PART - 1

SUMMARY AND AGENDA FOR ACTION

1. SUMMARY AND MAJOR FINDINGS

1.1 Rainwater Harvesting

- Water is one of the most common substances on our earth. But urban areas face a shortage of water and require an alternative source to bridge the gap between demand and supply. Rainwater would be an immediate resource to augment the existing water supply systems by "Catching water wherever it falls".
- Traditional Water Harvesting in Karnataka underlines the importance of step wells, lakes, tanks, channels, etc., as water storage bodies, the basic purpose of which was to establish a chain of water storage structures. However, a vanishing "Lake Culture" due to urbanization and industrialization has caused these systems to be neglected.
- The two hundred and sixty two tanks/lakes that were present in 1960 have been reduced to eighty-two, and less than ten have water in it.
- To make Rainwater Harvesting (RWH) a success, one should have a thorough knowledge of the following: geographic location; climate; geology; soil; landuse; water requirements; existing water supply system; cost of water; systems & forms of RWH and the potential of harvesting rainwater.
- RWH has the following unique advantages
    - Capturing rainwater in situ and augmenting water supply at a marginal cost
    - Replenishing groundwater through recharging of rainwater by using the soil column
    - Reducing pollution and contamination.
    - Reducing the water bill for the exchequer.
    - Providing clean and safe water.
    - Least capital investment with maximum benefits at household as well as city levels
- The demerits of RWH are
    - It is dependent on the monsoons and intensity of rainfall.
    - It depends on intensive participation from house level to the city level.
    - It is only a supplementary source and cannot replace the existing supply system completely.

1.2 Water supply in Bangalore City

- Bangalore has no perennial river passing through the city and hence it has to either import water from far away places or use groundwater.
- The major source of water for Bangalore City is imported from the Cauvery River situated at a distance of 95 km. The water from this source is at a lower elevation and is pumped to a height of 500 m. The other sources are the Hessarghatta and Thippagondanahalli reservoirs.
- These sources are insufficient to meet the demand completely. In addition to these sources, the city has a number of bore-wells, the overexploitation of which is depleting the groundwater. It has been estimated that nearly 40% of the population is dependent on groundwater.

- The design capacity of the three sources (existing and proposed) is 1494 MLD still leaving a gap of 209 MLD for the year 2011. This availability is dependent on the monsoons and the functioning of the pumps (In 1995-96 there was a reduction in supply of 20%).
- If for any reason the water imported from the Cauvery is stopped (which is quite possible considering the recent incidents between Mandya / Mysore as well as the interstate and inter regional disputes), Bangalore, which is so heavily dependent on this source, would be severely affected.
- The current production cost of water is about Rs.12 per kilolitre by the BWSSB. This may increase to Rs.45 per kilolitre with the implementation of the Cauvery IV Stage Water Supply Scheme.

1.3 Rainfall in Bangalore

- Bangalore receives rain from the southwest and the northeast monsoons. The southwest monsoon has an average of 34 rainy days and the northeast monsoon has 14 rainy days.
- The annual average rainfall in the study area is 846 mm. This has been studied for a hundred-year period and a steady increase in the rainfall has been observed.
- The rainfall in the city compared to its peripheral area shows an increase of around 100 mm due to “Heat Island Effect” and “Cloud Bursts”.
- In spite of increased rainfall, the Thippagondanahalli reservoir is not getting filled up to its capacity. This could be due to urbanization disrupting the natural drainage pattern. This is of great concern for an expanding city with shrinking water storage.
- The city experiences rainfall for a period of 8 months from April to November with around 60 rainy days in a year. In these 60 days the rainfall is more or less systematic and occurs between 4 p.m. and 7 p.m.
- The soil and water balance charts studied for a period of 3 decades show a clear moisture deficit phase, which is favourable for RWH.
- Around 80% of the annual rainfall occurs during the 6 months between June and November. The maximum intensity is in the month of September in all parts of Urban Bangalore.
- The intensity of rainfall is also seen to increase from the Southeast to Northwest part of the project area by nearly 100-mm i.e., from Sarjapur to Doddaballapur side.
- The potential months for Rooftop RWH are given in the following table.

