6. STORM WATER DRAINAGE

6.1. Existing Situation

6.1.1. Storm Water Drainage Network

Mumbai city receives seasonal rainfall for four months i.e. from June to September. Average rainfall is 2,000 mm, of which 70 per cent is during July & August. Mumbai is lined on the west by Arabian Sea and is intercepted by number of creeks (Mahim, Mahul and Thane creeks), rivers (Mithi, Dahisa, Poisar and Oshiwara rivers, and their tributaries) and a complex nallah system.

The SWD system of Mumbai comprises a hierarchical network of roadside surface drains (about 2,000 km mainly in the suburbs), underground drains and laterals (about 440 km in the island city area), major and minor nallahs (200 km and 87 km respectively) and 186 outfalls, which discharge all the surface runoff into rivers and the Arabian Sea.

Table 24: Summary of the storm water drainage system

Sl.	Drain Hierarchy / Type	Island City	Western Suburbs	Eastern Suburbs	Total
1	Major Nallah (width >1.5m)	9	90	102	200
2	Minor Nallah (width <1.5m)		21	66	87
3	Arch/Box Drains	59	40	52	151
4	Roadside Open Drains	20	669	1,298	1,987
5	Closed Pipe or Dhapa Drains	443	36	86	565
6	**Total SWD length**	**531**	**857**	**1,603**	**2,991**
7	No. of Water Entrances	27,893	609	1,706	30,208

Note: The above figures (for Sl. 1 to 6) are lengths in kilometers

Of the 186 outfalls, there are 107 major outfalls in city, which drain to Arabian Sea directly, 4 at Mahim creek and 4 at Mahul creek. There are 29 out-falls in western suburbs draining directly into sea while 14 drain into Mithi river which ultimately joins Mahim creek. In eastern suburbs 14 out-fall discharge in Thane creek while 6 discharge in Mahul creek.

Table 25: Summary of the storm water discharge system in Mumbai

Sl.	Outfall discharging into:	In Island City Area	In Western Suburbs	In Eastern Suburbs	Total
1	Arabian Sea	107	29	0	136
2	Mahim Creek	4	14	8	26
3	Mahul creek	4	0	6	10
4	Thane Creek	0	0	14	14
	Total	**115**	**43**	**28**	**186**

