

## Water Resources

WATER is vital for realising the full potential of the agriculture sector and the country's development. Optimum development and efficient utilisation of our water resources, therefore, assumes great significance.

The Ministry of Water Resources lays down policies and programmes for development and regulation of the country's water resources. It covers sectoral planning, coordination, policy guidelines, technical examination and techno-economic appraisal of projects, providing Central assistance to specific projects, facilitation of external assistance and assistance in resolution of inter-state water disputes, policy formulation, planning and guidance in respect of minor irrigation, command area development and development of ground water resources, etc.

The National Water Policy, adopted in September 1987, stresses that 'Water is a prime natural resource, a basic human need and a precious national asset. Planning and development of water resources need to be governed by national perspectives'. Since the adoption of the National Water Policy in 1987, a number of problems and challenges have emerged in the development and management of the water resources sector. Accordingly, the National Water Board in its meeting on 29 October 1998 reviewed the existing National Water Policy 1987, considered proposed changes and finalised and updated draft National Water Policy 1998. The updated National Water Policy will be placed before the National Water Resources Council for its consideration and adoption.

### WATER RESOURCES POTENTIAL

Average run-off in the river system of the country has been assessed as 1869 Km<sup>3</sup>. Of this, the utilisable portion is estimated as about 690 Km<sup>3</sup>. In addition, there is substantial replenishable ground water potential in the country estimated at 432 Km<sup>3</sup>. The per-capita availability of water has reduced from about 5277 m<sup>3</sup> in the year 1955 to the present level of 1970 m<sup>3</sup>. The situation may aggravate in future due to the growing water scarcity in the river basins.

### IRRIGATION DEVELOPMENT

Expansion of irrigation facilities along with consolidation of the existing systems has been the main strategy for increasing production of foodgrains. Irrigation support is provided through major, medium and minor irrigation projects and command area development. With sustained and systematic development of irrigation, irrigation potential has increased from 22.6 mha in 1951, when the process of planning began in India, to about 89.56 mha (provisional) at the end of the Eighth Plan (1992-97). The statistics relating to irrigation potential created and utilised under major, medium and minor irrigation during the various Five Year Plans, ground-water resources and irrigation potential of India are given in tables 16.1 and 16.2 respectively.

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TABLE : 16.1 : PLANWISE POSITION OF IRRIGATION POTENTIAL CREATED AND UTILISED

(in million Ha.)

Plan	Potential Created			Potential Utilised			Total
	Major & Medium	Minor		Major & Medium	Minor		
		S.W. <sup>1</sup>	G.W. <sup>2</sup>		S.W. <sup>1</sup>	G.W. <sup>2</sup>	
At the end of							
-I Plan (1951-56)	12.20	6.43	7.63	10.98	6.43	7.63	25.04
-II Plan (1956-61)	14.33	6.45	8.30	13.05	6.45	8.30	27.80
-III Plan (1961-66)	16.57	6.48	10.52	15.17	6.48	10.52	32.17
-Annual Plans (1966-69)	18.10	6.50	12.50	16.75	6.50	12.50	35.75
-IV Plan (1969-74)	20.70	7.00	16.50	18.69	7.00	16.50	42.19
-V Plan (1974-78)	24.72	7.50	19.80	21.16	7.50	19.80	48.46
-Annual Plans (1978-80)	26.61	8.00	22.00	22.64	8.00	22.00	52.64
-VI Plan (1980-85)	27.70	9.70	27.82	23.57	9.01	26.24	58.82
-VII Plan (1985-90)	29.92	10.99	35.62	25.47	9.97	33.15	68.59
-Annual Plans (1990-92)	30.74	11.46	38.89	26.32	10.29	36.25	72.86
-VIII Plan (Provisional) (1992-97)	32.96	N.A. <sup>3</sup>	N.A. <sup>3</sup>	28.44	N.A. <sup>3</sup>	N.A. <sup>3</sup>	80.76

