Urban Floods: Case Study of Kolkata

Mohit Bhattacharya

Introduction

The phenomenon of urban flood has in recent times engaged the attention of planners and administrators because of its disastrous consequences for the urban settlements in terms of sudden interruption in orderly and productive urban situation, and the human sufferings and damages to life, property, and urban infrastructure. In India many of our large urban agglomerations such as Greater Mumbai, Delhi, Kolkata and other areas have been used to living with flood as a matter of annual routine, and only recently national level discussions are going on to study the ground level reality and intervene in a planned manner in the flood situations in the large mega cities.

Approach to the Study

Generally, the public policy response in regard to `floods' has been basically relief and rehabilitation oriented. Only recently, wider policy implications of floods mitigation and floods control and management have come to the fore, as there is increasing realization at policy levels that `floods' need to be viewed in wider perspective in terms of planned natural resource management and disaster management to avoid resource loss and wastage. This is in sharp contrast to the conventional 'relief' oriented emergency flood management that has been the characteristic response of urban public authorities. It is now being suggested that the concerned public authorities are to adapt their policies to coalesce flood emergency relief operation, and management measures, spatial development planning and innovative strategies on safety standards.

Structural measures such as improved drainage system, installation of new pumping stations and so on are usually undertaken to reduce the probability of flooding. In addition, new approaches need to be developed to mitigate the impact of flood. Proper land use planning and management, zoning, flood insurance, water harvesting are a few examples to modify the susceptibility of the urban environment to flood damages. Equally important in this context are the innovative non-structural measures such as

* Contributed as Kolkata city team under National Coordinated Project of NIDM (Gupta, Anil K. and P.G. Dhar Chakrabarti, *Disaster & Development*, 3 (1):1-14, 2009)

community sensitisation and awareness, and local people's preparedness to face up to the challenges of the flood situation

Nidm Study

A very timely and much desired initiative has come from the National Institute of Disaster Management (NIDM) of the Ministry of Home Affairs, Government of India, to study and analyse `Urban floods' in the large cities that contain the nation's wealth and have large concentrations of urban population. The cities chosen for the study are Bangalore, Bhopal, Chennai, Delhi, Hyderabad, Kolkata, Mumbai, and Surat.

To have a degree of uniformity in presentation of the cases, a broad framework has been proposed focusing on:

- profile of the city
- city infrastructure with special reference to drainage
- floods in the city
- efforts made to mitigate and manage the floods, and
- strategies for the future.

Kolkata: History, Topography, Climate, Demography

The choice of Kolkata as one of the worst flood-affected metro cities has been very appropriate. Kolkata city has been living with annual visitation of widespread floods since, possibly, its birth in the early eighteenth century. Strangely enough, despite acute and large-scale human sufferings and colossal economic losses due to annual flooding, the city seems to have accepted it as annual routine. A city widely known for regular vociferous protests and processions has virtually been used to tolerating monsoon floods as a sort of way of life. The reactions have at best been journalistic with widest possible media coverage of flood scenes in newspapers and television channels. Surely, the civic body - Kolkata Municipal Corporation - girds up its loins as a sort of one-shot job, during emergencies, to ameliorate the sufferings of the citizens. What defies imagination is that a city that has been undergoing bouts of 'planning experiments' since the early sixties of the last century, continues to face flood ravages as a kind of annual 'festival'(?) of human misery; and managerially speaking, there has hardly been any worthwhile and effective longer term policy planning to come to firm grips with this regular cycle of 'natural' calamity. Only recently, as we will have occasion to refer later, a phased programme has been launched to save the city dwellers, to a great extent, from the regular onslaught of annual floods. The 'added areas' of the KMC annexed in the 1980s did not have proper drainage and sewerage

facilities and had been used to annual flooding during monsoon. An ambitious drainage and sanitation programme was launched in August 1998 with ADB fund ($ 220 million) to give the added areas a modicum of sewerage and drainage facility. This programme popularly known as KEIP (Kolkata Urban Improvement Programme) has been going on since then, giving some relief to the residents of these outlying areas. For the core city, the JNNURM programme has come as a god send; a large drainage and sewerage plan has been submitted under the Mission which has since been cleared by the Government of India. We will be discussing both the programmes later under 'strategies for the future'.

History, Topography and Climate

Like all 'Asiatic imperial cities', Kolkata was developed with a dual entity. At south, the 'white' European city had semblance of planned and orderly growth - with clean houses, wide roads and well laid-out pathways and gardens. But at north, the natïve city existed 'with its black, ill-lighted, narrow, slimy lanes'. The cultural divide between the two segments of the city was so deep that even after two hundred years it has not been possible to completely integrate these two halves. Thus, Kolkata suffers from the problems most of which had their historical roots in the city's colonial past. Kolkata's development was different due to its peculiar `land form' pattern as much as to its major communication routes - which run predominantly north-south along the riverbanks. The river Hooghly, over centuries, has deposited large quantities of alluvial silt along its both banks, forming natural levees of high land suitable for human habitation on both banks. Here the land slopes away from the river all along the banks and within short distances - about four to five kilometres away from the river, low-lying areas or swamps begin. Therefore, physical extension of the city towards easterly direction was practically restricted. This peculiar landform characteristics presented great constraint for any compact urban development form around a fixed nucleus.

Thus, in physical growth pattern of Kolkata the inevitable had happened. Rapid demographic growth could not be matched with supply of good quality build-able land for human settlement or with any systematic provision of extension of basic transportation and infrastructure networks throughout the city. Already developed build-able areas steadily got saturated and substantial communities had grown up in the low lying suburbs of eastern and south-eastern fringes. Within the municipal limits of Kolkata, the fastest growths have occurred in those relatively less accessible low-lying, poorly drained, un-sewered areas of Borough VI and XI to XV. (The City has 15 Boroughs as decentralised units of administration.) The urban growth that took place subsequently could not strike any desirable relationship with the existing landform

pattern of Kolkata. Residential growth, in fact, has been occurring in areas of severe geographical constraints where the only lands available for development were mainly those rejected as unsuitable by the earlier generations of Kolkata's residents. These lands are either predominantly low-lying, swampy and immediately flooded by the monsoon rains each year or squatted upon land of railways, canal banks, even dry canal beds, garbage disposal areas and the like. It is not only very expensive to make these areas suitable for decent urban living, it also became highly difficult and expensive for the Kolkata Municipal Corporation to extend all basic utility and civic services to these areas at later dates.

Physical Features

Kolkata is geographically located in the northern hemisphere, between $22^0$30' N to $22^0$37' North Latitude and $88^0$18' E to 88023' East Longitude. The city stands on the eastern or left bank of the river Hooghly, a former mainstream course of the River Ganga - at an average elevation of 6.40 meters from the Mean Sea Level. It is located about 145 km away from the mouth of the Bay of Bengal.

The natural landform characteristics of Calcutta[1] make the city's drainage problem inevitably problematic.[2] The land is more elevated towards the west and is gradually tilted towards the eastern marshy land which has been partly reclaimed and developed into the present Salt Lake City. The highest parts of the city lie along the eastern bank of the Hooghly River, maximum elevation being 9-12m. In the northern side, land slopes downward rather steeply; while in the south, the slope is gradually reaching to a height of 4.2m. The riverside levee is the highest part of the city. At Garden Reach on the riverside, the levee is nearly 7m above the mean sea level. Towards Tiljola on the eastern fringes, the height of the levee comes down to less than 3m. It is to be noted, therefore, that the entire drainage and sewerage network planning of the city is based on this eastern slope of the land.

Kolkata falls within the lower deltaic plane of the Bengal Basin, formed by the Ganga-Brahmaputra River System. General slope of the terrain is from north to south with local variations towards east and southeast. As mentioned above, the high ground on either side of the Hooghly River and areas in close proximity provide the city with a very gentle slope towards east. In the eastern part of the city, large wetlands and marshy areas with extensive swamps - spreading over an area of about 12,000 hectare - provide a unique `urban eco-system' in an environmentally sensitive area. This area has been declared as

1 Calcutta and the later Bengali version of Kolkata mean the same thing.
2 Saswati Mookherjee, 'Problems of Waterlogging in Calcutta', in Subhasranjan Basu (ed.), Changing Environmental Scenario of the Indian Subcontinenent, acb Publications, Calcutta, 2002.

the `East Kolkata Wetland and Waste Recycling Region' and has been recognized as a `Ramsar Site' by the `International Union for Conservation of Nature' (IUCN), a global agency. The East Calcutta Wetlands are widely known for the unique sewage fed fish culture-cum garbage farming system, that has been providing for long a natural demonstration of a wonderful resource recovery and recycling system on a grand scale.

As the city constitutes a part of the lower deltaic plain of the Bengal Delta, its soil is represented by a huge thickness of unconsolidated younger deltaic deposits of Holocene age. The sediments are composed of sand, silt and clay in varying proportions and often associated with angular calcareous concentration (kankar), decomposed organic matters and one or two peat layers. Since there is a close linkage between landform, sediment content and depositional process in deltaic environment, the composition of sediment in different landform units vary considerably. The presence of decomposed vegetative matter, wood pieces and peat layers within the clay silt deposit at shallow depth throughout the area, represents palaeo-tidal flat environment similar to the present- day environment of Sundarban area with mangrove vegetation.

Seismic Vulnerability

The city is located under zone-III or a 'moderate intensity earthquake prone zone' as per "India, Earthquake Hazard Zoning Map" (Vulnerability Atlas of India - Series), and IS 1893-2002, part-I. However the city borders very close to zone-IV towards the east, and therefore seismic activity is not very uncommon in this part of Bengal Basin. In the past, a number of earthquakes of high to moderate intensities (V-VI) have rocked Kolkata and its surrounding areas.

Climate

Kolkata's climate is essentially a tropical one. Further the presence of a large river and abounding swamps in very close proximity to this city makes Kolkata's climate characterized by high humidity and relatively higher temperature, but the city does not experience the extremes of temperature or humidity. The average diurnal temperature remains high for about eight months in a year - that is from the month of March to October. The highest maximum temperatures in a year are recorded in the months of May or June, when in some days the mercury touches around 40 to 42 degrees Celsius mark. During this time the nights are also very warm and sultry. A few Nor'westers occasionally relieve this uncomfortable weather conditions during evenings.

Rainy Season

The rains are generally preceded by cloudy weather condition with southerly winds from the sea. With onset of rains from mid-June, the city experiences sporadic showers with occasionally heavy downpour. In wet season, there can be prolonged periods of rain, which can last for three to four days at a stretch. The period from July to September is the rainiest when the city receives as much as 1000 to 1200 mm of rainfall due to intensive monsoon activity. During these three months the city receives nearly three fourth of its average annual precipitations. The adjoining graph gives a vivid picture of monsoon rains in the city over a twenty-year period. In 2007, there has been an unprecedented rainfall of 410 mm in the first week of July itself. When the weather clears after the rains, from early October onward, there is only a marginal drop in the temperature level though humidity remains very high even then, as may be seen from Table 1.

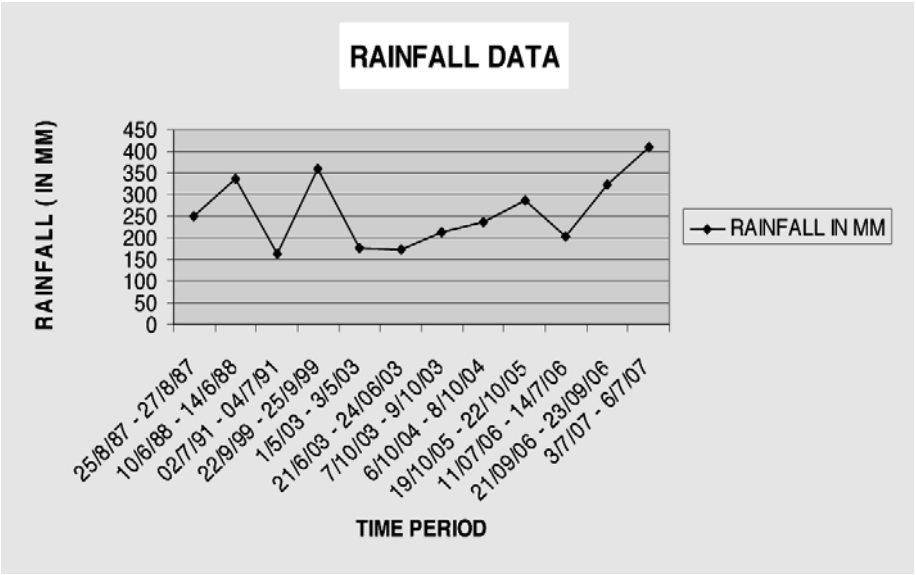


Table 1: Average Temperature, Relative Humidity & Rainfall in Kolkata

Month	Temperature (°C)				Relative Humidity (%)		Average Precipitation(mm)
	Average		Record				
	Min	Max	Min	Max	Max	Min	Total in a month
Jan	13	27	7	32	85	52	10
Feb	15	29	8	37	82	45	31
Mar	21	34	10	40	79	46	36
April	24	36	16	42	76	56	43
May	25	36	18	42	77	62	140
Jun	26	33	21	44	82	75	297
Jul	26	32	23	37	86	80	325
Aug	26	32	23	36	88	82	328
Sept	26	32	22	36	86	81	252
Oct	24	32	17	36	85	72	114
Nov	18	29	11	33	79	63	20
Dec	13	26	7	31	80	55	5

The cool weather sets in by the middle of November and lasts until mid-February. During this period the average temperature remains moderate around 25 degrees Celsius. December is the driest month of the year. However the dampness of climate manifests itself in frequent fogs over the river and water bodies including low surrounding areas. From around the end of February the days again begin to be clearer and appreciably warmer and in March - April the temperature rises rapidly during the day times.

Population

The population of Kolkata Municipal Corporation stood at 45.728 lakhs on 31March, 2001. The city has registered only a very marginal growth of 3.93 percentover its base population of 1991. Kolkata is one of the slowest growing cities among most metropolitan cities of India. The table below indicates that during last forty years the decadal growth rates of population have been steadily declining. Since 1991, Kolkata has been reporting a single digit growth rate on a diminishing basis, as could be seen from Table 2.

Table 2: Population Figures of Kolkata Municipal Corporation During 1951-2001

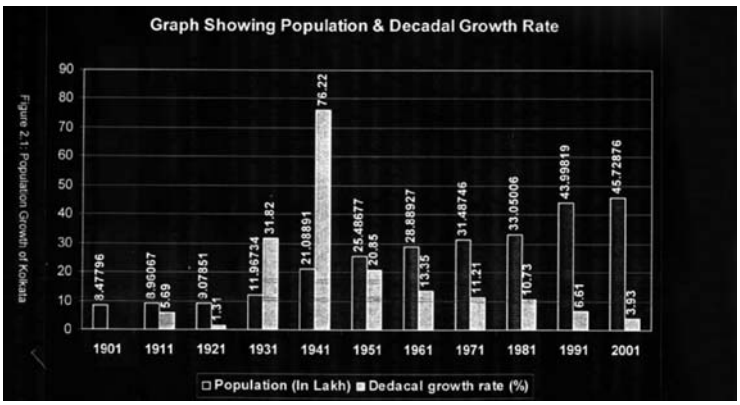
Census Year	Population (in thousand)	Growth Rate (in percentage)
1961	2889	…
1971	3149	11.21(61-71)
1981	3305	10.73(71-81)
1991	4400	06.61(81-91)
2001	4572	03.93(91-01)

Source: Census of India volumes, Population Tables

Note:

(1) There has been a major jurisdictional change in the area of Kolkata Municipal Area after the enactment of KMC Act, 1980. Accordingly all previous population figures of Kolkata have been readjusted to same physical area.

In real terms, growth rate figures for last two decades indicates depopulation in terms of the original city. Detailed ward-wise examination of census data reveals that out of 141 municipal wards as many as 60 wards have returned negative population growth rate during 1991-2001, and out of these there are at least 12 wards that have recorded negative growth rates during last three successive census operations. The wards, which have registered such declining population trends are all located within the dense residential areas of North and South Kolkata, for example wards 23 (Posta), 24 (Jorabagan), 37 (Amherst Street), 40, 48, 50 (Sealdah), 68 (Gariahat), 72 (Bhawanipur), 84, 85, 86, 87 (Gariahat and Lake area).



