

Chapter-7

Reservoirs & enroute storages

7.0 General

Reservoirs play significant role in conservation, management and development of water resources in our country. The precipitation in the country is uneven both in space and time and confined to monsoon i.e. June to October only. Some parts of the country receive much more than the normal rainfall leading to heavy floods and at the same time some other parts receive less than the normal rainfall leading to droughts. The water availability even for drinking purposes becomes critical, particularly in the summer months as the rivers dry up and the ground water recedes.

The demand of water for various purposes like irrigation, drinking & industrial, power generation etc. would be throughout the year in a set pattern. To bridge the gap between seasonal water availability on one hand and water demand on the other, creation of the storage reservoirs to store the water is essential. The reservoirs also facilitate the hydro power generation and supply of water to the needy areas by gravity flow. The natural inflow pattern, periodical water demands for various purposes and the techno-economic aspects, decide the size of the reservoirs in a particular project.

The objective of Godavari (Janampet) - Cauvery (Grand Anicut) link project is to transfer surplus waters available in Godavari river basin to serve the part deficits in Krishna, Pennar, Palar, Cauvery and other intermediate basins. It has been proposed to divert 7000 Mcum of water from Godavari basin to the south through the 1251.59 km long link canal. The transferred water will be partly used for irrigation enroute in the states of Telangana, Andhra Pradesh and Tamil Nadu and the remaining quantity of 1305 Mcum will be released into Grand Anicut to serve the Cauvery delta. A barrage is proposed as headworks for the link project at Janampet village in Pinapaka mandal of Bhadradi Kothagudem district in Telangana. The existing Nagarjunasagar reservoir on Krishna river and Somasila reservoir on Pennar river are integrated as balancing reservoirs for regulation of water supplies to the command areas and help in further diversion of the waters upto Cauvery. The existing Grand Anicut on Cauvery is the tail end structure for the link project.

7.1. Fixation of storage and reservoir levels

7.1.1 Headworks

The Janampet barrage is proposed at about 77 km downstream of the ongoing Tupakulagudem barrage across river Godavari near village Janampet in Pinapaka mandal of Bhadrachalam district. The Godavari (Janampet) - Krishna (Nagarjunasagar) link canal is proposed to take off from this barrage. The latitude and longitude of the proposed structure are $18^{\circ} 06' 11''$ N and $80^{\circ} 44' 24''$ E. The length of the barrage will be about 867.50 m. The gross capacity of the pond is about 251 Mcum at full pond level (FPL) of 67.00m. The average bed level at the barrage is about 55.50m. The crest level of under sluices is fixed at 57.0m and that of river sluices is 59.0m. The submergence area at FPL is about 6327 ha and the same is mostly confined to the river portion. The link canal will take off from the Janampet barrage with FSL of 66.00 m. The area - capacity curve of the pond is placed at **Plate 7.1**.

The barrage is designed for 100 year flood against the IS Code 10430 - 2000 recommendation of 50 year flood, keeping in view the huge size of the catchment of Godavari upto Janampet, using Gumbel's extreme value distribution.

The contour plan of the Godavari river at Janampet barrage is generated based on field survey and investigations carried out through bathymetric and drone technology. From the contour plan, the capacities at various elevations and the cumulative capacities are worked out. Keeping in view, the river bank elevations on both sides, the full pond level (FPL) is limited to 67m. The width of the river at this elevation is about 1.7 km.

Catchment area

The catchment area of Godavari river at the proposed Janampet barrage is about 273126 km². However, the area of 47274 km² between Medigadda barrage of Kaleswaram project and Janampet is considered for the hydrological studies.

Dead storage level

The structure is a barrage and hence there will not be any dead storage. The average bed level of the river at Janampet barrage is about 55.50m. The crest level of under sluices is fixed at 57.0m and that of river sluices is 59.0m. The sill level of the head regulator on right bank of the river is at 59 m.