<sup>1</sup> S.W. — Surface water

<sup>2</sup> G.W. — Ground water

<sup>3</sup> N.A. — Not available

TABLE 16.2 : GROUND-WATER RESOURCE AND IRRIGATION POTENTIAL OF INDIA

Sr. No.	States/UTs	Total Replenishable Ground-Water Resource (m.ha.m/Yr)	Provision for Domestic, Industrial & Other Uses (m.ha.m/Yr)	Available Ground-Water Resource for Irrigation in Net Terms (m.ha.m/Yr)	Utilisable Ground-Water Resource for Irrigation in Net Terms (m.ha.m/Yr)	Gross Draft Estimated on Prorata Basis (m.ha.m/Yr)	Net Draft (m.ha.m/Yr)	Balance Ground-Water Resource for Future Use in net terms (m.ha.m/Yr)	Level of Ground-Water Development (%)	Weighted Average Delta (m)	Utilisable Irrigation Potential for Development (m.ha.)
1	2	3	4	5	6	7	8	9	10	11	12
1.	Andhra Pradesh	3.52916	0.52938	2.09978	2.69981	1.01318	0.70922	2.29056	23.64	0.047-1.472	3.96000
2.	Arunachal Pradesh	0.14385	0.02158	0.12227	0.11005	-	-	0.12227	-	-	0.01800
3.	Assam	2.47192	0.37079	2.10113	1.89102	0.13455	0.09418	2.00695	4.48	1.283	0.90000
4.	Bihar	3.35213	0.50282	2.84931	2.56439	0.78108	0.54676	2.30255	19.19	0.40-0.65	4.94763
5.	Goa	0.02182	0.00327	0.01865	0.01670	0.00210	0.00164	0.01701	8.30	0.570	0.02020
6.	Gujarat	2.03767	0.30565	1.73202	1.55881	1.02431	0.71702	1.01500	41.45	0.45-0.714	2.75590
7.	Haryana	0.85276	0.12792	0.72484	0.65236	0.86853	0.60798	0.11686	83.88	0.385-0.8	1.46170
8.	Himachal Pradesh	0.03660	0.00731	0.02929	0.02637	0.00757	0.00530	0.02300	18.10	0.385	0.00850
9.	Jammu and Kashmir	0.044257	0.06639	0.37618	0.33858	0.00713	0.00500	0.37118	1.33	0.385-0.6	0.70795
10.	Karnataka	1.61857	0.24279	1.37578	1.23821	0.61443	0.43010	0.94568	31.26	0.18-0.74	2.57281
11.	Kerala	0.79003	0.13135	0.65868	0.59281	0.14374	0.10062	0.55806	15.28	0.53-0.88	0.87925
12.	Madhya Pradesh	5.08892	0.76332	4.32560	3.89298	1.01866	0.71312	3.61249	16.49	0.400	9.73249
13.	Maharashtra	3.78673	1.23972	2.54701	2.29231	1.10576	0.77403	1.77298	30.39	0.43-1.281	3.65197
14.	Manipur	0.31540	0.04730	0.26810	0.24129	Neg.	Neg.	0.26810	Neg.	0.650	0.36900
15.	Meghalaya	0.05397	0.00810	0.04587	0.04128	0.00260	0.00182	0.04405	Neg.	0.650	0.06351
16.	Mizoram		Not Assessed								
17.	Nagaland	0.07240	0.01090	0.06150	0.05535	Neg.	Neg.	0.06150	Neg.	-	-
18.	Orissa	2.00014	0.30002	1.70012	1.53009	0.20447	0.14313	1.55699	8.42	0.34-0.44	4.20258
19.	Punjab	1.86550	0.18652	1.67898	1.51109	2.25109	1.57576	0.10322	93.85	0.518	2.91715
20.	Rajasthan	1.27076	0.19945	1.07131	0.96418	0.77483	0.54238	0.52893	50.63	0.457-0.6	1.77783
21.	Sikkim		Not Assessed								
22.	Tamil Nadu	2.63912	0.39586	2.24326	2.01892	1.93683	1.35578	0.88748	60.44	0.37-0.93	2.83205
23.	Tripura	0.06634	0.00995	0.05639	0.05076	0.02692	0.01885	0.03754	33.43	0.630	0.08056
24.	Uttar Pradesh	8.38210	1.25743	7.12467	6.41233	3.83364	2.68354	4.44113	37.67	0.20-0.50	16.79896
25.	West Bengal	2.30923	0.34642	1.96281	1.76653	0.67794	0.47452	1.48829	24.18	0.33-0.75	3.31794
	Total States	43.14769	7.07414	36.07355	32.46621	16.42936	11.50055	24.57300	31.88	-	64.04513

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1	2	3	4	5	6	7	8	9	10	11	12
UNION TERRITORIES											
1. Andaman & Nicobar Islands			Not Assessed								
2. Chandigarh	0.002968	-	-	-	0.00351	0.002454	0.000512	-	-	-	
3. Dadra and N.Haveli	0.004220	0.000633	0.003587	0.00323	0.00065	0.000457	0.003130	12.74	0.640	0.00504	
4. Daman and Diu	0.001300	0.000200	0.001100	0.00099	0.00129	0.000900	0.000200	-	-	-	
5. NCT Delhi	0.029154	0.017832	-	-	0.01684	0.011800	-	-	-	-	
6. Lakshadweep	0.000243	-	-	-	0.00022	0.000155	0.000088	63.79	-	-	
7. Pondicherry	0.0002877	0.000432	0.002445	0.00220	0.00085	0.000595	0.001850	24.34	-	-	
Total UTs	0.040760	0.019197	0.007132	0.00642	0.02336	0.016362	0.005780	-	-	0.00504	
GRAND TOTAL	43.18850	7.093337	36.08062	32.47264	16.45272	11.516912	24.57878	31.02	-	64.05017	

### NOTE

1. Col. 5 = Ground-Water Resource-Provision of Domestic, Industrial & Other Uses (Col.3-Col.4).
2. Col. 6 = 90% of Column 5
3. Col. 7 = Gross draft is the total withdrawal from Ground-Water Resource for Irrigation
4. Col. 8 = 70% of Gross draft (bulk of the losses return back to the Ground-Water Reservoir).
5. Col. 9 = Col. 5 - Col. 8 in net terms.
6. Col. 10 = Level of Ground-Water Development (Col. 8/Col. 5) X 100
7. Col. 12 = Utilisable Ground-Water Resource for Irrigation/Weighted Average Delta (Col.6/Col.11).  
(This is 90% of ultimate irrigation potential which was computed as per available ground-water resource for irrigation and limited it as per the land availability).  
Utilisable irrigation potential has been kept as 90% of the ultimate Irrigation potential which is reasonable in view of the following:-
  1. To ensure sustainable development, the level of extraction has to be kept at a level reasonably lower than the ultimate availability.
  2. To maintain river ecology, minimum flows have to be ensured by limiting extraction of ground-water, which contributes to the lean season flows in the rivers.

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### MAJOR AND MEDIUM IRRIGATION PROJECTS

Irrigation projects with a Culturable Command Area (CCA) between 2,000 and 10,000 hectares are classified as medium projects and those with a CCA of more than 10,000 hectares as major projects. The expenditure incurred on major and medium projects and the irrigation potential created during the various plan periods are given in table 16.3. At the end of the Eighth Plan, there are 162 major, 240 medium and 74 extension renovations and modernisation schemes continuing from the previous plans spilling over to the Ninth Plan with a total spill-over cost of Rs 79,317 crore.

