REPORT

CURRENT STATUS OF MITHI RIVER AND POSSIBLE SOLUTIONS

National Environmental Engineering Research Institute

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Current Status of Mithi River and Possible Solution

1. Introduction

Mithi has become synonymous with all the ills which a river is experiencing such as encroachment of flood plains, storm water drainage and disposal of untreated sewage and liquid waste. The Mithi River originates at an altitude of 246 m above sea level, in the hills located in the east of the Sanjay Gandhi National Park, gathers water from the streams and spillway discharges of the Tulsi, Vihar, and Powai Lakes, and travels 17.84 kms to the Mahim bay. The river is narrow in initial stretch, but it widens gradually and is widest at Bandra-Kurla Complex. The watershed of Mithi river is covered within latitude $19^0$00' to $19^0$15'N and longitude $72^0$45'73" E (Toposheet No. 47 A/16).

The industrial policy on river catchments as per Department of Environment, Govt. of Maharashtra (GR No. NMW-2000/326/22/TB-3 dated 15 July 2000), classifies Mithi river under the category A-IV which implies that 500 m on either side of the river is said to be no development zone for any type of industry. Only green and orange type of industries with pollution control system can be allowed between 500m-1km. Any other industry may be set up with pollution control systems beyond 1km on either side of river. However, the river is ensconced within the city development with many activities along its bank.

The river receives raw sewage, industrial waste and garbage of all types making it like an undamaged open drain. There are many illegal industrial activities along the bank of the river.

The river is a natural drainage channel, which carries the excess waters during the monsoon from the overflowing lakes, storm water drains and also from the catchment area. River seasonally swells during the **monsoon** due to rain water coming in from its catchment area. Despite tidal influence of west coast, the river remains as a drain with very poor water quality. Based on the multiple activities, the river course can be mainly divided into 11 zones (**Table 1**).

Table 1: Classification of the River Course

Zone	Description	Desired Activity
I	River water delivery to Mahim Bay	Guiding of flow & prevention of bank spill over
II	Confluence of Mithi River and Vakola nalla River Island	Culmination of flows and conservation of wetland growth
III	Reclaimed area and unorganized slums/ zopad	Bank protection and removal hutments onto the river course
IV	Small commercial units and built in residents	Prevention of discharge and waste dump and clearance of water way
V.1	Airport Area – Run way section – Boundary Wall and Slums	Regular clearance of water way below the surface and vigilance
V.2	Airport Area – Taxiway / amenities – Boundary Wall and Slums	Regular clearance of water way below the surface
VI	Recently developed Hotels and Industrial	Prevention of discharge and waste dump and clearance of water way
VII	Industries and mixed up residential	Prevention of discharge and waste dump and clearance of water way
VIII	Residential –structured and non structured	Prevention of discharge and waste dump and clearance of water way
IX	Natural vegetation and open area	Preservation of vegetation growth
X	Industry and slums	Removal of hutments and clearance of water way
XI	Natural vegetation	Conservation of nature

Illegal activities of washing of oil/chemical drums, discharge of unauthorized hazardous waste are also carried out along the course of this river. Cattle sheds in some areas contribute animal waste. Barrel cleaners, scrap dealers and others dump sludge oil, effluent and garbage in the river. The organic waste, sludge and garbage dumping has reduced the carrying capacity of the river. The water with mixture of sewage and industrial waste is a threat to marine life and the river is showing sign of total loss of aquatic biodiversity. Preliminary survey indicates that the pollution levels have reached an alarming stage.

Mahim bay area, where Mithi river meets Arabian sea, is a nominated bird sanctuary called **"Salim Ali Bird Sanctuary"** where migratory birds come for nesting. This part is full of mangroves constituting a very rich but fragile ecosystem. **Figure 1** shows the map of Mithi River.

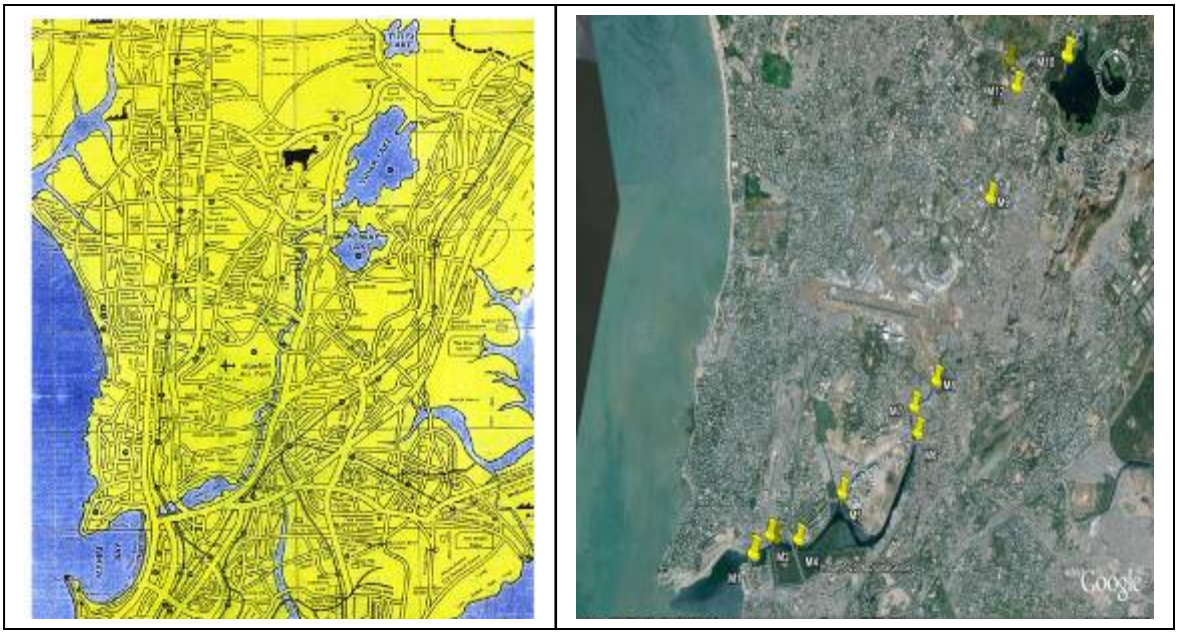


Figure 1 : Map of Mithi River

2. Location of Wastewater Discharges

Mithi river flows along the boundaries of K (E), H (E) and L wards. It has many industrial, residential and other point sources contributing waste to the river. The Storm Water Drainage (SWD) system of Mumbai comprises of about 2000 km length hierarchical network of roadside surface drains, about 440 km of underground drains and laterals in the island city. It also has 200 and 87 kms of major and minor channels, respectively. Out of total 186-storm water drain outfalls discharging all the surface runoff into rivers and the Arabian Sea**, 4 outfalls and 14 drains release water into Mithi river which ultimately reaches Mahim creek**. Mithi river provides two major services that of a **sewer** for the area carrying sewage as well as **storm water drainage system**. The storm water drainage for the Mithi river catchment areas has been disrupted due to the encroachment of hutments in large numbers, storage facilities, processing industries, workshops and other scrap yards situated along the banks that make it difficult even to delineate its path. To establish pollution load along the river stretch, 43-point sources were identified out of which 32 points were along Mithi river and 11 points were along Vakola nalla (**Table 2** and **Table 3)**. As a clean up action plan of the Mithi river, installation of sewage treatment plants was suggested at these 43 points by IIT, Bombay *(report on "Development of action plan for environment of improvement of Mithi river and along its banks).* The suggestion by IIT, Bombay, advocated decentralized treatment system which could have taken away large pollution load from the system.