On the contrary, there are 18 municipal wards, located under Borough Nos VII, Xl, XII, XIII, XIV within Tollygunge, Jadavpur, Thakurpukur and Metiabruz police stations, that have registered much higher population growth rates - exceeding 25 percent - during the corresponding period i.e. 1991-2001. Judging from this phenomenon, one conclusion seems obvious - while the original congested core area of the city is progressively getting depopulated due to residential populations' out-migration and commercial invasion to residential areas, some new residential districts located at the peripheral wards of the city are absorbing this new growth. Locationally it seems that most such new growths are taking place in southern and southeastern fringes of the core city. While there is no record of comparable growth in the northern fringes, there is definite evidence of growth taking place in suburban municipalities outside the limits of KMC like Bidhan Nagar, South Dum Dum, North Dum Dum and Rajarhat. But for the significant population growth in south eastern and southern peripheral wards of the KMC, the city as a whole would have reported negative population growth rates in 1991 and 2001, as could be deciphered from the figures in Table 3.

Table 3: Distribution of KMC's Population Growth - 1991-2001

Corporation Wards	Av. Decadal Growth Rates (in %)
1-100	1.34
101-141	+23.89

Source: Census of India: 2001. Population Tables: West Bengal (S-20)

This phenomenon of relative population stagnation in the core city and dispersal to the fringe areas is by no means unique for Kolkata city alone. All over the world, growth of metropolitan cities shows similar trends. With increase in size of the city and consequent expansion of various tertiary and service sector activities, land prices increase in core city leading to replacement of low value land uses like low income residences by high value, economically remunerative land uses. Further, higher rental structures squeeze out the low-rent accommodations to give way to high-rent commercial activities or luxury residences.

Kolkata Urban Agglomeration (KUA)

Kolkata Municipal Corporation, along with Howrah city forms the core of the second largest urban agglomeration of the country, only next to Greater Mumbai. In 2001, the

Kolkata Urban Agglomeration (KUA) had a population of 13.20 million. It appears that with rapid urbanization of rest of the metropolis, the share of Kolkata city with respect to the entire KUA has been slowly going down over the decades. Even then Kolkata held about 34.6 percent of total KUA's population in 2001 as it can be seen from Table 4.

Table 4: Urban Population in West Bengal and KMA: 1971-2001
(Population figures in million)

Year	West Bengal: Urban	KMA (Urban)	KMA's Urban share in West Bengal urban (%)	Kolkata City	Kolkata's share in KMA's Urban (%)
1971	10.97	7.42	86.18	3.14	50.13
1981	14.33	9.19	87.61	3.30	44.94
1991	18.71	11.02	87.18	4.40	39.92
2001	22.43	13.22	89.81	4.57	34.57

Source: Census of India, 2001: West Bengal, Series 20, and other Population Tables.

Migration Pattern

Kolkata's economic and cultural dominance over the entire region of eastern India, containing a quarter of India's total population, is overwhelming. Its attraction for migrants in search of employment and services is unrivalled by any other urban centre in the region. Thus the city has grown and perhaps suffered also, as its physical infrastructure and urban services have failed to cope with the mounting demographic pressure. The close interdependence of the city and its vast hinterland makes it imperative that the development of the region and that of the city be viewed as parts of a combined process. To understand the growth of the city, it is essential to consider the urbanization pattern of the hinterland. The crucial demographic fact about Kolkata is that the city had received substantial volume of migration in search of employment during the last hundred years. Kolkata had the misfortune of receiving two streams of migration from two different sources - one from the relatively poverty stricken rural hinterland of the eastern regional states and the second, when the city received a sudden

surge of displaced persons following the trauma of partition of the subcontinent. In this process, the city has overgrown along with its fringes, blurring the statutory boundaries of the local bodies - both urban and rural - in the fringes.

Though data on migration into the KMA as a whole over the period 1991-2001 are not available from the census, population growth figures of the city of Kolkata reveal that the streams of migration are no longer affecting the recent composition of the city. During the last fifty-year period, an additional ten million people - were reported to have come into the city from neighbouring Bangladesh as refugees, following the 1947 partition and subsequent events. Migration figures to the city since 1921 are given in Table 5.

Table 5 Migrants to Kolkata Municipal Area during 1921-91

Year	Total Population (in lakh)	Migrant Population (in lakh)	Percentage of Migrants
1921	10.31	3.25	31.52
1931	11.41	3.57	31.29
1941	21.09	6.64	31.48
1951	25.49	13.45	52.76
1961	29.14	7.58	26.01
1971	31.36	10.62	33.86
1981	33.05	9.28	28.08
1991	33.8	7.12	21.06

Source: Vision 2025 Perspective Plan of KMA: 2025: Draft Final Report, December 2005, KMDA (Table-3.18, pp 3-29)

Density of population is an important indicator in urban planning for the estimation of requirements of utilities and community facilities. Density also affects the environmental condition of a human settlement. Also, in accommodating future population growth and prospective commercial uses of land, assessment of optimum density is important. In 2001, the gross population density of Kolkata city stood at 24718 persons per sq. km, registering only about 4 percent growth over the 1991 figures. Looking at the density map of the city, it becomes clear that the central business districts

witnessed highest densities. Ward no. 23 has a very high density of 144,000 persons per sq. km, followed by Wards 24, 28, 39, 41, 62 and 134 - where the density figures range from 120,000 to 150,000 persons per sq. km. The density falls rather sharply at the peripheral Wards - for example, at Ward 57 near Dhapa, where the density is only 9357 person per sq. km or about one third of Kolkata's average. The gross population density of the city is shown in Table 6.

Table 6: Gross Population Density in Kolkata - 1961-2001 (pop. /sq. km.)

Year	KMA	Kolkata
1961	3817	16740
1971	4651	18813
1981	5666	22308
1991	6826	23782
2001	7950	24718

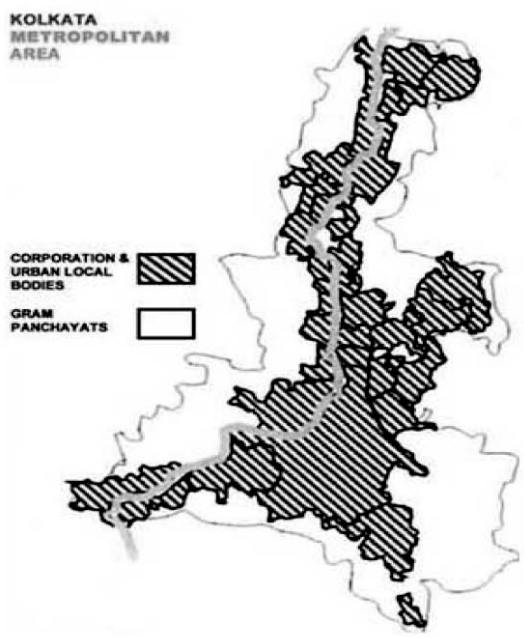
Source: Compiled from Census Data

The core city seems to have already reached near saturation point in terms of its population holding capacity. Indeed some of the municipal population growth figures during last three successive decades are due to out-migration of their resident population. As more and more residential areas near Central Business Area (CBA) are being converted into commercial or similar higher remunerative uses, the people are moving out of these wards, being pressurized by `rent squeeze'. In contrast, the peripheral wards, notably the added areas of Kolkata Municipal Corporation, are witnessing a positive growth in population - sometimes higher than the KMA rates even due to fresh population consolidation -resulting in population equilibrium at around little higher than the existing level. As per the Perspective Plan for KMA for 2025, the most likely resident population estimate for Kolkata city in 2025 is 4.682 million - a meagre addition of 1 lakh (100,000) in next two decades. Nearly 3 million additional people from KMA and beyond enter or use this city every working day for jobs, education, medical attention, service delivery or transport. The anticipated figure for future years would definitely be much higher when more and more tertiary sector jobs would be created in the city - a fact that city planning has to seriously reckon with.

Planning Interventions

Urban planning and development came to be nationally recognised as a focused area of governmental attention only towards end of the Third Five Year Plan in 1961. This was the time when Kolkata was not only exhibiting massive demographic growth but also was beset with the worrying problem of inadequacy of civic infrastructure and services. The cholera epidemic of 1958 drew the attention of the national government and the international agencies like the World Health Organization (WHO). This led to the creation, for the first time in 1960, of an urban planning organization in West Bengal - the Calcutta Metropolitan Planning Organization (CMPO), as a sequel to the WHO Report on Calcutta's environmental health and sanitation. The Basic Development Plan (1966-86) published by CMPO in 1966 presented a fairly detailed and well-researched Perspective Plan - no doubt a pioneering effort of its kind in India. This was followed by two sectoral Master Plans, namely, `Comprehensive Traffic and Transportation Plan' and the `Master Plan for Water Supply, Sewerage and Drainage'. The Basic Development Plan suggested for Calcutta a massive dose of infrastructure improvement, primarily with a view to arresting further deterioration in public utilities and services.

The national Fourth Five Year Plan recognized for the first time the need for special attention to urban infrastructure development. But due partly to overall economic recession in the country and partly to other factors, financial support was not readily available at that juncture. As the civic infrastructure facilities deteriorated further and reached almost a point of total collapse, the Government of India stepped in to bring about institutional change to arrest further deterioration and to work out planned intervention in the city's civic infrastructure and facilities. That was the historic moment in 1970 of the creation of the Calcutta Metropolitan Development Authority (KMDA). The objective was to study the urban



situation and to come out as quickly as possible with a definitive rescue plan that would be implemented with assured fund support. With great speed, the KMDA prepared several key planning documents having bearing on the phased development of the city. More important among these were the `Development Perspective and the Action Program' (1976), and the `Plan for Metropolitan Development: 1990-2015' in 1990. The State Planning Board in 1991 published the draft of `A Perspective Plan for Calcutta: 2011'. The KMDA thereafter in 1992 published the `Development Needs of Calcutta Metropolitan Area: 1992-2002', the `Calcutta Mega City Program: Project Profile and Investment Plan' in 1994, and `The Vision and Perspective Plan for Calcutta Metropolitan Area: 2025'. Besides, the sectoral Master Plans for Water Supply, Sanitation & Drainage; Traffic & Transportation; and Environment and Bustee Improvement were published in 2006.

Under the West Bengal Town and Country (Planning and Development) Act, 1979, KMDA was designated as the Planning and Development Authority for the KMA and it prepared the `Land Use and Development Control Plans (LUDCP) for Kolkata Municipal Corporation Area in 1996. Presently the KMC is carrying out development control functions in terms of LUDCP, as required under the Act. In 1997, the Environment Department, Government of West Bengal, with assistance from the DFID, U.K. prepared the `Calcutta Environmental Management Strategy and Action Plan' (CEMSAP) for the KMA (see attached map). The Kolkata Municipal Corporation, with international assistance (from Asian Development Bank) has since been engaged in the planning and implementation of a massive environmental improvement programme called the `Kolkata Environmental Improvement Programme' (KEIP).

Municipal Management Set-Up

Historically, Calcutta Corporation had grown up during colonial times as a highly centralised and bureaucratically controlled civic body. Despite democratization of the Corporation Council by fits and starts, it had basically been a Commissioner (the chief executive)-dominated municipal organisation. This basic set-up remained unaltered even after independence. So the legacy of a strong professional executive has lingered on, and the KMC's professional wing continues to be headed by a senior IAS officer as Commissioner.

Mayor-in-Council System

Under the Kolkata Municipal Corporation Act, 1980, a cabinet-type Mayor-in-Council

was introduced which marked a revolutionary change in municipal management - a quantum jump from the age-old colonial system of Commissioner-dominated bureaucratic management to a new political executive system headed by a Mayor along with his team members in the Mayor-in Council. The salient features of the present Mayor-in-Council in the KMC are:-

- After a general (Municipal) election, the Mayor is elected by the elected members of the Corporation from amongst the members (141 councillors are elected from as many Wards).
- The Deputy Mayor and other members of the Mayor-in-Council (Mayor's Cabinet) are chosen by the Mayor from among the elected members, all of whom function during the pleasure of the Mayor.
- The Mayor distributes charges (port-folios) among members of the Mayor-in-Council (12 members in all including Mayor and Deputy Mayor).
- The Mayor-in-Council is jointly accountable to the Corporation (the whole body of elected Councillors)

On the lines of the cabinet system, the Mayor is the head of the political executive called the Mayor-in-Council which consists of 12 members including the Mayor and the Deputy Mayor. Each member of the Mayor-in Council, like a minister in the cabinet system, holds charge of specific municipal functions (see Mayor-in-Council chart). Each member of the MIC looks after the functioning of specific departments of the KMC. The concerned departmental officers, as shown under KMC's Professional Wing, serve and report to their respective MIC Members.

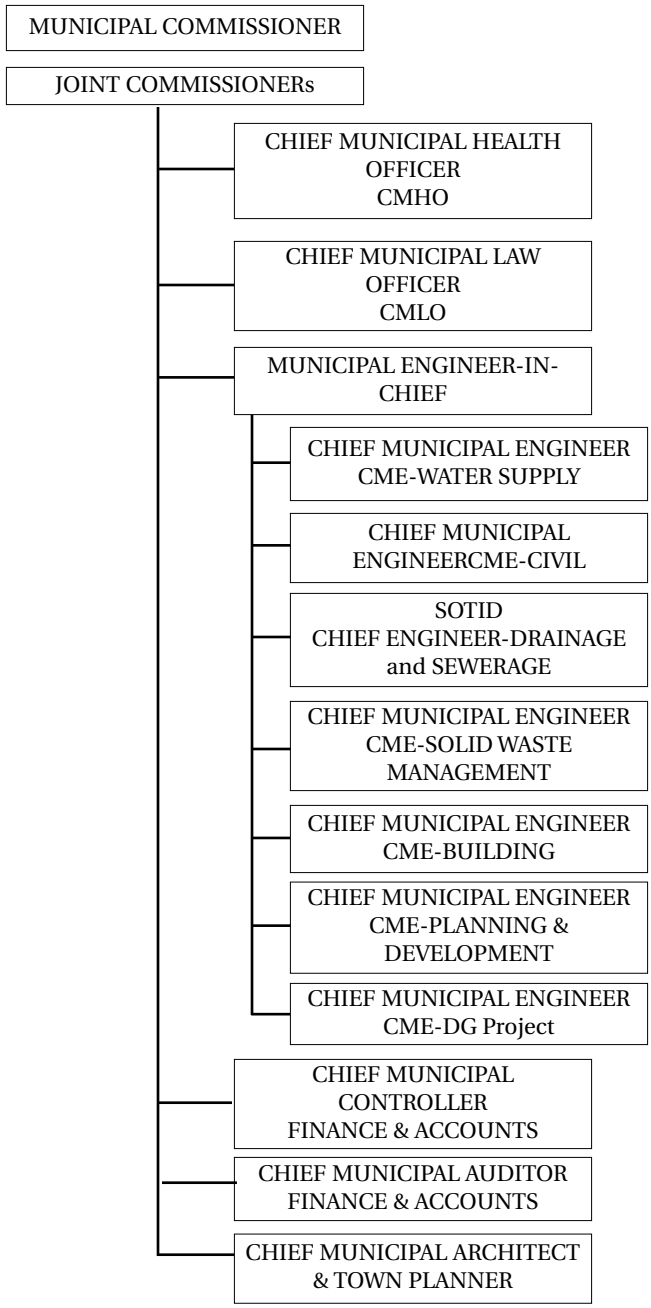
The relevance of certain departments, from the perspective of flood planning, mitigation and management, is quite obvious. For instance, the departments in charge of drainage and sewerage, and solid waste management would be directly involved in flood management activities. KMC's civil engineer would be having major responsibility in respect of building collapses and clearing roads of uprooted trees.