Full pond level (FPL)

The FPL of the Janampet is fixed at 67.00m based on the area capacity table and keeping in view the river bank levels on both banks. The submergence area of the reservoir at FPL is about 63.27 km² (6327 ha) with a gross storage capacity of 251 Mcum.

Afflux

The afflux is considered as 1.0m.

Barrage bays and gates

Eight under sluice bays are considered to carry about 18.19% of the designed discharge at the structure. The river sluice bays considered are 41 nos. The radial gates of size 15 x 10m for under sluices and 15 x 8 m for river sluices are considered. The allowed 100 year flood is about 74702 cumec. Various controlling levels of the Janampet barrage are given in **Table 7.1**.

Table 7.1: Controlling levels of Janampet barrage

| Sl.No | Controlling level | Elevation 'm' | Capacity 'Mm ³ ' |
|-------|---|---------------|-----------------------------|
| 1. | River bed level | 55.50 | |
| 2. | Barrage crest level | 57.00 | |
| 3. | Link canal HR sill level on right flank | 59.00 | |
| 4. | Full pond level | 67.00 | 251 |
| 5. | Top bund level | 76.00 | |

The Godavari (Janampet) - Cauvery (Grand Anicut) link project is planned to take off from the proposed Janampet barrage with an FSL of 66.00 m.

7.1.2 Intermittent/ Balancing Reservoirs

The Godavari (Janampet) - Cauvery (Grand Anicut) link project is planned as to optimally utilize the services of the existing reservoirs of Nagarjunasagar on river Krishna and Somasila on river Pennar and the Grand Anicut pond on river Cauvery. These reservoirs act as balancing reservoirs for the link project and facilitate the regulation of flows for irrigation, domestic and industrial needs according to upon the monthly demands in the command area as well as help further diversion of waters upto Cauvery.

i) Nagarjunasagar

The Godavari (Janampet) - Cauvery (Grand Anicut) link project at the end of its first reach will fall into the existing Nagarjunasagar reservoir with an FSL of 181.401m.

Nagarjunasagar is an existing reservoir on river Krishna located in Nalgonda district of Telangana. The project is formulated to provide irrigation facilities to about 8.95 lakh hectares situated in Guntur, Prakasam, Nalgonda, Khammam and Krishna districts, about 960 MW of seasonal hydroelectric power, navigation facilities, development of pisciculture and providing recreation benefits besides mitigation of flood hazards. Accordingly, the reservoir storages and levels have been fixed to fulfill the above needs. The controlling levels and corresponding storages of the reservoir are furnished in **Table 7.2.**

Catchment area

The catchment area of Krishna river at the existing Nagarjunasagar dam is about 220705 km².

Dead storage level

The average bed level of the river at Nagarjunasagar dam is about 74.68 m. The dead storage level is fixed at 149.05m. Keeping view the powerhouse operational requirements, the MDDL is fixed at 155.45m. The crest level of the spillway dam is at 166.42m. The sill level of the head regulator on right bank canal is at 149.05m.

Full reservoir level (FRL)

The FRL of the Nagarjunasagar Resviour is 179.83 m. The submergence area at this level is about 285 km² with a gross storage capacity of 11560 Mcum.

Maximum water level (MWL)

The maximum water level (MWL) of the dam is at 181.05 m . The submergence area at its MWL is 285 km². The top bund level of the dam is at 184.04 m.

Spillway and gates

The dam has a spillway of length 470.92 m. The total length of masonry dam is about 1449.63 m. The non-over flow section is of 978.71 m. There are 26 nos. of crest gates of size 13.72 m x 13.41 n, the crest level is 166.2 m.