TABLE 16.3 : MAJOR AND MEDIUM IRRIGATION PROJECTS (EXPENDITURE INCURRED AND POTENTIAL CREATED)

Period	Outlay/ Expenditure (Rs Crore)	Potential created (mha)	Cumulative
1	2	3	4
Pre-Plan period	Not Available	9.70	9.70
First Plan (1951-56)	376	2.50	12.20
Second Plan (1956-61)	380	2.13	14.33
Third Plan (1961-66)	576	2.24	16.57
Annual Plans (1966-69)	430	1.53	18.10
Fourth Plan (1969-74)	1,242	2.60	20.70
Fifth Plan (1974-78)	2,516	4.02	24.72
Annual Plans (1978-80)	2,079	1.89	26.61
Sixth Plan (1980-85)	7,369	1.09	27.70 <sup>2</sup>
Seventh Plan (1985-90)	11,107	2.22	29.92
Annual Plans (1990-92)	5,459	0.82	30.74
Eighth Plan (1992-97)	21,838 <sup>1</sup>	2.22 <sup>1</sup>	32.96
(1997-98)	8,134	1.04	
	(Revised Outlay)	(Target)	

<sup>1</sup> Provisional

<sup>2</sup> Potential created from Pre-Plan period to end of Sixth Plan was reappraised

### ACCELERATED IRRIGATION BENEFITS PROGRAMME

A large number of irrigation projects have been launched since the beginning of the era of planning in India. However, many projects remained incomplete owing to financial constraints of the States. An Accelerated Irrigation Benefits Programme (AIBP) was launched during 1996-97 to give loan assistance to the States to help them complete some of the incomplete projects. Loan assistance released to 20 States from 1996-97 onwards is given in table 16.4.

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TABLE 16.4 : CENTRAL LOAN ASSISTANCE RELEASED UNDER ACCELERATED IRRIGATION BENEFITS PROGRAMME

(Rs in crore)

Sl. No.	States	Amount released		
		1996-97	1997-98	1998-99
1.	Andhra Pradesh	35.25	74.00	79.67
2.	Assam	5.23	12.40	13.95
3.	Bihar	13.50	14.04	47.82
4.	Gujarat	74.77	196.90	423.82
5.	Haryana	32.50	12.00	—
6.	Jammu & Kashmir	1.30	—	—
7.	Karnataka	61.25	90.50	94.50
8.	Kerala	3.75	15.00	—
9.	Madhya Pradesh	63.25	114.50	90.75
10.	Maharashtra	14.00	55.00	50.86
11.	Manipur	4.30	26.00	10.78
12.	Orissa	48.25	85.00	71.50
13.	Punjab	67.50	100.00	—
14.	Rajasthan	2.67	42.00	140.05
15.	Tripura	3.77	5.10	3.97
16.	Tamil Nadu	20.00	—	—
17.	Uttar Pradesh	43.50	78.00	76.50
18.	West Bengal	5.00	20.00	10.00
19.	Goa	—	5.25	—
20.	Himachal Pradesh	—	6.50	5.00
Total		500.00	952.19	1,119.18

### HYDROLOGY PROJECT

Hydrology Project has been launched for a period of six years beginning from 1995-96 at an estimated cost of Rs 609.2 crore. The World Bank has extended a credit assistance of US dollar 142 million under the project. The project covers the peninsular states of India, namely, Andhra Pradesh, Orissa, Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Tamil Nadu and Kerala. The main objective of the project is to improve the infrastructure and staff capabilities of the Central and State agencies involved in surface and ground-water hydrology in the project area for collection and management of hydrometric and water quality data and the use of such data for water resources evaluation and management. The activities under the project include upgradation of infrastructure for collection of hydrological and hydrometeorological data; provision of equipment and materials; training and technical assistance; and institutional strengthening including new buildings and incremental operating and maintenance costs. Under the

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project interactive computerised data banks within Central Water Commission, Central Ground-Water Board and State agencies responsible for surface and ground-water data collection will be developed so that reliable data on quantity of water resources could be made available to the planners and users.

### COMMAND AREA DEVELOPMENT PROGRAMME

A Centrally-sponsored Command Area Development Programme was launched in 1974-75 with the main objective of improving utilisation of irrigation potential and optimising agricultural productivity and production from the irrigated areas by integrating all functions related with irrigated agriculture.

Beginning with 60 major and medium irrigation projects in 1974, the Programme included 217 irrigation projects at the end of 1998-99 with Culturable Command Area (CCA) of 21.95 million hectares spread over 23 States and two Union Territories. Since inception, an amount of Rs 1,993.85 crore has been released to the States as Central share for different activities of the Programme, while an amount of Rs 175.77 crore was spent during 1998-99.

The Programme involves execution of on-farm development works like construction of field channels and field drains, land levelling and shaping and conjunctive use of surface and ground-water. *Warabandi* or the rotational system of water distribution is undertaken with a view to ensuring equitable and timely supply of water to the farmers. Adaptive trials, demonstrations and training of farmers are encouraged to disseminate technical know-how among the farmers for establishing suitable cropping patterns and improved farming practices and for maintaining soil health.

Under the Programme, the Ministry is trying to shift the management paradigm from fully state managed systems to farmer managed systems by encouraging farmers participation in the management of irrigation. As an incentive, one time functional grant of Rs 500/ha (Rs 225/ha by Centre, Rs 225/ha by State and Rs 50/ha by Farmers' Association) is provided to the registered and functional Farmers' Associations. Reclamation of waterlogged areas in irrigated command is also an important component of the Programme.