Mayor - in - Council

Sl. No.	Name	Port Folios
1	MAYOR	General Administration, Finance & Accounts, Internal Audit, Personnel, Assessment - Collection, Planning & Development, Vigilance, Municipal Secretary's Department, Law, Records, Market, KMDA and other agencies' works, ADB, World Bank, DFID and other externally aided projects and any other work not covered under this allotment.
2	DEPUTY MAYOR	Water Supply to Shipping and Stores.
3	MMIC(WATER SUPPLY)	Generation and distribution of water.
4	MMIC (IPR and P&G)	Information and Public Relations, Parks & Gardens and Sports
5	MMIC (BUILDING)	Building and Licence.
6	MMIC (BUSTEE)	Bustee Development and Welfare Services and SSEP
7	MMIC (R & E)	Roads & Engineering, Asphaltum, Footpath, Sewer, Nikashi.
8	MMIC (EDUCATION)	Education.
9	MMIC (SWM)	Solid Waste Management and Entally Workshop.
10	MMIC (Ltg.)	Street Lighting & Electricity, Environment, Training Institute.
11	MMIC (HEALTH)	Health, Disinfection Services, Vaccination, Vector Control, Epidemic Control, Hospitals, Maternity Homes, Dispensaries, Chest Clinics, Analysts, Ambulance, Slaughter Houses, Burning Ghats and Burial Grounds, Registration of Birth & Death, Prevention if Food Adulteration, Central Medical Stores and T.B.Hospitals.
12	MMIC (S & D)	Drainage Pumping Stations, Mechanical Sewer Cleansing and Man-entry sewers.

Note: MMIC stands for Member of the Mayor-in-Council.

KMC's Professional Wing



Borough Committees

The KMC has 141 wards that are, for decentralization purposes, formed into 15 Boroughs each having a Borough Committee consisting of the elected members of the Wards falling within the Borough limits. The formation of Borough Committee introduces a kind of municipal federation, as powers and function are divided between the Central Municipal Office and the Borough Committees. Under the Regulation framed under the KMC Act, a Borough Committee has been given responsibility for the followed functions:

- Provision of supply pipes
- Sewerage and drainage connection to premises.
- Removal of accumulated water on the streets or public places due to rain or otherwise,
- Collection and removal of solid wastes
- Disinfections, provision of health and immunization services,
- Bustee services,
- Provision of lighting,
- Repair of locality-level roads (categories IV, V & VI)
- Maintenance of parks
- Drains and gulleys, and,
- Such other functions as may be delegated to the Borough Committee by the Corporation.

There is a Borough Officer (usually an Executive Engineer) who coordinates the work at the Borough level and executes the decisions of the Borough Committee. All resolutions of the Borough Committee are forwarded to the Mayor whose decision (in regard to acceptance or rejection) is final. Not all the Officers located at the Borough level are accountable to the Borough Committee, nor are they placed under the control of the Borough Officer. The Assistant Engineers in charge of water supply, drainage and sewerage, and roads report to the Borough Executive Engineer. But the decentralised solid waste management set-up has its own old 'District' based organisation which has hardly any relationship with the Borough administrative set-up. Interdepartmental financial relations have not been dealt with either in law or regulations, so there are no definite assigned revenue sources on which the Borough Committee could rely. Abject financial dependence on the Central Office coupled with the independent functioning of many of the field offices of headquarter departments has stood in the way of harmonious working of the decentralised Borough system and has naturally weakened

KMC's decentralization plan. Currently, attempts are being made to mend matters and strengthen Borough administration by placing almost all the field functionaries under the control of the Borough Committee.

Ward Committees

The need for decentralization and participative local management is now constitutionally recognized. The formation of ward Committee at the level of the locality or the electoral Ward has been mandated by the Constitutional (74th) Amendment Act, 1992. KMC Act has accordingly been amended providing for the formation of Ward Committee in each electoral ward. A ward committee consisting of the councillor elected from the ward (who acts as the Chairperson) and the nominees of the Corporation and the Councillor, is to help the Borough Committee and the Corporation in the following activities:

a. Identification of the problems of the ward and prioritizing them,
b. Overseeing the proper execution of various municipal works and services in the word,
c. Development and maintenance of civic services by enlisting people's participation and receiving feedback from the people from time to time,
d. motivating the people of the ward in making timely payment of tax and non-tax revenue,
e. planning and execution of various obligatory and discretionary functions as laid down in the Act,
f. detection of violation of various provision of the Act such as unlawful construction, encroachments on municipal and public properties, public nuisance, evasion of taxes, unlicensed activities, and the like,
g. arresting wasteful use of various municipal services like tap-water, street hydrant, street light, parks and playgrounds, community centres and libraries and the like
h. organization of greater civic participation by holding periodical meetings,
i. Listening to the grievances of citizens and, making arrangement for their redressal, and
j. Any other functions entrusted to the committee by the Borough Committee/ Corporation from time to time.

In sum, the Borough Committees and the Ward Committee are designed to introduce and sustain a participatory mode of civic administration. Both the devices are expected

to bring about a deepening of democracy as well as efficient and effective delivery of civic services. Strong ward committees, if and when these would be really functional, would go a long way to mobilise local civic energy in aid of normal municipal administration. In an emergency situation like flood control, the ward committee would be of immense help to organise and orchestrate local citizens' support for flood relief operations.

Unfortunately, the KMC's record in constituting ward committees has not been up to the mark, and special efforts at the political level are urgently called for to set up ward committees through out the KMC.

Flood Stuation

Turning to the flood situation in the city, during monsoon, the city is used to facing severe waterlogging for days together at many pockets every year. In 2007 the flooding had been quite extensive and damaging. A vivid pen-picture of the city's location-specific flood situation is portrayed here based on KMC's official report on 'Natural Calamities on 30th June, 2007.

1. Big trees were uprooted at the following points:
   In front of Basanti Devi College, Rawdon Street, Indian Museum, 40 N.S. Road, Middleton Street, Medical College, Elgin Road, Garcha Road, 1 Humayun Kabir Avenue, Gurusaday Road and Surawardy Road.
2. Three cases of electrocution reported; CESC has taken appropriate action.
3. At Choubhaga Point, the State Government's Irrigation & Waterways Department has 30 pumping machineries. All the pumps remained inoperative since 7-30 am to 12-00 hours due to non-availability of CESC power. After intervention, power was made available at about 12-15 hours and 20 pumping machineries were put into operation.
4. There was 105 to 120 mm rainfall all over the city, while the drainage capacity of the core city is only 6 mm per hour.
5. The water level at Palmer's Bazar rose to 17 ft. high while the normal level is 10 ft.
6. Water level at Choubhaga point rose to 8 ft. (2.7 meter) while the normal level is 2 ft.
7. The tidal effect of River Ganga was at high level from 7-30 am to 12-00 hours.
8. Building collapses at the following places have been reported. No report of death, however, was received:
   - 5 Girish Avenue, Borough-IV: part of existing two-storied old building has collapsed. Owner of the premises removed the debris.
   - 98 Manicktala Main Road: Existing single-storied Nut-Mandir has collapsed.

KMC has engaged labourers to demolish the remaining portion of the structure.

- 20/8/1, Brindaban Basak St.: Old two-storied vacant buildings attached with the adjoining premises in three sides have collapsed. KMC had earlier served notice declaring 'dangerous building' status. Demolition work has now been started to pull down the remaining portion.

9. Water Supply: Normal. Disinfection of water supply line will be undertaken in the afternoon.
10. Health: Borough Health Officers placed at 15 Boroughs of KMC have been alerted.
11. SWM: Normal activities are on.
12. The situation started improving since 12-00 hours.

Operation of Pumping Stations

The 'pumping stations' stationed at discrete locations of the city become the life-line of the city during the floods. An important report released regularly by the KMC authorities relates to ameliorative measures, particularly with reference to the draining out of flood waters through the operations of the pumping stations located in different parts of the city. The situation of the pumping stations as these were being operated at different locations is presented in Table 7.

Media Reporting & Citizens' Responses

Area-wise flood situation, as reported in the important Calcutta dailies, is presented below to give a first-hand impression of the crisis situation obtaining in different parts of the city.

General Post Office (9am)

The stretch in front of the GPO, which is just a stone's throw from Writers' Buildings - Government Headquarters - was under knee-deep water as office-goers were found struggling to make their way to work. The ongoing repair work on the pavement and a fallen trees made it a mess. "BBD Bag (former Dalhousie Square) has been badly hit. The knee-deep water is making it tough for cars and pedestrians," said a sergeant on duty.

Table 7: Pumping Stations: From 6 am to 9 am on 13.6.2007

Name of the Drainage Pumping Station	Cumulative Rainfall (in mm)	How many pumps in total	How many pumps under repair	How many pumps running condition	Outfall channels
1. Palmer Bazar	117	13	3	10	Town Head Cut Canal + DWF Channel
1a. Manicktala	75	5	1	4	Relay (PBPS)
1b. Belgachia	-	2	-	2	Relay (PBPS)
1c. Thanthania	107	2	-	2	Beliaghata Canal
2. Pagladanga	-	3	1	2	Town Head Cut
3. Kulia Tangra	-	2	-	2	Town Head Cut
4. Ballygunge	105	12	2	10	Suburban Head Cut Canal
4a. Mominpur	129	8	3	5	Boat Canal + Relay(BDPS)
4b. Chetla	79	3	-	3	Relay (BDPS)+ Tolly's Nullah
4c. Kalighat	72	2	-	2	Tolly's Nullah
4d. Jodhpur Park	51	5	-	5	Relay (BDPS)
5. Dhapa Lock	31	8	2	6	Central Lake Channel
5a(i). Ultadanga	70	11	2	9	Kestopur Canal + Relay of Dhapa Lock
5a(ii) Ultadanga Siphon	-	2	-	2	Kestopur Canal + Relay of Dhapa Lock
6. Topsia	48	7	2	5	SWF Channel
7. Birpara	2	2	-	2	Bagjola Canal
8. Nimak Mahal	-	2	-	2	River Hooghli
9. Southern Avenue	-	4	-	4	Tolly's Nulla
TOTAL		**93**	**16**	**77**	

Park Street (10am)

The food-and-fun street resembled a river during first half of the day. The cars swam and the food shops were flooded. McDonald's declared a rainy day and downed shutters, while Music World could not open before 1.30pm.

Ultadanga(11am)

The traffic junction at Ultadanga was thrown completely out of gear as the knee-deep water refused to recede. The ripples/waves were felt from VIP Road to Salt Lake and all the way down the EM Bypass.

Chittaranjan Avenue, up to Girish Park (noon)

The entire stretch was under water and vehicles were just not moving. All the arterial roads leading to and from Chittaranjan Avenue were also under water.

"It took me close to an hour to come from Girish Park to Medical College and Hospital," grumbled Rajesh Jhajharia, behind the wheel of his car.

Mahesh Agarwal blamed the civic authorities: "We were told last year by the civic engineers that the stretch opposite Mahajati Sadan would not be waterlogged. But look what has happened on Day One of the monsoon. We could not open our shops because they were all flooded."

Amherst Street (12.30pm)

If Park Street was a river, Amherst Street was more like a sea. Waist-deep water made the cycle van the only means of transport. Students of Shri Shikshayatan College, desperate to get to City College (North) for their Part II exams, did not mind paying Rs 50 each for a place on the submerged van rickshaw.

Most shops and establishments were shut. "An hour's downpour has exposed the inefficiency of the civic authorities even before the monsoon has set in properly," said Joy Sengupta, a resident.

College Street (1245pm)

It was no better for students arriving at Presidency College for admission tests. "Only we

know how we managed to come here from Baruipur - a suburban town. The train services were hit and there was no public transport available. When we got here, we were told that the exam had been postponed from 9am to 11am. There was no electricity and no drinking water on the campus," alleged Chaitali Banerjee, whose daughter was appearing for the test. All the bookstalls and shops were shut. College Street was a no-entry zone.

Elgin Road (1.30pm)

The mall-and-multiplex street of south Calcutta was practically out of bounds till 2pm. Till then, the knee-deep water made it a road to avoid for cars and shoppers alike. Rickshaws were the only wheels that turned. "Forum was almost deserted till 2pm," said an official at the Elgin Road mall.

Topsia Road (2.30pm)

Residents say the water-logging begins as soon as clouds gather. So, it was no surprise that Topsia Road drowned on Wednesday. Said resident Mohd. Atif: "Not only is the area flooded, it is flooded with such filthy water that it makes living here a serious health hazard. But the civic authorities won't bother. They should come here and see how we live."

- Srabani Roy Karmakar of Maharani Indira Devi Road, in Behala, has been living in knee-deep, filthy water since the downpour on July 3. She has no clue when the water will recede.
- Samir Sen, of Nibedita Sarani, is not just marooned; he is reportedly being forced to share space with snakes and poisonous insects.

Scenes such as these will greet visitors to several Behala pockets - the southwest fringes of the city.

A week had passed since the deluge, but Kshudiram Pally, Green Park, Adarsha Nagar, Mahendra Banerjee Road, Motilal Gupta Road, Hemanta Mukherjee Road, Subhas Marg, Airport Road, Pally Sree, Anandanagar and Joyrampur had still remained waterlogged.

"Aamra Shobai jole bondi (We are all imprisoned in water),"said Timir Bose, of Motilal Gupta Road, summing up the situation.

"We had never faced such a crisis," said Ratna Sur, the chairperson of Borough XIII of the Kolkata Municipal Corporation. She blamed the situation on the "negligence" of the engineers who are supervising the drainage revamp work, under the Calcutta Environment Improvement Project (CEIP) in Behala.

These are just some selective snippets of the widespread urban floods that, as earlier pointed out, have been a regular annual feature of the city's living design.

Municipal Administrative Response

Recent records of dealing with this kind of flood emergency (June, July 2007) reveal KMC's fairly prompt response to the stress situation. The Mayor held rounds of meetings with key officials of the KMC to review the flood situation from time to time. The canal system that serves as the main outfalls of KMC is under the management of State's Irrigation and Waterways Department. The Mayor held special meetings with the concerned officers of the I&W Department to ensure orchestration of the KMC's flood relief activities and the canal system operation by the State Department. Even the Minister in charge of Municipal Affairs took personal interest and held meetings with the key officers of the KMC to make an appraisal of the situation and work out short and long term plans for the city's flood mitigation. At the operational level, the Commissioner, Joint Commissioner (Development), the Engineer-in-Chief and the departmental heads of drainage and sewerage, solid waste management, civil engineering works, lighting, and health teamed up as an emergency operational group. The Mayor and the Commissioner used to review the overall situation through video conferencing which had been a very effective mode of tracking and monitoring the area-wise condition in the different boroughs of the Corporation. The field situation was being constantly monitored via the control room. The operations of the pumping stations including their electricity supply position were being constantly monitored. Supplementary arrangements were made for deployment of portable pumps in different boroughs. As many as 266 pumps were deployed out of which 46 were in operation in Borough VII alone.

Action Plan for Health, Water supply, Civil Works

During floods, apart from attending to immediate calls like electricity line repairs or removal of uprooted trees, emergency relief operations need to be mounted to give succour to affected people particularly in respect of food, water, and health related matters. From the recent experience, it transpires that relief materials for food and shelter had to be rushed to the families marooned in worst affected localities. In July, at the height of the crisis, the supply position in different boroughs had been as shown in Table 8.

Table 8: Item-wise Relief Materials Supply

Items	Qty.
Tarpaulin	550 pieces
Chira	30 Qtls
Gur	6.5 Qtls
Sugar	2.25 Qtls
Rice	4 Qtls
Dal	5 Qtls

To ensure effective and quick supply of relief materials, a special ad hoc arrangement was made for the procurement and supply of these essential items to the citizens in the worst flood affected areas of the city, particularly in the poorer localities.

The Health Department of the KMC had sprung into action by mobilising field workers, nurses and medical officers who had been working in full swing to ensure that the city did not get affected by public health hazards and vector borne diseases. At the borough level, the health establishments were alerted and asked to maintain adequate stock of emergency medicine and allied items. Individual councillors in their respective constituencies were charged with the responsibility of distributing ORS packets and Halogen tablets among the people in their areas. As many as 38,510 ORS packets and 1.13 lakhs Halogen tablets were thus distributed locally which possibly had yielded good results, as there was no report of widespread epidemic either during or after the flood.

The other important measure taken was disinfection work jointly with the SWM Department. Door-to-door surveillance had been intensified to track and monitor cases of fever and diarrhoea syndromes. Also, the department took prompt anti-malaria measures, particularly through anti-larval measures and early diagnosis and treatment. Important IEC activities had been the spread of awareness about general public health issues - particularly awareness against acute diarrhoeal diseases in the flood-affected areas. One mobile medical unit was set up to rush to affected areas on emergency call.