Table 1.1: Potential months for RWH

Potential for RWH	Months	Monthly rainfall
Lean months	Jan, Feb, Mar	Below 10 mm
Low potential months	April, Dec	10 to 50 mm
Moderate potential months	Jun, Nov	50 to 100 mm
High potential months	May, July, Aug, Sept, Oct	100 to 200 mm

1.4 RWH potential in Bangalore

- The high rainfall of 846 mm spread over the year, the geological structure with its weathered mantle, the physical and chemical properties of the soils, the terrain with its undulating landscapes, the drainage with its radial pattern and innumerable number of lakes scattered all over the city, are all a GIFT OF NATURE for Bangalore in terms of RWH.
- Soil plays a vital role in the removal of many of the contaminants of roof water and stormwater when it is allowed to recharge into soil column. Many of the organic

pollutants e.g., sewage, manure, sullage effluent & organic biocides, and other toxic heavy metals are safely adsorbed or fixed. Even the major pollutants like phosphorus and nitrates, which are not removed in treatment plants, are safely removed.

- The Comprehensive Development Plan (CDP) for Bangalore covers an area of 1279 sq. km. This consists of residential, commercial, public & semi-public, industrial, parks & open spaces, transportation, unclassified, spotted development and green belt areas. It is seen from the table below that the total incident rainwater is 2964 MLD.

Table 1.2: Rainwater incident on various landuses

Landuse		**Sq. km**	**MLD**
Residential	(19.1 %)	243.69	565
Commercial	(1.3 %)	16.44	38
Industrial	(3.0 %)	38.44	89
Public & semi public	(6.1 %)	77.88	181
Parks & open spaces	(3.8 %)	49.09	114
Transportation	(9.2 %)	116.97	271
Unclassified	(1.7 %)	22.14	51
Spotted development	(2.5 %)	32.35	75
Green belt	(53.3 %)	682.00	1581
Total		**1279.00**	**2964**

Note: 846-mm average rainfall

- Expert opinion is that 5-15% of the total rainwater incident can be harvested in an urban area through intensive efforts at all levels. The water that can be augmented through RWH would therefore be between 150 MLD and 450 MLD for Bangalore.

1.5 Forms and methods of RWH in the Bangalore context

- Rooftop RWH from buildings of different uses – residential, commercial, industrial, etc.
- Runoff RWH from landscapes, open fields, parks, stormwater drains, roads, pavements and other open areas, green belts, etc.
- Natural storage and collection through Lakes and Tanks.

Table 1.3: Methods of RWH

Source Components of RWH	**RWH Tools and Techniques**
Residential plots	1, 2, 3
Commercial plots	1, 2, 3
Layouts	2, 4, 5
Industrial plots	1
Hospitals	1
Public and semi-public areas	1, 2, 3
Parks and open spaces	1, 2, 3
Lakes and Tanks	5
Highways, avenues and low-lying areas	2, 4
Green belt	2, 3, 5, 6

1. Underground sumps / Ground level tanks / Above ground level tanks
2. Percolation pits / trenches
3. Percolation through wells and borewells
4. Underground galleries
5. Storage in natural lakes, ponds and tanks
6. Check dams

1.6 Rooftop harvesting

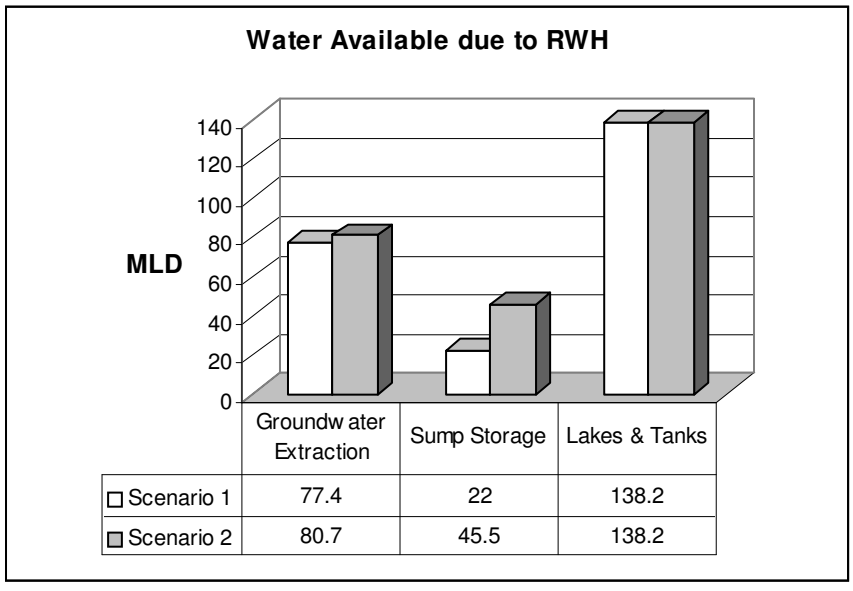
- The parameters influencing rooftop RWH are rainfall quantity, rainfall pattern, collection surface, storage capacity, daily consumption of water (lpcd), number of users, cost and alternative sources of water.
- A significant portion of the city is built-up and can be put to good use by storing rainwater or by recharging aquifers. This would reduce the stormwater discharge and consequent flooding of low areas.
- Rooftop RWH in Bangalore can provide an average of 77,600 litres per year from a roof surface of 100-sq m, which would meet the demand of a household of five for nearly a third of the year and is also cost effective.
- The water collected from rooftops of industries and hospitals need to be planned carefully to eliminate the possibility of toxic pollutants leaching into the ground.