Table 7.2: Controlling levels and storages of Nagarjunasagar reservoir

| Controlling level | Elevatio n (m) | Storage capacity (Mcum) |
|--------------------------|-----------------------|--------------------------------|
| MWL | 181.05 | 11918 |
| FRL | 179.83 | 11560 |
| MDD L | 155.45 | 5827 |
| DSL | 149.05 | 4727 |

The Godavari (Janampet) - Cauvery (Grand Anicut) link project (2nd reach) is proposed to take off from the existing Nagarjunasagar reservoir with an FSL of 151.665 m. The elevation and area - capacity curve is shown in **Plate 7.2**.

ii) Somasila reservoir

The Godavari (Janampet) - Cauvery (Grand Anicut) link canal at the end of its 2nd reach will fall into the existing Somasila reservoir with an FSL of 100.77 m.

The Somasila is an existing reservoir on Pennar river. The project is formulated by Govt. of AP to stabilise the existing Pennar delta system and the commands under the tanks under Kavali and Kanapur canals and also to provide irrigation to new areas through the South and North feeder canals. In addition, 409 Mcum of water for supply to Chennai city and 890 Mcum of water for irrigating 1.23 lakh ha under Telugu Ganga project will also be supplied from the Somasila reservoir. The component of Chennai water supply would be met from the 425 Mcum of water to be diverted from existing Srisailem reservoir on river Krishna through the Telugu Ganga canal while the requirement of irrigation under the Telugu Ganga project would be met by diverting the flood flows of Pennar and Krishna rivers to the Kandaleru reservoir. The controlling levels and corresponding storages of the reservoir are furnished in **Table 7.3**.

Catchment area

The catchment area of Pennar river at the existing Somasila dam is about 50492.5 km².

Dead storage level

The dead storage level and the MDDL are fixed at 82.30 m. The crest level of the spillway dam is at 86.87 m. The sill level of the head regulator on right bank canal is at 81.38 m and that on the left flank is at 79.25 m.

Full reservoir level (FRL)

The FRL of the Somasila reservoir 100.58. The submergence area at this level is 212.28 km² with a gross storage capacity of 2208 Mcum.

Maximum water level

The maximum water level (MWL) of the dam is at 101.80m. The top bund level of the gravity dam is at 105.15 m.

Spillway and gates

The dam has a spillway of length 236.21 m. There are 12 nos. of radial crest gates of size 15.24 m x 13.72 m. The capacity of spillway is 22375 cumec at MWL and the same at FRL is 19680 cumec. The crest level is 86.87 m.

Table 7.3 Controlling levels and storages of Somasila reservoir

| Controlling level | Level (m) | Storage capacity (Mcum) |
|--------------------------|------------------|--------------------------------|
| MWL | 101.80 | 2483 |
| FRL | 100.58 | 2208 |
| MDD L | 82.30 | 214 |
| DSL | 82.30 | 214 |

The Godavari (Janampet) - Cauvery (Grand Anicut) link project (3rd and final reach) is proposed to take off from the existing Somasila reservoir with an FSL of 97.30.

The area -capacity curve is furnished in **Plate 7.3**.

7.1.3 Tail end structure:

The Godavari (Janampet) - Cauvery (Grand Anicut) link canal ultimately will fall into the Grand Anicut pond with FSL of 61.43 m.

The Grand Anicut (Kallanai) is the terminal storage/ regulating pond on Cauvery river for irrigation purpose. The Grand Anicut controls the flow of the Cauvery to delta areas of about 3.78 lakh ha, through Cauvery and Vennar regulators. Also, it serves to supply the requirement of Grand Anicut canal for irrigation of about 1.04 lakh ha. In addition, it regulates the flood flows of the Cauvery to Coleroon through Ullar.

Catchment area

The catchment area of Cauvery river at the existing Grand Anicut is about 70129 km² .

Crest level

The sill level of anicut is at 57.70.m.

Full pond level (FPL)

The FPL of the Grand Anicut is fixed at 59.22 m.

Anicut vents and gates

There are 30 surplus vents of size 9.75m x 1.52m along with 5 scour vents of 6.10m x 3.05m. The allowed flood is about 3327.22 cumec.