### MINOR IRRIGATION

All ground-water and surface schemes having Culturable Command Area (CCA) up to 2,000 hectares individually are classified as minor irrigation schemes. The development of ground-water is mostly done through individual and cooperative efforts of the farmers with the help of institutional finance and through own savings. Surface minor irrigation schemes are generally

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funded from the public sector outlay. Irrigation potential created and utilised under minor irrigation during the various plan periods are given in table 16.5.

TABLE 16.5 : IRRIGATION POTENTIAL CREATED AND UTILISED UNDER MINOR IRRIGATION

(In million hectares)

Plan	Potential	Utilisation
At the end of the Pre-Plan up to 1951	12.90	12.90
First Plan (1951-56)	14.06	14.06
Second Plan (1956-61)	14.75	14.75
Third Plan (1961-66)	17.00	17.00
Annual Plans (1966-69)	19.00	19.00
Fourth Plan (1969-74)	23.50	23.50
Fifth Plan (1974-78)	27.30	27.30
Annual Plans (1978-80)	30.00	30.00
Sixth Plan (1980-85)	37.52	35.25
Seventh Plan (1985-90)	46.61	43.12
Annual Plan (1990-92)	50.35	46.54
Eighth Plan (1992-97) (Provisional)	56.60	52.32
During 1997-98 (Target)	00.80	01.44

The Ministry of Water Resources has been operating the Centrally-sponsored Scheme of Rationalisation of Minor Irrigation Statistics since the Seventh Five Year Plan. As a part of Rationalisation of Minor Irrigation Statistics, first census for Minor Irrigation works with base year as 1986-87 has already been conducted. The second census for Minor Irrigation works with base line data for 1993-94 is currently being undertaken.

### FLOOD MANAGEMENT

Of the country's total geographical area of 328 mha, 40 mha is prone to floods, out of which 32 mha can be protected. So far, an area of 14.4 mha has been provided with reasonable degree of flood protection by construction of embankments, drainage channels, town protection works and by raising villages. The cumulative expenditure on such works up to the end of the Eighth Plan is anticipated to be Rs 4,970.57 crore. The total area likely to be benefitted up to the end of the Eighth Plan will be about 16.0232 mha. Non-structural measures like flood plain zoning, flood-proofing and flood-forecasting are now being given priority to mitigate the losses from floods.

Although Flood Management is a State subject, Union Government provides Central assistance to states for a few specified schemes which are technical and promotional in nature such as critical anti-erosion works in



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Ganga Basin States, maintenance of flood-protection works of Kosi and Gandak projects, etc.

The Central Water Commission is engaged in the flood-forecasting on inter-state rivers through its 21 field divisions throughout the country. Forecasts are being issued at 157 stations on the various inter-state rivers and tributaries except Indus. These forecasts are normally issued 24 hours in advance and are found to be useful for civil and engineering authorities for arranging relief and rescue measures and for the protection of engineering structures. During the flood season of 1998, 7,943 forecasts were issued by the Central Water Commission.

### **RIVER WATER DISPUTES**

The major rivers of the country are almost all inter-state rivers. With increasing demand for water in all sectors, inter-state disputes do arise about the share of water. Efforts are made to resolve disputes by negotiations amongst states concerned with the assistance of Centre. Adjudication through Tribunals is also resorted to when warranted.

So far the following tribunals have been appointed to resolve inter-state water disputes : (i) Godavari Water Disputes Tribunal; (ii) Krishna Water Disputes Tribunal; (iii) Narmada Water Disputes Tribunal; (iv) Cauvery Water Disputes Tribunal and (v) Ravi-Beas Water Disputes Tribunal. The first three Tribunals have given their final reports. Ravi and Beas Water Tribunal gave a part report on 30 January 1987. The dispute is still under adjudication by the Tribunal.

### **GROUND WATER DEVELOPMENT**

In India ground water has been used for irrigation and domestic water supply since time immemorial. At present, more than 70 per cent of the population uses ground water for its domestic needs and more than half of irrigation is provided from this source.

The total replenishable ground water in India is estimated to be about 43.18850 million hectare metre per year (about 432 billion cubic metre). About 7.1 m ha m/yr is used for domestic and industrial use. It is estimated that about 32.47264 m ha m/yr is available for irrigation. According to an estimate by Central Ground Water Board, 32 per cent of available ground water resources have so far been developed.

In spite of the overall satisfactory availability of ground water, there are some areas in the country, which are facing scarcity of ground water. The reason for this is that the development of ground water in different areas of the country has not been uniform. Highly intensive development of ground water in certain areas in the country has resulted in its over-exploitation leading to fall in the level of ground water and salinity ingress in coastal areas.

Out of 4,272 blocks in the country (except Andhra Pradesh, Gujarat and Maharashtra where ground water resources assessment has been carried out on the basis of *mandals*, *talukas* and watersheds respectively), 231 blocks

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have been categorised as 'Over-exploited', *i.e.*, the stage of ground water development exceeds the annual replenishable recharge and 107 blocks are 'Dark', *i.e.*, the stage of ground water development is more than 85 per cent. Besides, six *mandals* have been categorised as 'Over-exploited' and 24 as 'Dark' out of 1,104 *mandals* in Andhra Pradesh. Similarly, in Gujarat out of 184 *talukas*, 12 are 'Over-exploited' and 14 are 'Dark' and out of 1,503 watersheds in Maharashtra, 34 are 'Dark'.

