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# WATERLOGGING AND ISSUES RELATING TO DRAINAGE IN CALCUTTA METROPOLITAN DISTRICT

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ABSTRACT

The present paper considers one of the vital issues of Calcutta's civic life, namely, the problem of waterlogging during the monsoon months. In this context the paper discusses various aspects of sewerage and drainage system in the city, including the technological choices confronting a programme of sewerage and drainage development. Further, the paper looks at the specific problems of the municipalities other than the Calcutta city in the Calcutta Metropolitan District.

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# WATERLOGGING AND ISSUES RELATING TO DRAINAGE IN CMD

Arpita Bhattacharyya

## I. INTRODUCTION

The phenomenal floods of 1986 once again exposed the inadequacies of the sewerage and drainage system of the city of Calcutta. Initially designed to serve a population of one million people over an area of 40 sq. km.[1] the sewer system now has to take a load of over 4.1 million people[2] in an inhabited area of 188 sq. km.[3] Consequently, practically every year, during the rainy season, the sewer system fails and, the city for a time takes the appearance of a Venice of the East though without its gondolas and domic arches.

Calcutta is largely served by a combined sewerage and drainage system which is more than one hundred years old. Though, since 1947, the city has experienced a massive population explosion with the influx of the refugees from East Pakistan, the sewer system has not been suitably expanded. The virtual collapse of the major trunk sewers along Rashbehari Avenue and Rafi Ahmed Kidwai Road bears evidence to the gross overuse of the existing sewerage and drainage system of the city. To make matters worse, the existing underground sewer system and the outfall system serving the city of Calcutta are gradually silting up. Furthermore, the inefficient operation of the pumping stations, largely due to power failure and mechanical faults, has also resulted in serious drainage congestion in the CMD areas. The random filling up of the wetlands in the fringe areas of eastern Calcutta is another factor that has aggravated the problems of removal of storm water from the city roads.

The city of Calcutta, comprising 141 'wards', covers the three amalgamated municipalities of Jadavpur, South Suburban, and Garden Reach and an area of 188 sq. km. The underground drainage and sewerage facilities, available in the city basin, cover an area of 72 sq. km.[4] which shows that the sewer coverage is far from comprehensive. (The total length of arterial network ranging from 6" diameter sewer line to 2' diameter sewer line is about 720 km.[5] Trunk sewer line above 2' diameter to 20' x 15' 3" special section sewers are about 170 km.[6])

A major problem with the removal of storm water in the Calcutta Metropolitan District (CMD) is the topographical characteristics of this area, which affords very little scope for drainage by natural means and thus necessitates the deployment of pumps. Of the 17 Drainage Pumping Stations[7], 3 are giant stations with an aggregate capacity of about 32 million gallons per hour[8]. The effluent, having been pumped out, is disposed off gravitationally into the outfall channels and ultimately in to the river Kulti. The total length of the outfall channels (open canals) is about 144 km.[9] In addition, there are 280 km. of other types of open channels, known as 'Nikashis'[10].

In this paper, we are attempting an indepth analysis of the sewerage and drainage situation in the Calcutta Metropolitan Area (CMA) of which the Calcutta Municipal Corporation (CMC) is a part.

In Section-II, we provide a historical outline of the development of the sewerage and drainage system in the city of Calcutta. It shows that the greater part of the construction work in this field was undertaken for

a much smaller population during the British colonial period; but the system is now grossly out of date; and the work done by C.M.D.A. and various other agencies has not brought about any significant change in the conditions.

In Section-III we are looking at the vital issue of water-logging which prompts our concern for an efficient sewerage and drainage system. It points out that such water-logging is not due to the overcharging of the sewers, nor is it a fact that the chronic water-logging is endemic in low-lying areas. Geomorphological conditions, construction of houses, roads and railways in low-lying areas without awareness of the drainage problems these create and bad maintenance are some of the major causes behind water-logging, according to us.

In Section-IV we examine some of the technological choices confronting a programme of sewerage and drainage development. These include the questions, whether a separate system would be built for storm water, whether an open sewer is desirable as opposed to underground systems and whether closed-circuit television should be introduced for monitoring the flow of sewers.

In Section-V we examine the supporting systems of drainage channels and pumping stations, and conclude that while the former is badly silted the latter is operating inefficiently, particularly at the time of heavy flooding.

In Section-VI we look at the specific problems of the municipalities other than Calcutta in the Calcutta Metropolitan Development Area. Here too some of the common problems and issues emerge.

Lastly, in Section-VII, we bring the conclusions together and examine their policy implications.

## II. A BRIEF HISTORICAL BACKGROUND

Even though Calcutta was established as early as in 1690 it was only around 1803[11] that Lord Wellesly first noticed the unhygenic conditions of the city. Eventually, a committee was set up around 1840[12], known as the Fider Hospital Committee, which prepared a drainage plan for the city, but its approval was delayed until early 1855[13]. The present sewerage and drainage system of Calcutta has been constructed in three distinct phases, supplemented later by several implementing agencies such as Calcutta Improvement Trust (CIT), Calcutta Metropolitan Water and Sanitation Authority (CMWSA), Calcutta Metropolitan Development Authority (CMDA) etc.

It was according to Clarke's Sewerage Plan of 1855 that the pumping station at Palmers Bridge was constructed (18.5 causes)[14]. Though the construction work started around 1859[15], the plan underwent certain modifications and by 1896, 7.5 sq. mile[16] area was served by sewerage and drainage systems. This system was known as the Town System. The second phase of the work started with the advancement of urbanisation southwards. The Baldwin-Latham Plan was prepared in 1896 for 12.5 sq. miles area[17] of the Southern region, and accepted in 1897[18] after some revisions. The remodelled plan, named as Sewerage Plan and Bantola outfall plan, proposed : (a) increased capacity of Palmers Bridge, (b) construction of a new pumping station at Ballygunge, (c) construction of high level sewers from the pumping stations to Topsia

and (d) construction of storm water drains from both Town and Suburban systems upto Bantala. From Bantala the ultimate outfall was named the River Bidyadhari. The construction work was completed in 1906[19].

The third phase was started in 1925[20], following the deterioration of the condition of BIDYADHARI outfall. The new plan prepared by Dr. B.N. Dey and known as Dr. Dey's Outfall and Internal Drainage Scheme recommended the construction of dry weather flow and storm water flow channels from Bantala upto river Kulti 17 miles away, as also construction of two sedimentation tanks at Bantala. The plan was sanctioned in 1935 and construction work was completed in 1943[21].

The main outfall or the primary outfall - for Calcutta Corporation Area and that portion of the Calcutta Metropolitan District area which is located on the east of river Hooghly - happens to be the river Kulti gung which is a distributory of the river Hooghly and joins the Bay of Bengal at the Raimangal estuary. The Hooghly river serves as an outfall for a small area of the Calcutta Corporation and for those areas of the Calcutta Metropolitan District which are located on the West of the river Hooghly. Both the rivers are tidal in nature.

After 1943, the most significant planning effort in the field of sewerage and drainage was made in the 1960's - the result of which was the Master Plan for water supply and sewerage and drainage for Calcutta Metropolitan District published in 1966. Following the widespread occurance of malaria, cholera and other diseases a need was felt for an immediate improvement of sewerage and drainage system in the Calcutta Metropolitan District

Area. Consequently, the World Health Organisation (WHO), requested by the Government of India, undertook to prepare an Engineering Report on water supply and sewerage and drainage for Calcutta Metropolitan District. The outcome of this endeavour was the completed Master Plan, which was published in the summer of 1966.

The Master Plan divided C.M.D. into 23 drainage basins and 18 sewerage zones, taking into account their relative importance. Subsequent proposals of the WHO team covered the following sewerage zones : Calcutta, Dum Dum, Chandannagar, Konnagar, Maniktala, Tollygunge, Howrah, Khardah, Garden Reach, and Northern Salt Lake, which, together, contain more than 75% of the present population of C.M.D.[22] Among the drainage basins the Master Plan considered the following as the most important : Tollygunge, Northern Salt Lake, Howrah, Konnagar, Maniktala, Manikhali, Calcutta, Bagjola, Khardah, Tolly Nullah.

The Master Plan proposed 30 different improvement works for Calcutta city proper, at an estimated cost of Rs. 21.47 million. These were gradually taken up by C.M.D.A., C.M.W.S.A., Irrigation and Waterways Department and other implementing agencies, but it was soon realized that the proposals were over-ambitious and could not be fully implemented due to financial constraints. The balance-sheet of progresses on the 36 specific recommendations of the Master Plan is as follows : only one has been fully completed, three more have been partly done and work on ten to twenty recommendations has been completed between 10% and 50%, while 12 or 13 of the recommendations have been left totally untouched. As for the Suburban System and the Town System of the city hardly 60% and 40% of the

work, respectively, has been completed till today[23]. Subsequently, the C.M.D.A. authorities appointed consultants to revise the Master Plan proposals and make new, more realistic, recommendations. These reports were published in 1982, but so far there has been no thorough appraisal of these reports.

## III. THE ISSUE OF WATERLOGGING

The citizens of Calcutta for many years now have been harassed and tormented by the problem of waterlogging. Though much hue and cry has been repeatedly raised over this issue, this has not led to any qualitative improvement in the conditions over the past four decades. The causes for such persistent waterlogging are numerous, while the adverse impact of waterlogging on the economic, social and cultural life of the city is extensive.

However, despite the numerous adverse effects of waterlogging hardly any attempt has been made to estimate the social cost of this phenomenon; some of whose constituents are as follows : (a) mandays lost due to ill-health following waterlogging (malaria, dysentry, fever, etc.), (b) mandays lost due to low attendance in offices and other work places, (c) road damage and the consequential maintenance cost, (d) disruption of telecommunication linkages causing loss of production, (e) loss of trade is especially severe when the water logged areas happen to be major marketing centres, and (f) loss of earning of workers on daily wage. Some of the losses might be compensated but not others, e.g. the lost earnings of street vendors selling food items or traders selling perishable goods. Our list is far from exhaustive : but it gives some idea of the difficulties that arise from waterlogging.

The problem of waterlogging generally arises during the months of July, August and September as also the last week of June. During the last decade three major floods occurred in September 1978, June 1984 and September 1986. The 1978 storm recorded a rainfall of 700 mm in a period of three days with a maximum rainfall of 369.6 mm occurring in one day, 150 mm of which fell within three hours. In 1984 also the storm rainfall was of similar order[24]. From the experiences of the 1978 and 1986 floods it can be said that the floods occurring in the month September were more extensive and persistent as September marks the end of monsoon period when the water level in the outfall channels naturally rules very high. Compared to this heavy downpour the underground sewerage system of Calcutta is designed only for a runoff of six milimetre per hour, i.e., 150 mm per day[25]. It should be categorically admitted that even with the best sewerage and drainage system of the world, waterlogging can not be avoided in cases of such exceptionally high rainfall. However, waterlogging characterises the life in Calcutta even in years when the downpour is much less; and for a variety of reasons.

One major explanation lies in the natural terrain conditions defined by the geomorphological and geological features. The general flatness of the terrain in the deltaic region renders it susceptible to waterlogging, especially after heavy rains. The bowl-shaped depression of the inter-distributory marshes are particularly susceptible to inundation. Further, the slope of the land being away from the main drainage channel, the Hooghly, seems to have aided the waterlogging problem. While the elevation of the western part on the river bank is about 6.0 metres, it comes down to 1.5 metres on the eastern fringe.