The controlling levels of the Grand Anicut are furnished in the **Table 7.4**.

Table 7.4: Principal levels of Grand Anicut

| Controlling level | Elevation (m) |
|--------------------------|----------------------|
| MWL | 60.84 |
| Full pond level (FPL) | 59.22 |
| Sill level | 54.64 |

The Cauvery river has encountered many high flood events in the times of unrecorded history. Known floods of high magnitude occurred are in November 1858, July 1896, November 1906, July 1911 and November 1920. In the year 1924 Cauvery carried the largest flood of 12900 cumec (4.56lakh

cusec). Though, large part of this has been carried by Coleroon from Upper Anicut itself, still the accumulation of flood above Grand Anicut was quite heavy. The need for an additional bye-wash above the anicut was immediately felt and on the left bank of Cauvery at about 2 km upstream of the Grand Anicut a bye wash of length 1219 m (4000 ft) was then created which would surplus 2792 cumec (98600 cusec) into Coleroon reducing the load on the Grand Anicut to that extent.

The Godavari (Janampet) - Cauvery (Grand Anicut) link canal will terminate in the Grand Anicut pond and the water delivered from the link will be utilised for Cauvery delta through Grand Anicut.

7.2 Sedimentation

Since, the proposed structure on Godavari river at Janampet is only a barrage, the chance of problem of sedimentation is quite remote and if at all encountered, it will be insignificant. Therefore, detailed sedimentation study is not needed.

Silt observations on Krishna river are being made systematically for a long time. They show that the Krishna river carries less silt compared to many other rivers of our country. Further, due to the construction of a number of reservoirs in the upper reaches of the Krishna and its tributaries, the silt is likely to be trapped in those reservoirs and relatively silt free water would flow into the Nagarjunasagar reservoir. Similar is the case with Somasila reservoir on Pennar river also.

7.3 Life of reservoir

Since, the proposed structure on Godavari river at Janampet is only a barrage, the chance of problem of sedimentation is quite remote and if at all encountered, it will be insignificant. Hence, there will not be any impact of sedimentation on life of the Janampet barrage/pond.

The Srisailem reservoir, situated upstream of Nagarjunasagar reservoir has a storage capacity of 4461 Mm³ upto MDDL and the useful life of the reservoir is estimated to be more than 300 years by the Andhra Pradesh Irrigation authorities. As the Nagarjunasagar reservoir is having a dead storage capacity of 4727 Mm³ and is located downstream of Srisailem reservoir, the useful life of the reservoir would obviously be still higher.

7.4 Effect of the link project on the life of reservoirs

The existing reservoirs of Nagarjunasagar on river Krishna and Somasila on river Pennar will have accumulated silt from their own catchments and there will be reduction in their capacity to that extent. Further, there may be silt in the waters that are planned to be transferred from Godavari river through the link project. Hence, it is essential to look into the life of these reservoirs with respect to the sedimentation process that may happen in these reservoirs as well as any silt being carried through link canal from the Godavari catchment.

7.4.1 Nagarjunasagar reservoir

There were apprehensions by the erstwhile Govt. of Andhra Pradesh that with the diversion of surplus Godavari waters into the Nagarjunasagar reservoir, it might get silted up soon and thereby cause reduction in the useful life of the reservoir, as the Godavari river carries more silt as compared to the relatively silt free waters of Krishna river. The diversion of surplus Godavari waters into the Nagarjunasagar reservoir is proposed from the contemplated Janampet barrage on Godavari river, and silt excluders will be provided to avoid entry of silt into the canal. Further, the transfer of water involves lifting in three stages and due care would be taken to protect the pumps from silt. Hence, all the necessary arrangements will be made to trap silt in the feeder channels and to pump only clear water into the main canal all along the conveyance system. As such, the effect of the diversion of surplus Godavari waters to the Krishna on the life of Nagarjunasagar reservoir is likely to be negligible. The silt from the Krishna catchment into Nagarjunasagar will also be not significant as the same will be trapped in the series of reservoirs built on its upstream including the Srisailem reservoir.

