

Intra-State Links Brief Details

Maharashtra

1. Wainganga (Gosikhurd) - Nalganga (Purna Tapi) Intra-State Link Project

The Wainganga (Gosikhurd)-Nalganga (Purna Tapi) link project proposed by Government of Maharashtra envisages diversion of 2721 Mm³ of water from the ongoing Gosikhurd project across river Wainganga to the Western Vidarbha. Out of this, a quantum of 2207 Mm³ is earmarked for irrigation, 253 Mm³ is planned to be utilized for municipal & industrial purposes in the command areas and the remaining 261 Mm³ will be lost in transmission.

The FRL of the ongoing Gosikhurd dam is 244 m. The link canal takes off from the right flank of the ongoing Gosikhurd dam with FSL 243 m and traverses for a length of 478.2 km through Bhandara, Nagpur, Wardha, Amaravati, Akola and Buldana districts of Maharashtra. The link envisages to bring 413750 ha of CCA under irrigation. Apart from irrigation, it is also proposed to cater to the future municipal and industrial water requirements in the command area and the city of Nagpur. About 22 lakh human population and the industrial water requirements by 2050 AD are proposed to be served utilizing 253 Mm³.

Total lifting involved is about 80 m in three stages. The total pumping capacity required is 224 MW and the annual power requirement for these lifting arrangements works out to 751 MU.

The maximum carrying capacity of the canal is 198 cumec with the corresponding cross section of 37 m of bed width and 4.65 m full supply depth.

The cost of the project is estimated to be Rs.8294.26 crores at the price level of 2007-08 which includes the cost of head works at Rs.684.75 crores, the cost of conveyance system at Rs.6410.38 crores, the cost of lifting arrangements Rs.1033.63 crores and the cost of on farm development Rs.165.50 crores. The benefit-cost ratio of the project works out to 1.96 whereas the internal rate of return works out to 15.90%.

2. Wainganga-Manjra Valley Intra-State Link Project

The Wainganga (Wainganga Hydro Electric project) –Manjra Valley (Arajkhed) link project envisages diversion of 1527 Mm³ of water of water from Wainganga HEP proosed across river Wainganga to Manjra valley. Out of this, a quantum of 1188 Mm³ is earmarked for irrigating 2,67,500 ha CCA (with 100% irrigation intensity) CCA in Yavatmal, latur and Beed districts. 207 Mm³ is planned to be utilized for municipal & industrial purposes in the command areas and the remaining 132 Mm³ will be lost in transmission.

The link canal takes off from the light flank of the proposed Wainganga HEP with FSL 218 and traverses for a length of 550 km including a tunnel of 29 km between from RD 354 km to 383 km, through Chandrapur, Yavatmal, Hingoli, parbahan and Beed districts of Maharashtra. The link canal has been provided with a total static lift of 425 m in seven stages and is supported by five branch canals and number of cross drainage and cross masonry works. The design discharge has been kept as 100 cumecs.

The total cost of the project at 2009-10 price level is Rs. 14,149 crores. B.C Ratio is 0.66 and IRR is 5%.

3. Upper Krishna – Bhima (System of Six Links) [Krishna – Bhima stabilization] Intra-State Link Project

Krishna Bhima Stabilization Project is conceived to transfer 3256 Mm³ (115 TMC) of flood waters by gravity from various rivers/streams viz. Kumbhi, Kasari, Warna, Koyna & Panchaganga in Upper Krishna sub-basin of Krishna basin through a series of links to cater to the needs of :

- Needy lift irrigation schemes in Upper Krishna sub-basin itself;
- Enriching the command areas of existing Nira and Ujjani projects in Upper Bhima sub-basin and also
- Meeting the requirement of new command areas in Upper Bhima sub-basin.

The scheme would benefit water short areas in parts of Pune, Satara, Sangli, Beed, Osmanabad and Sholapur districts in Upper Krishna and Upper Bhima sub-basins. The project consists of eleven parts. While the first six parts are primarily water transfer links by gravity, parts 7 to 11 are mainly utilization schemes through certain lift irrigation schemes and existing reservoirs / canal systems.

Part –1 Kumbhi (Khokurle Barrage) – Kasari (Sutarwadi Barrage) Link Canal

River Kumbhi is one of the tributaries of the river Panchganga in Krishna basin in Kolhapur district. Khokurle Barrage is proposed on Kumbhi river d/s of Kumbhi dam. Diversion of water is proposed from Khokurle Barrage through Kumbhi – Kasari link canal by gravity. The available yield at Khokurle Barrage from the free catchment below Kumbhi dam is about 288 Mm³ (10.18 TMC) at 50% dependability, out of which diversion proposed is 113 Mm³ (4 TMC). The total length of link canal 16.10 Km, out of which 15.20 Km is tunnel and 0.90 Km is open channel. The link outfalls into Sutarwadi Barrage on Kasari river. No utilization is proposed under this canal.

Part -2 Kassari (Sutarwadi Barrage) Warna (Mangle Barrage) Link Canal

River Kasari is another tributary of Panchganga river in Kolhapur district. 832 Mm³ (29.36 TMC) of surplus water is estimated to be available in free catchment area of Kasari river, d/s of Kasari dam upto proposed Sutarwadi Barrage at 50% dependability. It is proposed to divert 312 Mm³ (11 TMC) of waters of Kasari river in addition to 113 Mm³ (4 TMC) received from Kumbi river to Warna river u/s of proposed Mangle Barrage through Kasari (Sutarwadi Barrage) – Warna (Mangle Barrage) link canal. Total length of the link canal is 26.20 Km, of which 24.45 Km is tunnel and 1.75 Km is open channel. No utilization is proposed under this canal also.

Part -3 Warna (Mangle Barrage)-Krishna (Satpewadi) Link Canal

River Warna is the right bank tributary of the Krishna river, Mangle Barrage is proposed across Warna river, d/s of Warna dam. Surplus water in the free catchment upto Mangle Barrage (excluding the catchment area of Warna, Kadvi and Morna dams) is assessed to be 1480 Mm³ (52.3 TMC) at 50% dependability, out of which, 1104 Mm³ (39 TMC) is proposed for diversion. Thus, total water proposed for further transfer including the import from previous two link canals is 1529 Mm³ (54 TMC). Total length of link canal is 27.69 Km, consisting of 22.88 Km of tunnel and 4.81 Km of open canal. This link will also serve only as a supply channel with no irrigation component.

Part-4 Krishna (Satpewadi)-Nira (Somanathali) Link Canal

It is assessed that there is 113 Mm³ (4 TMC) of surplus yield from Krishna catchment and 1113 Mm³ (47 TMC) from the Koyna catchment. Thus, the total surplus water available in Krishna at Satpewadi is assessed as 1444 Mm³ (51 TMC) . Considering 1529 Mm³ (54 TMC) fromWarna-Krishna link canal, the total surplus available in Krishna will be 2973 Mm³ (54+51=105 TMC). Out of this, 85 Mm³ (3 TMC) is planned to be used under Takari LIS and 283 Mm³ (10.01 TMC) is proposed to be utilized by Tembhu LIS. Besides, 212 Mm³ (7.47 TMC) of water is proposed for utilization in Koregaon Khatav and Man LIS under parts 7-9 of KBSP. Further, 2393 Mm³ (84.52 TMC) of water is proposed to be transferred from Satpewadi to proposed Somanathali Barrage on Nira river through a conveyance system of 100.30 Km i.e. tunnel of 95.4 Km and 4.90 Km long open channel.

Part-5 Nira (Uddhat)-Bhima (Ujjain Dam) Link Canal

Out of the 2393 Mm³ (84.52 TMC) water received in Nira, quantity of 459 Mm³ (16.20 TMC) is proposed to be used by Nira canal system towards enrichment of its command of 138212 ha. In addition, a quantity of 58 Mm³ (2.05 TMC) is proposed to be used under Dhakale LIS as part-10 of KBSP.

Remaining quantum of 1877 Mm³ (66.27 TMC) water is let down in Nira river to be picked upat proposed Uddhat Barrage for further diversion to Ujjani dam on Bhima, through a conveyance system of 24.3 Km comprising of 20.6 Km of tunnel and 3.7 Km of open channel. Out of the waters received at Ujjani dam through Nira-Bhima link canal, 1282 Mm³ (45.27 TMC) is proposed for enrichment of Bhima command of 307593 ha and to supply domestic water to Sholapur, Baramati, Shrigonda etc. while the remaining 595 Mm³ (21 TMC) is proposed to be utilised under Krishna-Marathwada project as Part – 11 of KBSP, which consists of LIS I with 5 stages of lifting (total static head 239 m) and LIS II with 6 stages of lifting (total static head 209 m).

Part-6 Panchganga (Shirol)-Krishna (Ghatwad) Link Canal

The estimated yield in Panchganga catchment (2538 Km²) is about 4655 Mm³ (164 TMC) at 50% dependability. It is proposed to divert 283 Mm³ (10 TMC) of water from existing Shirol Barrage (CA: 2538 Km²) on Panchganga river to Krishna river near Ghatwad village to be utilized in the command of Mhasial LIS which is a part of Krishna – Koyna LIS. This link is completely an open channel of length 6.80 Km.

No Transmission losses are considered in any of the transfer components. NWEDA has also reassessed the yields at 50% dependability at each of the proposed diversion points and established the availability of water for diversion.

The water available for transfer from each and scheme wise water planning and benefited area under different projects is given below:

Name of the link	Water Transfer in	
	Mm ³	TMC
Kumbi – Kasari	113	4
Kasari-Warna	312	11
Warna – Krishna	1104	39
Krishna – Nira	1444	51
Nira – Bhima	0	0
Panchganga – Krishna	283	10
Total	3256	115

Name of the irrigated Scheme	Area in ha	Water utilization		Lift m
		Mm ³	TMC	
Jihe-Kathapur	24275 (P)	120	4.23	243
Tembhu LIS III A	10625 (P)	92	3.24	406
Takari LIS	14010 (P)	85	3.00	209
Tembhu LIS	33270 (E)*	283	10.01	
Dhakale	6000 (P)	58	2.05	40
Nira Project	138212 (E)*	459	16.20	RBC-39 LBC-32
Ujjani Project	307593 (E)*	1282	45.27	2.25
Krishna – Marathwada LIS	92141 (P)	595	21.00	239
Mhaisal LIS	46580 (P)	283	10.00	209
Total	672706	3256	115.00	

E-Existing; P-Proposed; *Enrichment of command in terms of 8 monthly cropping pattern in place of Kharif.

While Satpewadi on Krishna and Shiol on Panchganga are existing barrages, remaining five are proposed barrages. While existing Ujjani and Nira projects are integrated in the KBSP, some small storages are proposed to be created as required for augmentation / utilization. The proposed barrages are planned by the State mostly their extent confining to the river portion only. Further, the storages/tanks proposed for the scheme are very small. The major part of the conveyance system is through tunnels. The effect of the scheme on the downstream uses has to be analysed.

The total cost of the Scheme is estimated to be 13576.19 crore based on the 2009-10 price level. The Benefit-Cost ratio works out to 1.16.

4. Upper Ghat – Godavari Valley [Damanganga (Ekdare)-Godavari Valley] Intra-State Link Project

NWDA has also carried out studies and proposed diversion of 143 Mm³ of surplus water available at 75% dependable yield of Damanganga basin upto proposed Ekdare dam site to existing Gangapur reservoir in Godavari Valley, by lift in two stages (total static head = 218 m) and then through a tunnel of length 5.65 Km by gravity. The total length of link is of about 13.55 Km.