Table 2: Point Sources along Stretch of Mithi River

Sr.	Description		Sr.	Description
D1	Back wash water from Filter pada		D17	Waste discharge from Airport
D2	Back wash water from Filter pada		D18	Waste discharge from Air India colony
D3	Film City		D19	Waste discharge from residential and commercial area near CST road
D4	Vihar area (Royal Palm Club)		D20	Indira Nagar
D5	Wastewater from nalla near Vihar lake		D21	Prem Nagar
D6	Nalla from Aarey Milk colony		D22	Opposite of Chuna Bhatti Rly Stn at Agra Rd.
D7	Nalla downstream of Marol maroshi pipe line from slum area		D23	Ambedkar Nagar
D8	Manohar Nagar		D24	Mahim area
D9	Karuna Nagar		D25	Netaji Nagar
D10	Sag-bag industrial area at Saki Naka		D26	EPF office
D11	Waste discharge near Samhita industrial area from Air India work shop		D27	Opposite Bandra Terminus at Railway colony
D12	Nala from Saki Naka contributed from industrial, residential and agricultural area		D28	Bairam Naupada
D13			D29	Anant kanekar marg near ONGC
D14			D30	Kala Nagar
D15	Nathuram Magan Marg		D31	Drain discharging sewage from Bandra-Kurla complex
D16	Kalpana Talkies in Kalina Kurla road		D32	Vakola nala meeting Mithi river at Bandra-Kurla complex

Table 3: Point Sources along Stretch of Vakola Nala Joining Mithi River

Sr.	Description
DVN 1	Patuck Technical College
DVN 2	Pratiraksha Nagar
DVN 3	Santosh Nagar
DVN 4	Indira Nagar
DVN 5	In Golibar area
DVN 6	Near Jal Pradhikar, Dowri area
DVN 7	Shivaji Nagar industrial area
DVN 8	Teachers colony
DVN 9	Depakwadi, Khar road
DVN 10	Subhash Nagar
DVN 11	Mhada colony

Source: IIT Final Report, June 2006

3. Reviews of Various Studies

In order to rejuvenate the river, various committees have been formed and requested to study the situation and suggest recommendations. The details of the committees who had provided recommendations, before and after the disaster of floods in July 2005 have been summarized hereunder:

3.1 Natu Committee Report (1974)

This committee studied cause of 1974 floods and recommended pumping stations across city, especially on Mahim Causeway, Cleveland Bunder and Love Grove, electrically operated sluice gates, desilting and up gradation of drains.

3.2 Model Studies on the Effect of Proposed Reclamation in Mahim Creek Report (1978) by Central Water and Power Research Station (CPWRS), Pune

This report pertaining to Bandra-Kurla Complex area studied the effect of reclamation in Mahim Creek and changes in drain system for development of Bandra Kurla Complex (BKC) which is a special economic region developed along the banks of downstream Mithi river. The report recommended widening and deepening of the Mithi, sluice gates at Mahim Causeway and pumping of floodwater into creeks.

3.3 Dharavi Storm water Drainage System Report (1988) by Shah Technical Consultants, Mumbai

The report studied effect of flooding in Dadar-Dharavi catchment area. When Mahim Creek swells, rainwater accumulates in Dharavi. To solve the problem, it recommended a pumping station, dividing catchment areas into four zones, raising drainage between Dadar and Dharavi.

3.4 BRIMSTOWARD project: MGCM Master plan for Greater Bombay Storm Drainage and Sewer Rehabilitation for Mithi catchment (1993) by M/s Watson Hawksley International Ltd and Associated Industrial Consultants (India) Pvt. Ltd.

The current SWD system in city is about 70 year old. The old SWD system is capable of handling rain intensity of only 25 mm per hour at low tide for non-flooding of Mithi River. If the rain intensity is more during the high tide period, there is always a possibility of water logging in some parts of the city. 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 receding of water during low tide. There was heavy rainfall in June 1985 when the entire city was flooded and rail & road traffic were disrupted resulting in heavy losses to the industries. Many low-lying were inundated severely.

After studying the causes of flooding during 1985, the BRIMSTOWAD Project suggested an increase in the storm water drainage for the Mithi river catchments through clearing of

encroachments along Mithi and Vakola rivers, their widening and deepening, modifying drainage design for higher capacity, pumping stations at Cleveland Bunder, Love Grove, Milan Subway. **But the recommendations largely remained unimplemented and only about 15% of the recommendations was implemented by MCGM.** Some of the reasons for non implementation of the project recommendations were lack of financial resources, institutional hurdles as a assortment of agencies were involved with regards to procedural formalities for permission and execution of specific components, ownership of the water bodies, shifting of utilities, other issues with regards construction of pumping stations at outfall locations, and encroachment removal issues, rehabilitation and relocation costs, and implementation issues.

3.5 Report of NEERI , 1996, Supreme Court Case (PIL)

This report had delineated the impact of mangrove removal and reclamation of land in BKC area. The report had concluded that the mangrove removal in BKC area (based on satellite maps) will lead to flooding in the region. Further, it was suggested that an environmental assessment of the area development should be carried out.

3.6 MPCB Report on Mithi River Water Pollution and Recommendations for its Control (2004)

Mithi river water quality was studied to assess the pollution load and suggest certain recommendation for improving the water quality. To clean up and minimize the pollution of Mithi river, recommendations were made for reduction of input of pollutants due to following factors :

- Domestic sewage due to residential colonies as well as hutments in the thickly populated area
- Industrial waste generated by authorized as well as unauthorized industries
- Animal waste due to cow shed
- Garbage dumping by citizens all along its course
- Industrial sludge/ rejects discarded by recyclers at Kalina and CST Road

Report also provides short and long term measures for Mithi river pollution control.

Short Term Measures include:

- Immediate closure of all the unauthorized activities, which discharge industrial effluents, sludge, oil and chemicals.
- Provision of proper garbage collection system to prevent citizens from dumping the same into the river.

Long Term Measures include:

- Plan for interceptor sewers on both the banks and provide Sewage treatment plants at various locations. Such plants can be provided wherever proper drainage lines exist today.
- Dredge the entire length of Mithi river bed to improve its carrying capacity.
- Provide proper garbage collection stations for the benefit of hutment dwellers.