Precautionary measures through installation of extra submersible pumps were taken to prevent water logging within the water supply generating stations as well as the booster pumping stations. Through water tankers, water had to be supplied to water logged areas - 44 tankers making 334 regular trips supplied 1,76,000 litters on a single day (July 5, 2007). Besides, 6.150 stand posts and 738 small dia tube wells had to be disinfected in specific water logged areas.

During flood, building collapses and uprooting of trees are common occurrences. During June-July (2007) floods affecting extensive areas of the city, the civil engineering section had to respond to quite a few calls of building collapses in older parts of the city. From about 67 locations reports had come in of uprooting of trees that needed to be cleared promptly to restore traffic. Extensive road damage is another episode during floods. In 2007, as many as 84 roads had been badly affected due to heavy showers and consequent submerged condition. A moderate estimate was that KMC would be requiring about Rs. 1.60 lakhs for repair of potholes and damaged patches at different part of the city.

Ad hoc Response

Every year KMC wakes up to the flooding problem of the city during monsoon. Despite regular annual visitations and the attendant human misery and infrastructural damage and dislocation, KMC has not been able to develop a regular system of municipal flood management set-up. The response has always been ad hoc and instantaneous. Nor has the urban flood mitigation plan (since none exists) been integrated with the city's holistic urban planning. Kolkata has now been included as one of the Mission cities, under JNNURM, for which purpose the city has to have a comprehensive city development plan (CDP) as a funding conditionality. So, it is to be expected that water-logging issues and the city's larger problem of planned flood proofing would find a definite place within the CDP. The other aspect that deserves careful consideration is the preparation of a well-thought-out Flood Management Manual to consolidate the numerous ad hoc measures taken from time to time to cope with the city's flood problem. Once the Ward Committees would be in position, citizens need to be taken in confidence to develop in each ward, particularly in the most affected wards, participative local flood mitigation plans.

Need for Coordination

In the present Mayor-in-Council set-up, two members have almost overlapping portfolios - one holding charge of 'solid waste management', and another holding charge of 'drainage pumping stations, mechanical sewer cleansing and man-entry sewers'. Even in normal times, they need to coordinate their functioning; and in times of emergency, like meeting the flood situation during the rainy season, they have to coalesce and integrate their working both at headquarter and in the boroughs. In fact the two members of the Mayor-in-Council should form a kind of nodal point for data-based advance planning for flood warning, and prevention and mitigation. The

Member holding charge of 'health' has a major role to play during and after the flood to prevent epidemic outbreak and keep the municipal public health management system in a state of readiness.

The Control Room which functions round the clock even in normal times assumes a major role during flood emergency in terms of information collection and dissemination among the KMC departments. A senior officer, usually of the rank of Deputy Commissioner is placed in charge of the Control Room during emergencies along with a group of two to three supervisory staff to support him. It is time to think of developing a regular blue print for the organization and functioning of the Control Room during emergency operations.

Major Areas Of Water-Logging

There are clearly identifiable areas in the city which are prone to flooding each year. Details of some of the badly affected flood prone areas of the city are indicated below to give a first hand account of the flood situation in these areas. The descriptive account portrays (a) the site characteristic, (b) major reasons for flooding, and (c) the mitigation measures already taken or being proposed for the area in question.

1. College Street area

The college street area bounded by Sukea Street on the North, Kolutola Street on the South, Central Avenue on the West and Amherst Street on the East is a chronic water logging area within KMC that suffers from stagnation of water for hours together during every Monsoon in any heavy or even short duration rainfall. The whole area is at relatively much lower elevation than the surroundings and water from all sides of the area rushes to this part. The drainage of the area is served by the network of sewers leading to the trunk sewers along Kolutola Street and Mechua Bazaar Street and partly through the Sukea Street sewer and finally goes to the terminal pumping station (PBPS). The rate of storm runoff accumulation in the area is more than the rate of disposal of storm water through the sewer network. This can be attributed to two factors: 1) the reduction in hydraulic capacity of the sewer network due to heavy silting and 2) the existing gully pits being completely choked and not being sufficient in number. Cleaning of the gully pits to enhance the proper inflow of water to the sewer and cleaning of the sewer network and lining of them to enhance the hydraulic capacity of the system may partially solve the problem of water logging. This requires further study for a planned approach to the area's problem. To reduce the water logging problem in the area CMC has installed a pump house in this area at Hrisikesh Park in the last year

with an idea to discharge the accumulated water in this area to the near by Circular canal through force main. Water intake to the pump house is being done by connecting some lateral sewers in the area by an inlet sewer leading to the pump house. Water heads up in the sewer network and finally leads to the sump of the pump house through the connecting inlet sewer and is pumped to the Circular Canal through the force main. The problem of water logging is reported to have been reduced in respect of duration of inundation after installation of this pump house but this may cause malfunctioning of the sewer network in the long run as the direction of flow in the sewers has become reversed against the slope of the sewers that may cause more siltation in the sewers. Detailed recommendation is possible after further study.

2. B.B.Ganguly Street and Central Avenue Crossing

The water-logging at the junction of the B.B.Ganguly Street and Central Avenue Crossing is a localized problem. The sewer along the B.B.Ganguly Street was intercepted by the Metro Railway tunnel across the direction of the sewer. The invert of the sewer is slightly elevated due to the Metro Tunnel below the sewer. This location of the sewer requires regular maintenance so that silt does not deposit, allowing free flow of water through the sewer.

3. B.B.Ganguly Street near Writers' Building

Immediately after the formulation of 1966 Master Plan, CMWSA laid storm drainage network along Netaji Subhas Road, in-front of Writer's Building, Hare Street, Koilaghat Street and Clive Street and then along Strand Road and ultimately having three outfall sewers to the River Hooghly (Ganges) through the Calcutta Port Trust Area. Flap shutters were provided at the outfall ends.

Advantage of that storm sewer can be taken and additional gully pits may be constructed for quick entry of the storm water into the drain. The alignment of the sewer route has to be surveyed and revived and penstock gates with new flap shutters may be installed for operation.

4. S.N. Banerjee Road near Moulali

The problem of water logging along S.N. Banerjee Road, particularly in front of Calcutta Boy's School, was due to inadequacy of the existing sewer to take care of storm water flow along this road. Recently KMC has laid higher diameter RCC pipe sewer along the length of the road replacing the old one discharging to the AJC Bose Road Trunk sewer, and in consequence, the problem of water logging in this area reportedly has since been successfully solved.

5. Free School Street Area

The Free School Street area is comparatively lower than the surrounding area which stretches over North of Lindsay Street junction to the South of Kyd Street junction. This stretch gets water logged during heavy shower, especially in front of the Fire Brigade. The area drainage is served by the sewer along Free School Street that discharges to the trunk sewer of Lenin Sarani. The sewer itself is reduced in hydraulic capacity due to heavy silting. Structural condition is bad. Collapse at 3 or 4 places has already been reported, and similar collapses at two new places are under repair. The sewer crosses the S.N.Banerjee Road pipe sewer where there is a reported obstruction, causing restriction to the free flow of water down to the Lenin Sarani trunk sewer. The situation at this junction point needs to be investigated. The gully pits along this road may be choked or insufficient in number.

6. Elliot Road Area

Elliot Road sewer discharges the runoff of its catchment basin to the sewer along AJC Bose Road. The elevation of Elliot Road is less than the elevation of the AJC Bose Road and thus water first flows along reverse direction over the surface. Moreover there is no flow observed in the Elliot Road sewer where it discharges to the AJC Bose Road trunk sewer, which is suggestive of some obstruction at the junction. Cleaning of the sewer, revival of the junction and keeping the gully pits clean will solve to a large extent the water-logging problem of this area.

7. Park Street–Camac Street Area

Park Street and Camac Street area suffers from frequent water-logging during monsoon despite having extensive sewer network in the area. The sewer network in the area discharges partly to the southerly direction to the AJC Bose sewer and partly to the northerly direction to the Park Street sewer. A new sewer along Park Street in addition to the old one was laid by KMC according to the recommendation of the 1966 Master Plan, but the problem of water-logging was not solved. The capacity of the sewer network and the trunk sewers, where the area drainage is disposed of, is estimated to be adequate to cater to the runoff of the catchment. Despite adequate provision of sewerage network, water-logging problem in the area is still prevailing. The reason can be attributed to inadequate slope in the sewers/improper implementation/inadequate inlets/inadequate maintenance/improper operation of the pumping station either singly or in combination. This problem of the area therefore requires detailed investigation.

8. Waterlogging in Suburban System due to problems related with BDPS

There are two pumping stations in the BDPS. The old pumping station is comprised of 8 pumps, namely Pump No. B to Pump No. 1 whereas the new one is comprised of 4 pumps namely Pump No. 1 to Pump No. 4. The capacity of the Pump B is 75 cfs, Pump C, D, II and I are 50 cfs each; Pump E and F are 175 cfs each and Pump G is 130 cfs. In the new pump house the Pumps No 1 and 2 are 75 cfs each and the Pump No 3 and 4 are 200 cfs each. In general, the water level is kept at (+) 8.00 KODS[3] in the sump of the pump house by operating the pumps. The invert levels of all sewer lines entering into the BDPS are lower than this level. As a result, even in dry season free flow of water cannot occur in the sewers leading towards BDPS. Ground level of this area is around (+) 19 KODS, and hence in dry weather a water-logging problem does not arise in these areas even though the sewers cannot maintain a free flow of water. This does cause damage to the service condition of the brick sewers. Moreover, no regular desilting operation is possible in the sewers at these areas as they are always surcharged. This causes constant silt deposition in the sewers. This may also cause major damage to the system in the near future. The BDPS therefore must maintain the water level in the sump below a certain point that would allow all the incoming sewers to flow freely to the pump station. This requires further analysis of the sewers and the pumps in BDPS as well as the operation of sequence of pumps.

There is a bypass arrangement between the silt pit and the discharge channel for Pumps No. 3 and 4. The by-pass outlets are at level (+) 13.00 KODS and at (+) 10.0 KODS. There is a gate in this by pass arrangement to control the flow and is kept closed generally. The by-pass was constructed with an idea to avoid station inundation in case of occurrence of power failure. The gate of the by-pass should be kept in operable condition to serve its original purpose.

9. Waterlogging in Hide Road Area/problems with Nimak Mahal Pumping Station

As the existing sewer along Hide Road appears to be completely defunct, a new scheme for improving the sewerage and drainage situation at this area is badly needed. Total sewage generated in this area may be estimated in the following way:

The area covers ward No. 79 and 80.

Population in ward No. 79 is 42,725

Population in ward No. 80 is 36,305

(Population of 1991 is considered, as the increase in population since '91 is negative. The slum population density ratio with respect to total population is negligible as recorded in the 1981 population data.)

3 KODS stands for Khiddirpore Old Dock Sil. This is a local hydraulic engineering standard related to the Dock's water level.

With water consumption @ 40 gpcd and @ 35% of domestic demand as ICI demand and @ 5 gped as other demand, total usage of water amounts to 4.66 MGD. Assuming 80% of the water usage entering the sewer, waste water generated is 3.7MGD.

Under the existing situation the Nimak Mahal Pumping Station pumps the DWF of the Nimak Mahal Road area through a 9-in diameter force main to the Hide Road sewer. The Hide Road sewer, which was laid at a considerable depth from road level, (invert at 18 ft below ground) varies in size from 18-in. to 27-in.; after following a route below the dock yard and along Mayurbhange Road, it reaches to Mominpur Pumping Station. This sewer is almost non-functional as mentioned earlier. During a field visit, no manhole could be seen as they were covered by the road surface and it appears that the sewer has remained unattended for several years. The surface drains on both sides of the road are connected to the underground sewer at a certain distance apart and slope to either side of the road. One side of the road surface drain slopes towards north and discharges to the 5ft diameter RCC pipe along Nimak Mahal Road leading to the Hooghly River and the other side of the road surface drain slopes south leading to the tank beyond the Budge-Budge railway line. These surface drains are not adequate to carry the storm run off of the area resulting in water logging during rain.

10. Waterlogging in Swinhoe Street

Water logging in and around Swinhoe Street is a perennial problem of the area. The area, bounded by Gariahat Road on the west, Eastern Railway line on the east, Broad Street on the north and Rashbehari Avenue on the south, is a relatively low-lying area. The eastern end of Swinhoe Street is the lowest point of the area, almost 4-ft. below the surrounding land. During heavy showers, rainwater from the whole area drains toward this point. The water level would be about 5-ft above the road level.

The drainage of the area finds its outlet through the roadside open Nikashi along Swinhoe Street along with some sewers in other parts of the area leading to this Nikashi. This Nikashi conveys the water to the Rash Behari Avenue sewer at the other end of the Eastern Railway line through a culvert. The Railway embankment forms a barrier of the area on its eastern side and the water of the whole area gets accumulated at this point and passes through the culvert. The discharge rate through the Nikashi and the culvert is much less than the rate of accumulation of water in the area causing severe water logging. The open Nikashi itself is heavily silted. Moreover the Rashbehari Sewer, where the Nikashi discharges, is silted by more than half its depth. The terminal pumping station, i.e. the Ballygunge Drainage Pumping Station (BDPS) cannot keep the water level sufficiently low so that water from the sewers can have free flow to the pump house.

An extensive storm sewer network with RCC pipes of 15-in to 18-in diameter has since been laid along Ballygunge .Place, Ballygunge Place East, and Swinhoe Street that discharges the storm runoff of the area to the Bondel Road sewer. These newly laid sewers cannot cope with the water logging problem properly either due to their alignment along the reverse direction of the natural slope or inadequate slope of the sewers. However, these sewers together with proper operation of the pump house (BDPS) have reduced water logging problem of the area considerably.

The necessity of a pump house at the Eastern end of the Swinhoe Street in between Bhartia Electricals and Mackintosh Burn at the side of the Railway Embankment has been under consideration by the KMC since 1962 to pump the accumulated discharge to the R B Avenue sewer. This aspect needs to be looked into for further relief.

11. Waterlogging problem in Ballygunge Phanri Area

This area is the crossing of Gariahat Road with the Ballygunge Circular Road, Hazra Road, and Broad Street. The junction of the roads is the lowest point of the area causing water accumulation from all sides of the area through the link roads. Moreover, the Hazra Road sewer that carries the combined flow of the area to the terminal pumping station (BDPS) is severely inadequate against two-month frequency storm. In fact the Suburban system is designed against a rainfall of 4 mm/hr. Providing sufficient inlets to the sewers and increasing the capacity of the Hazra Road sewer may allow the free flow of surface runoff to the sewers. Increasing the hydraulic capacity of the Hazra Road sewer beyond Ballygunge Phanri may be achieved by linking this sewer with the Bondel Road sewer at the Broad Street and the Bondel Road junction. This sewer is mostly unutilized under design condition. Diversion of storm water toward western side of the Tolly's Nallah carried by the Hazra Road sewer may reduce the load on the Hazra Road sewer. The feasibility of these proposals requires further study.

12. Water-logging problem in Bhawanipur, Chakraberia and Elgin Road Area

The water-logging in this part of the area is purely a localized problem. The inadequate hydraulic capacity of the sewer system due to heavy silting and the silted up gully pits are the main reasons of water-logging in the area. Increasing the hydraulic capacity either by desilting or increasing the size of the sewer and proper maintenance of the sewer and the gully pits seem sufficient to solve the problem of the area.

13. Waterlogging problem in Baker Road and Gopal Nagar Area

This area is located at the close vicinity of' the Tolly's Nallah. The water-logging problem

is mainly due to the improper disposal of' storm water to the Nallah during heavy showers as the water level in the Nallah does not permit the free flow discharge within the sewers. The defunct penstock gates over the Nallah at the outlet in the sewers cause mal-controlling of water flow in between the sewers and the Nallah. The problem has been studied in detail earlier by the World Bank team during their field visit at the time of high tide in the Nallah. Their report needs to be carefully examined and their recommendations should be implemented without delay.

