

Module Two: Sewerage and Drainage

Indian Cities^{1, 2}

India has been undergoing rapid urbanization since Independence. While the total population of India in 1947 was about 270 million, the total population in 2016 is 1327 million, with the urban population standing at 430 million.

While Indian Cities have expanded, their drainage systems have not kept pace with building growth nor with the provision of Water Supply. In almost all Indian cities, developments in the Water Supply Sector have outpaced those in the Drainage Sector.

With increasing Water Supply to Cities, Drainage Managers are faced with additional Waste Water from populated areas for which the existing Drains are totally inadequate. Encroachment on Flood Plains as well as Inadequate Sewerage Systems flowing into Storm Drains mean that these drains cannot cope with Monsoon Runoff.

This module looks at the history, status and attempt of Kolkata Metropolis to tackle these problems.

Kolkata City³

The Metropolis of Kolkata has been facing acute drainage problems from its very birth burgeoning over three marshy and obscure hamlets since 1690.

Kolkata lies on the left bank of river Hugli about 130 km upstream of its confluence with the Bay of Bengal. The bank of the river has developed as a natural levee and the general slope of the land is Eastwards from the river bank.

Drainage and Sewerage History^{4, 5}

Initially, the drainage of this city had been effected against the general slope i.e. Westwards through the now defunct creek which ran from Salt Lake (now reclaimed) in the East to Hugli river at Princep Ghat on the West. Later on, excavation of Maratha Ditch (present Circular Road), which circumscribed the City in 1742 rang the death knell of the creek. River Bidyadhari has since then

served as an outlet for the drainage of the city for a long period from 1856 to 1928.

The situation was so bad during the early years that a large number of people succumbed during the rains, every year, throughout the eighteenth century. This state of affairs continued upto the middle of 19th century when efforts were initiated to improve the drainage.

The drainage systems of the city have been designed as a combined system for the disposal of Storm Water as well as Sewage and Dry Weather Flow. The core of the system had been proposed in 1855 and constructed during 1860-1875 to cover originally an area of 1920 hectares. Subsequent modifications and augmentations during 1891-1906 brought another 3200 hectares in the newer southern areas of the city under the sewerage system. The sewage from the combined drainage system flowed into the creek of the tidal river, Bidyadhari / Vidyadhari, on the east of the city.

Burdened with the entire city's drainage system River Vidyadhari began to show signs of rapid deterioration. In 1943, a new scheme for both the outfall and the internal drainage system was commissioned. Since then, the system has undergone major modifications and expansion to meet the city's rapid growth. The Master Plan prepared by the WHO for the Kolkata Metropolitan District in the 1960s dealt with these issues and has provided the guiding framework since then.

Rains in Kolkata⁶

Rains brought by the Bay of Bengal branch of South-West monsoon lash the city between June and September and supplies the city with most of its annual rainfall of 1,582 mm (62.3 inches). The highest rainfall occurs during the monsoon in August (306 mm).

Kolkata City is 6.9 metres (20 feet) above mean sea level. Draining is difficult, even when rain is modest but the task becomes alarmingly difficult whenever intense precipitation and the high tide in the Hugli river coincide.

Typical flooding during Kolkata Monsoons⁷

Though there was little or no downpour on 6th September 2016, the rainfall of around 110 mm in just three hours on 5th September 2016 along with the high

tide – raised the water level in the Hugli which serves as the main outlet for Kolkata’s drainage system – enough to keep many parts of the city under water.

“The city received around 110 mm of rainfall in three hours, which means hourly rainfall was 37 mm. It was enough to drown the roads because our drainage system cannot handle more than 20 mm of rain in one hour,” said Tarak Singh, member, Mayor-in-Council (Drainage) of the KMC.

Making matter worse was the high tide in the Hugli on Monday (5th September 2016) evening –the water level in the river swelled to 5.97 metres, said KMC officials. “We usually open the lock gates that allow drain water to enter the river or the canals when water level in the river is below 2.5 metres. Since the water level was so high all night we could not open the lock gates even on Tuesday (6th September 2016) morning,” said a KMC engineer.

