

PREFACE

NCT Delhi constitutes a small sub-basin of the Yamuna river. The city is greatly dependent on external water resources having little of its own. The city is economically vibrant, being the economic engine of north India, and thus attracts many migrants resulting in a rapid population growth and commensurate demand for water.

So far NCT Delhi has focused on augmenting supplies from distant basins [the last augmentation being from Tehri Dam in 2006], plundering its aquifers, fire-fighting summer crises, showing indifference at the first sign of monsoon showers and generally engaged in service related and billing issues.

There has never been a comprehensive strategic approach to the water sector. In 2011, Delhi Jal Board CEO Shri Ramesh Negi, initiated the task of formulating a water policy for Delhi with the objective of ensuring water security for Delhi in the face of an uncertain resource scenario. Without a policy the water sector actions in Delhi will remain flavoured with ad hocism with changes in CEOs and political governance.

The draft document was deliberated in 3 workshops where non-govt. experts, concerned NGOs, RWAs participated. In January, 2015 the document was posted on DJB website inviting public comments. Further, a fourth and final workshop on 10 September, 2015 was inaugurated by Hon. Chief Minister, Delhi, with participation from various govt. agencies and civil society organizations. Comments were invited from interested parties through newspaper advertisements. While these were welcome it is clear that there is a great need for water literacy at all levels.

Subsequent to all inputs the final policy document is presented in the following pages. It may be stated that this is not the end of the matter. The policy, to be effective, needs to be detailed for implementation through the deliberation of relevant sub-groups. Policy implementation brings results in the long run. The process requires consistent support at the political level. Otherwise the policy would be remembered only at the time of crisis and then forgotten. Let us remember the wise saying :

“ DON'T DIG A WELL WHEN YOU ARE THIRSTY”

CHAPTER I :**CONTEXT**

- 1.1. Water is the prime determinant of the sustainability of urban regions. The era of surplus river basins, high water tables, generously yielding under-exploited aquifers, plentiful dispersed water availability, certainty of supplies and conservative lifestyle is fast transforming into an uncertain future with galloping demand, consumptive lifestyles, emerging limits of available supplies, mindboggling infrastructure constraints, drying rivers and aquifers, competing users contesting the appropriation of the finite resource. Thus, in the last 100 years world population has tripled whereas demand went up by 6 times and UN statistics show that every 20 years demand for water is doubling. The times are marked with international tensions over trans-boundary rivers and aquifers, inter-provincial disputes, urban rural conflict and fierce inter-sectoral competition.
- 1.2. Climate change and global warming are just the latest entrants to a long list of variables that may enhance the temporal and spatial variation in resource availability. All forecasts point towards increasing water stress with exploding demand, especially urban, putting pressure on unevenly distributed, limited and increasingly variable resources. The IPCC [Inter-governmental Panel On Climate Change] report on receding glaciers, adverse effect on river flows, changing rainfall patterns with a trend towards extreme events is a pointer towards emerging challenges requiring deeply considered responses.
- 1.3. Additionally, the over-abstraction of water resources [both surface and sub-surface] is adversely affecting ecosystem functions and resource sustainability. River base flows in lean season and monsoon driven flood water recharge of floodplain aquifers have declined. River ecological functions have been affected with conditions no longer conducive for aquatic and riverine habitats negatively affecting a host of organisms and consequently their river cleansing function as well.
- 1.4. The 2030 Water Resources Group's report of 2009 "Charting Our Water Future" puts it succinctly — 'The ever-expanding water demand of the world's growing population and economy, combined with the impacts of climate change, are already making water scarcity a reality in many parts of the world and with it we are witnessing severe damage to livelihoods, human health, and ecosystems.' 'In just 20 years', this report shows, 'demand for water will be 40 percent higher than it is today, and more than 50 percent higher in the most rapidly developing countries. Historic rates of supply expansion and efficiency improvement will close only a fraction of this gap. Unless local, national and global communities come together and dramatically improve the way we envision and manage water, there will be many more hungry villages and degraded

environments and economic development itself will be put at risk in many countries.’ A sobering picture indeed. The report goes on to say — ‘By 2030, demand in India will grow to almost 1.5 trillion m³, driven by domestic demand for rice, wheat, and sugar for a growing population, a large proportion of which is moving toward a middle-class diet. Against this demand, India’s current water supply is approximately 740 billion m³. As a result, most of India’s river basins could face severe deficit by 2030 unless concerted action is taken, with some of the most populous - including the Ganga, the Krishna, and the Indian portion of the Indus - facing the biggest absolute gap.’

1.5. India is becoming an increasingly urban society. Even as the population has climbed to over a billion its distribution is changing in favour of urban centres. The 17% urban population of the 1951 population census figures have grown to 40% urban of a much larger population in 2011. By 2030 it is projected that the urban population would have grown to 600 million from the present 400 million. The enormous numbers involved have serious implications for the viability of our present model of milking rivers and mining groundwater, for environmental and economic sustainability and for heightened conflict potential.

1.6. The per capita water availability [in India] which was 5000 cu.m. per capita per annum in 1947 has declined to 1500 cu.m. per capita per annum [whereas 1700 cu.m. per capita annually is considered the threshold below which a society is considered to be water stressed]. At the same time an increasing percentage of the urbanizing population is benefitting from rising incomes with a resultant better standard of living thereby requiring greater supply of water. Consequently, the surface water sources [rivers and lakes] as well as groundwater resources are coming under abstractive pressure. **Many rivers are now reduced to drains with a trickle of a flow and some experts say that “we may be the generation that killed the rivers”.** In a business as usual scenario the future will be characterized by :

- Urbanization will require conveyance of water from large hinterlands and longer distances to population centres at enormous costs. Hydrological footprint of cities will get stamped on ever larger supply hinterlands milking distant basins constraining development of those regions and generating conflict scenarios
- Large volumes of water supply would in turn generate large volumes of sewage. The treatment alone would require large capital costs, scarce land allocations and continuous fossil fuel based energy. Demand would always outstrip infrastructure provision with the net result being pollution of rivers and aquifers.
- River flow regimes and riverine eco-systems, already under immense stress due to over abstraction, will fall below the threshold of e-flows required to sustain ecological services

- Aquifers, already depleting, will be exploited unsustainably and unscientifically to close the demand-supply gap whilst altering the chemical composition of the soil towards infertility
- Competitive land hunger would outweigh the benefits of wetlands and target them for reclamation decreasing storage, recharge and ecological functions
- Conflict between domestic, industrial, irrigation, urban vs. rural sectors for finite resource will sharpen
- Conflict between states over interstate river water use would rise with increasing resort to unilateral action [abrogation of water agreements by Punjab and its recent attempt to destroy the SYL canal] and Inter State River Water Dispute Act with volatile protest spilling into the street
- Lack of access to resource for the depressed socio-economic strata would result in social conflict especially when cost recovery and profit based service models are gaining popularity with decision makers
- River linking schemes and large dam building activities will get positive consideration despite their known environmental and monetary negatives outweighing the positives and thus leading to societal confrontation
- Whereas earlier drought affected people from the countryside migrated to cities the cities themselves would now also be vulnerable to drought

Issues of NCT Delhi

1.7. The NCT of Delhi, which is the largest metropolis in north India, has undergone explosive demographic expansion increasing pressure on water sources in various river basins in north India as well as on its internal groundwater resources. The small city state is high on consumption [with an insatiable demand], low on internal resource and high on external dependence [mainly dependent on river Yamuna, Ganga, Bhakra Beas system - all snow fed northern rivers]. Delhi has limited options to influence developments outside its boundary. With restricted sources of supply, no addition to its supply is expected for at least next 10-15 years.

1.8. The McKinsey Global Institute report [April, 2010] on urbanization in India projects Delhi's population [16.7 million in 2011 census] in 2030 at 26 million. The city, which presently just about manages to meet its water demand, is likely to face increasing water stress under a business as usual scenario.

1.9 **Concern for water security in Delhi has picked up from a nascent stage in the last decades to a centre stage issue in recent years.** As the NCT advances towards the 3rd decade of the 21st century it faces the daunting challenge of meeting rising demand in the face of rapidly changing externalities — erratic rainfall, decline in river flow, uncertainty of dam based

resource augmentation, declining groundwater output, reduced water for environmental flows, unmet demand, increasing friction with riparian states.

1.10 Business as usual trends are insufficient to close the demand – supply gap and therefore no longer an option. Historically, the focus for most public authorities in addressing the water challenge has been to consider additional supply. **With narrowing external choices supply side planning is reaching its limits. The challenge of ensuring enduring water security in a climate of multi-faceted uncertainty requires a long term perspective, considering long term variables of low predictability, in order to satisfy demand while managing this critical resource in a wise and sustainable manner.** The water sector is becoming increasingly complex. Water security is no longer a simple matter of supply side management but has come to acquire multiple dimensions. It now requires:

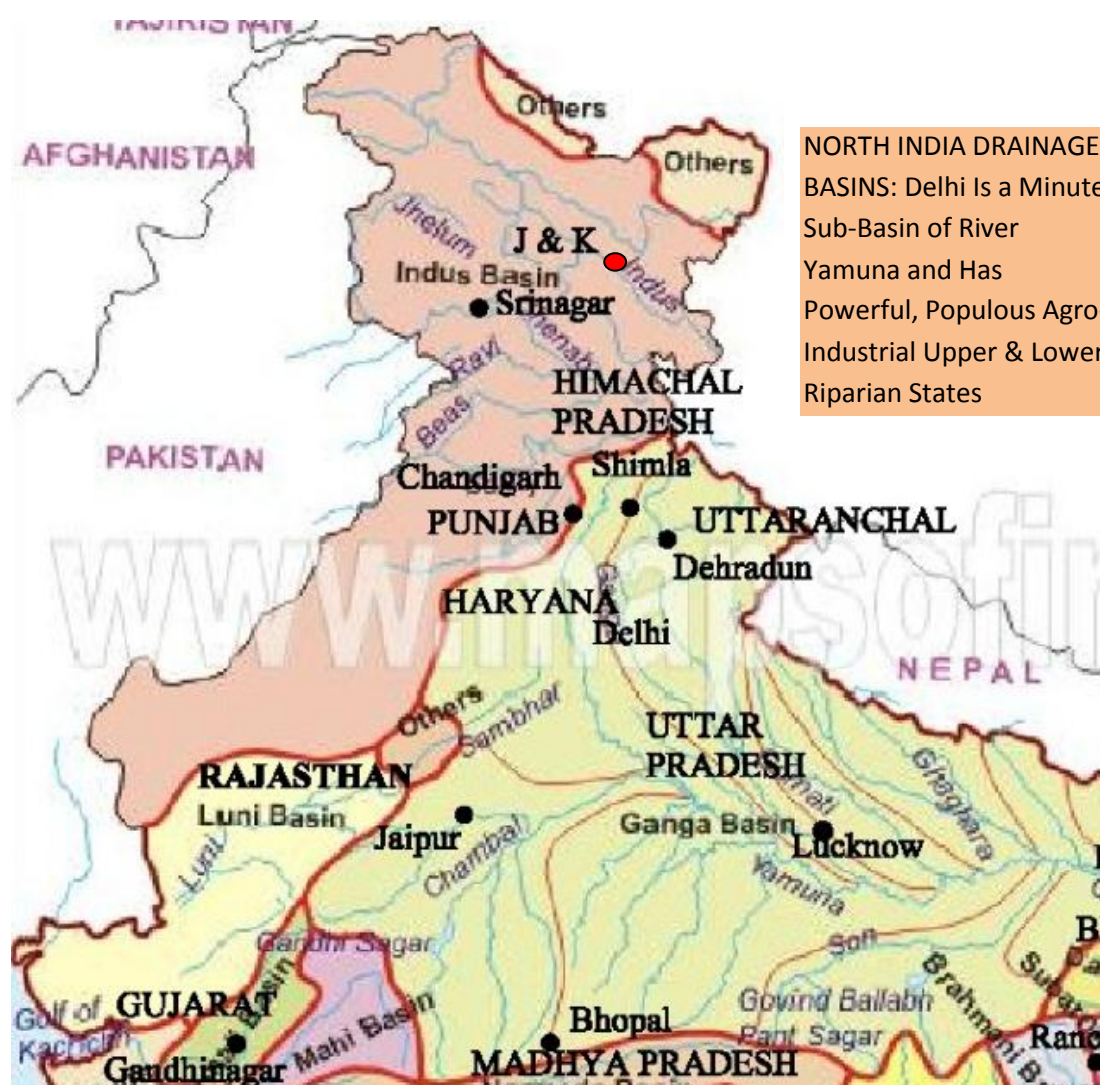
- ensuring affordable and adequate water supply to all sections of the population/sectors
- careful balancing between development and environment
- ameliorating political conflict between increasingly assertive upper and lower riparians
- financial sustainability
- equity in distribution spatially and amongst economic classes [range in Delhi is 20 lpcd – 450 lpcd]
- sourcing new supplies from distant basins in the face of increasing local resistance
- negotiating regulatory factors, institutional & constitutional requirements
- addressing issues of demand management and efficiency
- incorporating technological innovation
- above all ensuring long term water availability in the face of variable supplies

1.11 For far too long NCT Delhi has been drifting along without a strategic approach, depending on the Central Govt. and the Supreme Court to bail it out in crisis. The recent Jat agitation [Haryana, Feb., 2016] has demonstrated Delhi's vulnerability to external pressures, the fragile nature of its dependence on external sources and on the mercy of upper riparians. What if, in the course of political turmoil, Punjab was to similarly disrupt Delhi's supplies? What if both states disrupted Delhi's supplies simultaneously and during peak summer? What if, due to climate change, the flow in Yamuna declines?

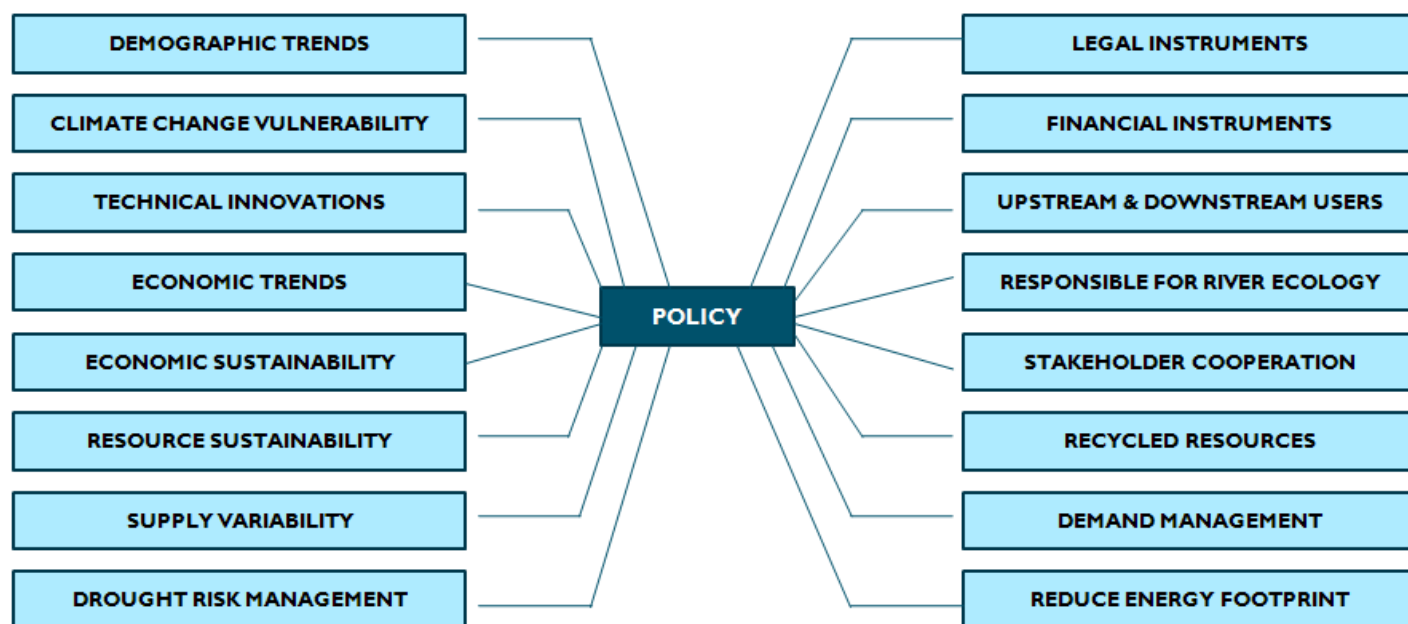
1.12 But with the passage of every crisis and every summer decision makers forget the long term and address the short term fire-fighting and service issues. Insuring

Delhi against debilitating water shortages by ensuring future water security demands implementing a policy based approach.

- 1.13 **Policy** is the set of guiding principles directing the actions of an organization arrived at through the exercise of wisdom, foresight, prudence and sagacity. **Policy formulation** involves assessment of long term trends in resource availability, demand and usage pattern priorities within and without Delhi. It also involves careful identification of issues, long term objectives, evolution of a futuristic outlook and alternative scenario generation, evaluation of technological, financial, urban and social policy trends and options, legal and constitutional considerations, environmental responsibility. **The long term important things which must be commenced today must get equal priority as urgent works and fire-fighting..**



1.13 The robust policy thus formed would lay out directions and priorities for successive governments, insulated from political change, unaffected by preference variation resulting from leadership subjectivity or lack of institutional coordination, capable of accommodating emerging trends and technological innovations. The policy thereafter becomes a guide to priorities and resource allocation. Thus, policy making must consider the following components:



1.13. The National Water Policy [2002] mandated each state to formulate its own water policy in consonance with local conditions within a period of 2 years. Several states have formulated their water policies and there are several international cases of area specific water policies which can be examined for their applicability in Delhi.

1.14. A shift in mindset is required. Hydrological sensitivity in planning, a hallmark of our historical settlements, departed as a result of a sense of technological mastery over nature. Thus settlement planning could be divorced from the natural resource base as technology made it possible to mine aquifers and milk distant basins to sustain unheard of population concentrations. Increasing conflict over resource sharing must make all settlements look inwards.

1.15. India is a vast country with nearly 8000 urban settlements with extreme variation in its regional resource endowments [topographic, climatic, surface waters, groundwater, and population distribution and income levels]. In addition capabilities for collection and treatment of sewage are concentrated in a few metropolitan areas and there also the coverage is far from

complete. The levels of water usage also vary with the level of affluence of a particular settlement. And even within a large urban area there is a wide geographical variation in resource availability and use. There is little scope for a universal policy and the same strategy cannot work everywhere.

- 1.16. Presently, Delhi does not have a water policy. While DJB is the organization with the largest mandate in Delhi's water sector, it does not have the sole and exclusive mandate. There are several organizations and factors within and without Delhi which have substantial influence, directly or indirectly, over Delhi's water sector. Fragments of a medium term strategy exist but these are not comprehensive or cogently organized. Thus it is that the Delhi Jal Board, which is a para-statal authority of the NCT Delhi Govt., responsible for water supply, sewage disposal, infrastructure investments and revenue functions, has taken the initiative to establish long term perspective and directions.

EXISTING POLICY BASELINE

- Delhi will increasingly recycle treated waste water to augment resources. Some initiatives have been taken but there is no coherent policy in this regard
- Technological upgradation will be adopted by DJB to obtain efficiencies and economies
- Delhi will continue to maintain its claims on its share of Ganga Basin waters while stressing on augmentation of supplies from future upstream reservoirs in the Yamuna basin
- Conveyance losses will be steadily reduced
- Yamuna river pollution abatement is to be attained
- There is concern about groundwater depletion
- There is some support for rain water harvesting initiatives
- Fledgling efforts at awareness raising are made occasionally but do not exceed tokenism

- 1.17. Clearly, the existing elements of policy leave large areas unaddressed and even the existing elements need to be spelt out clearly. Major unaddressed areas are:

- Clarity on policy objectives
- Realistic demand projections
- Lack of emphasis on demand management
- Factoring in uncertainty and risk
- Improving the database for policy making
- Increasing the efficient use of resource
- Recycling and reuse policy

- Conservation and augmentation of the groundwater reserves
- Ensuring adequate water supply to all sections of the population
- Careful balancing between development and environment
- Ameliorating political conflict between increasingly assertive upper and lower riparians
- Financial sustainability and social responsibility
- Equity in distribution spatially and amongst economic classes
- Sourcing supplies from distant basins in the face of increasing local resistance
- Negotiating regulatory factors, institutional & constitutional requirements
- Addressing issues of demand management
- Incorporating innovation
- Ensuring long term water security in the face of variable supplies

1.18. The absence of a comprehensive database is an obstacle to policy making. Thus:

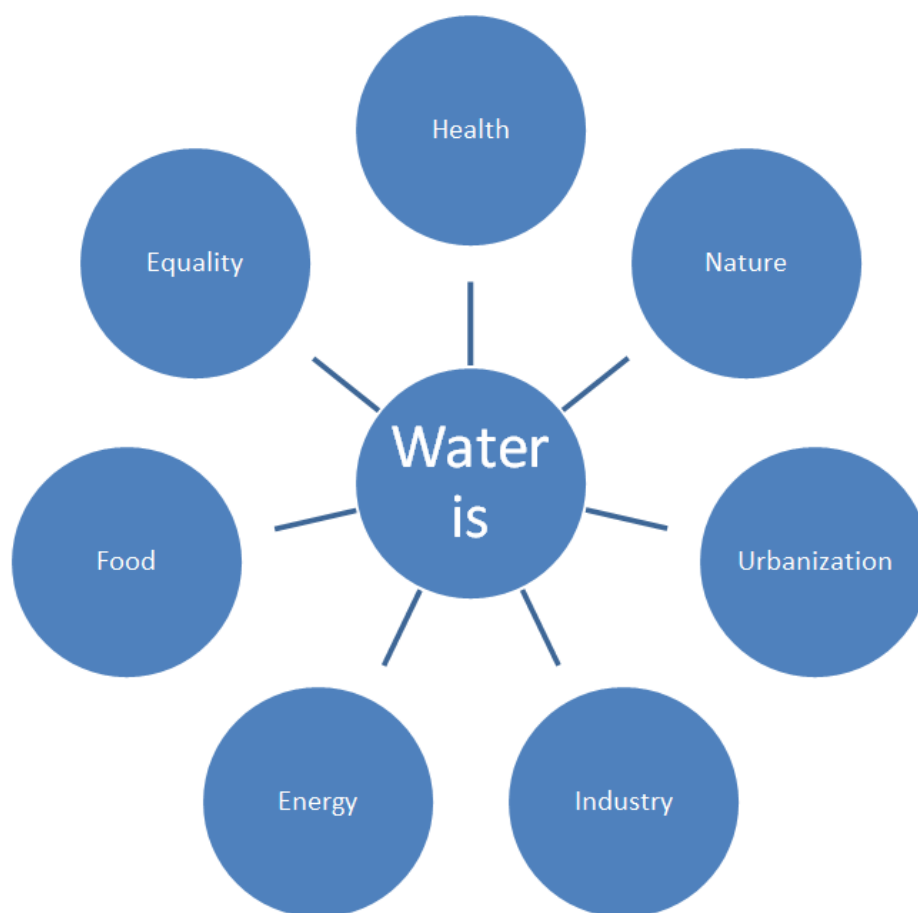
- spatio-sectoral data of consumption at macro-levels does not inspire confidence and is unavailable at district level limiting scope for analysis and generation of options
- the same is true of groundwater database
- monitoring of flows and discharges : this is neither available by sector or zone, neither for water supply nor for sewage nor for stormwater discharges in the main stormwater channels
- Substantial information available in the consumer billing system can be converted into actionable policy data if subjected to analysis

1.19. **New Thinking:** Every crisis seeds solutions for its own redressal. The looming water insecurity has led to ferment in thinking about the water sector. Thus, the Planning Commission has commissioned major studies; the National Water Mission has its own set of recommendations, the National Water Policy of 2002 has been revised again in 2012, the National Sustainable Habitats Mission is laying down new benchmarks governing city environmental sustainability, the Supreme Court has ruled in favour of inter-linking of rivers, the UN has voted in a resolution on human right to water to which India is signatory. Several Ministries, international aid agencies, several NGOs and corporate CSR groups too are actively promoting new initiatives to increase sustainability and water security. This new thinking about the water sector in general and urban water issues in particular is encapsulated here :

- Resource rich societies are cutting back on resource use whereas in India progress is still measured by high per capita consumption norms
- Water resources need greater emphasis on demand management than on supply augmentation
- It is illogical for cities, after incurring high cost of sewage treatment, only to throw it away – closed resource loops must be designed
- Nor does it make sense to transport sewage away from the point of origin, treat it for reuse, then pump it all the way back – hence the importance of decentralized treatment systems
- Sewage has to be seen as a resource and urban society as the greatest generator of waste water needs to set up incrementally increasing targets on recycle and reuse
- Less water consumption means less sewage to deal with
- Less sewage means lower energy consumption and land footprint
- STPS need to have a command area approach to recycle the treated sewage
- Water efficiency rating systems can bring down per capita consumption norms
- At some threshold water changes from a social good to an economic good where its conservation can be promoted through financial instruments
- Climate change impacts on rainfall, evaporation losses, soil moisture losses, declined river flows may impact gross water availability
- In order to decrease their fresh water footprint on hydrological systems urban society needs to set up water efficiency targets - quantitative efficiency gains must be factored in revising demand norms
- Unabated abstraction from river systems has to be balanced by ecological flow requirements and as such it is the responsibility of each consuming entity to reduce its fresh water abstraction
- Habitat sustainability initiatives may soon require city level environmental plans which lay down minimum bench marks for soft drainage systems, soft surfaces, percentage of rainwater harvested
- Decentralized treatment technology can obviate long sewer systems– the role of water is only for dilution and transport - if fecal matter and urine streams are separated at the source both become useful resources
- Smaller length of infrastructure means fewer losses
- Reducing distribution losses extremely important – National Water Policy deems 15% line losses acceptable – some cities in Japan, France, Singapore and even Cambodia [Phnom Penh] have achieved reduction of losses to just 5% - this should be NCT Delhi's target as well – even Jamshedpur has achieved under 10% losses
- Existing statutes and constitutional provisions need amendments to effect rearrangements in the water sector
- Governance, economics, new technology options and integration of environmentally sound approaches are required for holistically dealing with urban water management

- Envelope planning exercise where an urban entity thinks out of the box to manage its growing requirements within a fixed resource base
- Adoption of aquifer management approach where active focus is maintained on sustainable management of the groundwater reserves
- Water utilities must firmly project their viewpoint in sustainability of urban development in their jurisdictions
- That engineering solutions alone are not enough and society must be on board for effective solutions
- Conflict avoidance with fellow riparians may be more important than conflict resolution

1.20 While this exercise has been initiated by the DJB, policy notification and implementation are the task of the Govt. of NCT Delhi and its agencies [including DJB].



CHAPTER II : NCT DELHI: RELEVANT ECONOMIC & DEMOGRAPHIC CONDITIONS

2. 1. The NCT Delhi is a territorially small and largely urbanized city state with a huge and growing concentration of population which requires to be serviced with water supply and sewage treatment. Despite being a small territory, it has great significance, not only as the national capital, but also as an economic engine of north India, offering livelihood and economic opportunities as well as markets well beyond its borders. The sustained growth of the city is thus essential as part of the India growth story. Yet Delhi has limited internal water resource endowment and is largely dependent on external resources over which it exercises no direct control and is always under pressure from upper and lower riparians.
2. 2. The water sector of this metropolitan territory is characterized by its unique pattern of resource endowments, its location in the river basin, its peculiar sectoral transformations, its particular landuse mosaic - part planned and part organic, spatial planning without reference to ecology and hydrology, its tolerance for growth without reference to carrying capacity, its faith in engineering solutions as a panacea for all issues, its orientation towards treatment, supply and service delivery, its lack of cognizance of the pressures originating from rising demand in the immediate riparians. Understanding of the complex web of growth trends, existing conditions and prognostication of future conditions, emerging technological influences is a pre-requisite to formulating an effective and sustainable water policy.
2. 3. The city is presently serviced from the Ganga basin, Yamuna sub-basin, Indus basin and its internal aquifers. These sources are increasingly contested or depleted due to accelerating demand and thus augmentation of fresh water supplies is becoming more difficult with every passing day. [Thus, after introduction of water supply from Bhakra in 1970s the next augmentation from Tehri only came about 30 years later in 2006].
2. 4. **Economic Trends :** The economic trends in the last two decades have changed drastically altering the pattern of demand in the NCT. Table No.s 2.1 & 2.2 demonstrate the declining trend in irrigation water requirement [area under agriculture is being urbanized] as well as secondary sector water requirement [most industrial areas are showing a rapid change in landuse towards commercial activity]. These are noted here only to the extent that they confirm the slowdown in employment expansion in Delhi especially in sectors where entry level migrants can find opportunity. These trends

are major contributors to the dramatic deceleration in the decadal population growth attained in NCT Delhi in the decade 2001-2011 as revealed by Census of India, 2011. This deceleration in decadal growth, if continued, could lead to stabilization of population by 2031(as explained in 2.1.4) ushering an era when demand and dependence on external sources of supply may stabilize.

Table No. 2.1: Change in Occupational Profile (%)

Sector	Employment [1998]	Employment [2005]	Employment [2013]	1998 -2005 [%age Change]	%age Change In Share
Primary Sector	22334 [0.6%]	12262 [0.3%]	-	- 45.1%	- 50 %
Secondary Sector	1577842 [45%]	1257561 [35.36%]	-	- 20.3 %	- 21.43 %
Tertiary Sector *	1900696 [54.3%]	2286564 [64.29%]	-	+ 20 %	+ 18.40 %
Total	35,00,872	35,56,387	29,84,850**	+ 1 %	-

* Wholesale trade, transport, warehousing have declined while retail trade, tourism, finance services have gained -
Source: *Economic Survey of Delhi, 2010*

** Economic Survey 2013 is not comparable with 2005 data as persons engaged in govt. employ have been excluded.
Even so the Survey admits to a 12.22% decline in employment during the period 2005 – 13

Table No. 2.2: Sectoral Value of GSDP in Delhi (%)

Sector	1993-94	1997-98	1999-2000	2005-6	2007-8	2008-9	2010-11
Primary	4.11	1.48	1.43	0.8	0.6	0.6	0.5
Secondary	27.44	16.58	16.06	19.89	17.25	16.47	15.4
Tertiary	68.45	81.94	82.51	78.89	82	83.6	84.1
Total	100	100	100	100	100	100	100

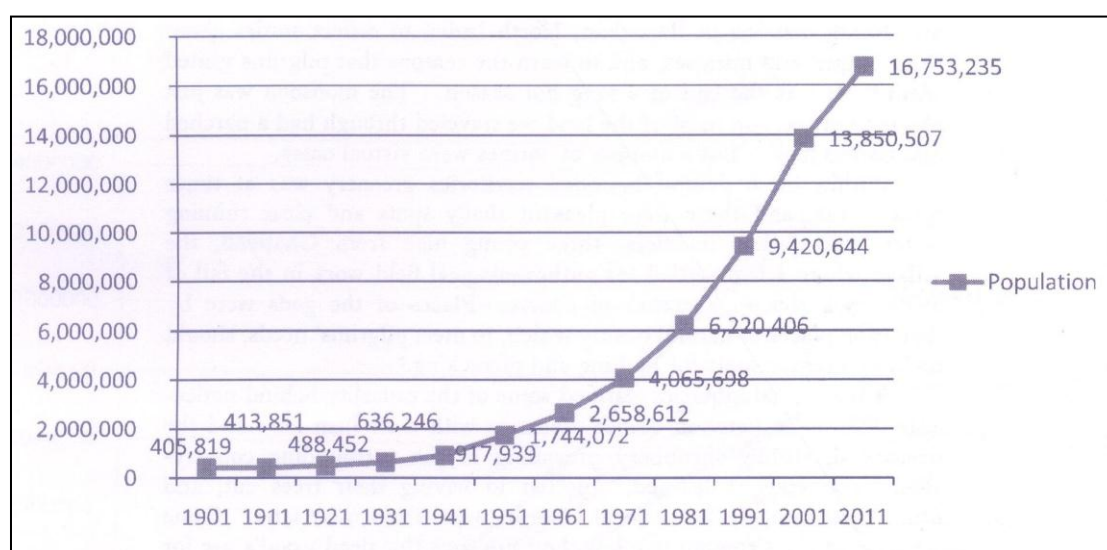
Source: *Economic Survey of Delhi (1993-2010)*

- 2.5. **Demography** : The planning horizon, as per scope of work, is 2050 or upto year of population stabilization (which is 2045 as per the National Population Policy). The projected population which is the basis for resource planning is shown in following table :

Table No. 2.3: Population Growth Rate in Delhi

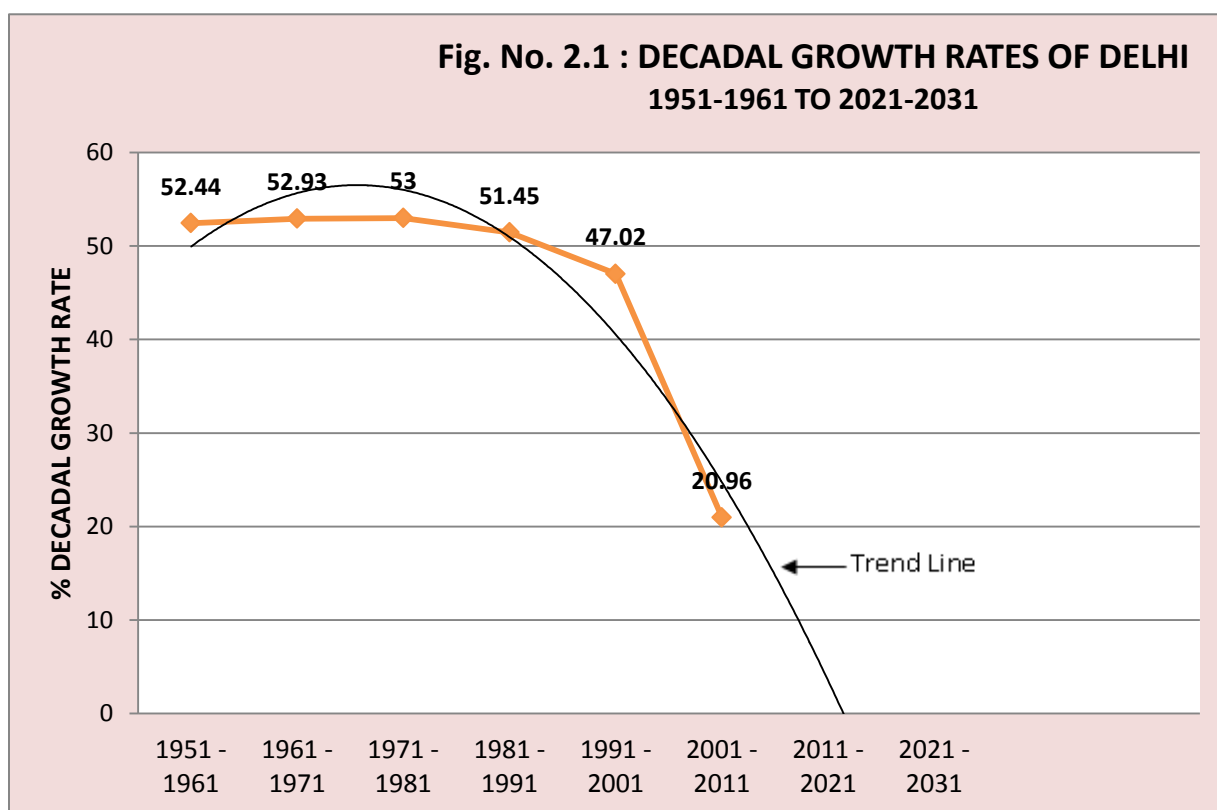
Year	Population (persons)	Decadal Growth rate %	Annual Growth Rate (%)
1951	1,744,072	90.00	6.63
1961	2,658,612	52.44	4.31
1971	4,065,698	52.93	4.34
1981	6,220,406	53.00	4.34
1991	9,420,644	51.45	4.24
2001	13,850,507	47.02	3.93
2011	16,750,000	20.96	2.10

Source: Census Data



Source: Census Data

2. 6. Census of India, 2011 data shows that the population has grown at a much slower rate than projected earlier with ***the actual figure for 2011 being 16.75 million as against the earlier projections of 18.2million.*** The decadal growth rate has shown a steep decline in this past decade slowing down from 47.02% in the 1991-2001 decade to just 20.96% in the 2001-2011 decade.