No less important are the man-made causes of waterlogging, mainly construction activities in marshy areas, which obstruct the free flow of water. Of all these man-made obstructions the most damaging in its effect has been the reclamation of marshy lands lying on the extreme eastern side of the CMD area. We have already mentioned that the general slope of the land is away from the river on the west towards the east. Previously this eastern fringe was dotted with frequently spaced inter-distributory marshes, which had the capacity to hold the rain water run off from the city proper. Reclamation of 12 sq. km. area of the original 48 sq. km. area of the great Salt Lake for the development of the Salt Lake township has, besides other things, caused reduction of a quarter of the area of surface run off from Calcutta city proper[26]. The shrinkage in surface area, in turn, has increased the depth of stagnating water and hence the risk of flodding even of areas at higher level, thereby exerting a great pressure on the drainage channels. These reclamations, coupled with embankments of roads, have also caused near-perpetual waterlogging problem at many places on the eastern fringe.

Traditionally, reclamation for building site is done by raising the ground level by filling with locally extracted earth material. The extraction results in the formation of a tank which serves as a small reservoir of water after rainfall. But now, studies in some low lying areas such as Bagha Jatin Colony, Garia, and other areas reveal that the pressure for space has resulted in the filling up of those very water tanks, which, has led to a decline in local reservoir of water and an increase in surface runoff. The roads and railway embankments hinder

easy flow of surface water, which, in turn, causes deterioration and silting of the drainage channels. In some cases, discharging of the organic effluents also led to a quick silting up of channels; for example, the discharge of cowdung from Haringhata farm has choked a part of Jamuna river and the Mathura Bil located on the east of Gayeshpur. Discharge of municipal sewage also leads to channel congestion.

Urbanization has led to the encroachment of the low lying marshes easily prone to waterlogging. Efforts to drain out the water along canals becomes difficult because of their limited capacity compared to the large amount of water accumulated. Moreover, subsurface drains, being old, also prove incapable of accommodating the larger volume of surface runoff following urban growth.

Waterlogging in the areas west of the Hooghly river is largely a consequence of unplanned road and rail construction which generally accompanies urban development. The municipalities most affected by waterlogging on the west of the Hooghly river channel are as follows : Chinsurah-Hooghly, Chandannagar, Champdani, Serampore, Rishra and Konnagar. Many rail tracks traverse the area accompanied by a dense network of roads. These roads and rail tracks are usually laid along embankments in the low lying marshy areas. The embankments are usually provided with culverts when they cross the deepest part of the depression or active/agraded courses. These openings however do not provide adequate space for draining the water accumulating after very heavy rains. These structures thus primarily create impediments to the flow of water and consequently cause stagnation to some extent. Both the National Highways leading to Bombay and Delhi traversing the Barajala and

the Dankuni marshes hinder the flow of water from the high ground in the east to the central part of the depression to the west. Similar problems also arise on the other side of the river. The newly constructed Barrackpore-Kalyani Express Highway and the Eastern Metropolitan Bypass which is extended in the north-south direction cut accross the general slope of the land from west to east. Although these structures are provided with a large number of openings to accommodate the flowing water, during heavy storm these stretches do cause significant volumes of water to stagnate on the side with higher elevation.

Embankments associated with railway tracks, running parallel to both of the levees of the Hooghly river, cut across the slope of these levees and thus the surface runoff flowing down to the corresponding inter-distributory marshes. Low lying spots close to the railway tracks thus get waterlogged, e.g., in Konnagar, Hind Motor, Loharpara, Bandel, and New Barrackpore. In many places in these areas the network of road and railway embankments forms traingular, four-sided or semi-circular enclosures where water stagnate after a heavy rainfall, e.g., marshy areas west and north-west of Bali and the area south of Kona Khalia and Dasnagar. Embankments of road and railway tracks are also associated with narrow linear depression of barrow-pits by their sides. The barrow-pits themselves form points of easy waterlogging as observed near Chinsurah, New Barrackpore, west Bally, and Dankuni marsh.

In the city of Calcutta and some other municipalities it has been observed that continuous extraction of ground water for meeting demand in a densely populated areas may lead to land subsidence which follows drop in the water table. The depression caused by such land

subsidence naturally gives rise to the problem of waterlogging in these areas. A table showing depressed ground levels in certain areas of CMD is given in the Appendix.

For Calcutta city proper it can be said that the entire sewerage and drainage system has been much damaged by the construction of the metro-railways. The construction of the metro railways has led to the disconnection of sewer lines from the trunk sewers, thus causing water overflows and unhygenic conditions in many places. More on the issue of metro railways would be discussed in another part of this section.

While these are some of the major factors contributing to waterlogging in Calcutta, and many other parts of the CMD area, it can be categorically stated that waterlogging problem is no less a consequence of lack of proper maintenance of the already existing system.

Improper maintenance of the existing system has led to the silting up of the existing sewer system serving the city of Calcutta. Certain estimates maintain that even after a desiltation drive carried out from 1977 to about 1982 the volume of silt in the Calcutta sewer system is almost about 1/3rd of the volume of the sewer system as a whole[27]. It is largely due to the negligence of the authorities concerned with the maintenance of the system, that the problem of siltation has assumed such vast proportions.

Calcutta city has a dual water supply system. A filtered water system for domestic uses, and an unfiltered system for the purposes of flushing water closet, street washing and fire fighting. As all the waste water has to be conveyed through the same (combined) sewer system a considerable amount of silt carried by the unfiltered water

system reaches the sewer in addition to normal solids from sewege and other household liquid wastes.

The traditional system of clearing Calcutta sewers has been by manual labour operating mostly during the night. This system which had proved to be reasonably successful could not be continued during the Second World War and has been discontinued since. Manual cleansing during the day is both hazardous and inefficient; as a result accumulation of substantial silt in the sewerage system has taken place and continues even today. The quantity of silt accumulated in the sewer network comprising of 100 miles of brick sewer and 325 miles of pipe sewers has been estimated at 21.25 lakhs cubic feet ten years back[28]. It was also estimated that the annual volume of silt deposition was about 0.015 million cu. ft. per year[29]. In order to derive the maximum benefits from the existing system augmented by proposed relief works it was felt the existing system had to be renewed to its original capacity through a rapid desiltation programme.

Mechanisation was introduced for desiltation by CMDA way back in 1973[30]. The machines procured by CMDA were some pulling power bucket machines, power prodding machines, high pressure water jetting machines etc. These were handed over to the Corporation which failed to make proper use of those. CMDA however took back the machines and operated those on a trial basis in 1974. Since then they set forth a proposal for mechanised desiltation programme to be completed in three years at an estimated cost of Rs. 20 million[31]. The programme's success however depended on procurement of more machines of the type mentioned above along with gully-pit emptises, truckers, tractors and

inspection vehicles. From the Information : CMDA Sectoral Projects we observe that the programme was introduced in 1977-78. The programme has been completed at the cost of Rs. 12.8 million by Calcutta Corporation and CMDA. However the authorities at CMDA feel that cleansing operation as done by Calcutta Corporation or CMDA (in part) has made little impact on the actual problem. Since then another massive desiltation programme has been undertaken under the CUDP-III scheme at an estimated cost of Rs. 50 million [32]. Its implementation started in 1984-85 and only 5% of the work has been completed so far at an estimated cost of Rs. 3 million [33]. The completion date for this work has been fixed for March 1990. However from previous experiences it can be expected that at the end of 1990 the Calcutta sewerage system will not be in any better position than at present if the desilted sewers are not maintained that way. Thus the desiltation programme should be accompanied by a regular and disciplined clearing of the sewerage system to make it meaningful and effective. Unless the importance of proper regular maintenance is realised, vast capital outlays alone would not produce any appreciable social benefit.

The problem of siltation is also very much obvious in the case of outfall channels and other canals as well. The high silt content of the monsoon runoff causes rapid siltation of canals and thereby reduces their hydraulic capacity. But the high siltation content of the runoff is also an argument against the use of canal lining meant for increasing the rate of flow within the canals. Lining a canal reduces the frictional forces and increases the velocity within the canal. But the high siltation rate would lead to a situation where

frictional forces would be increased and velocity reduced thereby decreasing the hydraulic capacity[34]. The siltation problem can be minimised to a great extent by adoption of selective siltation through provision of gully-pits/catch basins at selected points along the length of the canal. By providing greater depths at such selected points so as to ensure siltation at restricted points the regular maintenance process of desiltation of canals along the entire length can be minimised[35].

Works related to the lining of canals have often been undertaken by different implementing agencies like Irrigation and Waterways Department. The lining of the Circular and New Cut canals has been completed and the funds advanced to the Irrigation and Waterways Department has been around Rs. 2.3 million[36]. The estimated cost was Rs. 3.46 million[37]. Similar works have been carried out in the Tolly's Nullah by the same agency at a cost of Rs. 8.29 million. Both these works were completed around 1971-72[38].

It may be noted that much hue and cry has been raised over the issue of surcharged sewers in Calcutta, but some experts are more optimistic; they opine that the present sewerage system of Calcutta is in most cases capable of catering to the needs of the people if properly maintained and provided with more gullypits[39]. The argument moves along the following lines : if a sewer is surcharged then the flooding in the streets will be a consequence of the back flow of storm water and sewere from the sewers. These will be ejected from the gullypits and gradually spoil over the road space. Some air bubbling will be noticed from the

gully pits. But in most of the Calcutta streets, it is observed that the flooding starts along the kerb lined then gradually spreads over the road surface. Air bubbling and backflows are rarely observed excepting a few cases (e.g., Muktaram Babu Street). Another important feature which goes to prove the non-inadequacy of the sewer system is the fact that the opening up of the man-holes in several places allows quick relief from water logging.

The question to be asked therefore is : If the sewers were surcharged how could the flood water be accommodated in them as it flowed in through the manholes. Thus the problem seems to be one of the flood water not finding its way into the underground conduits. The correct way out would be the provision of sufficient number of gullypits and regular cleaning of all gullypits.

As far as the provision of an increased number of gullypits is concerned it is essential that an expert committee should draw up a comprehensive list of exact places at which these gullypits should be constructed. An estimate of the cost involved would also be welcome. However simply stating that more regular cleaning of gullypits and a greater number of gullypits required would not solve the problem. Some specific statements regarding the exact cleaning and the enumeration of the new gullypit spots would prove to be much more beneficial. It has already been mentioned that parts of the existing sewer system in Calcutta are in somewhat unsatisfactory state due to old age; however, this system is in substantially good condition and capable of rendering further useful service if properly operated and maintained.

Further, contrary to the popularly hold view, many of the chronic water-logged spots are not at all

located in low-lying areas. A survey of an approximate water map of Calcutta shows that the elevation of the city raises from about 1.5 m above sea level in the east to about 6.0 m above sea level in the west. It is further observed that most of the areas suffering from chronic waterlogging are at an elevation which is generally about 4.0 m. above sea level. Table-1 shows a list of the water-logging spots with their respective elevation levels. A quick perusal of the list shows that the major water-logging spots like College Street, Bidhan Sarani and Chittaranjan Avenue are at an average elevation of about 6.0 m. above sea level. By Calcutta's general elevation standards 6.0 m. above sea level marks some of the highest points of the city. Thus we can safely conclude that the severe water-logging in Bidhan Sarani, College Street and Chittaranjan Avenue areas is not due to their low elevation levels but due to some other causes like blockage of the trunk sewers, lesser number gullypits or overlapping of trunk sewers and water mains etc. It is absolutely essential that the exact cause of such severe water-logging at these points be pointed out. It is however observed that the major water-logged spots of south Calcutta like Gariahat Road, Swinhoe Street, Tapsia-Tangra (eastern Calcutta) are at elevations of about 3.0 - 3.5 m. above sea level. The water-logging problem in these areas is therefore more chronic as the major cause of water-logging here happens to be their low elevation levels. The way out is therefore provision of and maintenance of the pumping stations accompanied by restoration and revival of existing underground sewerage system in these areas.

