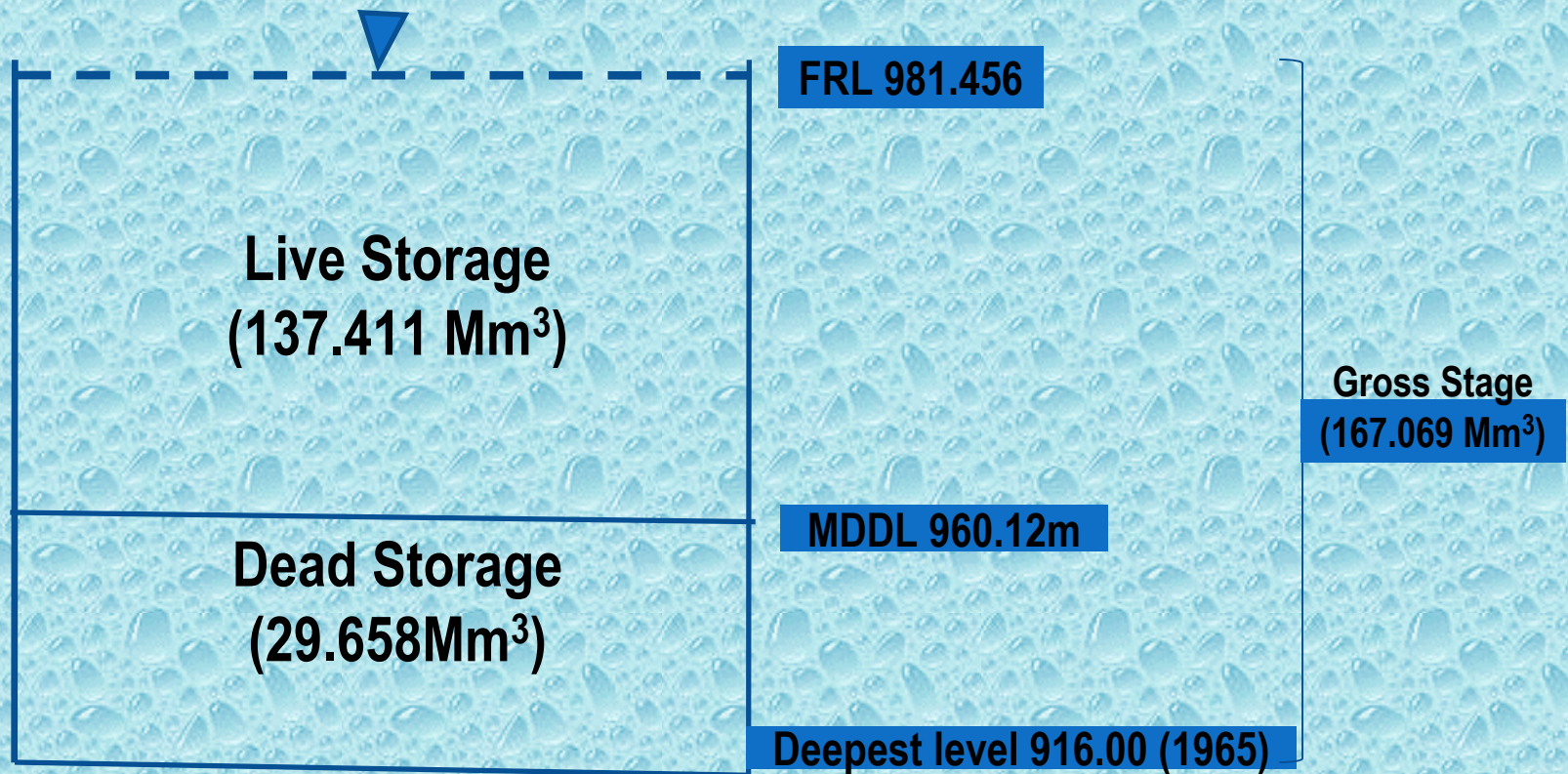