The ground water in most of the areas in the country is fresh. Brackish ground water occurs in the arid zones of Rajasthan, close to coastal tracts in Saurashtra and Kutch, some areas in the east coast and some pockets in Punjab and Haryana. However, contaminants and pollutants are being found increasingly in ground water, which make it unutilisable for drinking and in some cases injurious to health.

### **NATIONAL COMMISSION FOR INTEGRATED WATER RESOURCES DEVELOPMENT PLAN**

The Ministry of Water Resources has constituted a National Commission for Integrated Water Resources Development Plan. The Commission is chaired by Dr S.R. Hashim, Member, Planning Commission. The terms of reference of the Commission are : (i) to prepare an integrated water plan for development of water resources for drinking, irrigation, industrial, flood control and other uses; (ii) to suggest modalities for transfer of surplus water to water-deficit basin by inter-linking of rivers for achieving the above objectives; (iii) to identify important ongoing projects as well as new projects which should be completed on priority basis together with phasing; (iv) identify a technological and inter-disciplinary research plan for the water sector with a view to maximising the benefits; (v) to suggest physical and financial resource generation strategies for the water sector; and any other related issue. The Commission is likely to complete its work by June 1999.

### **NATIONAL WATER BOARD**

The National Water Board was constituted by the Government in September 1990 to review the progress of implementation of the National Water Policy and report to the National Water Resources Council for initiating effective measures for systematic development of the country's water resources. A number of policy issues such as Water Information Bill, setting up of river basin organisations, national policy on resettlement and rehabilitation of persons affected by river valley projects, national policy guidelines on water allocation of inter-state rivers amongst states, etc., have been considered by the Board.

### **NATIONAL WATER RESOURCES COUNCIL**

The National Water Resources Council was set up by the Government of India in March 1983 as a national apex body, with the Prime Minister as the Chairman, Union Minister of Water Resources as Vice-Chairman and concerned Union Ministers, Chief Ministers of State governments and

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Administrators/Lt Governors of the Union Territories as Members. The Secretary, Ministry of Water Resources is the Secretary of the Council. The Council has held three meetings so far. The National Water Policy was adopted unanimously at the second meeting held on 9 September 1987.

### **INTERNATIONAL COOPERATION**

#### **INDO-BHUTAN PROJECTS**

The Government of India has been assisting the Royal Government of Bhutan for hydro-power development and establishment of hydro-meteorological and flood-forecasting network on rivers common to India and Bhutan. Following the signing of the Memorandum of Understanding (MOU) in January 1993 between India and Bhutan, Detailed Project Report for Sankosh Multipurpose Project was completed in December 1995. Studies have also been conducted for Environment Impact Assessment and socio-economic aspects of the projects. The works were carried out in Bhutanese as well as Indian territory

#### **INDO-BANGLADESH COOPERATION**

Following the signing of the Indo-Bangladesh Ganga water sharing Treaty in December 1996, joint measurements during lean season (January-May) of 1997 and 1998 were conducted. Joint measurement of 1999 lean season is also going on smoothly. The existing system of transmission of flood forecasting data on major rivers like Ganga, Teesta, Brahmaputra and Barak during the monsoon season from India to Bangladesh was continued. The unprecedented floods during the monsoon of 1998 particularly in the Ganga and Brahmaputra rivers had caused devastation in India and Bangladesh. The transmission of flood forecasting information from India helped Bangladesh immensely in shifting people to safer places. Closure of gap on the right embankment of the Teesta river at the Indo-Bangladesh border was completed in June 1998 giving appropriate protection from floods during monsoon of 1998 to the inhabitants of both the countries. India and Bangladesh are jointly conducting scientific studies and field investigations to determine the reasons for the discrepancies in the flows related at Farakka on Ganga and those that arrive at Hardinge bridge.

#### **INDO-NEPAL CO-OPERATION**

The treaty between His Majesty's Government of Nepal and Government of India concerning the integrated development of the Mahakali River including Sarda Barrage, Tanakpur Barrage and Pancheswar Project was signed on 12 February 1996. During the visit of the Prime Minister of India to Nepal in June 1997, the instruments for ratification of Mahakali Treaty were exchanged as a result of which the treaty came into force with effect from 6 June 1997. Under the treaty, the Pancheswar Multipurpose Project is to be taken up for implementation. The detailed project report is being prepared jointly by the two countries.

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### INDUS WATER TREATY/PERMANENT INDUS COMMISSION

Under the Indus Water Treaty 1960, India and Pakistan have created two permanent posts of Commissioner for Indus Waters, one each in India and Pakistan. The two Commissioners together form the Permanent Indus Commission. The Commission in its meeting held in May 1998 finalised the Annual Report ending 31 March 1998. Flood-warning arrangements were made by India through priority telegrams, telephones and radio broadcasts for the benefit of Pakistan during the period from 1 July to 10 October 1998 for the Indus system of rivers.

### EXTERNAL ASSISTANCE

The task of extending irrigation to the various regions of the country is a resource-intensive endeavour. International support of around Rs 700 crore per annum in the form of soft loan, credit and grant-in-aid is available in addition to technical assistance. The Ministry assists the state governments in obtaining external assistance for irrigation, multi-purpose and related data management projects from international agencies. The World Bank is the prime source of external assistance in the water sector. At present, there are 24 ongoing schemes with external assistance from the World Bank and other bilateral agencies/countries in various states.

