

Chapter-7

Reservoirs & Enroute Storages

7.0 General

Reservoirs play a significant role in conservation, better management and optimum development of water resources in our country. The precipitation in the country is uneven both in space and time and confined to only monsoon i.e. June to October. Some parts of the country receive much more than the country's normal rainfall leading to heavy floods and at the same time extended lack of rainfall in other parts causing extreme droughts. In such areas, the water availability even for drinking purposes becomes critical, particularly during summer season as the rivers go dry and the ground water table recedes.

Wainganga is one of the principal tributaries of the river Godavari. The river Wainganga from which surplus water is proposed for transfer to water short Nalganga river (Purna Tapi sub-basin) receives 92% of annual rainfall during June to October. The sub-basin is situated in between 1000 mm and 1800 mm isohyets. The average monsoon run-off in the river is about 90% of annual run-off. While the flows are available for a limited period in a year, the demand for water for various purposes such as irrigation, drinking, industrial and power generation spread throughout the year. Therefore, to bridge the gap between availability of flows and demand to be met through the proposed 426.54 km long canal, the existing Gosikhurd dam constructed across Wainganga river is planned to be utilized as head-works / regulating structure. The existing Nalganga dam on Nalganga river is planned to be utilised as outfall reservoir of the link canal. In between, the existing Lower Wardha reservoir on Wardha river and Katepurna reservoir on Katepurna river will act as balancing reservoirs in diversion of water. Hence, no new reservoir/head-works are contemplated under this link project. The link canal takes off from the Gosikhurd reservoir and outfalls into Nalganga reservoir. 40 nos. of en-route tanks (including Lower Wardha and Katepurna) are identified for storage/augmentation of link canal water for utilization during non-monsoon period. The objective of Wainganga-Nalganga link project is to transfer surplus waters of Wainganga river at Gosikhurd to Nagpur, Wardha, Yeotmal, Amravati, Akola and Buldhana districts of water short Vidarbha region to meet irrigation, domestic and industrial needs.

The Gosikhurd dam, the very first National Project was constructed on Wainganga river in Pranhita sub-basin of Godavari basin, near Gosikhurd village upstream of Pauni town in Bhandara district of eastern Vidarbha region of Maharashtra. The Lower Wardha project was constructed on Wardha river, a tributary of Wainganga, near Dhanodi village, Arvi taluk of Wardha district. The existing Katepurna dam was built on Katepurna river, a tributary of Purna river in Tapi basin, near Mahan village, Barshi Takli taluk of Akola district. The Nalganga dam was built on Nalganga river, a tributary of Purna river in Tapi basin, near Motala town in Buldhana district of Maharashtra. All the above dams were constructed by Water Resources Department, Govt. of Maharashtra. The details of existing Gosikhurd, Lower Wardha, Katepurna and Nalganga reservoirs are presented in the following paragraphs.

7.1 Gosikhurd Dam

Govt. of Maharashtra constructed Gosikhurd dam (Indirasagar project), a major multi-purpose project across Wainganga river in Godavari basin, at latitude of 20° 52' 15" N and longitude of 79° 37' 00" E near Gosikhurd village in Pauni tehsil of Bhandara district. The CCA of the project is 2,00,000 ha. The project provides annual irrigation in Bhandara, Nagpur and Chandrapur districts to about 2,50,800 ha. Designed utilization of the project is 1634 Mm³. Four offshore lifts (Ambhora, Mokhabardi, Nerla/Paghora & Tekepar), left bank and right bank canals and supplementation to Asolamendha storage tank (gross storage 62.99 Mm³) from Gosikhurd reservoir through the right bank canal are the main irrigation components of the project. It is planned to generate electricity at outlet ends before letting out water in RBC & LBC. The proposed installed capacity at LBC is 0.5 MW and at RBC is 2.5 MW. Moreover, it is planned to install dam toe power house of capacity 2X12 MW at RD 5504 m of the dam by utilizing surplus water of Wainganga river. The catchment area of the Wainganga river upto Gosikhurd dam is 34862 km², out of which 24566 km² lies in Madhya Pradesh, 271 km² lies in Chhattisgarh and the remaining 10025 km² lies in Maharashtra. The Gosikhurd dam is 11.36 km long comprising 10.45 km long earthfill dam and 0.91 km long concrete dam with central spillway section. The height of earth dam is 22.55 m. The height of concrete portion with central spillway is 28.37 m from the lowest foundation level.

The various components of the Gosikhurd dam are furnished below:

1. Left flank earth dam of length 9205 m from RD (-)3300 m to 5905 m
2. Right flank earth dam of length 1247.1 m from RD 6808.9 m to RD 8056 m
3. Left flank irrigation outlet at RD 820 m with discharge of 39.39 cumec (with power house 0.5 MW)
4. Right flank irrigation outlet at RD 7875 m with discharge of 113.26 cumec (with power house 2.5 MW)
5. Spillway of length 903.9 m from RD 5905 m to RD 6808.90 m (Overflow: 773.9 m & NoF: 130 m)
6. 33 nos of radial gates of size 18.30 x 16.50 m
7. Dam toe power house – 2X12 MW

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link canal is proposed to take off from Gosikhurd reservoir with FSL of 241.00 m.

7.1.1 Fixation of Storage and Reservoir Levels

Details of various controlling levels of Gosikhurd dam are discussed as under:

7.1.1.1 Dead Storage Level (DSL)/ Minimum Draw Down Level (MDDL)

The Bed level of the river at Gosikhurd dam site is 221.60 m. The sill level of left bank canal sluice is 238.0 m where as that of right bank canal sluice is 235.0 m. Sedimentation studies have been carried out by Brune's curve by using sedimentation data at Pauni G&D site for the period from 1966 to 1980. Accordingly, considering 100 years siltation, Minimum Draw Down Level (MDDL) of the dam is fixed at 241.29 m. The capacity of the reservoir at MDDL is 406 Mm³.

7.1.1.2 Full Reservoir Level (FRL)

The FRL of the Gosikhurd dam is 245.5 m. The submergence area of the reservoir at FRL is 222.58 km² with a gross storage capacity of 1146 Mm³. The

FRL is kept unaltered for regulating diversion of flows into the proposed link canal.

7.1.1.3 Maximum Water Level (MWL)

The Maximum Water level (MWL) of the dam is at 245.70 m. The submergence area at its MWL is 229.55 km². The top bund level of the dam is at 250.05 m.

7.1.1.4 Spillway

The dam has a spillway of length 903.9 m (Over flow section: 773.90 m, Non-overflow section: 130 m) with 33 nos. of radial gates of size 18.30 m x 16.50 m. The spillway is ogee shaped. The capacity of spillway is 67373 cumec at MWL. The crest level is 229.0 m.

Various controlling levels of the Gosikhurd dam are given in **Table 7.1**.

Table 7.1
Controlling levels of Gosikhurd reservoir

Sl.No	Controlling level	Elevation 'm'	Capacity 'Mm ³ '
1.	River bed level	221.60	
2.	Spillway crest level	229.00	
3.	Canal sill level		
	a) Right	235.00	
	b) Left	238.00	
4.	Minimum Draw Down level	241.29	406
5.	Full reservoir level	245.50	1146
6.	Maximum water level	245.70	
7.	Top bund level	250.05	

7.1.2 Water Quality

Water Resources Department (WRD), Govt. of Maharashtra collects the water samples from Gosikhurd reservoir periodically for analysis at Water Quality Lab, Hydrology Project Division-II, Nagpur for both chemical and physio-chemical analysis for ascertaining the water quality status. The latest data

pertaining to the years 2015 to 2018 on laboratory test results of the water samples of Gosikhurd reservoir have been collected and are presented in **Table 7.2**.