Another problem very often highlighted is that of the direct runoff of stormwater from the residential

buildings onto the roads. Since the roads cover only about 6% to 10% (approx.) of the total city area, it becomes very difficult for the roadside openings to cater for the runoff from these residential buildings. The system of providing each house with yard gullies etc. is not maintained properly. This improper maintenance on the part of the individual citizens too leads to water-logging problem in many areas.

Heavy rainfall in the Calcutta city proper leads to stagnation of water in parts of the city. There used to be 250 chronic water-logging points in the city[40]. On an average there used to be 15 floodings each year with a duration of usually four to fortheight hours[41]. Some of the vulnerable waterlogging points in the city are : Rabindra Sarani, Bidhan Sarani, Chittaranjan Avenue, Ahmerst Street, Mahendra Srimani Street, Madan Mohan Burman Street, Sahitya Parishad Street, Hari Ghosh Street, Tarak Pramanik Road, Muktaram Babu Street, Chittaranjan Avenue (near Fire Brigade Station), Caloohtola Street, College Street, K.C. Sen Street, (junction of Ahmerst Street), B B Ganguli Street (near post office), Sundari Mohan Avenue, Lalbazar Street, Elliot Road, Park Street, Free School Street, Camac Street, Russel Street, Convent Road, Rafi Ahmed Kidwai Road, Ashutosh Mukherjee Road (near Jadu Babu Bazar), Romesh Mitra Road, Hazra Road, Rupchand Mukherjee Road, S.P. Mukherjee Road, Rashbehari Avenue (near Deshpriya Park), Gariahat Road (near Tram Dept.), Satya Doctor Road, Sarat Bose Road, Bakul Bagan Road, Panditya Road, Sadananda Road, Swinhoe Street, Corn-field Road.

The depth of water varies from 0.15 m. to 1.0 m. though in some localities it may go up to 1.3 m. after

exceptional heavy rainfall for long duration, for example, the flood of 1978[42].

Water-logging in the fringe areas of the city is also observed in the partly reclaimed low-lying land at Tapsia-Tangra, Kasba, Jadavpur, Garia, Bansdroni, Behala and Rabindranagar. Depressions around the Behala air-field remain waterlogged for three to four months with 0.3 m. deep water[43]. The low-lying marshy areas south of Sarsuna and Barisha remain inundated for long periods following heavy monsoon rainfall. The depth of inundating water in this area vary from 0.3 m. to 0.5 m.[44].

Another problem for the already deteriorating situation of Calcutta sewerage and drainage system has been created by the construction of the Metro Railways[45]. The Bhawanipore and Kalighat area of south Calcutta face the danger of severe waterlogging during monsoons because of drains damaged by Metro works. An engineer of Calcutta Corporation's drainage department believes that waterlogging along Metro's route from Esplanade to Ballygunge would also be worse than previous years as 27 damaged points in these areas have not been repaired[46]. The official however stated that the Metro had relaid the drains along the stretch after completion of the construction work but it has unfortunately been faulty at places[47]. Another official however added that the Metro had sanctioned Rs. 0.5 million and another Rs. 175 thousand for the sewers along Cathedral Road and Mayo Road[48].

The sewerage network in south Calcutta particularly between Ramesh Mitra Road in Bhawnipore and Hazra Road was not functioning largely due to the obstructions created by

the work of the Metro. The damage has been most extensive in the Bhowanipore and Kalighat areas where the sewer lines have collapsed at eight points[49]. According to an agreement reached with the Metro authorities some work on the damaged sewer lines was to be done by the Corporation and some by the Metro Rail but the entire amount was to be reimbursed by the Metro Rail. Unfortunately the Metro Rail has been keeping silent about the release of funds to the Corporation. The Corporation has written several times to the Metro Rail since November 1985 but to no avail[50]. The condition of roads at many places of Bhawanipore and Kalighat was stated to be bad. Dirty water overflows at many places as lines were choked and disconnected from trunk sewers creating unhygenic conditions. In view of the conditions stated above it is essential that immediate attention is given to these areas. Long term beneficial measures should be devised rather than taking up some interim measures as and when essential.

Digging by the Metro Railways in the northern stertch has distrupted the drainage system on Shanti Ghosh Street, B.K. Paul Avenue, Brindaban Pal Lane and other roads in north Calcutta. However some array of hope is seen by the fact that the Metro Railway Authorities and the Calcutta Corporation authorities have decided to construct new sewers along Bhupen Bose Avenue as Metro construction work there had blocked existing ones[51]. This work had aggravated the water-logging problem along Bhupen Bose Avenue, Brindaban Pal Lane and Shanti Ghosh Street, A sewer will also be constructed along Brindaban Pal Lane and the sewer will be drained into the Bagbazar Street trunk sewer[52]. However three big sewers along Bhupen Bose Avenue can not be connected because of the Metro tunnel.

Accumulated water will be drained by a sewer which goes via Keshabram Bose Street to the trunk sewer on Acharya Prafulla Chandra Bose Road (APC Road).

These plans for laying the above mentioned sewers should however be scrutinised before being executed. For very often the defects in planning are realised at the stage of execution. As an example it can be stated that the Calcutta Corporation has dug a drain which is designed to flow from a lower level to a higher one with the help of gravity. The drain was meant to carry water from one of the tanneries at Tangra. The people of Matpukur and nearby bustees have for many years been complaining about chromium poisioning from the tanneries. For the relief of the people a drain has been dug along the left hand (northern) side of the Park Circus connecter till where it meets the by-pass. At this point the drain turns right to disgorge into the right side of the connecter. The only problem is that the level on the right is higher than that on the left and the vital drainage ducts of the Bypass on that side have become choked. The result is that while the polluted water was previously confined to the area of the tanneries, now it forms a long stretch along the connecter. Thus it is obvious that this type of planning which creates problems for a large number of people is uncalled for.

## IV. TECHNOLOGICAL OPTIONS

It is generally possible to identify three distinct types of sewerage and drainage systems :

(a) Combined sewerage and drainage system;
(b) partly combined sewerage and drainage system;
(c) separated sewerage and drainage system.

In the combined system both storm drainage and sewerage flow through the same underground conduits. In case of the separate system the storm drainage and sewage flow through separate underground conduits. Whereas in the case of the partly combined system the characteristics of (a) and (c) are brought together where some underground conduits serve as combined conduits and others serve as separate conduits. For the Calcutta system the combined type of sewerage and drainage system has been adopted. However in the newly developed areas such as Salt Lake, Jodhpur Park etc. the separated system of sewerage and drainage has been adopted. We will now attempt to present a comparison between the combined and separate system.

The Master Plan for sewerage and drainage has however laid greater stress on the adoption of a separate sewerage and drainage system essentially for the following reasons : The conduit drains to accommodate storm water is a costly affair and it would effect considerable economy if this could be taken along the shortest line to the nearest drainage stream. This would not be feasible for combined discharge because of the necessity of treatment in numerous individual units. Moreover the maintenance of the combined sewer would be more obnoxious and difficult than the separate storm conduits. Furthermore a good part of the Calcutta Metropolitan District Area has to drain ultimately into the River Hooghly which is incidentally the main source of water for the Calcutta Metropolitan District Area. In view of this proper treatment of sanitary sewege will be required before such discharges are made. Since sewage treatment is a costly affair it would be undesirable to increase the quantity by inclusion of storm drainage. Additionally however, the small amount of sewage

flow during the dry weather would need laying the combined service conduits at steeper gradient (for attaining self clearing velocity for scanty sewerage flow). The steep gradient would make the outfall discharge level appreciably lower (in case where the conduit is of appreciable length). This could otherwise be avoided in particular cases of storm drainage in a separate system. As far as maintenance is concerned extraction of silt from both combined and separate sewers constitutes a major problem. However, the extraction of silt from the combined sewers is more problematic as they can never be kept dry whereas the separate storm drains can be efficiently cleared during the dry months. The increased maintenance cost of such conduits would cover the cost of a separate system (in most cases in monsoon areas where the storm drainage is proportionately very high).

Despite the above mentioned advantages, economic considerations make it imperative to retain the existing combined system serving the Calcutta Corporation area. Provision of adequate road space is a necessary precondition for having separate sewerage and drainage systems. In the case of the Calcutta Corporation area where only six to eight percent of total area is covered by roads, provision and maintenance of separate sewerage and drainage systems becomes physically, almost, impossible.

However, in places where new sewerage and drainage systems have been planned the emphasis has been more on the separate system than on the combined ones.

Comparison of Open Channels and Closed Conduits

As far as the open channels are concerned it can be said that the advantages over closed conduits are

apparently many. The construction of open channels is easier, involving less time and less capital costs. Furthermore if land is available on either side, the section can be increased on either side for accommodation of future increased flow, if any. Additionally these channels can be covered and lined as and when required. The maintenance too is simpler and easier. These channels can also serve as navigational channels as and when required. From the hygenic point of view it can be said that the B.O.D. (Biological Oxygen Demand) values of the waste are greatly reduced by aeration and photosynthesis.

But these apparently numerous advantages are more or less over-shadowed by the disadvantage which are as follows. The open channels cover appreciable ground surface which could otherwise be utilised as roads etc. by adopting closed conduits. Open channels require proper and constant watch against private encroachment; and obstruction of flow - this happens to be an added disadvantage. Furthermore, unless the drain is properly covered in urban areas, there is always a risk of accident. Also a minimum velocity has to be maintained in the channels in order to prevent mosquito breeding. However this velocity is hardly maintained and all areas adjoining such channels happen to be infested with mosquitoes.

Thus it is generally advisable to go in for (a) earthen open channels for storm water drainage in rural areas; (b) lined and covered open channel for storm water drainage of semi-urban and municipal areas; and (c) closed conduits for sanitary and combined waste for sewerage lanes as proposed. It can therefore be safely concluded that the municipalities should first start with construction of pucca open drains as these would be less

expensive. With the increase of population (population density) and growth of urbanisation attempts should be made to cover up these open drains. The break off point has to be determined by experts in consultation with medical practitioners who would be in a position to give an exact picture of the health hazards of open drains in the densely populated areas. Thus in comparatively less developed parts of the urban areas it may be convenient to use the road side drains (in place of conduits) feeding the conduit drainage system while for home connections (sanitary sewage and home sewage) conduits may be used. Apart from the economy involved the maintenance of the small open drains may be much more easier.

Some Proposed Innovations : Their Implication and Future Prospects

The sewerage and drainage system serving the city of Calcutta is more than a century old. Thus a rejuvenation of this existing system is an absolute necessity. The rejuvenation procedure however is a very complex one involving several radical changes. More than 1/3rd of the volume of the sewerage system has become choked due to siltation. Thus a major task happens to be the removal of this large quantity of silt from the system. Moreover the existing sewer lines in many places are in a very vulnerable state and this is evidenced by the frequent collapsing of sewer lines in several regions. The renovation of the system is much deferred by the non-availability of detailed underground maps of the city. Unfortunately neither the Calcutta Corporation nor the CMDA has made any attempts to produce some updated versions of such maps. The concerned authorities feel that it is physically impossible to provide any such maps at present. Thus very often it is observed

that newly constructed water mains overlap underground telephone cables or sewer lines - and this leads to all sorts of problem such as an inefficiently operating faulty telephone system. Thus prior to any innovation work an underground map should be worked out both for the purpose of a more secured and pleasant future and a proper planning system.