Sewer Desilting⁸

Siltation of the trunk sewer system is seen as the biggest issue facing Kolkata at present. It is assumed that at least 60% of the sewer capacity on average is filled with silt, and this will need to be removed as a priority. And as a regular ongoing measure.

Alleviation of Flooding^{9,10, 11, 12, 13,}

Along with the urgent need for sewer desilting, the alleviation of flooding should have also been accorded high priority. But this has not been done.

Kolkata's old 'khal' or canal system, which acted as an effective drainage system for some three centuries is in disrepair. Many Waste Water conduits out of the city such as storm-water drains, sewers and canals are silted. Besides, gully pits are blocked and there is a time lag for water to reach the pumping stations. This leads to flooding on the surface.

The original design of Calcutta's drainage system was based on the drainage capacity of the sub-basins. (Kindly refer to Annexure One). But the unplanned diversion of Surface Runoff from one sub-basin to another is one of the reasons for overloading of the existing drains resulting in flash floods.

In the metropolitan part of the city, the demise of small water bodies, has created problems in holding capacity of Surface Runoff and Waste Water recharge. The filling up of ponds and marshlands to obtain real estate for residential and commercial purposes has led to increased problems of drainage and flooding.

The Municipal Authorities have done precious little about the filling up of water bodies, unabated construction of high rises and roads, decrease in open surface areas and increase in impervious surface areas.

Except for some resettlement of Canal Residents – as a part of the statutory obligations towards meeting the Canal Improvement (CI) – the Municipal Authorities has also neglected the traditional roles of the Canals in the cities.

The Canals, with their prime function being carriage of Storm Water and Sewage (to the East Kolkata Wetlands) are now choked with silt, filth and debris.

The health and economic loss due to flooding in Kolkata City every year is alarming and phenomenal, yet nothing is done about it.

Pump Stations¹⁴

The major pumping station buildings require upgradation. The hydraulics of the sewers upstream of the pump station is unsatisfactory and needs to be improved – the sewers are too flat and operate in a flooded condition reducing their flow capacity.

Channels¹⁵

Due to a paucity of funds, periodic maintenance is not undertaken. Responsibility for maintenance of the channel system lies with the Irrigation and Waterways Department (I&WD) whilst the maintenance of the trunk sewers and pump stations is the responsibility of the KMC. This separation of responsibility for different parts of the drainage systems leads to problems. The budgets for channel maintenance are inadequate.

Sewage Treatment¹⁶

The majority of the sewage (DWF) from the core inner city area, about 1,100 MLD in magnitude, receives **no formal treatment (!)** and is discharged via the DWF channel 36 km distant to the Kulti River. In the medium to long term, Waste Water treatment is recommended to control disease and to protect the receiving water environment of the River Kulti.

Waste Water Treatment¹⁷

Total treatment capacity at three existing STPs is **154** MLD. MLD is million litres daily.

Current treatment in East Kolkata Wetlands is **966** MLD but the East Kolkata Wetlands still have a large surplus capacity to treat waste water.

These are sewerage baseline service level indicators status 2011.

KMC Sewerage and Drainage Department¹⁸

The KMC Sewerage and Drainage Department strives to provide safe and sufficient outfall for effectual drainage and provide proper discharge of Storm Water and sewage of Kolkata with minimal inconvenience to the citizens.

The Vision – from 1860 to 1875¹⁹

The sewer network / brick sewer was laid during 1860 to 1875 and it was designed to discharge a rainfall of 6 mm per hour. The main parts of the sewer network consist of century-old brick sewer of length 180 km. Most of the drainage pumping stations were constructed 50 to 100 years back.