Table 7.2
Test results of water samples from Gosikhurd reservoir

Sl. No	Characteristic (Parameter)	unit	Analysis Result				Drinking Water Specifications (IS 10500 : 2012)
			22/7/15	15/1/16	20/6/17	30/1/18	Requirement (Acceptable Limit)
1	Colour	Hazen	1	1	1	1	5 Max
2	Odour		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	pH		8.3	8.1	8.3	8.4	6.5 to 8.5
4	Dissolved Oxygen	mg/l	6.1	6.3	6.8	7	6 mg/l Min as per CPCB class A Tolerance limit
5	Total Dissolved Solids	mg/l	178	196	220	240	500 Max
6	Turbidity	NTU	7.4	4.4	4.6	7.6	1 Max
7	Total Alkalinity (as CaCO ₃)	mg/l	112	152	156	180	200 Max
8	Chloride (as Cl)	mg/l	16	14	18	13	250 Max
9	Sulphate (as SO ₄)	mg/l	14.2	10.7	10.6	9.8	200 Max
10	Fluoride (as F)	mg/l	0.58	0.5	0.5	0.52	1.0 Max
11	Total Hardness (as CaCO ₃)	mg/l	104	136	132	132	200 Max
12	Calcium (as Ca)	mg/l	30.5	31.3	29.7	31.3	75 Max
13	Magnesium (as Mg)	mg/l	6.8	14.1	14.1	13.1	30 Max
14	Boron (as B)	mg/l	0.08	0.12	0.14	0.16	0.5 Max
15	Ammonia	mg/l	0.05	0.05	0.06	0.05	0.5 Max
16	Nitrate as NO ₃	mg/l	1.6	1.94	2	2.3	45 Max
17	BOD	mg/l	2.8	2.8	2.9	2.8	2 mg/l Max as per CPCB class A Tolerance limit
18	Manganese (as Mn)	mg/l	N.D	N.D	N.D	N.D	0.1 Max
19	Aluminium (as Al)	mg/l	0.02	0.02	0.01	0.01	0.03 Max

20	Silica	mg/l	3.4	2.8	1.68	1.76	----
21	Iron (as Fe)	mg/l	0.18	0.14	0.1	0.12	0.3 Max
22	Total Coliforms	MPN/ 100ml	790	17	24	11	Shall not be detectable in any 100 ml sample
23	Faecal Coliforms	MPN/ 100ml	170	4.5	6.8	4	Shall not be detectable in any 100 ml sample

Source: EE, I&HEP Division, WRD, Nagpur; Note: ND - Not Detectable

It is observed that the pH level of water in Wainganga river ranges between 8.1 to 8.4 during the period. The pH level indicates slightly alkaline nature of the water and the values are within acceptable limits of 6.5 to 8.5 as per IS 10500-2012 specified for drinking and domestic uses. The levels of dissolved oxygen in various collected samples are in the range of 6.1 to 7.0 mg/l and fulfil the CPCB class A tolerance limit of 6mg/l Min. The levels of total dissolved solids are well within the acceptable limit of 500 mg/l i.e. ranging from 178 to 240 mg/l. The range of total Alkalinity (as Ca CO₃) is between 112 to 180 mg/l and satisfies the acceptable limit of 200 mg/l Max. It indicates that the water is suitable for drinking and domestic uses. The range of total hardness (as Ca CO₃) of the above water samples is from 104 to 136 mg/l which is well within the acceptable limit of 200 mg/l specified for drinking water. The concentration of Sulphate is in the range of 9.8 to 14.2 mg/l which is within the acceptable limit of 200 mg/l. The concentration of Chlorides (as Cl) is in the range of 13 to 18 mg/l which is within the acceptable limit of 250 mg/l as per IS 10500-2012 for drinking water quality standards. The concentration of Calcium also is within the acceptable limit of 75 mg/l, ranging from 29.7 to 31.3 mg/l. Other parameters such as Flouride, Magnesium, Boron, Ammonia, Nitrate, Manganese, Aluminium, Silica and Iron are also within the respective acceptable limits as per IS 10500-2012. Though the water is suitable for drinking and domestic uses, it cannot be supplied directly without proper filtration and chlorination. As the turbidity is high and varies from 4.4 to 7.6 against the permissible limit of only 1.0, water filtration plants with chlorination are required to be set up for water purification to make it potable.

As per the test results of water samples from Gosikhurd reservoir, the pH is within the limits of 6.5 to 8.5 indicating slightly alkaline nature of water and is fit for irrigation use. As the levels of total dissolved solids in various samples collected are well below the acceptable limits of less than 500 mg/l, the same is 'Excellent to Good-Class-1' for irrigation. The range of Chlorides in the water is less than 250 mg/l which indicates it as 'Excellent to Good-Class-1' for irrigation.

Also, the other parameters such as alkalinity, total hardness, Calcium/Magnesium/Sulphates etc. are within the limits for irrigation water. Hence, the water proposed for diversion from Gosikhurd reservoir through the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link canal is found to be suitable for irrigation purpose and with proper treatment for drinking and domestic use as well.

7.1.3 Sedimentation

Sediment analysis is being carried out by CWC at Pauni G&D site (35520 km²) on Wainganga river downstream of the Gosikhurd project (34862 km²). The data on sediment inflow at Pauni G&D site is available for the period from 1969-70 to 2004-05. As per the available sediment data, the rate of average annual sediment inflow to the Gosikhurd reservoir works out to 13173764 M.T, out of which 13084669 M.T is during the monsoon period. The data on sediment inflow at Pauni G&D site for the period from 1995-96 to 2004-2005 is furnished in **Table 5.5 in Chapter-5 ‘Hydrology and Water Assessment’**.

In the Gosikhurd Project Report (1982), the silt load has been estimated by using the observed silt load data at Pauni G&D site for 13 years from 1965 to 1977 by establishing runoff-silt load correlation and computing the silt load series for 64 years from 1914 to 1977. The expected annual silt load calculated as the average of this series was about 1740 ham. Based on this, the total silt load at Gosikhurd was calculated as 116.6 Mm³ and 243 Mm³ after 50 & 100 years of sedimentation respectively. The rate of sedimentation (annual silt load after consolidation) considered in the Project Report was 5.53 Mm³/year. The silt distribution was done by empirical area reduction method and treating the reservoir as Type-II. The zero elevation levels worked out for 50 and 100 years of sedimentation were 228.20 m and 232.88 m respectively. The MDDL and FRL originally considered in the Project Report were 244 m and 238.5 m respectively. The percentage encroachment (due to sedimentation) in the live storage above MDDL after 50 and 100 years was estimated to be 4.61% and 11.46% respectively.

Subsequently, the project was built with a FRL of 245.5 m and MDDL of 241.29 m. The corresponding storages fixed at MDDL and FRL are 479 Mm³ and 1146 Mm³ respectively as per the elevation-area-capacity table made available

by WRD, Nagpur. However, in the salient features of the project (2014) available, it was indicated that the dead storage provided in the project after 50 and 100 years of sedimentation are 406 Mm³ and 769 Mm³ respectively.

7.1.4 Life of Reservoir

All the outlets from the reservoir are fixed at respective levels after considering 100 years of sedimentation. Therefore, the life of the Gosikhurd reservoir has been considered as 100 years.

7.1.5 Capacities

The Gosikhurd project is a major multi-purpose project with lift, storage and diversion structure having a gross storage capacity of 1146 Mm³ at FRL 245.5 m. The dead storage capacity at MDDL of 241.29 m after 50 years of sedimentation has been considered as 406 Mm³.

7.1.6 Area of Submergence (ha)

The water spread area of Gosikhurd reservoir at FRL 245.5 m is 22258 ha. The same at MWL of 245.70 m is 22955 ha.

The Elevation-Area-Capacity values of the existing Gosikhurd Project are furnished in **Table 7.3**. The salient features of the Gosikhurd project are furnished in **Annexure 7.1**. The Elevation-Area-Capacity curves of Gosikhurd reservoir are furnished in **Fig- 7.1**.