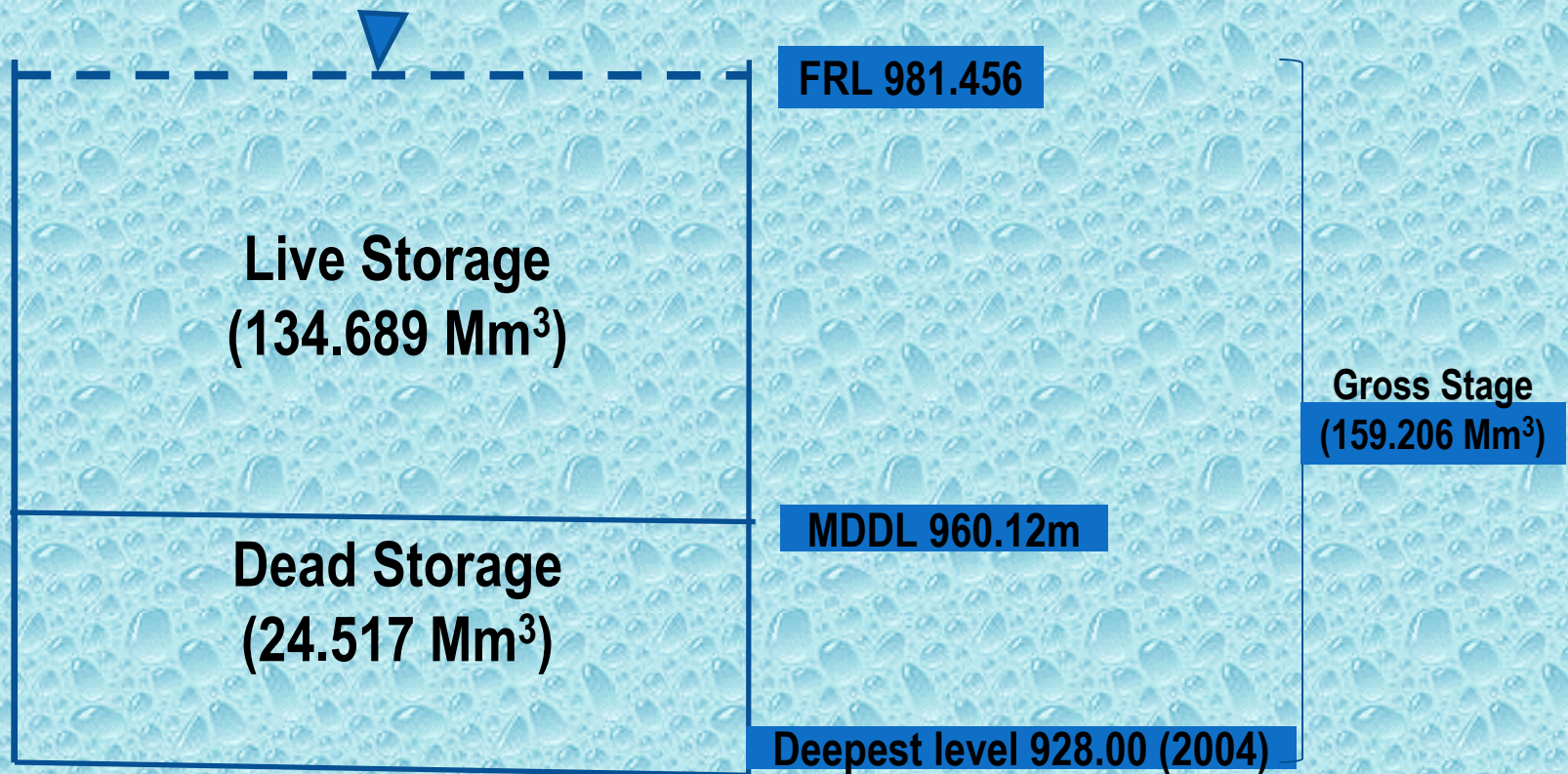