Graph of trend of annual growth rates

2. 7. The steep decline in the growth rate can be attributed to factors such as :

- Decline of the secondary sector in Delhi : Closure of industry in non-conforming areas, ban on polluting industry, comparatively stricter regulatory framework [viz . viz neighbouring states], high labour wages are contributory factors [minimum wages for unskilled labour in Delhi are Rs. 9568/- vs. Rs. 7979/- in Haryana]. Thus, recently, 1000 plots in Bawana industrial area of DSIIDC have been resumed for not having commenced building activity and most industrial estates are changing landuse from industry to offices. Lack of employment growth is the prime factor in reducing in-migration and perhaps encouraging out-migration
- Rigorous implementation of legal injunctions restricting growth of slums, unauthorized colonies and encroachments discourage in-migration
- High cost of living for entry level migrants is another retarding factor
- Decline in Total Fertility Rate [TFR] is reducing the natural growth rate of population
- Dispersal effect of NCR: the Census 2011 shows that growth rates of NCR towns have increased over the previous decade to twice that of Delhi. The expansion of the Metro Rail network has enabled people to work in Delhi but live elsewhere in more affordable NCR

- Implementation of schemes such as NREGA have retarded in-migration by holding back migrant labour in the main originating areas which earlier disgorged migrants to Delhi
- Better governance in areas of migrant origin and improved living conditions there have also retarded in-migration

These trends can be expected to continue and *hence the growth rate will continue to head south*. If the trend line projections are assumed to be correct then Delhi's population would tend to stabilize between 2021 – 2031.

2. 8. However, **reliable population projections are basic to this study** and hence a reference has been made to more sophisticated studies.
2. 9. The NCR Planning Board in its recent study 'Report On Water Supply and its Management in NCR', June, 2010 has estimated a decadal growth rate of 29.89% for 2001-2011 and 30.56% per decade from 2011 onwards. **This has resulted in a population projection of 23.48 million for 2021 and 30.65 million for 2031.** [However, the growth rate in 2001-2011 is only 20.96% thus negating the projections made by NCR Planning Board].
2. 10. McKinsey Global Institute's recent report 'India's Urban Awakening'[2010] projects Delhi's population as 25.6 million in 2030 [the projection is based on World Bank report 'World Population Prospects, 2008 authored by UN Population Division].
2. 11. The Population Foundation of India [a highly respected think tank whose projections in 2007 have closely approximated the actual census figures for Delhi], vide its paper on population projections, 2011 states "Population projections are not true forecasts of future population, but scenarios that result from assumptions made when they were prepared. Assumptions must be made about declines in the future birth rates [fertility], improvements in mortality [life expectancy at birth and infant mortality], and migration into and out of an area." The key concept in fertility is that of replacement level fertility and is often referred to as two child norm that is when couples have two children they are nearly replacing themselves and do not increase the size of successive generation. When this replacement level is reached, population will eventually cease growing and enter a zero growth condition. Based on this assumption the paper goes on to project the population of NCT Delhi under two different fertility rate scenarios [2.1 and 1.85] the results being as follows :

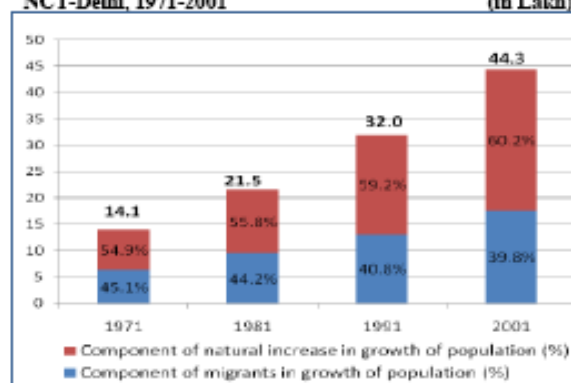
Table No. 2.4 : Population Projections [000s]

Scenario	2001	2011	2021	2031	2041	2051
A [TFR = 2.1]	13850	17075	20483	23442	25821	27723
B [TFR = 1.85]	13850	17057	20315	22943	24920	26269

Source: Population Foundation of India

2. 12. Both these scenario assume that fertility will decline continuously to the point where couples average two children each, the goal of India's National Population Policy 2000 as well as Millenium Development Goals [MDGs] set by the United Nations.
2. 13. According to Table No. 2.4 the population growth in Scenario A would taper off to 7% in 2041-51 or to 5.4% according to Scenario B. However, both scenarios are based on a constant total fertility rate assumption which may come down drastically with greater female participation in the work force. In fact, with the passage of time, considering societal trends, the fertility rate may decline well beyond replacement level. This decline in fertility rate would be accompanied by further reduction in job opportunities in the secondary sector reinforced by mechanization and relocation of Delhi's distributive trades as well as improved public transport links Delhi from NCR towns enabling people to access Delhi's opportunities while living affordably elsewhere. The projections in Table No. 2.4 have overshoot the actual Census 2011 figure by just 0.325 million and hence may be considered the most reliable.

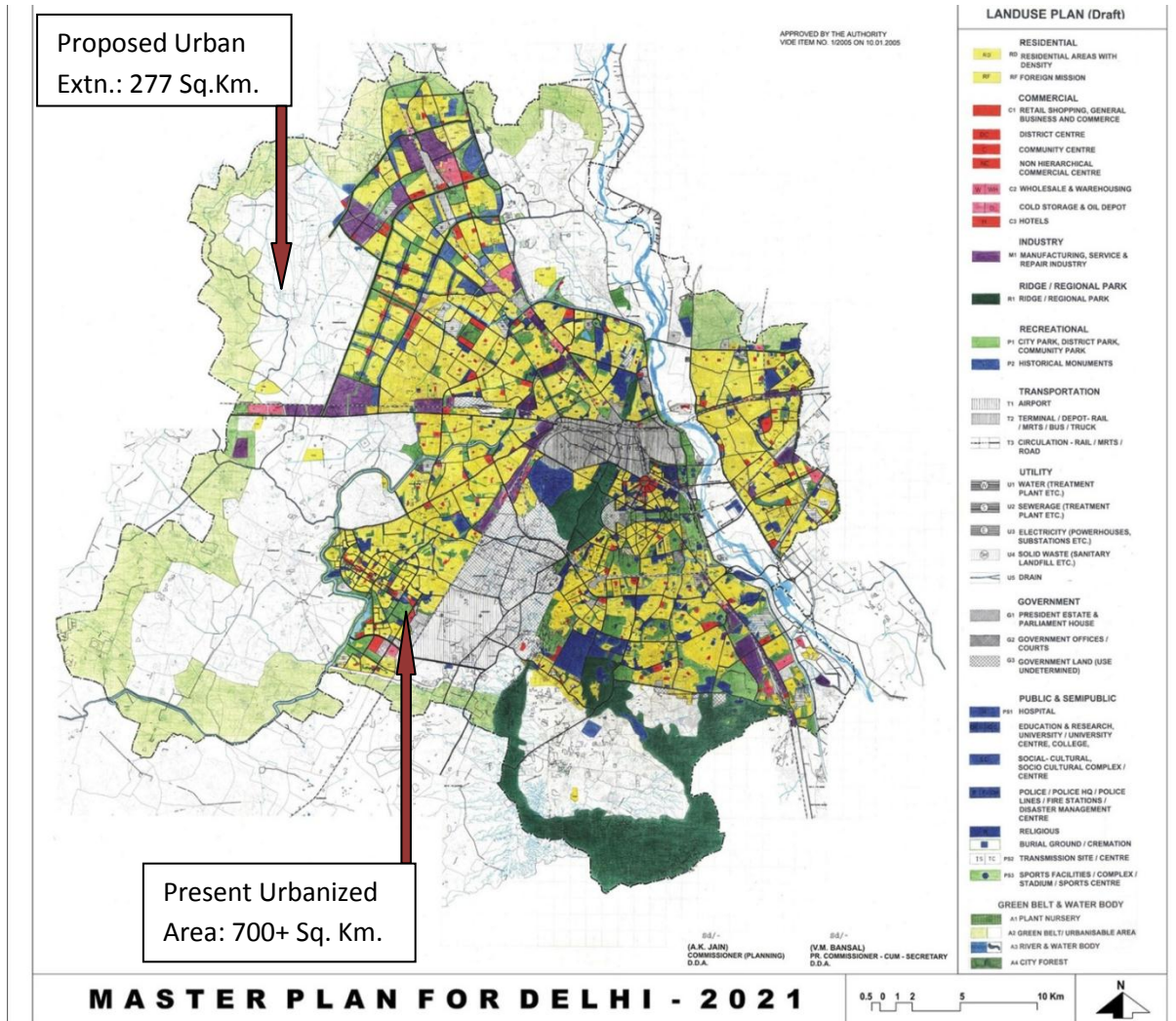
Figure 4.12: Component of Growth of Population in NCT-Delhi, 1971-2001 (in Lakh)

**Table No. 2.5 : Comparison of Population Projections by Various Agencies [Millions]**

Agency	2011	2021	2031
NCRPB	17.99	20.5	-
DDA/DJB	18.20	23.0	-
McKinsey/UN	18.451	-	26.0*
Population Fndn. Of India I	17.075	20.48	23.44
Population Fndn. Of India II	17.057	20.31	22.94
Census of India	16.75	<20.0**	-

* Actually stated as 25.6 million by 2030 ** Based on projected trend line

- 2.14. As such it may reasonably be expected that the population of Delhi may well stabilize by 2031 and at a figure not exceeding 25 million which includes a substantial margin for error.



- 2.15. DDA Masterplan 2021 projects a total urbanizable area of 920 sq.km. which could possibly have a gross population density of 300 pph [persons per hectare] which translates into a projected population of 27 million persons even after re-densifying existing urban areas.

- 2.16. Thus, for the final water demand projection for Delhi will be based upon a population of 27 million persons so as to have a very comfortable compensatory cushion for error.

CHAPTER III : SUPPLY NORMS & DEMAND PROJECTIONS IN DELHI

- 3.1. As per the analysis in the preceding chapter NCT Delhi's population may be assumed to stabilize at a maximum of 27 million by 2031. At the same time various agencies have been projecting future demand applying varying norms. These are as follows :

Table No. 3.1: Water Demand Projections By Various Agencies & Consultative Groups For 2021

Parameters	JICA Study Team	DJB	TCE	NCRPB
Population (million)	26.0	23.0	23.0	23.48
Net per Capita (gpcd)	52	-	-	-
Leakage (gpcd)	8(15%)	Incl. in gross	Incl. in gross	-
Gross Per Capita(gpcd)	60	60	51	50
Demand (mgd)	1,560	1,380	1,170	1,174

- 3.2. As per the 12th Five Year Plan Approach Paper of the DJB the demand has been projected as 1140 MGD by 2017 taking rate of supply as 60gpcd for 190 million population. In other papers [report prepared by JICA] DJB is projecting a total demand of 1113 MGD in 2021. This is based on a supply norm of 50 GPCD [228 lpcd] for most planned areas, 75 GPCD [320 lpcd] for NDMC area, 35 GPCD for outer Delhi [160 lpcd].

Norms

- 3.3. The DDA Master Plan 2021 states 'In line with the norms laid down in CPHEEO Manual 1999, in respect of mega cities, after taking into account 15% losses, the minimum water supply @ 172 lpcd (litres per capita daily) will have to be ensured for domestic use for the projected population.' [p.104 of Gazette Notification of 7th February, 2007]. The National Water Commission recommends a minimum supply of 135 lpcd for sewered areas. Considering that this is the end of pipe supply then after 15% losses the figure should be 160 lpcd.

- 3.4. It is proposed to project Delhi's water requirement based on the various official figures as follows :

Table No. 3.2: Projected Domestic Water Demand Based On Projected Population

S. No.	Author	Supply Norm	2021 [Population 23 Million]	2031 [Population 25 Million]	2051 [Population 27 Million]
1	DDA [CPHEEO]	172 LPCD	868 MGD	942 MGD	1018 MGD

2	National Commission	Water	160 LPCD	807 MGD	877 MGD	947 MGD
3	NCRPB		225 LPCD	1150 MGD	1250 MGD	1332 MGD

Note: These projections are on a fixed norm. In future norm can decline as efficiencies are factored in. CPHEEO norms were formulated in 1999

- 3.5. Thus, from above table it is proposed, for the time being, to adopt the CPHEEO's norm based projections for the basis of future resource planning. The norm is based on summer season requirement when demand peaks allowing a certain shrinkage in the demand during the period November – February.
- 3.6. A clear lack of coordination between DDA [the urban development planning agency] and Govt. of NCT Delhi [Delhi Jal Board] is visible. This results in planning for urban extensions by the former without the willing consent of the latter which has to rely on upstream reservoirs in the Himalyan river basins which are increasingly becoming difficult to construct in the face of land and environment based resistance.
- 3.7. Moreover DDA has, in 2006, presented the Delhi Masterplan 2021, which has increased FARs [higher building intensity on existing plot sizes. This is resulting in increasing demand and discharges all over the city whereas the infrastructure remains unchanged. Now, after mid-term Masterplan Review the concept of TOD[Transit Oriented Development] is underway, which allows further enhancement of FARs to a depth of 500m on either side of Metro corridors. Ultimately, the entire city is going to be covered by Metro Rail and hence the whole city demand and discharges will increase in the existing areas. The result will be increasing demand on and distortion of DJB infrastructure. It must be realized that it is no easy task to augment sub-surface infrastructure. At the same time the increasing concretization of the city will result in reduced soft surfaces reducing percolation to aquifer still further while accentuating waterlogging issues.

- In the near future with technological advancements such as more efficient water use devices such as low flow fixtures, water efficient washing machines, dry toilets, decline in water guzzling air coolers, less water consuming soaps, increasingly efficient irrigation of greens [drip. sprinkler, mulching, no till farming], will reduce demand enabling lowering of the per capita norm
- The future supply may also be partitioned into two streams: fresh water and recycled water thereby reducing the fresh water requirement still further. Again, the norms given above are for the peak summer season [1 March – 15 July and 1 October – 15 November]. The realistic demand during monsoons [15 July – 30 September] is somewhat lower and in winters [15 November – 29 February] lower still. Thus, if the entire year's requirement was projected on the norm of 172 lpcd the annual supply requirement would be 371570 MGD whereas if seasonal changes are factored in the annual supply requirement would be significantly lower at 348340 MGD or 23230 MG less annually
- Again, on the assumption that there will be no further growth of unauthorized colonies and slums, it can be reasonably assumed that 10 million out of the projected 27 million population

[stabilization level] for 2051 would be in upgraded slums and unauthorized colonies having a lower water norm of 160 lpcd, the daily water requirement in peak summer would be [10 million x 160 lpcd + 17 million x 172 lpcd] or 992 MGD

- Yet again, if the conveyance losses can be reduced to <10% this translates into a daily requirement decrease of 44 MGD

3. 8. **All in all we may foresee a future where :**

- ***fresh water demand* declines with growing recycled water availability**
- **decline in per capita norm with technical efficiency and growing conservation awareness**
- **whereas on account of factors listed [in box above] reasonable cushion is built into the projections**

CHAPTER IV : THE WATER RESOURCES OF NCT DELHI

4. 1. Delhi has several water resources. These are :
- surface water [chiefly Yamuna sub-basin, Ganga and Indus Basins]
 - potential surface water sources from proposed dams in the high Himalayas
 - ground water aquifers especially in alluvial formations
 - treated wastewater [increases commensurately with supplies]
 - rainwater [local storm waters generated in Delhi's 6 sub-basins and flood waters transiting through Delhi from Haryana discharging into Yamuna]

Surface Water Resource

4. 2. Delhi is a riparian state of the River Yamuna which is the only river flowing through the NCT of Delhi. This river constitutes the primary source of water supply to NCT Delhi. The water is abstracted from the river at Tajewala Barrage through Western Yamuna Canal traversing Haryana and is supplied to Delhi through the Delhi Tail Distributary at Haiderpur and Chnadrawal WTPs. In addition the river water is abstracted at Wazirabad Barrage within the NCT for Wazirabad WTP. Severally, the NCT also accesses water from the Ganga river and Indus Basin.
4. 3. **Upper Yamuna Agreement** : In view of water scarcity and competing demands, the basin states viz. Uttar Pradesh Haryana, Rajasthan, Himachal Pradesh and National Capital Territory of Delhi had concluded an agreement (on 12th May, 1994) regarding allocation of surface flow of Yamuna on the basis of mean year availability upto Okhla. Among the basin states Delhi has been allocated 0.724 BCM of water resources of river Yamuna annually. According to the agreement the states have agreed that a minimum flow shall be maintained downstream of Tajewala as well as downstream of Okhla headworks throughout the year from the viewpoint of ecological considerations. As upstream storages are built up progressively the extent of minimum flow will be raised upto 10 cumecs in a phased manner in proportion to the completion of upstream storages. The interim seasonal allocation of the annual utilizable flow of river Yamuna for Delhi is shown in Table 4.1. The interim seasonal allocation shall be gradually modified as the upstream reservoirs come up to reach a magnitude of 724 MCM.

TABLE No. : 4.1: Seasonal Allocation of Yamuna Waters (MCM)

	July-October	November-February	March-June	Annual
Delhi	580	68	76	724

Source: Ministry of Water Resources

4. 4. Here it may be pointed out that the present utilization of the allocation in the monsoon season is only 282 MCM and thus 298 MCM goes unutilized for lack of storage capacity in the NCT Delhi or by way of non-existent upstream reservoirs in the Himalayas. Also, under the Upper Yamuna Agreement Delhi is also bound to return 250 MGD [1.14 MCM] of treated effluent into the river between Wazirabad and Okhla barrage.

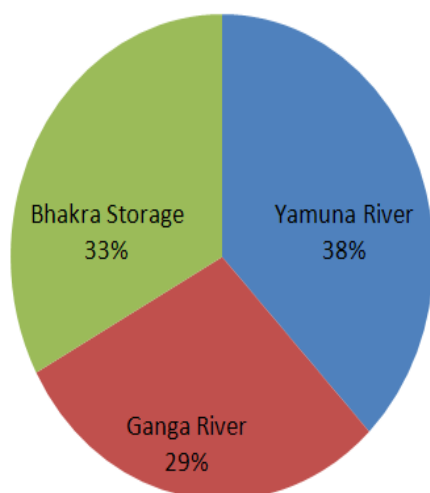


Map No.4.1: Indian Drainage Basin Map

4. 5. Surface water sources availability was 690 MGD in 2009, out of which 310 MGD comes from the Yamuna River, 240 MGD from the Ganga River & 140 MGD from the Satluj River, tributary of the Indus River. Official groundwater supplies amount to a further 100 MGD. Recycling of water treatment plants backwash water has added another 40 MGD. By making a parallel lined canal for transfer of Yamuna water through Haryana territory it is expected to curtail en route seepage losses thereby increasing the supply by a further 90 MGD at Delhi WTPs taking the total availability to 920 MGD.

Table No.4.2 : Source-wise Water Supply For Delhi

S.No.	Sources of Water	Quantity (MGD)
1	Yamuna River	310
2	Ganga River	240
3	Bhakra Storage	140
4	Expected Increase due to saving of losses via parallel lined canal and recycling backwashed water in filters of various WTPs	130
5	Sub Total	820
6	Ranney Wells/Tube Wells (G.W)	100
7	Total	920



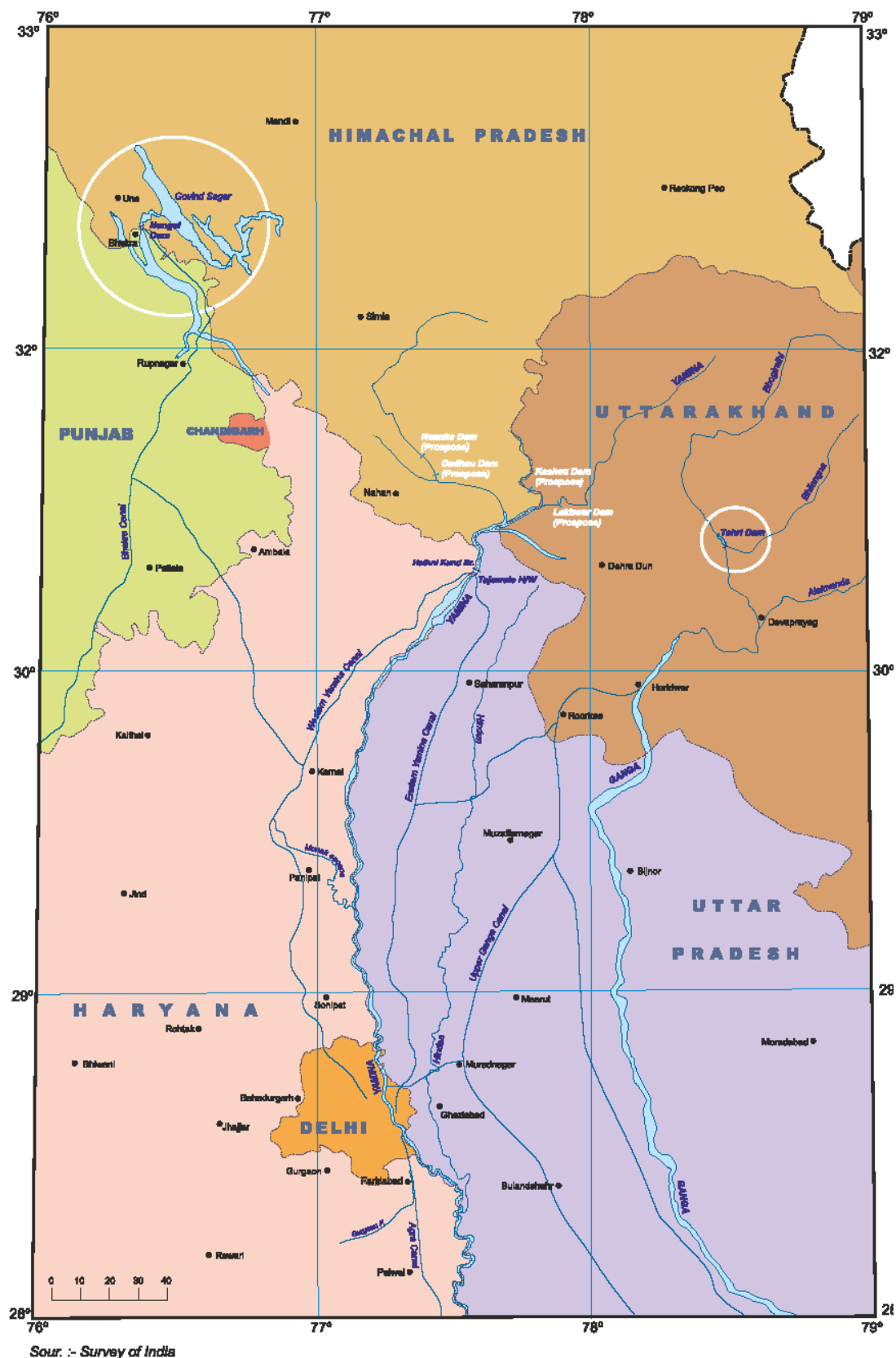
4. 6. Beyond the present resources several other dams are proposed in the Himalyas in which NCT Delhi is to get a share of water. All of them face a varying degree of uncertainty [the subject of a later Chapter] These are :

a) **Renuka Dam, Himachal Pradesh** : The proposal involves the construction of a 150m high, 456.0 MCM live storage capacity dam on Giri river; a tributary of the river Yamuna; in Himachal Pradesh is expected to generate 420 MW of power and will supply 1248 MLD (275 MGD) water to NCT of Delhi. The project is held up for clearance from MoEF, Govt. of India.

b) **Kishau Dam, Uttarakhand** : Proposal involves construction of a 225m high, 1330 MCM live storage capacity dam on river Tons; a tributary of river Yamuna; in Dehradun district of state of Uttarakhand. It is expected to generate 600 MW of power and provide 105.4 MCM of flood control. When complete it will supply 1700 MLD (372 MGD) of water to NCT of Delhi. Uttarakhand Government has signed a MoU with Tehri Hydro Development Corporation (THDC) for construction of this dam. The Ministry of Power, Govt. of India has given a go ahead to Tehri Hydro Development Corporation for updation of DPR.

c) **Lakhwar Vyasi Dam, Uttarakhand** : The proposal involves a construction of 173 m high, 334.8 MCM live storage capacity dam on river Yamuna in Dehradun district in the state of Uttarakhand. It is expected to generate 440 MW of power besides supplying 617 MLD (135MGD) of water to NCT of Delhi. Uttarakhand Govt. has signed a MoU with NHPC for the construction of this dam. Environmental clearance has been accorded by MoEF letter no. j-12011/48/2007-1al dated 07.09.2007. Forest proposal along with the CAT plan has been submitted to nodal officer, state forest Deptt. vide letter no. NH/LV/CE/12/162 dated 11.09.2007 of NHPC.

d) **Sarda – Yamuna Link**: This proposal is a part of the Himalayan component of the larger interlinking river project. NWDA has carried out feasibility studies of the proposal which involves construction of Pancheshwar and Pooranagiri dams on river Sarda at Indo-Nepal border. It is learnt that with the construction of Pancheshwar dam has been completed. 75% dependable yield of Sarda River at Tunukpura power station is estimated at 19271 MCM per year. It is proposed to construct a barrage upstream of Tunukpura barrage and divert 17906 MCM per year of unused flood water through the proposed Sarda-Yamuna link which will be available for NCR as a whole. NCT of Delhi is expected to get 6190 MCM per year from this proposed link if the same gets materialized [*although it is not clear what NCR and NCT would do with such excessive quantities of water greatly in excess of their estimated requirements*].



4. 7. JICA [consultants to DJB] have projected a demand for year 2021 as 1560 MGD against which the following resource scenarios have been evolved.

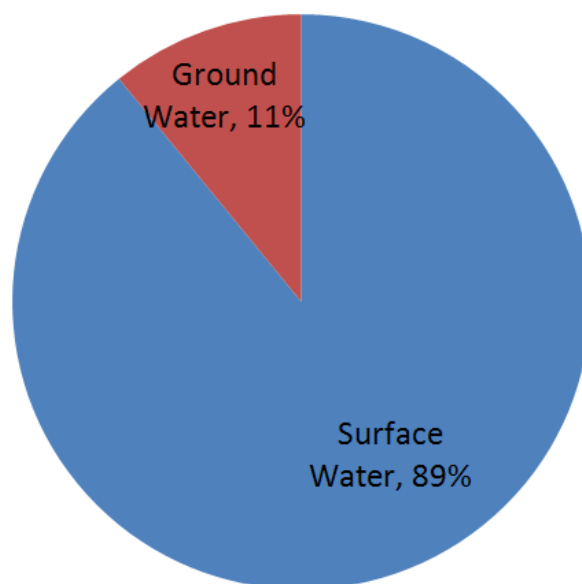
Table No. 4.3: Water Resource Scenarios for 2021

Scenario	Explanation [MGD]	Water Resource (MGD)
A (No Addition of supply)	Current Level	815
B (Recycling)	Scenario A+ Recycling (30)	845
C (Munak)	Scenario B+WY Canal (80)	925
D (Renuka Part)	Scenario C+ Renuka Dam (150)	1,075
E (Renuka Full)	Scenario D+ Renuka Dam (275)	1,200

Source: JICA, 2011

Groundwater Resources

4. 8. Groundwater forms the major internal resource which supplements the surface water supply. DJB supplies groundwater through 2488 tubewells and 21 Ranney Wells in the floodplains amounting to 90 MGD.



4. 9. Apart from this there are a large number of private tubewells in residential areas, industrial premises, commercial and institutional establishments which supply an additional estimated 100 MGD for domestic and industrial sectors [based on CGWB aggregate data of 2010].
4. 10. As per CGWB Report [2013] – “Masterplan For Groundwater Recharge in Delhi” the total annual groundwater draft in Delhi is 381 MCM and the net natural recharge is 281 MCM. In view of this, at present rates of extraction 100 MCM of recharge is required annually merely to keep the water table stabilized. Except for a

small area in Central and North Districts the water table is overexploited. The average level of exploitation in Delhi is 170 %.