3.7 NEERI's report on Mithi River flood prone areas and assessment (2004)

This report was prepared by a NEERI's researcher with a view to assess the Mithi rivers condition and identify the most likely flood prone areas. Mr. Gautam Kirtane visited all places and listed 8-9 areas, which could be highly flood prone. The reasons identified were encroachment, siltation, unauthorized activities within the river bed.

3.8 Report (2005) by IIT-Bombay: Milan Subway and Slater Road/Nana Chowk

The report provides technical opinion to reduce flooding at Milan subway and Slater road/Nana Chowk spots and recommends the pumping station at Slater Road, diverting flow of water from Milan Subway through a new pipeline.

3.9 Report of CWPRS, Pune: 1-D Mathematical Model and Desk Studies for mitigating floods of the Mithi River (2006)

The report suggests that the first two segments, (origin to Jogeshwari) and (Vikhroli Link Road to Sir MV Road) have steep slopes, which provide a swift discharge of water eliminating the chances of flooding. The downstream segments, however, have flat slopes and hence may cause flood. Presently, a maximum of 50 m^3/s discharge can be accommodated in the downstream courses of the river without causing any spill over. But the discharge corresponding to 50 yr rainfall (382.5 mm/hour) or 100 yr rainfall (418.3 mm/hour), averaged throughout the stream length, will cause a severe flood in the surrounding areas.

Report recommends following measures:

a) Bandra Kurla Complex (BKC) Area

- Providing a dredged channel of 60 m width from -2 m (with respect to Mean Sea Level or MSL) contour in the sea to Mahim Causeway bed level (dredged to -1 m) and removing existing rock over-crops.
- Widening of the waterway from Mahim Causeway to Dharavi Bridge to 100 m.

- Widening of the bed width from the existing 175 m to 200 m between Dharavi Bridge and CST Bridge.
- Widening of Vakola Nalla from the earlier designed width of 40 m to 60 m.
- Deepening of bed level at Mahim Causeway to -1 m & at CST Bridge to +0.67 m.

b) Upstream of BKC area

1. **Widening of existing bed from**
   - CST Bridge to MV Road to 100 m.
   - MV Road to Jogeshwari – Vikhroli Link Road to 60 m
   - Jogeshwari – Vikhroli Link Road to Morarji Nagar to 40 m.
2. **Deepening of existing bed levels**
   - CST Bridge (Ch. 5.88 km) from +2 m to 0.67 m
   - Air India Colony (Ch. 7.05 km) from +3.11 m to +1.0 m
   - Airport (Ch. 9.38 km) from +6.15 m to +4 m
   - MV Road (Ch. 10.47 km) from +8.12 m to +6.35 m
   - Aarey Dairy Foot Over Bridge (Ch. 12.18 km) from +12.75 m to +10 m
   - Jogeshwari-Vikhroli (Ch. 14 km) from +20.25 m to +18 m

All the suggested cross sections of Mithi River up to chainage 10.5 km need to be provided with slopes of 1:1.5. Further upstream up to Morarji Nagar, the required slope is 1:2. All the suggested measures taken together would roughly double the discharge capacity of the river.

c) Additional Recommendations

- Moderating the river course by replacing existing sharp bends with longer gentler bends.
- Providing Non-return valves for cross drains.
- Providing Regular maintenance and dredging.
- Providing smooth transition for waterways near bridges.
- Removal of temporary bridges with small waterways across the Mithi River and Vakola Nalla.

d) Action taken by the City Administration on these recommendations

The City Administration acting swiftly on recommendations accepted most of them and directed Mumbai Metropolitan Region Development Authority (MMRDA) and Municipal Corporation of Greater Mumbai (MCGM) to take the necessary action. The work was divided in two parts. The 11.84 km upstream stretch from Vihar Lake to CST Bridge was given to MCGM and the critical

downstream part of the remaining 6 km was undertaken by MMRDA. The downstream stretch was more critical due to flat slopes and nearness to sea and was further divided into two phases by MMRDA:

Phase 1: It involves de-silting and widening of the stretch. The time frame decided for this was 1st March 2006 to 30th June 2006. The amount sanctioned for the work was Rs. 30 crores.

Phase 2: It is planned for the post-monsoon period from 1 Oct 2006 to 30 June 2007 with a budget of Rs. 100 crores (subject to variation after post monsoon study). It involved dredging, widening, construction of retaining wall, beautification and building of service roads.

3.10 Chitale Committee's Fact Finding Report for July 2005 flood of Mithi river (2006)

The report studied the causes of 2005 floods and also suggests control measures for future. The recommendation includes :

- Preparation of contour maps of all watersheds
- Stream gauging –measurement of flow (1 for 200000 population) should be based on catchment area,
- Implement automatic rain gauges,
- Maintenance of Storm Water network –desilting, removal of obstructions, rehabilitation of SWD, ban on plastic, 100% desilting
- Removal of obstructions/ constrictions –water pipes, drain pipes, cables
- Additional gated outfalls/ pumping stations / holding ponds
- BRIMSTOWAD report (1993) be reviewed / revised
- Flood risk zones should be demarcated along the entire course of the river for a 1 in 10 year probability (high risk), a 1 in 25 year probability (medium risk) and a 1 in 100 year probability (requiring Insurance Cover). The zones should be illustrated in the development plan sheets for the city. The citizens need to be made aware of the risk posed by the river so that they have the option of adequate disaster preparedness.
- Immediately provide minimum buffer strips of 15 m on both sides of the Mithi channel for access, for maintenance and for management. A 12 m carriageway on either side of the prohibitive zone may be able to accommodate 1 in 25 year probability flood. 1 in 100 year probability may be applied only to the tidal creek portion (estuarine length) which is also subjected to reclamation activities. The report suggests immediate evacuation of 1:10

year rainfall probability flood zone on both banks of the rivers and regulation of 1:25 year rainfall probability flood zone on both banks of the rivers on priority basis.

- Restore the existing degraded rivers and river-banks to initiate recovery of the urban ecosystem. The first step should be to reinstate each river, nala, and lake or pond in its rightful place into the respective development plan sheets at once, followed by restoration of river channel and riverbank.
- Recommendation for Airport Authority's actions:
  - The waterway below the taxi bay will be effective and useful only when the existing 27 m wide waterway (culvert) below the runway is also widened at least to 40 m. The original proposal of the consultants for the airport was for a total width of 60 m.
  - Proper accesses to the section below the runway will have to be provided for the purpose of silt removal. Design of the taxiway bridge and the runway bridge will have to make suitable provisions for the same.

The report also recommended the following comprehensive studies to be conducted:

- Study of the Mithi River ecosystem in the context of flood proofing measures.
- Study of the environmental impacts of MUIP / MUTP's reclamation and building projects in Mumbai including all the developmental projects undertaken by MMRDA and BMC.
- Role of lakes and ponds in Mumbai in the context of beautification and flood protection, provision for detention or silt accumulation in conjunction with the management of the rivers and environmental up gradation of the aquatic ecosystems.