Provision of closed circuit T.V.'s, for proper "internal check" leading to a strong internal control system, has often been highlighted. But the economical and physical viability of such a sophisticated system has often been doubted. The large quantity of deposited silt accompanied by a high rate of siltation too acts as a physical barrier to the adoption of closed circuit T.V.'s. This is however true for a short-term period. Taking into account a longer planning horizon it is possible to think of setting up closed circuit T.V.'s at a proper phase after a desiltation drive has been successfully and completely implemented. Prior to this some cost estimates of the entire project has to be provided as this happens to be a very specialised job.

As mentioned in the foregoing if steps in the proper direction are taken and implemented successfully the various schemes as suggested will overcome the problems of water-logging in Calcutta city

## V. DRAINAGE CANALS AND PUMPING STATIONS

The important drainage channels serving the Calcutta Metropolitan District Area (Map No. 1) are as follows :

1. Dankuni Drainage Channel, 2. Howrah Drainage Channel
3. Rajapur Drainage Channel, 4. Barajola Drainage Channel,
5. Begher Khal, 6. Nawi Khal,
7. Tolly's Nullah, 8. Boat Canal,
9. Bagjola Khal, 10. Krishnapur Khal
11. Calcutta Outfall Channels, 12. Beliaghata Canal,
13. Circular Canal, 14. Panchannagram Khal.

Most of these channels were constructed more than seven or eight decades ago. For example, both Dankuni and Rajapur channels were constructed in the latter part of the nineteenth century. Tolly's Nullah, the oldest, said to be the life-line of the drainage system in the city, was first excavated in 1776[53]. As a consequence, repairing and maintenance is a major problem facing the outfall system in the city, more so because this task had been grossly neglected in the past, and even now does not receive the priority it deserves.

At present Tolly's Nullah is no more than an insignificant tidal creek, but even until 1909, it was navigable by a motor launch[54]. These days water is plentiful up to the point where the tidal effects operate; beyond which a great part of the channel remains dry, or covered with water hyacinth. In several places the width of the channel has been reduced by illegal encroachment on the high-value land by human settlements.

A stretch of the Tolly's Nullah has been renovated but the importance of regular dredging and silt clearance envisaged earlier was lost sight of; it is made only in the upper reaches by setting up cross dams. No arrangement has been made for dredging the lower part of the channel which is getting silted up gradually. The shortfall in the performance of storm drainage in the combined system

adopted in south Calcutta has necessitated the provision of relief sewers which, in a way, is effecting a separate system of storm drainage. Moreover certain other areas have been planned to be drained into Tolly's Nullah through open channel and conduit drains. In this context the importance of Tolly's Nullah is to be appreciated.

The Irrigation and Waterways Department has drawn up a plan for mechanised dredging of the lower reaches of the Tolly's Nullah whereas the silt clearance for the upper reaches is proposed by manual labour. Excavation by manual labour would obviously necessitate setting up of cross bunds for closure work which would involve two types of difficulties : (1) to dry, water would have to be pumped over cross bunds, (2) cross bunds would produce stagnancy of water in the Nullah, which in turn would encourage mosquito breeding. However, the Consultants are of the opinon that special types of machines have to be designed for the dredging of both upper and lower reaches with the same equipment. The consultants, however, feel that until such equipment is installed the proposals of the Irrigation and Waterways Department should be implemented.

The State Government's plans to give new life to the decrepit Tolly's Nullah hopes to ease the much burdened and clogged drainage system of the city. However, the Government's efforts are much hampered by the thousands of houses built along its banks. By 1990, the rescue project is expected to be completed with funds from the CMDA's CUDP-III and also in the future under the Centre's Ganga Action Plan. The Calcutta Municipal Corporation is drawing up a development scheme against which funds from the action plan will be allocated. Preliminary works of desilting has

already begun at a number of places but work is very often hampered by the obstructive activities of the squatters. Excavation work is also being hampered as settlements along the bank allows very limited space to work on. Despite such problems work is progressing at certain points like Siritsaran Ghat where more than 100 labourers were working everyday for eight hours[55]. The sum allocated for Tolly's Nullah under CUDP-III is Rs. 19.2 millions[56]. Implementation has begun from 1985-86 and about 1% of the work has been completed so far[57].

The Master Plan recommended construction of trunk drains and major drainage facilities in the Tollygunge Area as also design and construction of secondary sewerage and drainage facilities within the same area. Analysis of the programmes proposed by master plan would indicate that the first priority was on the trunk drains and main drains in respect of the Tollygunge part of the project. It appears that the programme was adopted along the above lines from the very beginning, i.e., early 'seventies' which enabled in about two or three years time interval completion of practically all the sewer outfalls into the Tolly's Nullah as well as drains and outfalls for Jodhpur Park - Selimpore - Dhakuria drainage areas. While in the former areas the construction of trilaterals were not followed up, those in Jodhpur Park - Selimpore - Dhakuria areas were generally completed simultaneously with the trunk drains.

Bagjola Channel is another important outfall which has been greatly silted up. Which affects the discharge into Bidyadhari river. The lining of the Canal upto the crossing of Jessore Road has augmented its carrying capacity, but so far not enough has been made in

terms of excavation.

The two canals - Beliaghata and Circular - separate the eastern part of the city from the rest. It acts as a minor storm water channel for the city, and is up to 50 metres in width at some points. There are proposals to convert the Beliaghata canal into a closed conduit and to develop it as a major storm water channel for the city.

In addition, two others - the suburban head-cut from Ballygunge Pumping Station and the Town Head-cut from Palmerbazar pumping station meet at Bantola - form storm water channels. A channel from Dhapa Lock Pumping Station meets the Town head-cut at Makalpota and another channel of shorter length from the Chowbhaga Pumping Station meets the suburban headcut at Chowbhaga. The Calcutta Municipal Corporation area, the Tollygunge Panchannagram Basin and a vast rural area is drained through this channel. It was found that during a abnormal heavy precipitation the outfall level in the Kulti or Hooghly River ruled much higher than the assumed levels for average conditions. This problem arises from a large inflow from upstream areas, which raises the water level in these storm water channels thereby creating drainage problems in the rural areas, as well as reducing the efficiency of the pumping stations.

Further the storm water channel from Bantala to Ghusighata has been designed for 80%[58] capacity of the designed runoff based on the assumption that peak discharge from different pumping stations of Calcutta would not synchronise and urban drainage would get preference over rural drainage. While peaks may not synchronise in normal heavy precipitation, during unusual heavy precipitation it is possible that the maximum pumped discharge may

synchronise with a heavy rural discharge, which would also increase the water level in the storm water channel. In addition to these there are the normal siltation problems which have also to be tackled as a routine measure.

Our discussion in this section can not be complete without reference to the Hooghly river.

The Hooghly River enters the area at Tribeni, moves straight South upto Hooghly-Chinsurah and then moves south along a sinuous course upto Mahesh. Down stream of Mahesh it flows straight upto Bali Khal. The consistency of the Hooghly Channel depends more or less on the harmonious interplay of the ebb and flood currents as modified by the curvature of the banks and the width of the river bed. The upland flow dominates during August to September. The tidal flow dominates during January to April while they are balanced during May to June. Tidal effect in the Hooghly River extends much upstream upto Guptipara. The Hooghly in the more recent past used to flow along a braided course - The Adi-Ganga.

The Adi-Ganga represents a palaeo channel of the Hooghly river. This stretches from the vicinity of Hastings where it has an outfall into the Hooghly, passes through Alipore, Kalighat, Tollygunge, Bansdroni and then swerving south to pass by the side of Boral, Rajpur and Baruipur. The stretch from Hastings to Bansdroni was reexcavated in 1776 to serve as a line of navigation by Major Tolly and is known as the Tolly's Nullah. The portion of the Adi-Ganga near Garia has been covered by residential sector. The bank height in this part is about 3 m. and the channel is about 30.0 m. to 50.0 m. wide. Some amount of water flows in the channel during monsoon.

Pumping Stations

Whilst considering the pumping stations serving the CMD area we will concentrate mainly on those serving the Calcutta Corporation area specifically. (An exhaustive list of the pumping Stations along with their pumping capacities, serving the CMD area is given in Table-2).

The three major pumping stations serving the Calcutta Corporation area are - (1) Palmersbridge Pumping Station serving the town system, (2) Ballygunge Pumping Station serving the suburban system, (3) The Dhapa Lock Pumping Station serving the Manicktola sub-basin. The CMDA has spent about Rs. 600 million[59] on account of sewerage and drainage works during the last 16 years to implement the Master Plan proposals. A portion of this has been utilised for the augmentation of pumping capacities at several pumping stations. However very little has been done to investigate whether the pumps in those pumping stations have adequate capacity to accommodate the rated amount of flow equivalent to the augmented capacity.

Besides the inadequate hydraulic capacity and ill design of the pumps, it is frequently observed that some of the pumping stations do not operate at times of necessity. It was especially noticed in the case of the Duttabagan Pumping Station which is run by the Public Health Engineering Department. The pump operators operate the pumps only till 5.30 P.M.[60], therefore a heavy rain after this leads to water-logging in the areas served by this Pumping Station. Furthermore power failure and mechanical failure at the pumping stations at times of urgency also aggravate water-logging problems in the command area.

Careful attention must therefore be paid to the efficient operation of pumps at all the pumping stations

for 24 hours. Failure to take up such measures would lead to inadequate utilisation of existing capacity resulting in unwanted economic losses as a result of water-logging.

## VI. DRAINAGE PROBLEM IN THE MUNICIPALITIES

In this section we are attempting to present a very generalised account of the existing state of drainage and sewerage in the different municipalities. For this purpose we have restricted ourselves to 5 distinct zones in line with the pattern prescribed by consultants appointed by CMDA on this subject.

### Zone - I

Zone-I is CMD Area bounded by Bally Khal on the North, Hooghly river on the East and South and CMD boundary on the West which extends upto Uluberia on the South West Corner. The Municipal Area contained are those of Howrah and Bally. Apart from these two urban area, extensive urbanisation has taken place over a considerable part of the remaining area, particularly along the bank of the river as also along the Railway lines and trunk roads. Of these the more important area is the Bally non-municipal urban area.

In the northern stretch from Bally Khal to Howrah Railway Station the ground slopes down from the higher river side towards the west. In the area south of Howrah Railway Station upto Shalimar the watershed line is at some distance from the Hooghly river from where the ground slopes towards both the east and west. Originally the drainage provisions were made as would be required for rural areas in the flat terrain of Howrah district. The area under consideration is drained by draining rivers and channels with tidal variation of 12 to 18 ft. in water level[61].

The Master Plan described Howrah as a densely populated area and drainage of this was urgently required. Accordingly they expressed that the programme in the interim phase concerned with emphasis upon sewerage and construction of some drainage relief in easily served areas, and expected expansion of the schedule in greater detail.

In this context planning for drainage programme for Howrah in the interim phase was drawn up which included six schemes. It is noticed that all six schemes were for areas having ground slopes in a direction away from the drainage river. In this context, the schemes which contemplated pumping stations etc. were not included in the programme for the interim phase. It is to be noted that selection of all the six schemes between Howrah Station and Bally Khal were made in areas where the drainage condition were acute (because of reverse ground slopes).

Planning for drainage of an area developed in an unplanned manner, is much more difficult than planning for drainage of projected urban areas. The schemes proposed for the Municipal areas in Howrah and Bally are not too inconvenient because the draining river Hooghly adjoins these lands. Drainage of the growing urban land areas would be much more complex, in as much as more of the comparatively low lands would gradually come under occupation and the distance from the river will increase. Further with gradual reduction of adjoining paddy lands the detention effect will gradually decrease which will have the effect of increasing the run-off.