1.7 RWH from paved and unpaved areas

- RWH at a layout level can use the Cascade Capture Method i.e., rainwater from rooftops can be harvested on the plot for storage and groundwater recharge followed by percolation for groundwater recharge in streets, open spaces and low lying areas. The runoff then can be channeled into lakes or tanks. The steps that need to be adopted in a layout are contour mapping, defining a drainage pattern, determining a storage point/outlet point and incorporating it into the landuse, ensuring segregation of sewage/sullage from stormwater runoff and treatment of non-point sources of pollution and storage/disposal.
- In a similar way, Bangalore has large institutions, industries, public and semi-public areas that can be utilised for RWH from rooftops as well as paved & unpaved areas.
- There are more than 200 parks in the city where rainwater could be collected by RWH structures to retain soil moisture and to increase the recharge capacity of the existing borewells in parks.

1.8 Likely harvested rainwater available in Bangalore

- The volume of harvested water available under two optimistic scenarios varies from 235 MLD to 265 MLD under existing conditions.



1.9 Changes in Byelaws and development rules

Amending the building byelaws and license sanction rules and regulations of development that make it mandatory for individuals to integrate RWH into their residential, commercial or industrial plots need to be done for successful implementation of RWH in the city.

1.10 Budget for RWH

If RWH is to be adopted at a city scale successfully, the cooperation and budgeted action of several institutions becomes necessary. The budget required for effective RWH for Bangalore Metropolis may cost Rs. 300 crores.

1.11 Group Meetings

A professional group meeting was held on 26th May 2000 at M.S. Building, Government of Karnataka and the major findings and agenda for policy action were discussed. The revised and approved version is presented in Chapter 2. The study report was also reviewed by experts and deliberated in different in-house expert group meetings.

2. AGENDA FOR POLICY, STRATEGY AND ACTION

2.1 Policy Measures

1. Revive traditional Rainwater Harvesting Management (RWHM) methods - It is important to protect and revive the lake culture of Bangalore to their full potential.
2. Recognize RWHM as a supplementary and renewable water source in towns and cities - A healthy mixture of the small and traditional, along with the large and modern is needed.
3. Integrate and internalize RWH in the development and construction process from individual houses to multipurpose landuse developments including industry, commerce, institutions, etc.
4. Establish or create an institutional mechanism to plan and implement RWH in the city.
5. Involve and encourage community, private and public/government sector participation through incentives, subsidies and awareness programmes.

2.2 Strategy

1. Evolve RWHM plans at city and state urban level (10 year plan and programme) - The priority regions for RWH should be areas those which have a high intensity of land degradation and low productivity areas. RWH should be taken up together with measures for good land and biomass management. Master Plans for each urban zone, wherein rainwater catchment areas are clearly demarcated and should be left undisturbed or protected need to be prepared. These catchments can be used for afforestation by the forest department or can be transferred to the forest Department as an Urban Sanctuary or Protected area, so that its landuse cannot be changed without government approval.
2. Develop plans to implement different forms of RWH and make it mandatory.

a) Rooftop RWH – for larger plots
b) Capturing storm water run off
c) Rooftop and water run off RWH for larger institutions, parks and playgrounds, public and semi-public areas – As these areas are well spread out make them as demonstration units.

3. Revive tanks and lakes for RWH - It is not just important to promote RWH projects. It is equally important to protect and revive, to their full potential the existing water harvesting structures and systems.

4. Introduce RWH as a component in the city budget.
5. Training NGOs, CBOs and government officials on the methods of RWH - It is important to educate the political leaders, NGOs, CBOs and government officials of not only about the potential but also of the methods of community and household-based RWH.
6. Set up rainwater quality monitoring at various places in the city to develop a quality & quantity database – Research on the health effects of rainwater and monitoring the quality and quantity of rainwater has to be followed on a regular basis.
7. Institution of awards to persons and communities for outstanding RWH efforts
8. Strict guidelines have to be laid down for installation of borewells including the amount of withdrawal of water from the same. Strict monitoring should follow this. Guidelines for recharging the tube wells through rainwater need to also be formulated.
9. Creation of a RWHM Cell / Wing in the Department of Ecology and Environment at the State level.