3.11 Development of Action Plan for Environmental Improvement of Mithi River and along its banks (2006) by Indian Institute of Technology (IIT), Bombay

Report includes assessment of all environmental aspects for 200 m stretch on either side of Mithi river and development of action plan for improvement of Mithi river along its bank. Some of the suggestions were:

- Area should be immediately declared as **Ecozone**
- Hydrological continuity between east and west should be restored by providing structure for adequate passage of water.
- Alternate storage system to make up for loss in Powai and Vihar reservoir capacity should be provided to take care of the run off.

To enhance the flow along river course, bridges/crossings should maintain the width of river either by reconstruction or repositioning of ducts and removal of debris from riverbed.

- Bridge on S V road near Mahim bay confluence should be widened.
- Encroachments on river course and banks need immediate removal.
- Transport out the debris from this watershed area to prevent sediment transportation to river during rainy season.
- Provide adequate diameter tunnel with sufficient openings for maintenance or other suitable alternative from airport to Mahim bay.
- Immediate stoppage of wastewater entering into river from all sources and diversion of wastewater to STP and then to river.
- Remove all hutments in two phases.
- Industries to set up CETP.
- Desilting of entire stretch of riverbed from D/S of Vihar and Powai lake up to BKC.
- Provide properly engineered storm water drains.
- Stop dumping and discarding of solid waste along the river. Municipal Corporation should review Solid waste collection and disposal within 500 m on either side.
- Proper plantation in upper, middle and lower stretches of river.
- Total area for ecological development along bank of river is 475436 m^2 which can be developed in 3 phases over period of 6 months each.
- Total 37 treatment plants for nallas before entering in to river have been proposed. The facility can be provided in phased manner based on flow and organic load.
- Development of certain locations from land use point of view has been identified.

IIT report also provides the information on assessment of water quality and impacts of pollution on Mithi river and vakola nalla at total 55 locations and details of these sampling locations are presented in **Table 4 and 5.** Sediments samples also have been collected at selected locations along Mithi river. The IIT report also provides comparison of water quality assessed by MPCB and IIT for the year 2004, 2005 and 2006.

Table 4: Water Sampling Points along Stretch of Mithi River

Sr.	Description	BOD (mg/l)	TSS (mg/l)
W1	Vihar Lake	8	3
W2	Overflow of Vihar lake	17	10
W3	D/s of Vihar lake	8	2
W4	D/s of filter backwash drain at Mithi river	21	37
W5	Mahatma Phule Nagar	6	4
W6	Filterpada	8	13
W7	Vihar overflow at Moraj Nagar	6	18
W8	Aarey Powai road	22	93
W9	Jagdishwar Mandir	12	20
W10	Surface water of Powai lake	6	5
W11	D/s of Powai lake at Ambedkar Udyan	1	10
W12	Saki Vihar road at Powai Garden	BDL	14
W13	Confluence of Vihar and Powai lake overflow	6	11
W14	Aarey Milk colony dairy farmland	6	8
W15	U/s of station W16 at Aarey milk colony	24	30
W16	D/s of D 5 Station, Jogeshwari-Vikroli link road bridge	14	42
W17	Marol Maroshi pipeline	11	48
W18	Custom colony	15	20
W19	Mahakali Nagar	60	148
W20	Military road	5	26
W21	Bamandaya Pada	5	16
W22	Marwah Estate	6	20
W23	M.V. Road	24	12
W24	Samhita industrial area	36	46
W25	Tanaji Nagar	138	182
W26	Jhari Mari area	60	178
W27	Wadia colony road	66	162
W28	Kalina Kurla road	60	126
W29	Kalina Kurla road	66	122
W30	CST road	66	70
W31	MMRDA road	18	44
W32	Behind American School of Bombay	66	578
W33	Mahim river at Maharashtra Nagar	60	924
W34	Johnson & Johnson	210	96
W35	Meeting point of stations 25, 26 and 27	120	132
W36	Hindustan construction	75	64
W37	Baba saheb Ambedkar chawl	45	126
W38	Sion-Bandra link road	18	42
W39	Western railway at Ali Yavar Jung marg	12	80
W40	Mahim causeway at Mahim Bay	6	124

Source: IIT Final Report, June 2006

Table 5: Water Sampling Points along Stretch of Vakola Nalla

Sr.	Description	BOD (mg/l)	TSS (mg/l)
VN1	Flight View Apt. bridge U/s	83	132
VN2	Near Panchasheel Apt. D/s	83	108
VN3	Vakola Nala U/s	60	86
VN4	Anand Nagar	54	196
VN5	D/s of Vakola bridge	38	44
VN6	Pratiksha Nagar Co-op. Hsg. Society	38	112
VN7	Across Chhatrapati Shivaji road	53	134
VN8	Shivaji Nagar	45	88
VN9	Shivaji Nagar bridge D/s	75	172
VN10	Shivaji Nagar bridge D/s	53	126
VN11	Santacruz Chember Link road	78	106
VN12	Opposite of Allahabad Bank	45	142
VN13	Vakola nalla at Vidyanagari campus	42	54
VN14	Tata Colony at Bharat Nagar	23	66
VN15	Confluence point of Vakola Nala and Mithi river	12	58

Source: IIT Final Report, June 2006

3.12 Development and Protection Plan of Mithi River and its Surroundings (2006) by MRDPA

The report summaries the status of the Mithi river and Vakola nala in terms of pollution load, legal aspects, implementation plans suggested, public awareness, infrastructural facilities like water supply, sewerage, SWD, solid waste management etc and ecological aspects. Chapter 10 covers Observations and Recommendations. **It recommended that banks of Mithi river, Vakola nala and all tributaries including the areas around Vihar and Powai lakes should be immediately declared as "ECOZONE".**

The major aspects covered in the recommendations are:

- Mapping of Mithi river
- Determination of pollution load
- Assessment of River quality and Impacts on the river
- Ecological aspects
- Treatment facilities
- Land use development

Most of the suggestions of this report are comparable to that of IIT, Bombay report.

4. River Typology

4.1 Morphology

The Mithi River in Mumbai meets the Arabian Sea at Mahim creek with a total length of about 17.84 kms and a catchment area of 7,295 ha. The Vakola nala which joins Mithi river has a length of 3.8 km and catchment area of 907 ha. It serves a dual purpose of a sewer for the area carrying sewage as well as storm water to sea. The river width is narrow in the initial stretch but it increases downstream. The present average width of the river is only 5.0- 15.0 m in the upper reaches starting from Vihar lake up to airport. It has been widened to 25 m in the middle stretches(from Airport up to Upstream of CST bridge) and 70 m in the lower reaches from CST bridge up to Mahim causeway **(Table 6)**. It has a depth of about 5.5 m at the center line of the river.