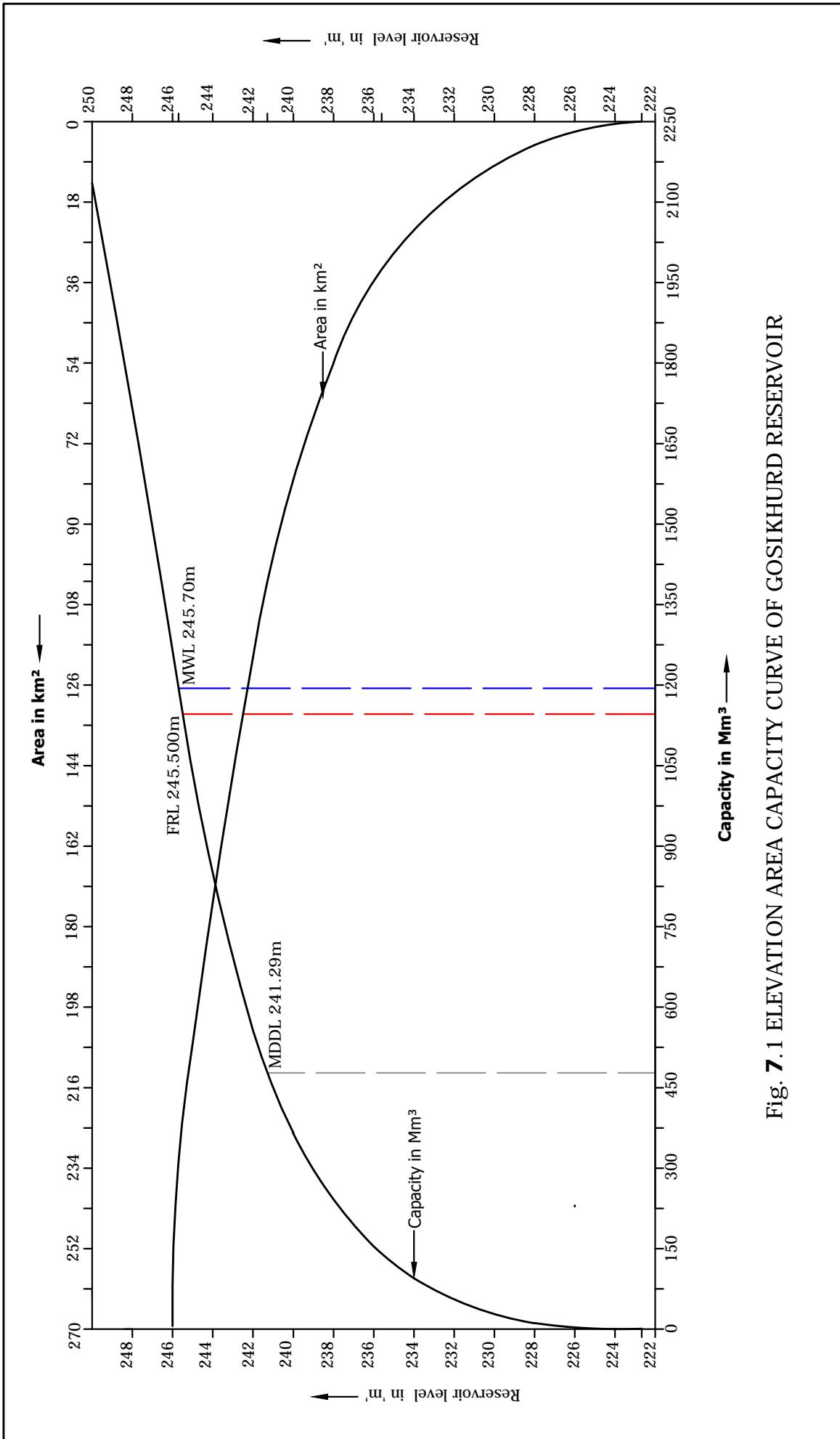


Fig. 7.1 ELEVATION AREA CAPACITY CURVE OF GOSIKHURD RESERVOIR

Table-7.3**Elevation - Area - Capacity table of Gosikhurd reservoir**

Sl. No.	Elevation (RL)	Contour interval	Water spread area	Root of area	Capacity between two successive contours	Cumulative capacity	Remark
	m	m	Mm ²	Mm ²	Mm ³	Mm ³	
1	222.675	-					
2	224.000	1.325	0.39897	0.63164	0.17621	0.18	
3	226.000	2.000	2.28364	1.51117	2.42475	2.60	
4	228.000	2.000	6.16612	2.48317	8.13483	10.73	
5	230.000	2.000	11.29948	3.36147	17.20847	27.94	
6	232.000	2.000	15.84810	3.98097	27.01966	54.96	
7	234.000	2.000	24.35545	4.93512	39.90008	94.86	
8	236.000	2.000	35.19740	5.93274	59.22109	154.08	
9	238.000	2.000	53.52500	7.31608	88.08453	242.16	
10	240.000	2.000	71.84240	8.47599	124.91895	367.08	
11	241.290	1.290	102.82200	10.14012	112.06314	479.14	MDDL
11	242.000	2.000	119.87270	10.94864	189.67711	556.76	
12	244.000	2.000	174.24724	13.20027	292.42996	849.19	
13	245.000	1.000	205.93091	14.35029	189.86862	1039.06	
14	245.500	0.500	222.96546	14.93203	107.19589	1146.26	FRL
15	246.000	0.500	240.00000	15.49193	222.7482	1261.81	

Source: Gosikhurd Project Circle, WRD, Nagpur

Note: As per the salient features of the project (2014) received from Vidarbha Irrigation Development Corporation (VIDC), the dead storage after 50 years of sedimentation is 406 Mm³ and is considered as such in reservoir simulation in the present study

7.1.7 Flood Absorption/Reservoir Operation Policy

As per the Gosikhurd Project Report (June, 1982), no appreciable flood control was anticipated due to the construction of the project. Thus, the project will not alter the existing flood characteristics.

As regards to normal reservoir operation, both the reservoirs of Gosikhurd and Asolamandha have been considered jointly to meet irrigation demand of the entire command area. The Right Bank Canal (RBC) of the project is considered for feeding Asolamandha tank to store surplus water available during monsoon period from the Gosikhurd reservoir to provide additional irrigation to a CCA of about 55098 ha.

As per the revised reservoir operation schedule (2016), though the M.D.D.L. is 241.29 m, it is planned by the project authority to maintain the reservoir to R.L. 239.00 m in the month of June as the sluice level of Right Bank outlet is R.L. 235.60 m and that of Left Bank outlet is R.L.238.50 m. Similarly, though the reservoir can be filled in the months of September and October even by keeping the reservoir level at M.D.D.L. till Aug.31 of every year, in order to ascertain full storage even in worst drought years, it is planned by the project authority to ensure the reservoir level to

R.L.243.00m. by 31st July
 R.L.243.20m. by 31st August.
 R.L.245.00m. by 30th September.
 R.L.245.50m. by 15th October.

7.2 Lower Wardha Dam

The Lower Wardha project is an earthfill and gravity dam, a major multi-purpose project constructed by WRD, Govt. of Maharashtra across river Wardha, a right bank tributary of river Wainganga in Godavari basin. The project is located at latitude of 20° 52' 30" N and longitude of 78° 15' 30" E near village Dhanodi in Arvi tehsil of Wardha district. It consists of earth dam on both flanks with gated spillway in between. The total length of the dam is 9.46 km with a maximum height of 24.82 m above the river bed in the gorge portion. It has a ogee type central spillway of 580 m length with 31 nos. of radial gates of size 12 m x 8 m. The catchment area upto the dam site is 6317 km² of which the free catchment is about 2015 km². The CCA of the project is 83704 ha including 8400 ha of Arvi LIS . The project also caters domestic water supply of 10.51 Mm³ to Pulgaon and Dhamangaon towns and industrial water supply of 40.20 Mm³ to Lanco industries.

The various components of the Lower Wardha dam are furnished below:

1. Left flank earth dam of length 2000 m
2. Right flank earth dam of length 6884 m
3. Spillway of length 580 m (Over flow: 462.5 m & NoF: 117.5 m)
4. 31 Nos. of Radial gates of size 12.0 m x 8.0 m
5. Left bank canal Head Regulator at RD 2800 m

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link canal falls into Lower Wardha reservoir at RD of 167.9 km with FSL of 284.38 m through Savangi stream near Savangi village and is again proposed to be taken off at Piplakhuta village from the right bank of Wardha river with FSL of 281.00 m.

7.2.1 Fixation of Storage and Reservoir Levels

Details of various controlling levels of Lower Wardha dam are discussed as under:

7.2.1.1 Dead Storage Level (DSL)/Minimum Draw Down Level (MDDL)

The bed level of the river at Lower Wardha dam site is 262.98 m. The sill level of left bank canal sluice is 274.40 m where as that of river sluice is 266.50 m. The Minimum Draw Down Level (MDDL) of the dam is fixed at 277.20 m.

7.2.1.2 Full Reservoir Level (FRL)

The FRL of the Lower Wardha dam is 283.80 m. The FRL is kept unaltered for receiving waters from as well as discharging into the proposed link canal. The submergence area of the reservoir at FRL is 5540 ha with a gross storage capacity of 253 Mm³.

7.2.1.3 Maximum Water Level (MWL)

The Maximum Water level (MWL) of the dam is at 284.50 m. The top bund level of the dam is at 287.80 m with a free board of 3.3 m.

7.2.1.4 Spillway

The dam has a ogee type spillway of length 580 m with 31 nos. of radial gates of size 12 m x 8 m. The spillway has a maximum discharging capacity of 20788 cumec at MWL. The crest level of the spill way is 275.80 m.