In respect of sub-basin III of Howrah the Master Plan does not have any proposal for drainage, on the ground that the areas are under-developed. The consultant

firm, however, does not support this argument. The area is composed of Bally Municipal and Bally non-Municipal urban areas and is growing fast. The area adjoining the Eastern Railway Main line - a part of the industrial area is located right within this sub-basin. Under these conditions the urban growth of this area is an urgent necessity and should take place in a natural way. If those points are taken into account, it becomes obvious that timely action should be taken to lay down the drainage system for the prospective urban area. At present this is wholly treated as a rural area, as regards provision for drainage. The runoff from urban area is several times more than the Drainage Index (run-off) used for rural areas, and hence policy of drainage is to be laid out in advance.

At present Howrah has a complete Sewerage Treatment Plant (STP) with a capacity of 10 million gallons per day (m.g.d.) and constructed at a cost of Rs. 60 millions[62]. House connections to the sewers already laid are missing. On the other hand, without enforcing house connections, the programme for conversion of service privies into septic tank latrines is progressing. CMDA is advancing 75% of the Rs. 2200 officially estimated to be required per unit to the individual Municipality[63]. The Sewerage Treatment Plant is expected to protect the Hooghly River as a source of water supply and to prevent pollution in the lower reaches of Howrah Drainage channel. However, the sewage needed for treatment are not coming from the sewers. At present the Sewerage Treatment Plant is made to operate with sullage water from the surface drains, in the absence of sewer connection to household, in order to keep the plant in commission.

The basic reason for the missing house connections is the excessive costs to be incurred in taking such

connections by an individual. The costs amount to about Rs. 3,500 per household - substantial amount in terms of the level of living of the people in the area[64]. Subsidies provided to the individual households for taking house connections - at Rs. 1650 - can not be easily given because of various problems such as tenant-landlord feuds and the difficulties of identification of the beneficiaries of the scheme.

Some experts, however, believe that complete sewage treatment in the Howrah area is not one of primary importance and should await the construction of sewers, sewage pumping stations, and other sewerage appurtenances. In the initial stage, sewage treatment in the Howrah Zone can be limited to primary sedimentation with provisions for disinfection of the primary affluent. Thus, according to this view, the construction of STP was premature.

Zone - II

Zone-II of CMD constituted the North-West Part of the District, mainly falling geographically within the Hooghly district, but for a very small part which falls within the Howrah District (i.e. area South of Bally Khal). This zone covers an area of approximately 240 sq. km.[65], comprises of 10 Municipalities, 2 non-municipal urban units and 23 Gram Panchayats.

The physical development in Zone-II, particularly in the municipal towns, has occurred in an irregular and haphazard manner. Refugee rehabilitation colonies, set up here and there, mostly along the periphery of the municipal limits in the low lying areas, have obstructed the flow of drainage water. In most of the regions within the zone it is very difficult to delineate residential, commercial and industrial blocks.

The tidal river Hooghly flowing through the east of this zone is navigable. In addition throughout this zone there are numerous, rivers and streams and there is also a fairly extensive system of canals for drainage and irrigation, although many of these streams and channels are in an advanced stage of deterioration because of siltation.

The terrain is exceedingly flat and higher ground is generally located along the western bank with a natural slope away from the river i.e., towards the west. A special feature of the landscape is the large number of ponds and ditches scattered throughout the urban and rural portion of the area helping directly or indirectly the surface drainage of the localities. The average annual rainfall in the area varies between 1,375 mm (55") and 1,540 mm (62") and about 80% of the annual rainfall occurs during the period of monsoon[66].

The removal of storm waters from populated areas is an important requirement, specially under conditions prevailing throughout much of the area under consideration, where drainage by natural means is poor on account of the flatness of the terrain. Drainage in most of this area is by means of open ditches and canals. In the past, storm water from these ditches and canals used to discharge channels is the area. A part of the storm water also used to flow through the peripheral paddy fields and other low lying areas which remained inundated for a few days and ultimately overflowed into nearby drainage channel systems. But, as new settlements have developed in these low lying areas in the last decade, mostly refugee rehabilitation colonies, now storm water accumulates in these areas and the inhabitants are often obliged to live under such conditions for periods which may extend for

several days. Moreover, ditch systems frequently do not have the necessary hydraulic capacity to remove storm water during the wet seasons, and, consequently, they overflow their banks and spill household sullage, waste water from cattle sheds and nearby industries and human excreta. Ditches and canals in the area are usually laid out on flat grades and are frequently obstructed with siltation, debris and unauthorised encroachment such that sewage together with storm water stagnates and becomes septic before draining away from the polluted areas.

Underground sewerage system exists in part only in Serampore town. Serampore sewerage system is about twenty five years old[67]. Since then the population has outpaced the development of the sewerage system, which covers only about 25% of the population[68]. A phased programme for underground sewerage has been undertaken by CMDA for Chandannagar Town as a priority problem area.

Of all the municipalities, Chamdani presents a somewhat better picture so far as the availability of drainage facilities and its proper maintenance is concerned. Municipalities so far have spent mostly on secondary drains and depend primarily on CMDA for extending primary drainage facilities to their residence[69]. Present availability of such facilities is scanty; particularly in Bansberia, Chandannagar ., Hooghly-Chinsurah, Baidyabati and Konnagar conditions of ditches or old pucca drain which mainly act as 'Nikashi' (i.e. clearing) drains within such areas are beyond description. They are hydraulically incapable of draining out water from the respective catchment areas. Drains within almost all municipalities are more or less in low operative condition mainly due to siltation, improper laying and maintenance

and by deposition of debris. In rural areas, availability of drainage facilities is almost absent[70]. Ditches which were dug out long ago to drain out water from residential areas and discharging into ponds or agricultural lands have becomes almost silted up.

Another important aspect to note is that a major part of the internal drainage system (even the pucca drains in some areas) within both urban and rural areas, had so long been connected to the nearby ponds/tanks on to the cultivation lands of individual ownerships for ultimate disposal. These water bodies are over time, becoming gradually silted up or filled up for land development purpose. During the rainy season, these water bodies become full and drainage water and sullage spill off to the low lying areas.

Zone - III

The Zone-III comprises of ten municipalities on the east bank, in the northern part, (viz. Panihati, Khardah, Titagarh, Barrackpore, North Barrackpore, Garulia, Bhatpara, Naihati, Halisahar, Kanchrapara), as also two non-municipal urban areas (Kalyani N.A. and Gayeshpur N.A.), five restricted areas (Barrackpore Cantonment, Palta Water Works, Barrackpore Air Field, Icchapur Defence Estate, Ordinance Factory), and 77 mouzas within the Gram Panchayat and 37 mouzas within the non-Municipal Urban areas.

This zone is bounded by river Hooghly in the West, the Jamuna Basin in the north, Bager Khal basin and Nowai Basin in the east and Khardah basin in the south.

The proximity of this area to Calcutta, and the concentration of industry, commerce and trade, led to over-crowding as well as excessive cultivation in the low lying

areas. All these, in addition to some natural causes has created an acute drainage congestion and increased the run-off in the area. The problems of drainage in the municipal areas and the adjoining non-municipal urban areas are inter-connected in-as-much as the storm water from both the areas are sometimes drained through a common outfall channel ultimately flowing either eastwards to river Kulli or westward to river Hooghly. Chokage or insufficient operation of the outfall channel mostly account for flooding and water logging of the low lying areas falling within the zone. The river Hooghly, which is the outfall for most of the drains, being a tidal river, account for flooding in some areas during the time of high tide. Requisits lockgates have not been provided and/or are not properly operated and maintained in most places. Some of the municipalities have to suffer two-fold in times of prolonged heavy storm; firstly the run-off from the municipality not finding a regular and adequate course to flow stagnates and secondly the run-off from the upper reaches of the outfall channel adds to the misery of the people.

Drainage in all the municipal towns consists of roadside surface drains meant to carry storm water during rainy season as well as sullage from the residences. Actually, due to lack of connected privies, a good amount of night soil and organic waste also find their way into these surface drains. The drainage system also is partial in many towns. These drains have not been built at one stage but have been extended piecemeal from time to time depending on the availability of funds and the necessity arising due to special circumstances. All the drains are not pucca. There are numerous kuccha drains and those too

without proper slopes. Besides, as the road surfaces are unpaved a large amount of silt are washed into these drains during rains. The combined effect of all these factors is accumulation of silt in the drains, thereby hampering the flow. Due to lack of funds none of the municipality can afford regular clearing or repairing of these drains.

There are many industries in these municipalities, which also drain their waste water into the surface drains, mostly without any prior treatment. Often these industrial wastes contain objectionable matter some of which putrefy during passage through the drains and bad odours.

Sewerage system along with treatment works exist in three of the municipalities within this zone viz. Titagarh, Bhatpara and Kalyani (N.A.). Out of these Kalyani is fully sewered whereas the sewerage systems existing in Bhatpara and Titagarh do not serve the whole municipal area. In the other municipalities within this zone the present system of night soil disposal is to use trenching ground. People use service latrines in their premises. Night soil accumulated in the container is collected early in the morning by the sweepers and transferred to the night soil carts which haul them to the trenching ground site where they are emptied into the trenches. Disposal of night soil by trenching is the crudest method of disposal. Cost of sewerage schemes for the towns in question are given in Table-3.

In Titagarh, the sewerage system with the treatment plant was constructed in 1928, when the population was 20,000, but it was designed to cater for 40,000 people. Since then the population has grown enormously (104534 in '81) but the sewerage system has not been augmented with the

inevitable consequence that the system is very much overloaded leading to chokage of sewer lines. The Sewerage Treatment Plant is also not functioning due to overloaded condition[71]. At present the sewerage system covers about 70% area of the town with a total length of 26,405 feet of sewerage of different sizes[72].

In Bhatpara, the sewerage system is equally old. It is interesting to note that a treatment plant constructed more than 50 years ago contained equipments and work on a principle which are even now seen to be one of the best modes of sewerage treatment. There was another novel arrangement in the treatment plant which is of modern interest : gas collected had been utilised in the past in running gas engines as prime movers for the power required to run the plant. Unfortunately, for lack of proper maintenance, the gas engines have been discarded and replaced by electric engines.

The total length of the sewerage system in Bhatpara is only 9 miles and works for the extension of the sewerage system is under contemplation. The present population density, at 18,026 - per sq. km. is one of the highest in CMD.

Zone - IV

Zone-IV comprises of the southern part of the east bank, an area bounded by the CMD limit on the North and East, Tolly's Nullah in the South and Panchannagram canal, City of Calcutta and circular canel on the West. There are 7 drainage basin within the area - Sunti, Bagjola, Manicktala, North Salt Lake, Boinchitala, South Salt Lake, Nawi (Part). Apart from these there are a few other smaller basins[73]. The increase in population pressure in and around the city of Calcutta led to the

development of residential settlements in these low pockets resulting in acute drainage problems and increase in the amount of run-off.

The existing status of the Sewerage system in this area (excluding the Manicktala Sewerage System, which has already been elaborately discussed in relation to the Calcutta City) is as follows :

Cossipore - Chitpur Sewerage System

This is mostly served by a network of surface drains. In recent years some underground pipes have been laid by the CMDA and the CMWSA to carry the storm sewerage and the sanitary sewerage separately. However it is understood that it will take some more years to develop the underground sewerage network fully in this area. The area is served by Kalicharan Ghosh Nikashi (open drain); Copes Lalababu Nikashi (open drain) and Bagjola canal. The major pumping station being Dutta Bagan pumping station and Bagjola pumping station.