# SIMPLIFIED DIAGRAM OF RESERVOIR (1990)



# SIMPLIFIED DIAGRAM OF RESERVOIR (2004)



## Observed Rate of Sedimentation

The reservoir was first impounded during the monsoon of 1965. Since the latest survey has been conducted before the monsoon of the year 2004, the age of the reservoir for sedimentation studies can be taken as 39 years. As per recent 2004 survey, total area of reservoir at FRL contour is 10.148 sq. km and corresponding storage is 159.206 M cum. Original storage corresponding to FRL is 179.735 M cum (pre impoundment 1965 survey after review) and 167.069 M cum (1990 survey after review). Rate of sedimentation in the reservoir during the 39-yr period (1965-2004), works out to 0.527 M cum / year as under:

Original Gross Capacity below FRL 981.456 m = 179.757 M cum

Gross Capacity as per 2004 Survey = 159.206 M cum

Loss in Capacity = 20.551 M cum / 39 years

Rate of Sedimentation = 0.527 M cum / yr

(Catchment Area = 221.5 sq. km) or 23.79 ham/ 100 sq km/ yr

**Table A**

	Original- 1965 (Reviewed ) (M cum)	Survey - 1990 (Reviewed) (M.cum)	Loss of Storage (M cum)		Percentage Loss	
			Total for 25 years	Annual Average	Total	Annual Average
Dead Storage below DSL 960.12 m	38.509	29.658	8.851	0.3540	<b>22.98</b>	0.919
Live Storage between DSL and FRL	141.248	137.411	3.837	0.1534	<b>2.72</b>	0.109
Gross Storage below FRL 981.456 m	179.757	167.069	12.688	0.5075	<b>7.05</b>	0.282

The sedimentation in different storage zones of the reservoir during 39 yrs (1965 – 2004 surveys) is given below:

**Table B**

	Original- 1965 (Reviewed ) (M cum)	Survey - 2004 (Reviewed) (M.cum)	Loss of Storage (M cum)		Percentage Loss	
			Total for 39 years	Annual Average	Total	Annual Average
Dead Storage below DSL 960.12 m	38.509	24.517	13.992	0.3588	<b>36.33</b>	0.932
Live Storage between DSL and FRL	141.248	134.689	6.559	0.1682	<b>4.64</b>	0.119
Gross Storage below FRL 981.456 m	179.757	159.206	20.551	0.5269	<b>11.43</b>	0.293

# UMIAM RESERVOIR

	Reservoir		
Year of survey (Pre-monsoon)	Area at FRL 981.456m Sq. km	Capacity At FRL 981.456 m M. cum.	Loss of gross storage
1965	10.148	179.757	20.551 in 39 years (1965 – 2004)
1990	10.148	167.069	12.688 in 25 years (1965 – 1990)
2004	10.148	159.206	7.863 in 14 years (1990 – 2004)

# UMIAM RESERVOIR

Sediment Volume trapped in 39-ys		20.551 M cum (as per 1965-2004 surveys)			
Year (Pre-monsoon)	T (Yrs) from 1965	Estimate of Sediment Trapped (M cum) Eq (5.2) : $V_s = 0.68(T - 0.93)$			
		Increment in		Total Volume $V_s$	Average Rate, $V_s / T$
		Volume (A <sub>vs</sub> )	Time (AT)	(M. cum)	(Mcum/Yr)
1965	0			0	
2004	39	20.551	39	20.551	0.527
2014	49	4.823	10	25.374	0.518
2024	59	4.784	10	30.158	0.511
2034	69	4.727	10	34.885	0.506

## OBSERVATIONS :

Progressive loss of storage due to sedimentation in different storage zones is assessed as under:

Loss of Dead Storage : 22.98% in 25 yrs and 36.33% in 39 yrs, 73% in 100 yrs, 96% in 166 yrs, 100% in 213 yrs.