Various controlling levels of the Lower Wardha dam are given in **Table 7.4.**

Table 7.4
Controlling levels of Lower Wardha reservoir

Sl.No	Controlling level	Elevation 'm'	Capacity 'Mm ³ '
1.	River bed level	262.98	
2.	Canal sill level, Left	274.40	
3.	Spillway crest level	275.80	
4.	Minimum Draw Down level	277.20	36.47
5.	Full reservoir level	283.80	253.34
6.	Maximum water level	284.50	
7.	Top bund level	287.80	

7.2.2 Water Quality

As ascertained from Project authorities, no lab testing of waters of Lower Wardha reservoir was carried out during the last 5 years. Also, no recorded data of water quality of the reservoir is available with them. However, in the 'Final Environmental Impact Assessment Report & Environmental Management Plan, 2017' got prepared by Vidarbha Irrigation Development Corporation through M/s SMS Envocare Limited, Pune for Arvi Lift Irrigation Scheme which is a part of Lower Wardha Project having command Area (8400 ha CCA) in Arvi and Deoli Tehsils for which 25.74 Mm³ water is reserved from main storage (available on net), surface water quality data of one sample from the Lower Wardha reservoir for the post-monsoon season-2016 (October, 2016 to December, 2016) is available. The laboratory test results of the water sample of Lower Wardha reservoir as furnished in the said report are presented in **Table 7.5.**

Table 7.5
Test results of water sample from Lower Wardha reservoir

Sl. No	Characteristic (Parameter)	Unit	Values	Drinking Water Specification IS 10500 : 2012
				Requirement (Desirable Limit)
1	Colour	Hazen	<1	5 Max
2	Odour	AG	Agreeable	Agreeable
3	Taste	AG	Agreeable	Agreeable
4	Turbidity	NTU	0.7	1
5	Total Dissolved Solids	mg/l	419	500
6	pH at 25°C	--	8.2	6.5 to 8.5
7	Dissolved Oxygen	mg/l	7	----
8	BOD (3 days at 27°C)	mg/l	<3.0	----
9	COD	mg/l	4	----
10	Conductivity	mS/cm	635	----
11	Total Alkalinity (as CaCO ₃)	mg/l	180	200
12	Total Hardness (as CaCO ₃)	mg/l	120	200
13	Calcium (as Ca)	mg/l	27.2	75
14	Magnesium (as Mg)	mg/l	14.6	30
15	Chloride (as Cl)	mg/l	35	250
16	Sulphate (as SO ₄)	mg/l	14	200
17	Fluoride (as F)	mg/l	<0.1	1
18	Nitrates as NO ₃	mg/l	3.46	45
19	Iron (as Fe)	mg/l	<0.1	0.3
20	Manganese (as Mn)	mg/l	<0.1	0.1
21	Zinc (as Zn)	mg/l	<0.01	5
22	Copper (as Cu)	mg/l	BDL	0.05
23	Aluminium (as Al)	mg/l	<0.01	0.03
24	Boron (as B)	mg/l	<0.01	1
25	Total Coliform	MPN/100ml	1	Absent
26	E Coli	MPN/100ml	2	Absent

27	Oil & Grease	mg/l	0.15	NR
B	Toxic Substances			
28	Cadmium (as Cd)	mg/l	<0.01	0.003
29	Arsenic (as As)	mg/l	<0.005	0.01
30	Lead (as Pb)	mg/l	<0.01	0.01
31	Chromium (as Cr)	mg/l	<0.01	0.05
32	Mercury (as Hg)	mg/l	<0.005	0.001

Source: 'Final Environmental Impact Assessment Report & Environmental Management Plan, 2017' by Vidarbha Irrigation Development Corporation through M/s SMS Envocare Limited, Pune for Arvi Lift Irrigation Scheme

It is observed that the pH level of water in Wardha river is 8.2 indicating slightly alkaline nature of the water. However, the value is within the desirable limits of 6.5 to 8.5 as per IS 10500-2012 specified for drinking and domestic uses. The level of dissolved oxygen is 7.0 mg/l which fulfils the CPCB class A tolerance limit of 6 mg/l Min. The level of total dissolved solids is 419 mg/l and is well within the desirable limit of 500 mg/l. The total Alkalinity (as CaCO₃) is 180 mg/l which satisfies the acceptable limit of 200 mg/l Max. It indicates that the water is suitable for drinking and domestic uses. The total hardness (as CaCO₃) of 120 mg/l is well within the desirable limit of 200 mg/l specified for drinking water. The concentration of Sulphate is 14 mg/l which is also within the desirable limit of 200 mg/l. The concentration of Chlorides (as Cl) is 35 mg/l and is within the desirable limit of 250 mg/l as per IS 10500-2012 for drinking water quality standards. The concentration of Calcium at 27.2 mg/l is within the desirable limit of 75 mg/l. Other water quality parameters such as Fluoride, Magnesium, Boron, Ammonia, Nitrate, Manganese, Zinc, Copper, Aluminium, Silica and Iron as well as toxic substances such as Arsenic, Lead and Chromium are also within the respective acceptable limits as per IS 10500-2012. Though the water is suitable for drinking and domestic uses, it cannot be supplied directly without proper filtration and chlorination. Therefore, water filtration plants with chlorination are required to be set up for water purification to make it potable.

As per the test results of water sample from Lower Wardha reservoir, the pH is within the limits of 6.5 to 8.5 indicating slightly alkaline nature of water and is fit for irrigation use. As the level of total dissolved solids in the collected sample is well below the desirable limits of 500 mg/l, the same is 'Excellent to Good-Class-1' for irrigation. The level of Chlorides in the water is less than 250 mg/l which indicates it as 'Excellent to Good-Class-1' for irrigation. Also, the

other parameters such as alkalinity, total hardness, Calcium/Magnesium/Sulphates etc. are within the limits for irrigation water.

7.2.3 Sedimentation

A rate of sedimentation of 1.37 acre feet/sq.mile/year which corresponds to 0.0476 ham/sq.km/year is adopted in computing the volume of sediments into the Lower Wardha reservoir. Total expected silt accumulation considering 100 years sediment in the reservoir would be 66.46 Mm³. The zero elevation computed was at RL 274.2 m. Accordingly, the elevation-area-capacity tables for 50 years and 100 years siltation have been prepared by the project authority.

7.2.4 Life of Reservoir

The Lower Wardha dam and reservoir have been designed for a life period of 100 years.

7.2.5 Capacities

The Lower Wardha project is a major storage and diversion structure with a gross storage capacity of 253 Mm³ at FRL 283.80 m. The dead storage capacity at MDDL of 277.20 m is 36.47 Mm³ while the live storage capacity is about 217 Mm³.

7.2.6 Area of Submergence (ha)

The water spread area of Lower Wardha reservoir at FRL of 283.8 m is 5540 ha. The same at MWL of 284.50 m is 6618 ha.

The Elevation-Area-Capacity values of the existing Lower Wardha reservoir are furnished in **Table 7.6**. The salient features of the Lower Wardha project are furnished in **Annexure 7.2**. The Elevation-Area-Capacity curves of Lower Wardha reservoir are furnished in **Fig. 7.2**.

Table-7.6**Elevation -Area - Capacity table of Lower Wardha reservoir**

Sl. No.	RL	Water spread area	Cumulative capacity	Remarks
	in m	Mm ²	Mm ³	
1	274.0	4.80	7.00	
2	275.0	7.20	12.80	
3	276.0	10.20	21.17	
4	277.0	14.00	33.38	
5	277.2	14.80	36.47	MDDL
6	278.0	18.00	49.00	
7	279.0	22.40	69.50	
8	280.0	27.00	95.00	
9	281.0	33.60	124.50	
10	282.0	41.00	155.00	
11	283.0	49.40	202.50	
12	283.8	55.40	253.34	FRL

Source : Office of the Executive Engineer, IPI Division, Amravati

7.2.7 Flood Absorption/Reservoir Operation Policy

The expected standard project flood at Lower Wardha is 20788 cumec while the maximum probable flood is 22596 cumec. The maximum discharging capacity of the spillway at MWL is 20788 cumec which is equivalent to the standard project flood. A flood lift of 0.85 m is provided in the project.

Normally, there are no rains after 15th September in the project area. Hence, the Reservoir Operation Schedule (R.O.S) is planned by the project authorities in such a way that the reservoir will be full even when there are no rains after 15th September. Accordingly, the maximum levels to be maintained at different dates are as follows:

Period	Live storage in Mm ³	Level in 'm'	Storage (%)
16 th Sept. to 30 th Sept.	216.87	283.80	100%
1 st Sept. to 15 th Sept.	188.93	283.35	87%
16 th Aug. to 31 st Aug.	168.92	283.00	78%
1 st Aug. to 15 th Aug.	163.25	282.95	75%
16 th July to 31 st July	149.45	282.67	69%