Salt Lake Sewerage System

The system covering the present township area was developed by the former Salt Lake Reclamation and Development Board and, after 1965, by Irrigation and Waterways Department. While storm water from Sector-I is discharged into Krishnapur Canal by gravity, the sanitary sewerage is taken into the sewerage treatment plant at Bagjola for treatment by pumping from one of the three lift stations. The Bagjola Swerage Treatment Plant has a capacity of a 6 mgd.[74] The plant, though constructed in 1966-67, is at present not very much in use, due to lack of adequate sewage inflow, and lack of security arrangements.

South Dum Dum

Surface drainage was introduced here as early as the beginning of this century. However, the sewerage system can be said to have been really introduced in the year 1971 when some sewer lines were laid and a drainage pumping station was constructed in the Lake Town area of the Municipality. A pumping station at the junction of Jessore Road and Bagjola was constructed in 1971 for the purpose of lifting and receiving combined sewage from the Birpara and Dutta Bagan pumping station. This pumping station now receives combined sewage from the Lake Town area and also discharges the sewage into the Bagjola Canal. Total area served by the sewer line in this Municipality is about 1.34 sq. km[75].

Zone - V

Zone-V comprises of 6 municipalities, 16 non-municipal urban areas, and 149 rural mouzas. The municipalities covered are as follows : South Suburban, Garden Reach, Budge Budge, Jadavpur, Rajpur and Baruipur Wards numbering from 65 to 100 of Calcutta Corporation area in '81) (excluding 66,67,71,91,92 and 93) also fall within this zone. The proposed township of East Calcutta and Baishnabghata - Patuli, now being implemented, also falls within this area. The drainage basins located in the zone are as follows : Tolly's Nullah, Tollygunge Panchannagram, Manikhali, Churial, Magrahat, Sonarpur Arapanch, and Rajpur. Most of the area under this zone has been considered already.

The Sonarpur - Arapanch basin represents the CMD area on the east of Garia Baruipur Road situated on the south of Tolly's Nullah. The area includes parts of Rajpur and Baruipur Municipalities, urban areas near Sonarpur railway junction, and also other urbanised areas

alongside the said road. The topography of the area shows a relatively higher elevation alongside the said road and this has been due to the course of the river Adi-Ganga running adjacent and parallel to the said road. The ground slopes gently on both sides of the Garia - Baruipur Road towards the low lands. In the mid-fifties, the Irrigation Department executed the Sonarpur Arapanch Drainage Scheme with a major pumping station at Uttarbhag. This changed the character of the low lands, made those cultivable and brought prosperity to the area. This is still the main drainage outlet of the area. The drainage is ultimately into the River Piali, which is a part of the bigger Matla System of rivers.

In the basin inadequate provision of culverts under the Eastern Railway line running parallel to the Rajpur - Baruipur Road causes difficulty of drainage. In earlier days the quick run-off from the urban areas could be absorbed and detained by the proportionately larger agricultural areas located on the west of the railway line. However, with gradual urbanisation of the comparatively lower lands not only the quick run-off volumes are increasing but at the same time, the agricultural land available to receive these run-off is getting reduced.

## VII. CONCLUSION

As has already been pointed out, the major causes of waterlogging are obsolecence of existing sewerage and drainage system, provision of inadequate number of gully-pits, silting up of the water carrying channels and canals and inefficient use and operation of the existing pumping stations. The whole system is burdened with an inefficient maintenance programme. Thus it is essential

that the above mentioned defects should be rectified immediately in order to free Calcutta at least to some extent, from the nagging problem of extensive waterlogging. Work has been undertaken by different agencies for the rectification of the various defects at different point of time. But, unfortunately, most of the work has been done on a piecemeal basis; projects have been left in an unfinished state for many years, and expenditure incurred on those have failed to produce the expected benefits.

The smooth functioning of the entire planning and operation mechanism of the sewerage and drainage system of the city is impeded by the non-existence of detailed underground maps. Discussion with CMDA and Corporation officials reveals that updating of any such maps in existence is practically impossible. Hardly any records have been maintained of the works undertaken on a piecemeal basis and the inter-linkage of the works has been lost sight of.

While CMDA officers complain of lack of funds, Calcutta Municipal Corporation sources believe that a significant change would be possible only if a massive amount - about Rs. 14,000 million - is allocated to control water-logging. However, with no such large scale grant forthcoming, both Calcutta Corporation and CMDA are now trying to provide instant and partial relief by implementing short-term projects aimed at reducing the duration of water-logging[76]. In February 1987 the Calcutta Corporation launched a Rs. 15 million scheme under CUDP III to repair clogged drains, in such flood prone areas as APC Road, AJC Bose Road, College Street, Bidhan Sarani, Lenin Sarani, Amherst Street and other vital throughfares in North and Central Calcutta. However Calcutta Corporation sources

revealed that heavy waterlogging after the city was lashed by rains in July 5, showed conclusively that the project had proved ineffective in augmenting the hydraulic capacity of the sewer system in the areas connected to the Balmer Bazar pumping station[77].

A recent scheme amounting to Rs. 5480 million envisages removal of silt from the existing network, replacement of the age-old pumping units including construction of new pumping stations in the low-lying pockets, repairs and procurement of sewers cleansing equipment, garage facility, installation of wireless sets and walkie talkies, providing primary and secondary sewerage facilities in the rest of the city basin and added areas, enlargement of 39% of the existing arterial network to remove the inadequacy of the capacity, renovation or repairing of 37% of the trunk sewers including annicut works, improvement of outfall channels, providing sewage treatment plant including digestor[78]. Table-6 gives a detailed break up of the financial requirement of Rs. 5480 million. This has however to be critically examined by the authorities concerned in other similar institutions as the total sum is a colossal one.

It is very essential to have a good understanding and proper coordination between the various executing agencies like CMDA, CMWSA, Calcutta Corporation, and Irrigation and Waterways Department for proper functioning of the entire system. Improper coordination will lead to wastage of time and unnecessary expenditures.

As far as the municipalities within CMD are concerned it has been proposed that a complete water-borne sewerage can be developed only in areas having water supply of about 130 - 140 lpcd[79]. This rule has been adhered to only in Calcutta (291 lpcd) and Kalyani (331 lpcd). In some places with with

established water-borne sewerage system like Bhatpara Municipality the water supply is as low as 8 lpcd. However there are many areas which do satisfy the condition of having water supply of 130 - 140 lpcd and yet do not have any well developed underground water-borne sewerage system, e.g., Bansberia, Chinsurah, Halisahar, Dum Dum.

Some discrepancy in the data does not allow us to give a true picture of the entire situation. For instance 70% of Titagarh's population is said to be served by sewer lines[80]. But from the report of the Municipal Finance Commission (March 1982) we find that Titagarh has no underground drains. In Calcutta 53.9% of the total length of drains is constituted of underground drains. But for the other sewered areas the percentage of underground drains varies from 4.2% (Howrah) to 7.6% (Bhatpara). However the percentage of pucca drains in other municipalities varies from 3% (Barasat) to 95% (Titagarh).

It has also been observed from MFC's Reports that the average expenditure per capita on drainage and conservancy from own revenue is about Rs. 11.18. The Status and Action Plan for Waste Water Collection, Treatment and Disposal in Class-I cities (New Delhi) suggests that per unit cost of sewerage development to be almost Rs. 200 per capita - in 1980. In comparison we find that for selected municipalities the average cost per capita for construction of sewerage system is about Rs. 612 (Table-3). Thus construction of sewerage system in the municipalities seems to be a 'bridge too far'. In view of the present expenditure conditions in the municipalities, it is generally proposed that sewerage system should not be developed all at once. It should be gradually developed in stages. The first preference should be towards having

pucca open drains rather than underground conduits. The heavy capital expenditure thus required for water borne sewerage system can be spread out over these various development stages so that affordability and economic viability of the undertaken projects can be maintained.

Consideration of natural and man-made hazards and geological-cum-geomorphological situation in the present area brings in the question : Wherein lies the remedy to all these? Having scanned the historical development of the metropolies within the framework of the natural terrain condition and identified to some extent the environmental potentials and problems of the area the following steps may be suggested.

1. As far as possible urban development should be restricted to the high ground of the levees.

2. As far as possible encroachment into low lying interdistributary marshes should be avoided so as to save agricultural tracts and also to maintain the drainage system.

3. As far as possible the palaeo - courses where encroachments are less may be reexcavated along with the canal to increase the number of flood routing channels Saraswati course is at present highly silted up. Steps may be taken to reexcavate it and increase its efficiency. Similar reexcavations are suggested for parts of Gouri gang, Kana Daodar and other associated palaeo courses. Drainage condition is to be improved by excavation of Sunti, parts of Sonai Nadi, Jamuna River and Bidyadhari As discussed earlier, in the area east of Hooghly River Channel, the ultimate flow of surface water is towards south east and into the Bidhyadhari river. Hence the

problem of water-logging is vitally linked up with the efficiency of the Bidyadhari River. Excavation and maintenance is also suggested for the whole or a portion of Tolly's Nullah, Adi-Ganga, Krishnapur Canal, Circular Canal, Calcutta Storm Canal to tackle the problem of waterlogging in Calcutta.

4. While designing storm water drains due consideration should always be given to the role of tides and monsoon discharges in the main streams into which the outfall occurs.

Howrah Corporation area and all the municipalities should be provided with better drainage facilities and also waste disposal sites. For Howrah and the municipalities to the south the suggested disposal site, west of Sankrail might serve the purpose.

Calcutta's subsurface storm water drains have had their capacity increased at a number of places but it still has to be improved at many others.

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TABLE : 1

LIST OF WATER LOGGING SPOTS WITH THEIR RESPECTIVE ELEVATION LEVELS

(mts. above sea level)

| | |
|---|---|
| Rabindra Sarani | 4.5 - 5.0 mts. |
| Bidhan Sarani | 6.5 mts. |
| Chittaranjan Avenue | 6.0 mts. |
| Ahmerst Street | 6.5 mts. |
| Mahendra Srimani Street | |
| Muktaram Babu Street | 6.5 mts. |
| College Street | 6.5 mts. |
| Keshab Chandra Sen Street | 6.5 mts. |
| B B Ganguly Street | 5.0 - 6.0 mts. |
| Dr Sundari Mohan Avenue | 3.5 mts. |
| Lal Bazar | 4.5 - 5.0 mts. |
| Elliot Road | 4.5 mts. |
| Park Street | 4.5 mts. |
| Free School Street | 5.0 mts. |
| Camac Street | 4.5 mts. |
| Russel Street | 4.5 mts. |
| Convent Road | 4.5 mts. |
| Rafi Ahmed Kidwai Road | 5.0 - 6.0 mts. |
| Ashutosh Mukherjee Road | 4.0 - 4.5 mts. |
| Ramesh Mitra Road | 4.0 mts. |
| Hazra Road | 4.0 mts. |
| S P Mukherjee Road | 4.5 - 5.0 mts. |
| Rashbehari Avenue | 4.0 - 3.5 mts. |
| Gariahat Road | 3.5 mts. |
| Sarat Bose Road | 4.0 - 4.5 mts. |
| Bakul Bagan Road | 4.5 - 5.0 mts. |
| Sadananda Road | 4.5 mts. |
| Swinhoe Street | 3.5 - 3.0 mts. |

Source : Data collected from C M D A, Sewerage and Drainage Department.