Table No. 4.4: Groundwater Development of the NCT Delhi as on 31 March, 2004

S.No	Assessment Unit	Stage of Groundwater Development %	Categorisation of future groundwater development
1.	Central	88.08	Safe
2.	East	130.27	Over-exploited
3.	North	34.61	Safe
4.	New Delhi	170.82	Over-exploited
5.	North East	129.15	Over-exploited
6.	North West	136.31	Over-exploited
7.	South	243.00	Over-exploited
8.	South West	214.41	Over-exploited
9.	West	111.56	Over-exploited
	TOTAL	170.28	

Source: CGWB [2004 Data Published in 2006]

4. 11. The groundwater consumption by sector is :

- Irrigation 40%
- Domestic Sector 50%
- Industrial Sector 10%

Table No. 4.5: Groundwater Draft Development of the NCT Delhi [ham]

S.No	Assessment Unit	GW Draft [domestic purpose]	GW Draft [industrial purpose]	GW Draft for Irrigation	Total Draft
1.	Central	165.18	0	0	165.18
2.	East	466.17	179.38	141.99	787.54
3.	North	254.56	0	0	254.56
4.	New Delhi	509.49	0	0	509.49
5.	North East	810.54	192.92	150.01	1153.5
6.	North West	821.75	1607.14	9799	12228

S.No	Assessment Unit	GW Draft [domestic purpose]	GW Draft [industrial purpose]	GW Draft for Irrigation	Total Draft
7.	South	7428.13	805.72	109	8342.9
8.	South West	11766.6	438.97	8567	20773
9.	West	1421.2	1075.44	1234.99	3731.6
	TOTAL	23643.61	4299.57	20002	47945*

*Source : CGWB [2004 Data Published in 2006] [current figure revised to 40000HAM annually]**

4. 12. As may be seen from the above Table the groundwater resources constitute a major resource for NCT Delhi which has been depleted severely. This is the buffer resource which comes to the rescue in deficit rainfall years. There is a great need to husband this resource carefully and use it sustainably. Accordingly :

- CGWA has notified most parts of Delhi territory as areas where new water extraction mechanisms are banned or require specific permission. The responsibility of effecting this notification now vests with the DJB
- Rainwater harvesting has been made mandatory in all new constructions and schemes are available to assist the incorporation of rain water harvesting mechanisms in existing constructions. So far great efforts have been made in this direction but the results are insignificant.
- The DJB has also formulated a large scale groundwater recharge strategy for NCT Delhi

4. 13. Groundwater occurs under the following three hydrogeological conditions in the NCT Delhi.

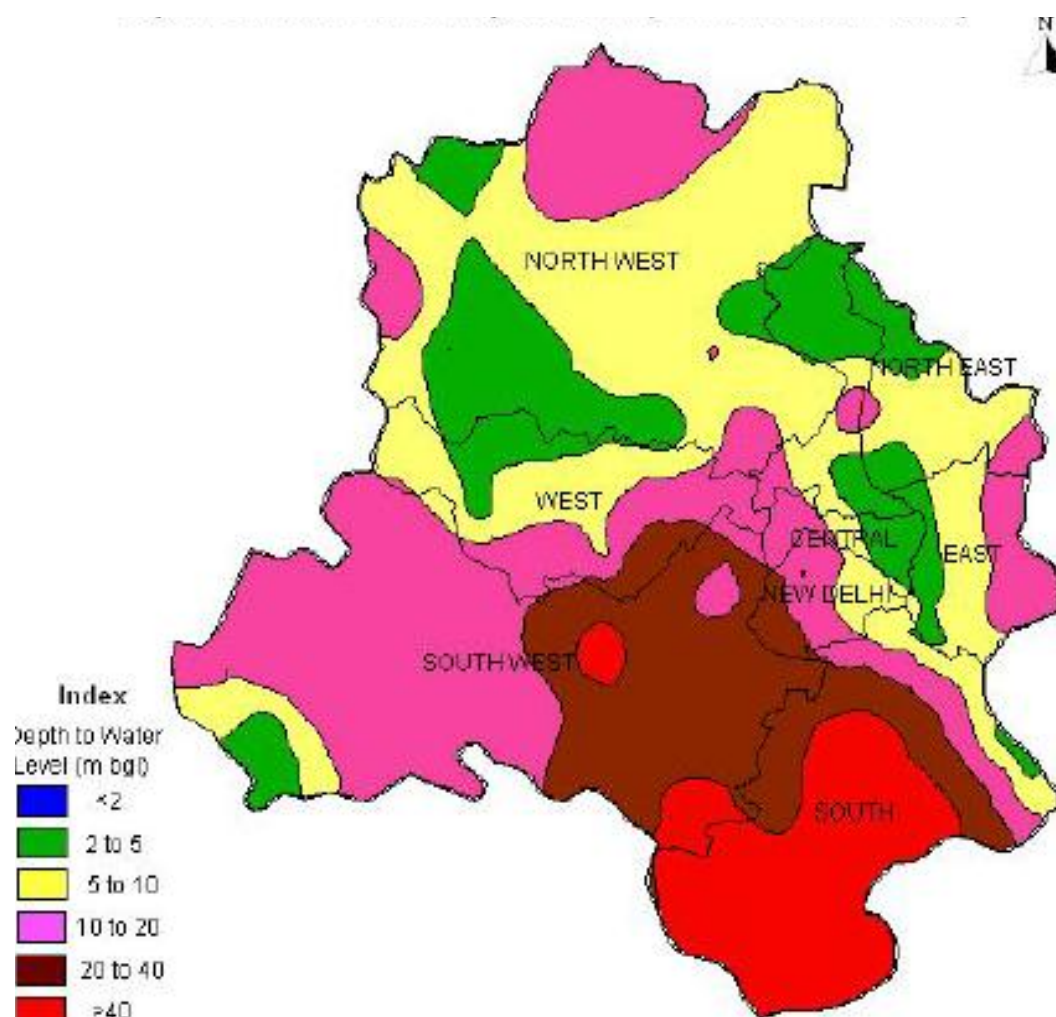
- Alluvial basin of Chhatterpur in the Mehrauli Block, south of Delhi, enclosed within rocky surroundings of the Delhi ridge. The basin acts as a single aquifer under unconfined groundwater conditions.
- Alluvial deposits to the west of the ridge. The aquifer is under semi-confined conditions.
- Alluvial deposits to the east of the ridge: (i) between the ridge and the Yamuna river, and (ii) east of the Yamuna river. The aquifers here are under semi-confined conditions.

4. 14. Floodplain: The curving length of river Yamuna in Delhi is about 50 kms with floodplains having width of 1.5 to 3 kms. The total area of active floodplain including river bed is about 97 sq. km. of which about 16.5 sq. km. is under water and the remaining 80.5 sq. km is water logged or has very shallow water table. In addition the **river floodplain**, now jacketed between left and right main embankments, consists of deposits of new alluvium with depth to bedrock of over 100m and contains mainly fresh water upto a depth of 50 mbgl. The older alluvium lies below this and consists of clayey silt containing mainly saline water.

Water Table Depth

4.15. As per CGWB [2010] the water table depth obtaining :

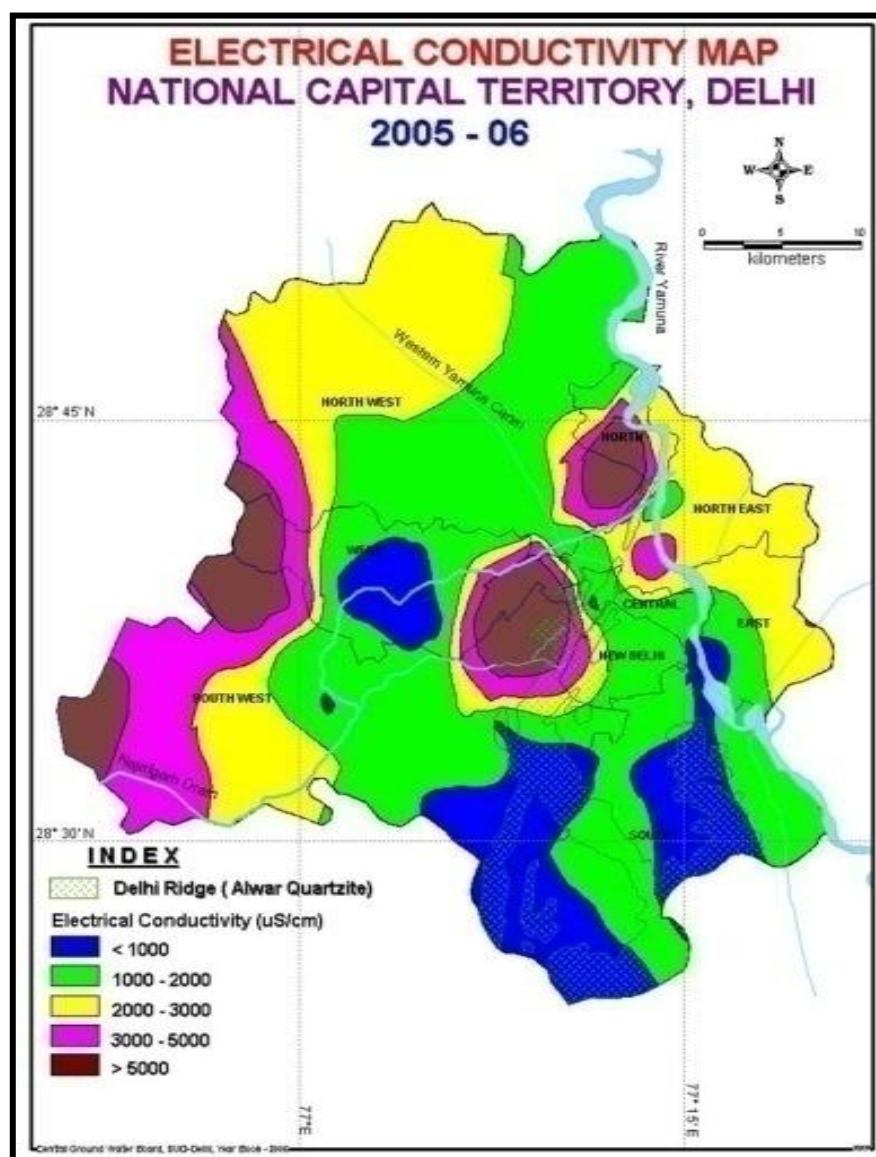
- In Central District the water table depth ranges between 2.0 – 10.0 mbgl
- In East District the water table depth ranges between 2.0 – 10.0 mbgl
- In New Delhi District the water table depth ranges between 5.0 – 20.0 mbgl
- In North-East District the water table depth ranges between 2.0 – 8.0 mbgl
- In North-West District the water table depth ranges between 2.0 – 10.0 mbgl
- In South District the water table depth ranges between 8.0 – 60.0 mbgl
- In South-West District the water table depth ranges between 2.0 – 15.0 mbgl
- In West District the water table depth ranges between 2.0 – 15.0 mbgl



Map 4.3: Depth to Water Level : May, 2013 [Source : CGWB]

Groundwater Quality

4. 16. The freshwater strata in the NCT Delhi average a depth of 40 mbgl. About 45.5% of ground water samples in NCT, Delhi have been found unsuitable for drinking based on overall impact of physico-chemical characteristics including heavy metals, total dissolved solids, nitrate, fluoride, trace metals or due to synergic effects of some or all of these.
4. 17. In over 30 percent of the area in NCT Delhi, the fluoride contents in ground water is more than permissible limit (1.5mg/l) particularly in the South-western and Western part of the city comprising Southwest, West and Northwest Districts.



Map 4.4: Electrical Conductivity Map of NCT Delhi [Source : CGWB]



Map 4.5: Thickness of Fresh Water Strata [Source : CGWB]

Waste Water Resources in NCT Delhi

4. 18. “At present about 1349 MLD of wastewater generated in the city is treated by sewage treatment plants and the rest of the waste water is being discharged into the drains without any treatment. To treat the all-available wastewater Soil-Aquifer Treatment plants can be put up near the existing sewage as well as near the major drains carrying the wastewater. A battery of tubewells for using the treated wastewater for domestic purposes can pump this wastewater out. As the water is free of foul smell it can be used for all purposes after proper chlorination.” – CGWB [Hydrological Framework AND Groundwater Management Plan of NCT Delhi, February, 2006]
4. 19. “The total installed wastewater treatment works capacity (2004) is 2,330 MLD. As part of this study, flows were measured at the WWTP and observed dry weather flows in 2003 were estimated as 1,384 mld (304 mgd).” [Report of Price Waterhouse Coopers, DHV, TCE, 2004 for DJB]

Table No.4.6: Projections of Influent Wastewater Volumes at STPs

Source of waste water	Projected wastewater Volumes (MLD)				
	2004	2005	2006	2011	2021
Total water demand	2,727	2842	2961	3623	5321
Total net water supply	2,185	2566	2774	3573	5259
Wastewater Generated	1,748	2053	2219	2858	4207
Diverted to CETP	200	217	234	346	755
Proportion not sewerred	14%	13%	13%	10%	5%
Outside sewerred area	244	267	288	286	210
Net generated wastewater	1,304	1569	1697	2226	3242
Infiltration	518	518	518	518	518
Gross wastewater for treatment	1822	2087	2215	2744	3760

Source: DJB

Levels of Treatment

4. 20. Presently most of the sewage treated is upto secondary levels of treatment [<20 mg/l of SS and <30 mg/l of BOD]. This is as per the MoEF’s norms for discharge into surface drainage. ‘If made mandatory by the Honourable Supreme Court all new WWTPs have to be designed for an effluent quality of 10 mg/litre BOD and 15 mg/litre SS. All WWTPs are to have disinfection facilities for coliform reduction to $<10,000$ MPN per 100 ml. If made compulsory for older works this will entail construction of tertiary treatment plants.’ - [Report of Price Waterhouse Coopers, DHV, TCE, 2004 for DJB]. The upgradation process is already in the works and effluent standards are improving.
4. 21. Presently, of the waste water generated, 200 MLD is from the industrial estates and this is treated in 10 operational CETPs. However, it is observed that the treated effluent quality of these

CETPs is above the norms of CPCB with detectable levels of heavy metals and high levels of TDS. The effluent standards of CETPs has also shown considerable improvement.

4. 22. It may also be added that the High Court has directed the installation of decentralized STPs [package units] in about 189 villages of Delhi and thus a decentralized, unquantified but substantial resource would be available for recharge purposes. Under National Green Tribunals orders of January, 2015 [‘Maili se Nirmal Yamuna’] 53 decentralized STPs are proposed.

Treated Wastewater

4. 23. The treated wastewater must be considered as an available resource that has the potential to be reused/ recycled for the non-domestic purposes, to allow the ground water table to rise to enable withdrawal of ground water. Some of the options available in general have been suggested in the Report prepared for the ‘*Delhi Jal Board - DWSSP – Project Preparation Study – DFR 3 – Part C – Sewerage - Volume I by PWC*’ below :
- Discharge into natural bodies of water
 - Utilisation for irrigated agriculture where agricultural produce which are eaten only after cooking comes in contact with treated wastewater
 - Utilisation for irrigated horticulture, parks, gardens, green areas, road flushing, fire fighting storage, forestry etc.
 - Use in industries as cooling water, boiler feed water and any other industrial process water.
 - Recharge of ground water after treating to suitable standards or indirect recharge and creation of recreational reservoirs/ lakes
4. 24. **Delhi is bound to return 250 MGD to River Yamuna under the Upper Yamuna Water Sharing Agreement. However, DJB provides 822 MGD water supply [from all basins and groundwater] and after Munak channel contribution another 100 MGD whereas private tubewells provide further 100 MGD i.e. a total of 1022 MGD. Assuming 80 % of this figure as return water [i.e. 815 MGD] Delhi has a potential wastewater resource of 565 MGD.**

Rainfall Runoff

4. 25. It is observed that while there are prominent trends in the rainfall characteristics there is no precise certainty about the timing and quantum of rainfall. Out of 94 years for which the record is available 49 years have recorded rainfall above 600 mm. and 74 years have recorded rainfall above 500 mm. While any rainfall would add to soil moisture or surface waters it is only on rainy days that significant runoff is generated. Thus July, August and the first half of September has the maximum number of rainy days but occasional heavy showers can occur in any month.

As per the Gazetteer of Delhi during the period 1867 – 1912 the average annual rainfall calculated from the above works out to 68.62 cm.

The Gazetteer of 1975 having a larger statistical base gives an annual average rainfall figure of 66.01 cm with average 35 rainy days (showing rainfall of 2.5mm in a day or more).

However, present figures being cited since 1996 on the basis of 100 year data place the annual average rainfall figure as 61.1 cm. with an average of 27 rainy days annually.

Here it may be noted that the rainfall in Delhi is not uniformly distributed but decreases from NE to SW. The isohyet maps of Delhi show that there is above average precipitation near the river and below average precipitation in the western area.

4. 26. The normal annual rainfall in Delhi is 611.8mm recorded at Safdarjung airport.

The variation of rainfall from year to year is large. **Occasional drought years occur. Whereas the worst year was 1951 [269mm] in recent memory two of the worst years were 1987 [380 mm] and 2002 [540 mm]. In 1987 and 2002 the depth to water table, post monsoon, instead of recovering actually fell further demonstrating the value of groundwater as a buffer stock in a period of crisis.** During the same 100 year period rainfall was less than 80% of the normal in about 21 years. Two consecutive years of low rainfall occurred four times in this 100 year period. Even in 2015 the rainfall deficiency has been of the order of 50%.

4. 27. The precipitation over NCT Delhi translates into substantial surface runoff. Urbanized areas and the intensity of urbanization in Delhi is increasing and as a collateral runoff generated will continue to increase in the years to come. An estimate of runoff generated is given in the following Table :

Table No. 4.7 : Block Wise Runoff at 75 % Probability

S.NO.	BLOCKS	RUNOFF VOLUME (MCM)
1.	Alipur	24.25
2.	Kanjhawla	20.26
3.	Najafgarh	37.88
4.	Mehrauli	24.96
5.	Shahdara	7.25
6.	City	98.96
TOTAL		213.56

Source: INTACH [see "Groundwater Recharge Strategy for Delhi" for DJB, 2010]

Some Relevant Characteristics of Water Supply in Delhi

4. 28. Presently 822 MGD is being supplied by DJB which translates into 220 lpcd. This supply is not distributed equitably over Delhi. In Delhi, water is distributed intermittently, twice a day for a few hours each in the morning and evening.
4. 29. Zonal Distribution is highly variable with Delhi Cantt. Getting 509 LPCD, NDMC area pegged at 440 LPCD, and areas of outer Delhi getting as little as 40 LPCD. As such there is a need for spatial equity in distribution.
4. 30. As per Census 2001 Delhi had a total of 3.13 million houses of which 1.92 million were being served by taps showing a coverage of 61% only. National Family Health Survey, 2010 has shown that major cities in India do not have more than a 69% household coverage of piped water supply.
4. 31. Further, Delhi has a high level of UFW/NRW. The National Water Policy has directed that an acceptable figure of losses is 15%. In private 24 x 7 water schemes spread over small areas zero% losses have been achieved mainly due to superior piping technology. [Dharwad-Hubli pilot 24 X 7 water supply project in Karnatak].

Summary of Resources Available To NCT Delhi

4.34 The present and future resources available to NCT Delhi are given in the following Table:

Table No. 4.8 : Summary of Present & Potential Water Resources

S No.	Present Resources	Quantum
1	Surface Water Resources	820 MGD
2	Sustainable Groundwater Resources	100 MGD
3	Rain Water Runoff Potential	213 MCM/140 MGD
4	Recycled Waste Water Potential	565 MGD
	Potential Future Fresh Water Resources	
5	Renuka Dam	275 MGD
6	Kishau Dam	372 MGD
7	LakhwarVyasi Dam	135 MGD
8	Sharda — Yamuna Link	4085 MGD

CHAPTER V : ALTERNATIVE SCENARIOS

5.1 Lack of water policy leads to a business as usual scenario with ad hoc measures in reaction to crises. A considered policy must consider the varying circumstances which are likely to unfold even though they lie beyond the control of the policy makers who still have to deal with the resultant situation. The following scenarios are anticipated each with its own combination of policy, controllable circumstances and circumstances beyond control.

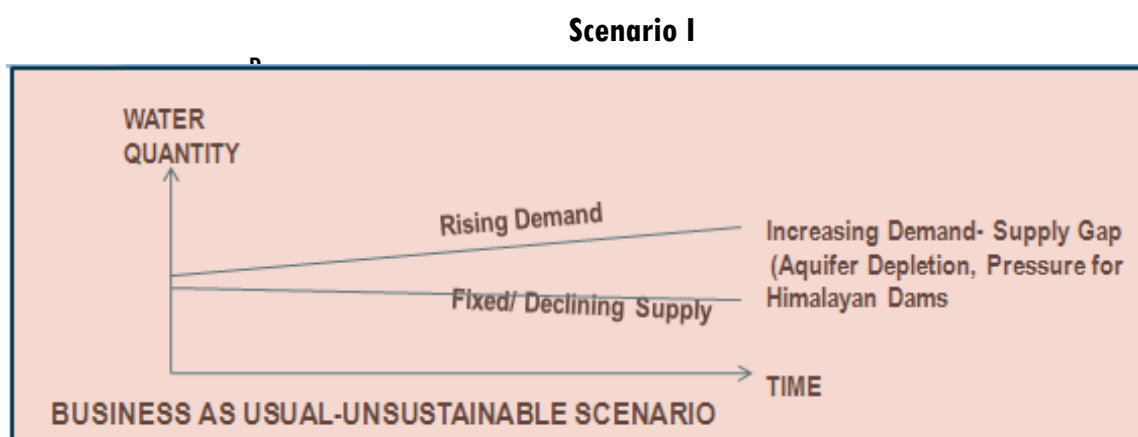
5.2 Controllable circumstances are identified as :

- Demand management [legal, financial and technical instruments plus attitudinal changes brought about amongst users]
- Additionality of resources through recycled resource generation
- Recouping aquifers as a buffer against external water crisis
- Influencing users attitudes
- Improving technology to continuously decrease per capita demand norm

5.3 Circumstances beyond control are identified as:

- Difficulties in augmentation of supplies from Himalyan rivers
- Decrease in river flow due to climate change
- Friction with upstream riparians
- Unanticipated disruption in river/canal supplies

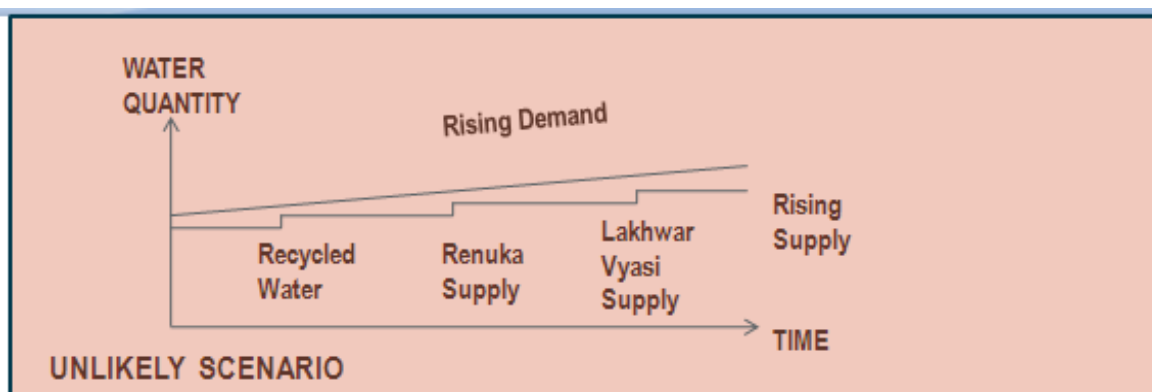
5.4 Five conceptual scenarios and their outcomes are outlined. **Scenario I** : In a business as usual scenario:



- Demand rises continuously in the absence of management
- Supply remains static or even declines under variable river flow as a result of climate change as well as depletion of aquifers

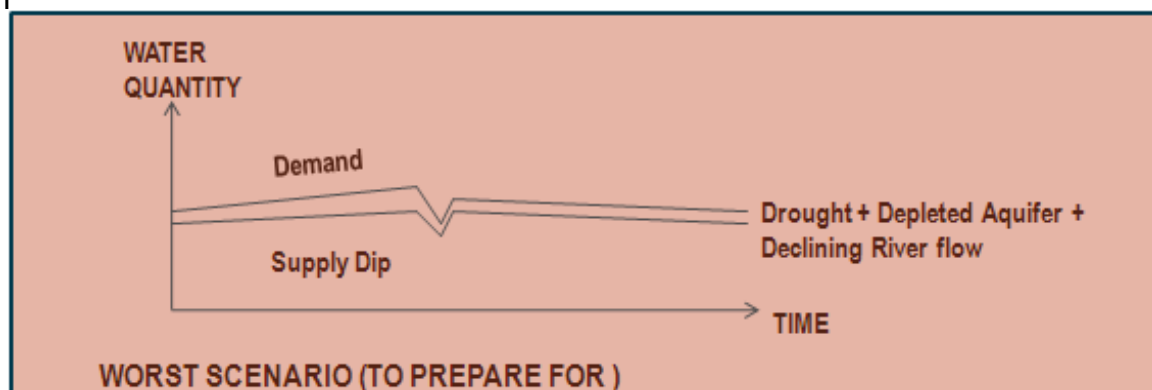
- Initial Demand-Supply gap widens
- Pressure on aquifers mount
- Pressures for implementing dams in Himalyas mount but face insurmountable challenge
- Citizens remain water illiterate - remaining part of the problem rather than contributing to solution

Scenario II



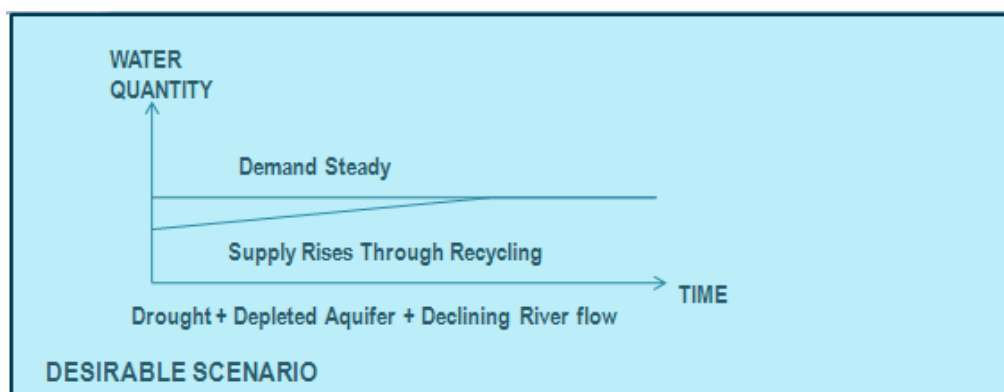
5.5 **Scenario 2 :** Here demand continues to rise but there is little pressure for management as the supply scenario improves. High quality recycled water is partially factored in and upstream reservoirs in the Himalayas are commissioned. Thus, if Renuka dam supply were available there will be no pressure to do today what will ultimately have to be done tomorrow. Given the existing realities about the latter this scenario is unlikely to materialize fully and is undesirable on account of the laxity it may generate to optimize the current resources.

5.6 **Scenario 3:** Occasional drought years have occurred in Delhi when rainfall has been highly deficient



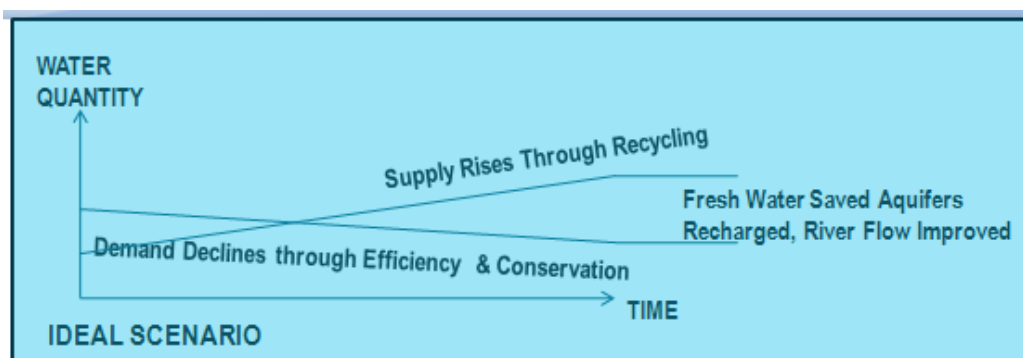
th. Two such years in recent memory are 1987 and 2002 when the rains failed and the aquifer instead of recouping after the monsoon actually declined further. Even this year [2014] a weak monsoon has created jitters with Haryana actually asking Delhi to curtail its requirements. This is actually a disaster management scenario which may get compounded if combined with reduced river flow and/or a more than 1 year rainfall failure. NCT Delhi needs to anticipate such a situation and plan for it. Only fully

recouped aquifers would help manage such a disaster situation along with forced reduction in demand by citizens.



5.7 Scenario 4: In this scenario demand is managed and stabilized at existing levels even as population rises. This is achieved by a water literate citizenry, technological improvements, financial and legal regulations. The supply side is improved through recycled water to match demand. The conveyance losses have been curtailed to 15% of supply. The increasing contribution of recycled water can offset drought crises, aquifer depletion and declining availability from river.

Scenario V



5.8 Scenario 5: In this scenario demand is exceedingly well managed to bring about an absolute reduction in demand from present levels. This is brought about with citizen cooperation in lowering the per capita norm. On the other hand the supply is increased through recycling large volumes of water using advanced innovative technology, reduction of conveyance losses to 5% of supply resulting in a situation of excess supply over demand. This enables not only overcoming crisis situations, but building of resilience by recouping aquifers [Delhi's only internal reserves] and adapting to vagaries of climate change, as well as serving the larger purpose of resource sustainability, economic sustainability, river ecology and flow.

5.9 Obviously, policy formulation must be directed towards attaining the ideal scenario so that at least the desirable scenario can be attained.

CHAPTER VI : SURVEY OF NATIONAL AND STATE WATER POLICIES

6.1. The National Water Policy of 2002 set the stage for the States to evolve their own water policies. NCT Delhi is an untypical City State which unlike other states has a small land mass, is an urbanized human dominated landscape, with few internal resources and largely dependent on external resources. Thus, many of the issues relevant to other States have no bearing on the challenges facing Delhi — for eg. land acquisition issues for dams or R & R issues or irrigation are irrelevant here. Still, a survey of the National Water Policy and a sampling of State Water Policies are in order at this point to draw useful inferences for policy formulation in Delhi.

6.1.1 The typical heads covered by the State Water Policies are as follows :

- The Need for a State Water Policy
- Information System
- Maximizing Water Availability
- Project Planning
- Maintenance and Modernization
- Safety of Structures
- Groundwater Development
- Water Allocation Priorities
- Drinking Water
- Irrigation Water
- Participation of Water Users
- Water Quality Monitoring
- Water Zoning
- Water Conservation and Efficiency of Utilization
- Flood Control and Drainage Management
- Drought Management
- Training and Education
- Legislation and Regulation

6.2 National Water Policy, 2002

6.2.1 The National Water Policy, 2002 is a landmark document with a very broad canvas. The policy framers recognizing the vast range of varying conditions to be governed by a National Policy stuck to broad

principles and enjoining each state to formulate its own water policy in consonance with local conditions within a period of 2 years.

- 6.2.2 By the 1980s, it became evident that while water was largely a state subject, the lack of a National Policy on water was a major impediment to the development of coherent water policies. This led to the development of the National Water Policy (1987) that was reviewed; updated and revised document called National Water Policy 2002[duly approved by National Water Resources Council] and accepted by the States and Union Territories. It stipulates optimization of efficiency of utilization in all diverse usage of water and an awareness of water as a scarce resource. It further focuses on developing a data bank, estimating the available water, prioritizing water (with access to drinking water accorded priority), developing groundwater rules, meeting drinking water needs, developing irrigation facilities, encouraging the participation of stakeholders in water management, monitoring water quality, promoting conservation consciousness, developing a flood control and management system, using cost effective measures to minimize erosion, maintenance and modernization of water works, ensuring the safety of structures built on water bodies, developing relevant science and technology, and training of personnel. The revised document lays emphasis on the development of an improved institutional framework with a focus on the performance of the institutions, promotion of rehabilitation schemes for the displaced, enhancing participation by private parties in water management, developing an effective monitoring system, and ensuring that states share the waters of a joint river. The National Policy has been supplemented by state water policies. The national and state policies are based on similar principles: water as a natural or economic resource that can be harnessed to foster the productive capacity of the economy, from irrigation water for agricultural production to water for hydropower; and priority of use that should be allocated in the following order: drinking water, irrigation, hydropower, ecology, agro-industries and non-agricultural industries, navigation and other uses. Safe water is essential for sustenance of life. Drinking water is a basic need and this has been well recognized by the government of India. The National Water Policy (2002), gives overriding priority to drinking water over other uses and inclusion of a provision for it, was made mandatory in all water development projects. It states that adequate safe drinking water facilities should be provided to the entire population both in urban and in rural areas; irrigation and multipurpose projects should invariably include a drinking water component, wherever there is no alternative source of drinking water; essential needs of human beings and animals. These should be the first charge on any available water resources. (National Water Policy 2002: §5; Rajasthan State Water Policy 1999: §8). Domestic uses of water have overriding priority in water allocation. Nevertheless, some policies also provide that this priority list can be changed if circumstances so require, thus ensuring that there is little substance in the prioritization (Maharashtra State Water Policy 2003: §4; Rajasthan State Water Policy (1999: §8).’ — ‘India : Evolution Of Water Law & Policy by Phillippe Cullet and Joyeeta Gupta in Joseph W. Dellapenna&Joyeeta Gupta eds, *The Evolution of the Law and Politics of Water*, p.169, 2009).