Out of the total diversion of 143 Mm³, 70% of water i.e. 100 Mm³ is allocated for irrigation purpose. The existing Gangapur Irrigation Project provides annual irrigation to an area of 9509 ha only out of 16505 ha of CCA available. Since the quantum of diversion is less, new command area for irrigation have not been identified and it is proposed to irrigate / stabilize the CCA available but not irrigated under the existing Gangapur Irrigation Project. Remaining 30% of water, around 22 Mm³ would be used for domestic and 21 Mm³ for industrial needs respectively. This quantity would be supplied to needy towns around the Gangapur project.

The total cost of the project is estimated as Rs.459.08 crore, at 2008-09 price level. The link proposal will provide annual irrigation benefits to an area of 15625 ha. The total energy required for lifting 143 Mm³ of water by around 218 m is 151.35 MU

annually. The power required for pumping is around 32 MW. The Benefit-Cost ratio is estimated to be 1.44. Internal Rate of Return (IRR) works out to 16.78%.

5. Upper Vaitarna – Godavari Valley [Vaitarna (Upper Vaitarna) – Godavari (Mukarne)] Intra-State Link Project

The Vaitarna (Upper Vaitarna) – Godavari (Mukane) link project, envisages diversion of 136 Mm³ of water from Vaitarna basin through existing Upper Vaitarna reservoir to Mukane reservoir / Vaki nadi of Darna valley of Godavari basin by gravity.

As per the water balance studies carried out by NWDA, it is possible to divert 14 Mm³ of surplus water available at existing Upper Vaitarna reservoir to Mukane reservoir by constructing an additional spillway at Saddle dam. This proposal would irrigate an area of about 1613 ha in Mukane command area in Nasik district.

It is also proposed to divert the surplus waters available at four identified storage reservoir sites viz. Kalampada, Dulachiwadi, Borachiwadi and Udhare located at down stream of Upper Vaitarna project and upstream of proposed Pinjal project in Vaitarna basin. The total surplus water available at these four storage reservoirs is 122 Mm³. All these four storages are proposed to be linked by open cut feeder link canals. The water from Kalampada storage reservoir will be diverted to Dulachiwadi storage reservoir and these combined waters and the water available at Udhare storage reservoir will further be diverted into Borachiwadi storage reservoir through open channels by gravity. The total length of canal involved to interconnect these four reservoirs is 17.42 Km. The waters received from all the three storages and the contribution of Borachiwadi storage reservoir would be lifted from Borachiwadi reservoir to Upper Vaitarna reservoir during non monsoon period (November to May). The total static lift involved is about 353 m in four stages. The total power requirement would be 35.31 MW and the annual energy consumption is estimated to be 194.89 MU.

Further, the water from Upper Vaitarna reservoir would be diverted to Vaiki nadi of Dama valley, by gravity through an outlet proposed on the right flank of Saddle dam. This proposal would irrigate about 13871 ha of area in Dama project command in Nasik district.

Out of the total diverted water of 136 Mm³ (14 + 122), about 70% of water i.e. 96 Mm³ is earmarked for irrigation to bring 15484 ha (1613 + 13871) of CCA under irrigation with 100% intensity and the remaining 30% of water i.e. 40 Mm³ is planned for municipal & Industrial use in and around the command areas of Mukane and Dama projects.

The total cost of the project is estimated to be 817.13 crore at 2009-10 price level, The benefit-cost ratio (BCR) of the project works out to 1.00 where as the IRR works out to 6.20%.

6. Damanganga (Val & Vagh) - Vaitarna - Godavari (Kadva/Dev Nadi) Intra-State Link Project

The Damanganga (Val & Vagh) - Vaitarna - Godavari (Kadva/Dev Nadi) link project, which is an Intra-state link proposal by Govt. of Maharashtra to divert the surplus waters of west flowing rivers of Damanganga and Vaitarna basins to east flowing Godavari river basin to cater the domestic & industrial and irrigation needs of drought prone Sinnar taluk of Nasik district in Upper Godavari sub-basin.

The Damanganga-Vaitarna-Godavari link project envisages diversion of 202 Mm³ of water from Damanganga and Vaitarna basins to Dev river, a tributary of Godavari in Upper Godavari sub-basin. In this proposal, it is proposed to divert the surplus water of 5 identified storage reservoirs viz., Val & Vagh in Damanganga basin located on Vagh river, a main tributary of Damanganga river, Kalampada, Dulachiwadi & Udhare reservoirs in Vaitarna basin located on tributaries of Pinjal river, a main tributary of Vaitarna river. The total surplus waters proposed for diversion from these five reservoirs is 186 Mm³. Further, as per water balance study carried out by NWDA, it is possible to divert 16 Mm³ of surplus water from the existing Upper Vaitarna reservoir.

The waters of Val reservoir (57 Mm³) would be lifted by 180 m in two stages through a raising main length of 1.94 km and then transferred through a tunnel of 3.08 km length to Upper Vaitarna reservoir to cross the ridge between Damanganga and Vaitarna basins. Similarly, the waters of Vagh reservoir (45 Mm³) will be lifted by 268 m lift in three stages through a raising main length of 8.26 km and then transferred through a tunnel of 1.17 km length to Upper Vaitarna reservoir.

The water from Kalampada reservoir (35 Mm³) will be diverted to Dulachiwadi reservoir through a lined canal of 3.56 km length by gravity. The water of Dulachiwadi reservoir (18.50 Mm³) and the water received from Kalampada reservoir will be lifted by 232 m in three stages into Upper Vaitarna reservoir. Further, the water of Udhare reservoir (31 Mm³) will also be lifted by 240 m in three stages into Upper Vaitarna reservoir.

The combined waters transferred from the five reservoirs and the balance available for diversion from Upper Vaitarna reservoir will be transferred to existing Kadva reservoir through a lined canal of 30.244 km length by gravity. Further, a net quantum of 196.73 Mm³ (after transmission losses) will be diverted into Dev River by 150 m lift in two stages for further use in Sinnar taluk of Nasik district. Out of this, a quantum of 22.51 Mm³ is earmarked for domestic water supply to serve 4.59 lakh human population & 2.90 lakh live stock, 73 Mm³ for Delhi-Mumbai industrial corridor uses, 41.50 Mm³ for other industrial uses and 59.73 Mm³ is planned for irrigation to bring 11480 ha under irrigation in semi-critical drought prone Sinnar taluk under the RBCs of proposed Sonamba and Phalak reservoirs on Dev river. The transmission losses in the link project is estimated to be 5.27 Mm³. Further an area of 16840 ha can also be brought under irrigation with recycled waters received from the regenerated waters of domestic and industrial uses as per the policy of Govt. of Maharashtra.

It is proposed to transfer the water from all the reservoirs during non-monsoon period from November to May. The total power requirement to lift the waters from all the reservoirs is 65.04 MW and the total energy consumption is estimated to be 303.34 MU.

The total cost of the project is estimated to be Rs.2690.23 crores (with Alternative -I Canal) & Rs.2708.27 crores (with Alternative -II Canal) at 2015-16 price level, which includes the cost of head works at Rs.1577.75 crores, the cost of conveyance system at Rs.580.45 crores (with Alt-I canal) and Rs.598.49 crores (with Alt-II) and the cost of lifting arrangements at Rs.532.03 crores. The annual cost after duly considering the annual power requirement for lifting arrangements works out to Rs.372.05 crores (with Alt-I canal) & Rs.374.04 crores (with Alt-II canal). The direct benefits from the link project due to irrigation, domestic & industrial water supplies, fisheries development and animal husbandry are estimated to be Rs.616.01 crores. The benefit-cost ratio (BCR) of the project works out to 1.656 (with Alt-I canal) and 1.647 (with Alt-II canal) where as the Internal Rate of Return (IRR) works out to 14.38% (with Alt-I canal) and 14.31% (with Alt-II canal).

7. North Konkan – Godavari Valley Intra–State Link Project

The North Konkan – Godavari Valley Link Project, envisages diversion of surplus waters available in Patalganga and Ulhas basins through proposed Balganga, Kalu and Shai reservoirs to Mula river of Pravara sub-basin of Godavari valley by gravity and lift. In addition, enroute irrigation also proposed in Patalganga basin.

As per the water balance studies carried out by NWDA, Balganga (Niphad) project of Patalganga basin, Shai and Kalu projects of Ulhas basin are having water surplus of 146 Mm³, 43 Mm³ and 80 Mm³ at 75% dependability respectively. Out of 146 Mm³ of water surplus available at Balganga project, 120 Mm³ would be diverted through the proposed Bhokarpada branch canal at RD 17 Km with lift of 30 m. Out of this, 95 Mm³ will be utilised in enroute to irrigate an area of 20000 ha. in Patalganga itself in Raigad district. 15 Mm³ will be supplied for enroute domestic and industrial uses and the remaining 10 Mm³ will be lost in transmission. The remaining 26 Mm³ (146 – 120) would be diverted to Kalu reservoir in Ulhas basin through 86.7 Km long open channel and with three stages of lifts proposed at RD 0.0 Km, RD 50.0 Km and RD 86.0 Km to lift waters by 30 m, 60 m and 36 m respectively. About 3 Mm³ will be lost in transmission. A tunnel length 3.75 Km is proposed from RD 33.25 Km to RD 37 Km.

In addition to 23 Mm³ reaching Kalu reservoir, the surplus water contributed by Kalu reservoir to the tune of 80 Mm³ at 75% dependability will be lifted by 60 m to a proposed Forebay reservoir located at 5 Km distance from Kalu reservoir. Similarly, the surplus water available at Shai reservoir to the tune of 43 Mm³ at 75% dependability will also be lifted by 60 m to the same Forebay reservoir, which is at a distance of 3.2 Km from Shai reservoir. Excluding transmission losses about 6 Mm³, a net quantity of 140 Mm³ will reach to the Forebay reservoir. From Forebay reservoir, the combined surplus water will be lifted by 660 m to Mula river. Excluding 7 Mm³ of transmission losses, 120 Mm³ of water will be utilised for irrigating 21000 ha., for domestic and industrial uses 12 Mm³ will be supplied through Mula Branch canal in Ahmednagar district in Pravara sub-basin of Godavari basin. The remaining 1 Mm³ will be dropped in Mula river as river flow. Thus, the total static lift envisaged in this project is 908 m. The total power requirement for lifting water would be 127.7 MW and the annual energy consumption is estimated to be 335 MU.

The total cost of the project is estimated to be Rs.4125.85 crore at 2009-10 price level, The Benefit-Cost Ratio (BCR) of the project works out to 0.44 whereas the IRR works out to 1.41%.

8. Koyna – Mumbai City [Koyna Tail Race Water – Mumbai City] Intra-State Link Project

The “Koyna Tailrace Water – Mumbai City Link Project” envisages diversion of net flows of about 1912 Mm³ for Mumbai Metropolitan City and its suburbs along with possible enroute towns/villages on left & right side of the link canal, even by lifts not exceeding 120 m, in all 365 days to meet the municipal and industrial needs as a whole. Hence, this link canal project is primarily planned & designed as a “Drinking Water Supply Scheme” without giving scope to the irrigation component so as to overcome the inefficiency & impracticable financial targets in various past studies, as discussed.

Out of 1912 Mm³ (67.50 TMC) of water diversion, a quantum of 785 Mm³ (27.72 TMC) is estimated for drinking water supply to Mumbai Mega City and its suburbs, 66 Mm³ (2.33 TMC) for enroute towns/villages in Ratnagiri and Raigarh districts. A provision of 10 Mm³ (0.35 TMC) is kept for livestock population under the link canal. 1012 Mm³

(35.73 TMC) of water is planned for industrial purposes and the remaining 39 Mm³ (1.37 TMC) will be lost in transmission.