Table 6: The Topography of the River is Marked by Four Distinct Segments

Sr.	Segment	Slope	Type of Slope
1.	Origin at Powai Lake Boundary to Jogeshwari Vikhroli Link Road	1:200	Steep
2.	Jogeshwari –Vikhroli Link Road to Sir M V Road	1:450	Step
3.	Sir M V Road to CST Bridge	1:850	Moderate
4.	CST Bridge to Mahim Causeway	1:4000	Flat

Because of very steep gradient in the upper reaches, i.e. upstream of MV Road, the flow of Mithi river is generally swift. In the lower reaches, i.e. downstream of MV Road, where bed gradient becomes moderate, the flood discharges tend to spill over the banks depending upon the topography of the region. The general bank levels along Mithi river in BKC area are (+)5.5 m except in the reach between mini confluence and Kurla court where bank levels are less than (+) 5 m. In the upstream reach of CST bridge, particularly in the reach between Air India Colony to Kranti nagar, Airport runway, the existing bank levels are below (+) 4.7 m. Further upstream, bank levels rise above (+) 5.5 m in accordance with topography.

4.2 Land Cover

The various land cover and land use features that were interpreted from satellite data 2004 within 100 and 200m corridor from the river are open area, grassy land, vegetation cover, scattered vegetation cover, mangroves, water bodies (reservoirs/river course), embarkment of reservoir, asbestos/GC roof, structured building used for residential/industrial use, infra-structure (road/railway/pipeline), airport area and runway. The entire river course was divided in to 11

zones depending on land cover (vegetation, open area), land use (industrial, infra-structure, residential etc), observed waste type (solid/liquid), wetland vegetation, river confluence and island, delivery channel etc.

4.3 Flow Measurement of Mithi River: (MPCB)

As Mithi river is subject to tidal flows, river water level changes substantially due to tidal variation. As the specific gravity of sea water is high, at the time of high tide, river water swells upstream and at low tide, water level at some points reduces to few feet. This variation makes it difficult to estimate flow of water in such short duration of time. Hence no effort was made to estimate water discharge in Mithi river at this juncture.

Field observation indicate that sub surface cable crossing on sides of bridge/culverts, debris dumping on banks, encroachment from banks, modified river course geometry hamper free surface flow in addition to sedimentation and solid waste dumping. Presence of obstructions in the form of piers, culverts, higher grounds etc. reduces the velocity of flow leading to deposition of suspended solids and other objects. The flows of drains were measured by IIT which are reported in **Table 7 and 8**.

4.4 Flooding Issue

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

4.5 Issues of Tidal Influence

The location of the Mithi river is an important administrative boundary that divides the City and the Suburbs. Flooding in the river has direct or indirect implications for disrupting traffic on five transport corridors; Central Railway Main Line, Central Railway Harbor Line, Western Railway Line, Western Express Highway, and Eastern Express Highway. The tidal reach in the river is about 7 km from Mahim Bay up to Air India Complex**.** However, the analytical results from MPCB report indicate that the tidal influence is up to the 3rd sampling location at Bridge near Kalanagar on junction of Bandra Kurla road with Dharavi road

4.6 Water Currents and its Influence on Water Quality

Since the Mithi river has significant variation of its width and depth, measurement of the currents at the predetermined locations are difficult. Moreover the area with significant depth and width is under the tidal influence so the direction and intensity of the flows are changing continuously within the various stretches of the river. Due to narrowing of the river because of manmade activities, the exact appearance of tidal elevation was not in concurrence with the tide table.

4.7 Siltation Issues

Mithi river is receiving immense wastewater discharges and surface runoff which lead to significant siltation through out the stretch. This has resulted in significant reduction of water carrying capacity of the river. MRDPA has proposed to dredge/excavate 12,98,00 Cu. M of silt/ debris/ rocks from the entire stretch of mithi river from Vihar lake to Mahim causeway through MMRDA and MCGM. MMRDA had appointed contractors for dredging of about 7,40,964 cu m of silts/debris from Mahim causeway to CST bridge where as MCGM had appointed contractors for excavation of about 5,57,000 cu m of silt/debris/rocks from CST bridge to Vihar lake.

4.8 Dilution Factor

The volume of flood water that could drain in to Mahim and flush out/dilute chemical and physical pollutants, through the river depends on width and depth. Discharge of liquid and debris dumps from encroachment activities on either side of bank or on the river bed leads to reduction in its discharge flow efficiency or choking of the course. Pinching of the river course is very common phenomena in most of the river courses flowing through the urban areas.

4.9 Assimilative Capacity/Pollution Load

Pollution load of point sources for BOD and COD were calculated for MIthi river and Vakola nalla along with flow measurement by IIT, Bombay which are presented in **Table 7 and 8**.

Table 7: Point Sources along Stretch of Mithi River

Sr.	Description	Mean Flow (m^3/day)	Pollution Load (kg/d)		Pollution Index
			BOD	COD	
D1	Back wash water from Filter pada	18	0.45	0.65	3.16
D2	Back wash water from Filter pada	432	8.21	15.12	2.38
D3	Film City	52	0.41	1.61	2.15
D4	Vihar area (Royal Palm Club)	104	0.83	1.87	2.35
D5	Wastewater from nala near Vihar lake	69	0.41	2.97	2.07
D6	Nala from Aarey Milk colony	1443	18.76	163.05	5.48
D7	Nala downstream of Marol maroshi pipe line from slum area	1074	141.76	932.19	15.31
D8	Manohar Nagar	3836	57.54	521.72	3.80
D9	Karuna Nagar	3313	347.91	980.78	9.74
D10	Sag-bag industrial area at Saki Naka	-	-		5.36
D11	Waste discharge near Samhita industrial area from Air India work shop	51382	2158.05	3185.69	1.23
D12	Nala from Saki Naka contributed from industrial, residential and agricultural area	47739	15275.52	41148.43	8.62
D13		36	0.12	0.47	1.61
D14		52	9.33	16.59	12.29
D15	Nathuram Magan Marg	29376	3319.49	11956.03	12.91
D16	Kalpana Talkies in Kalina Kurla road	4052	303.91	1146.76	10.40
D17	Waste discharge from Airport	1516	18.20	47.01	3.97
D18	Waste discharge from Air India colony	1232	51.75	129.37	6.38
D19	Waste discharge from residential and commercial area near CST road	65	2.33	7.58	1.01
D20	Indira Nagar	-	-		16.21
D21	Prem Nagar	233	50.86	93.31	9.84
D22	Opposite of Chuna Bhatti Rly Stn at Agra Rd.	2838	127.72	408.71	4.64
D23	Ambedkar Nagar	9	2.07	6.64	20.52
D24	Mahim area	11949	2509.32	5926.76	8.92
D25	Netaji Nagar	14628	7460.04	13574.34	12.14
D26	EPF office	2825	192.12	406.84	3.61
D27	Opposite Bandra Terminus at Railway colony	10070	755.24	2255.66	4.05
D28	Bairam Naupada	11690	1320.96	4488.93	10.21
D29	Anant kanekar marg near ONGC	86	15.55	38.71	0.37
D30	Kala Nagar	287	12.93	36.77	1.91
D31	Drain discharging sewage from Bandra-Kurla complex	11	0.13	1.08	0.79
D32	Vakola nala meeting Mithi river at Bandra-Kurla complex	26	0.47	3.24	1.57