6.2.3 Relevant extracts from the National Water Policy, 2002 have been reproduced here :

- ❖ Availability of water is highly uneven in both space and time. Precipitation is confined to only about three or four months in a year and varies from 100 mm in the western parts of Rajasthan to over 10000 mm at Cherrapunji in Meghalaya. Rivers and under ground aquifers often cut across state boundaries. Water, as a resource is one and indivisible: rainfall, river waters, surface ponds and lakes and ground water are all part of one system.
- ❖ Water is part of a larger ecological system. Realizing the importance and scarcity attached to the fresh water, it has to be treated as an essential environment for sustaining all life forms.
- ❖ Water is a scarce and precious national resource to be planned, developed, conserved and managed as such, and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the States. It is one of the most crucial elements in developmental planning. As the country has entered the 21st century, efforts to develop, conserve, utilize and manage this important resource in a sustainable manner, have to be guided by the national perspective.
- ❖ Floods and droughts affect vast areas of the country, transcending state boundaries. One-sixth area of the country is drought-prone. Out of 40 million hectare of the flood prone area in the country, on an average, floods affect an area of around 7.5 million hectare per year. Approach to management of droughts and floods have to be co-ordinated and guided at the national level.
- ❖ Growth process and the expansion of economic activities inevitably lead to increasing demands for water for diverse purposes: domestic, industrial, agricultural, hydro-power, thermal-power, navigation, recreation, etc. So far, the major consumptive use of water has been for irrigation.
- ❖ Production of food grains has increased from around 50 million tonnes in the fifties to about 208 million tonnes in the Year 1999-2000. This will have to be raised to around 350 million tonnes by the year 2025 AD. The drinking water needs of people and livestock have also to be met. Domestic and industrial water needs have largely been concentrated in or near major cities. However, the demand in rural areas is expected to increase sharply as the development programmes improve economic conditions of the rural masses. Demand for water for hydro and thermal power generation and for other industrial uses is also increasing substantially. As a result, water, which is already a scarce resource, will become even scarcer in future. This underscores the need for the utmost efficiency in water utilisation and a public awareness of the importance of its conservation.

- ❖ Water quality and improvement in existing strategies, innovative new technologies resting on strong science and technology based are needed to eliminate the pollution of surface and ground water to improve water quality.

Information System

- ❖ A well developed information system, for water related data in its entirety, at the national / state level, is a prime requisite for resource planning. A standardised national information system should be established with a network of data banks and data bases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities.
- ❖ Standards for coding, classification, processing of data and methods / procedures for its collection should be adopted. Advances in information technology must be introduced to create a modern information system promoting free exchange of data among various agencies. Special efforts should be made to develop and continuously upgrade technological capability to collect, process and disseminate reliable data in the desired time frame.
- ❖ Apart from the data regarding water availability and actual use, the system should also include comprehensive and reliable projections of future demands of water for diverse uses.

Water Allocation Priorities

- ❖ In the planning and operation of systems, water allocation priorities should be broadly as follows:
 - Drinking water
 - Irrigation
 - Hydro-power
 - Ecology
 - Agro-industries and non-agricultural industries
 - Navigation and other uses

However, the priorities could be modified or added if warranted by the area / region specific considerations.

Ground Water Development

- ❖ There should be a periodical reassessment of the ground water potential on a scientific basis, taking into consideration the quality of the water available and economic viability of its extraction.

- ❖ Exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity. The detrimental environmental consequences of overexploitation of ground water need to be effectively prevented by the Central and State Governments. Ground water recharge projects should be developed and implemented for improving both the quality and availability of ground water resource.
- ❖ Integrated and coordinated development of surface water and ground water resources and their conjunctive use should be envisaged right from the project planning stage and should form an integral part of the project implementation.

Financial and Physical Sustainability

- ❖ Besides creating additional water resources facilities for various uses, adequate emphasis needs to be given to the physical and financial sustainability of existing facilities. There is, therefore, a need to ensure that the water charges for various uses should be fixed in such a way that they cover at least the operation and maintenance charges of providing the service initially and a part of the capital costs subsequently. These rates should be linked directly to the quality of service provided. The subsidy on water rates to the disadvantaged and poorer sections of the society should be well targeted and transparent.

Private Sector Participation

- ❖ Private sector participation should be encouraged in planning, development and management of water resources projects for diverse uses, wherever feasible. Private sector participation may help in introducing innovative ideas, generating financial resources and introducing corporate management and improving service efficiency and accountability to users. Depending upon the specific situations, various combinations of private sector participation, in building, owning, operating, leasing and transferring of water resources facilities, may be considered.

Water Quality

- ❖ Both surface water and ground water should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality
- ❖ Effluents should be treated to acceptable levels and standards before discharging them into natural streams.
- ❖ Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations.

- ❖ Principle of 'polluter pays' should be followed in management of polluted water.
- ❖ Necessary legislation is to be made for preservation of existing water bodies by preventing encroachment and deterioration of water quality.

Water Zoning

- ❖ Economic development and activities including agricultural, industrial and urban development, should be planned with due regard to the constraints imposed by the configuration of water availability.
- ❖ There should be water zoning of the country and the economic activities should be guided and regulated in accordance with such zoning.

Conservation of Water

- ❖ Efficiency of utilisation in all the diverse uses of water should be optimised and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives.
- ❖ The resources should be conserved and the availability augmented by maximising retention, eliminating pollution and minimising losses. For this, measures like selective linings in the conveyance system, modernisation and rehabilitation of existing systems including tanks, recycling and re-use of treated effluents and adoption of traditional techniques like mulching or pitcher irrigation and new techniques like drip and sprinkler may be promoted, wherever feasible.

Flood Control and Management

- ❖ There should be a master plan for flood control and management for each flood prone basin.
- ❖ Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.
- ❖ While physical flood protection works like embankments and dykes will continue to be necessary, increased emphasis should be laid on non-structural measures such as flood forecasting and warning, flood plain zoning and flood proofing for the minimization of losses and to reduce the recurring expenditure on flood relief.

Science and Technology

- ❖ For effective and economical management of our water resources, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, including the following:
 - hydrometeorology;
 - Snow and lake hydrology;
 - Surface and ground water hydrology;
 - River morphology and hydraulics;
 - assessment of water resources;
 - water harvesting and ground water recharge;
 - water quality;
 - water conservation;
 - evaporation and seepage losses;
 - recycling and re-use;
 - better water management practices and improvements in operational technology;
 - crops and cropping systems;
 - risk analysis and disaster management;
 - use of remote sensing techniques in development and management;
 - use of static ground water resource as a crisis management measure;
 - sedimentation of reservoirs;
 - environmental impact;
 - regional equity;
 - Seismology and seismic design of structures;
 - the safety and longevity of water-related structures;
 - economical designs for water resources projects.

Conclusion

- 6.2.4 In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community needs to be taken into account for water resources development and management. The success of the National Water Policy will depend entirely on evolving and maintaining a national consensus and commitment to its underlying principles and objectives. **Since it has no judicial standing a National Law may become necessary.** To achieve the desired objectives, State Water Policy backed with an operational action plan shall be

formulated in a time bound manner say in two years. National Water Policy may be revised periodically as and when need arises.

6.2.5 The inferences for NCT Delhi in the NWP document can be drawn as follows :

- ❖ **Sectoral and spatial demands for water will increase all over the State. As a result, water, which is already a scarce resource, will become even scarcer in future.**
- ❖ **Water is an essential ecological resource and this requires efficient use and conservation**
- ❖ **A well developed information system, for water related data in its entirety, at the national / state level, is a prime requisite for resource planning**
- ❖ **Society has to be educated to bring about attitudinal changes to respect water availability. Such changes in attitude can also be brought about by legal formulations as well as financial incentives and disincentives.**
- ❖ **In the planning and operation of systems, water allocation priorities should be broadly as follows:**
 - **Drinking water**
 - **Irrigation**
 - **Ecology**
 - **Agro-industries and non-agricultural industries**
 - **Navigation and other uses**

However, the priorities could be modified or added if warranted by the area / region specific considerations.

- ❖ **Groundwater use must be sustainable with a regular assessment of potential and quality and with an emphasis on recharge projects and conjunctive use of surface and ground waters**
- ❖ **Financial sustainability of services must be ensured while giving due consideration to the needs of disadvantaged sections**
- ❖ **Efficiency of utilisation in all the diverse uses of water should be optimized and this should be attained through awareness as well as financial instruments**
- ❖ **Science and technology need to be harnessed in pushing forward the frontiers of hydro-meteorology, surface and groundwater relations, recycling and reuse, remote sensing techniques for development, use of static groundwater reserve for crisis management**

6.3 National Water Policy 2012 : Several macro — issues were raised by the States after which the Policy was adopted on 28 December, 2012. The relevant extracts are reproduced below :

“India has more than 17 percent of the world’s population, but has only 4% of world’s renewable water resources with 2.6% of world’s land area. There are further limits on utilizable quantities of water owing to uneven distribution over time and space. In addition, there are challenges of frequent

floods and droughts in one or the other part of the country. With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups. Low consciousness about the scarcity of water and its life sustaining and economic value results in its mismanagement, wastage, and inefficient use, as also pollution and reduction of flows below minimum ecological needs. In addition, there are inequities in distribution and lack of a unified perspective in planning, management and use of water resources. The objective of the National Water Policy is to take cognizance of the existing situation, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified National perspective.

- Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security.
- Issues related to water governance have not been addressed adequately.
- Mismanagement of water resources has led to a critical situation in many parts of the country.
- There is wide temporal and spatial variation in availability of water, which may increase substantially due to a combination of climate change, causing deepening of water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc.
- Climate change may also increase the sea levels. This may lead to salinity intrusion in ground water aquifers / surface waters and increased coastal inundation in coastal regions, adversely impacting habitations, agriculture and industry in such regions.
- Access to safe water for drinking and other domestic needs still continues to be a problem in many areas. Skewed availability of water between different regions and different people in the same region and also the intermittent and unreliable water supply system has the potential of causing social unrest.
- Groundwater, though part of hydrological cycle and a community resource, is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas.
- Inter-regional, inter-State, intra-State, as also inter-sectoral disputes in sharing of water, strain relationships and hamper the optimal utilization of water through scientific planning on basin/sub-basin basis
- Natural water bodies and drainage channels are being encroached upon, and diverted for other purposes. Groundwater recharge zones are often blocked.
- Growing pollution of water sources, especially through industrial effluents, is affecting the availability of safe water besides causing environmental and health hazards. In many parts of

the country, large stretches of rivers are both heavily polluted and devoid of flows to support aquatic ecology, cultural needs and aesthetics.

- Access to water for sanitation and hygiene is an even more serious problem. Inadequate sanitation and lack of sewage treatment are polluting the water sources.
- Low public consciousness about the overall scarcity and economic value of water results in its wastage and inefficient use.
- The lack of adequate trained personnel for scientific planning, utilizing modern techniques and analytical capabilities incorporating information technology constrains good water management.
- A holistic and inter-disciplinary approach at water related problems is missing.
- The public agencies in charge of taking water related decisions tend to take these on their own without consultation with stakeholders, often resulting in poor and unreliable service characterized by inequities of various kinds.

Public policies on water resources need to be governed by certain basic principles, so that there is some commonality in approaches in dealing with planning, development and management of water resources. These basic principles are:

- Planning, development and management of water resources need to be governed by common integrated perspective considering local, regional, State and national context, having an environmentally sound basis, keeping in view the human, social and economic needs.
- Principle of equity and social justice must inform use and allocation of water.
- Good governance through transparent informed decision making is crucial to the objectives of equity, social justice and sustainability. Meaningful intensive participation, 3 transparency and accountability should guide decision making and regulation of water resources.
- Water needs to be managed as a common pool community resource held, by the state, under public trust doctrine to achieve food security, support livelihood, and ensure equitable and sustainable development for all.
- Water is essential for sustenance of eco-system, and therefore, minimum ecological needs should be given due consideration.
- Water, after meeting the pre-emptive needs for safe drinking water, sanitation and high priority allocation for other domestic needs (including needs of animals), achieving food security, supporting sustenance agriculture and minimum eco-system needs, may be treated as economic good so as to promote its conservation and efficient use.

- Given the limits on enhancing the availability of utilizable water resources and increased variability in supplies due to climate change, meeting the future needs will depend more on demand management, and hence, this needs to be given priority, especially through
 - (a) evolving an agricultural system which economizes on water use and maximizes value from water, and
 - (b) bringing in maximum efficiency in use of water and avoiding wastages.
- Water quality and quantity are interlinked and need to be managed in an integrated manner, consistent with broader environmental management approaches inter-alia including the use of economic incentives and penalties to reduce pollution and wastage.
- The impact of climate change on water resources availability must be factored into water management related decisions. Water using activities need to be regulated keeping in mind the local geo climatic and hydrological situation.

Water Framework Law

- Even while it is recognized that States have the right to frame suitable policies, laws and regulations on water; there is a felt need to evolve a broad over-arching national legal framework of general principles on water to lead the way for essential legislation on water governance in every State of the Union and devolution of necessary authority to the lower tiers of government to deal with the local water situation.
- Such a framework law must recognize water not only as a scarce resource but also as a sustainer of life and ecology. Therefore, water needs to be managed as a community resource held, by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all. Existing Acts, such as Indian Easements Act, 1882, Irrigation Acts, etc., may have to be modified accordingly in as much as it appears to give proprietary rights to a land owner on groundwater under his/her land.
- There is a need for comprehensive legislation for optimum development of inter-State rivers and river valleys to facilitate inter-State coordination ensuring scientific planning of land and water resources taking basin/sub-basin as unit with unified perspectives of water in all its forms (including precipitation, soil moisture, ground and surface water) and ensuring holistic and balanced development of both the catchment and the command areas. Such legislation needs, inter alia, to deal with and enable establishment of basin authorities with appropriate powers to plan, manage and regulate utilization of water resource in the basins

USES OF WATER

- Water is required for domestic, agricultural, hydro-power, thermal power, navigation, recreation, etc. Utilization in all these diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered.

- The Centre, the States and the local bodies (governance institutions) must ensure access to a minimum quantity of potable water for essential health and hygiene to all its citizens, available within easy reach of the household.
- Ecological needs of the river should be determined, through scientific study, recognizing that the natural river flows are characterized by low or no flows, small floods (freshets), large floods, etc., and should accommodate developmental needs. A portion of river flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use.
- Community should be sensitized and encouraged to adapt first to utilization of water as per local availability of waters, before providing water through long distance transfer. Community based water management should be institutionalized and strengthened.

Adaptation To Climate Change

- Climate change is likely to increase the variability of water resources affecting human health and livelihoods. Therefore, special impetus should be given towards mitigation at micro level by enhancing the capabilities of community to adopt climate resilient technological options.
- The adaptation strategies could, inter alia, include increasing water storage in its various forms, namely, soil moisture, ponds, ground water, small and large reservoirs, and their combination, which provides a mechanism for dealing with increased variability because of climate change.

Enhancing Water Available For Use

- There is a need to map the aquifers to know the quantum and quality of ground water resources (replenishable as well as non-replenishable) in the country. This process should be fully participatory involving local communities. This may be periodically updated.
- Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use, incentivizing efficient water use and encouraging community based management of aquifers. In addition, where necessary, artificial recharging projects should be undertaken so that extraction is less than the recharge. This would allow the aquifers to provide base flows to the surface system, and maintain ecology.

Water Pricing

- For the pre-emptive and high priority uses of water for sustaining life and ecosystem for ensuring food security and supporting livelihood for the poor, the principle of differential pricing may have to be retained. Over and above these uses, water should increasingly be subjected to allocation and pricing on economic principles.
- A Water Regulatory Authority (WRA) should be established in each State. The Authority, inter-alia, will fix and regulate the water tariff system and charges, in general, according to the

principles stated in this Policy in an autonomous manner. Such tariff will be periodically reviewed.

- Recycle and reuse of water, after treatment to specified standards, should also be incentivized through a properly planned tariff system.

Conservation of River Corridors, Water Bodies and Infrastructure

- Conservation of river corridors, water bodies and infrastructure should be undertaken in a scientifically planned manner through community participation. The storage capacities of water bodies and water courses and/or associated wetlands, the flood plains, ecological buffer and areas required for specific aesthetic recreational and/or social needs may be managed to the extent possible in an integrated manner to balance the flooding, environment and social issues as per prevalent laws.
- Encroachments and diversion of water bodies (like rivers, lakes, tanks, ponds, etc.) and drainage channels (irrigated area as well as urban area drainage) must not be allowed, and wherever it has taken place, it should be restored to the extent feasible and maintained properly.
- Urban settlements, encroachments and any developmental activities in the protected upstream areas of reservoirs/water bodies, key aquifer recharge areas that pose a potential threat of contamination, pollution, reduced recharge and those endanger wild and human life should be strictly regulated.
- Environmental needs of aquatic eco-system, wet lands and embanked flood plains need to be recognized and taken into consideration while planning.
- Quality conservation and improvements are even more important for ground waters, since cleaning up is very difficult. It needs to be ensured that industrial effluents, local cess pools, residues of fertilizers and chemicals, etc., do not reach the ground water.

Water Supply and Sanitation

- Least water intensive sanitation and sewerage systems with decentralized sewage treatment plants should be incentivized.
- Reuse of urban water effluents from kitchens and bathrooms, after primary treatment, in flush toilets should be encouraged.
- Urban domestic water systems need to collect and publish water accounts and water audit reports indicating leakages and pilferages, which should be reduced taking into due consideration social issues.
- In urban and industrial areas, rainwater harvesting and de-salinization, wherever techno-economically feasible, should be encouraged to increase availability of utilizable water. Implementation of rainwater harvesting should include scientific monitoring of parameters like hydrogeology, groundwater contamination, pollution and spring discharges.

- Urban water supply and sewage treatment schemes should be integrated and executed simultaneously. Water supply bills should include sewerage charges.

Implementation of National Water Policy

- The State Water Policies may need to be drafted/ revised in accordance with this policy keeping in mind the basic concerns and principles as also a unified national perspective.”

- Critics of the Policy pointed out :
- Paradigm shift in approach from service provider of water to facilitator of service.
- Policy does not deter use among those who can afford to pay for water.
- PPP mode may not ensure equity.
- Policy does not follow polluter pay principle, rather it gives incentives for effluent treatment.
- Policy was criticized for terming Water as an economic good.

6.4 State Water Policies

6.4.1 Several states have drawn up their water policies and relevant features from some of them have been extracted in this survey. Again the canvas of the states is rather broad and only a few aspects are relevant to Delhi. Still, a general policy direction seems to emerge from these documents. The policies also introduce wide-ranging legal and institutional reforms, of which three are significant: the introduction of a legal framework for the formation of water user associations to decentralize water governance; the introduction of laws providing for the establishment of a water resources authority whose primary characteristic is to be largely independent from existing system where there is lack of clarity between the service provider and regulating authority; and the regulation of groundwater.

6.4.2 KARNATAKA STATE WATER POLICY

1. The preamble to the policy recognizes the state's limited water endowment and the challenge of rapidly growing water demand which are bringing the state under water stress. Unless water resources are properly developed and managed, the State will face acute crisis within the next two decades and serious destabilization of the water sector affecting the hydrology, economy and ecology of the State is likely.
2. After an overview of the status of water resources of the state the policy lays down objectives as follows :
 - ❖ Provide drinking water at the rate of 55 litres per person per day in the rural areas, 70 litres per person per day in towns and 100 litres per person per day in the city municipal council areas and 135 litres per person per day in city corporation areas.

- ❖ Create an ultimate irrigation potential of 45 lakh hectares under major, medium and minor irrigation projects. Facilitate creation of an additional irrigation potential of 16 lakh hectares by individual farmers using ground water.
- ❖ Improve performance of all water resources projects.
- ❖ Improve productivity of irrigated agriculture by involving users in irrigation management.
- ❖ Harness the hydropower potential of the State.
- ❖ Provide a legislative, administrative and infrastructural environment, which will ensure fair, just and equitable distribution and utilization of the water resources of the State to benefit all the people of the State.

3. **Future Vision:**

- ❖ Water resources planning, development and management will be carried out adopting an integrated approach for a hydrological unit such as River basin as a whole or for a sub basin, multi-sectorally, conjunctively for surface and ground water incorporating quantity, quality and environmental considerations.
- ❖ Appropriate cropping patterns will be adopted in co-ordination with the Agriculture Department. Drip and sprinkler irrigation to improve water use efficiency will be promoted. Irrigation and multi purpose projects will invariably include drinking water component.

4. **Institutional Arrangement**

- ❖ For multi-sectoral water planning, inter sectoral water allocation, planning of water development programmes, management decisions, and resolution of water resources issues, a State Water Resources Board will be established. The Water Resources Development Organization will act, as technical secretariat for the State Water Resources Board. A State Water Resources Data and Information Center will also be established.

5. **Allocation Priorities**

In planning and operation of water resources projects, water allocation priorities shall be broadly as follows :

- a. Drinking water
- b. Irrigation
- c. Hydropower
- d. Aquaculture
- e. Agro industries
- f. Non-Agricultural Industries
- g. Navigation and other uses

6. Water Rates

Water rates for various uses will be revised in a phased manner and fixed so as to cover at least the operation and maintenance charges of providing services.

7. Ground Water Recharge

Periodical reassessment of the groundwater potential on a scientific basis will be undertaken. Exploitation of groundwater resources will be regulated so as not to exceed the recharge capabilities. Ground water recharge project will be formulated and implemented.

8. Rainwater Harvesting and Water Conservation

The efficiency of utilization of water will be improved and awareness about water as a scarce resource fostered. Rainwater harvesting and water conservation will be encouraged. Conservation consciousness will be promoted through education, regulation incentives and disincentives.

9. Disaster Management

Disaster management strategy for drought and floods will be formulated.

6.4.3 UTTAR PRADESH STATE WATER POLICY [1999]

1. UP formulated its water policy in 1999 under the aegis of the 1987 National Water policy. The documents substantially reflects the text of the national policy with only a few differences as to specifics based on the state's individual characteristics.
2. The state is endowed with bountiful water resources which were considered abundant but because of increasing demand for various purposes namely irrigation, drinking and domestic, power (thermal and hydro), industrial and other uses, its scarcity is becoming apparent which shall get more pronounced with increasing population. Water is a prime natural resource, a basic human need and a precious asset. Planning and development of water resources of the state need to be governed by the development perceptions of the state.

3. Water Availability :

In Irrigation sector, which has so far been the principal consumptive user, about 43.8 BCM (35.5 m.a.f.) of surface water and about 27 BCM (21.9 m.a.f.) (net) of ground water has been utilised out of the total of about 161.70 BCM (131.0 m.a.f.) of surface water and about 72 BCM (58.4 m.a.f.) exploitable (Total replenish able 84 BCM or 68.1 m.a.f.) ground water resource of the state. Another about 27.8 BCM (22.5 m.a.f.) of surface water shall get utilised after completion of on-going projects. 43.2 BCM (35 m.a.f.) is the quantity which can not be

utilised at present. Thus there remains only about 22.2 BCM (18.0 m.a.f). Which can be utilised for future irrigation projects after reserving about 24.7 BCM (20 m.a.f.) for drinking industrial and pollution control.

State has a total of about 20 mha. of culturable land out of which about 17.4 mha. is presently under agriculture. For a projected population of 270 million by the year 2020 the food grain requirement has been assessed as 63 million tones. With the present irrigation and other inputs a productivity level of about 1.7 t/ha. has been achieved. A productivity level of 3.4 t/ha. will have to be achieved to meet the projected food grain requirements. In order to achieve this target, in addition to other inputs, irrigation facilities shall have to be adequately provided by harnessing the untapped potential and also by bringing about improvement in the management of water resources.

Water for drinking and domestic use has the highest priority while allocating the water resource of the state. The state has to provide adequate drinking water facilities (both for people and livestock) to the entire population in both urban and rural areas upto the year 2025. Sanitation facilities for entire population in urban areas and most of the rural areas should also be provided.

4. Hydro Power :

The state's hydro potential has been assessed as 15000 mw against which about 1500 mw has been harnessed so far. In addition, a potential of about 15000 mw has been assessed for the projects which lie in Nepalese territory. The state has been perennially short of power. Apart from shortfall in total energy requirements, the shortage of peak power is more acute. Hydel power is most suitable to take up the peak loads in addition to being environment friendly and using renewable resource.

5. Industry:

The present industrial status of the state calls for a quantum jump in industrial development, which shall have substantial requirement of water to be used consumptively. Adequate provision in water resource planning shall be made for industrial use also.

6. Ecology & Health:

Adequate provision for ecological, navigational, recreational and other purposes has also to be made. The quantity of water, its protection against pollution and safe guards against water related health hazards are also key concerns.

7. OBJECTIVES:

Having realized the need for formulation of state water policy as stated herein above the broad objectives of the water policy for Uttar Pradesh shall be:

- a. Ensure preservation of the scarce water resources and to optimise the utilization of the available resources.

- b. Bring about qualitative improvement in water resource management which should include user's participation and decentralization of authority.
- c. Maintain water quality, both surface and underground, to established norms and standards.
- d. Promote formulation of projects as far as and whenever possible on the concept of basin or sub-basin, treating both surface and the ground water as a unitary resource, ensuring multipurpose use of the water resource. This would inter alia consist of the following main uses:
 - i. Provide adequate water for drinking and domestic use.
 - ii. Providing water for irrigation.
 - iii. Maximize hydro power generation within the constraints imposed by other users.
 - iv. Provide water for industries including Agro industries.
 - v. Provide water for navigation, recreation, health and for other uses.
- e. Ensure ecological and environmental balance while developing water resources.
- f. Promote equity and social justice among individuals and groups of users in water resource allocation and management.
- g. Ensure self-sustainability in water resource development.
- h. Ensure Flood Management and drainage as integral part of water resource development.
- i. Provide a substantive legal framework for management.
- j. Provide a Management Information System (M.I.S.) for effective monitoring of policy implementation.
- k. Promote research and training facilities in the water resource sector.
- l. Provide mechanism for the resolution of conflicts between various users.

8. INFORMATION SYSTEM:

The prime requisite for resource planning is a well-developed information system. A standardised information system should be established with a network of data banks and data bases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities through suitable legislation for the purpose.

Standards for coding, classification, processing and methods/procedures for data should be adopted. Advances in information technology must be introduced to create a modern information system promoting free exchange of data among the various agencies. Special efforts should be made to develop and continuously upgrade technological capability to collect, process and disseminate reliable data in the desired time frame.

Apart from the data regarding water availability and actual water use, the system should also include comprehensive and reliable projections of future demands of water for diverse purpose.

9. Data Base:

Long term, strong and reliable data base is the prime requisite for water resources planning. The existing information and data collection system should be modernized and strengthened by making it more extensive and improving the quality of data and processing capabilities.

10. Ecology & Environment:

All water resources projects should be examined from ecological and environmental considerations and remedial measures wherever needed should form a part of the project itself and implemented along with it. A minimum flow in the natural streams should be allowed.

11. Water Harvesting:

Water harvesting should be given consideration in planning water resources. Viable projects, specially in scarce ground water areas, should be investigated and implemented to increase the surface water availability would also help in recharging the ground water.

12. Flood Protection:

Flood protection should be considered as an essential component while planning water resources of a basin or sub-basin.

13. ALLOCATION PRIORITIES:

In the planning and operation of systems, the state, water allocation priorities should be broadly as below:-

- Drinking water
- Irrigation
- Hydro & Thermal Power
- Agro- industries non agricultural industries
- Navigation & other uses

However, these priorities might be modified if necessary in particular region with reference to area specific considerations.

14. DROUGHT MANAGEMENT:

Drought-prone areas should be made less vulnerable to drought-associated problems through soil-moisture conservation measures, water harvesting practices, the minimisation of evaporation losses, development of the ground water potential including recharging and the transfer of surface water from surplus areas where feasible and appropriate. Pastures, forestry or other modes of development with relatively less water-demanding should be encouraged. In planning water resource development projects, the needs of drought-prone areas should be given priority.

Relief works undertaken for providing employment to drought stricken populations should preferably be for drought proofing.

15. GROUND WATER:

Present Status:

For the proper management of ground water resource which should ensure optimal utilisation and avoid over exploitation, the following aspects should be duly addressed.

1. Demand side management and conservation through the spread of efficient irrigation technologies, such as piping drip and sprinkler irrigation is essential.
2. Opportunities for and constraints on the spread of low water intensity cropping patterns should be investigated as a component of demand side management.
3. Conjunctive Use: Conjunctive management and ground water recharge should be central to ground water management. To augment the ground water by artificial means surplus monsoon runoff between sub-basin within river systems should be transferred and stored in the available aquifers, by applying different appropriate recharge techniques such as, construction of recharge ponds/percolation tank and desiltation of existing ponds, construction of recharge shafts in the existing ponds, construction of gravity head recharge wells and conversion of existing tube wells/wells into gravity head recharge well, construction of water conservation structures such as Nala Bunds, Contour Bunds, Gully plugs etc, construction of recharge basin etc. in the dark & gray blocks. However, while undertaking any recharge project, it must be ensured that such projects do not pollute the ground water aquifer.
4. Regulation: Methods to restrict ground water exploitation in the regions where the ground water is depleting at fast rate should also be considered keeping in view other constraints.

16. DRINKING WATER:

Drinking water and domestic needs of all the urban and rural population is to be fully met by the year 2025. The allocation to meet these requirement shall be the first charge on the water resources of the state.

17. Perspective Plan:

A perspective plan upto 2025 to meet this requirement shall be prepared and steps taken to provide adequate resources for this purpose in a phased manner both from state sources and by raising funds from various quarters. Efforts shall be made to make the water supplies self-sustaining, at least to meet O & M costs, as far as possible considering the socio-economic conditions of the population to be served. For water supply and sanitation, measures to ensure more efficient accessible delivery of water resources and sewage collection, treatment and disposal with the ultimate aim to provide universal coverage shall be adopted and enforced.

18. ECOLOGICAL HEALTH RECREATIONAL AND OTHER NEEDS :

All the water resources projects shall give due regard to the ecological health and other needs for which adequate provision shall be made on priority basis. While planning water resources, due consideration to development of navigation, whenever feasible shall be given. Even though there is no significant consumptive use for this purpose, yet certain flow restrictions in water ways shall have to enforce.

19. PARTICIPATORY APPROACH TO WATER RESOURCES MANAGEMENT:

The management of the water resources for diverse uses should be done by adopting participatory approach; by involving not only the various Governmental Agencies but also the users and other stakeholders in an effective and decisive way in various aspects of planning, design, development and management of the water resources scheme. Necessary legal and institutional changes should be made at various levels to ensure the implementation of above objectives. Water Users Associations and the local bodies such as Municipalities and Gram Panchayats should particularly be involved in the operation, maintenance and the management of water infrastructures/facilities at appropriate levels progressively with a view to eventually transfer the management of such facilities to the User groups/Local bodies.

20. FINANCIAL AND PHYSICAL SUSTAINABILITY:

Besides creating additional water resources facilities for various uses, adequate emphasis needs to be given to the physical and financial sustainability of existing facilities. There is therefore, a need to ensure that the water charges for various uses should be fixed in such a way that they cover at least the operation and maintenance charges of providing the services initially and a part of the capital costs subsequently. These rates should be linked directly to the quality of service provided.

21. INSTITUTIONAL ARRANGEMENTS:

Presently the water resource planning for various uses is being done by the respective departments. Realising the scarcity value of this resource as also the need for co-ordinate planned development, the state government has constituted a "State Water Board" under the chairmanship of the Chief Secretary.

22. LEGISLATION:

Looking to the scarcity value of water resources and need to conserve and keep this resource pollution free and to ensure its most efficient use, legislation in the following areas need to be considered.

- a) Regulation of exploitation of surface and ground water for diverse uses.
- b) Regulation of discharges made into surface and ground water sources by various agencies.
- c) Regulation in respect to bulk supply of water for irrigation and other purposes to associations.
- d) Creation of water rights in favour of users.
- e) Transfer of irrigation systems to users specially in respect of small and marginal farmers.

23. PERFORMANCE IMPROVEMENT:

There is an urgent need of paradigm shift in the emphasis in the management of water resources sector. From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities. Therefore, allocation of funds under the water resources sector should be reprioritized to ensure that

the needs for development as well as operation and maintenance of the facilities are met along with the funds allocated to other activities under the sector.