Since the topography does not permit the gravity flow due to prevailing highly dissected hills at head works as well as enroute the entire length of the link canal and also due to the tailrace waters being available at very low level of about +7.50 m, a pump house with a single stage lift of 38 m and an operation head of 45.373 m is proposed at canal of take point. Four pumps including one standby having a total installed pump capacity of 66 MW (3 x 22 MW) with ;annual energy requirement of 295 MU are designed. The canal takes off at RD 0.0 Km with FSL 44.90 m flows by gravity in its entire length and outfalls into a proposed reservoir at RD 200.00 Km with an end FSL of 29.277 m near Panvel town.

The link canal designed as lined canal of trapezoidal section with rounded corners. The canal is designed as uniform section throughout the entire reach. The maximum carrying capacity of the canal is 103 cumec with the corresponding cross sections of 18 m of bed width and 4.75 m full supply depth. Three intermediate tunnels of total length 17.950 Km (5.700 Km, 10.000 Km, 1.250 Km) are also proposed at RDs 9.750 Km, 43.700 Km and 178.600 Km respectively to cross the highly elevated hills enroute.

The total cost of the project is estimated to be Rs.2238.51 crore. The benefit-cost ratio (BCR) of the project works out to 1.89 whereas the IRR works out to 18.64%.

9. Sriramsagar Project (Godavari) – Purna – Manjra Intra-State Link Project

Considering the water availability, import, export, requirement and regeneration, the water balance at Sriramsagar project is worked out to be (-) 10008 Mm³ & (-) 6825 Mm³ at 75% & 50% dependability respectively.

Proposed diversion through Sriramsagar Project (Godavari) – Purna – Manjra Link

The water balance studies in respect of sub-basins of the Godavari basin upto Sriramsagar dam have revealed that the water available in the Godavari basin, upstream of the existing Sriramsagar project, is not fully sufficient to bring the available culturable area in that part of the basin under irrigation.

Further, it is observed that the yield available below Sriramsagar project is such that it gives rise to sizeable surplus water after meeting all the surface water requirements. Transfer of this surplus water available in the lower reaches of the Godavari to the water-short areas in its upper reaches may not be economically viable.

The inter-state link schemes are framed on the principle of successive substitution. But there is no substitution of water for the projects in Godavari basin. Hence No surplus water is available in Godavari basin up to SRSP.

Conclusion

(a) Godavari (SRSP)-Purna-Manjra link proposed by Government of Maharashtra is inter-state in nature as the location of Sriramsagar project lies in the state of Andhra Pradesh.

(b) Since there is no surplus water in Godavari river at Sriramsagar project as per the water balance indicated in Para 3.3.9, diversion of water from this reservoir is not feasible.

(c) Water cannot be diverted from SRSP to u/s areas on exchange of water from the contemplated Inchampalli-Nagarjunasagar link as this link is a part of the nine link canal system of the National Prospective Plan.

10. Middle Konkan - Bhima Valley Intra-State Link Project

The proposed Middle Konkan - Bhima Valley Link Project envisages diversion of 425 Mm³ (15 TMC) of water from the 3 dams on West-flowing rivers of Savitri, Kundalika and Amba in Middle Konkan region to the existing Valvhan lake for utilizing in the Upper Bhima Sub-basin of the Krishna basin. Out of this, a quantum of 298 Mm³ is to be utilised to bring an additional area of 52238 ha of CCA under irrigation with 100% intensity, in Pune District of Maharashtra to cater to the needs of Kharif, Rabi and Summer crops as proposed in the study and 127 Mm³ for Municipal & Industrial uses uniformly during the entire year.

Apart from the above, a quantum of 5.21 Mm³ of water from the surplus yields available at the above dam sites is allocated to cater to the irrigation, domestic and industrial needs of the enroutewater-short areas, conjointly, in the vicinity of the proposed dam sites in Raigad District of the Middle Konkan region.

The proposed Middle Konkan - Bhima Valley Link Canal system consists of three Dams on the Middle Konkan rivers viz, 1) at Bhale on Savitri river with FRL +76.00 m, 2) at Yeral on Kundalika river with FRL +59.00 m and 3) at Utra on Utra nadi, a tributary of Amba river with FRL +76.00 m.

The total cost of the Project at 2010-11 price level is estimated to be ₹ 319214 lakh which includes the (i) cost of head works at ₹ 13542 lakh, (ii) cost of conveyance system at ₹ 61863 lakh, (iii) cost of Power-houses, Pump-houses and lifting arrangements at ₹ 241693 lakh and (iv) cost of On-farmdevelopment works at ₹ 2116 lakh. The annual cost, after duly considering the annual power requirement for lifting water, works out to ₹ 68478 lakh. The total annual benefits from the link project are estimated to be ₹ 58438 lakh, which consists of (i) ₹ 16072 lakh from irrigation sector, (ii) ₹ 41966 lakh as revenue from Municipal & Industrial water supply and (iii) ₹ 400 lakh as revenue from Power generation. The Benefit-Cost Ratio of the project works out to 0.85. The IRR works out to 13.89 % without considering distributional and employment effects.

11. Koyna - Nira Intra-State Link Project

The Koyna - Nira link project proposals is diversion of 25 TMC of Koyna water to Nira rivers a tributary of Bhima river. Government of Maharashtra prioritized Koyna - Nira link project as one of the first Priority links in their proposal of 20 links.

As such, NWDA has carried out studies and proposed diversion of 198 Mm³ from (7 spills of Koyna project in the Monsoon period (65.23% dependable spills at Koyna dam).

The water would be diverted from the reservoir to pond through an approach channel (500 m) by gravity. Thereafter, the flow would be through the tunnel of length 33.9 km and canal of length 21 km by gravity in to the Ram odha river which is tributary of the Nira river. The diverted water will be stored in the five proposed tanks. The total length of link is of about 56 km. Out of the total proposed diversion of 198 Mm³, 133 Mm³ is earmarked for irrigation and 24 Mm³ for domestic needs and 24 Mm³ for industrial needs. The remaining 17 Mm³ is loss in transmission. A new area of 21,000 ha is proposed for irrigation in the downstream of Nira Deoghar dam in Upper Bhima sub-basin which is the proposed command area of Nira.

The total cost of the project is estimated as 913030 lakh at 2011-12 price level. The cost of Head works, Conveyance system and on farm development is 86926 lakh, 825054 lakh and 1050 lakh respectively. The link proposal will provide annual irrigation benefits to an area of 21,000 ha in Pune district. The net annual benefits from irrigation, domestic and Industrial water supply are 18060 lakh, 4342 lakh and 17842 lakh respectively. Total benefits from the project are 40244 lakh. The annual cost of the project is worked out as 108428 lakh. The Benefit-Cost ratio is estimated to be 0.37 and by using discounted cash flow method and @ 10% discounting rate, it is 0.36. The IRR works out to 3.4%.

12. Mulshi-Bhima Intra-State Link Project

Government of Maharashtra has proposed six Intra-State links and the Maharashtra Pani Parishad has proposed thirteen Intra-State links to divert water from surplus areas to deficit areas within the State. One of such proposals is diversion of 25 TMC of water from Mulshi lake to Bhima basin.

Earlier, Sri C.V. Gole Committee of Planning Commission, Government of India has made studies on feasibility of diversion of water from west flowing rivers. The Committee assessed water resources of each west flowing river basin and made some proposals for diversion of surplus waters of west flowing rivers to east side, which are otherwise going waste into Arabian sea. The Committee submitted its report in February 1978. The Committee opined that 25 TMC of water of Mulshi lake can be diverted to Bhima basin.

Later, Government of Maharashtra also initiated and carried out studies about Intra-State links and prioritized them. Mulshi-Bhima link project is one of the first priority link in their proposal. This link envisages diversion of 25 TMC of water from western Maharashtra to eastside. The ridge level between Middle Konkan region and Upper Bhima basin is about 700 m to 800 m. Hence, water diversion is possible only by lift and tunnel construction.

This report details with the pre-feasibility studies for diversion of 466 MCM (16.5 TMC) of Mulshi water to upper Bhima sub-basin (i.e. into the Pauna river) for irrigation, drinking water supply and industrial requirements in the water-deficit areas of Rajgarh and Pune districts of Maharashtra State. This proposal of diversion of 466 MCM of water, is beneficial to some extent in Rajgarh and Pune districts. Plate-I shows the Index Map of the Mulshi-Bhima link project.

Water from the Mulshi lake is brought through two tunnels to the hydroelectric project located at Bhira. The installed capacity of the Bhira power house is 300 MW. The monthly releases after power generation at Bhira power station during the period from 1976 to 2006 are collected from Government of Maharashtra. The 75% and 50% yields are worked out for these available 31 years releases as 668.32 MCM (23.60 TMC) and 737.13 MCM (26.00 TMC) respectively.

The Government of Maharashtra has constructed Ravalje power station with 80 MW installed capacity to generate power by the tail race releases of Bhira hydroelectric project in the Maharashtra State. The tail race water of Ravalje power house will be let into Kundalika river through tail race channel.

It is proposed to construct a diversion weir on tail race channel of Ravalje power house and lift the water through pipelines. The monthly releases at Ravalje power station after power generation during the period from 1988 to 2008 have been collected from

the Government of Maharashtra. The 75% and 50% dependable yields are worked out from these 21 years releases as 621 MCM (22 TMC) and 699 MCM (25 TMC) respectively.

Mulshi-Bhima envisages to transfer 466 MCM of west ward flowing tail race water of Ravalje power station (75% of 75% dependable yield at Ravalje power house) to Bhima basin and the remaining 155 MCM of water (25% of 75% dependable yield) will be let into the Kundalika river to meet any commitments in the downstream of the Kundalika river. The requirement for domestic and industrial needs is worked out as 197 MCM in the enroute drought prone areas i.e. Rajgarh district in Middle Konkan region of Pune district. The remaining water i.e. 269 MCM (including transmission losses) water will be diverted through the proposed Mulshi-Bhima link to the upper Bhima sub-basin which is a deficit sub-basin. The diverted water will be utilized for irrigation in upper Bhima sub-basin which includes transmission losses.

The gross command area (GCA) is identified as 55000 ha under Pauna branch canal using toposheets and irrigation Atlas of India. Based on the land use statistics available from the respective water balance studies and the information derived from the toposheets, 75% of the area i.e. 40000 ha is considered as Culturable Command Area (CCA). However, keeping in view the quantity of water transferable from the Fore bay reservoir an area of 40000 ha is considered as CCA under the link canal under the Pauna branch canal.

Mulshi-Bhima link comprises of the following components:

- i) **Diversion weir:** This is a proposed diversion weir across the Ravalje power house tail race channel near Ravalje village of Raigarh district. The FRL of weir is 45.00 m and the total length of weir is 170 m and the length of the spillway is 40 m.
- ii) **Conveyance system:** The total length of the link is 37.6 km which includes 3.3 km long tunnel. The proposed quantity of diverted water is lifted in six stages at RD 0 km, RD 27.3 km, RD 32.3 km, RD 32.8 km, RD 33.3 km, RD 33.8 km, with lifts of 30 m, 91.21 m, 109 m, 109m, 108 m and 109 m respectively. The stretch from RD 2.7km to RD 27.3 km, the link canal run through pipeline by gravity. From RD 34.3km, the water flows through tunnel by gravity till it outfalls in the Pauna river which is the tributary of Bhima river.
- iii) **Command area proposed:** This proposed command area is located in Upper Bhimasub-basin in the district of Pune in Maharashtra State. The length of the proposed branch canal is 15 km. The proposed annual irrigation under this project is 40000 ha and water utilisation is 269 MCM.