TABLE : 2

CAPACITY OF EXISTING PUMPING STATIONS IN CMD

| Location (1) | Pump No. (2) | Rated Capacity (Litres per minute) (3) |
|---|---|---|
| | Raw Sewage Pumping Station | |
| Titagarh | 1 | 10,010 |
| | 2 | 10,010 |
| | 3 | 10,010 |
| | 4 | 10,010 |
| | | 40,040 |
| Bhatpara | 1 | 6,819 |
| | 2 | 6,819 |
| | 3 | 13,638 |
| | 4 | 13,638 |
| | 5 | 13,638 |
| | | 54,552 |
| Serampore | 1 | 7,578 |
| | 2 | 7,578 |
| | 3 | 7,578 |
| | 4 | 3,791 |
| | 5 | 3,791 |
| | | 30,316 |
| Kalyani Notified Area Near Kalyani Rly. Station (Lift Station) | 1 | 3,536 |
| | 2 | 3,535 |
| | | 7,070 |
| Block 'A' (Near E S I Hospital) | 1 | 4,700 |
| | 2 | 2,370 |
| | 3 | 2,370 |
| | | 9,440 |

TABLE : 2 (Continued)

| (1) | | (2) | (3) |
|---|---|---|---|
| | | Raw Sewage Pumping Station | |
| Near National Rubber Factory | | 1 | 6,800 |
| | | 2 | 3,900 |
| | | 3 | 3,900 |
| | | | 14,600 |
| (Raw Sewage Pumping Station) | | 1 | 7,500 |
| | | 2 | 7,500 |
| | | 3 | 15,000 |
| | | 4 | 15,000 |
| | | 5 | 30,000 |
| | | 6 | 30,000 |
| | | | 240,000 |
| Salt Lake | Sewage Pumping Station No. 1 | 1 | 6,312 |
| | | 2 | 6,312 |
| | | 3 | 6,312 |
| | | | 18,936 |
| | Sewage Pumping Station No. 2 | 1 | 6,312 |
| | | 2 | 6,312 |
| | | 3 | 6,312 |
| | | 4 | 6,312 |
| | | | 25,248 |
| | Sewage Pumping Station No. 3 | 1 | 6,312 |
| | | 2 | 6,312 |
| | | 3 | 18,960 |
| | | 4 | 18,960 |
| | | 5 | 25,260 |
| | | 6 | 25,260 |
| | | 7 | 25,260 |
| | | 8 | 25,260 |
| | | | 151,584 |

TABLE : 2 (Continued)

| (1) | | (2) | (3) |
|---|---|---|---|
| | | Raw Sewage Pumping Station | |
| Howrah | Raw Sewage Pumping Station No. 1 (Outside S T P) | 1 | 31,540 |
| | | 2 | 31,540 |
| | Raw Sewage Pumping Station No. 2 (Inside S T P) | 1 | 31,540 |
| | | 2 | 31,540 |
| | | Intermediate Lift Pumping Stations | |
| Nimakmahal | | 1 | 4,243 |
| | | 2 | 4,243 |
| Mominpore | | 1 | 19,200 |
| | | 2 | 19,200 |
| | | 3 | 34,200 |
| | | 4 | 34,200 |
| | | 5 | 3,738 |
| | | 6 | 11,214 |
| | | 7 | 11,214 |
| | | 8 | 3,738 |
| Chetla | | 1 | 3,000 |
| | | 2 | 3,000 |
| | | 3 | Not available |
| Jodhpur Park | | 1 | 1,818 |
| | | 2 | 1,818 |
| | | 3 | 3,637 |
| | | 4 | 18,180 |
| | | 5 | 18,180 |
| Manicktola | | 1 | 3,364 |
| | | 2 | 3,364 |
| | | 3 | 11,214 |
| | | 4 | 11,214 |
| | | 5 | 11,214 |

TABLE : 2 (Continued)

| (1) | (2) | (3) |
|---|---|---|
| | Intermediate Lift Pumping Stations | |
| Belgachia | 1 | 4,546 |
| | 2 | 9,092 |
| Ultadanga | 1 | 20,559 |
| | 2 | 20,559 |
| | 3 | 20,559 |
| | 4 | 2,617 |
| | 5 | 2,617 |
| | 6 | 2,617 |
| | 7 | 2,617 |
| | 8 | 20,559 |
| | 9 | 20,559 |
| | 10 | 20,559 |
| | 11 | 20,559 |
| | 12 | 20,559 |
| Dutta Bagan | 1 | 31,560 |
| | 2 | 6,180 |
| | 3 | 15,900 |
| | 4 | 3,150 |
| | 5 | 15,900 |
| | 6 | 6,180 |
| Ballygunge (Old Building) | B | 121,227 |
| | C | 83,343 |
| | D | 83,343 |
| | E | 295,496 |
| | F | 295,496 |
| | G | 166,687 |
| Ballygunge (New Building) | 1 | 121,227 |
| | 2 | 121,227 |
| | 3 | 333,373 |
| | 4 | 333,373 |

TABLE : 2 (Continued)

| (1) | (2) | (3) |
|---|---|---|
| **Intermediate Lift Pumping Station** | | |
| Pulmers Bridge (Old Building) | A | 136,380 |
| | B | 128,803 |
| | E | 232,604 |
| | F | 216,693 |
| | G | 128,803 |
| | H | 128,803 |
| | I | 128,803 |
| Pulmers Bridge (New Building) | 1 | 416,717 |
| | 2 | 416,717 |
| | 3 | 416,717 |
| | 4 | 416,717 |
| Dhapa Lock | A | 3,410 |
| | B | 5,114 |
| | C | 8,524 |
| | D | 34,100 |
| **Terminal Pumping Station** | | |
| Chowbhaga (Old Pumping Stn.) | 1 | 84,960 |
| | 2 | 84,960 |
| | 3 | 84,960 |
| | 4 | 84,960 |
| | 5 | 84,960 |
| | 6 | 84,960 |
| | 7 | 84,960 |
| | 8 | 84960 |
| | 9 | 84,960 |
| Chowbhaga (New Pumping Stn.) | 1 | 84,960 |
| | 2 | 84,960 |
| | 3 | 84,960 |
| | 4 | 84,960 |
| | 5 | 84,960 |

TABLE : 2 (Continued)

| (1) | (2) | (3) |
|---|---|---|
| | Terminal Pumping Station | |
| Chowbhaga (New Pumping Stn.) | 6 | 84,960 |
| | 7 | 84,960 |
| | 8 | 84,960 |
| | 9 | 84,960 |
| | 10 | 84, 960 |
| Topsia (Old Police Stn.) | A | 28,640 |
| | B | 28,640 |
| | C | 28,413 |
| | D | 4,546 |
| Topsia (New Police Stn.) | 1 | 18,690 |
| | 2 | 18,690 |
| | 3 | 18,690 |
| Kulia Tangra | A | 6,819 |
| | B | n.a. |
| | C | 3,738 |
| | D | 2,002 |
| Pagladanga (Old Building) | 1 | 2,002 |
| | 2 | n.a. |
| Pagladanga (New Buildings) | 3 | n.a. |
| | 4 | 7,487 |
| | 5 | 7,487 |
| Birpara | 1 | 7,476 |
| | 2 | 11,214 |

Sources : (i) For pumping stations in Municipalities, see Operation and Maintenance Report (Prepared by CES - consultants and Published by CMDA), 1978.

(ii) For Calcutta City's pumping stations, data are collected from Calcutta Municipal Corporation.

TABLE : 3

COMPERATIVE COST OF SEWERAGE PROJECTS IN FEW SELECTED MUNICIPALITIES

| Name | Population 1981 | Cost of sewerage scheme (Rs. mill.) | Per Capita cost (Rs.) | Population density (per sq.km.) |
|---|---|---|---|---|
| Panihati | 101,500 | 100.0 | 619.19 | 8310 |
| Garulia | 51,500 | 31.0 | 601.94 | 9255 |
| Barrackpore | 161,800 | 67.5 | 644.08 | 8994 |
| North Barrackpore | 89,400 | 55.0 | 615.21 | 10618 |
| Naihati | 91,800 | 56.0 | 610.02 | 21105 |
| Halisahar | 74,200 | 45.0 | 606.46 | 5242 |

Source : Consultants' Report on Sewerage and Drainage Basins for CMD Zone III (CMDA).

TABLE : 4

WATER SUPPLY IN THE DIFFERENT MUNCIPALITIES AND MUNICIPAL CORPORATION OF C M D

| Name of Municipal Bodies | Gross Supply/ day litres | Per Capita Supply/ day litres |
|---|---|---|
| Calcutta Corporation (0) | 1160 | 291 |
| Howrah (0) | 27 | 37 |
| Bally | 2 | 18 |
| Bansberia | 11 | 143 |
| Chinsurah | 19 | 150 |
| Chandannagar | 8 | 79 |
| Bhadreswar | 5 | 85 |
| Champdani | 3 | 42 |
| Baidyabati | 3 | 36 |
| Serampore (0) | 11 | 90 |
| Rishra | 8 | 99 |
| Konnagar | 2 | 39 |
| Uttarpara - Kotrung | 6 | 71 |
| Kanchrapara | 8 | 92 |
| Halisahar | 18 | 193 |
| Nalhati | 6 | 50 |
| Bhatpara (0) | 2 | 8 |
| Garulia | 1 | 25 |
| North Barrackpore | 2 | 20 |
| Barrackpore | 3 | 26 |
| Titagarh (0) | 7 | 66 |
| Khardah | 4 | 93 |
| Panihati | n.a. | n.a. |
| Kamarhati | 7 | 31 |
| Baranagar | 7 | 43 |
| Garden Reach | 6 | 30 |
| Budge Budge | 2 | 38 |
| South Suburban | n.a. | n.a. |
| North Dum Dum | 3 | 27 |
| Dum Dum | 7 | 196 |
| South Dum Dum (0) | 2 | 9 |
| Kalyani NA (0) | 12 | 331 |

Note : (i) '0' - Represents municipalities having underground sewerage system.

(ii) n.a. - Not available. Calcutta Corporation has 210 thousand house connections.

(iii) Sewerage system is proposed for areas with water supply of the order of 130-140 lpcd.

Source : Municipal Finance Commission's Report 1982.