6.4.4 GUJARAT DRAFT VISION OF WATER SUPPLY AND SANITATION -2010

The Govt. of Gujarat has come out with a detailed draft vision of the water sector. The salient features are instructive:

- **Human Rights**—Access to safe water and sanitation is recognized as a human right and citizens are active partners and managers in water and sanitation services.
- **Water Supply**—Everyone has access through a connection to a regular, reliable, and affordable supply of adequately safe water through systems that are socially acceptable, environmentally sustainable, technologically and economically viable, and managed in a way that is centered on people. Every public tap gives potable water.
- **Water Resources**—Integrated water resources management is practiced at all levels.
- **Sanitation**—Everyone has access to latrines connected to waste disposal systems. All schools have latrines for boys and girls. Slum dwellers also have sanitation.
- **Health and Hygiene**—These are strongly promoted.
- **Information, Education, and Communication**—These are promoted.
- **Equity**—Gender, religion, class, caste, and community equity are attained. Slum settlements are integrated into urban water supply and sanitation systems. Women are involved in decision making for natural resources management. Instances of girls dropping out of school on account of water and sanitation are eliminated.
- **Financial and Economic**—Users are paying for services. They pay according to the level of service they want and are willing to pay for. O&M costs involve communities. Household contributions toward both capital and service costs, routed through communities, make the water supply system more sustainable. Community groups monitor service charges as well as maintenance. Water charges are raised at a progressive rate in urban areas. In urban areas pay-and-use sanitation systems are available.
- **Water Technology**—All urban structures have rainwater harvesting facilities. Local sources predominate in drinking water supply. Tanker supplies are reduced to a minimum. Research and development are promoted. Desalination is introduced.
- **Water Recycling**—All high-rises and large structures have recycling facilities. At least 50% of water used is recycled. Storm water is used to recharge underground aquifers.
- **Sanitation Technology**—Water use is minimized. Manual handling of excreta is banished.
- **State Institutions**—Government monopoly is transformed into facilitation. The Gujarat Water Authority oversees the water sector and undertakes water accounting and auditing. Good governance, transparency, and accountability are practiced. Each district has its own water authority.
- **Civil Society and Market Institutions**—The Gujarat Water Authority, set up as an autonomous body with full stakeholder participation, is the apex organization in charge of regulating all water resources in Gujarat. Civil society is an active participant in it. Water committees are functional in every community. User groups have been trained. Local people's institutions are legally empowered. Thirty percent of larger schemes are maintained through private sector initiatives. Civil society in general and women in particular are involved in planning. A positive and synergistic partnership between communities, government, the private sector, and NGOs is established.
- **Policy, Legislation, and Regulation**—Policy framework toward decentralized control as well as responsibilities is centered on people and gives opportunity for employment creation, leading to greater self-sufficiency and sustainability of services. Gujarat has a water policy and legislation to back up its actions. Drinking water gets first claim on water supplies. A regulatory framework has been developed to encourage and control private operators of water and sanitation services. Recognition and incentives for drinking water and sanitation performance are given. Regional water supply schemes are adopted as a last resort or backup system. Industrial pollution is controlled. Conflict resolution mechanisms are put in place. (National Institute of Design, Gujarat, Jal-Disha, 2000)

6.3.5 Govt. of Gujarat also has a policy checklist which offers insights to the policy spectrum:

- Water supply service coverage
- Tariff policies and objectives
- Sewerage service coverage
- NRW
- Water availability (hours per day)
- Demand management
- Water quality
- Criteria for selecting investments
- Levels of service
- Accountability of utilities
- Service to the urban poor
- Accountability of water
- Water vending
- Accountability of finances
- Bottled water
- Public awareness
- Funding of source development
- Water pollution control
- Funding of capital investments
- Tariff structure
- Trading water rights
- Water extraction (groundwater)
- Subsidies and cross subsidies
- Watershed conservation
- Recovery of O&M costs of sewerage
- Private water supplies
- New connections
- Reselling water
- Operator performance
- PSP
- Operator incentives
- Regulation
- Staff numbers
- Illegal connections
- Wastewater and sanitation
- Institutional responsibilities

More than indifferent monsoons, this scarcity of water has been caused by over exploitation of groundwater and lack of water conservation measures at the micro level. The answer to this monumental challenge that stares at an otherwise resurgent India comes from Gujarat. The state shows the way in the form of a unique government-people partnership model for water conservation.

In 2004, the water table of 112 tehsils of the total 225 tehsils in Gujarat was in semi-critical to over-exploited condition. But a satellite based survey done last year by the Central Ground Water Board (NGWB) found that as many as 60 of these 112 tehsils have regained their normal water table. What's more, the water table is rising further in many of these tehsils. Most of these tehsils are in Saurashtra and Kutch where the farmers and the government together have started a unique check dam revolution.

In the mid-90s, large parts of Saurashtra used to get water through train tankers from water-abundant areas of central and south Gujarat. Today it is a thing of the past. Earlier, many small rivers and rivulets in this region used to go dry by the end of monsoon. Now they have become almost perennial and several villages have become self-sufficient in water.

In the past 10 years, 1,05,000 check dams costing Rs 1,480 crore have been built in Gujarat under the government-people scheme. The villagers have contributed between 10 and 15 per cent of the cost in the form of labour while the Government has done the rest. Around 70,000 of these dams have been piloted by the state irrigation department and the rest by the state rural development department. These dams have a cap of Rs 15 lakh in terms of investment.

The mechanism for these check dam scheme is very simple. As and when a village committee wants to make a dam, it takes the local irrigation engineer to the selected spot. After seeing the spot, the engineer helps them select one of the six technical designs for a check dam. The six designs are finalised by the Government depending on the local geological conditions. Once that is done the department releases funds and the work on the dam begins.

The changes are less evident in north Gujarat where the topography for building check dams is not as conducive and the farmers here are also not very enthusiastic. But in this region also the water level, barring some tehsils where it is falling due to local factors, has been rising for the past two years. Says R.C. Jain, Regional Director of the cgwb and in-charge of Gujarat, "Gujarat has shown that where there is a will there is always a way. This experiment can inspire people in many water starved areas of India."

In 2001, emphasis was laid on creating farm ponds in areas like north and central Gujarat where building check dams was not very feasible. As a result 1,81,00,000 farm ponds have been built till date at a cost of Rs 181 crore. Farm ponds are built in that part of a farm where rain water collection happens in natural course.

In 2003, the Gujarat Government launched the Gujarat Green Revolution Company to propagate sprinkler and drip irrigation technology among farmers by giving them hefty incentives. Rated as the best in the country by the Union Agriculture Ministry for last three years, this initiative is one of the reasons why the groundwater level is getting recharged in the state.

(Source: Indian Today; June 4, 2010)

6.3.6 RAJASTHAN STATE WATER POLICY

1. The Need for a State Water Policy

The State of Rajasthan is the second largest state in the country covering an area of 34.271 Million ha which is more than 10% of the total geographical area of the country. About 5% of the total population of the country resides in the state and it has more than 15.7 million ha of land suitable for agriculture. The State of Rajasthan is one of the driest states of the country and the total surface water resources in the state are only about 1% of the total surface water resources of the country. The rivers of the state are rainfed and identified by 14 major basins divided into 59 subbasins. The surface water resources in the state are mainly confined to south and south-eastern parts of the State. There is a large area in western part of the state which does not have any defined drainage basin. Thus the water resources in the state are not only scarce but have highly uneven distribution both in time and space.

The ground water also plays an important role especially in agriculture and drinking water supply. The situation of ground water exploitation is also not satisfactory as in areas where surface irrigation is provided there is a tendency of not using ground water for agriculture which creates problem of water table rise and even water logging. On the contrary, in large areas of the State, ground water is being over exploited and the water table in some areas is going down even at the rate of 3 metre per year.

2. Policy Objectives

This background leads to the formulation of the following water resources development and management objectives:

- a. Development of all utilisable water resources to the maximum possible extent, including surface water - local and imported -groundwater and waste water, for optimal economic development and social well-being.
- k. Motivating and encouraging water conservation through appropriate and socially acceptable water rates, introduction of water-saving devices and practices in all sectors, and educational campaigns.
- o. Emphasis to be given for recharge of ground water aquifers to mitigate the crisis of drinking water supply and demand of drinking water supply and for industrial and other purposes.

3. Information System

The prime requisite for resources planning is a well developed information system. Timely availability of reliable information, conveniently accessible to all users, is necessary as a tool for integrated planning of new projects, and for following up the performance of existing systems and the status of water resources. Following actions shall be taken in this regard:

- a. Setting up of a central information center for the entire water sector of Rajasthan.
- b. Clear definition of duties and responsibilities of those charged with data collection.
- c. Detailing of main reports to be generated.

4. Maximizing Water Availability

Following actions shall be taken for maximising water availability:

- a. Comprehensive and integrated water resource planning shall be done for the State on the basis of hydrological units i.e. basin or a sub-basin.
- b. Water resources potentials, both surface and ground, shall be assessed.
- c. Basin-wise and State-level water resources development and environmental plans shall be prepared.
- d. Water resources development projects shall be prioritised on economic, social and financial criteria to aid in budget allocation.
- e. Waste water reclamation shall be considered in all basin plans.
- f. Efficient water application and utilization practices shall be encouraged.

5. Central Planning Authority for policy related issues for integrated water resources development and management shall be created.

- Traditional water harvesting practices shall be preserved and encouraged.
- Projects for artificial recharge of ground water shall be prepared.
- Inter basin transfer projects shall be prepared based on a State-wide perspective, after taking into account the requirements within the basins.
- The case for full utilisation of State's share in Ganga waters shall be pursued.

6. Institutional Reforms:

- integrated long and short term planning of water resources development.
- economic analysis and feasibility studies of projects.
- monitoring and evaluation of existing projects.
- drafting annual and multi-annual expenditure programmes for the entire water sector and obtaining approval.
- encourage private initiative in water sector.

7. Groundwater Development

Exploitation of groundwater resources should be so regulated as not to exceed recharging possibilities, and also to ensure social equity. There should be a periodical reassessment on a scientific basis of groundwater potentials, taking into consideration the quality of the water available and economic viability. Following steps shall be taken in this regard:

- **Legal** : Existing laws shall be amended /new legislation shall be enacted.
- **Organisational** :Organisational structures and procedures shall be changed. Attempt to control deep drilling through licensing and control on private operators shall be made.
- **Social**: Public awareness for self-control in ground water exploitation from WUAs shall be fostered.

- **Educational:** Sense of water scarcity and need to conserve shall be developed.
- **Technological :** Data collection shall be improved, conjunctive use of ground and surface water shall be planned, mathematical modeling of aquifer shall be done and artificial recharge of ground water shall be planned.
- **Environmental :** The detrimental environmental consequences of over exploitation of ground water need to be effectively prevented.

8. Water Allocation Priorities

In the planning and operation of systems, water allocation priorities shall be to Drinking water, Irrigation, Power generation and Industrial and other uses in that order. However, these priorities might be modified if necessary in particular regions with reference to area specific considerations, and they may be different in the context of allocating water to existing consumers than in the context of planning the development of water resources for new consumers.

9. Drinking Water

Adequate drinking water facilities shall be provided to the entire population both in urban and in rural areas. Future irrigation and multipurpose projects shall invariably include a drinking water component wherever there is no dependable alternative source of drinking water. Drinking water needs of human beings and animals shall be the first charge on any available water.

10. Water Rates

Water rates shall be so decided that it conveys the scarcity value of water to users and foster the motivation for economy in water usage. Rates shall be gradually increased to cover the annual maintenance and operation charges and part of the fixed costs to assure undisturbed and timely supply of irrigation water. Water rates shall be rationalised with due regard to the interests of small and marginal farmers. It shall be accompanied by volumetric measurement of water consumption in all sectors.

11. Water Quality Monitoring

Both surface water and ground water as well as soil quality shall be regularly monitored for quality and a phased program shall be undertaken for improvements in water quality. Government shall issue orders to routinely enter future water and soil quality figures in the water resources database and publish groundwater statistics and maps for River Basins. Proposals for contracting the work of water sampling and analysis to private operators will be studied. Effluents should be treated to acceptable levels and standards before discharging them in natural streams. Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations.

12. Water Conservation and Efficiency of Utilization.

The efficiency of utilisation in all the diverse uses of water should be improved and an awareness of water as a scarce resource should be fostered. Conservation consciousness shall be promoted through education, regulation, incentives and disincentives by taking following actions:

A. Domestic Sector:

- Introduction of domestic water saving devices
- Water meters on all consumers.
- Progressive water tariff structure.
- Auditing of water balance from distribution systems. etc...

B. Industrial sector:

- Progressive water tariff.
- Water recycling facilities.
- Treated urban sewage water for cooling and other processes.

C. Agriculture Sector:

- Water rates on volumetric basis should be kept sufficient for maintenance.
- Treated sewage water for non-edible crops.
- Saline water for tolerant crops.
- Improvement in irrigation practices and reduction of water losses.
- Pressure irrigation systems to be introduced

13. Flood Control and Drainage Management

Sound watershed management through extensive soil conservation, catchment area treatment, preservation of forests and increasing the forest area and construction of check dams shall be promoted to reduce the intensity of floods. Adequate flood cushion shall be provided in water storage projects whenever feasible to facilitate better flood management. An extensive network for flood forecasting shall be established for timely warning to the settlements in the flood plains, along with the introduction of regulation for settlements and economic activity in the flood-prone zones to minimise loss of life and property caused by floods. Master plan for flood control and management for each flood prone basin / area shall be got prepared. Due consideration to provide proper drainage shall also be given to build up capabilities to tackle water logging and salinity problems.

14. Drought Management

Drought prone areas shall be made less vulnerable to drought associated problems through measures listed below. In planning water resource development projects, the needs of drought prone areas should be given priority. Relief works undertaken for providing employment to drought stricken populations should preferably be for drought proofing.

- a. Continue efforts to assure water supply and livelihood to population and care for livestock.
- b. Employment and direct provision of basic needs to population in times of crisis.

- c. Drought-proofing of the area in measures such as plantation, dry farming.
- d. Development of training and skills to enable population to supplement the earnings from agriculture.
- e. Development of the ground water potential including recharging and the transfer of surface water from surplus areas wherever feasible and appropriate.

15. Legislation and Regulation

After a critical examination of rules, regulations, ordinances, legal and legislative measures related to the State's water sector has been made, with a view to improve and streamline their scope and cover in the legal framework all aspects pertaining to water resources management, protection of water quality, flood protection, drought proofing, abstraction licensing, water rights, etc. the Government shall introduce the following measures:

- a. Enact the necessary amendments and additions to existing Act, rules, regulations, orders, decisions, etc.;
- b. Ensure that the responsibilities and powers of Governmental agencies and the rights and obligations of individuals be clearly spelled-out in the relevant laws and regulations;
- c. Ensure that the legislation would allow for easy implementation of policy decisions while protecting the interests of individuals and taking into account the administrative capacity to implement them;
- d. Empower the appropriate agencies to carry out their obligations and responsibilities as implied by the public ownership of water projects, and spell out the administrative procedures necessary for coordinated, equitable and efficient control, as well as the resolution of conflicts which may arise from them;
- e. Provide legal support for the formation of WUAs and handing over to them the distribution of water for irrigation and the maintenance of canals;
- f. Establish rules and regulations for the involvement of the private sector in development and operation of water-related projects;
- g. Provide in the law for an effective participation of farmers in the planning and decision making processes which involve users and public authorities;
- h. Introduce the necessary legislation for a periodic amendment of water rates and tariff structures which would enable the full coverage of O&M expenditures, based, as far as possible on volumetric metering of supplies, while motivating users to economise in the use of water, and catering for the weaker sections of the population;
- i. Establish effective conflict resolution legal entities and procedures. The entire body of water-related laws and regulations will eventually be amalgamated into a State Water Law, which would, in addition to the above mentioned subjects, establish the State ownership of all the water resources within the State, as well as waters imported from outside the State under various agreements, and the requirement for any public or private entity or individual to obtain from the Government a permit to abstract surface water or groundwater, to utilize it, to sell or distribute it, or to dispose off after use. Permitting and enforcement rules and regulations will be spelled-out accordingly.

6.3.7 MAHARASHTRA STATE WATER POLICY [2003]

1. The Government of Maharashtra announced its State Water Policy in July 2003, which ensures sustainable development, efficient management and optimal use of scarce water resources in a manner to maintain importance of ecological values within rivers and adjoining lands in order to provide economic and social benefits to the people.
2. The key issues dealt with in the Maharashtra State Water Policy are —
 - Adoption of an integrated and multi-sectoral approach to water resource planning, development and management on a sustainable basis taking river basins/sub-basin as a unit.
 - Based on the water resource development and management plan developed by the respective river basin agencies, the State shall prepare a state water resource plan to promote a balanced development.
 - This shall be done by proper coordination among diverse water uses which include structural measures, operational measures, and watershed management measures, demand management measures such as conservation, scarcity scheduling and efficient technologies, water pollution control measures and monitoring measures.
 - These will assure comprehensive sustainable management of water resource and equality of water distribution for the benefit of the State and its peoples.
 - User's participation in planning, development and management of water resources as well as farmers' management of irrigation systems is also discussed in the policy.

6.3.8 Chennai Waste Water Recycling:

In the last decade the water problem of Chennai has become rather acute paving the way for innovative efforts to meet the demand. Large scale implementation of water harvesting is being practiced and wastewater recycling against revenue is also practiced. Thus, from Kodungaiyur STP, the secondary treated sewage is being supplied to the following Industries at the rate of Rs.8.75 per kilo litre:

- Chennai Petroleum Corporation Ltd (CPCL) : 23.0 MLD
- Madras Fertilizer Ltd (MFL) : 11.5 MLD
- Manali Petro Chemicals (MPL) : 1.5 MLD

A total of 36.0 MLD is supplied against which revenue of about Rs. 10.0 crores is generated annually through the sale of secondary treated sewage to the industries. About 3.0 Lakh liters per day of secondary treated sewage is supplied to the Chennai Municipal Corporation for watering of plants and lawns at public parks and traffic islands free of cost.

6.3.9 Summary of Insights Relevant To NCT Delhi

6.5 With the increase in population coupled with urbanization, industrialization and rise in standard of living, the demand of water for various uses is increasing continuously. To meet the future requirements of different sectors, there is an urgent need for improving water use efficiencies in all sectors of its use. For this, it is necessary to draw an action plan and implement the same with the co-operation and involvement of all concerned viz., Government Agencies, Non-Governmental Organizations and the Stake Holders. State Water Policy documents which will be prepared on the same lines as the NWP [2002] covering the above postulates allowing only a certain difference in emphasis. The substance of the Policy Statements as relevant to NCT Delhi can be summed up as follows :

- ❖ Rising demand from all sectors would increase pressure on finite water resources
- ❖ Water is an essential ecological resource and this requires efficient use and conservation of resource In the development of water resources for domestic use. The most important and challenging issue is that of sustainability of source and quality, NCT of Delhi being a fast growing urban conglomerate, adequate provision for safe drinking water are vital as increased income of the stakeholders calls for better quality of life, this being a basic need is essential for sustenance of life this has been well recognized by Govt. of India while framing the national water policy 2002 and has been given top priority in the planning and operation of system
- ❖ A well developed information system, for water related data in its entirety, at the national / state level, is a prime requisite for resource planning
- ❖ In the planning and operation of systems, water allocation priorities should be broadly as follows:
 - Drinking water
 - Irrigation
 - Ecology
 - Agro-industries and non-agricultural industries
 - Navigation and other uses

However, the priorities could be modified or added if warranted by the area / region specific considerations. For Delhi irrigation is a declining activity. As such the order of priorities could be different and as follows:

Drinking water and human freshwater use [domestic, institutional and commercial]

Ecology

Irrigation and horticulture

Power generation and industry

- ❖ Groundwater use must be sustainable with a regular assessment of potential and quality and with an emphasis on recharge projects and conjunctive use of surface and ground waters
- ❖ Financial sustainability of services must be ensured while giving due consideration to the needs of disadvantaged sections

- ❖ So far, there has been little or no thrust on conserving water either in the mega cities or in the smaller ones. (For example, Delhi claims to supply water at the rate of 225 lpcd whereas most cities like London supply about 150 lpcd. There is a scope of reducing per capita water supply and people should learn to live with less quantity of treated water. Large quantities of potable water is used for non-potable uses, while treatment of waste water and its re-use continues to be neglected. These unfinished tasks in water supply in urban areas of Delhi are to be specifically brought out in the state water policy so that efficiency of utilization in all the diverse uses of water should be optimized and this should be attained through awareness as well as financial instruments.
- ❖ Science and technology need to be harnessed in pushing forward the frontiers of hydro-meteorology, surface and groundwater relations, recycling and reuse, remote sensing techniques for development
- ❖ **Drought management** aspect should be incorporated in view of variable climatic conditions and the static **groundwater reserve should be a buffer for crisis management** – this should be an aspect of disaster management strategy as well
- ❖ A single unified agency such as 'State Water Resources Board' should be established and tasked with policy related issues for integrated water resources development and management shall be created.
- ❖ A State Water Resources Data and Information Center should be established. SCADA development - which aims at establishing a database center as an analytical tool for decision making and information sharing within DJB staff for equitable distribution revenue increase and leakage reduction etc. - need to be commissioned at the earliest
- ❖ **Water rates** for various uses will be revised in a phased manner and fixed so as to cover at least the operation and maintenance charges of providing services.
- ❖ Periodical reassessment of the **groundwater potential** on a scientific basis will be undertaken to ensure sustainable extraction. Groundwater recharge projects are to be formulated and implemented.
- ❖ **Rainwater harvesting:** Rainwater harvesting and water conservation will be encouraged. All urban structures to have water harvesting facilities.
- ❖ **Reduction of UFW** must be emphasized. Conservation consciousness will be promoted through education, regulation incentives and disincentives.
- ❖ From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need **to give greater emphasis on the improvement of the performance of the existing water resources facilities.**
- ❖ **Minimum flow should be ensured in the perennial streams** for maintaining ecology and social considerations.
- ❖ **Ensuring access to regular, reliable and affordable water supply to all i.e 100% coverage**
- ❖ **Entire populace to have access to sanitation facilities and sewage disposal systems**
- ❖ **Demand management** strategy must be formulated

- ❖ Major urban structures and complexes to **incorporate recycling** facilities and at least 50% of the water used is to be recycled water
- ❖ Prevailing drinking water quality standards are only recommendatory in nature and are not enforceable. Govt. of India is in process of enacting law to define drinking water standard and NCT of Delhi may enact legislation to ensure safety of drinking water as per the standards.

6.6 NCT Delhi must also deliberate :

- whether the state's role as a service provider will be diluted
- how to design policy to prevent excessive use by affluent users
- whether PPP mode will ensure equity
- to strictly implement polluter pays principle in addition to pushing effluent treatment

CHAPTER VII : A SURVEY OF SELECTED INTERNATIONAL WATER POLICIES

7.1 Existing and emerging water stress combined with growing demand and uncertain climatic conditions affecting rainfall patterns are the drivers behind evolution of water policies worldwide. The need for policy direction is most pronounced in regions and cities with relatively scarce resource endowments and/or where a recent drought event has triggered policy making. The following text culls out aspects from several international policy documents relevant to Indian conditions more specifically to Delhi.

7.2 Fukuoka City, Japan: *[the following text is quoted from “Public Sector Water Conservation: Technology and Practices outside the Great Lakes – St. Lawrence Region”]*

The population of Fukuoka City, one of Japan’s most dynamic cities, was approximately 1.3 million people in 2000, and is continuing to grow at a rapid pace. Even though Japan receives approximately 1,714 millimeters (67.5 inches) of precipitation each year, this part of the world has historically been prone to frequent and severe droughts resulting in major water shortages for the city. During the Great Drought in 1978, water supply restrictions were enforced for a total of 287 days and some parts of the city had no water at all, causing considerable disruption to the lives of residents.



Map No 7.1: Location Map of Fukuoka City

7.2.1. Since that time, Fukuoka City residents, businesses, and city administrators have been working together to establish Fukuoka City as a “Water Conservation Conscious City” and to develop additional reliable water resources to meet its growing demand. In 1979, Fukuoka City established a plan for comprehensive and systematic water conservation.

Salient features of the plan were:

7.2.2 Water Rates — Since 1997, residents and businesses have been required to pay a surcharge on water use to help establish the Fukuoka City Forest and Water Resource Foundation.

7.2.3 Leak Prevention and Detection —At 5% leakage, Fukuoka City has the lowest leakage rate in Japan. Fukuoka has worked to manage its potential leakage by using its resources for leak prevention surveys, distribution pipe maintenance, and water distribution regulation. One method of leakage prevention that is used by the city is surveys using the correlational leak detection method, the water leakage measuring method, and the acoustic leakage sound detection method.

- The correlational leak detection method uses detectors during nighttime surveys in areas where water leakage could lead to serious accidents, such as where distribution pipes are crossed by railroad lines or major roads. This type of detection method is used on over 30 kilometers (18.6 miles) of pipeline. (Shinoda, 2000)
- The water leakage measuring method uses transportable electromagnetic flow meters to conduct nighttime surveys one block (1.7 kilometers or 1 mile) at a time. This method is applied to 2,900 kilometers (1,802 miles) of pipeline in a four-year cycle (Shinoda, 2000).
- The acoustic leakage sound detection method applies sound detection bars to division valves and other points to investigate the presence or absence of leak sounds on over five blocks per day. This method is applied to the same 2,900 kilometers of pipeline as the water leakage measuring method, but over a two-year time frame (Shinoda, 2000).
- In addition to these types of leakage detection, old distribution pipes are being replaced to prevent leaks. Of the city’s 3,300 kilometers (2,050 miles) of distribution pipes, 2,930 kilometers (1,820 miles) were laid five or more years ago and are thus subject to a systematic survey to locate and repair leaks as early as possible.
- The city has also created an innovative water distribution regulation system to regulate pressure and flow in distribution pipes to promote the effective use of water. This system uses pressure gauges and flow meters that have been installed throughout the city to monitor conditions within the pipes on a 24-hour basis from the Water Distribution Control Center via telephone lines. Based on the information that is obtained from these gauges and meters, the motorized valves can be opened and closed remotely to regulate the water pressure and flow. This helps to reduce excess pressure which, in turn, helps to reduce the occurrence of leaks within the system (Shinoda, 2000).

7.2.4 Residential Indoor Use — Water-saving devices such as plugs in faucets have been installed by about 94 percent of Fukuoka’s water users to help reduce the flow of water from faucets. The effect of fitting water-conserving plugs to faucets such as those in kitchens and bathrooms is equivalent to saving approximately 1,000 liters (264 gallons) per month for a family of four (Shinoda, 2000). In addition to water-saving plugs, the city is also working to promote the use of water efficient toilets and other equipment such as bath heaters that are used to reheat water as it cools instead of adding more hot water. Similarly, reclaimed water use projects within the city have taken advantage of

treated wastewater, a stable supply source, for flushing toilets, which helps to conserve approximately 7 million liters (1.85 million gallons) of potable water each day (Together Foundation, 2002).

7.2.5 Landscaping/Outdoor Use — The city also encourages the collection and reuse of rainwater for outdoor watering needs to reduce the usage of potable water.

7.2.6 Demonstration of Results

Based on the collective conservation efforts and leakage protection measures that have been adopted by Fukuoka's residents and businesses, per capita water use is currently less than what it was before the Great Drought in 1978, even though there are more flush toilets in use today. In addition, Fukuoka City consumes about 20 percent less water than other comparably sized cities (Together Foundation, 2002).

Reclaimed Wastewater: More recently, Fukuoka City has been active in promoting three different systems to reuse reclaimed wastewater for flushing toilets. The Wide-Area Circulation System is one such project where reclaimed water is supplied to a total area of 7.7 square kilometers (3 square miles) in the central part of the city, which includes the City Hall building and subway stations. The District Circulation System provides reclaimed water to several apartment complexes outside of the above area, which are equipped with their own treatment facilities that recirculate reclaimed water within the complexes. The third project, the Individual Facility Circulation System, provides reclaimed water to any large new buildings within the city.

In 1996, 384 facilities and two apartment complexes were reusing reclaimed wastewater. This has helped to save approximately 7 million liters (1.85 million gallons) of potable water per day. According to the Statistics of Sewage Works for fiscal year 1996, the maximum total amount of reused wastewater for the city was 480 million liters (127 million gallons) per day.



Restoring water flow and water levels through recreational impoundments

7.3 **Western Australia** [the following text is quoted from Govt. of Australia sources]

In 2001 and 2002, the state of Western Australia experienced its worst drought on record. This critical period impacted the way the state approaches water management and resulted in the creation of a water task force to establish a sustainable future for Western Australia's water resources.

With Western Australia's population projected to grow from 1.5 million to 2.5 million by 2020, and with recent trends toward drier conditions, additional water supplies will be needed to meet the rising demand for water. In addition, the development of new freshwater sources and the upgrading of sewage transport and treatment infrastructure are costly, as are the impacts to the environment. Therefore, it is critical that Western Australia work to conserve its water resources.

Australia is the driest of the world's inhabited continents, with the lowest percentage of rainfall as runoff, the lowest amount of water in rivers, and the smallest area of permanent wetland. On average, only 12 percent of Australia's rainfall runs off and is collected in rivers. The remaining 88 percent of rainfall is accounted for by evaporation, water used by vegetation, and water held in storages including natural lakes, wetlands, and groundwater aquifers. (Radcliffe, 2004)



Map No. 7.2: Map showing location of Western Australia

Over the past 30 years, climate change has contributed to a 10 percent to 20 percent reduction in rainfall for the state of Western Australia, and a subsequent 40 percent to 50 percent reduction in runoff into dams and reduced recharge of groundwater sources (Government of Western Australia, 2003). Climate models predict that the southwest of Western Australia will become even drier over the coming century. This long-term shift in climate has had significant implications for the allocation and management of water resources.

Water supply planning is now based on the region's drier conditions and reduced rainfall that has occurred since 1975. Western Australia obtains its water supply from surface and ground waters.

Based on studies by the Water and Rivers Commission (WRC), the state's sustainable surface water yield is estimated to be 5.2 trillion liters (1.4 trillion gallons) per year, which includes both fresh and marginal water resources. Thus, much of this water is not suitable for drinking. Currently, Western Australia is using 657 billion liters (174 billion gallons) of water per year, or about 13 percent, of the estimated sustainable yield. (Government of Western Australia, 2003)

Approximately two-thirds of Western Australia's water needs are met by groundwater. Within the state, there are seven groundwater divisions, divided into 174 groundwater management units that are individual aquifers. The largest groundwater resource is believed to be the Canning Basin, which has an estimated storage of over 12 quadrillion liters (3.2 quadrillion gallons, or roughly half the capacity of the Great Lakes). The sustainable groundwater yield (including hyper saline waters — not suitable for potable use) within the state is estimated to be 6.3 trillion liters (1.7 trillion gallons) per year. Groundwater extraction at the time of the WRC water assessment in 2000 was 1.1 trillion liters (290 billion gallons) per year, or about 18 percent of the estimated sustainable yield. However, some areas within the heavily populated Perth Basin are rapidly approaching their sustainable groundwater limits or have no further groundwater allocations available.

The main objectives of this strategy were to improve water use efficiency in all sectors; achieve significant advances in water reuse; plan and develop new sources of water in a timely manner; foster innovation and research; and protect the value of the region's water resources.

To achieve these long-term goals, the State Water strategy proposes to:

- Achieve a 14 percent reduction in water use per person per year by 2012 for domestic consumers served by the Perth component of the Integrated Water Supply System
- Establish a 20 percent reuse of treated wastewater by 2012
- Plan a major new water source for the Integrated Water Supply System,
- Establish broad-based community education campaigns focusing on conservation for both scheme and self-supplies,
- Utilize the Integrated Resource Planning Process to ensure that all water source development includes consideration of, and appropriate investment in, conservation measures, and
- Require water conservation management plans for large water users, before the renewal of a license or a new license is provided.

Education — Media campaigns have been used to inform residents about the scarcity of water in different parts of the state as well as to encourage people to assess their water needs and prioritize their use of water.

The Waterwise Schools Program was introduced in 1995 to educate school children about water issues in Western Australia. This program provides resources to support teachers and has provided staff with in-service training on aspects related to being a Waterwise School. A water audit of each school is also a prerequisite for participation in the program

Water Rates — Current water rates for Water Corporation customers in Western Australia include a fixed service charge with a variable usage charge. The fixed costs associated with the water rates are to recover the fixed costs of water supply such as maintenance of infrastructure such as pipes, dams, pump stations, and bore fields. The variable costs are based on how much water is consumed and the costs associated with providing water to a given location.

Efficient Devices: All new toilets in Western Australia are also required to be a water-efficient dual flush design. This requirement has helped to significantly reduce the amount of water used for residential purposes each year. Since 1982, average water use in toilets has dropped by more than 35 percent as a result of the mandatory installation of dual flush toilets in new installations and renovations (Government of Western Australia, 2003).

The **Waterwise Plumber Program** was developed in 2003 in conjunction with the Master Plumbers Association. Plumbers endorsed under this initiative have undergone training in the latest water-efficient plumbing practices. In addition, under the Waterwise Plumber Program, residents can take advantage of comprehensive, professional water efficiency appraisals for half the normal price, which is subsidized by the Water Corporation.