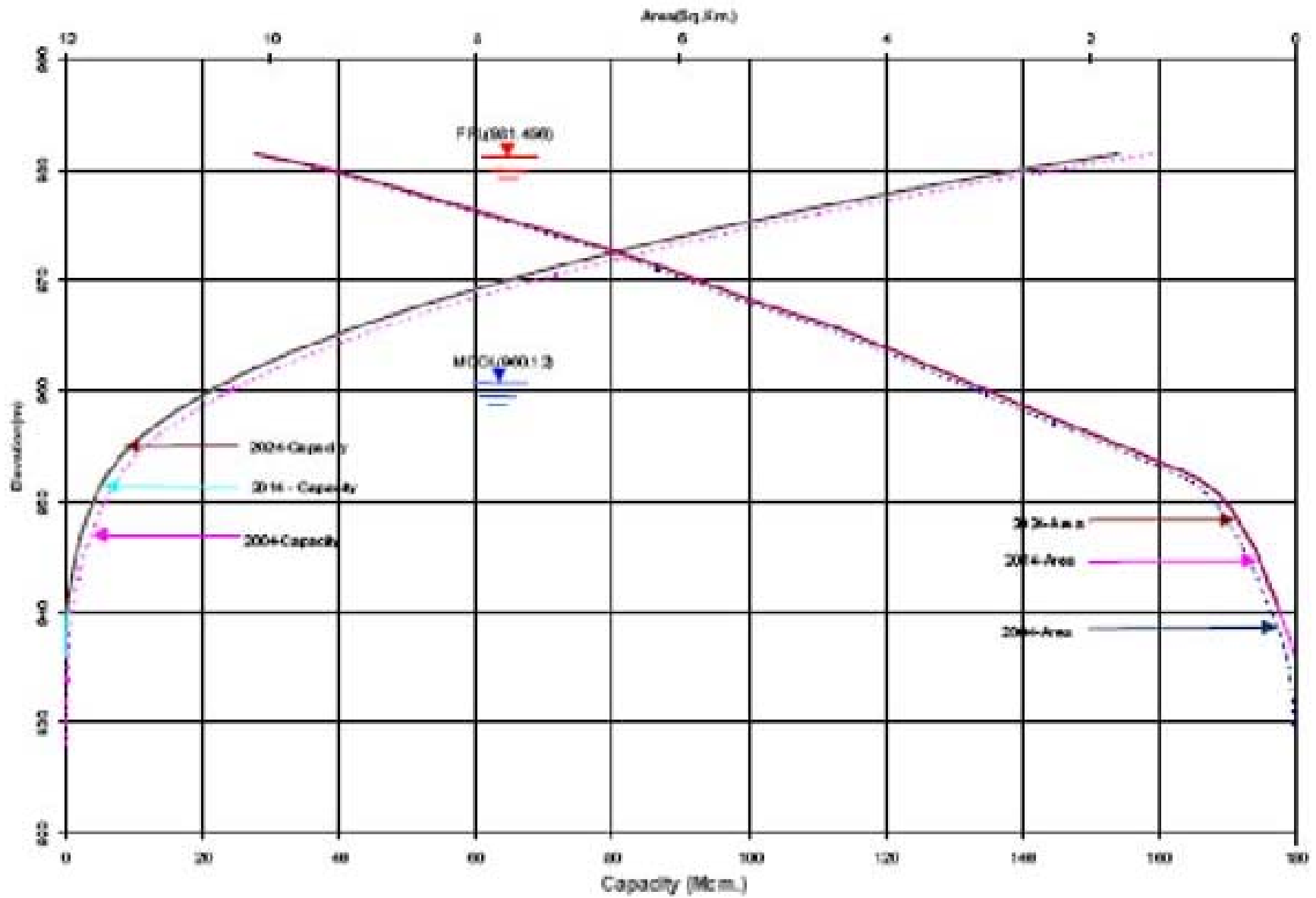
Loss of Live Storage : 2.72% in 25 yrs and 4.64% in 39 yrs, 15% in 100 yrs, 30% in 166 yrs, 45% in 213 yrs.

Loss of Gross Storage : 7.05% in 25 yrs and 11.43% in 39 yrs.

Reservoir capacities were re-worked with adjusted areas to bring uniformity in the area at FRL with all the three surveys (1965, 1990 & 2004) and elevation – area – capacity curves obtained after the effecting the corrections, are shown in Fig 3.