14. Waterlogging problem at junction of National Medical College, Lady Brabourne College and Darga Road

The junction of Darga Road, CIT Road near National Medical College is a chronic water logging area during monsoon. The area drainage is served by the two parallel trunk sewers, one along the CIT Road and then along Darga Road, it discharges to the terminal pumping station (BDPS) and the other along Dihiserampur Road that also discharges to BDPS independently. The sewer along Dihiserampur Road is completely silted up and defunct as reported. The 1966 Master Plan recommended an additional storm drain along the CIT Road to link across the Dihiserampur Road sewer to this proposed new sewer so that combined flow of the Dihiserampur Road area can be disposed off properly to BDPS via the CIT Road sewer. Inspite of laying a new sewer CMC connected the Dihiserampur Road sewer across to the exiting CIT Road sewer causing overloading of the CIT Road sewer. Under two-months frequency storm, the CIT Road sewer is found to be inadequate to cater the discharge of the vast area under this basin. The recommendations have since been made after proper study and these need to be implemented at the earliest.

15. Waterlogging Problem of Southend Park and Panchanantola Area.

The location of South-end Park and Panchanantola is at the extreme southern end of the suburban system boundary. The areas are comparatively lower than the adjoining areas; as a result storm water rushes to these areas at a faster rate that the existing gully pits can cope with.

Sewerage and drainage of this area finds its outlet through pipe sewer network leading to the Brick Sewer of Gariahat Road south and Ballygunge Station Road respectively. Extensive storm network has been laid but had not yielded desired result. Due to heavy silting of the BS of R.B Avenue and improper operation of Ballygunge drainage pumping station, water-logging in the area persists for hours. Complete removal of water logging from the areas will probably not be feasible. Rather it is not desirable also as it helps the flushing of the sewer system.

The recommendation for construction of a storm pump house to force the water into an existing system of network deserves careful consideration from long-term solution point of view. The solution would have been easier had there been a separate outfall channel available nearby. Existing roads are not wide enough to accommodate all utilities. To reduce the period of' water-logging, storm water may be allowed to accumulate in a sump in Panchanantola near the bridge approach and then to pump it out either to the sewer of Ballygunge station through the delivery sewer of Jodhpur Park Pumping Station or to pump it to the box drain of Raja Subodh Mullick Road through force main under the railway track. In that case addition and alteration of Jodhpur Park Pumping Station would be necessary.

16. Waterlogging Problem in Southern Avenue and Rabindra Sarobar area.

The area bounded by R.B. Avenue on the north, Rabindra Sarobar on the South, Sarat Bose Road and Lake Road on the west and south west and Southend Park on the East, is prone to water logging from heavy precipitation during monsoon. The crossing of Lansdowne Road and R.B. Avenue in front of Deshapriya Park, Lake Road, Southern Avenue and Southend Park get water-logged. The sewerage network in this area is inadequate in capacity to take care of rainfall more than 6 mm/hr. Although the area does not drain into the lake, Southern Avenue often gets inundated due to entry of over flow water from the lake into Southern Avenue sewer through the existing connection.

Water-logging in this area can be minimized by desilting and cleaning sewer system of R.B. Avenue where Southern Avenue sewer finally discharges. There are also inadequate inlets along the Southern Avenue. It has been recommended to provide additional inlets to Southern Avenue Sewer. Road surface gradients leading to these inlets need also to be checked for proper drainage.

The 1966 Master Plan, when considering flooding of this area, recommended constructions of a trunk drain between Dhakuria Lake and Tolly's Nullah that includes the lakes and part of the RB Avenue trunk sewer system. Very little drainage from the adjacent area enters the lakes unless the rainfall exceeds the design capacity of the system. The Master Plan also suggested construction of an overflow west on the south-westerly end of the lake thus permitting the area to drain into the lake and thence through a trunk drain to the Tolly's Nullah.

A pump house would be required in a suitable location in or around Rabindra Sarobar area to pump out storm water through a force main to Tolly's Nullah. The head and capacity of the pumps are to be considered carefully so that the pumps can discharge freely into Tolly's Nullah even during high tide. Cost effectiveness in terms of

permanent liability and recurring expenses for having a pumping station should also be investigated in detail.

It has been reported that KMC has prepared a storm drainage scheme for construction of a pumping station having a capacity of 140 cfs in Rabindra Sarobar area as suggested by the Calcutta Improvement Trust for disposing the storm water to Tolly's Nullah through a force main.

17. Waterlogging in Ultadanga area

Dhapa Lock Pumping Station (DLPS) receives the combined discharge of entire Maniktala Basin. The DWF and storm water of Kankurgachi and Ultadanga area lead to Ultadanga new pumping station through a 10ft diameter brick sewer. Combined flow, after having been pumped at the station, discharges to a common chamber from which the flow finds its outlet through a high-level 10-ft diameter brick sewer leading to DLPS. Before DLPS, this 10-ft diameter sewer meets with the 8-ft 6-in diameter brick sewer from Beliaghata Main Road in a Junction Chamber near the buildings of C.I.T. The two sewers lead into a 14-ft x 13-ft 3-in 'horse-shoe' type brick sewer that siphons below the Beliaghata canal and enters into DLPS.

It can be seen that the invert level (IL) of the 14-ft x 13-ft 3-in horseshoe type sewer at its starting point is (-) 4.4 KODS and the I.L at the entry to the siphon is (-) 4.76 KODS. The IL beyond siphon i.e., after crossing the canal is (-) 3.5 KODS. The ideal siphon action cannot occur with the outlet side higher than the inlet side, although in this case the siphon is reported to be functioning properly as adequate water is found to be entering into the sump for pumping. Moreover, there is no silt deposition reported in the siphon chamber as well as in the silt chamber of the DWF channel just before the sump. Silt is found deposited in the silt pit of SWF entry at the upstream of the screen gate. The 14-ft x 13-ft 3-in-horse-shoe type sewer through out its length up to the inlet of siphon chamber is heavily silted. Although the existing twin barrel siphon is working well, its capacity appears to be less than the full bore capacity of horseshoe type inlet sewer.

There are two storm water box drains laid by CMWSA, one along Maniktala Main Road from Kankurgachi (9-ft x 5-ft RCC twin box) leading to Keshtopur Canal and the other along Narkeldanga Main Road from Phoolbagan (11-ft x 5-ft RCC box) to Beliaghata Canal. There are two cross-over structures at the junction of these RCC boxes with the 10-foot diameter delivery sewer from Ultadanga Pump House. The twin boxes along Maniktala Main Road after crossing the 10-ft. diameter sewer runs parallel to it but in reverse direction and finally discharges to Keshtopur canal near Ultadanga. The RCC box along Narkeldanga Main Road after crossing the 10-foot diameter sewer runs

parallel to 10-foot diameter delivery sewer along same direction and discharges to the Beliaghata Canal near DLPS. There is an interconnection between the twin box along Maniktala Main Road and the10-ft diameter delivery sewer near Purbasha Housing complex. The IL of the discharge point of this storm drain in the canal is reported to be + 7.76 KODS whereas the prevailing water level in the canal in monsoon is about + 14.00. Moreover the discharge point of the storm drain is almost silted. This is causing obstruction to the free discharge of water from the box to the canal even if the water level in the canal is low. If the full supply level (F.S.L) becomes excessively high i.e. + 14.00 there is a chance of water to flow back to the box. This obstructed storm water or water from the canal may lead to the 10-ft diameter delivery sewer of the Ultadanga pump house through the interconnection point near Purbasha housing and finally lead to the sump of the pump house. This will cause overflow, flooding and water logging. The water-logging problem of Ultadanga area, therefore, needs to be carefully studied to work out appropriate solution.

18. Waterlogging problem in Maniktala Main Road

Ghose Bagan area on the North of Maniktala Main Road and the areas under M/s Bengal Chemical and Pharmaceutical Works are comparatively lower than the surrounding areas as a result of which storm water from the adjoining areas rushes to the spot causing water logging. Storm drain has already been laid at Maniktala Main Road but arterial drains have not been developed. Besides thorough cleaning of the box drain right from Kankurgachi gyratory to Keshtopur Canal is necessary. Desilting of the Keshtopur canal and maintaining the F.S.L at +10.25 need to be confirmed by the State Irrigation and Water Ways Department. Alternatively the storm water could be disposed off through pumping by construction of a storm pumping station at the tail end of the box drain. As a second alternative, Ultadanga siphon pumping station can be renovated, and by installing high head pumps for pumping the storm water may be discharged through a force main to the canal.

19. Waterlogging in Narkeldanga, Kankurgachi and Beliaghata Area

The problems are local in nature, and can be removed if the full use of the storm drains which have been already built by CMWSA including construction of the additional inlets and branch storm sewers is done by linking to the main storm drain. The problem will be solved provided the main box drains are kept clean during the monsoon. Beleghata canal also requires desilting. Box drain led along Narkeldanga Main Road to the west of Railway line has a size of 8-feet x 5-feet with IL 8.76 and FDL 13.76 KODS discharging

into the canal, where the ruling FSL should be maintained + 12.25 to have a free discharge of the canal. If the FSL of the canal cannot be maintained to allow gravity discharge, there is no other alternative than to pump storm water into the canal by constructing the pumping station at the tail end of the box drain. Unless FSL is maintained at +12.25 KODS, free flow is not possible. The only alternative would be to have a pump house at the end, with the flow being pumped to Dhapa Lock Pumping Station through a siphon of 8-inch diameter to be constructed under the canal.

This detailed account of the city's known pockets of waterlogging has been presented along with the reasons for water logging and suggestive measures that need to be taken to substantially reduce the acute flooding problem of the respective areas. Lack of funds coupled with lack of a longer term vision has stood in the way of taking a planned approach to this massive problem of reducing considerably (not completely) the annual flood risks that continue to plague city life in Kolkata. Only now, as can be surmised from the suggested ameliorative measures cited above, attempts are being made (with JNNURM fund) to deal with this scourge (flood) in a phased and planned manner.

Drainage & Sewerage System

The problem of waterlogging of Calcutta city is intimately connected with the city's original drainage system which had been designed as a 'combined' system for the disposal of storm water as well as sewerage and dry weather flow in 1855, sanctioned in 1859, and laid down between 1860 and 1875. A brick sewer with a height of 8 feet and a width of 6 feet was constructed beneath the city's principal streets subsequently linked to small underground cross-sewers. The drainage system designed and built during Colonial times could take care of storm water flow from 6mm litres of sewerage per inhabitant per day. The system had thus its in-built inadequacies, and it never took note of heavy intensity rainfall and sewerage generated due to tremendous population explosion in subsequent decades. The old sewerage system could cover only about 55 per cent of the city. Part of the remaining portion is covered by septic tank system and the existing storm sewer network is being used to carry sewage as well. The system has adequate conveyance capacity during dry weather flow, but does not have enough capacity to handle storm flows. The city does not have any conventional facility for wastewater treatment. There are a total of 815 km of sewer, of which there are about 645 km of pipe sewer and about 170 km of brick sewer. About 88 km of the brick sewer is man-entry sewer, i.e. sewers above 42-in in diameters.

At present the City of Calcutta (CMC area) can be broadly divided into six catchment basins (Table 9) having independent sewer networks and terminal pumping stations.

Table 9: Catchment Basin Data

Sr. No	Name of Basin	Area of the Basin (Sq Km)	Terminal Pumping Stations
I	Town System	19.13	Palmer Bazar Pumping Station (PBPS)
2	Suburban System	25.69	Ballygunge Drainage Pumping Station (BDPS)
3	Maniktala System	8.91	Dhapa Lock Pumping Station (DLPS)
4	Topsia-Tangra System	5.17	Topsia Pumping Station & others
5.	Tollygunge-Panchnnagram System (i) Tolly's Nallah Basin (ii) Panchannagram Basin	 4.00 32.00	Chowbhaga Pumping Station
6	Bagjola Basin	6.07	Bagjola Pumping Station

1. Town System

The oldest part of the sewer system, which is more than 100 years old, is called the Town System. The southern part of the sewer system, called the Suburban System, is about 80 years old. The Town System was designed for l /4-in. rainfall per hour, whereas the Suburban System was designed for I/6-in. rainfall per hour with 100 per cent runoff. Three large and 22 smaller pumping stations are used to pump combined wastewater from the sewer system to a canal system and, ultimately, carry wastewater to the creeks of the Bay of Bengal.

Deficiencies of the existing system are:

- Lock gates control the whole canal and discharge system. The coincidence of high tides with heavy rains makes satisfactory drainage difficult.
- Hydraulic capacity of City's sewerage system and discharge canal system has been reduced significantly due to heavy siltation.
- Due to lack of proper maintenance of the age-old pumps and unavailability of

spare parts, pumping stations are inefficient and unreliable, resulting in frequent failures.

- Many gully pits are covered with debris and polythene bags, making it difficult for storm water to enter the sewer system.
- Outfall structures are inoperable for long periods of time due to lack of spares, and storm water-pumping stations cannot discharge freely into the canal system due to heavy siltation.
- Many canal banks have been encroached upon by squatter settlements. The growth of aquatic vegetation also decreases the carrying capacity of canals.
- There are still some dairy farms in the area that discharge wastes directly into the sewer, causing siltation of sewers.
- Rapid, uncontrolled urbanization, indiscriminate real estate development, and destruction of wetlands (Salt Lake city being a glaring instance) have aggravated the flooding problem.

The primary goal of KMC is to keep the city's sewerage and canal system clean and pumping stations operable and efficient to reduce the frequency of flooding of the city streets during heavy rains. This can never be a solo affair of the KMC. Besides KMC's own efforts, integrated approach is necessary by synergizing the efforts of agencies like the State Irrigation Waterways Department, the Calcutta Port Trust and others.

General Description

The inception of Calcutta sewerage and drainage system dates back to the year 1859 when the Town System sewerage network was commissioned. At the time, Calcutta was limited by the area bounded by the River Hooghly on the west, today's Circular Road or the then Maratha ditch on the east and south, Cossipur-Chitpur on the north covering an area of 19.13 sq. km. The City expanded over time and the sewer network has also been gradually extended. At the end of nineteenth century, the Suburban Sewer System network was built covering the southern part of the City, and in the second quarter of the twentieth century the Eastern part of the City called the Maniktala system started to take some form which was later fully developed as a separate sewerage & drainage network known as the Maniktala system.

Out of the 141 Wards of the city, the present study area covers Ward No. 7 to Ward No. 100, and the drainage basins coming under the scope of the study are (I) Town System, (2) Suburban System, (3) Maniktala System, (4) Topsia-Tangra System and (5) part of Tollygunge Panchannagram System.

General Gradient and Flow of Sewage

The general elevation of Calcutta above Khidderpore Old Dock Sill (KODS) is between 19 and 22 ft. as revealed in the existing reports. The average slope is in general from west to east from the east bank of the Hooghly River to the Salt Lakes. The Salt Lake City is at (+) 18.5 KODS and the Netaji Subhas Road is at (+) 22.0 KODS. The trunk sewers laid along the East-West direction carry the wastewater and storm runoff from the western part of the City east to the different pumping stations like Palmer's Bridge Pumping Station (PBPS), Ballygunge Drainage Pumping Station (BDPS) and Dhappa Lock Pumping Station (DLPS). From DLPS, water is pumped to the dry weather flow (DWF) channel and storm water flow (SWF) channel for disposal into the Kulti River almost 36 km away from the City. The major part of the sewer network carries combined flow, whereas in few areas partially separate drainage systems are present. There is no sewage treatment plant in the city at present. In the Town system the average invert level of the trunk sewers near the Hooghly River is (+) 13.5 KODS and at the pumping station end is (+) 3.61 KODS producing a 10 ft. fall approximately.