### CENTRAL ORGANISATIONS

#### CENTRAL WATER COMMISSION

The Central Water Commission (CWC) is responsible for initiating, coordinating and furthering in consultation with the State Governments concerned, schemes for the control, conservation and utilisation of water resources for the purposes of flood management, irrigation, navigation and water power generation throughout the country. The Commission, if so required, also undertakes the construction and execution of schemes. Over the years, the Commission has developed considerable technical know-how in plan formulation, appraisal, design of major hydraulic structures and projects for development of water resources projects.

#### CENTRAL SOIL AND MATERIALS RESEARCH STATION

The Central Soil and Materials Research Station (CSMRS), New Delhi deals with field exploration, laboratory investigations, basic and applied research in the field of geomechanics and construction materials relevant to river valley projects. The Research Station primarily functions as adviser and consultant to various departments of Government of India, State Governments and Government of India Undertakings/Enterprises. The activities of the Research Station broadly cover Soil Mechanics; Soil Dynamics; Rockfill Technology; Rock Mechanics; Foundation Engineering; Concrete Technology; Construction Materials; Geophysical Investigations; Field instrumentation and Chemical Analysis and Grouting.

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### **SUBORDINATE ORGANISATIONS**

#### **CENTRAL WATER AND POWER RESEARCH STATION**

Central Water and Power Research Station (CWPRS) in Pune provides comprehensive Research and Development support to a variety of projects in the areas of water and energy resources development and water borne transport. It has taken up projects in selected disciplines such as ship hydrodynamics, photo-elasticity, hydro-machinery, coastal engineering, hydraulic instrumentation, earth sciences, hydraulic structures and information technology, over the last four decades. The infrastructure developed with these inputs over the successive Five Year Plans has paved the way for work in the areas of 'Mathematical Modelling of Fluvial and Ocean Hydromechanics' and 'Automated Operation of Irrigation Canal Systems'.

The CWPRS was recognised as the Regional Laboratory for the ESCAP in 1971. Nearly 80 per cent of the research efforts is currently devoted to the study of government financed projects executed through various Central and State agencies. The Research Station is connected with the projects constituting over 30 per cent of the planned investments in the country.

#### **CENTRAL GROUND-WATER BOARD**

Central Ground-Water Board (CGWB) is responsible for carrying out scientific development and management of ground-water resources from national perspective. The regional hydrogeological surveys of the country have already been completed and the Board is currently conducting reappraisal surveys every fifth year to assess the impact of ground-water development on the ground-water regime and to update the status of development of the ground-water resources and water quality. Under the reappraisal surveys, areas having specific problems like waterlogging, declining ground-water levels and ground-water pollution, etc., are accorded priority. Special emphasis is being laid now on monitoring of ground-water levels and water quality through a network of about 15,000 observation stations in the country. In order to promote the scientific management of ground-water resources, specially in the problematic areas, the Board is undertaking pilot projects for augmenting recharge of ground-water in the States of Karnataka, Maharashtra, National Capital Territory of Delhi, Union Territory of Chandigarh and some other States. Studies on the conjunctive use of surface and ground water are also being undertaken in specific areas to work out the best possible option for optimal development of the total water resources with minimum deleterious effects.

In pursuance of the order passed by the Supreme Court of India in December 1996, the Notification constituting the Central Ground-Water Board as an Authority under the Environment (Protection) Act, 1986 for the purposes of regulation and control of ground-water management and development was issued. The Authority constituted in January 1997, however, started functioning during 1998-99. It took up major programme of mass education about over exploitation of ground water and about the

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quality of ground water in Delhi and some other areas. The Authority has also given 'Notice' to all concerned in National Capital Territory of Delhi who are abstracting or intend to abstract underground water through well/ borewell or from excavation in the underground strata to register their ground water abstraction structures with the Authority within a period of thirty days of publication of the notice. The notice was published on 28 and 29 May 1998. In the implementation of its objectives the Central Ground Water Authority has notified the Najafgarh Block in NCT Delhi, Municipal corporation areas of Faridabad and Ballabhgarh industrial towns in Haryana, Ludhiana and Union Territory of Diu as the areas where abstraction of ground water should be regulated to prevent its over exploitation. It has banned drilling/construction of any new ground water abstraction structure and started the registration of existing ground water abstraction in notified areas. The Central Ground Water Authority along with Central Pollution Control Board has started the survey of aquifers contaminated by various pollutants.

### **FARAKKA BARRAGE PROJECT**

The Farakka Barrage Project is designed to subserve the need of preservation and maintenance of the Calcutta Port by improving the regime and navigability of the Bhagirathi-Hooghly river system. The river Bhagirathi, the Feeder Canal and Navigation Lock at Farakka form part of the Haldia-Allahabad Inland waterway. The principal components of the project are :

- (a) a 2,245 metre-long barrage across the Ganga with rail-cum-road bridge, necessary river training works and a head regulator on the right side;
- (b) a 213 metre-long barrage across the river Bhagirathi at Jangipur;
- (c) feeder canal of 1,113 cumec (40,000 cusec) carrying capacity and 38.38 km long, taken off head Regulator on the right of the Farakka Barrage and
- (d) navigation works such as locks, lock channels, shelter basins, navigation lights and other infrastructures.

Farakka Barrage Hydro Electric Project with a capacity of 125 MW generation, estimated to cost Rs 602 crore, is under consideration. The Government has decided to implement this project through private participation on Build, Own and Operate (BOO) basis.

### **SARDAR SAROVAR CONSTRUCTION ADVISORY COMMITTEE**

Sardar Sarovar Construction Advisory Committee (SSCAC) located at Vadodara, was constituted in 1980 as per the directive of the Narmada Water Disputes Tribunal (NWDT) for scrutiny of estimates, technical features, design and to monitor the progress of the construction activity of Unit-I (Dam and Appurtenant Works) and Unit-III (Hydro-Power Complex) of the Sardar Sarovar Project (SSP). The Secretary, Ministry of Water Resources, is the Chairman of the Committee. The officers of the concerned Departments of the Government of India, the States of Gujarat, Maharashtra, Madhya Pradesh and Rajasthan and Narmada Control Authority (NCA) are members of the Committee.