The **Waterwise Rebate Program** was introduced by the state government in February 2003 to encourage water use efficiency in residents' homes and gardens. This program was initially launched for one year and offered rebates for washing machines and showerheads for indoor use. Due to its success, the government extended the program for a second year and now offers rebates for tap timers and AAA-rated tap flow regulators. The following rebates are currently available for residents in Western Australia:

- **Showerheads** — A Waterwise Rebate of \$10 AUD (approximately \$7 USD) is available for homeowners who purchase and install an AAA-rated shower head. This rebate is available for up to two showerheads per household.
- **Washing Machines** — A Waterwise Rebate of \$150 AUD (approximately \$104 USD) is available for purchases of AAAA-rated (or better) washing machines. This rebate is only available for one washing machine purchase per household.
- **In-Tap Flow Regulators** — A Waterwise Rebate of \$10 AUD is available for authorized AAA-rated (or better) in-tap flow regulators that are installed by a licensed plumber. To be eligible for the rebate, in-tap flow regulators must only allow a flow of 9 liters (2.4 gallons) a minute or less. This rebate applies for up to 10 in-tap regulators per household.

- **Tap Timers** — A Waterwise rebate of \$10 AUD is available for tap timers that can accommodate two-day-per-week water restrictions by allowing sprinklers to operate for an allocated time, on two specific days at specific times of the week. This rebate is available for up to two tap timers per household. (Our Water Future Website, 2004)

Landscaping/Outdoor Use — Western Australia was the first state in Australia to implement watering limits for conservation. Existing drought response measures involve the restriction of watering gardens to two days per week with no watering between 9 a.m. and 6 p.m. when evaporation rates are highest. Existing state by-laws require \$100 AUD (approximately \$70 USD) infringement penalties for individuals that do not observe these watering restrictions. (Government of Western Australia, 2003)

Despite obvious competition with the Western Australia Water Corporation, homeowners are encouraged to sink bores with low-throw sprinklers so long as they are responsible in their use of water and follow waterwise gardening principles. These include only watering enough to meet the garden's needs, using plants that require less water, and observing the daytime watering restrictions. Within the city of Perth alone, there are an estimated 130,000 private bores which are used for watering lawns and gardens. Activities removing large volumes of groundwater require an abstraction license from the WRC; however, household bores in the Perth metropolitan area do not need a license mainly due to the relatively minor amounts of water they remove. (Government of Western Australia, 2003)

The Waterwise Rebate Program, described in greater detail above, also includes rebates for garden bores, rainwater tanks, and soil wetting agents and, after October 2003, graywater reuse systems. The following rebates are currently available for residents in Western Australia:

- **Garden Bores** — A Waterwise Rebate of \$300 AUD (approximately \$208 USD) or 50 percent of the installation cost (whichever is less) is available for all households which connect to a new garden bore as a substitute for the use of other potable water for outdoor landscaping.
- **Rainwater Tanks** — A Waterwise Rebate of \$50 to \$150 AUD (approximately \$35 to \$104 USD) is available for homeowners who purchase a new rainwater tank with a capacity greater than 600 liters (160 gallons), based on the size of the tank. A rebate of \$50 applies for tanks between 600 and 1,999 liters (160 and 528 gallons), and a rebate of \$150 applies for tanks over 2,000 liters (528 gallons). An additional rebate of \$150 AUD will be offered to those households that connect the tank for toilet and/or washing machine use. This must be completed by a licensed plumber.
- **Graywater Reuse Systems and Aerobic Treatment Units** — A Waterwise Rebate of up to \$500 AUD (approximately \$350 USD) or 50 percent of the purchase/installation cost (whichever is less) is available for an approved graywater reuse system or aerobic treatment unit that has been installed by a licensed plumber.
- **Soil Wetting Agents** — Soil wetting agents break down the water resistance that soils and lawns build up and allow water to penetrate to the roots. A Waterwise Rebate of \$10 AUD is available for 10 kilograms (22 pounds) of approved granulated agent, 10 liters (2.6 gallons) of approved liquid agent, or 2 liters (0.5 gallons) of approved liquid concentrate. The rebate is available for two soil wetting agent purchases per household. (Our Water Future Website, 2004)

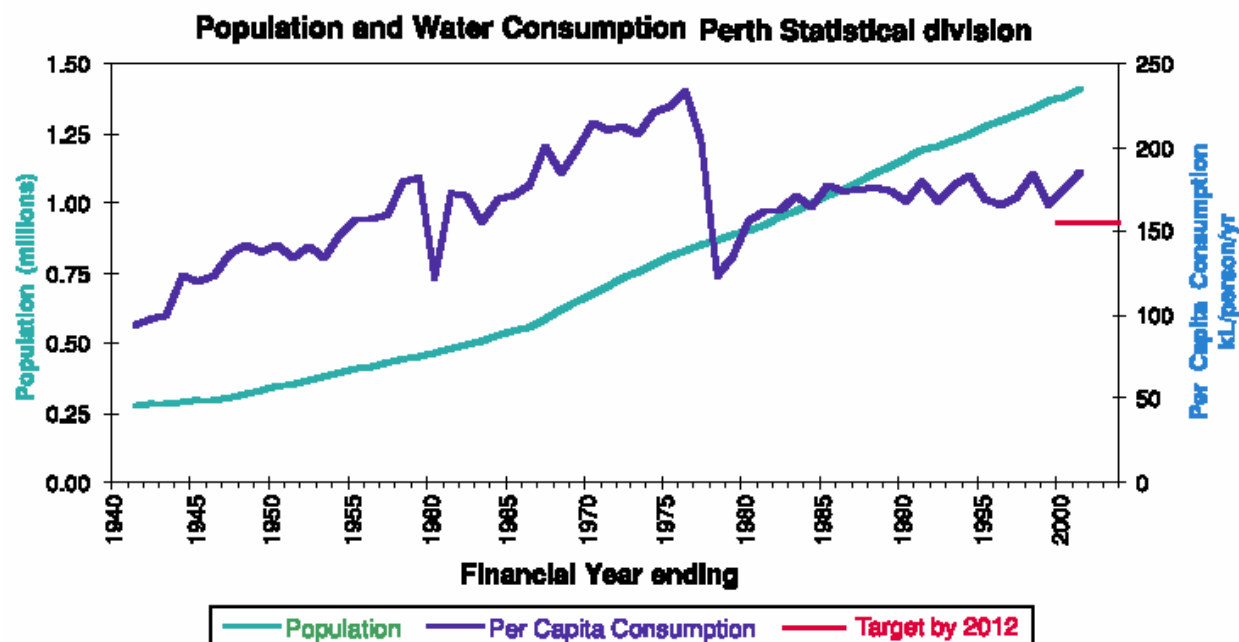
In addition, a number of other Waterwise initiatives were introduced in 2003 to improve water use efficiency within the community. These programs include:

Waterwise Garden Center Program — This program was launched in September 2003 in conjunction with the Nursery & Garden Industry in Western Australia. Waterwise Garden Centers stock a variety of information on how to make your garden water-wise, including garden designs and plant species. All staff of the Garden Centers has been trained in the latest waterwise gardening techniques. As of February 2004, 17 centers were participating in the program. (Water Corporation Website, 2004)

Waterwise Garden Irrigator Program — This initiative was developed in conjunction with the Irrigation Association of Australia and was launched in November 2003. Irrigators endorsed under the program are qualified to design and install water efficient garden watering systems to an industry standard. Irrigators must have two years of experience and pass a written test to be endorsed by the program. As of February 2004, 28 irrigators were participating in the program. (Water Corporation Website, 2004)

Demonstration of Results

The combined effect of these initiatives (including water use restrictions) has been to reduce water use from 185,000 liters (48,872 gallons) per person per year in 2000-2001 to 150,000 liters (39,626 gallons) per person per year in 2003-2004, meeting the defined target reduction in water use from the State Water Strategy.



During the first year of the Waterwise Rebate Program, from February 2003 to February 2004, 46,558 applications were approved for a total of \$6.48 million AUD (\$4.45 million USD) in rebate checks. The estimated annual water savings from this program are 1.2 billion liters (317 million gallons) (Government of Western Australia, 2004).

Associated Issues

Kalgoorlie-Boulder Water Efficiency Program — Beginning in 1995, \$3.5 million AUD (approximately \$2.4 million USD) was invested in one of the first large-scale water efficiency retrofit programs in Australia to help reduce the high costs associated with supplying water from Perth to Kalgoorlie-Boulder. This program involved replacing existing plumbing fixtures with efficient toilets, taps, and showerheads in residential properties; providing rebates on mulch, drought tolerant plants and tap timers; and undertaking water audits of the top 150 water using nonresidential premises, excluding industrial and mining sites

- **Water Recycling** — The Government of Western Australia is committed to achieving 20 percent reuse of treated wastewater by 2012. In working to meet this goal, the state conducted a trial project at McGillivray Oval in the city of Nedlands to demonstrate effective use of reclaimed water from the Water Corporation's adjacent Subiaco Wastewater Treatment Plant for the irrigation of community parks and ovals.
- The continued development of a diverse portfolio of water supply options to mitigate the impacts of climate change — even though it is not possible to predict precisely what sources of water will be included in any given portfolio, the principle of spreading water resources risks over multiple sources of water is immutable.
- The design of our homes, suburbs and commercial developments will need to factor in water elements at the outset rather than having to 'bolt on' water sensitive solutions as an afterthought.
- Innovation and adaptation will be essential so that the benefits of new technology and new research outcomes can be implemented quickly and efficiently
- Legislation to implement the Water Efficiency Labelling Scheme (WELS) to be in place in all jurisdictions and regulator undertaking compliance activity by 2005, including mandatory labelling and minimum standards for agreed appliances ii) develop and implement a 'Smart Water Mark' for household gardens, including garden irrigation equipment, garden designs and plants

Recycled water in Australia

Recycled water is becoming an increasingly important source of water for urban Australia. Since 2002 the volume of water recycled by the urban water industry has increased by over 120 percent. The 173 gigalitres of recycled water produced in 2008/09 by the major urban water utilities is equivalent to the total water supplied to all households in Perth in 2008/09. Major capital cities have increased the volume of water recycled by a staggering 52 percent in the three years between 2005/06 and 2008/09.

To date recycled water schemes have only supplied water for non-drinking purposes such as irrigation of sports fields and parks, commercial and industrial uses and for third pipe systems supplying households with recycled water for garden watering and toilet flushing. Recycled water is also being used to provide environmental flows to stressed river systems.

As explained in WSAA Position Paper No. 2 'Refilling the Glass — exploring the issues surrounding water recycling in Australia', the position of our major capital cities on the coast can be a significant impediment to the wholesale production of recycled water. As the wastewater treatment plants where recycled water is produced are generally at the lowest point in the catchment to take advantage of gravity, recycled water often

has to be pumped significant distances uphill to areas where it can be used. This can result in recycled water being a very expensive and energy intensive source of water.

Inland regional cities and towns have many more options available for using large volumes of recycled water for purposes such as horticultural and agricultural irrigation. For instance, Western Water in Victoria recycles 77 percent of the total wastewater treated.

Up to this point, none of the water recycling schemes supplies water to potable water systems even though systems have been built in South East Queensland that would allow this to happen. It is essential that data from all the existing water recycling plants is collated so that industry can point to a solid track record of treatment plant performance which will assist in building community confidence in recycled water.

Water security will become an increasingly important issue in the future and, as technology advances and new recycled water schemes prove safe and viable, the use of recycled water for indirect potable reuse will be inevitable. While significant amounts of recycled water are being used across Australia, in order to make full use of this resource over the coming decades we will need to address blending this water with traditional drinking water sources. If this is to happen, the urban water industry will need to begin working closely with the community and key stakeholders to build trust in recycled water systems and assure the community that risks can be managed. Indirect potable recycling will not always be the optimal or preferred water supply choice and, for many utilities, using recycled water for purposes other than replenishing drinking water supplies may remain a preference. *However, with innovation, leadership and commitment to maintaining public health and safety, indirect potable recycling will come to be considered a legitimate source water option to be included in a diverse portfolio of water sources.*

7.3 Israel

7.3.1 Background

Israel is a water-scarce, arid to semi-arid country with less than 300,000 liters (79,250 gallons) of water per capita per year for all its water uses. Annual rainfall ranges from 1,000 millimeters (39 inches) in the north to 30 millimeters (1 inch) in the south, and averages around 400-800 millimeters (16-31 inches) with nearly all rainfall occurring between November and February. With such limited water resources, many international organizations classify Israel as a highly water-stressed country (Arlosoroff, 2002).¹²

Due to high evaporation rates, aquifers and groundwater reserves act as the most effective storage of water between seasons, dry and wet years, and weather fluctuations. However, with increased groundwater extraction, low water levels and decreased water quality problems also occur. Water tables in all aquifers, lakes, springs, etc. are monitored regularly with water quality sampling and use patterns and any changes in patterns are recorded and investigated.



Map No. 7.3: Map Showing location of Israel

Of Israel's total average annual potential of renewable water (approximately 1.8 trillion liters or 475.5 billion gallons), about 95 percent is used for domestic use and irrigation (Israel Ministry of Foreign Affairs, 2002). Groundwater is considered to be the major resource of the country, with over 65 percent of the total water supply for the country being pumped from aquifers (Arlosoroff, 2002).

Experts have declared that the country's water reservoirs have been overexploited beyond the natural replenishment rate since 1993. In recent years, the average annual overdraft has increased to 400 billion to 500 billion liters (106 billion to 132 billion gallons). All of the country's major water sources are severely depleted, and have dropped below the so-called "redlines" which were set in order to prevent the risks of pollution, salination, and ecological degradation. But the crisis is not only quantity related but quality related as well.

Largely as a result of years of overexploitation, nearly 20 percent of the water pumped from the coastal aquifer does not comply with existing potable water standards. Average chloride concentrations have been increasing at an average rate of 2-3 milligrams per liter per year. (Israel Ministry of the Environment, 2001)

7.3.2. Application of Water Conservation Technology and Practices

Water conservation has been determined to be the most reliable and least expensive way to stretch the country's water resources.

Education — Wide scale education campaigns for schools and the general public, coupled with technical and economic measures, are being applied to reduce water use and increase awareness of water scarcity. For example, in February 2000, a \$2.5 million USD water conservation campaign was launched to save 10 percent of annual urban water use. In February 2001, the Water Commissioner introduced a “Blue Label” campaign to encourage the use of water-saving devices, with blue labels issued to products and devices such as faucets and showerhead fittings. The slogan, “Don’t waste a drop”, is part of national public awareness and media campaigns, and is widely known throughout the country based on the success of these campaigns.

Water Rates

Progressive block rates have been set for over 70 percent of the water use in the country, coupled with a total metering system for each water user. An increasing block rate prices system is applied to payment for the first 50 percent, 80 percent, and 100 percent of the water allocation. Prices are updated automatically with a cost of living formula, removal of subsidies, and water abstraction fees.

Water Metering — One of Israel's greatest water system achievements is its total water metering system. Each well and water producer and consumer in the rural, urban, and industrial sectors are legally obligated to install standard water meters. These meters must be calibrated regularly by certified laboratories and are read and reported routinely to the water authorities. These meters form the basis for Israel's water demand management strategy.

Water Allocations — Water in Israel is used within a system of allocations, instead of allowing landowner rights to determine water use and demand, as is common in many other regions and countries throughout the world. This practice began in 1959, and was initially based on the production and water-use norms from the agriculture and industrial sectors. These norms have been updated over time, through an extensive research and development program, in order to determine the optimum water use for crops, industrial products and the region. Penalties are applied for exceeding allocation rights. “Water markets,” trading with administrative allocations on an economic basis between members of a sector, between sectors, and hopefully between Israel and its neighbors, may be introduced in the future. It has been shown that the efficiency of water resource allocations and water use can be improved through the use of such price and trading mechanisms. (Arlosoroff, 2002).

Residential Indoor Use — The retrofitting of homes with pressure reducer devices in faucets and showerheads, pull handle taps, two-volume flush toilets, and cisterns with double quantity dispensers is promoted within Israel to encourage efficient water use within the home. In fact, all new buildings are required to install such water-saving devices. Citizens are also encouraged to repair leaking faucets and to report leaks.

Landscaping/Outdoor Use — Homeowners are encouraged to introduce water-saving plants, mulching, and automated drip irrigation systems into their gardens. Water restrictions prohibit watering private gardens from 7 a.m. - 7 p.m. between May and October. In addition, for gardens larger than 50 square meters (540 square

feet), watering is banned unless appropriate systems for efficient irrigation are used. Prohibitions are also in place against washing cars or paved areas with hoses. Violators of these restrictions and prohibitions are subject to fines. Parks are also included in the country's water conservation strategy. Specifically, parks must use drought-resistant (native) plants, minimize water use through automated drip irrigation, and only water at night.

7.3.3. Demonstration of Results

Recent water conservation efforts have decreased Israel's per capita water usage by over 26 percent, from 150,000 liters to 108,000 liters (39,625 to 28,530 gallons, respectively). In addition, Israel's UAW has been reduced over the last 15 years from 25 percent to only 10 percent. (Arlosoroff, 2002)

Recycled Water — About 95 percent of the return-flow from water supplied by public waterworks within the country is collected. Of this amount, about 80 percent is adequately treated and, in many cases, reused for irrigation (Israel Ministry of National Infrastructures, 2002). Recent regulations have increased quality requirements for the treatment of sewage effluents in order to maximize its reuse potential (mainly for irrigation purposes) and minimize health and environmental risks.

Desalination — As a result of recent dry spells within the region, the Israeli Government has accelerated the construction of reverse osmosis sea water desalination plants, which will add about 25 percent to the total freshwater availability of the country.

SINGAPORE [Background material drawn from 'World Bank Analytical and Advisory Assistance (AAA) Program China: Addressing Water Scarcity, Background Paper No. 4, 2006' and from 'SINGAPORE: AN EXEMPLARY CASE FOR URBAN WATER MANAGEMENT, by Cecilia Tortajada, Vice President, Third World Centre for Water Management, 2006]]

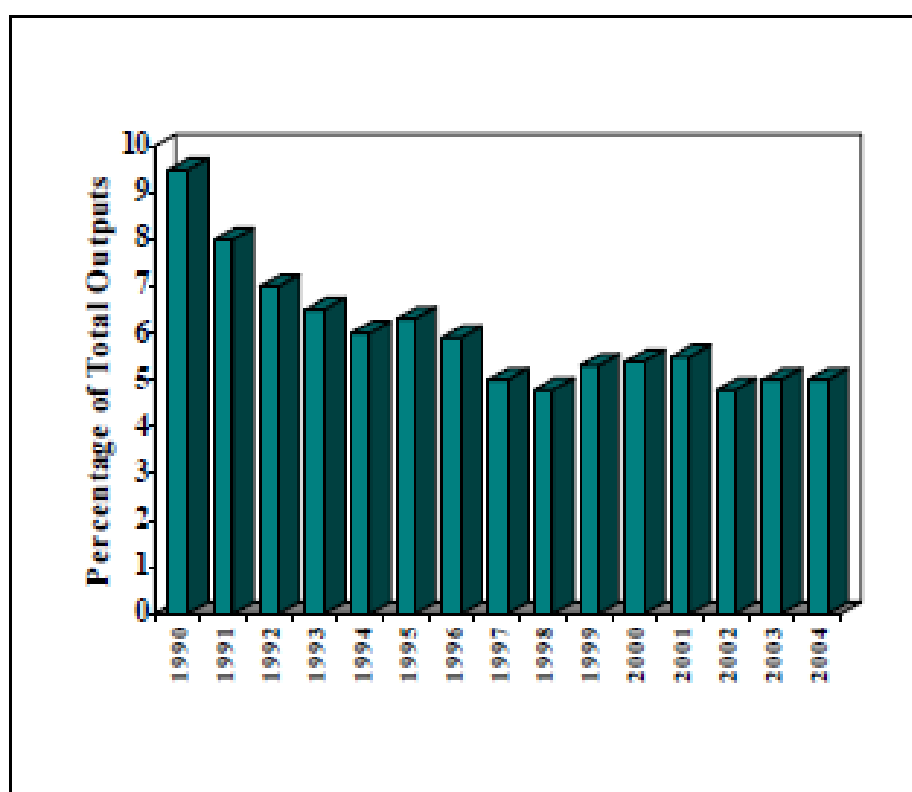
7.4 From the 1980s to 1990s Singapore made tremendous efforts to create a comprehensive environmental management system, including water supply, control of river pollution, establishment of well planned industrial estates, and a world class urban sanitation system for the whole island. More recently, the Singapore government has made **"sustainable water supply"** the main target of water management, and a series of initiatives and actions have been undertaken. Singapore has achieved remarkable progress in water resource management based primarily on urban catchment management and water reuse. The key points of the Singapore experience are highlighted below:

Singapore is a city state with an area of about 680 square kilometers and a population of 4 million, and has highly developed industrial, business, and financial services. As an essentially urbanized country, but one which lacks natural resources, Singapore is facing a serious shortage of water resources. Its current water demand is about 1.4 million cu meters daily but domestic resources only meet about 50% of that (Baumgarten, 1998). Water resource management becomes, therefore, a strategically important issue for national economic development and public and social life.

Singapore has been active in diversifying its water sources with its *Four National Taps Strategy* (MOEWR, 2006). The first tap is the supply of water from local catchments. This consists of an integrated system of reservoirs

and an extensive drainage system to channel storm water into the reservoirs. The second tap — imported water from Johor — supplements Singapore's needs. So does the third tap — NEWater, which is drinking water-quality water produced by further purification of the secondary effluent. The fourth tap is desalinated water. Increasing the portions of the first, third and fourth Taps is the target and challenge.

The country is now fully sewered to collect all wastewater, and has constructed separate drainage and sewerage systems to facilitate wastewater reuse on an extensive scale. In 1990, unaccounted for water (UFW) was 9.5% of the total water production. Even at this level, it would still be considered to be one of the best examples in the world at the present time. However, PUB has managed to lower the UFW consistently to around 5% in recent years.



Unaccounted For Water in Singapore [1995 - 2004]

Demand Management in Singapore

Concurrent to the diversification and expansion of water sources, PUB has put in place a well thought out and comprehensive demand management policy. The components of this policy are :

- i) Increasing Block Tariff
- ii) The poor who cannot afford to pay for the current water tariffs receive a targeted subsidy. This is a much more efficient policy in socio-economic terms, instead of providing subsidised water to all

- for the first 20-30 m³ of water consumed by all households, irrespective of their economic conditions
- iii) No cross subsidy from industrial and commercial users to domestic users
 - iv) Water conservation tax (WCT) is 30% of the tariff for all consumers, except for domestic households who use more than 40 m³/month. The WCT on consumption of each unit higher than 40 m³/month goes up by 50%, from 30% to 45%, which must be having perceptible impacts on household behaviour in terms of water conservation and overall demand management.
 - v) Water-borne fee (WBF) is used to offset the cost for treating wastewater and for the maintenance and extension of the public sewerage system. It is set at S\$0.30 m³ for all domestic consumption. For non-domestic consumption, this fee is doubled, S\$0.60/m³, presumably because it is more difficult and expensive to treat non-domestic wastewater.
 - vi) A Sanitary Appliance Fee (SAF) is also levied per sanitary fitting per month. It is currently set at S\$3.00 per fitting.

Item	1995	2000	2004
Average monthly consumption, m ³	21.7	20.5	19.3
Average monthly bill, inclusive of all taxes	S\$14.50	S\$31.00	S\$29.40

Source: PUB, 2005, Personal communication.

Average Monthly Water Consumption and Bills Per Household [1995, 2000, 2004]

7.4.1 Institutional Reform

Institutional reform to allocate all water related administrations under one umbrella is a key component of Singapore's water resource management. Public Utilities (Water Supply) Regulations stipulate that "No supply of water, except with the consent of the Board, be given otherwise than through a meter". The same regulations also stipulate that "No person shall install, or cause or permit to be or to remain installed... any water fitting in any premises which is not fitted with such water saving devices as may be stipulated by the authorized officer". These regulations make water metering and water saving devices mandatory in Singapore.

Water Tariff System : Demand management is implemented with various economic instruments to reduce water consumption in Singapore. An increasing block rate water tariff structure is used.

Penalties : Singapore is rigorous in its application of fines to enforce regulatory measures.

Public awareness about environment, especially water matters, is developed in Singapore through three major avenues, namely specialized campaigns, the education system and the "Clean and Green Week." The first campaign, "Keep Singapore Clean," focuses on building public awareness about environment and water

management. Often, a campaign will precede introduction of an environmental or public health law, which is then followed up with strict enforcement.

NEWater Program

In 2000, a full-scale demonstration plant to produce NEWater with a capacity of 10,000 cubic meters per day was commissioned to undertake extensive tests on the quality of reclaimed water and the technical capability and operational reliability of the membrane technology to recover good quality water from treated effluent of a municipal activated sludge wastewater treatment plant. At same time a pilot-scale plant with the same process to use NEWater as feed water producing ultra-pure water as in a water factory, was set up to verify the feasibility of using NEWater in the water industry.

A comprehensive water sampling and analysis program was implemented and the quality of the NEWater benchmarked against World Health Organization (WHO) Drinking Water Guidelines and the United States Environmental Protection Agency (USEPA) Drinking Water Standards. Leading advanced water testing laboratories of local and foreign institutions were engaged to carry out extensive and comprehensive physical, chemical and microbiological test analyses of the water at various stages of the production process over a 2 year period. Chemical parameters of emerging concerns were also included. In all, some 190 parameters and over 30,000 analyses were carried out during this period. An international panel of experts comprising renowned local and foreign experts in engineering, biomedical science, chemistry and water technology was formed to provide independent advice on the water reclamation study and to evaluate the suitability of NEWater as a source of water for potable use. The test results and the plant operation were regularly audited and reviewed by the Panel. The Expert Panel concluded that NEWater is consistently of high quality, well within the requirements of the USEPA and WHO standards for drinking water. It is safe as a source of water. The Panel also recommended indirect potable use by introducing NEWater into raw water reservoirs. The NEWater studies have confirmed that extremely high quality reclaimed water can be reliably and consistently produced by the NEWater Factory. PUB hence embarked on a program for the large scale production and supply of NEWater directly to industries and commercial sector for direct non-potable use. PUB officers visited potential clients, studying industry needs and concerns. Government leaders took actions to boost the NEWater program through meeting with industry and drinking NEWater in public occasions, etc. A NEWater centre was established for demonstration and public education purposes. Economic incentives such as low price and tax reduction, etc. help with implementation of the program. A series of contracts between the PUB and industrial clients for NEWater supply have been signed. **Source:** Lim, (2005)

Water Saving. Due to strict enforcement of the regulations, water usage is 100% metered in Singapore and installation of water saving devices such as water saving toilets and water taps are carried out throughout the island. An important implication of these regulations is that all apartments in an apartment block are individually metered, as well as a bulk meter for the apartment block as a whole.

Water audits are undertaken to ensure appropriate water consumption. Leakage prevention is conducted through a rehabilitation program on a regular basis. The proportion of leakage, or unaccounted for water, dropped from the previous 11.2 to 6.2 percent (Ng et al., 1997), which is the lowest in the world. Increase supply of water from nonconventional sources, such as desalination and water reclamation, to at least 25% of Singapore's water demand.

Lessons from the International Studies

Comprehensive metering for mapping and managing demand and planning investments is to be implemented mandatorily.

Leakages/UFW levels can be brought down to an amazing <5%

Achieve targeted reduction [quantified] of per capita water use within a given time frame

Establish targeted reuse of treated wastewater [quantified] within a given time frame. This also includes collection of 95% of the return flow. Reclaimed water used for flushing, gardening, industries and even indirectly for potable water use. Economic incentives such as low price and tax reduction, etc. help with implementation of the program.

Demand management strategy implemented through application of economic instruments to reduce water consumption with application on progressive block rate water tariff.

Reduction of fresh water use is a major objective.

Awareness campaigns to raise public support for conservation and receptivity for regulation and laws is an important and essential component of water strategy. Establish broad-based community education campaigns focusing on conservation

Rigorous application of penalties to enforce regulatory measures.

Require water conservation management plans for large water users, before the renewal of a license or a new license is provided. Encouraging efficient garden irrigation and water conserving strategies in private and public gardens

Retrofitting program promoting pressure reducer devices in faucets and showerheads, pull handle taps, two-volume flush toilets, and cisterns with double quantity dispensers, garden sprinklers.

Efficiency rating system of devices to be introduced

Rebates on water efficient devices and water conservation such as rain water harvesting systems, local user of grey water, soil wetting agents

Allocations for user units are based on water audits to determine appropriate consumption and there are penalties for overuse. In Israel these allocations are accompanied by water trading rights. Planned development of new water sources in a timely manner - The continued development of a diverse portfolio of water supply options to mitigate the impacts of climate change

Foster innovation and research in the water sector as a continuous input to policy.

CHAPTER VII : CONSTITUTIONAL PROVISIONS & ACTS RELEVANT TO FRAMING WATER POLICY IN DELHI

Constitutional Provisions

- 8.1 The Constitution of India includes detailed provisions with regard to the relationship between the center and state governments. The distribution of powers between the Union Parliament and State Legislatures is dealt in Articles 245 and 246. Article 245 empowers Parliament to make laws for the whole or part of the country, and the legislature of the state to make laws for the whole or part of that state, in both cases, subject to the provisions of the Constitution.
- 8.2 According to Article 246(1) Parliament is given exclusive powers to make laws with respect to any matters enumerated in List I in the Seventh Schedule to the Constitution. This list is known as “the Union List”. Likewise, Article 246[3] of Constitution bestows powers on to State Govt.s for making laws on matters listed in List II of the Seventh Schedule. This is known as the ‘State List’. The Union or any State Legislature also has, according to Article 246(2) of the constitution, concurrent powers to legislate on any matters listed in List III in the Seventh Schedule and this is known as “the Concurrent List”.
- 8.3 In the constitutional context of India and its quasi-federal character, the relationships centering around water have, of late, assumed vital importance. The discussions on federalism by far focus on centre-state financial and political relationships, balance of political power, issues of decentralization and local government and so on. Examination of relevant constitutional provisions like entry 17 in the State List, entry 56 in the Union List and Article 262(2) show the direct link to the subject matter of water. Entry 17 in the State List, which specifies water as state matter reads “water that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of entry 56 of List I”.
- 8.4 Entry 56 on the other hand endows Union Parliament with legislative authority over “regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest.”
- 8.5 Further Article 262(1) of the Constitution deals with disputes relating to inter-state rivers. It states that Parliament may, by law, provide for the adjudication of any disputes or complaint with respect to use, distribution or control of the waters of or in any inter-state river or river valley. Article 262(2) states that Parliament may, by law, provide that neither the Supreme Court nor any other court shall exercise

jurisdiction in respect of any such dispute or complaint as is referred to in Clause (1), notwithstanding anything in the Constitution. Pursuant to Article 262 of the Constitution Parliament enacted Inter-State Water Disputes Act in 1956.

- 8.6 The two laws enacted by the Union under Article 262 and Entry 56 of List I are the Inter-State Water Disputer Act, 1956 (as amended up to 1980) and the River Boards Act, 1956. No law has been passed bringing any river under the control of the Union and no such Board has been established under the latter Act.
- 8.7 It has also been argued that water is not as much a State subject as it is believed to be. In the Indian federal system the Centre has not made much use of the potential for legislation and executive action given to it by Constitution in respect of inter-state rivers and river valleys (Iyer '94). This observation was made in the light of competing demands for water, which are ever increasing among the states and the disputes between them defying solutions. The 14 major rivers in the country are shared by two or more states each, and the spatial and temporal variations of water resources are many. Added to this are the factors of steadily declining per capita availability of water and heavy reliance on irrigated agriculture.
- 8.8 In the present circumstances when the NCT of Delhi does not possess adequate natural water resources of its own in the form of rivers and is greatly dependent upon reservoirs situated at long distances on the interstate rivers of the Ganges and Indus basins. Inter-state water disputes would be increasing with passage of time.
- 8.9 The Sarkaria Commission on center-state relations examined the issue of constitutional provisions in respect to water and did not favor the suggestion that water should be included in the Union List alone.
- 8.10 **The recent report submitted by Ashok Chawla Committee which was primarily concerned with the question of rationalization of allocation of natural resources is learnt to have recommended inter-alia shifting of water to the Concurrent List.** However, this flies in the face of the recent moves for strengthening the federal structure of India by allowing greater assertion by the states.
- 8.11 **MoU Regarding Constitution & Functions Upper Yamuna River Board :** Delhi is a riparian state of the Yamuna River from which it draws 38% of its supplies currently. In a preceding Chapter it has been noted that Renuka and Kishau Dams are to be established in Himachal Pradesh in which storages Delhi has a substantial share.