6.1.2. Flooding

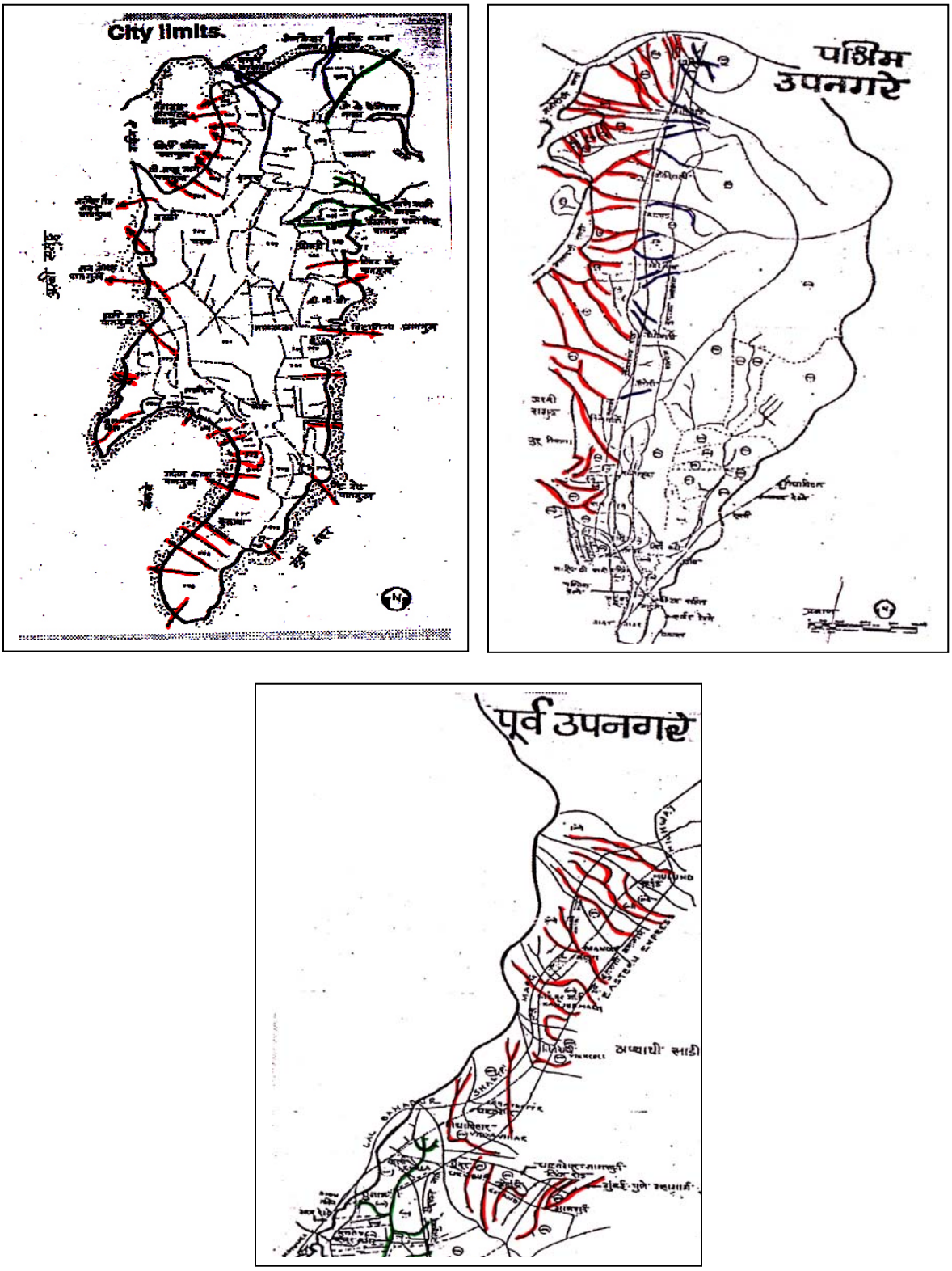
The core of the present SWD system in city is about 70 year old, comprising of about 400 km of underground drains and laterals built on the basis of population and weather conditions. The old SWD system is capable of handling rain intensity of 25 mm per hour at low tide. If the rain intensity is more than 25 mm per hour and high tide occurs, there is always a possibility of water logging.

Since the discharge of all the storm water and treated sewage is into the Arabian Sea, tidal variation has a major bearing in the system of storm water drainage (SWD) resulting in flooding and water logging during heavy rains and recession of water during low tide.

There was heavy rainfall in June 1985 when entire City was flooded rail & road traffic was disrupted and industry suffered heavy losses. Low-lying areas were marooned. Such events occur 2-3 times in a year even today. Apart from the agony faced by the flood-affected people, the losses due to flooding per day in such events are to the tune of Rs. 100 crore.

Most of the key reasons for flooding apart from tidal variations, flat gradients, mud flats (in the eastern catchments, which cause excessive siltation), are manmade inappropriate levels of outfalls, poor placement of gullies, loss of holding ponds due to land development over the years and increase in runoff coefficient, dilapidated drains (especially in the island city area), encroachments on drains, enhanced silting and choking of drains due to sullage/sewage inflows and garbage dumping in drains, obstruction due to crossing utility lines, poor structural conditions, etc.