Source: IIT Final Report, June 2006, '—' No measurement

Table 8: Point Sources along Stretch of Vakola Nala Joining Mithi River

Sr.	Description	Mean Flow (m^3/day)	Pollution Load (kg/d)		Pollution Index
			BOD	COD	
DVN 1	Patuck Technical College	43	4.9	13.82	7.3
DVN 2	Pratiraksha Nagar	35	0.3	1.9	3.1
DVN 3	Santosh Nagar	7327	1047.7	2461.78	9.5
DVN 4	Indira Nagar	4605	1174.3	2357.82	7.0
DVN 5	In Golibar area	2583	1550.0	3141.37	23.0
DVN 6	Near Jal Pradhikar, Dowri area	-	-		14.1
DVN 7	Shivaji Nagar industrial area	-	-	177.42	7.3
DVN 8	Teachers colony	482	86.8	798.06	8.8
DVN 9	Depakwadi, Khar road	2169	357.8	925.46	6.4
DVN 10	Subhash Nagar	1701	217.8	114.05	16.2
DVN 11	Mhada colony	238	69.6	13.82	12.6

Source: IIT Final Report, June 2006

5. Review, Summary of Suggestions and Gap Analysis

After the floods in Mumbai on 26 July 2005, Government of Maharashtra had established "Mithi River Development and Protection Authority" **(MRDPA)** for protection and development of Mithi river. The empowered committee was formed by this authority to review the status of river and to check the feasibility of all the recommendations stipulated by various institutions for development and improvement of Mithi river situation.

- **During the 3rd meeting held on 6 Nov 2006, following decisions were taken for further consideration and implementation.**

- The empowered committee decided to adopt the recommendations of CPWRS and IIT, Bombay for the widening of river up to 100 ms from Mahim Causeway to Dharavi bridge and provide buffer zone of 20 ms on either side. It was also suggested that the widening of river should be up to 200 ms from Dharavi bridge to CST bridge and buffer zone of 20 ms on either side should be kept.

  However, on the opposite bank of BKC, there are permanent structures of Taximen society and also between BKLR bridge and CST bridge there are permanent buildings of Kapadia nagar. Therefore, any widening including development of buffer zone in these areas is not possible.

  After elaborate discussions, it was decided that Mithi river alignment should be kept fixed with due consideration to the permanent structures and these should not get affected or destroyed.

- The suggestions given by IIT, Bombay for maintaining certain areas along the side of Mithi river as additional buffer zones to act as holding ponds is accepted by committee and the same was recommended to provide holding ponds wherever feasible.

- The recommendations of CPWRS for widening of the river up to 100 m within MCGM stretch, can be implemented only after removal of existing Masjid, acquisition of Bakshasingh compound, removal of total 1215 residential and commercial structures and destruction of one authorized industrial estate. Collector Mumbai Suburb district suggested certain measures to solve these problems viz. by shifting of Masjid and similar corrective modifications that will help in minimum conflict among the people while widening the river.

- Municipal Commissioner informed that as per CPWRS recommendations, widening is not possible at the upstream side of Safed pool Nalla up to Jogeshwari Vikhroli link road due to the existing authorized residential and industrial buildings. He further declared that achievement of maximum feasible width has already been acquired during Phase I.

- However, it was emphasized that it is necessary to construct retaining wall in this stretch, as scouring of embankment would endanger the existing structures at bank of river.

- Metropolitan Commissioner, MMRDA pointed out that the widening of river could be possible as per recommendations of CPWRS as there are no permanent structures on the upstream of Jogeshwari Vikhroli link road up to Vihar lake

- CPWRS and IIT, Bombay recommended to widen the Vakola nalla within MCGM's stretch up to 60 ms and keep buffer zone of 20 ms on either side but as per Municipal commissioner, MCGM, widening is not possible due to presence of permanent structures on either side of Vakola nalla in certain stretches. Therefore, after discussions, it was decided that Vakola nalla alignment should be fixed by retaining the permanent structures.

➢ **4th meeting, held on 20th April, 2007**

Municipal Commissioner, MCGM informed that Mithi river is to be widened by considering the recommendation of Chitale Committee. There are many difficulties in implementing recommendations of CPWRS as it involves relocation of authorized industrial and residential structures. He also opined that further widening is not necessary.

- **5th meeting, held on 5th May 2008**

The progress on the implementation of the recommendations was reviewed. The committee informed the members that the developmental activities are going ahead in the expected manner of timeframe. It was also informed that a study on the feasibility of construction of a marine platform at BKC and Valmiki Nagar near Vakola nala is being undertaken through consultants. The attendees still expressed their profound concern on the issues and the possible adverse effects due to continued solid waste dumping practices, release of excess water from Vihar lake during monsoon, entrance of the floodwater in the hutments during extreme rains etc.

- **6th meeting, held on 25th May 2010 :**

The chairman of the committee informed the members the outcome of the activities on the improvement of Mithi river.

- Up till now, total 84% of desilting work, 42% of protection wall construction, 2% of service road provision and 23% of beautification work has been completed by both MMRDA and MCGM
- Airport authority is ready to widen the Mithi river bridge up to 47 m without altering the river.
- There is no need to construct sluice gate at Mahim causeway.
- Both organizations, MMRDA and MCGM, responsible for the implementation of stipulated recommendations, informed the gathering that the work would be completed by Dec. 2010 and March 2012 respectively. The delay for completion by MCGM is due to requirement of reconstruction of 10 bridges over the river within their jurisdiction.

Though various institutions provide basic recommendations for improvement of Mithi river status it is not possible to implement all these recommendation because of financial and technical constraints as well as intervention from illegal or unauthorized encroachment, industrial establishment, involvement and interest of political parties etc. Therefore, the river environment through out its entire stretch and along the bank still remains unchanged.

6. Improvement Options Considered by MMRDA

Mithi river originates from water discharges of Powai and Vihar lakes and meets Arabian sea via Mahim bay. The average depth of river at the centerline is 5-6 m. The river is narrow in initial stretch (nearly 10 m in width) but widens gradually towards Bandra-Kurla complex. The water quality of Mithi river is overwhelmed by the illicit discharges of sewage, industrial waste,

dumping of solid waste, oil processing etc. The river is treated as open drain. This has resulted in significant growth of water hyacinth. A number of nallas carrying domestic wastewater from slums join the 17 km long path of Mithi River. Encroachment by hutments and other organizations affects the carrying capacity of river. The river carries floating matter like plastics, and other debris, which leads to clogging of river at bends and near culverts. It is clear that river has low Dissolved Oxygen and high nutrient level, BOD, COD and Fecal Coliforms. Reduction in oxygen leads to anaerobic conditions causing release of sulphide concentrations and related odour due to ammonia, aldehydes etc.