The underground sewage network spreading under Calcutta, built back in 1875 by the British settlers, was equivalent to the systems of European cities like London and Hamburg, Germany. Being in operation for over than 130 years, but with no significant maintenance work performed, the 2006 cave-ins urged for de-silting operations and structural rehabilitation. The maintenance works were undertaken in 2007 by the Kolkata Municipal Corporation, which today are almost complete. Upon completion, it is estimated that the flooding affecting the city every monsoon will be largely controlled.

Being built 130 year ago, Calcutta's sewage tunnel system is perhaps the most complicated system than any other city's system, receiving both Storm and

Waste Water. It is still amazing that it was built so large than it can nowadays serve the needs of its 22 million people, daily visitors included. Given the above and the lack of any serious maintenance work performed since its first operation, engineers and contractors faced a major challenge during the restoration works.

Sewage Generation and Collection²⁰

All estimations of Kolkata's sewage generation are, necessarily, off the mark – as the city has no idea how much Waste Water is extracted from private sources, and hence, how much Waste Water is generated from it. Geography also determines its sewage disposal.

The drainage slopes to the sea, in the east of Kolkata. But over the years, unplanned growth and construction over its drainage outlets and Wetlands has left the city exposed to floods and sewage backflows.

East Kolkata Wetlands²¹

The expanding city is overrunning the Eastern Kolkata Wetlands, the natural draining ground for the easterly sloping city. Some of the Wetlands have already been lost to Hotels, High Rises and Apartments Blocks.

It would be an environmental tragedy if the high rises were to cross into the East Kolkata Wetlands beyond the Eastern Metropolitan Bypass and from the Rajarhat side.

The work now²²

The Kolkata town system sewer network is 140 years old and the suburban system is 100 years old. The brick sewers in these two systems have already outlived their life and silted and are collapsing at various locations primarily where tram line is in operation. The project influence area consists of following sewerage / drainage network:

- Man-entry brick sewers: 88 km **{i. e. sewers above 1.07 m (42 in.) diameter}**
- No-man entry brick sewers: 92 km
- Pipe sewers: 1207 km

The part of sewer network under consideration upgraded / to be upgraded has 36.271 km of non-man entry brick sewers spread across various sections / locations of the project influence area for town system and suburban system.

A Journey Into the 140-Year-Old Tunnels Below Calcutta^{23,24}

Built back in 1875 by the British rulers, this elaborate underground sanitation network in eastern India was, at the time, matched only by the systems in London and Hamburg, Germany. Almost 130 years later, in 2006 and 2007, the Kolkata Municipal Corporation (KMC) began cleaning the tunnels, which had become choked with silt. The task was monumental, but by 2014, the challenge has nearly been met by the KMC engineers and contractors.

Despite the system's capacity, however, it would be considered structurally flawed by today's engineering standards, in part because of its lack of redundancy. "We have no parallel sewer," says Tytues. "We do not have storm sewer or sanitary sewer separately like in other cities when you can divert the sewer to one and make the other dry."

Dr. Nilangshu Bhusan Basu, the principal chief engineer of the KMC's planning and development department and the team leader on the brick sewer rehabilitation project, explains why. "Kolkata receives an average annual rainfall of more than 1,800 mm, mostly during the monsoon. As a result, the system of underground sewers that was subsequently constructed was sized to convey Storm Water as well as Waste Water, and the network of brick sewers remains a combined system to this day."

Hence, the critical task of keeping that combined network clean – when monsoon season arrives, the waste from the city's sinks and toilets must compete with the terrific deluge from the sky. The men down here perform their job under gruelling conditions. The sharp odour of human waste is so overpowering that removing a mask for just a few seconds makes one feel dizzy. Below one's feet, one can feel the deep siltation through thick boots; the workers sometimes wade through this muck through the tunnels for more than a kilometre, forced to navigate the labyrinth in the absence of manholes, which were built by the British every thirty meters, but were later covered over by the unplanned urbanization above ground.

Pumps drain the tunnels so they'll be dry when engineers line them with glass reinforced polymer (GRP).