- 8.12 The allocation of the river Yamuna's waters is governed by the MoU between the riparian states of Uttar Pradesh, Haryana, Rajasthan, Himachal Pradesh and National Capital Territory of Delhi. The MoU provides for the establishment of the Upper Yamuna Board tasked with the co-ordinated management of river Yamuna upto and including Okhla.
- 8.13 Under this MoU these States have agreed for the construction of the Renuka Dam, Kishau Dam, Lakhwar Vyasi project, Hathnikund Barrage and Parallel Water Carrier System for Delhi, and have identified Chatra, Chami Naingaon, Arangpur and Dhauj/Kot Storage Projects for construction.
- 8.14 The MoU provides that the States :
- shall have exclusive right to the non-consumptive use of Yamuna water within their respective territories.
 - have agreed that a minimum flow in proportion of completion of upstream storages going upto 10 cumec shall be maintained downstream of Tajewala/Hathnikund and downstream of Okhla Headworks throughout the year from ecological considerations as upstream storages are built up progressively in a phased manner
 - separate agreement will be executed in respect of each identified storage within the frame work of overall allocation made under this agreement
 - the allocation of available flows amongst the beneficiary States will be regulated by the Upper Yamuna River Board within the overall framework of the agreement
 - provided also that in a year when the availability is less than the assessed quantity, first the drinking water allocation of Delhi will be met and the balance will be distributed amongst Haryana, U.P. Rajasthan and H.P. in proportion to their allocations

This agreement may be reviewed after the year 2025, if any of the Basin states so demand.

- 8.15 **Groundwater:** Serious concerns are now coming up relating to ground water- rapid depletion of aquifers in many parts of the state. It is interesting to note that there is no explicit reference to ground water or aquifers in the Constitution. For groundwater, landowners had a virtually unlimited right to access water under their holdings under the Indian Easements Act [1882].
- 8.16 Since the Central Government does not have jurisdiction over groundwater, the measures that it can take are limited. To overcome this difficulty the Ashok Chawla committee constituted by the prime minister has also recommended amending the River Boards Act 1956 and including Ground Water in its ambit. It has further recommended that the River Boards Act may be assigned (RBA) a managerial role in the management of water resources.

- 8.17 The rapid depletion of groundwater as a result of extraction for irrigation and other uses over the past 50 years has led to policy development in this area. The central government formulated the Model Bill to Regulate and Control the Development and Management of Ground Water (2005). The Environment Protection Act (1986) established a Central Ground Water Authority to regulate and control development and management of groundwater resources. The main features are :
- establishment of a groundwater authority under the direct control of the government;
 - the authority is given the right to notify areas where it is deemed necessary to regulate the use of groundwater;
 - the final decision is taken by the respective state government
 - in any notified area, every user of groundwater must apply for a permit from the authority unless the user only proposes to use a hand pump or a well from which water is withdrawn manually
 - decisions of the authority in granting or denying permits are based on factors that include such technical questions as the availability of groundwater, the quantity and quality of water to be drawn, and the spacing between groundwater structures
 - the authority also takes into account the purpose for which existing overuse of groundwater and provides only a basis for ensuring that future use is more sustainable
- 8.18 Overall, the model bill constitutes an instrument seeking to broaden state control over the use of groundwater by imposing the registration of all groundwater infrastructures and providing a basis for introducing permits for groundwater extraction in regions where groundwater is over-exploited. Besides providing a framework for asserting government control over the groundwater use, the model bill also expresses limited concerns for the sustainability of use. It does not, however, propose a clear break from rules of access linked to land ownership.
- 8.19 For regulating the exploitation of groundwater in the NCT and collecting charges on groundwater extraction the Govt. of NCT Delhi did frame a bill on the lines of the model bill. This bill entitled 'THE DELHI WATER BOARD (AMENDMENT) BILL, 2002' [as an amendment to the Delhi Water Board Act, 1998] has not been passed by the State Assembly so far. However, by now the entire territory of the NCT has been notified as regulated area by the CGWA and the installation of new tube wells and deepening of existing ones has been generally prohibited or requires permission of the CGWA/DJB.
- 8.20 The Delhi Water Board has been established under section 3 of the Delhi Water Board Act, 1998 (Delhi Act No.4 of 1998) to discharge the functions of water supply, sewerage and sewage disposal and drainage within the National Capital Territory of Delhi and for matters connected therewith. Section 9(1) of the Delhi Water Board Act, 1998, provides for the functions of the Board. Clause (b) of that section provides that one of the functions of the Board shall be to plan for, regulate and manage the exploration of ground water in Delhi in consultation with Central Groundwater Authority. It also speaks of the Board's role of

advising the Delhi Municipal Corporation and Delhi Cantonment Board or another local authority in respect of exploration of groundwater. Clause (b) puts an embargo on Board's power to license and levy user charges for the exploration of groundwater in any area falling within the jurisdiction of the New Delhi Municipal Corporation or any other local authority, except with the authority of the Central Government. Conversely, this lays down that the Board has inherent power to license and levy charges for exploration of groundwater in Delhi excluding the areas which come under the jurisdiction of three local authorities, namely, NDMC, DCB and DDA. Reading section 9 (1)(b) with section 55 of the Delhi Water Board Act, the Board even today has power to license and levy charges for exploration of groundwater. The existing provisions of the Act therefore empower the Board to initiate steps for licensing of and levy charges for exploration and management of groundwater.

8.21 Model Bill circulated by the Union Ministry of Water Resources has underlined the broader issue of regulation and control of development of the groundwater in the country. The Model Bill provides for an independent regime for this purpose obviously looking to the geographical size of the States and multiple problems of regulation and development of groundwater in urban and rural areas of these States. Fortunately for Delhi this problem more or less restricted to urban area with rural pockets. For this, as explained above, there is already a provision in the Delhi Water Board Act authorising the Delhi Water Board to advise the other local authorities in consultation with the Central Government. (Vide proviso to section 9(1)(b)). It is, therefore, thought appropriate that necessary powers are given to the Board by amending the existing Act, instead of going in for a new regime as the Delhi Water Board is a statutory body already having required technical knowhow for handling matters relating to regulation and control of development of groundwater. The Bill accordingly, provides for the Amendment of the Delhi Board Act, 1998 as explained below.

- (a) **Amendment of long title:** - Long title of the Act requires amendment to expand the scope of the Act for empowering Delhi Water Board (DWB) to regulate, control and develop; the groundwater supply in Delhi. This is as per the mandate of the Model Bill circulated by the Ministry of Water Resources.
- (b) **Definitions** - Certain new 'definitions such as 'groundwater', 'sink', 'user of groundwater' and 'well' will have to be inserted in the Act.
- (c) **Amendment of Section 9** - It is proposed to amend section 9(1)(b) to enlarge the scope of present provision to include therein the regulation, control and development of groundwater as per the Model Bill. The clause now provides "Planning for regulation, control and development of groundwater" as one of the functions of the Board instead of only exploration and management of groundwater.
- (d) **Insertion of new Chapter** - A new Chapter III-A has been inserted in the Act, which provides for regulation, control and development of groundwater in Delhi. New section 35-A provides for declaration of notified areas for the regulation, control and development of groundwater. Sections 35-B

and Section 35-C, respectively, provide for permission for sinking any well for use of groundwater and for registration of existing users in areas notified. In granting or refusing permission for new well or registration of existing one the Board shall have regard to:

- (i) The purpose or purposes for which water is to be used;
- (ii) The existence of other competitive users;
- (iii) The availability of water;
- (iv) Quality of groundwater with reference to use;
- (v) Spacing of groundwater structures keeping in consideration the purpose for which water is to be used;
- (vi) Long term groundwater level behaviour; (vii) any other factor relevant thereto.

Subsequent sections 35-D, 35-E and 35-F provide for powers to the Board for alteration, amendment and varying the terms of permit and registration and their cancellation. Section 35-F in particular provides for entry, search, closing of water supply concerned and sealing of the water supply if situation so demands.

- (e) **Levy of user charges for use of groundwater** - As explained in the beginning reading section 9(1)(b) and section 35 of the Act, the Board can levy user charges for use of groundwater. But a new section 35-H has been added specifically providing for levy of user charges by the Board to clarify the position beyond doubt.
- (f) New offences have been added in the Fourth Schedule to the Act for effective implementation of the new provisions. The tenors of punishment

8.22 The Right To Water : Law is not static but evolving to expand the definition of human rights. The existing provisions of Constitution of India and some significant court rulings can be interpreted to pave the way for interpreting the right to water as a human right. This would make it incumbent for governments to ensure a guaranteed level of access to water for each individual.

8.23 The Right to protection of life and personal liberty is the main object of Article 21 and it is a right guaranteed against State Action as distinguished from violation of such right by private individuals. In other words, in case of violation of such rights (which are guaranteed under Part III of the Constitution of India) by private individuals, the person aggrieved must seek his remedies under the central law. Article 21 being one of the fundamental rights guaranteed by the Constitution, the same cannot be taken away by statutes. It is also necessary to mention at this juncture itself before we proceed to analyze Article 21 in detail that it has been held by our Hon'ble Supreme Court in *Behram Vs. State of Bombay* (1995 (1) SCR 613) that fundamental rights have been put into our Constitution on grounds of public policy in pursuance of the objects declared in the preamble; though these rights are primarily for the benefit of individuals and hence there can be no question of a fundamental right being waived.

8.24 Article 21 of the Constitution read thus :

“No person shall be deprived of his life or personal liberty except according to due process of law”. In the light of decision of the Supreme Court, the words ‘Life’ and ‘Liberty’ are liberally interpreted. Expansion of Article 21 has led to many of the directive principles being enforced as fundamental rights. On account of this expanded interpretation, now the right to pollution free water and air, right to food clothing, environment, protection of cultural heritage, right to every child to a full development, right of persons residing in hilly areas to have access to road and right to education (Mohini Vs. State of Karnataka (AIR 1992 SC 1858) have all found their way into Article 21. In another remarkable feature of the expanded meaning given to Article 21 that though it is in the form of a negative duty cast upon the State not to interfere with life and liberty of individual, yet various decisions of Supreme Court have now imposed positive obligations on the State to take various steps of ensuring enjoyment of life by an individual with dignity. Thus every condition conducive for leading a better life with human dignity is brought within the fold of Article 21. The State is now enjoined to fulfill these positive obligations.

8.25 In *Bandhua Mukti Morcha vs. Union of India* AIR 1984 SC 802: Characterizing Art. 21 as the heart of the Fundamental Rights the Court give it an expanded interpretation —“... the minimum conditions which must exist in order to enable a person to live with human dignity. No government can take action to deprive a person of enjoyment of these basic rights.” In *Cham Ji Singh Vs. U.P.* AIR 1996 SC 1051 — The Court observed in this connection : “In any organized society, right to live as a human being is not insured by meeting only the animal need of man- it is secured when he is assured of all facilities to develop himself and is freed from restrictions which enables his growth. All human rights are designed to achieve this object. Right to live granted in any civilized society implies the right to food, water, decent environment, education and medical care and shelter. These are basic human right known to any civilized society.”

8.26 **UN Resolution** : The UN General Assembly [64th Plenary — 108th Meeting] adopted resolution recognizing access to clean water, sanitation as human right, by recorded vote of 122 in favour, none against, 41 abstentions, calling on States and international organizations to provide financial resources, build capacity and transfer technology, particularly to developing countries, in scaling up efforts to provide safe, clean, accessible and affordable drinking water and sanitation for all. **To this resolution India is a signatory.**

8.27 **The 74th Amendment** : This Constitutional Amendment was passed in 1993 with the objective of empowering urban local govt.s and decentralizing urban governance. This Amendment, if properly implemented, enables substantial citizens’ participation in decision making on issues of direct concern to them. Unfortunately, so far the devolution of powers and formation of participatory mechanisms is incomplete. Effective implementation of this Amendment could bring in greater democratic participation by

RWAs, NGOs, Ward Committees and proposed Mohalla Sabhas in determining water policy which otherwise would remain a field for technocratic experts.

- 8.28 In recent times it has been clarified that Delhi is a Union Territory [Class C state] with limited powers. In view of the substantial stake of the Union Govt. on local bodies [Corporations, NDMC, Delhi Cantt.] as well as through agencies such as Central Pollution Control Board, Central Ground Water Authority, Central Ground Water Board it may be possible for the Parliament to legislate for the water sector in NCT Delhi.

CHAPTER IX : THE STAKEHOLDERS

- 9.1 NCT Delhi may be a small city state but it is blessed with several layers and levers of authority. All have their areas/domain of jurisdiction and this adds to the complexity of policy formulation and implementation. It would be wise to be acquainted with them.
- 9.2 **The individual citizens of Delhi collectively** are the largest water users in Delhi. They have the maximum stake in the sustainability of water resources for the NCT on which depends their survival, economic sustainability as well as quality of life. The massive water consumption of Delhi has an impact on river ecology [through abstraction and pollutants discharge] as well as on the environment through use of humongous amounts of energy consumption in water treatment, transmission, sewage conveyance and treatment.
- 9.3 They are the ones most affected by policy decisions made in their interest. Their understanding of water issues can mould their receptivity towards seemingly harsh policies as well impart robustness to policy. Simultaneously, their attitudinal change [influenced by awareness of issues, judicious use of financial and legal instruments] can help conserve water, minimize usage, augment the aquifer.
- 9.4 However, the citizenry is not one vast homogenized mass but a highly stratified society both economically and socially, with different levels of access to water resources. This stratification also suggests that policy sophistication is required to address this differentiation.
- 9.5 The **following institutional agencies** can be termed as stakeholders in the water sector of Delhi albeit from differing perspectives. These entities can be categorized as follows :

Agencies of the GNCTD

- 9.6 The GNCTD has the largest area under its jurisdiction with several agencies actively concerned with water resources. Thus **DJB** is a major player in the extraction of groundwater which it uses to augment supplies in many areas including far flung areas. DJB also supplies groundwater through tankers in any crisis situation. Several tubewells of the DJB have failed over time including Ranney wells in the floodplains. Thus DJB cannot but be interested in sustainable supplies and groundwater quality. DJB is a major source of treated effluents from its STPs which can be recycled as a resource depending on the level of treatment. At the same time it is incumbent upon DJB to extend its sewerage network and remove the flow of sewage from the stormwater drainage system.

- 9.7 **Irrigation & Flood Control Dept.** — this Dept. is the owner responsible for the maintenance of the drainage network in rural Delhi and the flood control works along the river Yamuna. The Yamuna floodplains constitute some of the most significant recharge areas. Several major drains and irrigation channels which are useful for groundwater recharge come under their jurisdiction. Of late the Dept. has also been entrusted with the upkeep of various village ponds.
- 9.8 **Other GNCTD Departments :**
- **Development Dept.** would be a major player in the GWRS on account of their capabilities to verify land titles and acquire land
 - **Public Works Dept. & Tourism [DTTDC]** undertaking macro-construction projects
- 9.9 **DSIIDC:** This corporation has several industrial estates under its jurisdiction and is also in the business of undertaking macro-construction projects.
- 9.10 **Several user Departments and Agencies [Metro, DTC, Education, Forests, etc.]** which have large land parcels under their control
- 9.11 **Energy sector :** with Pragati power plant

Agencies of the Gol & Riparian State Governments

- 9.12 The Gol is a major player in NCT as it is perhaps the single largest landowning agency through its various ministries. Thus, major land owning ministries are :
- Defence [are also large consumptive entities]
 - Railways [are also large consumptive entities]
 - Aviation [are also large consumptive entities]
 - Urban Development [includes urban estates, DDA, CPWD] [are also large consumptive entities]
 - All ministries have major establishments in Delhi [are also large consumptive entities]
 - Haryana Irrigation and Water Resources Department
 - Uttar Pradesh Irrigation
 - Uttar Pradesh Jal Nigam
 - Govt. of Rajasthan
 - NTPC [Badarpur Power Plant]

Local Bodies

All local bodies are responsible for several water consumption and disposal activities in their respective areas apart from enforcement of water related byelaws [rain water harvesting and waste water recycling]

- 9.13 **MCD** : The trifurcated MCD are the major local bodies of Delhi having vast jurisdiction in residential colonies, commercial areas, urban villages, self-owned built areas, drainage
- 9.14 **NDMC** : This body has jurisdiction over an area of 42 sq.km including several drainage systems
- 9.15 **Delhi Cantonment Board** : The Cantonment Board controls construction and drainage systems in its area as well as some large parcels of land

DDA

- 9.16 As per the DDA Act this agency's planning domain spans the entire area of NCT. It controls construction in several ongoing development areas including their drainage system and greenscape and is in a position to make a major contribution to the Groundwater Recharge Strategy. DDA also determines the detailed landuse in its zonal plans as also plans water supply system and disposal. DDA also determines building related byelaws including those pertaining to water harvesting and recycling, ground coverage
- 9.17 Delhi Disaster Management Authority, too, can be termed a stakeholder from the long term security point of view. Severe drought years such as 1987 and 2002 may be recalled when the groundwater supplement had to be fallen back upon in full measure. Extreme weather conditions promise to be the norm in the future and an augmented water table offers the best security against water scarcity.

Institutions in the Public Domain

- 9.18 Several educational & medical institutions, research facilities, courts, hostels, stadia, underutilized industries in the midst of urban areas are scattered over NCT are also large consumptive entities. Many of them are owners of massive chunks of land. Foreign Embassies and State Bhawans too would have to be persuaded to adopt rainwater harvesting in their areas.

Institutions in the Private Domain

- 9.19 Several educational & medical institutions, hotels, are scattered over NCT. Many of them are owners of massive chunks of land and are large consumptive entities.

Planned Residential Colonies

- 9.20 These fall in 2 categories — a very large number of multi-storeyed group housings and several plotted colonies are also large consumptive entities. Here the drainage systems are reasonably intact or can be improved upon with relative ease.

Farmhouses

- 9.21 Outer Delhi farm houses: several such affluent farmhouses are more country houses than farms and bear a major responsibility for groundwater depletion. Cooperation from them would result in conservation of the groundwater resources.

Irrigated Farm Holdings

- 9.22 Almost 275 sq.km. of irrigated farm holdings exist in Delhi which rely mainly on tubewell irrigation. Over the years the area under farmlands will decline but while farmed will consume groundwater resources. Efficient irrigation techniques and use of treated effluent for irrigation would help conserve groundwater resources.

CHAPTER X : AQUIFER MANAGEMENT

- 10.1 Groundwater is the main buffer resource of NCT Delhi which has closed the demand-supply gap year after year until now. The CGWB's estimates are that the annual extraction is 400 MCM [264 MGD] whereas the natural recharge is of the order of 281 MCM. Thus, at 145% extraction the situation is clearly unsustainable.
- 10.2 Groundwater reserves are the only buffer available for managing crisis situation and drought situations. Imagine a situation where the Tehri dam collapses in a major seismic event — there will be no recourse but to fall back on the groundwater reserves. The years 1952, 1987 and 2002 were severe drought years where groundwater availability tided over the supply deficiency. And in 2015 monsoon has been deficient to the extent of 50%. Given the uncertainties of climate change it is incumbent on Delhi to recoup its aquifers and ensure more recharge than extraction to manage a possible 2 year drought situation. [In the last 100 years there have been 21 occasions with 2 successive years of monsoon deficiency].
- 10.3 The other issue regarding groundwater is the quality of groundwater. Salinity affects nearly 40% of the area and nitrates, fluorides and even pesticides have been found in the water samples. All these adverse constituents can be dealt with by
- Preventing leachates from entering the aquifer
 - Encouraging the natural rain water recharge
 - Augmenting the recharge with adequately treated recycled water
- in order to dilute the concentration of adverse elements. This process, if consistently pursued, can improve the groundwater quality in the medium term [at least 10 years].
- 10.4 The idea of promoting aquifer management in Delhi has been pushed with ever increasing resonance in the last decade. Many of the above listed ideas have been detailed in INTACH's 'Groundwater Recharge Strategy For Delhi [DJB, 2010] and Masterplan for Groundwater Recharge, 2016 [for Dept. of Irrigation and Flood Control] but have largely not been implemented owing to lack of motivation in the involved agencies, absence of a sense of urgency, lack of inter-departmental coordination, lack of persistent and unambiguous direction at a higher level as well as absence of clear cut project outlines and concomitantly no specific budget allocations.
- 10.5 The concerned agencies are fully stretched with their routine tasks and as such unable to spare adequate resources to detail the projects and follow them through. Being fully stretched with urgent commitments

and fixed manpower resources most agencies are unable to re-orient themselves to prioritize new tasks such as groundwater recharge projects.

- 10.6 The survey of stakeholders has shown that there are several large landowning & construction agencies [planning and urban local bodies], water issues related agencies [supply, treatment, disposal, irrigation], user entities such as governmental/institutional/residential entities which would be involved in the implementation of projects in their respective jurisdictions.
- 10.7 The variation of scale amongst the portfolio of recharge projects is as varied as the number of stakeholders. Many projects span several departmental jurisdictions and require collaboration/coordination of several agencies to make them operational. Thus, to initiate and sustain a groundwater recharge program the Delhi Jal Board has to take other major Delhi agencies on board. This requires a direction from higher authorities which in this case may be the CM and Lt. Governor [whose jurisdiction extends to the major agencies such as DDA, MCD & NDMC, represents the Central Govt. as well enjoys the necessary hierarchical stature to ensure ironing out of jurisdictional hurdles].
- 10.8 The following institutional arrangements are recommended :
- i) The major agencies [DJB, DDA, MCD, I & FC, Development Dept., CGWB, UDD of Delhi, MUD] would designate a senior officer [Chief Engineer level] as a member of a task force on implementing groundwater recharge/management strategy. The DJB representative would be the Member Secretary of this task force which would report to the Chief Minister.
 - ii) A core group sited within DJB, headed by a fulltime Chief Engineer, drawn from Irrigation & Flood Control Dept. would be tasked with prioritization of projects, development of DPRs, coordination with individual stakeholders, monitor the progress of projects, encourage and persuade various entities to participate in groundwater management in their premises.
 - iii) The major land owning agency in any multi-agency multi jurisdictional project would become the lead agency in the said project.
 - iv) Political representatives [one from each District] would provide guidance to the Task Force
 - v) The proposed Mohalla Committees would provide inputs/feedback through website

TECHNICAL CONSIDERATIONS

- 10.9 Spatially considered it is clear that south and south-west Delhi are now relatively more deficient in groundwater compared to other parts of the city. This is due to receiving less water supply being at the tail end of the distribution network and high overdraft. Ironically, it is this relatively higher exploited area which has fewer natural recharge sites and less suitable storage strata available.

10.10 NW, N, NE, E and Central Delhi have suffered relatively less water depletion. This is mainly due to a variable combination of better natural recharge owing to proximity to river, high density network of irrigation and drainage channels, suitable soil strata for recharge, better supply from the distribution network. It is these relatively better off areas which have a larger number of natural recharge sites.

10.11 The macro recharge projects would be identified on a sub-basin [Block-wise] basis and served by the various STPs in that basin/Block by conveyance systems. Thus each STP would have a command area. In cases where the projects span more than one Block these would be treated as inter - Block projects.

10.12 **Groundwater Bill:** this Bill needs to be piloted through the Delhi Assembly with initial applicability to industry, institutions, commercial establishments and farmhouses. Later, when elements such as piped supply is adequate [with curtailment of line losses] and recycled water starts meeting a significant fraction of the demand the domestic extractors of ground water can be included in the ambit of the Bill.

Potential Resources Available For Groundwater Recharge In NCT Delhi

10.13 The potential resources which can be partially used for effecting recharge are as follows :

- i) The runoff generated by the rainfall in the NCT Delhi at a 75% level of probability and amounting to 177 MCM
- ii) Delhi's monsoon season allocation of the River Yamuna water amounting to 282 MCM which flows past unutilised for lack of upstream storages
- iii) Floodwaters entering NCT Delhi through seasonal streams and escaping to the River Yamuna. This is as yet an un-quantified resource.
- iv) "At present about 1349 MLD of wastewater generated in the city is treated by sewage treatment plants and the rest of the waste water is being discharged into the drains without any treatment. To treat the all-available wastewater Soil-Aquifer Treatment plants can be put up near the existing sewage as well as near the major drains carrying the wastewater. A battery of tubewells for using the treated wastewater for domestic purposes can pump this wastewater out. As the water is free of foul smell it can be used for all purposes after proper chlorination." — CGWB [Hydrological Framework And Groundwater Management Plan of NCT Delhi, February, 2006] The net water supply from all sources including tube wells is estimated at 2185 MLD and the return water for the river is pegged at 1280 MLD. The amount of treated effluent available would only increase in the years to come. The utilization of this resource would be limited only by the recharge rate and space available.
- v) **Substitution with recycled water** can reduce groundwater extraction in the industrial sector by 23 MCM annually approximately and in the irrigation sector by approximately 60 MCM annually. Substitution of recycled water in transport sector, horticulture, tourism sector, institutions and residential sector could also result in potential big ticket savings depending on the quality of the recycled water.

Objective Of Aquifer Management

10.14 Delhi may seek to stabilize its water table by neutralizing overdraft through a spatially well distributed scheme of recharge. In other words the equation should be as follows:

$$\text{Natural Recharge} + \text{Artificial Recharge} > \text{Extraction}$$

This would enable Delhi's unencumbered water buffer to build up to provide a reserve in any kind of crisis.

10.15 This can only happen when the current extraction level of 400 MCM annually is reduced and the recharge is augmented through various measures broadly outlined above. **The ideal scenario of groundwater under-draft can be attained only by Mission Mode whereby :**

- Natural rainwater recharge is facilitated and enhanced
- Artificial recharge with recycled water is actively pursued
- Substituting groundwater use with recycled water in various processes
- Reducing conveyance losses so that more fresh water demand is met by DJB supplies
- Demand reduction through efficient and conservative use
- Extraction is metered and billed so that over-extraction can be financially dis-incentivized

CHAPTER XI : WASTEWATER RECYCLING

11.1 Based on the projected population of 27 million in 2051 and based on the current CPHEEO supply norm of 172 lpcd the projected demand would be 1018 MGD. The present supply position of DJB is pegged at 920 MGD without recourse to Renuka Dam. After 15% distribution losses [in future] the actual delivered supply would be 790 MGD and as such after treatment of the return water 550 MGD of treated wastewater would be available. Of this, under Upper Yamuna Basin Agreement, NCT Delhi is supposed to return 250 MGD to the Yamuna River leaving 300 MGD available for recycling usage and thus closing the demand supply gap.

11.2 The equation would then be :

$$790 \text{ MGD [Freshwater]} + 300 \text{ MGD [Recycled Water]} = 1090 \text{ MGD Availability}$$

thus enabling reduction of fresh water [surface or ground] use to the extent of 70 MGD [1090 - 1018 MGD/availability - demand]

11.3 With progressive reduction of distribution losses to 5% [say by 2030] the delivered freshwater availability would be [930 MGD x 0.95] i.e. 880 MGD generating a recyclable component of 610 MGD. Thus, the total water availability by 2025 would be 880 MGD + 610 MGD - 250 MGD [mandatory return water to river] = 1240 MGD. This would be greatly in excess of the final demand of 1018 MGD leaving Delhi with a surplus of 222 MGD. This would enable Delhi's aquifers to remain untouched and enhance the river flow thus benefiting the river ecology and recharge of floodplain aquifers. The revised equation would be:

$$880 \text{ MGD [Freshwater]} + 360 \text{ MGD [Recycled Water]} = 1240 \text{ MGD Availability}$$

11.4 On the other hand, as efficiencies take effect, the per capita norm and total demand would come down. At say 150 lpcd the equation would read as follows :

$$880 \text{ MGD [Freshwater]} + 360 \text{ MGD [Recycled Water]} = 1240 \text{ MGD Availability}$$

Vs.

Demand of 888 MGD

And the per capita norm can come down drastically further leaving aquifers untouched and river flow further restored – it is very much in the realm of possibility to achieve per capita consumption norm of between 90 – 120 lpcd.

Jamshedpur Reduces Line Losses And Non-Revenue Water To Under 10%

This industrial town, which has grown around the Tata Iron and Steel Company (TISCO) has set up its own water provider—JUSCO. Also a Tata company, this is India's first private sector service provider in the water business. Its core area of work is in managing the water and waste business of Jamshedpur, but now it is branching out to offer its services to many other needy cities and industries.

In Jamshedpur, a town spread over some 64 sq km, with roughly 0.7 million inhabitants, JUSCO is responsible for water and waste services. It supplies some 190 mld over a network of 550 km of water mains. The key achievement is that in this town non-revenue water—or water that gets lost, say through leakage or in other ways—has been brought down from 36 per cent in 2005 to below 10 per cent by 2010. The success lies in the company's ability to manage its water supply efficiently. It has replaced pipes and has service-guarantee conditions. It monitors leakage and distribution losses through a city-wide computer mapping system. JUSCO says that with all this done, failures (complaints) about the water system are down from 44 each month to nil. Its 57,000 connections are not completely metered—only 30 percent are—but with losses down, operating costs have lowered and recovery has improved. It has only 4 employees per 1000 connections, lower than most cities even in Asia.

The big question now is if this Jamshedpur experience can be replicated in other cities of the country. JUSCO, which has now bagged performance-based management contracts in Mysore, Haldia and Salt Lake cities for supply of water and reduction of losses, will have to work its magic once again.

Source : Planning Commission [2011]

Sectors of Use

11.5 The usage of the recycled water depends on several factors :

- Quality of the recycled water
 - Secondary level treated water can be recycled for horticulture and irrigation
 - Tertiary level treated water can be recycled for industry, transport, power sector and flushing
 - Potable level recycled water can be used across all sectors [acceptability for potable purposes has to overcome a psychological barrier — **the best solution is to use recycled water for recharge and treat and supply the extracted water**]
- Demand for recycled water will depend on cost and legal provisions
- Infrastructure difficulties
 - Substrata in several parts of the city is already crammed with pipes and cables making it extremely difficult to lay new pipelines for transporting recycled water. It also needs to be considered that recycled water of potable quality does not require any additional distribution network.

- The urban extension envisaged in western Delhi under Masterplan [2021] would permit integrating such infrastructure right from the beginning. In fact, the infrastructure could be fed from decentralized STPs and WTPs so that the transport distance would be greatly reduced and hence distribution losses as well [incident to the shortening of the pipe lengths]
- Even in existing urban areas the easy targets would be industrial estates, commercial centres, institutional areas, transport sector, green areas
- **Domestic sector :**
 - Recent survey [DJB, 2012] has brought out the reluctance of domestic users to accept recycled water. The grounds for this are psychological and a suspicion of inconsistent water quality being supplied.
 - Thus, the new residential areas would be appropriate destinations for secondary and tertiary class of recycled water.
 - It also needs to be considered that recycled water of potable quality does not require any additional distribution network or pose problems of psychological acceptance.
 - Newer efficient flushing systems would gain ground [even as low as 5 liters or less per use] decreasing the requirement for recycled water even in existing colonies

11.6 Hence, rationally to use existing infrastructure the requirement is for potable water quality. However, to obtain potable water from sewage requires high end energy guzzling technology. The options are:

- Mixing tertiary class of recycled water with river freshwater or groundwater and then treating the same in WTPs
- Allowing treated STP discharge to be stored in pondages and filter through the soil and be extracted for treatment in WTPs

Both options would have to be used as appropriate.

11.7 **STP Command areas:** Recycling can be planned on the basis of a command/influence area approach for each STP. A command area approach for STPs may be drawn up, where treated water is recharged, soil filtered, blended with a small percentage of fresh water and then sent to decentralized water treatment plants for distribution to the Zonal UG reservoirs. The STP command area/influence area will allow rational planning and distribution of the various classes of recycled water. This requires detailed project reports for each of the existing STPs.

CHAPTER XII : Water Efficient Fixtures, Sustainable Habitats, Detergent Composition

Water Efficient Fixtures Rating System

12.1 Efficient Devices: Similar to energy efficiency star rating system [Min. of Power, Bureau of Energy Efficiency, GoI] for energy efficient devices there is a need for efficiency rating of water devices as a demand side containment measure. This is an approach implemented in several water scarce countries such as Australia on a mandatory basis and encouraged by many farsighted nations [Water Efficiency Labelling System — Australia], WaterSense — USA, Water Efficiency Labelling Scheme — Singapore, WaterWise — UK]

12.2 In India the same is mandated by the National Water Policy, National Water Mission and even by the newly formed National Mission For Sustainable Habitat and as encouraged by Green Building Rating Systems [LEEDS, GRIHA, IGBC].

12.3 Water efficient fixtures can be of many types such as :

- Dual flush toilets/low consumption water closets
- Sensor operated urinals
- Sensor taps/pressure restrictor taps/aerator taps/timer taps
- Flow restrictor showerheads
- Washing Machines

Table No. 12.1 Estimated Water Saving By Water Efficient Fixtures

Fixture	Water Use In Standard Fixtures	Water Efficient Fixtures	Water Saved
WC	Single flush toilet uses 10-13 liters/flush	Dual flush toilet in 3/6 and 2/4 liter models	4-11 liters/flush
Urinals	4 liters; 10-13 liters/flush if toilet pan is used	Sensor operated adjustable flush	2.2-10 liters per flush
Taps	10-18 liters/minute depending on pressure	Sensor taps	5.5-15.5 liters/minute
Showers	10-15 liters/minute	Flow restrictors	4-20 liters/minute

Source: Down To Earth [15 October, 2010]

12.4 Roadmap : Centre For Science & Environment have published [March, 2011] a road map for implementation of 'Rating System For Water Efficient Fixtures' which states 'In India, a 2009 survey by Tata Consulting Engineers conducted in Mumbai found that by using simple water-efficient fixtures, a five

member household could save [on an average] over 400 litres of water every day'. The roadmap proposes formation of a 'Bureau of Water Efficiency' under Ministry of Urban Development. However, an all India decision can be a long time in coming having to take into account the differing situation of various states and the lobbying from various manufacturing interests. There is nothing to prevent NCT Delhi from implementing the rating scheme at the state level and encouraging the same with a differential level of VAT taxation and/or disincentive cess.