Figure 6.5  
Elevation-Area-Capacity Curve



# Umiam Reservoir

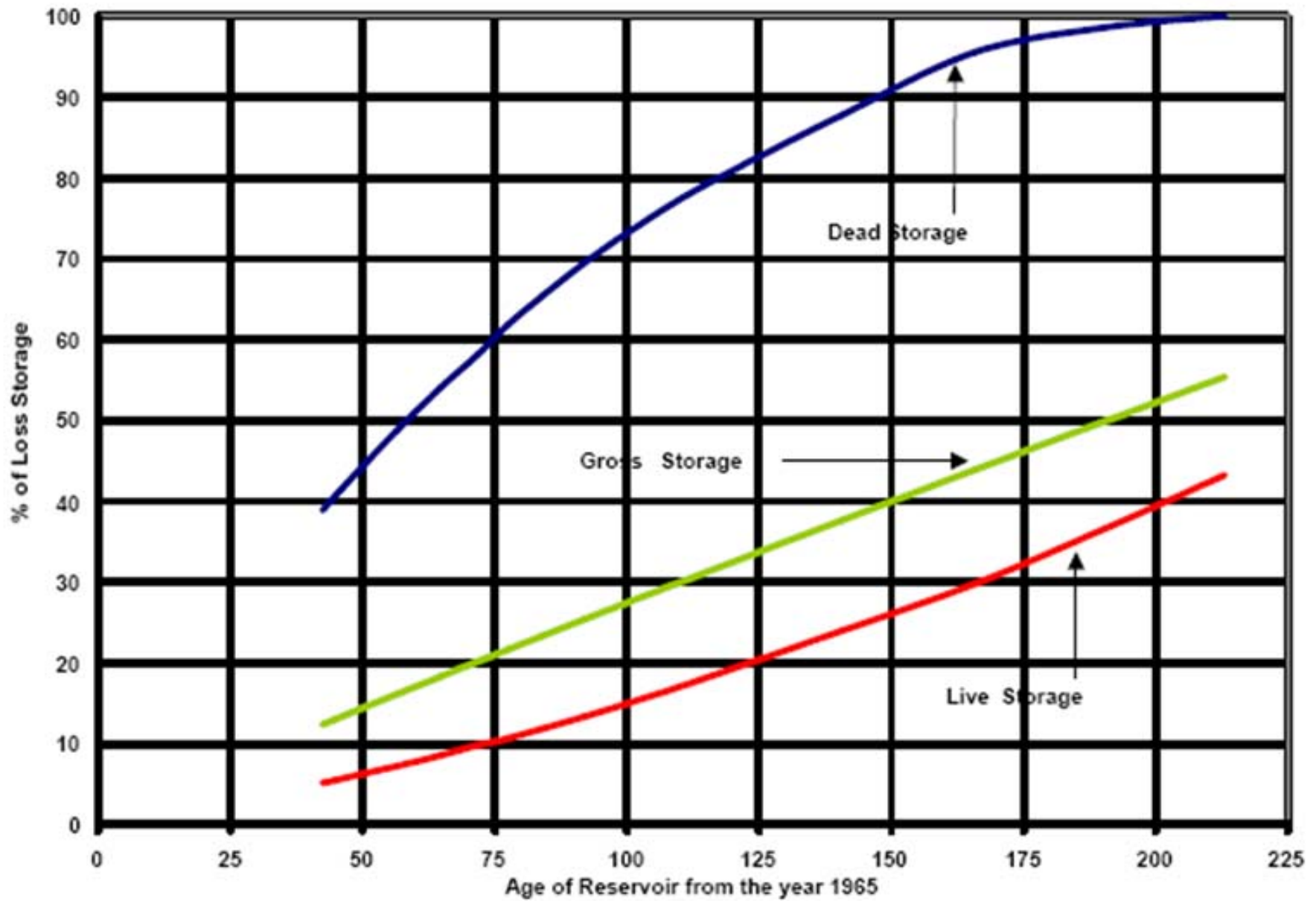


Fig 6.8 : Progressive Loss of Reservoir

## Desilting and Dredging of Reservoir:

Umiam reservoir sedimentation surveys conducted in April- May 2004 indicate that the reservoir has silted to the extent of 11.43 % of the gross storage volume of the reservoir, which comprises two components namely, 36.335 % in the dead storage zone and 4.67 % in the live storage zone. The depth of water in the dead storage zone is of the order of 44 m up to the original bed level of EL 916 m and is 38 m upto the present silted level of EL 922 m. Desilting or dredging to this depth is not technically and economically feasible. The balance life of the reservoir is more than 174 years and siltation of the dead storage zone will thus have no effect on the economic utility of the reservoir. Hence, dredging of dead storage zone is ruled out.