The Calcutta Town System sewerage network is comprised of following trunk sewers:

	Sewer	**Shape**
1.	Lenin Sarani Sewer	Egg shape
2.	Kolutola Street Sewer	Egg shape
3	Nimtolaghat Street Sewer	Egg shape
4.	Grey Street Sewer	Egg shape
5.	Bagbazar Road sewer	Egg shape
6.	A.J.C Bose Road Sewer	Egg shape
7.	A.P.C. Roy Road Sewer	Egg shape

The trunk sewers along Kolutola Street, Nimtolaghat Street, Grey Street, and Bagbazar Street - running west to east - are intercepted by APC Roy Road Trunk Sewer running along North-South direction. The APC Roy Road Trunk Sewer is inter-connected with another sewer along Canal West Road running parallel to APC Roy Road by means of overflow connections at five different locations. Prior to the construction of' the sewer along Canal West Road the overflow discharge from the APC Roy Road sewer was disposed off to the Circular Canal directly through penstock gates; those are now all defunct except the one at Maniktala Main Road. The storm runoff from the above-mentioned trunk sewers along east-west direction is finally shared by the intercepted sewer along A.P.C. Roy Road and the Canal West Road. The A.P.C Roy Road trunk sewer, A.J.C Bose Road trunk sewer and Lenin Sarani trunk sewer meet at

the Moulali junction and then flow onwards through a special section trunk sewer of 20 ft. x 15 ft. This is known as the 'Town outfall' that leads to the Palmer's Bridge Pumping Station. Apart from these, there are branches and lateral sewers made of brick masonry of size's ranging from 3 ft. x 2 ft. to 6 ft. 6 in x 4 ft. 4-in. All these brick sewers are egg shaped.

The Maidan Area is separate from the Town System. The water from this area finds its outlet through surface drain to the Hooghly River. Recently a part of this area's drainage has been included in the Town System network through an inter-connection between the Town System and Maidan Drainage.

Other pumping stations within this system of sewer are Belgachia Pumping Station and Maniktala Pumping Station. The Belgachia Pumping Station with 9-cfs discharge capacity receives wastewater from the R.G. Kar Medical College Hospital area and a small portion of the area outside the hospital campus. The combined flow is pumped to a sewer along Raja Dinendra Street through a force main and it finally discharges to Maniktala Pumping Station. The Maniktala Pumping Station, having a total discharge capacity of 108 cfs receives the discharge from the Raja Dinendra Street Sewer and from Sukia Street Sewer and pumps the discharge to PBPS through a high-level delivery sewer along Dinendra Street. PBPS receives 94% of the discharge of the Town System directly through the sewer network and only 6% of the discharge from the intermediate pumping station at Maniktala.

The Thantania Pumping Station has been commissioned in the year 2000 and is located within the Town System boundary. To remove the chronic waterlogging problem in the College Street, Amherst Street and Sukhia Street areas, this pumping station was built with a total pumping capacity of 30 cfs.

The total area covered under the Town System sewer network is 19.13 sq. km. The total storm runoff produced in the system is 1172 cfs with two-month frequency rainfall (6mm/hr over a period of three hours or more). The average daily DWF generated in this system is 268 cfs. Total combined flow in the system thus becomes 1440 cfs. The total sewer capacity against this flow is 1425 cfs and the total pumping capacity (installed capacity) of Palmer's Bridge Pumping Station (PBPS) is 1720 cfs. This suggests that the sewerage system is sufficient to take care of the DWF, but with two-month frequency rainfall the overall sewer capacity of the system is marginally less under design condition. The problem of frequent water logging occurs due to local bottlenecks of the system. There is sufficient pumping capacity under installed condition. Under existing condition, the sewer sections are filled up to the extent of 40% to 50% with silt thus causing further reduction in the sewer network. The age-old

pumps are also reduced in their efficiency by 30% to 40%, and thus the net pumping capacity has been reduced to almost 1100 cfs. This suggests a gross inadequacy of the capacity of the system to carry storm flows. Also, due to siltation and inadequate pumping ability, even the dry weather flow capacity is compromised.

2. Suburban System

The Suburban System area is bounded by A.J.C Bose Road and Convent Road on the north, Eastern Railway Line on the south and east, and the dock area on the west, covering an area of 25.69 sq. km. There are three trunk sewers running west to east carrying the combined flow of the area and finally discharging to Ballygunge Drainage Pumping Station (BDPS). The trunk sewers and their shapes are as under: -

Sewer	**Shape**	
1.	Rashbehari Avenue Trunk Sewer	Circular.
2.	Hazra Road Trunk Sewer	Circular
3.	Poddapukur Road trunk Sewer	Circular
[Two other trunk sewers running north to south in direction carry the discharge from CIT Road area and Tiljala area and discharge to BDPS.]		
4.	CIT Road Trunk Sewer	Circular
5.	Tiljala Road Trunk Sewer	Circular
[Another trunk sewer brings the storm discharge from a part of Town System and discharges to BDPS]		
6.	Park Street Trunk Sewer	Circular

The total storm runoff produced by this drainage system is 1574 cfs at a two-month frequency storm (6 mm/hr over a period of three hours or more), and total average daily DWF generated is 175 cfs. The total sewer capacity against this flow is 1236 cfs and the total pumping capacity of BDPS is 1275 cfs. This suggests that there is a deficiency in the overall system under design condition for storm flows, apart from the local bottlenecks. In fact, the Suburban System sewer network was designed for l/6inch per hour rainfall, i.e. 4.17mm/hr rainfall, and thus the runoff flow becomes 1100 cfs. Under the existing condition with more than 50% sectional area of' the sewers silted and 30% to 40 % reduction in efficiency of the age-old pumps in the pump house, the capacity reduces to approximately 600 cfs in the sewers and 800 cfs at the pumping station with no standby. This is suggestive of gross inadequacy of the system against seasonal storm flows.

3. Maniktala System

The Maniktala Sewerage and Drainage area is bounded by E.M. bypass on the east, Circular Canal on the west and south and Keshtopur canal on the north, covering an area of 8.91 sq. km. At the time of the inception of the sewer network in the early thirties, the Cossipur-Chitpur area was also considered as part of this sewerage basin but later these areas were separated from this system. Circular brick sewer laid along CIT road from Kankurgachi and sewer along Ultadanga Main Road or Bidhan Nagar Road cover the Kankurgachi and Ultadanga areas and lead to the Ultadanga Pumping Station which lifts the combined flow. It pumps to high-level delivery sewer along E.M bypass leading to Dhapa Lock Pumping Station (DLPS). The Phoolbagan and Beliaghata areas are served by two trunk sewers, one along CIT Road from Kankurgachi following CIT Road and Hem Naskar Road and the other along Beliaghata Main Road from the western side of Eastern Railway Line crossing. These two sewers meet at the CIT Road junction. The combined flow goes along Beliaghata Main Road through a sewer discharging to the high level delivery sewer of Ultadanga Pumping Station and finally to DLPS. A network of lateral and collection sewers is also there to feed these trunk sewers. Apart from these, CMWSA has installed a few box drains to meet the deficiency of the sewer network capacity against storm. Box drains along Maniktala Main Road receive storm runoff from Kankurgachi area in between Kankurgachi Island to Bengal Chemical near E.M bypass and finally discharge to Kestopur canal. Box drains along Narkeldanga Main Road receiving storm runoff from the Phulbagan area in between Phulbagan Island to E.M bypass crossing and finally discharge to Beliaghata Canal. These storm sewers carry the runoff from west to east. There are three other box drains on the western side of the eastern Railway line that drain from East to West and finally discharge to the Circular Canal. These boxes are laid along Narkeldanga Main Road, Maniktala Main Road and along Barin Ghosh Sarani. All these box drains were laid in a very mild slope, and at the discharge ends in the canals they are almost choked by silts deposited in the canal beds causing flow obstruction in the boxes.

Total storm runoff produced by the Maniktala drainage system area with two-month frequency storm (6 mm/hr over a period of three hours or more) is 546 cfs. The capacity of the sewer network leading to the DLPS is 542 cfs, and the pumping capacity of DLPS is 480 cfs. This suggests that the pumping capacity is just short of the runoff produced. Additional box drains laid by CMWSA had brought about improvement in the system to handle the storm runoff. The 468-cfs capacity Ultadanga Pumping Station was designed to accommodate the Cossipur-Chitpur area drainage in addition to Ultadanga area, but after exclusion of this area from the Maniktala system, the additional pumping capacity of the station may be considered as standby.

4. Tangra-Topsia System

The Tangra-Topsia sewerage and drainage system area is bound by Eastern Railway Line on the west, E.M. Bypass on the east, Park Circus connector on the south and the Circular Canal on the north, covering an area of 5.17 sq. km. Basically this is a low-lying area and a part of it is below the full supply level of SWF Channel from Palmer's Bazar Pumping Station that passes through this basin, resulting in frequent water logging. The very poor sewer network of the area aggravates the situation. The storm pipes laid in this system are incapable of discharging to the pumping station due to inadequate gradient. The roadside Nikashis, which serve the purpose of carrying the DWF, are not kept properly clean, and they are linked with the storm pipes. The area is mainly inhabited by poor people with a sprinkling of Railway quarters near by. Recently, some high-rise buildings have come up - indicative of possible future changes in land use pattern of the area. Drainage of the whole area is dependent on the operational efficiency of four different pumping stations:

(1) Topsia Pumping Station of 221-cfs capacity
(2) Chingrighata Pumping Station of 34-cfs capacity
(3) Pagladanga Pumping Station of 40-cfs capacity
(4) Kulia-Tangra Pumping Station of 100-cfs capacity.

5. Tollygunge Panchannagram System

It is a relatively larger system of the south and southeastern part of the city covering an area of about 36 sq. km. For storm drainage disposal, this area has been divided into nine sub-basins of which three southwesterly basins drain into Tolly's Nallah, whereas storm drainage from the rest of the area is transported to Panchannagram Canal directly through a system of lead canal. From Panchannagram canal, the water is lifted and discharged into the storm water flow channel through three pumping stations at Chowbhaga with a combined discharge capacity of 1450 cfs. Unplanned and indiscriminate building activities in the area in recent years have created problems of drainage in general and storm drainage in particular.

Outfall System

The combined flow produced by the different systems as mentioned above is finally pumped by the terminal lifting pumping stations and discharged into the Storm Weather Flow (SWF) channel and Dry Weather Flow (DWF) channel. .

PBPS and BDPS pumps the DWF from the Town System and Suburban system area

respectively into two high-level delivery sewers leading to a common chamber at Topsia known as point 'A', and thereafter the flow gravitates to the River Kulti through open DWF channel via Bantola. The excess flow, however, is discharged into the storm water channel through a by-pass. BDPS pumps the combined flow of Suburban System into two high-level delivery sewers leading to point A with the excess flow discharged into the SWF channel known as Calcutta Storm Water Flow Channel. SWF Channel from PBPS and SWF channel from DLPS meet at a point near Makalpota; thereafter it becomes a single much wider channel and meets the Calcutta Storm Water Channel through Bantola regulator. The SWF channel beyond Bantola to Kulti is known as Calcutta Storm Water Channel.

Admittedly, the sewer and pumping capacities within the Suburban and Maniktala Systems are inadequate. The pumping capacity in the Panchannagram System is also inadequate. Factoring in the effect of siltation and reduced pumping capacity due to age and wear in the pumps, it is evident that neither the sewers nor the pumping stations throughout Calcutta have sufficient capacity for dealing with the storm water flows.

Existing conditions of the individual trunk sewers reveal structural deterioration in the case of more than century old trunk sewers, and substantial reduction of the hydraulic capacity of the sewers for a variety of reasons.

The CCTV and video photography of the man-entry/non-man entry sewers conducted recently reveals that the sewers are reasonably in shape with loss of mortar from the sidewalls and longitudinal cracks along the crown in certain places. Collapse repair work at the junction of Moulali has been undertaken. All the tie-rods of the arch of town outfall sewers have been found damaged. Tree-root intrusions have also been noticed at places.

SOLID WASTE MAGEMENT

Kolkata Municipal Corporation has to provide services to 8 million people every day, out of which daytime population (floating) constitutes about 3.4 million. The total number of households of about 4.25 lakhs and population living in slums of about 15.24 lakhs need to be served by KMC through its "District"-based "conservancy" services. By any standard, it is a massive operation that requires adequate organization and management.

Present System of Waste Handling

Within KMC area, the generated waste is stored within the premises in commercial and industrial areas, whereas in residential areas occupants take it out and throw either on the streets or transfer to community bins.

Availability of storage space for collection:

(i) Total no of container points and vat points: 662

(ii) Other small bins & trash bins: 435

Collection: Table 10 shows the existing status of collection from different points. The average daily accumulation of garbage is of the order of 3000 MT. The field staffs commence their work at 5 am and continue till 12.00 noon with a break of half an hour in between.

(i) **Street sweeping and cleaning:** After the first mastering, conservancy workers carry out sweeping and cleaning of roads and pavements and thereafter remove the collected garbage to the assigned vat/containers. This task is expected to be completed by about 7.30 am.

(ii) **Residential commercial, slums and office complexes:** From 7.30 am onwards the conservancy workers move on to their assigned areas with their hand carts giving whistle signal, calling the residents to bring their garbage. This process continues till 10.30 Am. Garbage thus collected is taken to the nearest vat / container from where vehicles pick up the garbage and transport the same to the disposal ground. Presently this process of house-to-house collection of garbage is practiced in all the 141 wards.

(iii) **Hotels & Restaurants:** Big hotels have their own vats wherefrom garbage is collected and transported regularly by KMC / Private vehicles on charge basis. Others dispose their waste on the road or nearby vat with the help of KMC / own sweeper. In case of KMC's own markets, wastes are collected regularly. In case of roadside and unauthorized markets, the waste from these markets is dumped on the road and collected by KMC street sweepers.

(iv) **Hospitals (Bio-medical wastes):** KMC was earlier collecting the waste from those bio-medical generators who did not have the treatment facility and disposing the same at Dhapa landfill site by deep burial method. From 1st April 'O4, collection and treatment of bio-medical wastes of KMC and other areas, have been entrusted to a private organization and the processes used in this connection are (i) Autoclaving (This is a process of steam sterilization under pressure) and (ii) Incineration.

Table 10: Status of present collection points at Kolkata

Borough Nos.	Total Collecti-on points	Type of Collection points			Category wise assessed solid waste generation (MT/d)		
		DL * points	Open Vat/ Space	Container Points** (B/N)	Domestic & Street Sweeping	Market & Commercial	Silt & Debris
I	58	3	35	20(12B, 16N)	140.90	52.00	16.00
II	19	0	12	7(14B)	92.50	70.00	7.00
III	33	0	16	17(30B, 2N)	173.80	40.00	14.50
IV	22	0	14	8(19B)	180.00	85.50	14.00
V	22	0	17	5(9B)	110.90	197.00	10.00
VI	20	1	13	6(12B)	131.20	180.00	25.50
VII	57	7	27	23(34B)	194.70	116.00	46.00
VIII	34	3	11	20(36B)	155.00	45.00	15.00
IX	53	6	31	16(23B)	181.10	40.00	23.00
X	81	18	53	10(11B, 6N)	166.30	30.00	20.00
XI	52	2	19	31 (33N)	45.80	9.00	4.50
XII	48	5	11	32(33N)	40.20	11.00	8.00
XIII	63	0	43	20(4B, 18N)	57.80	22.00	7.00
XIV	52	1	38	13(13B, 2N)	48.30	28.00	10.00
XV	48	9	48	0	56.80	15.00	10.00
TOTAL	662	46	388	228(217B, 110N)	1775.30	940.50	230.50

* Direct loading ** Big (7m3) / Normal (4.5m3)

Total category wise assessed solid waste generation is 2946.30 MT/d and may be considered approximately 3000 MT/d

Source: ADB Report, 2005

Transportation: There are five main vehicle garages and three subsidiary garages from where conservancy vehicles operate to transport garbage from their assigned areas to the disposal ground. Currently private carriers transport nearly 60% of daily-generated garbage. Of the remaining 40%, three main systems are in vogue viz. manually loaded vehicles, pay loader loaded vehicles and containerized vehicles. An average of 330 nos @ 4.9T/trip garbage trips, 54 nos. @6T/trip silt / rubbish trips are performed by the hired lorry vehicles, and 320 nos. @ 3.3T / trip garbage trips are performed by KMC lorries daily to remove the garbage from the city to the disposal ground.

Deficiencies of the present collection & transportation system

(i) About 58 - 60% of collection points are in the form of open vat, and the waste is lifted daily. However no of collection points remains in bad condition due to citizens dropping the waste haphazardly at the collection point after the clearance is done.

(ii) At present there is no source segregation system in KMC area.