Figure 4: Map showing location of outfalls in Greater Mumbai

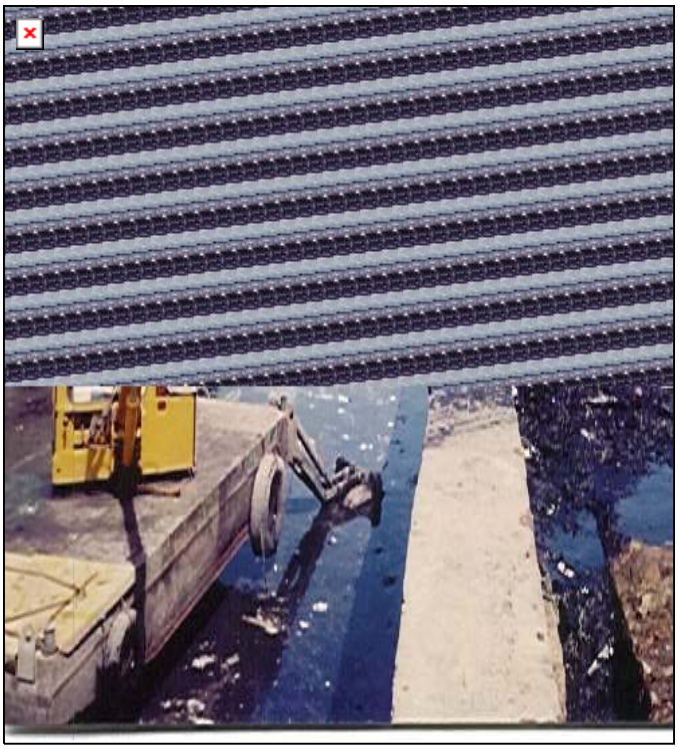


Some of the major flood-prone areas in Greater Mumbai are presented in the following table

Table 26: Summary of Flood-prone areas in Greater Mumbai

Sl.	Location Name	Remarks
A.	Island City Area	
1	Carnac Bunder	
2	Sandhurst Road Station Area (Low Level)	
3	Sleater Road, Nana Chowk, Grant Road (W)	
4	Maratha Mandir, Mumbai Central	This flooding spot is partially eliminated due to improvement works carried out in the past.
5	Satrasta, Mahalaxmi (E).	
6	Sakhubai Mohite Marg, Curry Road	
7	Hindmata Cinema, Dr. B.A. Road, Parel	
8	Dadar T.T.	
9	Gandhi Market, King Circe	This flooding spot is eliminated due to improvement works carried out in the past.
10	Rafi Ahmed Kidwai Marg, Shivdi, Wadala	This flooding spot is eliminated due to improvement works carried out in the past.
A	Western Suburbs Area	
1	Gazdarbund, Santacruz (W)	
2	Milan Subway, Santacruz (W)	
3	Malad Subway, Nutan VIdya Mandir, Malad	
4	Valnai Joglekar Nalla Area in R/South Ward	
C	Eastern Suburbs Area	
5	Indira Steel Yard, Mulund (W)	This flooding spot is eliminated due to improvement works carried out in the past.
6	Damodar Park, L.B.S. Marg, Ghatkopar (W)	
7	Postal Colony, Chembur	This flooding spot is eliminated due to improvement works carried out in the past.
8	Umarshi Bappa Chowk, Hemu Kalani Marg, Chembur	
9	Brahmanwadi, Kurla (W)	

6.1.3. *SWD Maintenance Equipment*



MCGM has a total of 63 vehicle mounted equipment of various types for maintenance of the SWD system, including amphibious dredgers, jetting and suction machines and other customized vehicle mounted equipment for dredging, de-silting, and de-choking of drains. However, of the 63 such equipment, about 24 are mounted on vehicles that are over 8 years of age and are rendered non-usable as per the ruling of Honorable Supreme Court / Regional Transport Office Norms. Moreover, there are several drain stretches in case of drains where dense slum encroachments alongside them that restrict application of such equipment

Table 27: Summary of SWD maintenance equipment in MCGM

Sr.	Type of Equipment (Vehicle-mounted)	Total Nos.	No. with age over 8 years	No. with age less than 8 years
1	Firex Machine	12	10	2
2	Suction Machine	9	4	5
3	Jetting Machine	3	1	2
4	Suction Cum Jetting Machine	4	2	2
5	Mahabali Machine	28	-	28
6	Dumper	4	4	0
7	JCB	1	1	0
8	Foun Machine	1	1	0
9	Trucks	1	1	0
	Total	**63**	**24**	**39**

6.1.4. *MCGM Initiatives for SWD Management*

MCGM has taken several assorted initiatives to address some of the causes for flooding, like

a. Permitting developers to cover stretches of nallahs near their properties at their own cost based on in a manner that facilitates cleaning of the drains – this was intended to reduce the amount of garbage getting into the SWD system.

b. Instructing the Assistant Commissioner of each Ward to remove encroachment coming

within 5 meters from the nallah edges, wherever possible to provide access for desilting.

c. Plugging connections/entry of sewage/sullage into the SWD system so as to ultimately prevent discharge of silt and solid waste into the creeks/rivers/Arabian Sea,. Wherever such plugging is not possible, the MCGM is attempting pick-up of dry-weather flows from the discharge points and pumping it into the sewerage system – as a pilot case, MCGM proposes to tap the adulterated storm water at the discharge point of P.Balu and Kirti College outfalls by gravity mains upto a new pumping position and to pump the collected dry-weather flow into the regular sewerage system.