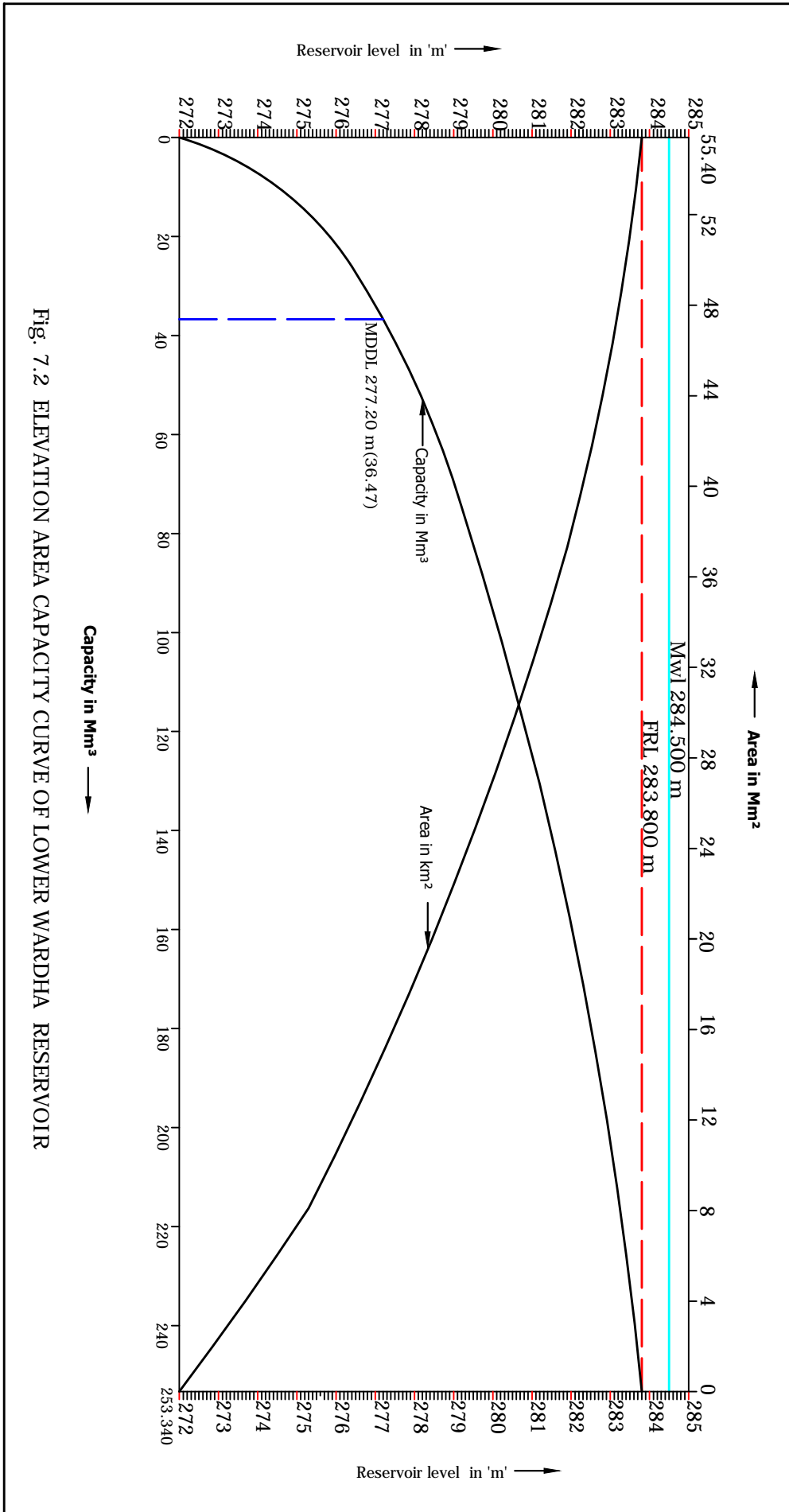


Fig. 7.2 ELEVATION AREA CAPACITY CURVE OF LOWER WARDHA RESERVOIR

7.3 Katepurna Dam

The Katepurna is a major multi-purpose project, an earthfill dam across river Katepurna, a left bank tributary of river Purna Tapi in Tapi basin, constructed by WRD, Govt. of Maharashtra. The project was completed in the year 1970-71. The project is located at latitude of 20° 28' 53" N and longitude of 77° 09' 24" E near village Mahan in Barshitakli tehsil of Akola district. It consists of 1.830 km long dam with a maximum height of 32.31 m. It has a 145 m long ogee type central spillway. The dam taps a catchment area of 514 km². The project has a gross storage capacity of 97.67 Mm³ at FRL and irrigates 8325 ha annually over CCA of 11187 ha through a pickup weir located near village Khambora in Akola district at latitude 20°36'00" N and longitude 77°12'00" E. The project is planned to utilise 86.35 Mm³ annually which includes 25.20 Mm³ towards municipal and industrial water supply to Akola city.

The various components of the Katepurna dam are furnished below:

1. Dam of length 1830 m and maximum height of 32.31 m
2. Spill way of length 145 m with 10 Nos. of gates of size 12 m x 5.20 m

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link canal falls into Katepurna reservoir near village Mahan at RD of 298.63 km with FSL of 348.301 m and then is proposed to be taken off from the left flank of Katepurna reservoir with FSL of 342.80 m.

7.3.1 Fixation of Storage and Reservoir Levels

Details of various controlling levels of Katepurna dam are discussed as under:

7.3.1.1 Dead storage Level (DSL) / Minimum Draw Down Level (MDDL)

The river bed level at Katepurna dam site is 321.04 m. The Minimum Draw Down Level (MDDL) of the dam is fixed at 337.41 m.

7.3.1.2 Full Reservoir Level (FRL)

The FRL of the Katepurna dam is 347.78 m with a gross storage capacity of 97.67 Mm³. The FRL is kept unaltered for receiving waters from as well as discharging into the proposed link canal. The submergence area of the reservoir at FRL is 1243 ha.

7.3.1.3 Maximum Water Level (MWL)

The Maximum Water level (MWL) of the dam is at 348.69 m. The top bund level of the dam is at 351.13 m.

7.3.1.4 Spillway

The dam has a ogee type central spillway of length 145 m with 10 Nos. of gates of size 12 m x 5.2 m. The spillway has a maximum discharging capacity of 2784 cumec at MWL. The crest level of the spillway is 342.90 m.

Various controlling levels of the Katepurna dam are given in **Table 7.7**.

Table 7.7
Controlling levels of Katepurna reservoir

Sl.No	Controlling level	Elevation 'm'	Capacity 'Mm ³ '
1.	River bed level	321.04	
2.	Minimum Draw Down level	337.41	11.32
3.	Spillway crest level	342.90	
4.	Full reservoir level	347.78	97.67
5.	Maximum water level	348.69	
6.	Top bund level	351.13	

7.3.2 Water Quality

As per the data provided by IPI division, WRD, Akola for the years 2010-11, 2011-12, 2012-13 & 2014-15 for the Katepurna reservoir, 12 parameters of water quality are tested in three seasons viz. monsoon, winter and summer, every year. The season-wise mean data of the test results of the water samples during the aforesaid 4 years is presented in **Table 7.8**.

Table 7.8
Test results of water samples from Katepurna reservoir

Sl. No.	Characteristic (Parameter)	Unit	Season-wise mean data			Drinking Water Specification IS 10500 : 2012
			Monsoon	Winter	Summer	Requirement (Acceptable Limit)
1	pH at 25°C		8.3	8.3	8.4	6.5 to 8.5
2	EC	µmhos/cm	536.6	548.4	631.1	--
3	Dissolved Oxygen	mg/l	6.2	6.6	6.3	--
4	BOD	mg/l	3.8	3.2	3.7	--
5	COD	mg/l	14.3	10.9	14.3	--
6	Total Dissolved Solids	mg/l	321.9	330.8	377.4	500
7	Alkalinity (as CaCO ₃)	mg/l	242.7	261.3	273.2	200
8	Chloride (as Cl)	mg/l	41.3	39.6	52.4	250
9	Calcium (as Ca)	mg/l	51.4	54.1	59.7	75
10	Magnesium (as Mg)	mg/l	17.1	19.6	20.2	30
11	Total Coliforms	MPN/100ml	438.1	71.0	43.4	Absent
12	Faecal coliforms	MPN/100ml	167.5	22.1	15.3	----

Source: EE, IPI Division, WRD, Akola

It is observed that the pH level of water in Katepurna river ranges between 8.3 to 8.4 during the period. The pH level indicates slightly alkaline nature of the water and the values are within acceptable limits of 6.5 to 8.5 as per IS 10500-2012 specified for drinking and domestic uses. The levels of dissolved oxygen in various collected samples are in the range of 6.2 to 6.6 mg/l and fulfil the CPCB class A tolerance limit of 6mg/l Min. The levels of total dissolved solids are well within the acceptable limit of 500 mg/l i.e. ranging from 321.9 to 377.4 mg/l. The range of total Alkalinity (as CaCO₃) is between 242.7 to 273.2 mg/l and does not satisfy the acceptable limit of 200 mg/l Max. However, it is within the permissible limit of 600 mg/l as per IS 10500-2012. It indicates that the water can be used for drinking and domestic uses. In fact, Akola city water supply is being catered

from Katepurna reservoir. The concentration of Chlorides (as Cl) is in the range of 39.6 to 52.4 mg/l which is within the acceptable limit of 250 mg/l as per IS 10500-2012 for drinking water quality standards. The concentration of Calcium also is within the acceptable limit of 75 mg/l, ranging from 51.4 to 59.7 mg/l. The concentration of Magnesium is in the range of 17.1 to 20.2 mg/l which is within the acceptable limit of 30 mg/l. Though the water is suitable for drinking and domestic uses, it cannot be supplied directly without proper filtration and chlorination. Therefore, water filtration plants with chlorination might certainly be in place for water purification for supply to Akola city.