7.4.2 Somasila reservoir

As the silt, if any, carried by the link project will get trapped to a large extent at the Nagarjunasagar; reservoir relatively silt free water is expected to flow into the Somasila reservoir. As such, there may not be any effect on the life of the Somasila reservoir due to the link proposal.

7.5 Capacities and sufficiency of the balancing reservoirs

The Godavari (Janampet) - Cauvery (Grand Anicut) link canal is envisaged to divert about 7000 Mcum of Godavari waters to river Krishna in the first stage. Though, a part of this quantity is utilized in Kharif in reach between Godavari - Krishna, the total 7000 Mm³ is assumed to be released into Nagarjunasagar reservoir. Hence, it is necessary to verify the sufficiency of storage with the available average ten daily storage data provided by Central Water Commission (CWC) for the past ten years vis-a-vis the link discharges into the reservoir. The details are furnished in **Annexure 7.1**.

The space available on ten daily basis in Nagarjunasagar reservoir after addition of water through the link canal is shown in **Fig 7.1**. This is just indicative and the detailed daily simulation of janampet vis-a-vis Nagarjunasagar storage space has been described in chapter-5 “Hydrology & Water Assessment”.

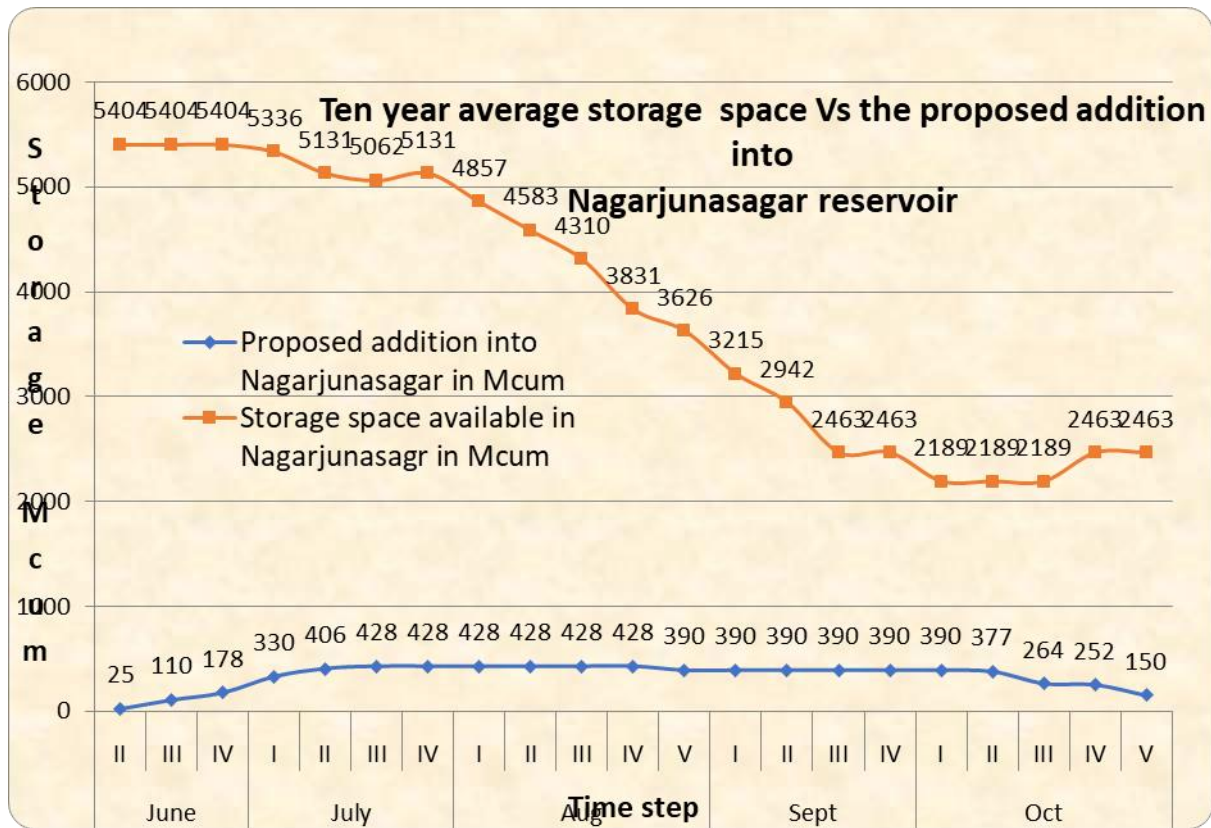


Fig 7.1: Storage space available in Nagarjunasagar reservoir

Similarly, about 2928 Mm³ from Nagarjunasagar will reach the Somasila reservoir after enroute utilization between Krishna and Pennar rivers. Accordingly, the sufficiency of the Somasila reservoir capacity is verified with the available average ten daily storage data vis-a-vis the link discharges into the reservoir provided by Central Water Commission (CWC) for the past ten years. The details are furnished in **Annexure 7.1**. The space available on ten daily basis in Somasila reservoir after addition of water through the link canal is shown in **Fig 7.2**.

