water source is considered to be available as regeneration to the streams. The industrial requirement by 2025 AD has been assumed to be of the same order as that of domestic water requirement which is 799 Mm<sup>3</sup>. It is proposed to be met from the surface water sources. 80% of this use is considered to be available as return flow to the streams.

The water balance computations at Somasila project site taking into account the availability, import, regeneration and water needs is given in Table 5.3.

**Table 5.3**  
**Surface water balance at Somasila Project on the**  
**river Pennar**

Units: Mm<sup>3</sup>

<b>1.</b>	<b>Availability</b>		
	a) Gross annual yield		
	i) At 75% dependability		1892
	ii) At 50% dependability		3242
	b) Surface water import (+)		3813**
	c) Surface water export (-)		1865 (2776*)
	d) Overall availability		
	i)At 75% dependability		3840
	ii)At 50% dependability		4279
<b>2.</b>	<b>Surface water requirement for</b>		
	i) Irrigation	7868	
	ii) Domestic use	470	
	iii) Industrial use	799	
	iv) Hydro-power use	NIL	
	Sub-total	9137	9137
<b>3.</b>	<b>Regeneration (+)</b>		
	i) Irrigation	460	
	ii) Domestic use	376	
	iii) Industrial use	639	
	Sub-total	1475	1475
<b>4.</b>	<b>Surface water balance</b>		
	i)At 75% dependability		(-) 3822
	ii)At 50% dependability		(-) 3383

Note: \* Export includes 911 Mm<sup>3</sup> of water to be exported to streams between Pennar and Palar through Telugu Ganga canal to be met from 50% dependable yields available at the Somasila Project.

\*\* Import includes 425 Mm<sup>3</sup> meant to Madras Water Supply.

#### 5.4.2 Hydrological and water balance studies of enroute basins

The Pennar – Palar – Cauvery link project is envisaged to divert the surplus water made available at Somasila by the preceding links namely Nagarjunasagar- Somasila and Srisaillam – Pennar. The enroute river basins namely Basin area covered by Streams between Pennar and Palar, Palar Including Poini and Cheyyar, and Basin area covered by the streams between Palar and Cauvery are found to be deficit as such, no additional water is proposed to be transferred. However the water balance status of above enroute river basins are given as Tables 5.4, 5.5 & 5.6.

**Table 5.4**  
**Surface water balance in the basin area covered by streams between Pennar and Palar**

1.	Availability	Units: Mm <sup>3</sup>	
	a) Gross annual yield		
	i) At 75% dependability		2021
	ii) At 50% dependability		2436
	b) Surface water import (+)		1936**
	c) Surface water export (-)		NIL
	d) Overall availability		
	i)At 75% dependability		<b>3957</b>
	ii)At 50% dependability		<b>4372</b>
2.	Surface water requirement for		
	i) Irrigation	3282	
	ii) Domestic use	1383	
	iii) Industrial use	1533	
	iv) Hydro-power use	NIL	
	<b>Sub-total</b>	<b>6198</b>	<b>6198</b>
3.	Regeneration (+)		
	i) Irrigation	121	
	ii) Domestic use	470	
	iii) Industrial use	590	
	<b>Sub-total</b>	<b>1181</b>	<b>1181</b>
4.	Surface water balance		
	i)At 75% dependability		<b>(-)1060</b>
	ii)At 50% dependability		<b>(-) 645</b>

**Table 5.5**  
**Surface water balance in the Palar including Poini and**  
**Cheyar basin**

<b>1. Availability</b>	Units: Mm <sup>3</sup>	
a) Gross annual yield		
i) At 75% dependability		1455
ii) At 50% dependability		1832
b) Surface water import (+)		Nil
c) Surface water export (-)		299
d) Overall availability		
i)At 75% dependability		1156
ii)At 50% dependability		1533
<b>2. Surface water requirement for</b>		
i) Irrigation	3145	
ii) Domestic use	383	
iii) Industrial use	580	
iv) Hydro-power use	NIL	
Sub-total	4108	4108
<b>3. Regeneration (+)</b>		
i) Irrigation	42	
ii) Domestic use	306	
iii) Industrial use	464	
Sub-total	812	812
<b>4. Surface water balance</b>		
i)At 75% dependability		(-) 2140
ii)At 50% dependability		(-) 1763

**Table 5.6**  
**Surface water balance in the basin area covered**  
**by streams between Palar and Cauvery**

<b>1. Availability</b>	Units: Mm <sup>3</sup>	
a) Gross annual yield		
i) At 75% dependability		2098
ii) At 50% dependability		2912
b) Surface water import (+)		927
c) Surface water export (-)		NIL
d) Overall availability		
i)At 75% dependability		3025
ii)At 50% dependability		3839
<b>2. Surface water requirement for</b>		
i) Irrigation	5617	
ii) Domestic use	526	
iii) Industrial use	866	
iv) Hydro-power use	NIL	
Sub-total	7009	7009
<b>3. Regeneration (+)</b>		
i) Irrigation	232	
ii) Domestic use	421	
iii) Industrial use	693	
Sub-total	1346	1346
<b>4. Surface water balance</b>		
i)At 75% dependability		(-) 2638
ii)At 50% dependability		(-) 1824

#### **5.4.3 Hydrological and water balance studies of Cauvery basin up to Grand Anicut**

The catchment area of Cauvery basin up to Grand Anicut has been divided into 13 sub-basins. The catchment area of the basin is 70129 km<sup>2</sup> which lies in Karnataka (34273 km<sup>2</sup>), Tamil Nadu (32990 km<sup>2</sup>) and Kerala (2866 km<sup>2</sup>). The sub-basin wise catchment area of Cauvery basin up to Grand Anicut is presented in Table 5.7.