There are no thumb rules to decide this aspect nor there are any reservoir projects of similar nature where desiltation by dredging has been undertaken on any such large scale in the country. The present siltation is only about 4.67% of the live storage and when the siltation rate increases to about 10% of the live storage (as per the sedimentation studies (it would be about 10% in the year 2040) may be the appropriate time to undertake desiltation or dredging based on economic studies.

## **Water Quality and Pollution Control Measures:**

The development of Shillong town lead to generation of liquid and solid wastes, which found way through the Umkhrach, Umshyrpi and Umiam rivers into the Umiam reservoir. The deforestation and agricultural practices, urbanization and other soil erosion activities increased the sediment load to river waters. The sediment deposit in the reservoir and nutrients carried along threatened the useful life of the Umiam reservoir.

**Table No.2.2**  
**WATER QUALITY IN UMIAM RESERVOIR**

Parameters	Spillway	Near Left Bank	Umiam river entry	Umiam River East West	Confluence point 500 mts	Right bank	Report of ICAR lab
	WSR-1	WSR-2	WSR-3	WSR-4	WSR-5	WSR-6	
Temp of Water °C	-	16.0	16.5	17.0	17.0	17.0	23.6
pH	7.4	7.1	7.1	7.2	7.1	7.3	7.32
Conductivity $\mu$ mhos/cm	105.0	93.0	133.8	74.6	103.0	89.0	56.46
Total Alkalinity mg/L	40.0	-	-	-	-	-	29.08
Total hardness mg/L	36.0	-	-	-	-	-	28.68
Chlorides mg/L	8.0	-	-	-	-	-	-
Total Solids mg/L	80.0	80.0	170.0	79.0	147.0	89.0	-
Suspended solids mg/L	14.0	16.0	66.0	25.0	71.0	29.0	-
Total dissolved solids mg/L	66.0	64.0	104.0	54.0	76.0	60.0	28.05
Dissolved Oxygen mg/L	8.3	9.0	8.0	8.4	7.5	8.8	6.03
BOD mg/L	1.6	1.4	3.1	2.3	1.3	0.80	-
COD (Unfiltered) mg/L	8.0	6.4	20.8	11.2	14.4	11.20	-
COD (Filtered) mg/L	8.0	6.4	12.8	11.2	11.2	6.40	-
Total Nitrogen mg/L	-	1.2	2.72	1.41	2.19	1.59	-
NO <sub>3</sub> -N mg/L	0.22	0.2	0.28	0.25	0.21	0.17	-
Total Phosphates mg/L	0.72	3.11	3.48	1.72	1.04	1.21	0.063
Dissolved Phosphates mg/L	0.02	0.22	0.88	0.37	0.45	0.002	0.001
Coliform MPN	360	NIL	2300	730	1500	2300	-
Faecal mg/L	360	NIL	NIL	NIL	360	360	-