(iii) Dumper placer containers and KMC vehicles are not washed daily or periodically even once a week. This results in heavy corrosion giving ugly appearance and reduced life of the vehicles.

(iv) 70% of KMC vehicles are more than 8 years old. The operational efficiency is less than 50%.

(v) In added areas large quantity of waste is disposed of in open canal and drains or dumped into low-lying areas instead of collecting and transporting to Dhapa waste disposal site.

In Kolkata the disposal ground is in the eastern fringe of the city with an average distance of 20 km from the collection points. Computerized weighbridges with capacity of 20T & 30T have been installed at the Dhapa Check Post where all vehicles are checked and recorded. Area of the Dhapa land fill site is 21.47 ha where, on an average, 1100 MT of wastes per day are disposed by the departmental vehicles within an area of 8.125 ha, and remaining 1800 MT of wastes per day are disposed by the private vehicles within an area of 13.345 ha. Another land fill site is situated at Garden Reach area of 3.52 ha where approximately 100 MT of wastes are disposed of by open dumping daily.

Deficiencies in the present Disposal system:

- Maximum balanced life of Dhapa is less than a year if the land presently used by cultivators is not taken over and developed for 'engineering landfill'.

- The method of operation of Dhapa waste disposal site is uncontrolled without providing earth cover, liner and leachate collection and treatment.
- No studies have been carried out to determine the effect of landfill operations on the surrounding environment and ground water.
- Rag picking carried out at Dhapa site for recycling and reuse of recyclable waste is most unorganized, hazardous and unhygienic, affecting seriously the health and safety of rag pickers.

Solid waste management is basically dependent on how the ground level staff functions and how they are supervised. The role of the Block Sarkars in their respective areas of operation (an electoral ward will be having a number of blocks) along with their gang of workers is of crucial importance in this context. During heavy rains in 2007 from 13 June to 3 July, the garbage from vats and polythene bags was a major problem - blocking gully pits at many places. Lack of timely collection, transportation and disposal of solid waste was identified as one of the major reasons for choked drainage and consequent flooding at many locations. Night-time collection and disposal, it has been suggested, might be useful. Kolkata's floods mitigation plan must take into account the proper management of solid waste in terms of frequency of collection and prompt collection, transportation and disposal.

Task Force Report

Recently, a high power Task Force was appointed, under the KEIP, to examine the sewerage and drainage problem of the city with special reference to the city's chronic flooding problem. The problems were studied, very rightly, in the broader context of urban planning. The Task Force has come out with a number of major recommendations which are of far reaching consequences.

Uncontrolled Urbanization

One issue that is seen as hampering any attempt at rational planning of the sewerage and drainage system is uncontrolled urbanization in various areas - which has been evident in some parts of Kolkata in the past 15 years.

A number of new residential apartments for NRIs are springing up in a number of areas in Kolkata. There is a requirement that high rise apartment complexes need to provide their own sewage treatment plants if there are no KMC sewers nearby. There is anecdotal evidence that this requirement is not always complied with and apartment complex sewage treatment plants are sometimes switched off to save power. This situation needs to be better policed and regulated by KMC.

The experience gained in implementing the KElP project in the Added Areas reveals that streets are generally small and narrow and there is insufficient room for separate wastewater and drainage systems -e.g. 2 m dia sewer being laid in 4 m wide road. This highlights the difficulties of constructing sewer networks in highly congested, unplanned neighbourhoods.

The other issue encountered when extending the sewerage system in the Added Areas is that most houses do not have separate discharge systems for sanitary sewage and grey water on the one hand and storm water on the other.

Separate sewerage systems are therefore difficult to implement in crowded existing areas. Separate sewerage systems should however be planned for if possible in the development of housing in any new areas, where streets can be sized to accommodate utility corridors. This should be spelt out in new regulations to be promulgated.

A high priority for Kolkata is therefore an improvement in the system of sewerage and drainage planning and the links it has to urban planning in general. To really improve the standard of sewerage and drainage in Kolkata a more comprehensive approach to planning and utilities is desirable, encompassing all urban services including roads, traffic, water supply, electricity, telecommunications, public space, green areas, sewerage systems etc. The urban plan might include off-channel storage areas for storm water which would be used to attenuate and help confine any initial flooding to pre-designed open areas. These areas might normally be used as parks or playing fields for example.

An integrated urban planning approach is required based on an updated Urban Plan that clearly spells out in which areas of Kolkata future development should take place and where high rise apartments may be built. Also required is a review of the KMC Act, new regulations to be promulgated for wastewater disposal from new houses and high rise apartments (to include on site treatment for new high rise apartments if necessary), industrial premises to be required by regulation to have on-site treatment of wastewater as part of an KMC-wide Industrial Pollution Control Action Plan and town planning is required to incorporate off-channel storm water storage in open areas and basins (e.g. parks) to attenuate storm flow peaks.

Sewer Desilting

Siltation of the trunk sewer system is seen as the biggest issue facing Kolkata at present. It has been assumed for the purposes of the Master Plan Study that 60% of the sewer capacity is filled with silt, and this will need to be removed as a priority.

As a result of the Metro works, an amount of bentonite was accidentally pumped into the trunk sewers adjoining the Metro alignment. This bentonite and other cemented

mounds of silt in the central part of sewers that are difficult to reach by manual methods will be cemented hard and difficult to remove with conventional jetting methods. Compressed air tools will likely be required in places for full silt and hard material removal.

The removal of the silt is essentially an under-ground mining application, that requires special equipment and technique in a hazardous, dangerous environment, and it will need to be planned and managed in that light.

Alleviation of Flooding

Along with the urgent need for sewer desilting, the alleviation of flooding has a high priority for the Master Plan. Sewer desilting will, however, assist but will not totally solve some of the waterlogging issues, which are also caused by undersized sewers in certain parts of the city such as in Camac Street. Undersized sewers are also found extensively in the Suburban system, where the sewers were designed for 4 mm/hour rainfall rather than the 6 mm/ hour used in the Town Area. This will require introduction of an extensive programme of upgrading of small sized sewers over a long period.

Other Sewerage System Issues

The siphons need a special study. The siphons being referred to are the twin compartment steel siphon under Tolly's Nullah; the twin siphons under Beliaghata Canal and the series of siphons under APC road to Canal East Road.

The construction of the Metro system caused damage to the existing sewers west of the Metro line in the Barabazar and Mahatma Gandhi Road areas. The hydraulic modelling will look at the feasibility of constructing Combined Sewers Overflows (CSOs) to transfer storm water (SWF) originating in the Town area west of the Metro line to the River Hooghly.

The limited hydraulic capacity of the trunk sewer along Hazra Road and the capacity of the discharge sewer from Mominpur PS have been highlighted in all Master Plans completed to date. The hydraulic modelling will examine what improvements can be made to the sewers particularly at the upstream ends of these sewers, and whether some of the SWF can be diverted to Tolly's Nullah, which was also recommended in earlier Master Plans.

Gully pits and storm water entry manholes in various locations are blocked with solid waste or have inadequate hydraulic capacity to quickly admit storm water to the sewers during the monsoon. Gully pits should be provided at the rate of 100 1/ sec/ ha in built up areas and this requirement is not met.

The identification and replacement of the poorly performing gully pits is required, together with the construction of new gully pits to allow storm water to quickly drain to the drainage system.

Pumping Stations

Most of the major pumping station buildings are in a state of disrepair and require upgrading. The building fabric is old and dates from pre-independence time. Some of the pumps in the pump stations are old. Old pumps should be replaced with a modern, efficient design of pump preferably VSD controlled, and preferably of a standardised make throughout the KMC area for ease of maintenance. Spare parts for the old pumps are not available any more and spares therefore have to be manufactured locally. The 2035 DWF and SWF flows have been compared with the capacities of the major Drainage Pump Stations. Whilst DWF pump capacities are adequate the SWF pumps have inadequate capacity for 2035 SWF flows in all cases. Additional capacity is also required at BDPS to improve the flow of sewage to the pump station. The installation of a deeper pump sump is required to allow incoming sewers to be desilted.

Old and inefficient pumps along with lack of proper maintenance consume high energy. A programme of replacement of pumps older than 30 years is recommended. At all major pump stations, the electrical switchgear and pump control panels require replacement and upgrading. Pump station silt pits need to be re-designed to facilitate the removal of silt from both sewers and pump station.

The silting up of the outfall canals require the SWF pumps to pump to a higher level, reducing the volume of water pumped. Therefore, it has been recommended that better coordination of the entire pumping system functioning and introduction of a SCADA control system from a central control room need to be ensured early. At all pump stations, mechanical screens should be installed at secondary screen chambers and primary screens replaced by new stainless steel screens to protect the mechanically raked screen downstream. Another recommendation is that at all pump stations, penstock/ sluice gates need to be renovated, ventilation needs to be improved and a monorail arrangement with 2T capacity is needed.

Canals

The hydraulic capacity of the outfall canal system has been reduced due to siltation and deposition of solid waste. Due to paucity of funds, periodic maintenance is not undertaken - the DWF canal was last maintained in 1999 and the SWF canal was last maintained in 2003-2004.

Responsibility for maintenance of the canal system lies with the state Irrigation and Waterways Department. The maintenance of the trunk sewers and pump stations is the responsibility of the KMC - this separation of responsibility for different parts of the drainage systems leads to problems.

Control structures have been installed at various places including the outfall at Ghusighata. Due to paucity of funds these sluice gates and outlet structures have not been maintained, and up to 40-50% of the gates require repair.

Canal banks have been encroached by informal dwellings within the KMC limits. Access to the canals for maintenance is made more difficult. Resettlement of the canal dwellers should be given a high priority.

The budgets for canal maintenance are inadequate. In 2003/2004, only 7.7 Iakh was spent on canal maintenance in the KMC area and on outfall canals.

l &WD have estimated the minimum amount of funding required per annum for canal maintenance as 190 lakh. Separately, PMC have estimated that 2,021 lakh rps is required per annum for 10 years to bring the canals back to their designed condition.

A pumping station at Ghusighata has been recommended in previous Master Plans. The need for a pumping station at Ghusighata will be reviewed as part of the hydraulic modelling work being undertaken for this Master Plan and is reported on in section 11.

The need for dredging in the Kulti River to accommodate the continuing discharge from the Kolkata outfall canals - a major issue in flood proofing of the city - requires further detailed study and cost estimation.

Institutional Issues

Kolkata Corporation

The Constitution (74th) Amendment Act provides the KMPC to prepare a development plan for the larger metropolitan area. (Vision 2025).Each municipal body within the larger area will need to prepare short-term and long-term development plans.

There should be clear provision within the KMC Act conferring the responsibility of preparing development plans for the city on KMC. The responsibility for land use and development control should also be given to KMC.

Traditionally, KMC employed a large number of unskilled staff for the purposes of sewerage and drainage maintenance. A major 0&M issue has arisen with a directive from KMC management placing a ceiling on labour recruitment (hence freezing of manual

labour engagement); also, there is the recent directive from the Supreme Court that unskilled labourers should not be used for the removal of silt from sewers by manual means. Thus, henceforward sewer desilting will have to be undertaken primarily by mechanical means. KMC have only 10 jetting machine trucks; so, more need to be purchased for sewer desilting.

Due to division of work, KMC (Hd. Qtr.) is responsible for sewer maintenance for sewers greater than 600mm dia., and the Boroughs for sewers less than 600 mm dia. There are problems of coordination due to this sort of division of responsibility.

State I&W Department

There have been no overflows from canals within the KMC area. However at the moment the canals are not being maintained regularly. Water hyacinth should be dredged and removed from canals at the time of hyacinth growth and before the onset of the monsoon each year to improve canal carrying capacity. Every year there should be a post - monsoon survey of the canals at the same place each year to assess the amount of siltation. Repair of the flap shutters and sluice gates at the Ghushigata lock gates is required urgently. Land use is changing on the banks of the canal, the storm water and wastewater flow is therefore increasing and the smaller channels have inadequate capacity.

The Kulti River is considered to have adequate capacity for drainage discharge based on cross sections and observations of I&WD staff since the 1950s. The environmental condition of the Kulti River at the outlet sight is poor.

It is accepted by l&WD that there is a paucity of funds for canal maintenance. Standing arrangements need to be worked out to ensure functional coordination between the staff of I&W Department and the KMC's concerned departmental staff, particularly before the onset of monsoon every year.

Kolkata Metropolitan Development Authority

KMDA has broad responsibility over the entire KMA area for urban planning, urban drainage, transportation and the Ganges Action Plan (GAP) sewer construction system. Its activities within the study area of the KMC area are currently limited to maintenance of assets created earlier and some GAP Phase II work. Within the KMC area the GAP Phase I works are completed and were located in Borough I at Kestopur area and in Borough XV in South Suburban East and Garden Reach Service areas. The GAP Phase II system within KMC area is currently under construction and involves the construction of interceptor sewers on the north bank of Tolly's Nullah and discharge

to the KMC trunk sewer system. There is also work underway as part of GAP Phase II at the Circular Canal. A problem is the low number of households actually joining onto a newly constructed sewerage schemes. KMDA trunk sewer assets within KMC area are currently being transferred to KMC. Since KMDA functions now as the technical secretariat of the KMPC, any worthwhile flood mitigation plan of the KMC, both technically and financially, needs to be integrated with the planning and executing responsibilities of the KMDA.

The KMWSA, now functioning within the overall umbrella of the KMDA, is charged with the responsibility of construction and operation of water supply and sewerage systems outside the core KMC area. A key issue for KMWSA was the clarification of responsibilities for an improvement in the maintenance of the canal outfall system. This problem needs to be worked out in consultation with the State's I&W Department.

Long Term Goals

The following section sets out a list of goals that should be aimed for in 30 years time. These goals arise from the list of issues set out above and, if implemented, would result in an efficient and modern sewerage and drainage system for Kolkata with much-reduced flooding incidence in the core area of the city.

Integrated Urban Renewal

A very high priority for Kolkata is seen as an improvement in the system of sewerage and drainage planning and the links it has to urban planning in general.

Difficulties encountered in the implementation of the KEIP project in the Added Areas - e.g. 2 m dia sewer being laid in 4 m wide road - point to the difficulties of constructing sewer networks in highly congested, unplanned neighbourhoods.

To really improve the standard of sewerage and drainage in Kolkata a more comprehensive approach to planning and utilities is desirable, encompassing all urban services including roads, traffic, water supply, electricity, telecommunications, public space, green areas, sewerage systems etc.

The urban plan would include off- channel storage areas for storm water which would be used to confine any flooding in the monsoon to particular open areas- which could otherwise be used as parks or playing fields for example.

An integrated urban planning approach is required based on an updated urban plan. This would result in real upgrades of entire areas and with it an increase in land and housing values and increased revenue from property taxes.

Particular urban planning goals include the following:

- Integrated urban renewal approach
- Land Use plan to be prepared for KMC area and updated regularly
- Review of the KMC Act
- New regulations to be promulgated for wastewater disposal from new houses and high rise apartments, to include on site treatment for new high rise apartments if necessary
- Industrial premises to be required by regulation to have on-site treatment of wastewater as part of an KMC-wide Industrial Pollution Control Action Plan
- Separate sewerage systems should be planned in new areas as part of integrated planning of transportation, water supply, sewerage, gas, electricity, telecommunications etc
- Town planning is required to incorporate off-channel storm water storage in basins to attenuate storm flow peaks

Sewerage System

The goals for the sewerage system are primarily to attend to deferred desilting and maintenance of the trunk sewer system, and once the backlog of desilting has been cleared to implement a regular system of sewer maintenance. An additional important goal is the alleviation of flooding in the monsoon, particularly in the CBD area of the Town Basin.

Particular sewerage system goals include the following:

Desilting of Trunk Sewers

- Desilting of the trunk sewer system undertaken by specialist contractors using specialist vacuum trucks
- Backlog of desilting work to be undertaken by coordinated approach by the letting of a number of contracts to run concurrently
- Once sewers are desilted, regular sewer maintenance programme to be instituted to keep them desilted

Alleviation of Waterlogging

- Alleviation of waterlogging in the core area, by specific measures at identified locations
- Increase number of catch pits and gully pits and improve the process of storm water entry to sewers.