As per the test results of water samples from Katepurna reservoir, the pH is within the limits of 6.5 to 8.5 and is fit for irrigation use. As the levels of total dissolved solids in various samples collected are well below the acceptable limits of less than 500 mg/l, the same is 'Excellent to Good-Class-1' for irrigation. The range of Chlorides in the water is less than 250 mg/l which indicates it as 'Excellent to Good-Class-1' for irrigation. Also, the other parameters such as alkalinity, Calcium / Magnesium etc. are within the limits for irrigation water. Hence, the water is found to be suitable for irrigation purpose and with proper treatment for drinking and domestic use as well.

7.3.3 Sedimentation

Maharashtra Engineering Research Institute (MERI), Nashik carried out the first sedimentation assessment survey of Katepurna reservoir in the year 2006-07 by satellite remote sensing technique. As per this survey, the live storage capacity between FRL and MDDL was estimated to be 76.91 Mm³ indicating an average annual loss of 0.19% for the period of 36 years from 1970 to 2006. Subsequently, the second survey has been carried out by MERI in 2012-13 and the live storage has been assessed to be 76.1 Mm³ indicating an average annual loss of 0.18% for the period of 42 years from 1970 to 2012. It has been concluded by MERI in its technical report titled "Assessment of Live Storage Capacity of Katepurna Reservoir Dist. Akola by Satellite Remote Sensing Technique, October-2013" that the annual reduction in live capacity of less than 0.2% is not alarming.

7.3.4 Life of Reservoir

The Katepurna dam and reservoir have been designed for a life period of 100 years.

7.3.5 Capacities

The Katepurna project is a major storage and distribution structure with a gross storage capacity of 97.67 Mm³ at FRL 347.78 m. The dead storage capacity at MDDL of 337.41 m is 11.32 Mm³ while the live storage capacity is about 86.35 Mm³.

7.3.6 Area of Submergence (ha)

The water spread area of Katepurna reservoir at FRL of 347.78 m is 1243 ha. The same at MWL of 348.69 m is 1415 ha. The Elevation-Area-Capacity values of the existing Katepurna Project are furnished in **Table 7.9**. The salient features of the project are furnished in **Annexure 7.3**. The Elevation-Area-capacity curves of Katepurna reservoir are furnished in **Fig 7.3**.

Table-7.9
Elevation -Area - Capacity table of Katepurna reservoir

Sl. No.	RL	Water spread area	Cumulative capacity	Remarks
	m	Mm ²	Mm ³	
1	2	3	5	6
1	323.092	0.0087	0	
2	326.140	0.0569	0.0892	
3	329.188	0.0646	0.2742	
4	332.236	0.2486	0.7211	
5	335.284	2.2788	4.0537	
6	336.198	3.5130	6.8125	
7	337.113	3.7872	10.1634	
8	337.410	3.8243	11.3234	MDDL
9	338.332	4.4442	15.0080	
10	340.161	5.7621	23.7860	
11	341.075	6.6691	29.7640	

12	342.295	7.0539	37.9750	
13	342.900	7.2537	42.4750	Ogee crest
14	343.819	8.9219	49.6450	
15	344.733	9.7398	58.8990	
16	345.647	10.5483	69.1630	
17	346.562	11.5242	79.9020	
18	347.775	12.7433	97.6700	FRL
19	348.690	14.1496	111.2680	MWL

Source: Office of the Executive Engineer, IPI Division, Akola

7.3.7 Flood Absorption/Reservoir Operation Policy

The controlling levels and storage as per the sanctioned R.O.S of Katepurna reservoir are as under:

Month	Level in 'm'	Storage in Mm ³	Storage (%)
31 st July	344.65	58.02	59%
31 st August	346.02	73.35	75%
30 th September	347.77	97.67	100%

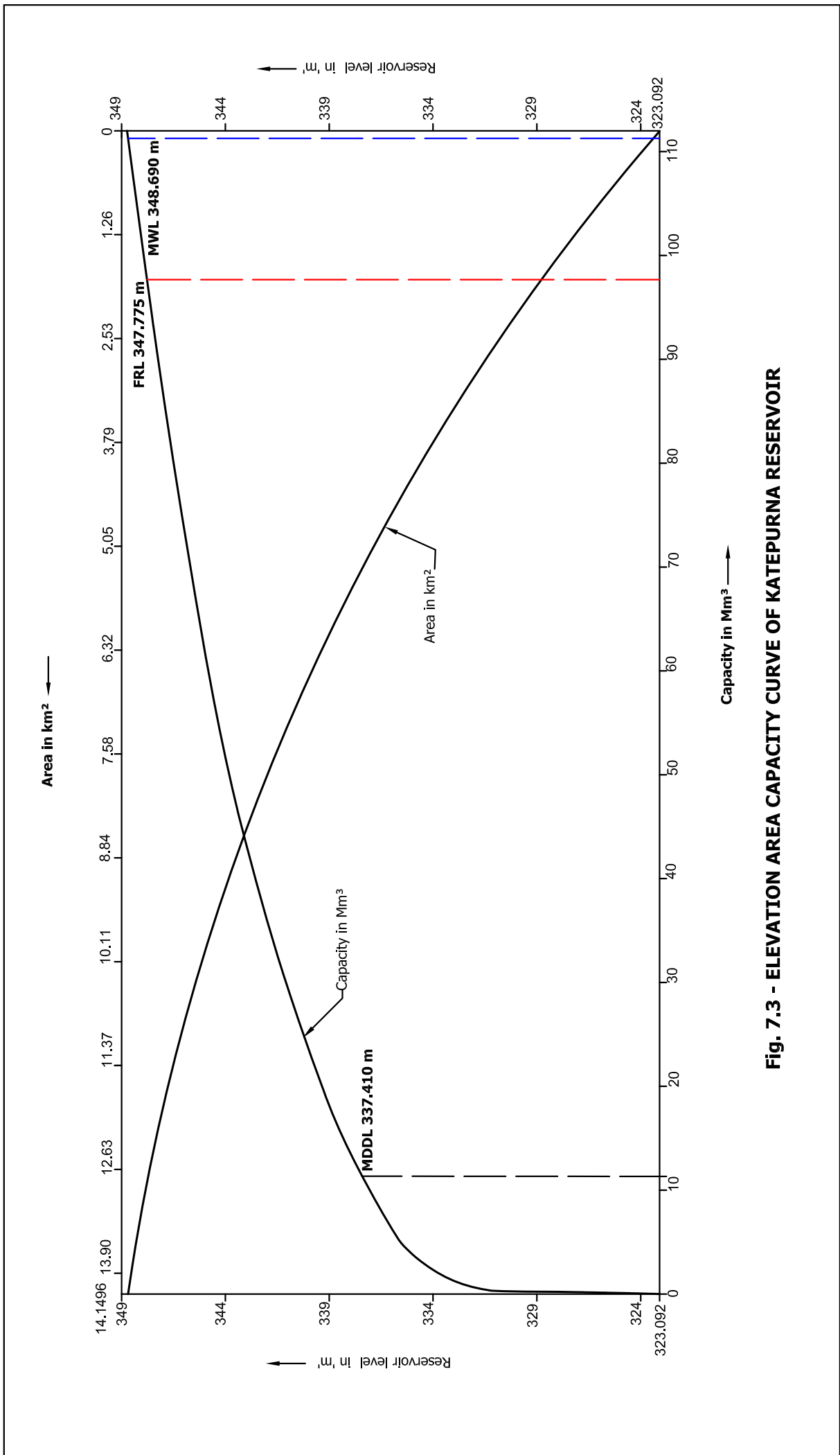


Fig. 7.3 - ELEVATION AREA CAPACITY CURVE OF KATEPURNA RESERVOIR

7.4 Nalganga Dam

The Nalganga Dam is a medium multi-purpose project constructed across river Nalganga, a left bank tributary of river Purna Tapi in Tapi basin by WRD, Govt. of Maharashtra. The project was completed in the year 1963. It is located between latitudes of 20° 45' 00" to 20° 53' 00" N and longitudes of 76° 11' 00" E to 76° 20' 00" E, downstream of village Sanglad in Motala tehsil of Buldhana district. It consists of 2.516 km long earthen dam including an Ogee type spillway in the right portion. The maximum height of the dam at gorge is 29.87 m. The dam taps a catchment area of 316 km². The project has a gross storage capacity of 71.86 Mm³ at FRL 294.44 m. The project is planned to irrigate 8741 ha annually over CCA of 9165 ha utilising 53.21 Mm³ through a right main canal of 28.77 km in length and provide domestic water supply to the extent of 2.83 Mm³ to Malkapur town.