Table No. 2.3  
CHARACTERISTICS OF SEDIMENT IN UMIAM RESERVOIR

PARAMETERS	SILT SAMPLE NUMBERS													
	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10	SS-11	SS-12	SS-13	SS-14
Moisture %	23.82	31.42	29.03	32.7	47.66	50.5	52.97	24.0	58.7	29.9	72.6	61.99	67.99	48.4
Grain Size Distribution dry basis(%)														
Gravel	NIL	1.0	4.0	20.0	NIL	NIL	NIL	NIL	2.0	NIL	NIL	NIL	NIL	NIL
Course Sand	NIL	NIL	3.0	3.0	NIL	NIL	1.0	0.6	5.0	NIL	1.3	NIL	NIL	NIL
Medium Sand	31.0	57.0	50.0	33.0	6.0	13.0	10.0	25.7	27.0	2.0	43.4	25.4	43.01	2.0
Fine Sand	54.0	30.0	32.0	38.0	47.0	64.0	60.0	44.9	43.0	46.0	36.9	60.3	35.5	31.0
Silt	3.03	1.82	1.87	1.75	17.0	13.9	18.5	28.1	2.2	20.0	0.59	0.3	11.3	17.6
Clay	11.97	10.18	9.13	6.25	30.0	9.1	10.5	0.75	20.8	32.0	17.8	13.99	10.3	49.4
Sp. Gravity	2.32	2.10	2.24	2.16	1.98	2.28	2.08	2.68	2.12	2.35	1.98	2.18	2.0	2.23
Total Nitrogen Kg/Ha	1854	2390	1617	2727	3330	3519	3691	338	8925	4838	5923	3832	4348	2716
Total Phosphate Kg/Ha	912.0	1890	989	1098	2043	1216	959	367	6996	610.9	1044	1199	1284	380
Silicates-Sio <sub>3</sub> (%)	89.9	86.3	87.2	88.2	78.5	87.3	80.6	96.6	86.1	86.12	81.9	83.86	60.4	69.6
Bulk Density gm/cm <sup>3</sup>	3.45	2.36	3.54	3.64	2.6	2.77	2.71	3.42	2.56	3.45	2.4	2.58	3.11	2.86
Dry Density gm/cm <sup>3</sup>	2.79	1.80	2.74	2.74	1.76	1.84	1.77	2.74	1.61	2.69	1.4	1.59	1.85	1.93

The cost estimates for the engineering and other ameliorative measures proposed in this report is given below –

**Annex 1**

**POLLUTION CONTROL MEASURES  
Abstract of Costs**

<b>Description</b>	<b>Amount (Rupees)</b>
A Solid Waste Management Total (a)	11,251,000
B. Sewage aspects	8,000,000
C. Mass awareness and Public participation	3,500,000
D. Monitoring of water quality of rivers and Reservoirs	1,840,000
E. Retaining walls	7,675,120
<b>Grand Total</b>	<b>32,266,120</b>

**Rupees Three Twenty two lakhs, sixty six thousand one hundred and twenty only**

## ➤ **Watershed Management and Soil Conservation Measures:**

Soil conservation measures in the 17 identified directly draining sub-watersheds have been planned and designed, in a detailed manner with survey maps based on topographic surveys of the Sub watersheds. The engineering and biological measures suitable for each Sub watershed have been identified.

## ➤ **Cost Estimates**

The costs in respect of Soil Conservation Measures and Drainage Line Treatment works have been worked in full details and are given in Statements of the main report. However, in the first stage, only the costs of 10 Sub watersheds are included in the abstract of costs, as mentioned earlier. For other general items, cost have been indicated for all the 17 watersheds on the basis of rates indicated in earlier reports reviewed by us and updated for escalation based on present market value for similar items. The abstract of cost for the all the works proposed in the first stage are given below –



## COST ESTIMATES IN RESPECT OF SOIL CONSERVATION & DRAINAGE TREATMENT MEASURES

Measures	Units	Qty./Nos.	Rate (Rs)	Cost (Rs)
1.Policlinic (Godown-potato/vegetation)	nos.	6	1,200,000	7,200,000
2. Refrigeration	nos.	6	120,000	720,000
3.Agri.Implements	nos.	6	110,400	662,400
4 Distillation Centre -Aromatic oil production	nos	3	540,000	1,620,000
5.) Silt Monitoring Station	nos	4	150,000	600,000
6.) Silt Detention Dam	nos	7	532,000	3,724,000
7.) Treatment of Arable /Non-Arable Land -Conservation Method (As per Statement 1)	Hectare	555.85 Ha		10,272,928
a.) Bench Terracing				
b.) Staggered Trenches				
c.) Half Moon Terraces				
d.) Diversion Channel				
e.) Graded Stone Wall				
8.) Drainage Line Treatment (As per Statement ( 3)	Km	39.07Km		144,416,175
a.) Loose Stone Check Dam (LSCD)				
b.) Gabion Structure				
c.) Minor Masonry Structure (MMS)				
d.) Earthen Dam				
e.) Earthen Dam with Pipe outlet				
f) Farm Pond				
8 Afforestation in all subwatersheds (As per Statement 7)	ha	1384 ha	8,000	11,072,000
9 Pasture Development in all subwatershed as per Statement 7	ha	272 ha	8,400	2,284,800
10 Aromatic cover Crop Java Citronella in all subwatersheds as per statement 7	ha	485 ha	6,000	2,910,000
11 Road Forest /Road Erosion in all sub watersheds as per statement 7	km	41 km	200,000	8,200,000
12 Mining Spoils/ Quarry in subwater sheds-U 6.1& U 13.4	ha	12 ha	30,000	360,000
13 Land Slides in 12 subwatersheds as per Statement 7	km	22 km	60,000	1,320,000
			<b>TOTAL</b>	<b>195,362,303</b>