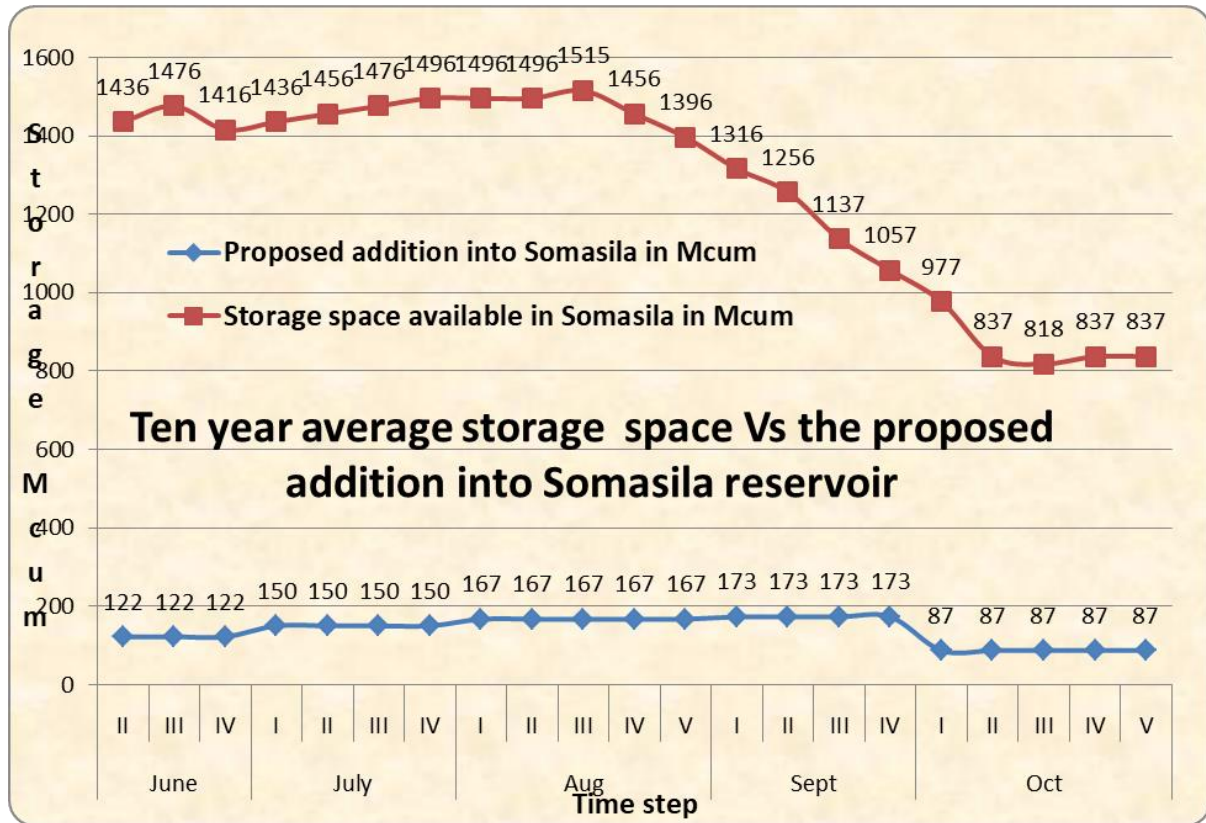


Fig 7.2: Storage Space available in Somasila reservoir

7.6 Area of Submergence (ha)

7.6.1 Janampet barrage

The proposed structure at Janampet on river Godavari is a barrage and water spread area at the proposed full pond level will be about 6327 ha. The entire area will be confined to river portion and there will not be submergence of any property, lands or settlements due to construction of the barrage.

7.6.2 Nagarjunasagar

Since it is proposed to utilize only the existing storage capacity of Nagarjunasagar there would be no additional submergence under the reservoir on account of the Godavari (Janampet) - Cauvery (Grand Anicut) link project.

7.6.3 Somasila reservoir

Since it is proposed to utilise only the available storage facility of the existing Somasila reservoir, there would be no additional submergence under Somasila reservoir due to the Godavari (Janampet) - Cauvery (Grand Anicut) link project.

7.6.4 Grand Anicut

Since the maximum water level is confined within the flood banks of Cauvery river, no additional submergence at the anicut due to the link proposal is anticipated.

7.7 Evaporation losses

Evaporation losses play vital role in planning and operation of reservoirs. The Godavari (Janampet) - Cauvery (Grand Anicut) link project comprises two major reservoirs of Nagarjunasagar and Somasila; and two ponds at Janampet and Grand Anicut. The information on the evaporation losses in these reservoirs and ponds is furnished in the following paras.

7.7.1 Janampet barrage