**Table 5.7**  
**Catchment area of Sub-basins of Cauvery basin up to**  
**Grand Anicut**

<b>Sl.No</b>	<b>Name of sub-basin</b>	<b>Catchment area (km<sup>2</sup>)</b>
1	Upper Cauvery	10691
2	Kabini	7040
3	Suvarnavathi	1787
4	Shimsha	8469
5	Arkavathi	4351
6	Middle Cauvery	2676
7	Chinnar	4061
8	Palar	3214
9	Bhavani	6154
10	Noyil	2999
11	Tirumanimuttar	8429
12	Amaravathi	8280
13	Ponnanai Ar	2050
	<b>Total</b>	<b>70129</b>

The hydrological studies in respect of all the above sub-basins have already been carried out by National Water Development Agency and the annual yield series have been generated. The annual gross yields of above sub-basins have been added to arrive at the annual gross yields of the Cauvery basin up to Grand Anicut. The 75% and 50% annual yields thus assessed are 15337 Mm<sup>3</sup> and 17350 Mm<sup>3</sup> respectively.

The ultimate surface water requirement for irrigation in the basin is shown in the Table 5.8.

**Table 5.8**  
**Ultimate annual irrigation and surface water**  
**requirement in Cauvery basin up to Grand Anicut**

<b>Project</b>	<b>Annual irrigation (ha)</b>	<b>Annual utilisation (Mm<sup>3</sup>)</b>
<b>Category/State</b>		
<b>Existing</b>		
Karnataka	367289	5046
Tamil Nadu	424985	6050
Kerala	16270	125
<b>Ongoing</b>		
Karnataka	575823	4026
Tamil Nadu	9808	65
Kerala	25287	275
<b>Proposed</b>		
Karnataka	157227	1682
Tamil Nadu	20487	204
Kerala	68251	745
<b>Additional area</b>		
Karnataka	67418	450
Tamil Nadu	148395	1584
Kerala	-	-
<b>Grand Total</b>	<b>1881240</b>	<b>20253</b>

Regeneration from irrigation utilisation is taken as 18% of net water utilisation from the existing old irrigation projects and 10% of net water utilisation from all the remaining existing, ongoing and identified future major and medium projects. The total regeneration from irrigation works out to 1726 Mm<sup>3</sup>.

The domestic water needs of the projected human and livestock population of the basin to 2050 AD have been assessed to be 3318 Mm<sup>3</sup>. Details are given in Table 5.9.

**Table 5.9**  
**Domestic water requirement by 2050 AD in Cauvery**  
**basin up to Grand Anicut**

Category	Population in thousands	Per capita daily needs (Litres)	Water requirement (Mm <sup>3</sup> )
Rural	21277	70	544
Urban	31462	200	2297
Live stock	26126	50	477
Total			3318

The urban water requirement in full and 50% of the rural water requirement is proposed to be met from surface water sources. This works out to 2569 Mm<sup>3</sup>. 80% of domestic water needs to be met from surface water sources is considered to be available as regeneration to the streams, which works out to 2055 Mm<sup>3</sup>. The industrial water requirement by 2050 AD has been assumed to be of the same order as that of domestic water requirement, which is 3318 Mm<sup>3</sup>. The entire industrial needs is proposed to be met from surface water resources. 80% this use is considered to be available as return flow to the streams.

The total evaporation losses of all Hydel Power projects in the catchment works out to 47 Mm<sup>3</sup>.

The water balance in the basin taking into account the availability, import, export, regeneration and water needs is given in Table 5.10.



**Table 5.10**  
**Surface water balance in Cauvery basin up to Grand Anicut**

<b>1. Availability</b>	Units: Mm <sup>3</sup>	
a) Gross annual yield		
i) At 75% dependability		15337
ii) At 50% dependability		17350
b) Surface water import (+)		744
c) Surface water export (-)		12479
d) Overall availability		
i)At 75% dependability		3602
ii)At 50% dependability		5615
<b>2. Surface water requirement for</b>		
i) Irrigation	20253	
ii) Domestic use	2569	
iii) Industrial use	3318	
iv) Hydro-power use	47	
Sub-total	26187	26187
<b>3. Regeneration (+)</b>		
i) Irrigation	1758	
ii) Domestic use	2055	
iii) Industrial use	2654	
Sub-total	6467	6467
<b>4. Surface water balance</b>		
i)At 75% dependability		(-) 16118
ii)At 50% dependability		(-) 14105