6.2. Proposals / Plans for Storm Water Management & Drainage

6.2.1. BRIMSTOWAD Project Proposal

Following the sever flooding in 1985, MCGM carried out an extensive study to diagnose the storm water drainage system and prepare a master plan for storm water drainage system in Greater Mumbai so as ensure efficient storm water drainage and to address the recurrent flooding issue – the Brihanmumbai Storm Water Drain (BRIMSTOWAD) project. The BRIMSTOWAD project was prepared in 1993, MCGM has carried out only about 15 per cent of the recommendations. Some of the reasons for non-implementation of the project recommendations are:

a. Lack of financial resources

b. Institutional hurdles as a multiplicity of agencies were involved with regards procedural formalities for permission and execution of specific components, ownership of the water bodies,

c. Shifting of utilities,

d. CRZ issues with regards construction of pumping stations at outfall locations,

e. Encroachment removal issues, rehabilitation and relocation costs and implementation issues, etc.

On 26 July 2005 and for subsequent days, Mumbai experienced one of the worst floods ever due to unprecedented rains. There was a huge damage in terms of loss of life, property and to the overall economy of the city and state.

MRPDA and CWPRS, appointed by the Government of Maharashtra to survey the Mithi river from Mahim causeway to Vihar lake suggests widening and deepening of the river path with immediate effect – prior to the monsoons in 2006 – MCGM has provisioned about Rs. 20 crore to undertake the works identified therein and is in the process of implementation of the works. Similarly, WAPCOS has been mandated to study three rivers, viz. Oshiwara, Poisar and Dahisar on similar lines.

6.2.2. Improvement of Mithi

Mithi River originates in the Vihar lake area, flows southwards and through the Bandra-Kurla Complex, and finally meets Arabian Sea at Mahim bay. For a large part of its southern course it is influenced by tidal action. It has a total aerial length of 13.75 km and a catchment area of 7295 ha that covers parts of the eastern and the western suburbs. A 3.5 km stretch passes through the Bandra-Kurla Complex which is planned and developed by the MMRDA.

Importance of Mithi

Location of Mithi River is important from the point of view of the city in the sense that it is a dividing line between the City and the Suburbs and the effect of flooding has direct or indirect implications for disruption of traffic on 5 transport corridors viz. Central Railways, Western Railways, Western Express Highway, Eastern Express Highway & Harhour Railway Line.

The storm water drainage for the Mithi River catchment areas is disturbed due to encroachment of hutments in large numbers, storages, processing industries, workshops and scrap yards situated along the banks of Mithi River that make it difficult even to delineate its path. Direct discharges of untreated sewage, wastewater from the unauthorized settlements and industrial effluents along the River's course are a cause concern.

The BRIMSTOWAD Project which is the currently available Master Plan for Greater Bombay Storm Drainage prepared for MCGM in 1993 ,had suggested the storm water drainage for the Mithi River catchment areas, but the recommendations largely remained unimplemented. Report on Model Studies on the Effect of Proposed Reclamation in Mahim Creek by CWPRS conducted in 1978, formed the basis for BKC development by MMRDA. In the recent years more concern has been expressed by individuals, professionals and institutions of GoI and GoM for improving the condition of Mithi River.

The intensity of flooding following the unprecedented rainfall of 944 mm recorded at Santa Cruz on 26th July 2005 led to submergence of some areas adjoining Mithi River to an alarming extent which caused disruption of abovementioned corridors of Railways & surface transport. The reduced flood discharge capacity of the river may have worsened the situation.