The total cost of the project is estimated as Rs.281527 lakhs at 2010-11 price level. The link proposal will provide annual irrigation benefits to an area of 40000 ha. The total energy required for lifting 466 MCM of water to the height of 556 m is 1135 MU annually. The net annual benefits from irrigation, domestic and industrial water supply are Rs.93335 lakh, Rs.12184 lakh and Rs.64141 lakh respectively. The annual cost of the project is worked out as Rs.58763 lakh. The power required for pumping is around 175.16 MW. The Benefit-Cost ratio is estimated to be 1.46 and by using discounted cash flow method @10% is 42. The IRR works out to 14.96%.

13. The Savitri – Bhima Intra-State Link Project

The Government of Maharashtra has entrusted the study of Intra-state river link proposal to NWDA for transfer of 1133 Mm³ (40 TMC) of water from Savitri Basin to Bhima valley through the proposed Savitri - Bhima valley link. As per the proposal, NWDA studied the Hydrology of Savitri Basin and observed that it is possible to divert 715 Mm³ (25 TMC) of water only, to Bhima valley. It is proposed to utilise 7 Mm³ of water in surrounding areas of Chaudharwadi & Amshet reservoirs in the Savitri Basin for irrigation & domestic needs. In order to harness a quantum of 708 Mm³ of water available, it is planned to create two reservoirs namely Chaudharwadi and Amshet on two independent tributaries of Savitri river. These reservoirs will be inter connected by 5.15 km long tunnel of dia 3.40 m to transfer waters of Chaudharwadi to Amshet reservoir thereafter, the combined water of 708 Mm³ (25 TMC) will be transferred from Amshet reservoir to the existing Khadakwasla dam on river Bhima (through tunnel and open canal) for further utilization in Bhima Valley.

The Savitri - Bhima link canal system proposal consists of two dams viz., (i) Chaudharwadi on Bhaovira nadi with FRL +100.00 m and (ii) Amshet reservoir on Kharak/Kal nadi with FRL +75.00 m, both on tributaries of Savitri river. These two reservoirs are planned to be inter connected by 5.15 km long tunnel, so that the water from Chaudharwadi reservoir will be let into Amshet reservoir. The total availability of water from both the Chaudharwadi and Amshet reservoirs is about 708 Mm³ (25 TMC) and is available for further transfer, after utilizing for irrigation & domestic needs in the surrounding area of the above two reservoirs in Savitri Basin.

The water from Amshet reservoir is proposed to be lifted to a height of 567.41 m by a multi-stage pumping arrangement in 10 stages. Thereafter, the water will be transferred by another conveyance tunnel. A tunnel with dia of 6.20 m off-takes at RD 0.000 km with an FSL of 600.010 m and runs for a length of about 24.730 km. The tunnel exits at RD 24.730 km with an FSL of 591.770 m from where an open canal continues and traverses for a small stretch of 1.650 km and finally outfalls in to the existing Khadakwasla reservoir on river Bhima at RD 26.380 km with an FSL of 588.40 m for utilization in Bhima valley. The requirement of power for lifting the above water works out to 359 MW (1535 MU). It is also proposed from the monsoon spills of D/s of Amshet dam to generate the power of 33 MW (64 MU).

Out of 708 Mm³ (25 TMC) of diverted water to Bhima valley, it is planned to use 495 Mm³ for irrigation and 213 Mm³ for municipal & industrial use. An irrigated area of 86764 ha can be stabilized with the assured water supply of 495 Mm³ for irrigation under the command of existing Khadakwasla project in the Bhima sub - basin in Pune district of Maharashtra.

The diversion of water through the link canal is proposed for throughout the year from June to May to cater to the needs during Kharif, Rabi & summer crops. The conveyance system is designed for carrying a maximum discharge of 52.74 m³/sec to meet the required demands.

The total cost of the project including establishment and tools & plants, works out to ₹ 4744.21 crores at 2010-11 price-level.

The Benefit - Cost ratio is calculated based on annual cost and annual benefit which works out to 1.15. The IRR of the project with and without distributional and employment impacts works out to 14.81% and 13.12 % respectively.

14. Kolhapur - Sangli/Sangola Intra-State Link Project

The Kolhapur-Sangli/Sangola Link project is formulated to utilize the surplus waters of western Upper Krishna in the drought prone eastern areas in Upper Krishna and Bhima sub-basins.

The Sangli/Sangola Link project envisages diversion of 2472 MCM of water from the Shirol barrage across Panchaganga & Mhaisal barrage across river Krishna (to tap Warna waters) to the eastern areas in Sangli, Solapur and Satara districts. Out of this, a quantum of 2099 MCM is earmarked for irrigation, 255 MCM is planned to be utilized for municipal & industrial purposes in the command areas and the remaining 118 MCM will be lost in transmission.

The link canal takes off from the left flank of the proposed Shirol barrage with FSL 528 M and traverses for a length of 117 km out of which 60 km is open channel and the rest is by raising mains. The alignment passes through Sangli, Satara and Salapur districts of Maharashtra. The link canal has been provided with a total lift of 241 m in 4 stages and is supported by 3 branch canals and number of cross drainage and cross masonry works. It is observed that the demands in rabi season are not met and hence storage tanks are proposed in the command area. Accordingly, water diversion is limited to the period from June to September.

It is proposed to bring 400000 ha of new area under irrigation. Apart from irrigation, it is also proposed to cater to the future municipal and industrial water requirements in the command area. About 22.5 lakh (14.23 lakh as per Census 2001) human population and the industrial water requirements by 2050 AD are proposed to be served utilizing 255 MCM.

The topography doesn't permit the gravity flow irrigation through out canal system, lifting arrangements are provided on link canal in 4 stages. The total pump capacity required is 1601 MW and the annual power requirement for these lifting arrangements works out to 3379 MU. The land to be acquired is 989 ha for main canal, offices and colonies, borrow areas and the structures.

The link canal is designed as lined canal of trapezoidal shape with bottom rounded corners. The maximum carrying capacity of the canal is 335 cumec with the corresponding cross section of 41 m of bed width and 6 m full supply depth.

The cost of the project is estimated to be Rs.700304 lakh, which includes the cost of head works at Rs.11257 lakh, the cost of conveyance system at Rs.323424 lakh, the cost of lifting arrangements at Rs.349383 lakh and cost of on-farm development at Rs.21017 lakh. The annual cost after duly considering the land development and the annual power requirement for lifting etc. works out to Rs.155091 lakh. The direct benefits from the link project due to irrigation, municipal & industrial water supplies are estimated to be Rs.225122 lakh. The Benefit Cost ratio of the project work to 1.45 whereas the Internal Rate of Return works out to 15.30%.

15. The River Linking Projects of Tapi basin in Jalgaon District

The water shortage in the existing minor irrigation tanks varies from 18% to 76% as per TIDC. In order to feed these minor irrigation tanks, and to augment the ground water resources, domestic water supply etc. the flood flows have been proposed to be diverted through the existing canal networks / proposed short links. Since flood flows are not readily available at the diversion sites except Jamda weir, the rainfall-runoff relationship method has been followed to arrive the yield at diversion points. Out of the

30 schemes under Stage-I, 18 schemes have been found feasible hydrologically. If any supplementation by the diversion of west flowing rivers to Jalgaon district is possible, then some of the non-feasible schemes may also become feasible for which separate studies can be taken up subsequently.

The 18 link proposals together would supplement / irrigate 5580 ha. of command area under existing minor irrigation tanks in Jalgaon district. About 87 km length of link canals from the existing canal networks including proposed short links to the existing minor irrigation tanks have been proposed. Out of the 74 Mm³ of water proposed to be diverted through the 18 links, 45 Mm³ of water will be utilized for irrigation purpose, 6 Mm³ of water for domestic needs and remaining for ground water recharge purpose.

The total estimated cost of 18 link schemes is Rs.12049 lakh at 2010-11 price level which includes the cost of head works at Rs.908 lakh, the cost of conveyance system at Rs.11141 lakh.

The benefit-cost ratio of the project works out to 1.50:1 where as the IRR with & without employment and distributional effect works out to 15.34% & 13.25% respectively.

16. Nar – Par - Girna Valley Intra-State Link Project

Nar-Par-Girna Valley link project is an Intra-State link proposal of Maharashtra State to divert the surplus waters from twenty small proposed dams located in Maharashtra portion of west flowing river basins i.e. Ambika basin, Auranga basin and Nar-Par basins to east side i.e. Girna river of Tapi basin to utilize in the proposed command areas identified in Nasik, Jalgaon and Aurangabad areas of Girna sub-basin.

Nar-Par-Girna Valley link project envisages diversion of 534 MCM of water from Ambika/Auranga/Nar-Par basins through twenty proposed small dams to Girna river by gravity and lift. One small dam i.e. Devipada project is proposed in Ambika basin. Four small dams i.e. Hivarpada, Songir, Umerpada and Savanavan are proposed in Auranga basin. Fifteen small dams i.e. Pratapgarh, Rakshas, Bhaven, Milan, Deomal, Ghodi, Bhendshet, Khirdi, Ukhedmal, Chokda, Savarpada, Mankhed, Menmal, Borwan, Dehre, Pilpada are proposed in Nar-Par basin. The Index Map of the -Par-Girna Valley link project is enclosed.

As per the water balance studies carried out by NWDA, it is possible to divert 534 MCM of surplus water available at 75% dependability from twenty proposed small reservoir to Girna sub-basin by constructing three lift schemes. Scheme-I envisages inter-connecting six small reservoirs and two water sumps with pipelines and lifting the surplus water from reservoir to reservoir and finally diverting 159 MCM of water into the Girna river.

Scheme-2 envisages inter-connecting four small reservoirs and one water sump with pipelines and lifting the surplus water from reservoir to reservoir and finally diverting 124 MCM of water into the Girna river. Similarly, Scheme-3 envisages inter-connecting ten small reservoirs and three water sumps with pipelines and lifting the surplus water from reservoir to reservoir and finally diverting 251 MCM of water into the Girna river. A tunnel of length 3.8 km would be provided between Bhendshet and Khirdi reservoirs to cross the hillock area.

This proposal would irrigate an area of 95760 ha in Girna sub-basin. The total length of pipeline in all the three schemes would be 108 km approximately. the surplus

waters from all the three schemes would be lifted to Girna river, throughout the year in all the twelve months. The total static lift would be 683 m, 696 m and 1161 m in all the three schemes respectively. Seven stages of lifts are proposed in Scheme-1. Similarly, seven stages of lifts and eleven stages of lifts are proposed in Scheme-2 and Scheme-3 respectively.

The proposal would irrigate 53626 ha in Nasik area, 38304 ha in Jalgaon area and 3830 ha in Aurangabad area of Girna sub-basin. Girna command canal will take off from main Girna river, downstream of outlet point for irrigating proposed command in Nasik/Jalgaon/Aurangabad areas. Out of the total diverted water of 534 MCM, about 72% of water i.e. 384 MCM is earmarked to bring 95760 ha of CCA under irrigation with 100% intensity and the remaining 28% of water i.e. 150 MCM is planned for domestic and industrial use in proposed command area. The domestic and industrial requirement of Jalgaon city by 2059 AD i.e. 86 MCM is also included.

The total power requirement for lifting the water would be 2054 MW and the annual energy consumption is estimated to be 1307 MU.

The total cost of the project is estimated to be Rs.1005310 lakh at 2010-11 price level, which includes the cost of head works at Rs.236121 lakh, the cost of conveyance system at Rs.61543 lakh, the cost of lifting arrangements at Rs.149927 lakh and cost of on-farm development Rs.3830 lakh. The annual cost after duly considering the annual power requirement for lifting works out to 148591 lakh. The direct benefits from the link project due to irrigation, domestic & industrial water supplies are estimated to be Rs.80738 lakh. The Benefit-Cost ratio of the project works out to 0.54 whereas the IRR works out to 3.16%.