### **BANSAGAR CONTROL BOARD**

The Bansagar Control Board was constituted by the erstwhile Ministry of Agriculture and Irrigation, in consultation with the Governments of Madhya

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Pradesh, Bihar and Uttar Pradesh, by a resolution dated 30 January 1976 with a view to ensuring efficient, economical and early execution of the Bansagar Dam on Sone River including all connected works in Madhya Pradesh but excluding the canal systems. The headquarters of the Board is at Rewa (Madhya Pradesh). The Union Minister of Water Resources is the Chairman of the Board and the Union Minister of State for Water Resources, the Union Minister of Power, Chief Ministers, Ministers-in-charge of Irrigation and Finance Ministers of the three states and the Minister-in-Charge of Power, Madhya Pradesh are its members.

### **GANGA FLOOD CONTROL COMMISSION**

The Ganga Flood Control Commission was established in April 1972, with headquarters at Patna. It serves as the executive limb of the Ganga Flood Control Board (which is headed by the Union Minister of Water Resources and has as its members, the Chief Ministers or their representatives of the basin states and concerned Union Ministers) and acts as the Secretariat of the Board. The Commission is headed by a Chairman and is assisted by two full-time members and other officers and staff. The representatives of the concerned Central Ministries and Departments as well as the Chief Engineers of the basin states are either part-time members or permanent invitees to the Commission.

The Commission has been mainly assigned the task of preparing comprehensive plans of flood management of the river systems in the Ganga sub-basin, drawing out a phased programme of implementation of various schemes from techno-economic angle, monitoring of important flood management schemes, assessment of the adequacy of waterways existing under the road and rail bridges and providing other technical guidance to the basin states. The Commission also technically examines flood-management and flood-proofing schemes submitted by the States.

### **PUBLIC SECTOR UNDERTAKINGS**

#### **WATER AND POWER CONSULTANCY SERVICES (INDIA) LIMITED**

Water and Power Consultancy Services (India) Limited (WAPCOS), a public-sector undertaking under the Ministry of Water Resources, provides integrated technical consultancy services in the water and power sectors in India and abroad. It was established in 1969. Besides the traditional specialisations like irrigation and drainage, flood control and reclamation, WAPCOS' specialisation covers disciplines like water supply and sanitation (rural and urban), ground-water exploration and development, hydro/thermal power generation, transmission and distribution, integrated agricultural development, ports and harbours, environmental engineering, dam safety and surveillance, etc.

#### **NATIONAL PROJECTS CONSTRUCTION CORPORATION LIMITED**

National Projects Construction Corporation Limited (NPCC), a Government of India enterprise, was established in 1957 for developing infrastructure in the core sectors of irrigation and water resources, power and heavy industry. The Corporation has to its credit execution of more than 120 projects of irrigation/river valley projects, barrages, canals, hydro and thermal power

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projects, tunnels and industrial projects/steel plants, residential buildings and township projects, bridges, express highways and runways and others like water and sewerage treatment plants on turnkey basis.

### **OTHER ORGANISATIONS**

#### **NARMADA CONTROL AUTHORITY**

In pursuance of the decision of the Narmada Water Disputes Tribunal, the Government of India framed the Narmada Water Schemes, which among other things constituted Narmada Control Authority and a Review Committee in 1980 for implementation of the decisions and directions of the Tribunal. The Narmada Control Authority is headed by Secretary, Ministry of Water Resources, Government of India, as its Chairman, with secretaries of Ministry of Power, Ministry of Environment and Forests and Ministry of Welfare, Government of India, Chief Secretaries of the four party states (Gujarat, Madhya Pradesh, Maharashtra and Rajasthan), one executive member and three full-time members appointed by the Central Government and four part-time engineering members nominated by the party states, as members. The Review Committee is headed by Union Minister for Water Resources with Chief Ministers of the four party states as its members.

#### **TUNGABHADRA BOARD**

The Tungabhadra Board was constituted by the President of India in exercise of the power vested under section 66 (4) of the Andhra State Act, 1953, for completion of the Tungabhadra Project and for its operation and maintenance. The Board is responsible for the common portion of the Tungabhadra Project. The Krishna Water Disputes Tribunal has made specific provision in the Award for the use of Tungabhadra water by the States of Karnataka and Andhra Pradesh. The responsibility for carrying out this specific provision relating to the use of Tungabhadra Waters has been entrusted to the Tungabhadra Board by the Tribunal. The Board is regulating the water for irrigation, hydro-power generation and other uses on the right bank.

At present, the Board consists of a Chairman appointed by the Government of India, Member from Government of India and two members one each representing Andhra Pradesh and Karnataka, all working part-time in the Tungabhadra Board. An officer of Central government appointed as the Secretary of the Board is the Chief Executive of the Board, too. The funds for the functioning of the Board are provided by the two State governments.

#### **BETWA RIVER BOARD**

The Betwa River Board was constituted under the Betwa River Board Act, 1976 by the Ministry of Water Resources, for efficient, economical and early execution of the Rajghat Dam Project, a joint venture of Madhya Pradesh and Uttar Pradesh. The headquarters of the Board is at Jhansi (Uttar Pradesh). The Union Minister of Water Resources is the Chairman of the Board and Union Minister of Energy, Chief Ministers and Ministers-in-charge of Finance, Irrigation and Power of the two States are its members. The activities of the Board are managed by the Executive Committee of the Board under the Chairmanship of the Chairman, Central Water Commission. The



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funds for construction of the Rajghat Dam and Power House Projects and for meeting the expenses of the office of the Board are borne by the States of Madhya Pradesh and Uttar Pradesh in equal proportions.