The annual evaporation loss at Janampet barrage is considered to be negligible as the storage is confined in the pond for relatively small period of time. Moreover at the end of monsoon each year the barrage will be at its full capacity of 251 Mcum which is presumed to be accounted for downstream use and evaporation till the onset of monsoon next year.

7.7.2 Nagarjunasagar reservoir

The Krishna Water Disputes Tribunal (KWDT) has allocated a quantum of 481 Mcum (17 TMC) of water towards evaporation losses of the Nagarjunasagar project. The monthly evaporation depths at of Nagarjunasagar reservoir are furnished in **Table 7.5**.

Table 7.5: Monthly evaporation losses from Nagarjunasagar reservoir

| Month | Evaporation (cm) | Month | Evaporation (cm) |
|--------------|-------------------------|--------------|-------------------------|
| June | 23.7 | December | 10.2 |
| July | 15.2 | January | 10.2 |
| August | 15.2 | February | 19.8 |
| September | 15.3 | March | 22.9 |
| October | 15.2 | April | 30.6 |
| November | 10.2 | May | 30.4 |

7.7.3 Somasila reservoir

The average annual evaporation losses from Somasila reservoir are assessed as 266 Mcum (9.4 TMC).

7.7.4 Grand Anicut

The annual evaporation loss at Grand Anicut is considered as zero due to its negligible storage

7.8 Ecological releases

Since the proposed diversion through the link from Janampet is only during monsoon, no specific provision is made for ecological releases downstream from Janampet barrage and the same will be accounted from the spills at the barrage .There will not be any diversion from Janampet through link canal in non-monsoon and hence the lean season flow in the river is kept intact. Detailed hydrological studies are furnished in **Chapter 5: Hydrology and Water Assessment.**