Urgent attention is therefore required to chanellize Mithi River, remove and rehabilitate the residential and commercial establishments whose activities adversely impact the environmental conditions of Mithi River, beautify and re-develop suitable activities along the river so as to improve the hydraulic efficiency and water quality of the Mithi River. The GoM has established the Mithi River Development and Protection Authority in August 2005

for this purpose.

MMRDA has already commissioned two studies regarding Mithi river. The CWPRS, Pune has been asked to undertake the hydrological study and submit preliminary report in two months. The CESE, IIT, Mumbai has been asked to prepare the development plan for environmental improvement of Mithi river, and the preliminary report is now submitted by CWPRS.

Based on the recommendations by CWPRS and the decision taken in the Mithi River Development and Protection Authority meeting, MCGM is required to carry out the development and improvement of the portion of the river where MCGM is the planning authority (about 10.25 km) and MMRDA has to do likewise for the portion of the Mithi River (3.5 km) where MMRDA is the planning authority. The block estimate for entire stretch of Mithi River (length 13.50 km) and Vakola Nallah (length 5 km) is about Rs.1200 crore. The above block estimate cost includes cost to be incurred for widening, deepening, providing pitching, beautification, construction of retaining walls and rehabilitation of PAPs etc.

6.2.3. Fact Finding Committee Recommendations for Revised SWD Project Implementation

A Fact Finding Committee constituted by GoM under the chairmanship of Mr. MA Chitale to establish the causes of the July 2005 flooding and to suggest remedial measures has in its interim report suggested the following priority works before the onset of the 2006 monsoon

a. Thorough / full de-silting of SWD / nallahs / rivers:- As per the findings of the committee, the de-silting works is required to be done thoroughly and it has been suggested to keep the de-silting operation through out the year. MCGM has therefore proposed enhancement in the budget provision for de-silting to consider suggestions.

b. Provision of Pumping Stations and Flood Gates at various Outfalls:- Fact Finding Committee has observed that the major cause of flooding is due to tidal effect in the SWD / Nalla System. It has therefore been suggested to provide floodgates at all major outfalls and provision of pumping stations to the same has been made mandatory. Considering the last 10 years experience and higher intensity of rainfall the above suggestions are being considered by MCGM. Adequate Budget provision has been proposed for these works and it is being proposed to provide floodgates / pumping stations at all major outfalls in phased manner.

6.3. Key Issues and Strategy Options/Plans

Key Issues	Strategy Options / Plans
SWD capacity inadequacies and associated health and flooding issues, due to - Encroachments alongside drains, disturbing catchments runoff - Adulteration of storm water in drains by garbage and sewage/sullage infusions, which are in turn discharged into the environmentally sensitive creeks and the sea - Increase in overall runoff coefficient due to loss of holding ponds - Silting of drains and poaching of space by utility lines, reducing carrying capacity - Structural deficiencies due to age and poor workmanship	Implementation of the various recommendations suggested by the BRIMSTOWAD project report of 1993 and subsequent studies. There is a consensus in all studies regarding the action plan, including: - To divert sullage water flow to sewage pumping station. - To provide storm water pumping stations - To improve flood gates at various places - To increase the capacity of drains wherever necessary. - To repair dilapidated drains and augment capacity wherever possible - To remove obstruction of water pipe lines, cables etc. from SWD - To widen, deepen and extend the nallahs & out falls. - To remove encroachment along over the nallahs / drains and rehabilitate as per Govt. Policy. - To desilt and maintain storm water drain during rainy season by various equipment. The estimated project cost to implement the BRIMSTOWAD project report Rs. 1,200 crore
Project implementation hurdles: - Encroachment removal and R&R - Multiplicity of agencies associated with permissions, ownership of water channels/bodies, - Shifting of utilities - CRZ issues, and - Lack of funding sources	Formation of a Coordination Committee comprising representatives from all associated stakeholder agencies to sort out institutional / procedural issues Framing and implementation of slum rehabilitation plan to rehabilitate displaced families due to encroachment removal – land for rehabilitation will be a critical issue to be addressed Generation of resources required through a combination of routine budgetary allocation, enhanced revenue through financial reforms, special levy for SWD improvement, convergence of existing grants for various schemes and additional grants from State / Central Government