TABLE : 5

SEWERAGE AND DRAINAGE SITUATION IN MUNICIPALITIES OF WEST BENGAL

INFORMATION REGARDING DRAINS BOTH UNDERGROUND AND SURFACE

| Name of the District and Municipality | Total Length of the Drain in km. | Kutche | | Pucca | | | |
|---|---|---|---|---|---|---|---|
| | | | | Surface | | Underground | |
| | | Absolute length km | % to total length (km) | Absolute length km | % to total length (km) | Absolute length (km) | % to total (km) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| HOWRAH | | | | | | | |
| Howrah | 593 | 68 | 11.47 | 500 | 84.32 | 25 | 4.23 |
| Bally | 88 | 46 | 52.27 | 42 | 47.73 | - | - |
| HOOGHLY | | | | | | | |
| Bansberia | 82 | 23 | 28.05 | 53 | 64.63 | 6 | 7.32 |
| Chinsurah | 170 | 77 | 45.29 | 90 | 52.94 | 3 | 1.77 |
| Chandannagar | 161 | 117 | 72.67 | 40 | 24.84 | 4 | 1.49 |
| Bhadreswar | 97 | 21 | 21.65 | 76 | 78.35 | - | - |
| Champdany | 51 | 4 | 7.02 | 53 | 92.98 | - | - |
| Baidyabati | 71 | 56 | 78.87 | 15 | 21.13 | - | - |
| Serampore | 186 | 96 | 51.61 | 80 | 43.01 | 10 | 5.38 |
| Rishra | 32 | 20 | 62.50 | 10 | 31.25 | 2 | 6.25 |
| Konnagar | 92 | 80 | 86.96 | 10 | 10.87 | 2 | 2.17 |

TABLE : 5 (Continued)

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| HOOGHLY | | | | | | | |
| Uttarpara | 66 | 39 | 59.09 | 25 | 37.88 | 2 | 3.03 |
| Arambagh | 10 | 6 | 60.00 | 4 | 40.00 | - | - |
| 24-PARGANAS | | | | | | | |
| Kanchrapara | 43 | 8 | 18.60 | 35 | 81.40 | - | - |
| Halishahar | 43 | 40 | 93.02 | 2 | 4.65 | 1 | 2.33 |
| Naihati | 62 | 28 | 45.16 | 26 | 41.94 | 8 | 12.90 |
| Bhatpara | 13 | 12 | 92.31 | - | - | 1 | 7.69 |
| Garulia | 34.3 | 9 | 26.24 | 25 | 72.89 | 0.3 | 0.01 |
| North Barrack-pore | 107 | 99 | 92.52 | 8 | 7.48 | - | - |
| Barrackpore | 88 | 60 | 68.18 | 28 | 31.82 | - | - |
| Titagarh | 43 | 3 | 6.98 | 40 | 93.02 | - | - |
| Khardah | 16 | 10 | 62.50 | 6 | 37.5 | - | - |
| Panihati | 327 | 311 | 95.11 | 16 | 44.29 | - | - |
| Kamarhati | 210 | 117 | 55.71 | 93 | 44.29 | - | - |
| Baranagar | 221 | 25 | 20.66 | 96 | 79.34 | - | - |
| Garden Reach | 39 | 13 | 33.33 | 26 | 66.67 | - | - |

TABLE : 5 (Continued)

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| 24-PARGANAS | | | | | | | |
| South Suburban | - | - | - | - | - | - | - |
| Jadavpur | - | - | - | - | - | - | - |
| Barasat | 265 | 256 | 96.60 | 9 | 3.40 | - | - |
| New Barrackpore | 150 | 140 | 93.33 | 9 | 6.00 | 1 | 0.67 |
| North Dumdum. | 161 | 160 | 93.38 | 1 | .62 | - | - |
| Dum Dum | 27 | 5 | 18.52 | 16 | 59.26 | 6 | 22.22 |
| South Dumdum | 240 | 195 | 81.25 | 30 | 12.50 | 15 | 6.25 |
| Rajpur | 50 | 48 | 96.00 | 2 | 4.00 | - | - |
| Baruipur | 61 | 52 | 85.25 | 9 | 14.75 | - | - |
| Kalyani | 350 | - | - | 200 | 57.14 | 150 | 42.86 |
| Gayeshpur | 200 | 100 | 50.00 | 100 | 50.00 | - | - |

Source Municipal Finance Commission's Report, 1982

TABLE : 6

COST ESTIMATES OF VARIOUS SCHEMES FOR IMPROVEMENT OF DRAINAGE AND SEWERAGE SYSTEM IN CALCUTTA

1st Phase :

| S C H E M E S | Cost (Rs. million) |
|---|---|
| 1. Desilting of 75 M M Trunk Sewers 2 lakh of Silt at the rate of Rs. 100/M | 20.0 |
| 2. Replacement of age-old Pumping Units | 15.0 |
| 3. Construction of new Pump House | 40.0 |
| 4. Enlargement of section to remove inadequacy of capacity - approx. 288 of arterial net work - 200 K M at the rate of Rs. 900/M | 180.0 |
| 5. Providing sewerage facilities in the unsewered areas : | |
| a. In City Basin including construction of Treatment Plant - 7822 acres at the rate of Rs. 0.907 lakh per acre | 709.8 |
| b. In City Basin excluding construction of Treatment Plant - 350 acres at the rate of Rs. 80,000 | 28.0 |
| c. Primary facilities in South Suburban, Jadavpur and Garden Reach Units - 261 K M at the rate of Rs. 35.36 lakh/K M | 922.9 |
| 6. Improvement of outfall channels including Block Pitching, providing/improving pathway for the facilities of inspection etc. at Circular Canal, Beliaghata Canal, Suburban Head Cut | 300.0 |
| 7. Renovation/repairing of brick sewer - 30 K M (188 of trunk sewers) Rs. 12,000/M | 360.0 |
| 8. Repairs and providing Penstock Gates | 2.0 |
| 9. Laying of additional sewer in low-lying pockets for removal of water logging 130 K M at the rate of Rs. 1200/M | 156.0 |
| 10. Construction of additional manholes, lamp holes, Gullypits in the City Basin | 20.0 |
| 11. Renovation/Repairs to the sewers cleansing equipment including construction of garage, purchase of wireless set, walkie talkie etc. for better communication | 23.6 |
| | 2777.3 |
| Add : 25% escalation | 694.3 |
| Rs. | 3471.6 |

TABLE : 6 (Continued)

2nd Phase

| S C H E M E S | Cost/ (Rs. million) |
|---|---|
| 1. Replacement of age-old Pumping Units | 35.0 |
| 2. Construction of New Pump House | 59.7 |
| 3. Enlargement of Section to remove inadequacy of capacity 80 Km at the rate of Rs. 900/M | 72.0 |
| 4. Providing sewerage facilities in the unsewred area : Secondary facilities in South Subarban, Jadavpur and Garden Reach Units - 18352 acres at the rate of Rs. 40,000/- per acre | 734.1 |
| 5. Improvement of outfall channel i.e. D W F, S W F etc. Channels - 34 Km | 200.0 |
| 6. Renovation/Repairs of Brick Sewer 30 KM at the rate of Rs. 12,000/- per M 3 KM at the rate of Rs. 15,000/- per M | 405.0 |
| 7. Extn. of Brick Sewer/Syphon at D L P S | 22.5 |
| 8. Shifting Water main from the Trunk Sewer | 3.0 |
| 9. Providing corridor over Trunk Sewer for facility of maintenance when it passes through private land etc. | 9.0 |
| 10. Primary Treatment Plant | 50.0 |
| 11. Renovation of Quarters | 15.0 |
| | 1605.3 |
| Add : escalation 25% | 401.3 |
| | 2006.6 |

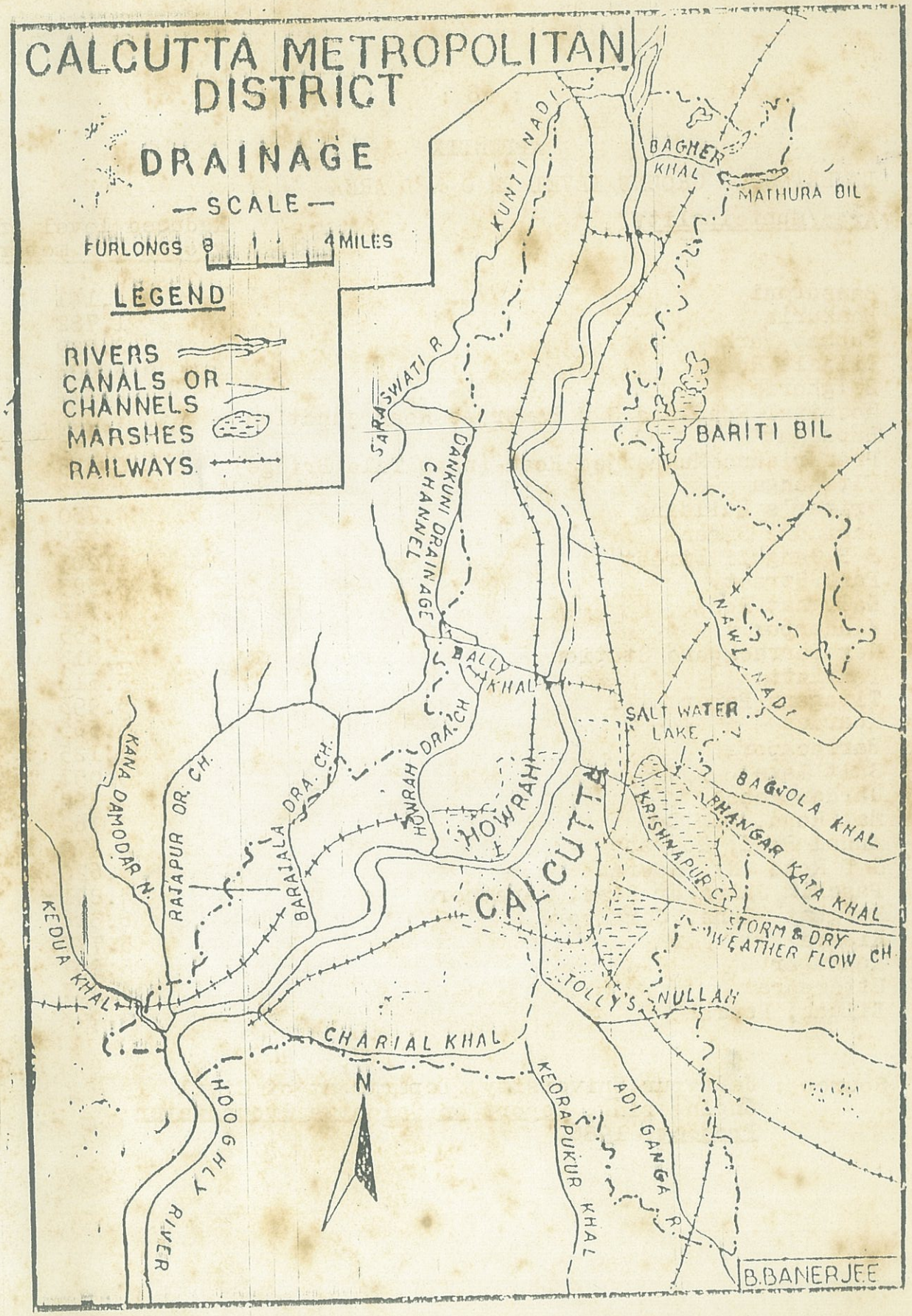
Source : Calcutta Corporation, Calcutta - a city of Joy, 1986.

APPENDIX

LOWERING OF GROUND LEVEL IN C M D AREA

| Area/Municipality | Reduced level of ground (in meters) |
|---|---|
| Bansdroni | 4.141 |
| Dhakuria | 1.782 |
| Subhas Park | 2.809 |
| Tiljala Road | 3.803 |
| Belghoria | 2.177 |
| Hospital Road and S N Banerjee Road junction | 7.000 |
| Babughat | 4.545 |
| Prankrishna Mukherjee Road (near Tala Bridge) | 6.935 |
| Ultadanga | 4.372 |
| Writer's Building | 4.730 |
| Rabindra Sarani | 6.335 |
| B B Ganguli Street | 7.263 |
| Park Street | 3.523 |
| Kalighat Road | 4.742 |
| Kidderpur | 4.255 |
| New Barrackpore Station | 4.613 |
| Panihati | 5.510 |
| Titagarh Paper Mill | 5.995 |
| Khardah | 6.565 |
| Barrackpore | 6.125 |
| Salt Lake | 3.097 |
| Garden Reach | 4.789 |
| Mal Road, Dum Dum | 3.762 |
| Andul Road, Howrah | 4.479 |
| G T Road (N), Howrah | 5.620 |
| Paschim Jamnagar Road, Serampore | 4.841 |
| Royghat Lane, Serampore | 6.316 |
| Rishra | 5.777 |
| Konnagar | 5.807 |
| Uttarpara | 4.767 |
| Liluah, Howrah | 4.442 |

Source : Jadavpur University, Department of Civil Engineering, Report on Calcutta Groundwater Project, 1986.




MAP-1

SOURCE: B. Banerjee and D. Roy, Industrial Profile of the Calcutta Metropolitan District, Calcutta: India Publication, 1967.