- Sluice Gate Structure to be constructed across Tolly's Nullah at Hastings. These sluice gates to be closed in the monsoon against tidal lock to aid drainage to Tolly's Nullah

Construction of additional trunk sewers

- From hydraulic modelling, construction of additional trunk sewers in areas where hydraulic modelling shows existing capacity is insufficient.

Extend Sewerage System to Unsewered areas

- Extension of sewerage system areas to areas currently unsewered or not covered by KEIP Phase 1. These additional sewerage systems would be constructed mainly in Added Areas Boroughs I and Xl-XV but also in Boroughs IX and X.

Storm Water Drainage

Particular storm water drainage goals include the following:

- Separation of DWF and SWF achieved over entire KMC area
- Peak storm flows in monsoon to be accommodated by discharging SWF to Tolly's Nullah and River Hooghly
- Off channel storm water storage and attenuation basins to be included in system design

Pumping Stations

The pumping stations are old and inefficient and have a history of breakdowns. Pump station upgrades will increase their efficiency and reduce the energy cost.

The recommended approach is for complete rehabilitation, including upgrades for all mechanical equipment, improvements in electrical, control and ventilation systems and general repair of the pump station structures.

Particular pump station upgrade goals include the following:

- Complete pump station upgradation, including electrical upgradation
- Introduction of latest synchronization system (SCADA system) to improve pump station and sluice gate operation coordination.
- Separation of DWF and SWF as part of pump station upgradation.
- Construction of deep pump sumps at major pump stations to aid in improving trunk sewer hydraulics and in desilting inlet sewers
- Installation of mechanically raked screens at all pump stations
- Sustainable system of maintenance introduced at all pump stations

Canals

The hydraulic capacity of the outfall canal system has been reduced due to siltation and deposition of solid waste. Due to a paucity of funds, periodic maintenance is not undertaken. Siltation of canals leads to reduction in hydraulic capacity. Control structures, sluice gates and outlet structures on the canals have not been maintained. Canal banks have been encroached by informal dwellings. The budgets for canal maintenance are inadequate. Adjoining municipalities also used the canal system for discharging wastewater and the responsibility for improving re outfall canals is not only KMC's.

Particular outfall canal goals include the following:

- Implementation of an institutional arrangement which guarantees the outfall canals are regularly maintained for all municipalities using them in the future
- Canal desilting programme
- Setting up of an O&M system to ensure that canals are regularly maintained in the future
- Rehabilitation of sluice gates and lock gates
- Resettlement of informal dwellers living on canal banks
- The DWF and SWF canals separated and not mixing together upstream of Bantala Lock
- Review of need for dredging of Kulti River
- Receiving water discharge standards to Surface Waters set by the Central Pollution Control Board fully complied with
- Industrial wastewater discharges must be either controlled at their source or provision made at a central treatment facility to accept such wastewater.

Private Sector Participation

A few examples in this context are:

- Sewer maintenance including desilting sewers.
- Canal desilting and dredging.
- Residuals removal from pump stations (screenings) and sewage treatment plants (sludge, screenings).
- Pump Station Electrical Maintenance.
- Pump Station SCADA Instrumentation Maintenance.
- Independent Water and Sewerage Authority set up, independent of KMC.
- Engineering Design and Construction Supervision.
- Client/Consultant partnership in undertaking projects and sharing risk (of The New Engineering Contract, Institution of Civil Engineers, UK).

Mayor's Vision

At the height of the latest flood in June-July, 2007, the Mayor of KMC, faced by severe media criticism and public outcry, had come out with an unusually candid and detailed explanation of the city's recurring annual floods along with suggested concrete measures to mitigate (not eliminate) flood havoc to give the citizens much sought after relief. The following excerpts from the Mayor's article published in an important local daily (Anandabazar Patrika, July 17 and 18, 2007) reveal as much his anxiety as his determination to save the city from the annual deluge:

The upshot of Mayor's argument is: On one side is the unprecedented, huge rainfall and on the other is the city's choked drainage system. Since the British days, the combined drainage system has been such that domestic sewers and rainwater are drained through different sizes of pipes into outfall channels via a number of pumping stations. The brick sewers are of two types - man entry sewers and non-man entry sewers. As the name suggests, the former used to be cleaned by 'man', and the latter by natural flooding during high tide of the river Ganges. For the last several decades, the humdrum task of regular cleaning of these sewers has somehow not received the attention it deserves. Successive surveys have revealed that through years of sedimentation the 'man entry' brick sewers - the lifeblood of the city - have virtually turned into solid impervious stone slabs. As regards the non-man entry sewers, steady loss of navigability of the River over the years and appearance of sand bars have rendered the old process of natural flooding of these sewers inoperable.

As the Mayor has written, on emergency basis the KMC engineers have visited cities like Mumbai and Delhi, as also some of the cities of South-East Asia, to see at first hand the advanced system of 'micro-tunnelling'. Detailed project report has since been prepared and submitted to the Government of India for approval. This would cost nearly Rs.5oo crores. The project is now under implementation in phases. To quote the Mayor, "We have now embarked upon working out a fundamental solution - an exceedingly difficult task where every body's help is needed."

Commenting on the problem of the 'added areas', the Mayor has said, "Contrasted with the old city, the newly added areas have hardly any drainage structure. Starting from Cossipore in the North (Ward Nos. 1-6) and the extensive areas of Garden Reach-Behala-Jadavpur in the South, at no point of time there has been any planning and construction of durable structure of drainage and sewerage for them. After a great deal of thought, the State Government and the KMC have jointly launched the Rs. 2000-crore project called the KEIP (Kolkata Environmental Improvement Project) with loan fund from the Asian Development Bank. The project has been under implementation for the last one and a half years".

Referring to problem of the drainage outfalls, the Mayor observes that the city's sewers and storm water drain out to two main outfalls: the river Ganges in the west and Bidyadhari in the north. Regarding the main canals at the south-west fringes of the city - Tolly's Nallah, Monikhal, Bagor khal, Churial Khal etc., his observation is that the reason why Behala gets flooded during the monsoon is due to the fact that all these canals are then in spate. Similar is the situation with the river Ganges. To make things worse, during high tide the river water rushes into the canals and the neighbouring areas. There is back flow of water from the pumping stations. The story is much the same with the canals at the eastern fringes of the city - Tollygunge-Panchannagram Canal, Bhangor Katakhal, Kestopur Canal, Bagjola Canal etc.

The role of these canals in managing urban floods in Kolkata is of crucial importance. These canals are looked after by the Irrigation and Waterways Department of the State Government. Hence, the Mayor has taken up the issue of desilting and excavation of these canals with the concerned Minister of the Department as well as the engineers of the Department. For this purpose, a substantial amount - Rs. 200 crores - has been allocated, and the work has just commenced.

The Mayor has made special mention of the East Kolkata wetlands in this context, which he has likened to the 'kidney' of the city. As he has rightly pointed out, most of city's sewerage flows through the wetlands and drains out to Kulti-Bidyadhari Gang. Since the 1950s, as the Mayor makes a caustic remark, 'there has been a lot of torture on the wetlands in the name of spread of civilization'! Currently, however, steps have been taken to save the wetlands (now declared as a Ramsar Site) in the interest of wider environmental considerations.

Acknowledging the gravity of the problem, alongside the big investments, provision has been made for phased desilting of the sewer pipes throughout the year out of the limited revenue budget of the KMC.

As the Mayor concludes, 'spending Rs. 2,500 crores is a huge and time-consuming task. It will take quite some time to see results flowing from these investments.

Action Plan Under Execution

Meanwhile, multi-pronged ameliorative measures have been planned, and these are already under execution at selected sites. To the great relief of the citizens of Kolkata, quite a few areas have since been made relatively free of water-logging through planned and appropriate interventions. These areas are:

Borough VI: Junction of APC Road & S. N. Banerjee Road - new sewer along S. N. Banerjee Road leading to Circular Road, Brick sewer laid including construction of additional gullypits

Borough VI: Free School Street in front of Fire Brigade to Market Street - Existing brick sewer reconstructed enhancing capacity, and hard silt within brick sewer (80% silted) removed successfully. Also, additional gullypits constructed

Borough VII: Circus Avenue and Lower Range - existing sewer on Circus Avenue leading to new Park Street - brick sewer was damaged during construction of AJC Bose Road flyover. Difference of invert level between lateral sewer on Lower Range and invert of new sewer laid by HRBC (flyover construction agency). New sewer now laid along Circus Avenue leading to sewer at Shakespeare Avenue

Borough VII, Ward 66: Swinhoe Lane & Adjoing Areas - New drainage system developed on Swinhoe Lane leading to BDPS. Originally, drainage system was leading to TP Channel through DD-I Canal, causing water logging for a longer period

Borough VIII: Southern Avenue & Adjoining Areas - New lifting pumping stations commissioned beside Nazrul Stadium to cater to storm water on Southern Avenue & adjoining areas - same being discharged in Tolly's Nullah.

Besides these interventions, KMC has been able to access the JNNURM fund recently and this has greatly facilitated KMC's longer term planning to ameliorate the flood situation at critical locations in the city. A list of such areas (other areas are being taken up in phased manner) along with planned measures to bring relief is presented below:

Project Sites and Ameliorative Measures

- Suddar Street: Rehabilitation of non-man entry Brick Sewer
- Kyd Street: : Rehabilitation of non-man entry Brick Sewer
- Free School Street Part-A: Rehabilitation of non-man entry Brick Sewer
- Free School Street Part-B: Rehabilitation of non-man entry Brick Sewer
- Free School Street Part-C: Rehabilitation of non-man entry Brick Sewer
- Jhawtolla Road: Rehabilitation of non-man entry Brick Sewer
- Samsul Huda Road: Rehabilitation of non-man entry Brick Sewer
- Baker Road: Rehabilitation of non-man entry Brick Sewer
- Gopal Nagar Road: Rehabilitation of non-man entry Brick Sewer
- Mominpur Road: Rehabilitation of non-man entry Brick Sewer
- Dehi Srirampur Road: Rehabilitation of non-man entry Brick Sewer
- Dehi Srirampur Part-A Road: Rehabilitation of non-man entry Brick Sewer
- Gora Chand Road Part-B: Rehabilitation of non-man entry Brick Sewer

Other measures under implementation are (a) canal desiltation to improve the outfall system, (b) survey and planned maintenance of water bodies within KMC area,

(c) planned improvement of the pumping stations including new constructions, (d) strengthening Borough administration to enhance its capacity to cope with local level ameliorative measures, and (e) strengthening of KMC's planning function to ensure coordinated approach (as against stand alone approach) to floods mitigation.

The Way Ahead

Kolkata, as can be surmised from the elaborate presentation above, has a very extensive and complicated drainage system, a chain of pumping stations and an age-old outfall system. Hence the technical aspects of floods mitigation are of formidable nature. These need to be scientifically studied, and the situation needs to be constantly watched for timely upgradation. It is not merely KMC that has to look after the system; it is a whole network involving the KMC, Government departments, parastatal organizations and even private agencies.

On the planning front, floods mitigation and city planning need to be dovetailed to evolve an integrated vision and action plan. It has been our experience that intensity of flooding has a certain relationship with 'unplanned' growth of the city under situations of tremendous demographic pressure. Two of the familiar responses, have been to permit house building activities without much thought to zoning and land use regulations, and the sprouting of unregulated squatter settlements in any area of the city, particularly in the low-lying areas. As the Calcutta experience bears this out clearly, the first phenomenon - the real estate boom - increases the housing stock no doubt but in most cases at the cost of the urban environment especially the urban open spaces, the water bodies and the greeneries. As regards the squatter settlements, these unplanned growths along rail lines and canals, and in the midst of low-lying areas create sanitation hazards and act as barriers to natural egress of storm water flow. Structures that come up haphazardly encroach on the flood plain. Unplanned land use and other human activities influence the peak discharge of floods by modifying how rainwater is stored on and run off the land surface into streams and low lying areas. The permeable soil is replaced by impermeable surfaces such as roads, roofs, parking lots and side walks that store little water, reduce infiltration of water into the ground, and accelerate run off to ditches and streams.

Under these circumstances, it is now dawning on the planners and policy makers and urban managers that what is needed is an integrated and comprehensive urban planning and not just the conventional ad hoc fire-fighting approach. Coping with urban flood has to be integrated with the overall planned development effort as in the case of the nationally sponsored JNNURM for the large mission cities. As the upgradation plan for city's infrastructure is taken up and the urban poor are assured of

improved access to urban civic services and a decent livelihood, such planned efforts must take into account the flood hazards that need to be mitigated and removed within the broader framework of comprehensive planned city development. Special mention needs to be made in this context of 'urban water harvesting plan' which is now being strongly advocated in many cities for flood proofing as well as water retention for drinking, fire-fighting and other urban water uses.

Based on weather forecasting data and information by the meteorology department, a fairly precise early warning system on flood occurrence can be developed. Such a system would be alerting the municipal authority including the citizens of the relatively vulnerable areas in the city so that the municipal organization and the citizens might be put on high alert about the impending heavy showers and consequent flooding of specific localities. From this point of view, intra-municipal communication system is as important as municipality-citizen communication.

As things stand now, KMC has prepared a comprehensive floods mitigation plan that has to be steadily implemented in a phased manner and monitored under close supervision. Alongside these measures, KMC has to develop mechanisms to involve the citizens in floods mitigation planning and implementation. This would call forth a full-throated effort to invigorate the 'ward committees' that have so far remained either moribund or non-existent. Particularly, the worst sufferers - the bustee dwellers - need to be organised and made conscious of their own innate strength to combat flood ravages. SJSRY set-up may be mobilised and tied up with KMC's disaster management plan for the purpose with appropriate training and resources support. Popular participation, particularly the participation of the poor and the marginalized, has not so far been a strong point of the KMC.

Select References

A. *Official Reports*

i) Sewerage and Drainage, Vol. I, Draft Final Report; Project Preparation Studies for Calcutta Water Supply, Sewerage and Drainage Projects; World Bank Project No. P-050648, June 2001.

ii) Vision 2025: Perspective Plan of CMA, CMDA, December 2005. (Calcutta Metropolitan Development Authority has prepared quite a few technical reports on drainage and sewerage, and solid waste management for the entire Calcutta Metropolitan Area including KMC).

iii) Plan for Development of Kolkata Municipal Corporation Area - 2025, Report Series II, March 2007, Bengal Engineering and Science University, Shibpur.

iv) Calcutta Environment Improvement Project Part A: Sewerage and Drainage Final Report, January 2000.

v) Calcutta Environment Improvement Project Part B: Solid Waste Management Final Report, January 2000.

vi) Draft Sewerage and Drainage Master Plan for Kolkata City: Volume I - Main Report; Volume II - Appendices; and Addendum Report, Kolkata Environmental Improvement Project, Project Management Unit, Kolkata Municipal Corporation, May 2007.

B. Books and Conference Reports

i) Saswati Mookherjee, 'Problems of Waterlogging in Calcutta', in Subhasranjan Basu (ed.), Changing Environmental Scenario of the Indian Subcontinent, acb Publications, Calcutta 2002.

ii) Andras Szollosi-Nagy and Chris Zevinbergen, Urban Flood Management, Taylor and Francis, 2004.
iii) Janathan Parkinson and Ole Mark, Urban Stormwater Management in Developing Countries, IWA Publishing, London, 2005.
iv) Elena Nikitina, 'Flood Risk Reduction: Some Lessons Learned Across Countries, paper (unpublished) presented at the Workshop on 'Science and Practice of Flood Disaster Management in Urbanized Monsoon Asia, Chiangmai, 4-5 April, 2005
v) Disaster Management in India - A Status Report, National Disaster Management Division, Ministry of Home Affairs, Government of India, August 2004.
vi) Ivan Andjelkovic, Guidelines on Non-structural Measures in Urban Flood Management, IHP-V, Technical Documents in Hydrology, No. 50, UNESCO, Paris, 2001.

C. Newspapers and other local sources
i) Important local newspapers publish flood reports and articles on different aspects of flood. Some of the Calcutta Dailies consulted are: Ananda Bazar Patrika, The Telegraph, The Statesman, and the Times of India.
ii) A valuable data source is Kolkata Municipal Corporation's daily reports on the city's flood situation. KMC's pumping stations maintain rainfall data of their operational zones.