17. Narmada - Tapi Intra-State Link Project

PFR of this link has already been prepared by Government of Maharashtra. Government of Maharashtra vide their letter No. PFR of T-P/2012-DB/1878-79 dated 11.07.2013 requested NWDA to drop the link. Further action is not being taken by NWDA in view of the above.

18. Jigaon – Tapi – Godavari Valley Intra-State Link Project

Vidharba Irrigation Development Corporation (A Government of Maharashtra undertaking), Nagpur has proposed an intra-state link project to divert some quantum of waters from the proposed Jigaon irrigation project located in Purna sub-basin of Tapi basin to Godavari valley by lift. However, complete details of the proposal are not readily available from the Government of Maharashtra. As such, the available hydrological data has been collected and the study has been made accordingly. At first, to assess the hydrological feasibility and firm up the overall quantum of water availability & water balance at Jigaon project, hydrological studies have been conducted. It is seen that there is a water deficit at 75% dependability to the extent of 333 MCM. Therefore link is not found feasible.

Gujarat

19. Damanganga – Sabarmati – Chorwad Intra-State Link Project

Damanganga–Sabarmati–Chorwad link proposed by Government of Gujarat envisages diversion of 4200 Mm³ of surplus waters from eight west flowing rivers viz., Damanganga, Kolak, Par, Auranga, Ambica, Purna, Mindhola and Tapi by gravity. The link

canal takes off from existing Madhuban dam with an FSL of 78 m and pick up the surplus waters from en route rivers through barrage/weirs and outfalls into proposed Vataman barrage on Sabarmati river after traversing about 400 km. From Vataman barrage the waters are proposed to be lifted into a canal. The canal after traversing 400 km outfall in Metal river near Chorwad. Government of Gujarat also proposed an alternate alignment i.e., to divert the transferred water into Saurashtra branch of Narmada canal instead of Chorwad. Link canal shall provide drinking water in industrial corridor en route and domestic & irrigation facilities in Saurashtra and arrest the salinity ingress in coastal area.

Study by National Water Development Agency (NWDA):

As per the water balance studies carried out by NWDA, it is possible to divert a total surplus water of 2071 Mm³ of water available at 75% dependability from the eight rivers. The link canal starts from Madhuban reservoir on Damanganga river and pick up waters from other west flowing rivers enroute between Damanganga and Tapi (excluding Tapi) through 10 barrages at river crossings. The link canal after traversing 196.20 km outfall into Amravati river which joins Narmada, upstream of proposed Bhadbhud barrage across Narmada river. Bhadbhud barrage is proposed by Government of Gujarat to divert the flood waters of Narmada to Kalpsar project through a canal. NWDA proposes to utilize this canal to divert the surplus waters from the eight west flowing rivers into Kalpsar project.

Transmission losses through canal are worked out to be 98 Mm³. Kalpsar project is proposed at Gulf of Khambhat to harness water from the rivers that joins it along with the flood waters from Narmada. These waters thus received at the proposed Kalpsar project are proposed to be utilised in Saurashtra region by lift (Proposed water utilisation by Kalpsar project is 6558 Mm³ and corresponding area to be irrigated is 10.54 lakh ha). Kalpsar project has sufficient carry over storage capacity. Proposed diversion of water through Damanganga – Kalpsar link is unregulated one. The storage at Kalpsar can meet the designed requirement of its proposed command and hence, water is proposed to be delivered into Kalpsar through the link canal can also be used efficiently through Kalpsar project in Saurashtra by lift.

Government of Gujarat has proposed 3 lift canals at 100 m, 80 m and 50 m contour levels. All canals are proposed to off take from Kalpsar project, traverse parallel to southern coastal line of Saurashtra benefit 10.54 lakh ha utilising 6558 Mm³. From Kalpsar reservoir, the water transferred through the link canal can be let in to the proposed contour canal at RL 50 m with slight modification of the canal and this can serve the purpose of link canal up to Chorwad. The additional area that can be benefited because of the additional water through the Damanganga – Kalpsar link would be 3.46 lakh ha with 100% intensity of irrigation with semidry crops.

The Damanganga – Kalpsar link is a transit canal and will pass through developed and to be developed command areas, as such, water requirement for enroute area is found to be Nil. The link canal discharge varies from 17 cumec at head to 448 cumec at tail. Due to water shortage during non monsoon to maintain draft and non suitability of canal section and type of canal structures en route, navigation through link is not proposed.

Total cost of the link project is estimated to be approximately ₹ 626197 lakh at 2010-11 price level, which includes cost of head works at ₹ 98293 lakh, cost of conveyance system at ₹ 527904 lakh. Annual benefits from irrigation have been estimated based on net value of crop produce and is found to be ₹ 32.40 lakh per 100

ha. Total annual benefits through supply of domestic and industrial water have not been assessed as the area is not entirely demarcated and the quantum of water is not firmed up. The Benefit Cost (BC) and IRR of the project is found to be 1.53 and 13.05% respectively, which is derived excluding the apportioned cost of Kalpsar project, Bhadbhut barrage and its flood canal, irrigation canal from Kalpsar and lift arrangements. Various other alternatives are also being explored to select the best based on cost-benefit analysis.

Odisha State

20. Mahanadi (Hirakud) – Brahmani (Rengali) Intra-State Link Project

The Mahanadi (Hirakud) – Brahmani (Rengali) intra state link project is proposed by Government of Orissa which envisages diversion of 550 cumecs spill water of Hirakud (Mahanadi) to Rengali reservoir (Brahmani) basin during three months i.e. July to September for providing (i) enroute irrigation of 4000 ha (ii) stabilization of irrigation of 7000 ha in Rengali command and generation of hydropower to the tune of 145 MW. Thus total quantity of water diverted @ 550 cumecs in three months (92 days) comes to 4372 MCM. The total length of the link canal is 96 km from its off take at Hirakud to its out fall in proposed dam at Garda nala. It is proposed to construct a power house 2.1 km down stream of Garda reservoir on the periphery of Rengali reservoir with installed capacity of 145 MW. For this purpose 500 cumecs of spill water of Hirakud reservoir will be utilized. It is also proposed to divert 15 cumecs of water at RD 51.15 km into the Sankh nala which finally joins Tikra nala, a tributary of Brahmani river, for irrigating new command area of 4000 ha in the downstream of Tikra barrage and stabilization of irrigation of 7000 ha in Rengali command. The total cost of the link project is estimated as Rs2793 crores at 2008-09 price level. The B.C. Ratio works out to 0.46 only. The link proposal is thus found techno-economically not viable.

21. Mahanadi (Barmul) – Rushikulya Intra-State Link Project

This report contains the pre feasibility study of the Mahanadi (Barmul) – Rushikulya Intra- State link of Odisha. This link project envisages diversion of 1663 MCM of surplus water of Mahanadi river from the proposed barrage at Barmul which is about 13 km down stream of Tikrapara and 14 km up stream of Manibhadra dam site proposed by Government of Odisha and 21 km upstream of Gania village in Nayagarh district of Odisha. The pond level of the proposed Barmul barrage is 70 m and seven numbers of villages namely; Naya Gaindi, Hati Bari, Gochiraparha, Kakaraparha, Behera Sahi, Majhiparha and Onakoni will come under submergence of Barmul barrage and the approximate area of submergence will be 3406 ha. The water proposed to be diverted through the link canal (1663 MCM) along with the committed down stream releases of Mahanadi delta requirement would be guided through the power house to be constructed on the right bank for power generation of 373.30 MW and the required quantity will be picked up in to the link canal, letting the rest into the Mahanadi river for down stream requirement. The tail water level is 55.00 m. The available gross head of 15m will be utilized for power generation.

The Mahanadi (Barmul) - Rushikulya link canal is proposed to take off from the tail race of power house proposed at right bank of Barmul barrage near Barmul village on river Mahanadi with FSL 55m and will carry 1663 MCM of water for enroute irrigation of 100000 ha of command area in the districts of Nayagarh, Khurda and Ganjam of Odisha in addition to cater domestic and industrial needs. Out of the 1663 MCM of water, 1380 MCM will be utilized for irrigation and 130 MCM for Domestic and industrial use. The canal after traversing a total distance of 224.30 km through the districts of Nayagarh, Khurda and Ganjam of Odisha, outfalls into Rushikulya River at a location downstream of the

confluence of Bada nadi with Rushikulya river near Aska town which is about 15 km downstream of the existing Rushikulya (Janivilli) weir project.

Mahanadi (Barmul) - Rushikulya link canal will have a trapezoidal section of 19.5 m x 4.50 m for 146.85 km and 12.50 x 4.50 m for remaining 77.45 km and side slopes 1.5 H: 1 V. The canal will have a bed slope 1: 15,000 for the entire length. A total number of 65 cross drainage works including 45 under tunnels would be provided along the course of the canal in addition to a total number of 27 road bridges. The schedule of construction of the link project is planned over a period of five years.

The total cost of the link canal is estimated as 3806.61 crore at 2010-11 price level. Annual cost of the project works out to Rs 402.43 crore whereas annual benefits from irrigation, power and municipal use work out to Rs 169.96, 136.32 crore and Rs 106.60 crore respectively and the total annual benefit is Rs 412.88 crore. Thus the benefit cost ratio works out to be 1.03 and the IRR is estimated to be 5.82%.

22. Vamsadhara - Rushikulya (Nandini Nalla) Intra-State Link Project

This report contains the pre feasibility study of the Vamsadhara- Rushikulya (Nandini nalla) project, an Intra-State link of Odisha.

The Odisha Government has proposed to construct Nandini dam on Nandini nalla, a tributary of Harabhangi river in Vamsadhara basin. The main purpose of the project is to store the water in the proposed Nandini reservoir and supply 56.98 MCM of water to the existing Harabhangi reservoir through a 4.00 km long covered canal for providing irrigation to 7225 ha during Rabi season of the Harabhangi command in the adjacent Rushikulya basin in addition to augment the drinking water supply to Berhampur town to the extent of 24 MCM of water. The Harabhangi command area is drought prone and the statistics indicate that number of total droughts occurred during the 31 years period (1971 to 2001) is 15 and out of which 38.71% is marginal and 9.68 % moderate and probability of occurrence of drought is 48.39%. This link will be a boon to the people of this area who otherwise are suffering from frequent droughts.

The water will be first utilized for power generation with installed capacity of 2 MW to generate 13.92 MU energy annually, before letting into the Harabhangi reservoir. The proposed FSL of the flow channel at the head is 500.00 m and the FRL of the existing Harabhangi reservoir is 387.50 m. Four (4) nos. of villages; namely, Buradang, Karabarhi, Poigurha and Laram will come under submergence of Nandini reservoir affecting about 214 persons and 48 houses as per 2011 census.

Both the Nandini dam (proposed) and the Harabhangi dam (existing) lies in Vamsadhara basin and the command area in the Rushikulya basin. Thus, this link project is an inter basin water transfer link.

Vamsadhara - Rushikulya (Nandini nalla) link canal aligned as a contour canal passing through hilly terrain/hard strata. The canal will have a trapezoidal section of 0.80 m bed width , 1.75 m depth and bed slope 1: 10,000 with side slopes 0.50 (H) to 1(V). No CD/CM works are required for the link canal.

The total cost of the link canal is estimated at Rs 195.80 crore at 2011-12 price level. Annual cost of the project works out to Rs 21.90 crore whereas annual benefits from irrigation, power and domestic water supply works out to Rs 19.30 crore, Rs 6.96 crore and Rs 9.14 respectively. Thus the benefit cost ratio works out to 1.62 and the IRR is estimated to be 7%. Thus, this project is techno economically viable.