The various components of the Nalganga dam are furnished below:

1. Earthen dam of 2516 m long with maximum height of 29.87 m
2. Spillway from RD 0.00 m to 158.60 m with 11 Nos. of radial gates of size 12.19 m x 4.27 m.
3. Head regulator at RD 1310.64 m with discharging capacity 10.05 cumec.

The Wainganga (Gosikhurd)-Nalganga (Purna Tapi) link canal terminates into Nalganga reservoir near Motala at RD 426.54 km with FSL 310.53 m.

7.4.1 Fixation of Storage and Reservoir Levels

Details of various controlling levels of Nalganga dam are discussed as under:

7.4.1.1 Dead Storage Level (DSL) / Minimum Draw Down Level (MDDL)

The river bed level at Nalganga dam site is 267.00 m. The dead storage level (DSL) of the dam is fixed at 279.40 m. The minimum draw down level (MDDL) of the dam is at 280.72 m.

7.4.1.2 Full Reservoir Level (FRL)

The FRL of the Nalganga dam is 294.44 m with a gross storage capacity of 71.86 Mm³. The FRL is kept unaltered for receiving waters from the proposed link canal. The submergence area of the reservoir at FRL is 1098 ha.

7.4.1.3 Maximum Water Level (MWL)

The Maximum Water level (MWL) of the dam is at 295.05 m. The top bund level (TBL) of the dam is at 296.88 m.

7.4.1.4 Spillway

The dam has a gated spillway of length 158.6 m with 11 Nos. of radial gates of size 12.19 m x 4.27 m. The spillway has a discharging capacity of 2158 cumec at MWL. The crest level of the spill way is 290.17 m.

Various controlling levels of the Nalganga dam are given in **Table 7.10**.

Table 7.10
Controlling levels of Nalganga reservoir

Sl.No	Controlling level	Elevation 'm'	Capacity 'Mm ³ '
1.	River bed level	267.00	
2.	HR sill level	279.40	
3.	Dead storage level	279.40	
4.	Minimum Draw Down level	280.72	2.54
5.	Spillway crest level	290.17	
6.	Full reservoir level	294.44	71.86
7.	Maximum water level	295.05	
8.	Top bund level	296.88	

7.4.2 Water Quality

As ascertained with the Project authorities, no testing of quality of waters of Nalganga reservoir has been carried out during the last five years and no recorded data of water quality of the reservoir is available.

7.4.3 Sedimentation

Maharashtra Engineering Research Institute (MERI), Nashik carried out the conventional hydrographic survey along with topographical survey of Nalganga reservoir in the year 1985. As per this survey, sedimentation of the order of 4.34 Mm³ was estimated in the span of 22 years from 1963 to 1985. Subsequently, the survey has been carried out by MERI in the year 2010 by satellite remote sensing technique. It revealed that the live storage capacity between FRL and MDDL has been reduced by 11.46 Mm³ (16.31%) on account of sedimentation in 47 years from 1963 to 2010. The annual percent loss was estimated to be 0.35%. The annual silt rate was assessed to be 7.72 ham/100 km². The revised live storage capacity of the reservoir was estimated to be 58.82 Mm³ as indicated by MERI in its report titled “Capacity Evaluation and Sediment Assessment in Nalganga reservoir, Dist. Buldhana by Satellite Remote Sensing Technique, 2011-12’.

7.4.4 Life of Reservoir

The Nalganga dam and reservoir have been designed for a life period of 100 years.

7.4.5 Capacities

The Nalganga project is a medium storage and distribution structure with a gross storage capacity of 71.86 Mm³ at FRL 294.44 m. The storage capacity at Dead Storage Level of 279.40 m is 2.54 Mm³ while the live storage capacity is about 69.32 Mm³.

7.4.6 Area of Submergence (ha)

The water spread area of Nalganga reservoir at FRL of 294.44 m is 1098 ha. The same at MWL of 295.05 m is 1162 ha. The salient features of the Nalganga project are furnished in **Annexure 7.4**. The Elevation-Area-Capacity values of the Nalganga reservoir are furnished in **Table 7.11**. The Elevation-Area-capacity curves of Nalganga reservoir are furnished in **Fig 7.4**.

Table-7.11
Elevation -Area - Capacity Table of Nalganga Reservoir

SI No.	Level in 'm'	Area in Mm ²	Gross Capacity in Mm ³	Remark
1	278.89	1.090	0.675	
2	279.81	1.301	1.491	
3	280.72	1.524	2.541	MDDL
4	281.64	1.858	3.775	
5	282.55	2.206	5.286	
6	283.16	2.439	6.551	
7	284.07	2.834	8.712	
8	285.29	3.391	20.080	
9	286.21	3.786	15.093	
10	287.12	4.274	18.621	
11	288.04	4.871	22.648	
12	289.26	5.714	28.944	
13	290.17	6.317	34.492	
14	291.08	7.051	41.002	
15	292.00	7.990	48.423	
16	293.22	9.430	59.558	
17	294.44	10.898	71.860	FRL

7.4.7 Flood Absorption/Reservoir Operation Policy

As per the reservoir operation schedule of the Nalganga reservoir, the average levels to be maintained between the upper guide curve (90% dependability) and the lower guide curve (75% dependability) are as under:

Month/Date	Level in 'm'	Storage in Mm ³
10 th October	294.44	71.86
30 th September	294.435	71.82
31 st August	294.42	71.64
31 st July	294.365	71.1
30 th June	294.36	71.1