National Mission on Sustainable Habitats

12.5 The 'Report of Sub-committee for Development of National Sustainable Habitat Parameters on Urban Stormwater Management' recommends the following indices to be developed for enhancing availability of water resources :

- i) **Permeability Index** : This index can be defined as the percentage of the catchment which is impervious. (Note — Attempts should be made through sustainable drainage practices to restore the permeability index of the catchment to pre-development levels).
- ii) **Waterbodies Rejuvenation Index** : This index is to define the sustainability of the water bodies (past and present). For the rejuvenation of water bodies, the ratio of total area under water bodies planned for rejuvenation to the total area of water bodies including those encroached upon may be used as an indicator.
- iii) **Waterbody Vulnerability Index** : In regard to the habitations in the existing water bodies/flood prone areas, it was proposed that the ratio of total area under water bodies encroached (present date) to the total area under water bodies (on a datum date) may be used as an indicator.
- iv) **Rain water Harvesting/Artificial Ground water Recharge Index** : With reference to the encroachment of natural streams passing through urban areas, it was observed that on one hand, the pathway/water line of natural streams are being blocked / constructed and on the other hand, more and more developments are coming on by paving the way in enhancing the run-off causing increased peak flow and frequent inundation in urban area. To overcome this, rain water harvesting to be made mandatory, while following building bye-laws and at suitable places, considering the overall suitability, artificial ground water recharge also to be encouraged. The recharge index may be defined as the ratio of the rainwater volume stored/harvested to the ratio of the measured rainfall volume. In the planning level itself, 2 to 5% of urban area should be reserved for water bodies to work as recharge zone.

Detergents Policy

12.6 In order to achieve recyclable water quality it is essential that many of the current STPs [which are of secondary level discharge quality] discharge cleaner water quality at lower energy/chemical costs. An important ingredient of many detergents is phosphate in the form of sodium tripolyphosphate (STPP). A consequence of the use of STPP in the domestic environment can be an increased level of phosphates in

household waste water, which may then contribute to the phosphorus load in rivers, lakes and inland waters. This can be an environmental issue because of “eutrophication”, the increase of nutrient levels in water, which can lead to the formation of large masses of algae or blooms which are unsightly, cause slow moving water to be turbid, and may be toxic.

- 12.7 Legal bans on phosphate in detergents are in place in Germany, Italy (ban 1989), the Netherlands, Switzerland (ban 1986), Japan (ban limited to areas containing sensitive lakes but in effect no STPP-based detergents sold in Japan), Canada (ban 1973) and the USA (different dates in different states from the 1970s onwards) (Glennie, et al., 2004).
- 12.8 The WRc study (Glennie et al., 2002) to address the current use of phosphates in detergents throughout the EU recommends measures to reduce phosphorus concentrations in surface waters below levels that cause eutrophication, through either improving wastewater treatment, banning the use of phosphates as detergent builders, or a combination of the two approaches. The study suggests that banning phosphorus from household detergents can achieve a phosphorus load reduction of up to 40% entering surface water bodies.
- 12.9 Germany: The maximum permitted concentration of phosphates in detergents was reduced by 50%. Following the regulation there was a decline in the consumption of STP (sodium tripolyphosphate), from 185 900 tonnes in 1984 to 13 000 tonnes in 1990, and none in 1998. The significance of this legislation must also be viewed in a wider context. Since 1986 consumers have generally decided in favour of phosphate-free products and since then there have been virtually no phosphates in detergents in Germany.
- 12.10 The same can be attempted in India with progressive reduction in phosphate levels in detergents resulting in a policy based reduction of pollution rather than on solely technology based results. This would, of course require a much wider and thorough debate. The use of natural cleansers such as ‘reetha’ and ‘hingot’ would be promoted to decrease phosphate content and water used in laundry. These natural cleansers also halve the usage of water for rinsing.

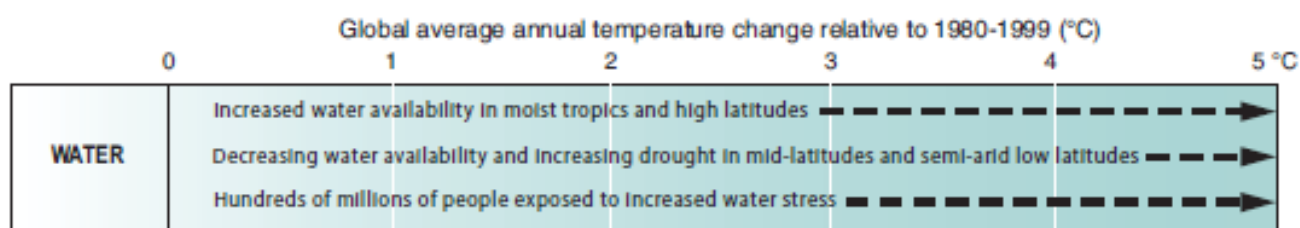
CHAPTER XIII : CHALLENGES OF UNCERTAINTY

- 13.1. Securing the water future of Delhi confronts policy makers with challenges of uncertainty. In the present circumstances the NCT Delhi does not possess adequate natural water resources of its own in the form of rivers or ground water and is greatly dependent upon reservoirs situated at very long distances on the interstate rivers of the Ganges and Indus basins.
- 13.2. Evolving politico-socio-economic developments are bringing different combinations of pressures on the future of these water supplies to Delhi. Inter-state water disputes and bitterness of these disputes would be increasing with passage of time. Compounding these pressures are the changing global climatic conditions and global warming. These uncertainties are examined briefly over here to understand their implications for water policy for Delhi :
- 13.3. “Climate change could affect water supply systems in any number of ways. It can affect the water demand for drinking and cooling systems. Where climate change leads to failure of small local water sources such as wells, it could lead to greater demand for regional water supplies. Changes in precipitation patterns could lead to reduction in water availability and fall in water tables . . . One of the climate change risks to the Indian economy and its people, and therefore to sustainability of habitats, is the increased intensity, frequency and geographical coverage of drought. Its primary impact is on rural areas where agriculture, animal husbandry, and to a lesser extent forestry and fishing, are significantly impacted leading to cycles of seasonal and distress migration. Droughts lead to drinking water shortages and increase in food and biomass fuel prices that hurt the urban poor and middle classes and hence the city economy. It also leads to a number of other impacts like depressed demand for secondary goods and services because of depressed agricultural demand. Rural-urban migration has only contributed about 20 per cent of India’s incremental urban population growth since 1971. This trend could change due to climate change related impacts that may render subsistence agriculture uneconomical in parts of semi-arid central, western and southern India. The most serious regional impact of climate change could be changes in the river hydrology in the Indo- Gangetic plain and the Brahmaputra valley.”
- 13.4. **River Flow:** In June, 2011 ISRO has released a study on the 15 year monitoring of 2190 glaciers in J & K, Himachal and Uttarakhand which shows that that many glaciers are in retreat. For eg. all 119 glaciers in the Alaknanda sub-basin have retreated by 10% since 1990. Out of the 29 glaciers feeding the Gori Ganga, a tributary of the Ganga, 20 are in retreat. These developments portend serious implications in the river basins both upstream and downstream of Delhi.

13.5. **Climate Change:** The Intergovernmental Panel on Climate Change [IPCC] has in its 4th Assessment Report, November, 2007 [Summary for Policy Makers] clearly stated that between 1970 and 2004 there has been a 0.2°C to 1.0°C rise in temperature.

13.6. The IPCC has projected “For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emissions scenarios. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emissions scenarios.”

Table No. 13.1: Projected Water Impacts



Source: IPCC

13.7. The impact on climate has been decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes. In irrigation systems that rely on high mountain glaciers for water, high runoff periods will advance earlier in the spring, when irrigation water demand is still low. In addition, rising temperatures will increase crop water demand.

Table No. 13.2: Projected Regional Impacts

Asia	<ul style="list-style-type: none"> By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease. Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers. Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development. Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.
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Source: IPCC

13.8. The rise in temperature will result in greater evaporation losses in reservoirs as well as trans-evaporation losses from vegetation. The water requirement of irrigation may thus be expected to rise increasing the competing claims from the basin states.

13.9. **Status Of Major Dams:** Construction of dams in the Himalayas is increasingly becoming difficult in the face of R&R issues, forest submergence issues, local community resistance on various grounds,

environmental groups resistance. In a recently held meeting of the Upper Yamuna River Committee to iron out issues over the construction of Dams on Yamuna and water sharing, it has been decided that fresh proposals will be drafted simultaneously for all three dams- Renuka dam, Kishau dam & the Lakhwar-Vyasi Dam and the water sharing formulae will be based on as fresh agreements.

13.10. Renuka: Here, the MoEF has rejected the Himachal Pradesh Govt. proposal to divert forest 775 ha land for submergence in August, 2010. In its letter, the ministry informed the state Additional Chief Secretary (Forests) about its decision to reject the proposal for land diversion since the area had a high density of forests and the project would involve felling of a very large number of trees. The Renuka Bandh Sangharsh Samiti and many other groups are active saying approval for land diversion would spell havoc on the forest and rights of locals. This year [July, 2014] with the new Govt. at the Centre the project has received a fund allocation of Rs. 50 cr [against requirement of Rs. 4000 cr] and also received forest clearance from MoEF [August, 2014]. Even so water from the project is at least a decade away. *With implementation of this Water Policy, Delhi does not need any further additionality in freshwater supplies and should have no stake in Renuka or Lakhwar Vyasi dams.*

13.11. Sarda Yamuna Link: This project requires international cooperation. Agreements for this project were signed with HM's Govt. of Nepal. Since then the political changes in Nepal have put a question mark over the treaties with the Nepal Govt. taking a hard stance over all water projects connected with India. *This project is absolutely not required by NCT Delhi.*

13.12. Disputes with Upper Riparians: 1994-MoU, regarding water allocation between the riparian state of Yamuna basin viz Haryana, Rajasthan, U.P & NCT of Delhi provides for construction of Renuka Dam, Kishau Dam, Lakhwar Vyasi Dam projects besides parallel water carrier channel (Munak Canal) which was supposed to have been completed by 2009, has been lingering on since. However, the matter has been resolved in a recently held meeting of GoM; Government of India and Haryana has agreed to complete the parallel carrier channel within 2 months and make available to Delhi 610 cusecs per day of water through Munak Canal as was agreed to initially. This is expected to mitigate Delhi's water woes to some extent.

13.13. In recent years Punjab has abrogated its water sharing treaties with other states on the grounds that the water flows in the rivers have declined below the level prevalent when the treaties were signed. Matter is pending with the Hon'ble Supreme Court of India as a result of presidential reference on the complaint of Haryana Govt. In spite of the matter being subjudice the Punjab Govt. has gone ahead with the closure of the SYL canal and return of the canal lands to the original owners.

13.14. Rainfall: Vagaries of rainfall too have to be considered. The IPCC forecasts increase in extreme events. More pertinently, in recent years such as 1952, 1987, 2002, 2008 and 2015 there has been a widespread deficiency in rainfall resulting in conflict between upper and lower riparians.

13.15. Population Projections: While several forecasts have been referred to [stabilization at 25 million populations by 2031] and a substantial margin for error has been included even so unforeseen circumstances could result in upsetting the estimates. For eg. under growing urbanization profile and pressures from the landowners in Delhi the residential FAR could be raised to accommodate more population. This would result in greater than estimated demand.

13.16. Technological Advancements: These could actually result in increasing use efficiency and conservation thereby decreasing the per capita demand norm. Thus for eg., flush toilets could be replaced by dry toilets, cloth washing processes may become water free, air coolers may be eliminated through retrofitted housing, more efficient washing machines would be prevalent and industrial processes would become water efficient.

Note : At the presentation of the policy to Chief Secretary on 22 April, 2013, the CS had called for an examination of the water policies of Upper Yamuna riparian states for their implications for Delhi. The trends then are noted below :

a) **Haryana :** The state's water resources planning has been severely impacted by

- The unstated acknowledgement that Sutlej - Yamuna Link is all but aborted and may yield no additional resources to the state
- Renuka dam has is in doldrums and may not come through
- Accordingly, Haryana refuses to cooperate with Delhi. For eg. the parallel carrier will curtail the percolation of water which accrues to Haryana. Thus, Haryana will resist any move by Delhi to access its share of Yamuna waters and this non-cooperation will steadily worsen.

b) **Himachal :** this state is a bit player with no capacity to use Yamuna waters without Renuka Dam

c) **Rajasthan :** this state is at the tail end of the system and cannot utilize its share without Renuka Dam. In case the Dam comes through the state, with its increasing requirements, will become more assertive especially when the Upper Yamuna Agreement has to be renewed in 2025. The state has a water policy which adopts guidelines from the

NWP with usual emphasis on reducing demand, conservation, increasing efficiencies, etc.

- d) **UP** : this state will look to utilizing its share of Yamuna water in future as its requirements go up. Again without Renuka Dam this is not possible. At the same time the state has no conflict with Delhi with regards to Yamuna water. Regarding Ganga water, however, if Tehri Dam silts up at a faster rate than estimated, water supply from that source may reduce leading to friction with Delhi. The state has a water policy which adopts guidelines from the NWP with usual emphasis on reducing demand, conservation, increasing efficiencies, etc.

Assessment : Given the recent Uttarakhand disaster dam building proponents will be on the back foot for several years and this will place the Upper Yamuna reservoirs into limbo for the foreseeable future. Thus, Haryana's non-cooperation may increase to active acrimony while Rajasthan may become more assertive in its claims. Tehri Dam's storage capacity may reduce much faster than anticipated resulting in reduced yields. This may lead to friction with UP.

Thus, it will be advisable for Delhi to assume a situation of static supply at current levels and plan to manage its demand within these finite resources. If Delhi does manage to do so, especially by substantially recycling its sewage Haryana may be tempted to poach on Delhi's allocation in 2025 officially and much earlier unofficially. Clearly, Delhi would have to be assertive on retaining its freshwater allocation whether it is fully utilized or not.

Delhi would also have to press the Central Govt. to encourage Haryana and UP to implement the NWP provisions vigorously in order to balance their demand and supply equation in their own interest and in the interest of the environment and in order to adjust to the vagaries imposed by climate change on resource variability. The NCRPB can also initiate conducive programs in this direction in the NCR region. Thus, increasing irrigation efficiency in Haryana and UP can moderate their water requirements substantially thereby enabling cordiality amongst states and increasing flow in the river Yamuna. This thrust can avoid acrimony and enhance water security for all states.

CHAPTER XIV : EMERGENT POLICY ISSUES AND OPTIONS

14.1. It is by now clear that the water sector in NCT Delhi has to evolve under circumstances of volatile externalities and supply constraints. Thus the critical water resource has to be managed by a long term perspective which should not be generalist in nature but offers pragmatic direction.

14.2. The previous chapters have examined the policy measures recommended in the National Water Policy [2002] and Draft National Water Policy [2012], policy recommendations in some States, and salient features of policy practiced in significant regions abroad. NCT Delhi can learn from all of these yet needs to go far beyond in view of its own specific circumstances.

14.3. It can be reasonably inferred from the population forecasts and demand projections that NCT Delhi's population would stabilize at 27 million by 2051 on which basis the demand, based on present norms, would be 1018 MGD. With the successful completion of the Munak carrier system the city state's supply level would be at 920 MGD and together with recycled water would be well in excess of the demand.

14.4. **The prime objective of policy** is ensuring the long term water security of the NCT Delhi even under conditions of external flux. **Water security** may be defined as having access to norm based supply to all citizens of Delhi over a long term horizon such as year 2050 and building resilience to face challenges of resource variability.

14.5. The emergent policy issues which NCT Delhi needs to address are :

- i) Shifting the emphasis from supply side to demand side management
- ii) **Priority In Water Allocation** : The priorities will come into play in a situation where there is a shortage of water. NCT Delhi needs to determine its order of sector priorities in a situation of scarcity.
- iii) **Legal Issues** : here the most important issues are :
 - Addressing the emergent issue of human right to water since many parts of the NCT Delhi are being undersupplied at well below norms — this should be tied with guaranteed service levels by the DJB. This can be further elaborated as ensuring access to an identified minimum amount [to meet bathing, cooking, washing needs] of potable quality water to all classes of citizen

- Groundwater bill has been pending since last 10 years allowing unregulated extraction of groundwater. Hence acquiring the instruments for groundwater management is essential
- A charter of water duties for the citizen needs to be drawn up to ensure this vital stakeholder's active and positive role in water management in the NCT.

iv) **Adjustment To Climate Change** : River flows variability, monsoonal variability and temperature rise are the three aspects which will affect the water availability in Delhi as also the upper and lower riparian states. This will need availability of adequate groundwater reserves and incremental increase in wastewater recycling to make up for resource deficiency. It will also be prudent on Delhi's part to minimize its fresh water footprint over the northern basins in order to mitigate future conflict with upper riparians.

v) **Recycled Water Resource** : It is by now accepted that wastewater will have to be treated and recycled even upto drinking water level to reduce dependence on variable freshwater resources. In this regard :

- Recycled water usage to be encouraged to reduce freshwater imprint
- Recycled wastewater use target to be framed for 2019/2022/2027
- Norms of treated wastewater to be upgraded to at least tertiary levels
- Industries, power plants, large scale users in transport sector to changeover their water use to recycled water to the extent possible
- Promote use for irrigation, large gardens, flushing
- Use to be promoted by inductive tariffs or by regulation
- Use for indirect groundwater recharge and for waterbodies maintenance
- Rebates may also be given for decentralized wastewater treatment where the same is put to reuse and curtails freshwater requirement. Decentralized STPs should be encouraged so that the resource loop can be closed near the point of generation. The byelaws in this regard may be strengthened
- In areas proposed for urban extensions in MPD 2021 the landuse policy should provide for decentralized STPs
- Detergents: phosphate content in detergents is a major bane in pollution treatment as it is very difficult and costly to remove from the water stream. Many countries have acted to reduce the phosphate content in soaps from 14% to 5% thereby improving the quality of STP effluent. This again can be accomplished by tax instruments and discussion with

manufacturers. The use of natural cleansers such as 'reetha' would be promoted to decrease phosphate content and water used in laundry.

- Further, treatment technology of existing STPs should be improved to get tertiary level output wherever possible. Thereafter, a command/influence area plan should be created for each STP. Targets for recycle and reuse would need to be fixed on a bi-annual basis.

vi) **Controlling Distribution Losses** : The National Water Policy [2002] has fixed a maximum norm of 15% losses in the distribution system as an acceptable figure of losses. Currently, the level of loss in distribution in Delhi is claimed to be 30%. Some cities [Singapore, Paris] have lowered their distribution losses to 5%. NCT Delhi also needs to fix up more ambitious targets [far lower than 15%] over the next decade. The curtailing of losses means lesser extraction of groundwater and greater availability of recycled water.

vii) **Demand Management** : Demand has to be managed within sustainable supplies. This requires targeted decrease in present per capita norm which could be targeted for reduction at a rate of 10 litres per decade from the present supply norm of 172 lpcd. Consumers outside the domestic sector also have to work constantly to meet their requirements with lesser water use. Potential thrust areas which converge in taking demand southwards are :

- Conservation thrust : This is to be attained through constant efficiency upgradation in water consuming technology
- A conservation movement needs to be generated so that presently uninformed consumers would adopt attitudinal changes to use water resources wisely
- Use of price instrument : Application of economic instruments to reduce water consumption with application of progressive block rate water tariff

viii) **Water Conservation And Decrease In Per Capita Norm** : Over time, with increased awareness and integration of water saving technology, the per capita norm can be steadily brought down. There are several options which converge in this direction :

- Conservation of freshwater through use of water saving devices [shower heads, taps, sprinklers, etc.] — this should be reinforced by a retrofitting program and also by rebates on efficient devices [Efficiency of water devices to be rated] and disincentive cess applied to less efficient devices.
- Retrofitting program promoting pressure reducer devices in faucets and showerheads, pull handle taps, two-volume flush toilets, and cisterns with double quantity dispensers, garden sprinklers

- Encouraging efficient garden irrigation and water conserving strategies in private and public gardens. Public gardens to be watered through sprinklers only
- Require water conservation management plans for large water users, before building plans are sanctioned. Formulation of Water Use Policy need to be expedited so that before apply for the building clearance, it should be known as to how much water utilization there would be and what amount of that could be recycled and it is on that certificate a new project should be given permits for being on the DJB grid. Both new and existing developments should aim at being water neutral in due course.
- Water Audit : capacity to be built to carry out water audit on large scale users to establish reduction possibilities and encouraging recycled water use.

ix) **Aquifer Management** : groundwater conservation and recharge is an essential back up for Delhi being its only internal resource. Periodically deficient rainfall has affected Delhi whence recourse to the aquifers bridged the demand — supply gap. In a prolonged drought situation supply norms can be lowered [metering essential to support this] and recharged aquifers would form the buffer supply. A high water table would also ensure a healthier lean season base flow in the river. In this regard :

- Target for recovery of depleted aquifers needs to be set
- Groundwater legislation should be enacted
- Aquifer recharge and management strategies to be elaborated
- Rainwater harvesting to be pursued aggressively at both micro and macro scale and promoted through incentives. Scientific advice and monitoring should be incorporated into the program for sustained effectiveness.
- Waterbodies: these form gateways to the aquifer and hence are part of groundwater recharge strategy. Maintaining water level and water quality in waterbodies is thus essential for raising water table and maintaining groundwater quality. Waterbodies have been under threat from reclamation and waste disposal. Each waterbody needs to have a conservation plan and maintenance of its water balance and healthy water quality status. The lost water spread in Delhi needs to be recovered to the extent possible.
- Drawing up baseline studies on sustainability indices [Chapter 12] and planning measures to improve upon them :
 - Permeability Index
 - Waterbodies Rejuvenation Index
 - Waterbody Vulnerability Index
 - Rain water Harvesting/Artificial Ground water Recharge Index

- x) **Database:** The city's water budget [spatially and sectorally] cannot be precisely comprehended in the absence of an accurate data base. This calls for comprehensive metering at micro and macro level. This metering must be taken to the level of individual dwelling units to facilitate conservation through pricing instruments, establish system losses and overdrawing entities. Metering must also extend to groundwater. Return water must also be measured at a zonal level. This will enable effective implementation of regulations and in conservation effort. Comprehensive metering for mapping and managing demand and planning investments is to be implemented mandatorily.
- xi) **River Related Issues:** NCT Delhi abstracts substantial freshwater from the river and is thus responsible for restoring the maintaining adequate flow in the river to maintain it as an ecological entity. Although under the Upper Yamuna Water Sharing MoU a 10 cumec flow is to be maintained this has not been accomplished so far. Even this is an arbitrary figure and should be arrived at scientifically as it appears insignificant for a major river. By increasing recycled water usage and decreasing its fresh water footprint Delhi can actually reduce its abstraction from the river thereby increasing the flow.
- xii) **Pricing :** Surveys show that until recently the water tariff was so low as to encourage profligacy. Price instrument needs to be exercised in order to influence conservative use by consumers. The following categories of pricing may be considered :
- 1) In the domestic sector price for the first 100 lpcd would be based upon meeting operational and maintenance costs
 - 2) Consumption beyond this level would be based upon full cost recovery
 - 3) Pricing for the institutional, commercial and industrial sector should be based upon profitable levels to recover losses under (1)
- To determine realistic tariff levels an independent regulatory body would have to be positioned on the lines of similar regulators in other key sectors.
- xiii) **Institutional Integration:** Supply, collection of sewerage, river water, groundwater, waterbodies, water harvesting and local bodies jurisdictions are all fragmented making it difficult to take a fully coordinated approach on water issues. Comprehensive coordination of the entire gamut of issues should come under a single agency i.e. DJB. The NCT of Delhi where all water management comes under a single agency viz DJB. Its regulatory and institutional frameworks are the prime areas where reforms needed. As a matter of fact a **water**

resources regulatory authority [an independent regulator to enforce policy or benchmark policy performance] is the need of the hour. Such an authority would have different cells to bring specific focus upon :

- Demand Management Cell [hydro-literacy, conservation, demographic trends, urban trends]
- Recycling and Decentralized wastewater treatment cell
- Climate change cell, green operations and energy conservation
- Water audit cell and large user entities water management cell
- Aquifer Management Authority
- Tracking unit to keep abreast of new trends — developments in the northern basins, treatment technologies, conservation innovations, financial innovations, regional weather trends, changes in the aquifers, energy conservation

xiv) **Education & Awareness:** The public at large remains ill-informed and water illiterate about Delhi's water endowments and constraints. Citizens, being the largest stakeholders, need to play their part in furthering the objective of water security. Awareness campaigns to raise public support for conservation and receptivity for regulation, pricing strategy and laws are an important and essential component of strategy to achieve policy objectives.

xv) **Innovation :** There is a need to foster innovation and research as a continuous input to policy i.e. encouraging ever increasing efficiency of resource use through advanced/innovative technology and policy innovation

xvi) **Building Resilience :** The objective of water security is vulnerable to the several uncertainties outlined in Chapter 13. This calls for building resilience the face of resource variability and/or demand flux. The possible thrust areas in this endeavour can be :

- Continuous reduction of demand
- Continuous increase in quantum of recycled water
- Augment and maintain aquifers to the fullest
- Maintain NCTs stake in Himalyan basins while keeping a watch on postures of riparians towards the review of Upper Yamuna Agreement up for review in 2025
- Encourage conservation, efficiency and recycling in riparian states through the good offices of the Central Govt. and the NCR Planning Board

xvii) **Privatization :** In view of the several well documented failures of privatization of water utilities worldwide and a reversal to re-municipalization this distracting idea may be

abandoned for the foreseeable future. It is also seen that the DJB has ample capacity to meet service norms given good leadership

- xviii) The energy footprint of utilities would have to be factored in technology adoption to curtail their ballooning carbon footprint

CHAPTER XV : PROPOSED POLICY STATEMENTS

15.1 The Water Policy Of NCT Delhi consists of a series of policy statements each of which will have to be elaborated into an actionable program by a working group. Components of different statements could converge on a common objective.

15.2 **The prime objective of policy** is ensuring the long term water security of the NCT Delhi even under conditions of external flux. **Water security** may be defined as having access to norm based supply to all citizens of Delhi over a long term horizon [2050] and building resilience to face challenges of resource variability.

15.3 The policy is built around 5 pillars :

- Demand Management
- Optimization of available resources
- Recycling
- Augmentation of internal resources and building resilience to climate change
- Equity

15.4 POLICY STATEMENTS

Statement 1 : Priority In Water Allocation

101 The priority in allocation of water resources, in case of shortage, would be in the following sequence :

- Drinking water and meeting domestic demand
- Institutional, Commercial, Industrial Use
- Power Sector
- River and Wetland Ecology
- Irrigation

Statement 2 : Demand Management

201 NCT Delhi will focus on Demand Management : Towards this end NCT Delhi will reduce its present per capita consumption norm of 172 lpcd by a minimum of 10 litres every 5 years

Statement 3 : Recycled Water Resource

301 NCT Delhi will progressively use recycled wastewater to meet its water requirement and thereby decrease its freshwater footprint.

302 NCT Delhi will frame targets to increase its recycled wastewater use :

- to 35% by 2019
- to 70% by 2024
- to minimum 80% by 2026

303 Decentralized treatment of sewage/wastewater will be promoted and alternative treatment systems will be encouraged and local reuse promoted

304 New urbanization will be built around decentralized small footprint STPs located close to points of generation, treating upto tertiary level

305 Sewage (black and grey water combined) from unsewered areas will be treated to tertiary levels at suitable locations, used directly for some non-potable activities, but mainly for indirect groundwater recharge, after which it can be recovered and reused for all purposes after treatment. The treatment technologies will depend upon space availability.

306 Treated discharge of existing STPs would be reused to the extent possible by users located in their command areas

307 Large generators of sewage/wastewater such as transport sector or large campuses would have to install own treatment plants and recycle the resource

Statement 4 : NCT Delhi Will Promote Conservation & Efficiency

401 Towards This End Delhi Will Implement A Water Device Efficiency Rating System

402 NCT Delhi will use financial instruments to promote the use of water efficient devices

403 Delhi will promote use of natural soaps to reduce water use in rinsing - towards this end NCT Delhi will regulate the phosphate content of detergents as well as promote the use of water saving natural cleansers such as 'reetha' and 'hingot'.

404 Further, NCT Delhi will make arrangements for water audit on lines of energy audit and implement the results thereof. Water audit capacities are to be built up for water budgeting internal to large consuming entities

Statement 5 : Controlling Distribution Losses

501 NCT Delhi will curtail distribution losses at all levels of the distribution hierarchy to limit maximum loss figure to under 10% progressively by 2025

501 NCT Delhi will curtail distribution losses at all levels of the distribution hierarchy to limit maximum loss figure to 5% progressively by 2030

Statement 6 : Aquifer Management

- 601** To regulate groundwater extraction the groundwater legislation will be duly reintroduced and enacted in the legislative assembly
- 602** NCT Delhi will take wide ranging measures to augment aquifers as measured in terms of depth to water table.
- 603** Plans will be implemented to neutralize aquifer exploitation by 2022 and attain water table recovery to 1995 levels by 2030
- 604** To achieve above objectives an aquifer management strategy is to be drawn up which would include legislative, regulatory, technical, strategic, water harvesting, waterbodies conservation, groundwater substitution, sustainability indices measures

Statement 7 : Database Management

- 701** To close massive gaps in the database of dispatch, distribution and use, metering devices are to be installed at various levels in the hierarchy down to household/plot level. This would enable support to decision making, promote effective conservation, curb system losses. Sectoral and spatial supply, losses and use data would be generated
- 702** Metering would also be done for the return water at various levels of the hierarchy
- 703** Metering targets are to be set up for various levels of the hierarchy to achieve 100% metering by 2022
- 704** Real Time Water Audit Capacities Are To Be Built Up For Water Budgeting In Large Users

Statement 8 : Access To Water For All

- 801** NCT Delhi will ensure access to water to every resident of the territory for their minimum water requirements in keeping with the interpretation of Article 21 of Constitution of India and in accordance with UN Resolution to which India is a signatory. The minimum requirement per capita will be determined and may vary downward with the passage of time based on supply constraints and efficiency gains
- 802** Affordability of norm based water supply would be maintained.

Statement 9 : Institutional Organization

- 901** To track and integrate several strands of the dynamic water environment, internal and external to NCT Delhi, a Water Resources Commission will be set up.
- 902** The Commission would be a steering body with comprehensive mandate regarding the water sector and provided with defined regulatory and monitoring powers. The Commission would coordinate the actions of all agencies directly concerned with water services, resource management, river issues, foster technological and administrative and financial innovations, track developments in the northern river basins, track climate

change impacts on resources, monitor performance on policy parameters and may act as a pricing regulator

Statement 10 : River Related Issues

1001 NCT Delhi will take steps to restore river water quality to bathing quality by 2020 and also implement ecological approach to floodplain, riparian areas and in stream ecological recovery.

1002 NCT Delhi will progressively reduce its abstraction of river water from Yamuna and Ganga Rivers by reducing demand and increasing its reliance on recycled water resources. The allocated unutilized volumes will remain solely in the river not to be consumed by any other riparian and in emergency be available to NCT Delhi.

1003 NCT Delhi will assure its water security by managing demand, recycling used water, sustainable management of aquifers and will not further enhance its dependence on river freshwater beyond the present levels of abstraction from river basins.

Statement 11 : Public Education and Awareness

1101 NCT Delhi will enlist the cooperation of the public and other sectoral entities in attaining policy objectives. This would be done by initiating campaigns to raise the level of public literacy about Delhi's water endowments, constraints, challenges and wise use of resources

1102 NCT Delhi would draw up a charter of water related duties of the state and duties/rights of the citizens in conformity with policy objectives

Statement 12 : Promoting Innovation In The Water Sector

1201 NCT Delhi will devise innovative projects/approaches involving technical, social, regulatory, governance innovations to improve sustainability, service delivery, affordability and equity in the water sector

1202 NCT Delhi would decrease the energy footprint of its entire cycle of water operations [treatment, supply, sewage collection and treatment]

1203 NCT Delhi will implement 'Report of Sub-committee for Development of National Sustainable Habitat Parameters on Urban Stormwater Management' in order to enhance the availability of local water resources.

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