23. Nagavali – Vamsadhara – Rushikulya link project

The NVR link project envisages diversion of 47 MCM of surplus water of Nagavali river from the proposed Lower Nagavali dam, 305 MCM of surplus water of Vamsadhara river from the proposed Lower Vamsadhara dam in Rayagada district of Odisha, and spills 71 MCM from Harabhangi dam. The total water proposed to be diverted through the link canal is 423 MCM.

The FRL of the proposed Nagavali dam is 300 m and FRL of the proposed Lower Vamsadhara dam is 190m. This link canal is proposed to take off from Lower Nagavali dam left bank near Bheja village on river Nagavali with FSL 290 m and outfalls into Right Main Canal of Godahada project in Rushikulya basin. The total length of the canal is 277.750 km, out of which 18 km of tunnel is proposed to pass through Nagavali – Vamsadhara ridge from RD 22.750 km to RD 40.750 km and another tunnel of 7.50 km from RD 147.00 km to RD 154.50 km between Vamsadhara and Jalangi river and third tunnel of 26 km long from RD 222.00 km to RD 248.00 km is proposed to pass through Vamsadhara- Bahuda ridge. The canal is aligned as contour canal with bed slope 1:15,000 for the entire length and 1:6000 at tunnel reaches.

The link project will provide irrigation facility to about 45472 ha (31960 ha CCA) to the drought prone area of Rayagada, Gajapati and Ganjam district of Odisha State located in Vamsadhara , Bahuda and Rushikulya basins and assured domestic & Industrial water supply to rural people of Godahada area in Rushikulya basin and also to water scarce Berhampur Town . Out of the 423 MCM of water, 345 MCM will be utilized for irrigation and 59.50 MCM for domestic & Industrial use. Transmission loss would be 18.50 MCM.

The total cost of the link canal is estimated as Rs. 11275.00 crore at 2020-21 price level. Annual cost of the project works out to Rs. 1337.00 crore whereas annual benefits from irrigation, power and municipal use work out to Rs. 510.00 crore, Rs. 22.00 Crore and Rs. 111.00 crore respectively and the total annual benefit works out as Rs. 643.00 Crore. Thus, the benefit cost ratio works out to 0.47 and the internal rate of return (IRR) is estimated to be 4.62 %.

Jharkhand State

24. South Koel – Subernarekha Intra-State Link Project

The South Koel – Subernarekha link canal project proposed by Government of Jharkhand envisages construction of Padyar barrage on river South Koel near village Padyar. The proposed link canal (76.250 Km) off takes from left bank of Padyar barrage at an elevation of 299 m and outfalls in Subernarekha river at a level of 81.825 m. The canal has been aligned at bed slope of 1:10,000. This link envisages diversion of 1792 MCM (including 403 MCM water from Sankh river and 1281 MCM water from South Koel river) water from South Koel to Subernarekha. Out of 1792 MCM quantum of water, 38 MCM water is proposed to be utilized for irrigation, 30 MCM for domestic purpose and 40 MCM for transmission losses, remaining 1684 MCM of water will reach to Subernarekha which Government of Jharkhand may utilized for industrial and navigational purposes.

The enroute gross command area of the link project is 7200 ha where as culturable area is 4320 ha. The intensity of irrigation & delta are kept as 100% & 0.89 respectively.

Total cost of this project is worked out as Rs. 1399 crore at 2008-09 price level which includes Rs.353 crore for head works, Rs.421 crore for canal & canalization and Rs.624 crore for power houses at four locations for its generation of about 100 MW of power across the link canal and about Rs.1 crore for on farm development. Annual cost of the project is worked out as Rs.164 crore while annual benefits as Rs.670 crore. B.C. Ratio and IRR works out to be 4.09 and 36.91 % respectively.

25. Sankh - South Koel Intra-State Link Project

The Sankh-South Koel intra-state link project is proposed by Government of Jharkhand. The link canal envisages diversion of 498 MCM water of Sankh river to South Koel river and further transmission to Subarnarekha river through another intra-state link namely South Koel – Subarnarekha link for navigation and industrial requirement in Subarnarekha basin. Out of 498 MCM of divertible quantity of Sankh water, 403 MCM of water reaches South Koel, 55 MCM of water is required to irrigate the command area of 6221 ha, drinking water requirement is 30 MCM & transmission loss is 10 MCM.

The link canal will off take from Sankh river near Bartoli village at an elevation of 640 m and after traversing a total length of 41.2 km, it falls in South Koel river at level of 520 m. There are five falls along link alignment ranging from 16 m to 30 m. It has been proposed to install three power houses with total hydel power generation of 169.4 MW.

The total cost of project works out to Rs.519 crores at 2008-09 price level. The BC Ratio & IRR works out to 2.78 & 8.16% respectively.

26. Barakar – Damodar - Subarnarekha Intra-State Link Project

The Barakar-Damodar-Subarnarekha intra state link proposed by Government of Jharkhand envisages diversion of 760 MCM of Barakar water to Subarnarekha River. The purpose of the study is to provide additional unused water of Barakar river at Bhalpahari dam to Subarnarekha River for industrial use in Subarnarekha basin and to help in making river Subarnarekha navigable.

This project envisages construction of dam on river Barakar near Bhalpahari. The proposed link canal, 114 km long (including 5 km tunnel) off – take from right bank of Bhalpahari dam near village Budhdia at an elevation of 237 m and out falls in Subarnarekha river at level of 257 m. The slope of the canal has been kept as 1:20,000. The link envisages pumping of water through 30 m at RD 75.7 km. Out of the 760 MCM of diverted water from Barakar 207 MCM will be utilized for enroute irrigation, 30 MCM for domestic use and 493 MCM water diverted to Subarnarekha river for industrial navigation purpose, 30 MCM water will be consumed in transmission losses. Total cost of the project is worked out to Rs.1148 crore at 2008-09 price level. The Benefit Cost Ratio and IRR works out to 1.23 and 10.66% respectively.

Bihar State

27. Kosi – Mechi Intra-State Link Project

The Kosi – Mechi Intra State Link Project proposed by Government of Bihar envisages diversion of 12,582 MCM of Kosi water from existing Hanuman Nagar Barrage on Indo-Nepal border to Mechi river (a tributary of Mahananda) near Gambhirgarh village in Kishanganj district of Bihar, about 15 km upstream of its confluence with Mahananda. The total length of canal is 120.15 km.

The link canal will provide 8347 MCM of water for irrigation out of which 6082 MCM in existing command of eastern kosi main canal and remaining 2265 MCM in new command areas. Provision of 14 MCM of water for domestic and industrial water needs for enroute village/towns has also been made. Transmission loss in canal will be 73 MCM. Thus after meeting all the enroute requirements remaining 4148 MCM of water will reach Mechi river which can be utilized by Government of Bihar to supplement irrigation demand of Mahananda basin. Even if this water is not used for irrigation purpose in Mahananda basin, there will be relief from flood in Kosi to some extent as this diversion of water in Mechi has been proposed during 7 months. i.e. from June to December. The total cost of the link project has been estimated as Rs. 4441.82 crores at 2008-09 price level. The B.C Ratio and IRR of the link canal project has been assessed as 1.51 &

15.99% respectively.

28. Barh (Ganga) - Nawada Pump Canal Scheme Intra-State Link Project

Barh-Nawada pump canal scheme is an Intra State link proposed by Government of Bihar for irrigation of drought prone area between Punpun and Kiul rivers. It is proposed by the State Government to divert about 5733 MCM balance water of Ganga at Hasan Chak through Goithawa river by lifting water from starting RL 46 m at Ganga to RL 90 m at Nawada. The area falling between 90 m to 140 m contour have already been covered by Sone-Kiul Link.

As per the study carried out by NWDA the water balance of river Ganga at Hasanchak during monsoon are 127900 MCM and 166272 MCM respectively at 75% and 50% dependability. The water balance during non monsoon are (-) 46767 & (-) 42755 MCM respectively at 75% and 50% dependability. Hence a reservoir with gross storage capacity of 4850 MCM is proposed near Masathu village at RD 8.000 km of the proposed Barh – Nawada pump canal scheme to store surplus waters of Ganga during monsoon and to utilize the same during non-monsoon for fulfilling the requirements of Barh – Nawada pump canal scheme of Bihar.

The link canal will provide annual irrigation to an area of 700402 ha (CCA) by utilizing 4483 MCM of Water. Domestic & industrial requirement enroute of the link canal is 1206 MCM.

The total cost of the project is Rs. 12298 crore. Benefits Cost Ratio is 0.92 and IRR is 8.7%. The scheme is not found techno-economically viable.

29. Kohra – Lalbegi Intra-State Link Project

As per decision taken in meeting held on 16th June 2008, between officials of Government of Bihar and NWDA, NWDA agreed to prepare PFR of six intra – State links of Bihar. Kohra-Chandravat link is one of these links

Accordingly, the possibilities of linking the rivers from Kohra to Chandravat has been studied. It came in notice that the catchment area of Kohra upto diversion point is 33% of the Kohra basin & elevation of the link canal alignment from Kohra to Chandravat is varying from 71 m to 73 m from off takes point to outfall point of the link canal. So passing the discharge by gravity is not technically possible. Also, the assessed quantity of the flood discharge upto diversion point is very less. In view of above, the alignment from Kohra to Chandravat was dropped & alternate alignment for diverting flood water of Kohra in downstream of Chandravat was examined. Finally, the alignment from Kohra at Binwalia (downstream of earlier diversion point) to Lalbegi near Debaria was proposed to be linked up.

The report deals with the PFR study of Kohra – Lalbegi link which envisages diversion of 80 cumecs of flood water (approx. 50% of flood discharge) of Kohra river (a tributaries of Burhi Gandak river) to the Gandak river through linking the Kohra & the Lalbegi rivers so that flood damages in the lower reaches of Kohra & Burhi Gandak river can be minimized.

The Kohra – Lalbegi link off takes from Kohra river near village Binwalia in district of West Champaran and outfalls into river Lalbegi near Debaria. Further the river Lalbegi traverses upto a distance of 9 Km & join near village Bharwalia. The total length of link canal is 26 Km i.e. 17 Km lined canal and 9 Km river course Lalbegi.

The G & D data of Gandak at Lalbegiaghat have been considered as there is no G & D site of CWC/State Government on Kohra river. The maximum flood discharge of 164 cumecs has been considered in proportionate to its catchment area upto the diversion point. Now, about 50% i.e. 80 cumecs of flood water is considered to divert through the

link canal assuming that it would provide benefit to the downstream area of Kohra basin which is about 40% of the basin area lying in West Champaran & East Champaran districts as well as some relief to downstream area of Burhi Gandak basin. The link canal has been designed for capacity of 80 cumecs of discharge. Bed width & full supply depth of link canal are 20 m & 43 m respectively and bed slope of canal is considered as 1:15,000.

The total estimated cost of the link canal project works out to Rs.168.86 crore at 2008-09 price level. The Benefit Cost Ratio of the link project works out to 0.033.

30. Burhi Gandak – Noon – Baya – Ganga Intra-State Link Project

The Burhi Gandak-None-Baya-Ganga link proposed by Government of Bihar envisages diversion of 300 cumecs of flood water (i.e. partial quantity of flood discharge) of Burhi Gandak river to the Ganga through linking the None and the Baya rivers to reduce flood damages in the lower reaches of Burhi Gandak basin area falling under Samastipur, Begusarai and Khagaria districts. The Burhi Gandak-None-Baya-Ganga link canal off-take from Burhi Gandak river near Darhia Ramkrishanpur of district Samastipur and outfall into river Baya near Jhamtiyaghat which ultimately falls into river Ganga near village Roopnagar of Mokamah town. The total length of the link canal is 71 Km out of which 26 km is new lined canal and remaining 45 Km through river courses of river None (23 Km) & river Baya (22 Km). The total estimated cost of the link canal project works out to Rs. 387.21 Crores at 2008-09 price level. The Benefit Cost Ratio of the link project works out to 1.12.