As regards rejuvenation of this polluted river, a stretch of about 6 km starting from CST Bridge to Mahim bay is supposed to be handled by MMRDA. For the clean-up and restoration of water quality status of Mithi river, the following pollution control measures needs consideration:

1. Stoppage of non point sources of domestic sewage from to residential colonies as well as hutments in the catchments zone.
2. Collection and treatment systems for industrial waste generated by authorized as well as unauthorized industries.
3. Diversion of Animal waste discharges from the cow sheds in various areas.
4. Withdrawal of Garbage dumping by citizens all along its course.
5. Installation of innovative treatment systems for enhancement of self-purification capacity of the river

7. Technology – Implementation and its evaluation

In order to improve the river water quality as well as aesthetic appearance of Mithi river, MMRDA has established various comprehensive programs from time to time which focuses on elimination of pollution but full compliance is time consuming and expected to take years to reach the expected improvement. Therefore, MMRDA has made attempts to remediate the immediate problem of odour in its own area.

One possible example of remedial measure is infusion of oxygen in the river to control its stink. The oxygen added to river water is supposed to increase dissolved oxygen level, which can lead to oxidation of organic waste and removal of odour. Once the waste is aerobically degraded, the obnoxious compounds like hydrogen sulfide, methane and ammonia will not be generated. This may solve the odour problem. MMRDA undertook an “Oxygenation Demonstration Project”. This experimental study considers introduction of Oxygen using DynamOx Oxygen infusion device developed by Environmental Consulting and Technology, Inc., Florida, US.

- **Working of DynamOx System**

The "DynamOx" system introduces high amount of oxygen in the form of "**nano bubbles**" by using oxygen gas supersaturated in water. The addition of oxygen rich liquid through DynamOx system is supposed to shift the Oxidation Reduction Potential (ORP) and changes the form of odour producing compounds to eliminate the offending odour. The manufacturers claim that the system delivers a predetermined quantity of water supersaturated with dissolved oxygen in the form of **NANO BUBBLES** with a concentration over 800 mg/L of DO. NEERI has undertaken the evaluation of the system installed near BKC on the request of MMRDA.

- **Objective of assessment**

The main objective of the activity is to assess the efficiency of the aeration system of DynamOx system demonstration project through water quality evaluation before and after the aeration process during high and low tide.

- **Study Area**

The system was established within the Mithi riverbed near MMRDA office at Bandra-kurla complex. Two diffusers were spaced at a distance of 300 m of each other. Based on the location of diffusers, study area was divided in different transects to cover entire length of the plume. On each transect, within the width of the river three points were selected. The total length of study region was 700 m, which includes distance between two diffusers and two points at 200 m upstream and downstream of the diffusers. The water samples were also collected at CST Bridge, vakola nalla and Mahim Bridge to have broad idea about river water quality. The schematics of sampling locations and transects are given in **Table 9** and **Figure 2 and 3**.

Table 9: Details of Sampling Locations

Site Code	Site Name
SB 1	Dharavi Bridge
SV 1	Mahim Bridge
A 1	200 m Downwards from 1st Oxygenator
A 2	20 m from A 1
A 3	40 m from A 1
B 1	1st Oxygenator
B 2	20 m from B 1
B 3	40 m from B 1
C 1	Between 2 Oxygenators
C 2	20 m from C 1
C 3	40 m from C 1
D 1	2nd Oxygenator
D 2	20 m from D 1
D 3	40 m from D 1
E 1	200 m up wards from 2nd Oxygenator (towards CST bridge)
E 2	20 m from E 1
E 3	40 m from E 1
WN 1	Vakola nalla
CST 1	1st points towards CST bridge at curve
CST 2	New Mithi bridge
CST 3	CST bridge before Airport

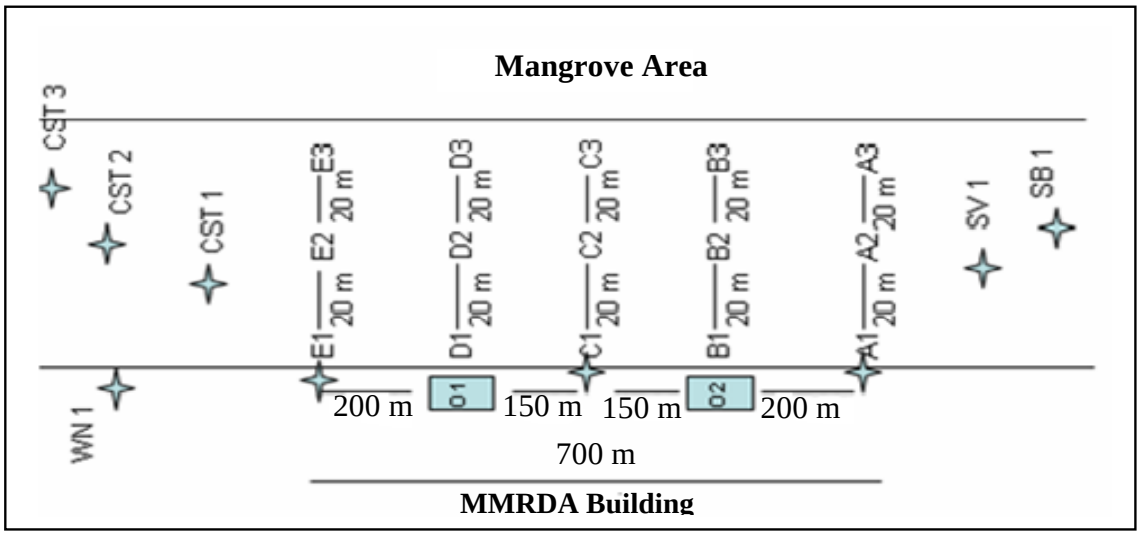


Figure 2: The Schematic Representation of Sampling Locations and Transects

Figure 3: Aerial View of Sampling Locations and Transects

Sampling Schedule

Mithi river is subjected to tidal variation. In order to get proper idea of pollution load, the samples were collected during flooding and receding tides. Based on tide timings sampling was conducted during oxygenation. The first sampling was conducted on 9 July 2010 to have background water quality status. During the sampling, it was raining heavily which resulted in dilution of water with the rainwater run off. Second sampling was conducted on two different days since it was not feasible to take samples of both flooding and receding tides on same day due to non availability of time during day time. The receeding tide samples were collected on 28 July 2010 and flooding tide samples were collected on 30 July 2010. The tide timings on selected sampling days are given in **Table 10**.

Table 10: Tide timings on Sampling Days

Day	High Tide Timing	Low Tide Timing
9.07. 2010	10.21 am*	4.12 pm*
28.07.2010	1.28 pm*	7.42 pm
30.07.2010	2.21 pm	7.52 am*

* samples collected

- **Condition of Oxygenators on Sampling Days**

During sampling only one diffuser was in working condition. The oxygenation started 30 minutes before actual sampling. The plume of oxygen rich recycled water added to the river was small. It was only seen in localized area of 3 to 5 meters, which could be seen visually. The diffusers activity was heavily influenced due to high sediment and muck.