According to one of the engineers working in the tunnels, the successful performance of the sewage system was proved in August 2013, when streets did not flood for long after the city received about 430 millimetres of rainfall in just four days.

Coming to Terms with Water Logging^{25,26}

The city typically faces water-logging every monsoon. The main reasons of water-logging are:

1. Reduction of Hydraulic Capacity of the sewerage system due to heavy siltation.
2. Century old brick sewers in poor structural condition along most stretches leading to collapse.
3. Rapid urbanization and destruction of wetlands resulting in increased runoff reaching the sewers.
4. Century old pumps and pumping machineries of the pumping station.
5. Silted up outfall canals in and around Kolkata.

KMC has undertaken several measures to prevent water logging through upgradation of sewerage and drainage systems over the past few years. It involved upgrading the existing infrastructure and rehabilitation of the century old brick sewers and pumping stations.

Over the years, the Municipal Authorities have added to their equipment such as Gully Pit Emptiers, Blow Vac Machine, Jetting Cum Suction, Jetting, Suction and Rodding machines.

It has also augmented the Storm Water Drainage Pumping Stations capacities to ___ MLD. It has also undertaken repair and renovation of existing drainage pumping stations.

This year, under Kolkata Environmental Improvement Project (KEIP), with assistance of Asian Development Bank (ADB) a major project of Rs. 1,900 Crore has already started. This includes improvement of sewer system / network, repair, renovation, augmentation of the existing pumping stations,

construction of new pumping stations, re-excavation of existing drainage canals and rehabilitation thereof.

Outfall Channel Responsibility^{27, 28}

In Kolkata, most drains discharge via outfalls and a number of pumps are needed to pump out the excess Storm Flows during the Monsoon to the nearby channels. However, due to inadequate maintenance of the outfalls, the outfalls have become silted to such an extent that in some cases the storm drainage lines discharging into them now lie embedded in silt. Surcharging of sewers is commonly observed, resulting in waterlogging of nearby areas.

A single organisation – Kolkata Municipal Corporation or Department of Municipal Affairs -should be made responsible for operation and maintenance of the outfall channels. In the past maintenance of the channels has resided with I&WD but there has been a paucity of funds for effective channel maintenance. There are about seven channels in the KMC area for whose maintenance no one is responsible. These channels should also be taken over by KMC or Municipal Affairs.

Paying for Sewerage and Drainage^{29,30}

Cost recovery by KMC from the municipal services it provides is small. Financing options for major projects such as those outlined in the Master Plan include increased cost recovery for S & D by increased water and sewerage rates, increased property tax recovery; funding from the State and Central governments; or ADB or World Bank funding of targeted projects.

Water bodies of Kolkata³¹

Water bodies of Kolkata requires urgent management initiatives say NGOs that works for Wetlands Development. Water bodies are essentially water resources for poor people. Hence, efforts to improve people's quality of life must include a plan to use these water bodies wisely. The encroachment and filling of water bodies in the urban areas are taking place because of lack of planning, information and management. And of course, malafide intention.

Sewage-fed aquaculture in Wetlands³²

Kolkata has a unique system for the utilisation of sewage in the Eastern suburbs of the city. For a long time now, the vast wetland there has supported sewage fed fisheries, which supply a considerable quantity of fish to the Kolkata market. Sewage irrigation is also practiced to produce vegetables for bulk supply to the city.

Conclusion

Kolkata Metropolis is still a long way off before it lessens its exposure to Monsoon Flooding.

Desiltation by Contractors is becoming the new norm.

The East Kolkata Wetlands account for 85 per cent of sewerage treatment of Kolkata Metropolis. The East Kolkata Wetlands speak for themselves as Mother Nature's very own solution to Mankind's refuse.

In such a scenario, the Kolkata Metropolis Municipal authorities would do well to increasingly resort to the use of Water Bodies, clean choked up Canals and enhance Wetlands usage.