2.3 Action Programme

1. Make rooftop RWH mandatory in larger urban buildings and dwellings by suitably amending byelaws and by providing incentives or subsidies for adopting RWH by all urban dwellings.
2. Construction of 1000 RWH demonstration units in Government/public buildings like schools, colleges, complexes, hospitals, layouts & dwellings and giving wide publicity.
3. Rejuvenating existing lakes and tanks through planned RWH within a time span of 5 years.
4. Integration of RWH in maintenance budget of BCC/BDA to cover all parks with RWH structures like percolation pits/dispersion trenches/well recharge.
5. Launching a campaign with industries, public sector undertakings and institution to start RWH.
6. Incorporation of RWH in all future road & storm water drain works. Incorporate RWH as part of maintenance works.
7. Targeting the green belt area for RWH and preservation of all ponds/lakes/tanks/wells in this area & to recharge them.
8. Putting in place legal provisions to stop commercial and non-sustainable exploitation of groundwater. All future wells/bore wells to mandatorily have recharge provisions.
9. Organisation of a series of training programmes for architects, engineers and other professional on RWH.
10. Organisation of a mass awareness programme on RWH involving GOs/NGOs to generate demand from new buildings as well as old buildings.
11. Development of Information, Education and Communication (IEC) material for publicity through various media. Bringing out posters, booklets in Kannada and English for distribution.
12. Providing a token subsidy/low interest loan for RWH.
13. All future Government buildings as well as private buildings with more than 2500 sq. ft floor area should have RWH systems and make it mandatory under building bye-laws or licensing and regulation rules by various departments.
14. Integration of RWH in the new CDP exercise slated for the year 2001.
15. An annual budget of Rs. 30 crores may be provided for RWH by the major stake holders in the government and public sectors.

2.4 Role of Public/Government, Private Sectors and NGO's

Public/Government Sector role

1. Incorporating into policy and design a healthy mixture of the small and traditional, along with the large and modern by all govt. departments is needed.
2. The government should be perceived by the people as a promoter of water supply systems (both traditional and modern) and not as a munificent provider of water. A gradual shift to economic costing of water reflecting true costs of its provisions should be the objective.
3. The need for the community to feel a sense of ownership, responsibility and involvement in the management of the systems is necessary for their success.
4. Protection of water bodies
5. Master plans for each urban zone should be prepared identifying clearly possible area of aquifer recharge. Necessary assistance from the mines and geology department of the GOK and from the Central Ground Water Board should be taken.
6. Provide technical and engineering advice on structures and systems.
7. Policy changes in the building bye-laws to make RWH mandatory and limit the extent of paved area in a plot.
8. IEC - The best thing about RWH is that households and communities can get involved in increasing and managing their water supply. Thus, RWH has the potential to become a mass movement.

Table 1.4: Role of Various Agencies, Organisations and Institutions

Agencies / Organisations / Institutions	Type of Development	RWH Methods
A. Central Government		
1. Research institutes	1, 2, 3	a, b
2. Defence	1, 2, 3	a, b, c
3. P & T	3	a, b
4. Railways	1, 2	a, b
5. Others	1, 2, 3	a, b
B.State Government		
1. PWD	1, 3	a, b
2. Forest Department	2	b, c
3. Minor Irrigation Department	2	c
4. KHB	1	a, b
5. Police Department	2, 3	a, b
6. Others	1, 2, 3	a, b
C. City level/Quasi government		
1. BMP	1, 2, 3	a, b
2. BDA	1, 2, 3	a, b, c
3. BWSSB	2	Diverting & treating sewage
4. TMC/CMC	1, 2, 3	a, b
5. Others	1, 2, 3	a, b
D. Other large Institutions		
1. IIM	1, 2	a, b
2. IISc	1, 2	a, b
3. UAS	1, 2	a, b
4. Bangalore University	1, 2	a, b
5. Others	1, 2	a, b

1. Townships / residential layouts
2. Open spaces
3. Buildings – residential & industrial

a. Rooftop harvesting
b. G.W. recharge
c. Storage in Lakes & Tanks

Private Sector Role

1. Independent of legislative mechanisms from the Government, individuals and groups can take up RWH for houses, apartments, institutions and industries. Increased awareness and information will enable people to take up RWH on their own.
2. Private consultancy, which provide detailed analysis and design for RWH are likely to emerge and should be facilitated.

Role of NGO's

Individuals and local NGOs can easily take up the work of increasing awareness, educating people and mobilizing local action. The aim is that community self-reliance is increased while dependence on the State is reduced.