The Rajghat Dam and Rajghat Hydro-electric Projects, are inter-state projects of Madhya Pradesh and Uttar Pradesh. Construction of the Dam and its appurtenant works and civil works of power houses are being executed by the Betwa River Board. The E&M works of the power house are being executed by the Madhya Pradesh Electricity Board under the overall supervision of Betwa River Board. The works of canals are being executed by the two states themselves in their respective territories. The estimated cost of the Rajghat Dam is Rs 266.16 crore and that of the power house Rs 123.63 crore. Rajghat Dam and Rajghat Hydroelectric Projects are in the advanced stages of construction.

### **NATIONAL INSTITUTE OF HYDROLOGY**

National Institute of Hydrology (NIH) was set up with headquarters at Roorkee by the Government of India in 1979 for undertaking, promoting and coordinating systematic, scientific works in all aspects of hydrology. The Institute is an autonomous society under the Ministry of Water Resources. The Union Minister of Water Resources is the President of NIH Society.

### **BRAHMAPUTRA BOARD**

The Brahmaputra Board, an autonomous statutory body, was set up in 1982 for the planning and implementation of multi-purpose measures for the control of floods and bank erosion in the Brahmaputra valley (including Barak valley) and some rivers of Tripura. The main functions of the Board is to prepare master-plans for these purposes keeping in view the optimum development of utilisation of water resources of Brahmaputra and Barak valley and hydro-power, irrigation, navigation, etc. The Board also prepares detailed project reports in respect of the dams and other projects proposed and the master-plans. The Board has prepared Master Plan Part-I for mainstream of river Brahmaputra, Part-II for the Barak and its tributaries which have been approved by the Government of India in July 1998.

### **NATIONAL WATER DEVELOPMENT AGENCY**

Suggestions for a National Water Grid envisaging interlinking of rivers with a view to transferring surplus water available in some regions to water-deficit areas have been made from time to time. The Government of India prepared a National Perspective for Water Resources Development in August 1980 envisaging inter-linkages between various peninsular rivers and Himalayan rivers for transfer of water from water-surplus basins to water-deficit basins for the optimum utilisation of water resources. The Government of India established the National Water Development Agency (NWDA) in 1982 to firm up these proposals. A total of 36 water transfer links, 17 under peninsular component and 19 under Himalayan component have been identified by the National Water Development Agency.

Under the peninsular component, National Water Development Agency has completed the collection of data for all the 137 basins/sub-basins, water balance studies of 137 basins/sub-basins and 52 identified diversion points, 58 studies of identified storages, toposheet studies of 18 links and

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prepared pre-feasibility reports of all the 17 water transfer links. The feasibility reports of five links had been completed by March 1999. Survey and investigations of eight more links, namely, Mahanadi (Manibhadra)—Godavari (Dowlaiswarm) link; Krishna (Almatti)—Pennar (Somasila) link; Krishna (Nagarjunasagar)—Pennar (Somasila) link; Damanganga—Pinjal link; Parbati —Kalisindh—Chambal link; Inchampalli Low Dam—Nagarjunasagar Tail Pond link; Pennar (Somasila)—Cauvery (Grand Anicut) link and Cauvery (Kattalai)—Vaigai (Gundal) link for the preparation of feasibility reports were continued during 1998-99.

The component of development of the Himalayan rivers envisages construction of storage reservoirs on Ganga and Brahmaputra and their principal tributaries in India and Nepal, along with inter-linking canal systems to transfer surplus flows of the eastern tributaries of the Ganga to the west, apart from linking of Brahmaputra and its tributaries with Ganga and Ganga to Mahanadi. It will also provide the necessary augmentation of flows at Farakka to flush the Calcutta Port and facilitate inland navigation facilities across the country. Up to March 1998, water balance studies of all 19 diversion points, toposheet studies of 16 storages and toposheet studies of 19 water transfer links and pre-feasibility reports of 14 links were completed. The survey and investigation of six links namely Manas-Sankosh-Tista-Ganga link; Sardar-Yamuna link; Ghagra-Yamuna link; Ganga-Damodar-Subarnarekha link; Yamuna-Rajasthan link and Chunar-Sone Barrage link for preparation of feasibility reports are continuing.

### CHRONOLOGICAL HIGHLIGHTS

- 1957 National Project Construction Corporation Limited established.
- 1960 Indus Water Treaty between India and Pakistan.
- 1969 Water and Power Consultancy Services (India) Limited established.
- 1972 Ganga Flood Control Commission established (April).
- 1974-75 Hydrology Project launched.
- 1978 The National Institute of Hydrology set up at Roorkee.
- 1980 The Sardar Sarovar Construction Advisory Committee constituted.
- 1982 National Water Development Agency (NWDA) established.
- The Indian National Committee on Hydrology constituted.
- 1983 National Water Resources Council set up.
- 1986 The Ravi & Beas Water Tribunal constituted.
- 1987 The National Water Policy adopted (September).
- 1990 National Water Board constituted.
- 1996 Treaty signed between India & Nepal for integrated development of the Mahakali river including Sardar Barrage, Tanakpur, Barrage and Pancheswar Project (12 February).
- 1996-97 Government launches Accelerated Irrigation Benefit programme.
- 1998 India Network on Participatory Irrigation Management set up.