31. Bagmati - Burhi Gandak (Through Belwadhar) Intra-State Link Project

The Bagmati-Burhi Gandak Intra State link proposed by Government of Bihar is flood control scheme. The link off take from Bagmati river near village Belwa of Sheohar district at FSL 66.0 m and out fall into river Burhi Gandak near village Dumaria of Minapur block. The link canal envisages diversion of partial quantity of flood water to the tune of 500 cumecs of Bagmati River to the river Burhi Gandak through Belwadhar to reduce some extent of flood damage in the middle and lower reaches of Bagmati in Sitamarthi, Sheohar & Muzaffarpur districts of Bihar.

The total length of link canal is 60 Km, out of which initial 1 Km is a lined gravity canal and the remaining part follows the river course of Belwadhar till its outfall into river Burhi Gandak.

The total estimated cost of the link project works out to Rs.125.96 crores at 2009-10 price level. The Benefit Cost Ratio works out to 1.25

32. Kosi (Bagmati) – Ganga Intra-State Link Project

The Kosi (Bagmati) – Ganga Intra State link proposed by Government of Bihar is a flood moderation scheme which envisages diversion of 300 cumecs of flood water (i.e. partial quantity of flood discharge) of Bagmati river to the river Ganga through linking the Musharadhar & Kasraiya rivers so that flood damages in the lower reaches of Bagmati falling under Khagaria and Bhagalpur districts could be reduced upto a great extent.

The link off takes from Bagmati river near village Malpa of district Khagaria at FSL 38.0 m and outfalls into river Ganga near village Chaidha. The total length of the link canal is 9.0 Km out of which, the initial reach of 1 Km is a lined gravity canal and remaining part follows the stream Musharadhar for 3.5 Km and then river Kasraiya for remaining 4.5 Km till its out fall into river Ganga.

The total estimated cost of the link project works out to Rs.88.93 crore at 2008-09 price level. The Benefit Cost Ratio works out to 1.17.

33. Kosi – Adhwara - Bagmati Intra-State Link Project

The Water Resources Department (WRD), Government of Bihar has submitted the river linking proposal viz. The “Development of Bagmati Irrigation and drainage project Phase-II (Barrage near Kataunjha in Muzaffarpur district) and Adhwara Multipurpose Project with Kosi-Adhwara-Bagmati link” to NWDA for preparation of Detailed Project Report. The link proposal envisages the diversion of surplus flow of Kosi and Adhwara group of rivers through construction of a barrage across Bagmati river near Kataunjha in Muzaffarpur district and construction of a link canal from Kosi (U/S of existing barrage) to Bagmati with required number of structures to intercept Adhwara surplus water. The main objective of the link project is to maximize agricultural Productivity through provision of assured irrigation to the entire culturable land in Muzaffarpur district and to minimize the intensity of recurring flood in North Bihar area, lying in Adhwara river basin, which almost always affects every year. The project has been planned to provide irrigation to a CCA of 42,000 ha through the Kataunjha barrage and the annual irrigation is 1,00,800 ha at 240% intensity of irrigation and the corresponding water utilizations will be 528 MCM. In this regard, the WRD, Government of Bihar has also carried a preliminary study mainly emphasizing on the details of crop pattern and the water requirement for the crops. However, no hydrological studies have been carried out by the Government of Bihar.

As suggested by WRD, Government of Bihar, NWDA has studied the proposal based on toposheets/satellite maps and data received from WRD, Government of Bihar for ensuring the irrigation to the command area proposed under Muzaffarpur district using the waters from Kosi and Adhwara group of rivers. In order to ascertain the availability of water in river Kosi and Adhwara group of rivers, the studies were carried out by NWDA. From the studies, it is revealed that there no surplus water available in Kosi basin at Hanuman nagar barrage for diversion through the Kosi-Adhwara-Bagmati Link Project.

Further, the Adhwara group of rivers originates in Nepal, carry high discharge and very heavy silt load. During monsoon period, nearly all the streams get interconnected and the entire catchment gets inundated. Further, in view of the near flat topography no suitable sites are available for storage of monsoon water. During non-monsoon period, there is practically no flow in Adhwara group of rivers. Therefore, diversion of water of Adhwara group of rivers into the link canal may not be feasible. Thus in view of the non availability of surplus water in Kosi basin and infeasibility of tapping of Adhwara group of rivers water due to topographical constraints, the proposal of Kosi-Adhwara-Bagmati link is not feasible.

From NWDA studies, it is also revealed that the irrigation requirement of the command area of Muzaffarpur district can be met by integrating the link proposal with the proposed Kamla Multi Purpose Project of Government of Bihar, near Tetaria village in Nepal, if Government of Bihar so desires. However, in that scenario the link project will not remain an intrastate link.

Rajasthan

34. Mahi – Luni Intra-State Link Project

Mahi – Luni link project is an Intra-State proposal of Rajasthan state to utilise the surplus water, if available, in Mahi & Sabarmati river basin to the water deficit Luni river basin in Barmer and Jalore districts of Rajasthan.

Considering the surface water availability and requirement in Mahi basin in 2041 AD the Mahi river basin is deficit to the tune of 402.59 MCM at 75% dependability after accounting for surface water requirement and regeneration. Therefore, there is no water

available in Mahi river basin for further utilisation/ diversion in the basin or out side basin.

The Wakal, Sabarmati & Sei river sub basins of Sabarmati river basin also have no surplus water to further transfer. Similarly, the surplus water, if any, of Anas river of Mahi basin has not been considered for diversion through this link, being as inter state river having catchment in Madhya Pradesh, Rajasthan & Gujarat.

However, bilateral agreement signed on 10.01.1966 between Rajasthan and Gujarat for the exploitation of River Mahi, the maximum quantity of Mahi water that can be available for transfer to out side Mahi basin i.e. Luni basin in Rajasthan state is only about 1133 MCM (40 TMC) which is presently released to Gujarat State through PH - 2 situated at tail end of left bank canal of Mahi Bajaj Sagar (MBS) project.

The proposed Mahi - Luni intra state link tunnel will pick - up the surplus water of Mahi basin released through PH-2 situated at tail end of left bank canal of Mahi Bajaj Sager Project at proposed pick - up weir on Anas river near village Ummedgarh. The water will be diverted through tunnel and it cross Mahi river through syphon near village Timurva. Further, the link tunnel will carried the water through proposed syphon across Mahi river near Timurva village to Sukri river near Bisala village in Luni Basin.

Total area to be irrigated through this proposal in the Barmer and Jalore districts of Rajasthan is about 2.333 lakh ha. The total cost of the Mahi - Luni intra state link project is estimated as Rs. 20,55,531.39 lakhs at the price level 2012.

The annual cost of the project has been works out as Rs. 2,48,063.56 lakhs whereas annual benefits from the project works out as Rs.71,856.40 lakhs. Thus, the B.C. Ratio of the link project works out to 0.290.

35. Wakal - Sabarmati - Sei - West Banas to Kamberi Intra-State Link Project

Wakal-Sabarmati-Sei-West Banas to Kamberi river link project is an Intra-State proposal in Rajasthan to utilize the surplus waters, if available, in Wakal, Sabarmati & Sei rivers of Sabarmati river basin in the water deficit Luni river basin in Sirohi district of Rajasthan.

Government of Rajasthan mooted the idea of transferring surplus waters from Wakal, Sabarmati & Sei to West Banas & Kamberi nadi, a tributary of Krishnawati river of Luni river basin. Based on this proposal, National Water Development Agency has made an attempt to assess the feasibility based on the data available in the "River Basin Planning" of Sabarmati Basin (2009), a compilation of Water Resources Department, Government of Rajasthan and toposheet studies.

For assessment of surface water availability of Wakal, Sabarmati and Sei rivers at the proposed diversion points, rainfall-runoff co-relationship has been developed using observed data of CWC gauging site at Jotasen across Wakal river. Since adjoining sub-basins of Wakal basin have same characteristics, therefore, same regression equation has been used for Sabarmati and Sei sub-basin. In this study all the existing, ongoing, proposed/identified irrigation as well as industrial & domestic water supply schemes and the water requirements of Rural as well as livestock population in the upstream catchment of proposed diversion points of Wakal, Sabarmati & Sei rivers have been considered for assessing the total water requirement.

Considering the water availability, needs and regeneration, it is estimated that the surface water balance at Wakal-III dam, Sabarmati irrigation project and Sei Pick up Weir diversion points at 50% and 75% dependabilities are as under:

Sl. No.	Particulars	At 50% dependability (MCM)	At 75% Dependability (MCM)
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1.	At Wakal-III dam across Wakal river	(-)53.20	(-)116.61
2.	At Sabarmati irrigation project across Sabarmati river	(-)0.60	(-)7.64
3.	At Sei Pick up Weir across Sei river	(-)5.76	(-)24.74

After assessing the water balance status, it is concluded that Wakal -Sabarmati-Sei-West Banas to Kamberi river link project proposal is not feasible due to deficit surface water balance at the proposed diversion sites.

Tamil Nadu

36. Ponnaiyar (Krishnagiri) - Palar Intra-State Link Project

Ponnaiyar (Krishnagiri)-Palar Intra State Link envisages transfer of 99 MCM of water, annually available at Krishnagiri dam as flood flow to the Kal ar, a tributary of Palar river in the adjacent basin through 55.7 km long canal by gravity during the months from October to December for 15 days at the rate of 5 days in each month. The diverted water is proposed to be utilized for recharging the ground water potential of Palar basin and thereby to stabilise the existing command area of about 11870 ha being irrigated through the existing wells and bore wells.

Considering the water availability, utilisation and regeneration, the water balance at Krishnagiri dam site works out to 100 MCM and 222 MCM at 75% and 50% dependability respectively. However, it is proposed to divert 99 MCM of water from the flood flows available at 50% dependability through this link scheme.

Ponnaiyar (Krishnagiri)-Palar Intra State link comprises the following components:

- i) Off-take tunnel of 200 m length
- ii) Link canal for a length of 55.70 km from the exist of tunnel with necessary CD and CM works.

The Index Map of Ponnaiyar (Krishnagiri)-Palar Intra State link is enclosed.

A tunnel of modified horse shoe section with a radius of 3.10 m for a length of 200 m is proposed at the off-take from the existing Krishnagiri reservoir across Ponnaiyar river. The link canal takes off from the exit of tunnel and runs for a length of 55.70 km by gravity with an off-take FSL of 480.00 m and outfalls into Kal ar river which is a tributary of Palar river near Natrampalli village of Vaniyambadi taluk at FSL of 428.625m. The canal is designed as lined trapezoidal section, with bottom corners rounded to carry a discharge of 85.631 cumecs with a uniform bed width of 14.50m and full supply depth of 3.0m. Uniform bed slope of 1:5000 is adopted for the entire length of the link canal.

The total cost of the project is estimated as Rs.25793 lakhs at 2008-09 price level. The annual cost of the project works out to Rs.2628 lakhs and the annual benefits from irrigation work out to Rs.3169 lakhs. The Benefit Cost Ratio is estimated to be 1.21. The IRR works out to 10.88%.

Karnataka State

37. Bedti-Dharma-Varada Intra-State Link Project

The study of this link project proposal has been taken up based on the request of Government of Karnataka to assess the feasibility of diversion from Bedti basin, a west flowing river of Karnataka to the water deficit Tungabhadra sub-basin of Krishna basin.