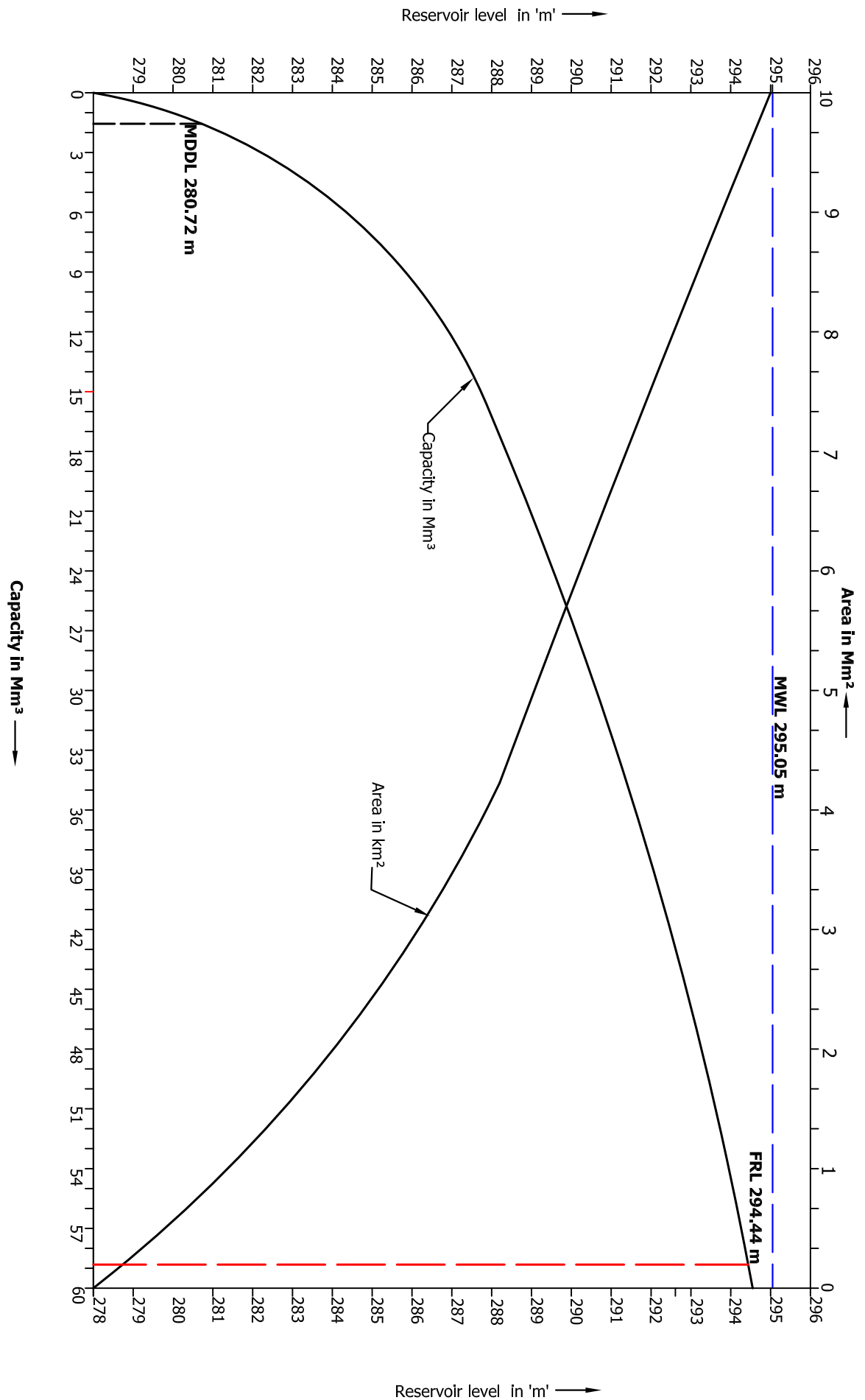


Fig. 7.4 - ELEVATION AREA CAPACITY CURVE OF NALGANGA RESERVOIR

7.5 Intermittent Storages

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project envisages transfer of 1772 Mm³ of waters from Gosikhurd reservoir. While firming up the project planning, about 40 nos. of medium sized storage tanks/sites are identified enroute the link canal in the project command area for creation of additional storage to meet the domestic, irrigation and industrial requirements of the link canal enroute, especially during non-monsoon period. Out of 40 Nos., 9 are existing reservoirs while 31 are proposed tanks. All the storages/tanks are planned to be integrated with the supplies of the link canal. A Quantum of 1715 Mm³ will be stored/augmented in these storage tanks.

7.5.1 Selection of Storages

In order to effectively store/augment the link water in the tanks and regulate the same during the post-monsoon, medium sized storages of about 50 Mm³ capacity are mostly planned. While identifying and selecting the storage tanks enroute, due care has been taken that minimum submergence is involved to store the required quantum of water and canal supplies to these tanks be by gravity. However, due to topographical constraints prevailing in the region, some of the tanks are located at higher elevations in order to cater the needs of water short upland areas. In such reaches, the canal is planned to flow at a higher elevation in order to feed the tanks by gravity instead of by individual lifts. However, very few tanks as proposed by Govt. of Maharashtra which require pumping of water directly from link canal are also considered in view of their storage capacity and scope for its utilisation in needy areas. The details of storages requiring lifting of water are given in **Table 7.12**.

Table 7.12
Storages proposed by Govt. of Maharashtra that require augmentation from Canal by lift

Sl. No.	Name of Storage	link canal RD (Km)	Supply from link (Mm ³)	Culturable command area (ha)	Operating Head (m)	Energy Reqt. (MU)
1	Borkhedi Kalan (LIS)	117.20	38.4	7200	7.1	0.96
2	Sukhli	147.55	43.1	7885	5.1	0.77
3	Vai/Malatpur	150.00	137.1	25204	10.6	5.10
4	Papal-I	246.30	68.7	13927	10.3	2.49
5	Shelodi	377.13	108.6	24682	8.3	3.16
	Total					12.5

Note: 1. The power requirement can be met from the locally available sources of Govt. of Maharashtra as well as from the planned canal solar power.

2. In case, these tanks as proposed by Govt. of Maharashtra are found techno-economically not viable, the water will be released into Katepurna river to meet the deficit of the ongoing Jigaon project on Purna river.

7.5.2 Integration of Storages

A network of feeder canals/direct sluices considering the FSL of the main canal, FRL/FTL of storages/tanks, natural soil level etc is planned to supply the water from the link canal to the selected storage tanks enroute in the project command area. In all, 22 feeder canals/direct sluices are proposed. Details of feeder canals/direct sluices vis-a-vis storage tanks to be integrated with the link canal are given in **Table 7.13**.

Table 7.13
Details of Feeder canals/ Direct sluices and storage tanks

Sl. No.	Feeder canal /Direct sluice	Link canal RD (km)	Proposed Storages (Capacity in Mm ³)	Capacity of feeder canal/DS (Mm ³)	Integration by
1.	Satara (Feeder 1)	25.00	Satara (62.18) Pandegaon (11.16) Sawargaon (23.48) Khursapur (13.16)	114.7	Gravity

2.	Saiky (Feeder 2)	42.70	Saiky (E) (8.42) Makardokada(E)(11.04) Pandharabori(E)(38.52) Thana(E) (65.35) Khaurgaon (26.78)	156.6	Gravity
3.	Khalsana(DS 1)	42.70	Khalsana (14.43)	15.1	Gravity
4.	Vadgaon(DS 2)	66.85	Vadgaon (13.64)	14.2	Gravity
5.	Bhansuli (Feeder 3)	85.10	Bhansuli (32.27) Mangli (18.48)	52.9	Gravity
Nagpur dist. total				353.5	
6.	Seldoh (Feeder 4)	89.52	Seldoh (31.32)	32.7	Gravity
7.	Juwadi Khairi (Feeder 5)	112.50	Juwadi Khairy (37.22)	38.8	Gravity
8.	Borkhedi Kalan (LIS) (Feeder 6)	117.20	Borkhedi Kalan (36.82)	38.4	Lift (7.1m)
9.	Tamaswada (DS 3)	123.77	Tamaswada (22.29)	23.2	Gravity
10.	Sukali (Feeder 7)	147.55	Sukali raising (E)(41.28)	43.1	Lift (5.1 m)
11.	Vai (Feeder 8)	150.0	Vai/Malatpur (60.00) Khurzadi (10.31) Vaiphad (11.76) Dahigaon (41.19) Rota I&II (E) (8.17)	137.1	Lift (10.6 m)
Wardha dist. total				313.3	
	Main canal	167.9	Lower Wardha (E) (253.34)	93.0*	Gravity
12.	Vadagaon Dipori (Feeder 9)	184.30	Vadgaon Dipori (59.92)	62.5	Gravity
13.	Bembla (Feeder 10)	195.45	Bembla (E) (50.18)	52.3	Gravity
14.	Yerandgaon (DS 4)	208.30	Yerandgaon (18.78)	19.6	Gravity

15.	Nandgaon Kh. (Feeder 11)	214.30	Nandgaon Kh. (90.78) Khandala (26.83)	122.7	Gravity
16.	Shelgund (Feeder 12)	237.30	Shelgund (36.25) Takali Kannad (24.64)	63.5	Gravity
17.	Papal 1 (Feeder 13)	246.30	Papal I (39.54) Kharbi (26.36)	68.7	Lift (10.3 m)
Amravati & Yeotmal dist. Total				482.3	
18.	Lower Katepurna (Feeder 14)	293.32	Lower Katepurna(79.79)	83.2	Gravity
	Main canal	298.63	Katepurna (E) (97.67)	101.9*	Gravity
19.	Yelwan (Feeder 15)	303.32	Yelwan (43.12) Sisa Udegaon (96.36)	145.5	Gravity
20.	Chikhalgaon (Feeder 16)	321.32	Chikhalgaon (46.50)	48.5	Gravity
21.	Kolori (Feeder 17)	371.38	Kolori (26.43)	27.6	Gravity
22.	Shelodi (Feeder 18)	377.13	Shelodi (104.17)	108.6	Lift (8.3 m)
	Main canal	426.54	Nalganga (E) (71.86)	50.1*	Gravity
Akola & Buldhana dist. total				565.4	
Grand Total				1714.5	Say 1715

* Supplementation from the link canal for these reservoirs;

Operational head is indicated for the proposed lifts to the enroute storage tanks.

The salient details of en route storages are furnished in **Annexure 7.5**. The location of storages along with their command area is shown in **Plates 8.1/1 to 8.1/3 of Chapter 8: 'Irrigation Planning and Command Area Development'**.

7.6 Land Acquisition-Property Submerged-Rehabilitation

No new dams/reservoirs are proposed as head works or balancing or out fall structures for the link canal. The existing Gosikhurd, Lower Wardha, Katepurna and Nalganga projects which are already executed and in operation by Water Resources Department (WRD), Government of Maharashtra are planned to be utilized for the purpose of diversion through the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project. However, in order to store the water received

from the link canal during monsoon and utilise the same in the command area during the post-monsoon period, about 40 enroute storages/tanks (including Lower Wardha and Katepurna) are proposed to be integrated with the link canal. Out of these, six existing tanks are proposed to be raised while 31 are new tanks to be constructed. One existing storage 'Bembla' is proposed to be utilised without any structural change. The issues of submergence and Resettlement & Rehabilitation (R&R) on account of the 37 (31 new+ 6 raising) enroute storages are considered and presented in detail in the **Chapter-11: 'EIA &EMP' and Chapter 12: 'Socio-Economic Studies and R&R Plan'**.