**Rupees nineteen crores fifty three lakhs sixty two thousand three hundred three only**

*Note: For details of Statements 1 to 7 refer Report Volume 4 "Report on Watershed Management Measures for Umiam Reservoir"*

# CONCLUSION

- ❖ The primary purpose of the above stated study done by MeSEB was to ascertain if the siltation in the reservoir is likely to create any problem in the continued operation and maintenance of the Umiam Barapani H.E. Project. The study has established that the reservoir has a life of over 200 years and concluded that it is not a problem at all for MeSEB.
- ❖ As an adjunct to this study, it was also ascertained as to the status of the pollution of the lake from the two major rivers Umkhrah and Umshyrpi, which contribute to the inflow into the reservoir. Since the two rivers flow through the city of Shillong it was recognized that any remedial measures to be taken to reduce the pollution of the rivers would be the **responsibility of the Municipal Corporation of Shillong** and the **State Pollution Control Board** who have also done some studies and undertaken some measures in the past to solve the city's pollution and sewerage problems. Hence, any **measures suggested in the report got prepared by MeSEB** is only to help the **Corporation to formulate its long term plans**. MeSEB's report only provides short term measures, which also need to be undertaken by the Corporation in consultation with the Pollution Control Board. The estimated provisions made in the reports prepared by MeSEB are for the use of the Municipal Corporation who has to implement them.

❖ Also, since the silt contributed by the highly degraded catchment of the reservoir affects the life of the reservoir, it is essential to undertake some water shed management measures to arrest the silt flow to the extent possible. This work is again the responsibility of the State Forest Department and Agricultural Department under whose jurisdiction the catchments falls. **The main measures suggested in the report only enhance the life of the reservoir beyond the 200 years life assessed as per the study.** This is again optional and left to the **Forest Department and Agricultural Department** to undertake the measures suggested in the **MeSEB reports** as first step before **long term measures** are identified.

❖ **The report also establishes that dredging is not required both on technical and economic grounds.** As the life of the reservoir assessed as per surveys and study is **213 years** (time taken to completely vitiate the dead storage) there is no need for MeSEB to do any thing with the problem of siltation but **request the concerned department of Forest and Agriculture to undertake measures of water shed treatment to further enhance the life of the reservoir.** Pollution of the lake water is a problem but the solution to this problem lies within the city of Shillong, which again is under the control of Municipal Corporation of Shillong and MeSEB has no locus standing in implementation of the measures. Although the report establishes that it is not a problem for MeSEB for operation the reservoir, however to keep the beauty and enhance the life of the lake, the measures suggested in the report should be undertaken by the Forest Department and Agricultural Department of the State Govt. of Meghalaya.

The image features a vibrant blue background filled with a dense pattern of water droplets, creating a fresh and clean aesthetic. At the top, there are stylized, wavy lines in shades of cyan and blue, suggesting a sky or a breeze. Centered in the lower half of the image is the text "Thank You" rendered in a bold, 3D, sans-serif font. Each letter is a different color, following a rainbow gradient: 'T' is red, 'h' is orange, 'a' is yellow, 'n' is light green, 'k' is lime green, 'Y' is dark green, 'o' is teal, and 'u' is dark blue. The letters have a slight shadow, giving them a three-dimensional appearance as if they are floating above the droplets.

Thank You