The Government of Karnataka has proposed six intra state links viz., 1)Almatti

(Bagalkot) - Malaprabha 2)Malaprabha - Tungabhadra 3)Bedti - Dharma - Varada 4)Bhadra - Vedavati (V.V. Sagar) 5)Diversion from Bedti & Aghanashini to Varada 6) Barapole - Upper Cauvery.

Bedti-Dharma-Varada Link is one among the above six intra state link for which pre-feasibility report is taken up by NWDA.

The Bedti - Dharma - Varada link proposal of Government of Karnataka envisages diversion of 566.4 Mm³ (20 TMC) of water to Tungabhadra sub-basin of which 283.2 Mm³ (10 TMC) shall be diverted from the surplus available in Bedti basin and another 283.2 Mm³ (10 TMC) that would be received from Almatti dam for irrigating 129925 ha in Haveri, Davangere and Bellary districts. The diversion from Bedti basin is in 3 stages, which involves a tank / dam near Mishrikot village in Kalghatgi taluk, 23 km long canal and 22 km long tunnel besides increasing the storage capacity of existing Attiveri and Bachanki tanks and 265 km length of canal for combined distribution of water received from Bedti basin and Almatti dam. On detailed study it was found that only 51 Mm³ of water is available for diversion from Bedti basin as against 283.2 Mm³ and the Almatti-Malaprabha Link is not feasible.

Hence alternate proposals are formulated by NWDA. In this proposal a dam is proposed across Bedti river just upstream of Suremane village with a FRL of 461.78 m and gross storage of 299 Mm³. The divertible balance water available at the dam site is worked out as 583 Mm³. Excluding 32 Mm³ of water towards reservoir evaporation losses, 551 Mm³ is proposed to be lifted to a static height of 179.07 m and let in to a stream joining Dharma reservoir. The length of raising main required is 19.7 km and the energy required for lifting is worked out as 425 MU. The length of feeder canal from the power cistern/sump to the tributary of Dharma river is 3.90 km. The FSL of feeder canal at off take is 626.0 m and the FSL at outfall is 617.79 m. The bed width of feeder canal is 5.7 m with FSD of 1.5 m.

The link canal takes off from the existing Dharma Reservoir and runs for a length of 72.65 km by gravity with an off take FSL of 585.00 m and outfalls in to a tributary of Varada river at FSL of 571.337 m. The canal is designed as lined trapezoidal section, with bottom corners rounded to carry a discharge of 29.936 m³/sec with bed width of 7.5 m and full supply depth of 2.50 m at off take. Uniform bed slope of 1: 7500 is adopted for the entire length of link canal. Tunnels are proposed at three locations for a total length of 6.68 km in the conveyance system to avoid heavy cutting and to cross small hillocks. The proposed tunnel section is of Modified horse shoe of 6.00 m dia.

The link canal will irrigate an area of 52900 ha annually with an irrigation intensity of 100 % in Hangal, Savanur and Haveri taluks in Haveri district, Shirhatti and Mundargi taluk in Gadag district. The annual maintenance cost of command area is considered as Rs.600/ha for 52900 ha of CCA in the annual cost of the project. The link canal will also meet the domestic needs of the command area enroute the canal.

As the command area proposed on the left side of Dharma and Varada rivers are limited to 52900 ha only due to the areas covered by the two ongoing projects viz., Shiggaon LIS and Singatalur LIS, it is proposed to deliver 168 Mm³ through the Dharma river from Dharma Reservoir for augmentation of requirement in the command area of Singatalur LIS for irrigating 25150 ha.

The total cost of the project is estimated as Rs.250011 lakh at 2015-16 price level. The annual cost of the project works out to Rs.40524 lakh and the annual benefits from irrigation and domestic water supply works out to Rs.50256 lakh. The Benefit-Cost Ratio is estimated to be 1.24. The IRR works out to 11.81%.

Chhattisgarh

38. Pairi (Pairi High Dam) – Mahanadi (Rudri Barrage) Intra-State Link Project

Pairi (Pairi high dam) – Mahanadi (Rudri barrage) link canal, Pairi- Mahanadi feeder canal as mentioned by the Govt., of Chhattisgarh takes off from the Pairi high dam with FSL 333.00 m and runs as a contour canal for a total length of 62.60 km and outfalls into the existing New Rudri barrage on river Mahanadi. The canal with carrying capacity of 84 cumecs at head reach will run almost at the boundary of forest area in few reaches and inside the forest area for certain length. This link canal receives water from Dhanbura tank across Bosana nalla in middle of the reach. After this the carrying capacity of the link canal has been increased to 97 cumecs . There is no enroute irrigation proposed along the link canal. The main purpose of the link canal is to increase availability of water for meeting the increasing demands of the MRP complex command area. The entire link project lies in Raipur district of Chhattisgarh state.

The Government of Chhattisgarh proposed Pairi high dam across Pairi river with FRL 335.000 m, MWL 336.350 m, MDDL 326.440 m with Gross Storage capacity of 540 Mm³ and live storage capacity of 420 Mm³. Two more reservoirs are proposed in Pairi basin on Sondur river at Bankura and Chandanbahar village to store and supply water to Pairi high dam as per the requirements. Fourth dam is proposed at Dhanbura village on Bosana nalla from which the link canal receives water

The link canal will provide irrigation to an area of 71853 ha in the district of Raipur of Chhattisgarh which is the additional area identified by Govt., of Chhattisgarh in the command of M.R.P.Complex and not covered by irrigation due to insufficient water. The existing cropping pattern of M.R.P.Complex command with intensity of irrigation of 136% is only adopted for the new command area also. Thus, the additional annual irrigation works out to 97720 ha. The irrigation water requirement is worked out to 382.07 Mm³.

Apart from irrigation it is also proposed to provide future domestic and industrial water requirements in the command area. Additional domestic and industrial requirements are estimated to be 294 Mm³ and 49.60 Mm³ respectively. The total domestic and industrial water requirement worked out to 343.60 Mm³. Thus the total requirement of the link canal works out to 725.67 Mm³.

Transmission losses in the link canal are estimated to be 11 Mm³. The remaining quantity of 44.03 Mm³ out of the total diverted quantity of 780.70 Mm³ will be utilized for stabilisation of the existing irrigation system of Mahanadi Reservoir Project Complex (M.R.P. complex).

The link canal is designed as a lined canal with trapezoidal section with rounded corners. The design discharge in the canal at head reach is 84.0 cumec upto Bosana nalla crossing and thereafter the design discharge of the link canal is increased to 97 cumec as the link canal receives contribution from Bosana nalla. Accordingly, the link canal is divided into two reaches. The maximum carrying capacity of the canal in the first reach is 84.0 cumec with corresponding cross section of 17.50 m of bed width and 4.0m of full supply depth with a bed slope of 1 in 20,000. Similarly, the maximum carrying capacity of the link canal in second reach is 97.00 cumec with corresponding cross section of 21.00 m of bed width and 4.0m of full supply depth. The bed slope of 1 in 20,000 is kept uniform for the entire length of the link canal. The link canal mostly passes through forest boundaries, forest area and plain area in some reaches.

In its entire run of 62.600 km, the link canal has been provided with 13 cross drainage structures, of which 5 are aqueducts and 8 are under tunnels. A total of 28 single lane road bridges have been proposed across the link canal as it passes through thinly populated areas. A level crossing is proposed across Bosan Nalla so as to receive water from Dhanbura tank and divert through the link canal.

A total area about 316.72 ha needs to be acquired, of which 185 ha will be for construction of main canal, 130 ha for borrow areas, 0.67 ha for rehabilitation colonies, 1.05 ha for construction of office and staff colonies. Out of the total land to be acquired, about 233.72 ha is Patta land and 83 ha is forest land. In all 6 villages are partially affected and about 84 families consisting of 336 people need to be rehabilitated. Suitable provision for compensation, afforestation, attractive compensatory package for rehabilitation and resettlement have been made in the estimate for the construction of link project.

The climate and ecological conditions of the area remain more or less the same even after construction of the link canal. No mineral wealth is likely to be lost as a result of construction of canal.

The link canal would greatly help in improving the general prosperity of the region on account of introduction of irrigation in about 0.72 lakh ha of area which would increase the agricultural production nearly by 3 to 4 times. More over the socio economic objectives i.e., the regional development, equity, employment generation and pollution control will greatly improve in the vicinity of the project.

Direct net benefits per annum from the link project due to irrigation, domestic and industrial water supplies in the canal are estimated to be Rs. 30194 lakh. The total cost of the link canal project is estimated to be Rs. 139445 lakh at 2013-14 price level. Based on the quantity of water presently planned for utilisation, apportioned cost of the project is worked out to be Rs. 133736 lakhs. The annual cost has been worked out as per the standard norms to Rs. 15370 lakh. The Benefit Cost Ratio works out to 1.96 and the IRR works out to 17.20 %.

Uttar Pradesh

39. Sarda – Gomti Link Project

The objective of preparation of pre-feasibility report of Sarda-Gomti Intra-State Link Project of Uttar Pradesh is mainly to facilitate the diversion of Sarda water to river Gomti for its rejuvenation as well as supply of drinking water to the towns situated on or near to river Gomti. The river Gomti is receiving only monsoon and ground water as it originates from Gomat Taal near Madho Tanda town in Pilibhit district of Uttar Pradesh. Two options for head works has been explored to link the Sarda river with Gomti river.

Option-I Existing Banbasa barrage and its system:

In this option existing Banbasa barrage can be utilised as head work. Existing Sarda main canal & Hardoi branch upto the RD 23.50 km will be utilised as link canal after remodeling to carry the additional water. From RD 23.50 km of Hardoi branch, a 4.40 km long feeder channel has been proposed to link the Gomti river. In this option remodeling of Sarda main canal and Hardoi branch are very expensive task. Apart from this, the head work (Banbasa barrage) and 35.20 km long Sarda main canal are situated in Uttarakhand. Therefore, the interstate matter will also involve for linking the Gomti through this option.

Option-II Construction of a New barrage on Sarda river:

Study for construction of new barrage on river Sarda has explored at two sites namely near village Maini Guleria and Kanjaria Gauria. In both the cases height of gates are big challenge and construction of barrage is not economical. Also the pond water and Marginal bund crosses over the Indo-Nepal International boundary and submergence will spread in Nepal which will involve International matter.

It is seen that above options are very expensive and involve Interstate/International matters. Therefore, **Option-III, i.e. From Ghaghara- Yamuna link under NPP:** arrangement for transfer of water to Gomti river can be made in the report of Ghaghara (Karnali)-Yamuna link prepared by NWDA for transfer the water in Gomti river at its crossing.

The monthly discharge data given in the feasibility report of Karnali multipurpose project report prepared by M/s. Himalayan Power Consultants for Government of Nepal, were used on the water year basis for 25 years from 1961-62 to 1985-86 and the 75% and 50% dependable annual yield are worked out and presented in the preliminary water balance study at Poornagiri (Technical Study No, PWBS(H)/2/91). Based on the above flow data and additional data collected from 1986-87 to 1997-98, the monsoon, non-monsoon and annual yields at 75% dependability are reassessed as 14195 MCM, 3427 MCM & 17230 MCM and at 50% dependability are 16193 MCM, 3677 MCM & 19569 MCM respectively.

The 75% and 50% dependable water balance at proposed Poornagiri dam site, considering availability of water, upstream water needs and in-basin export is worked out as 922 MCM and 3261 MCM respectively.

The proposals as suggested for linking Sarda river to Gomti river has yet to be finalised by the Government of Uttar Pradesh. Therefore, the cost estimate will be works out after the finalisation and acceptance of option for linking the rivers.