- **Results**

The various parameters pH, Conductivity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Sulfate, Sulfide were tested as per standard methods to know the water quality. Background status of water quality of samples collected earlier is given in **Table 11**.The results of samples collected during receding and flooding tide with operational oxygenation process is presented in **Table 12 and 13**.

Table 11: Results of Background Sampling during July

Sample Code	Receding tide				Flooding tide		
	pH	DO (mg/L)	BOD (mg/L)		pH	DO (mg/L)	BOD (mg/L)
A1	7.2	1.5	34.0		7.0	0.7	42.0
A2	7.3	1.9	37.8		7.1	0.6	48.0
A3	7.5	1.7	35.1		7.1	0.6	37.5
B1	7.2	1.9	34.0		7.1	0.6	48.7
B2	7.3	1.7	41.8		6.9	0.5	39.0
B3	7.3	1.5	35.8		7.0	0.6	46.0
C1	7.3	1.3	41.0		7.1	0.5	48.6
C2	7.4	1.5	32.0		7.1	0.5	32.7
C3	7.4	1.7	47.8		7.2	0.7	39.0
D1	7.3	1.1	56.7		7.1	0.5	48.9
D2	7.3	1.7	38.3		7.1	0.6	52.0
D3	7.3	1.6	43.0		7.1	0.5	45.2
E1	7.2	0.9	62.9		7.3	0.8	56.8
E2	7.3	1.6	45.0		7.2	0.5	52.3
E3	7.2	1.4	62.0		7.1	0.6	58.4
CST1	7.3	2.4	48.0		7.1	0.8	49.3
CST2	7.2	3.2	53.7		7.2	0.4	67.1
CST3	7.2	2.6	46.7		7.2	0.9	54.9
Vakola	7.2	0.4	102.7		7.2	0.2	109.3
Mahim	7.2	0.8	88.9		7.2	0.3	102.8
Dharavi	7.2	0.8	80.1		7.2	1.2	80.2

* Since the sampling was carried out in monsoon seasons, the background levels are likely to be lower.

Table 12: Results of Receding Tide Samples during Oxygenation (28.07.10)

Sample Code	pH	Cond. (mS/cm)	Temp (^{0}C)	DO (mg/L)	BOD (mg/L)	Amm. N (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
A1	7.0	38.5	30.5	0.5	22.8	3.8	292	BDL
A2	7.2	38.9	28.7	2.5	32.4	4.1	285	BDL
A3	7.3	37.3	29.3	2.7	35.5	4.1	321	BDL
B1	7.4	40.8	28.8	2.3	29.3	3.7	284	BDL
B2	7.6	25.0	29.5	2.0	47.0	4.3	285	BDL
B3	7.5	39.0	28.6	2.2	29.8	4.3	278	BDL
C1	7.5	40.8	29.2	2.5	39.9	3.6	284	BDL
C2	7.5	30.0	29.6	2.3	30.0	3.7	255	BDL
C3	7.5	29.4	29.7	1.8	44.3	4.7	264	BDL
D1	7.5	47.0	29.6	1.8	50.9	3.3	284	BDL
D2	7.6	37.3	29.0	2.2	36.1	3.3	278	BDL
D3	7.6	39.0	30.3	3.3	39.9	4.2	310	BDL
E1	7.6	40.5	30.2	1.0	67.8	3.0	279	BDL
E2	7.7	23.6	29.6	2.1	38.5	5.8	237	BDL
E3	7.6	23.5	30.2	0.6	53.6	6.5	232	BDL
CST1	7.6	16.4	30.3	0.7	41.9	6.1	200	BDL
CST2	7.9	1.36	30.5	1.9	45.3	7.9	52.4	BDL
CST3	7.8	1.30	30.0	1.6	41.8	7.4	46.4	0.05
Vakola	7.7	2.15	30.0	0.7	76.1	4.3	42.7	0.44
Mahim	7.5	46.9	29.3	3.5	53.8	3.8	59.7	0.14
Dharavi	7.5	35.1	29.5	1.2	39.6	5.7	264	0.19

Table 13: Results of Flooding Tide Samples during Oxygenation (30.07.10)

Sample Code	pH	Cond. (mS/cm)	Temp (^{0}C)	DO (mg/L)	BOD (mg/L)	Amm. N (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
A1	6.8	7.7	28.8	0.5	34.5	8.1	132	0.84
A2	7.8	2.76	28.2	0.5	39.3	8.7	132	1.26
A3	7.1	8.28	28.3	0.4	42.8	10.5	66.0	7.08
B1	7.1	6.44	28.4	0.5	40.8	8.2	116	2.16
B2	7.3	4.33	28.3	0.4	33.0	8.5	124	0.14
B3	7.3	1.87	28.3	0.4	41.8	9.0	97.6	0.59
C1	7.32	5.92	28.3	0.4	42.1	8.0	53.5	2.37
C2	7.4	2.28	28.2	0.6	29.6	8. 7	115	1.37
C3	7.4	2.99	28.3	0.5	36.0	9.1	55.0	4.07
D1	7.3	6.33	28.4	0.4	43.9	8.4	61.7	2.44
D2	7.4	1.79	28.1	0.4	48.6	7.7	127	BDL
D3	7.4	1.33	28.2	0.4	39.9	8.1	60.8	1.94
E1	7.4	3.76	28.2	0.5	47.4	7.3	88.4	1.53
E2	7.5	0.95	28.1	0.4	49.6	6.9	92.8	1.51
E3	7.5	0.94	28.2	0.5	53.4	7.7	51.4	1.24
CST1	7.5	1.98	28.4	0.4	45.0	7.0	49.2	0.92
CST2	7.6	1.94	28.1	0.5	59.6	8.7	71.5	0.49
CST3	7.5	1.59	29.3	0.4	53.5	8.7	129	0.47
Vakola	7.5	5.2	28.8	1.8	57.3	4.2	55.1	BDL
Mahim	7.5	4.12	27.6	2.4	57.6	8.1	337	1.94
Dharavi	7.6	2.62	27.4	3.6	57.8	8.7	91.0	1.48

- **Observations**

- The pH and Temperature were within normal range and not showing any significant variation.
- The conductivity values confirm presence of seawater during receding tide and fresh or partially mixed with seawater during flooding tide.
- During receding tide a positive correlation was observed between DO and BOD.
- The BOD values during both receding and flooding tide are almost in same range, during background and oxygenation process.
- Ammonia was high during flooding tide as compared to the receding tide because the source of ammonia is essentially domestic wastewater.
- Sulphate concentration was on higher side during receding tide and lower during flooding tide. The sulphates are introduced from the seawater.
- All the sulphide values except for Vakola, Mahim and Dharavi samples were below detectable limit during receding tide representing more proportion of seawater. Flooding tide representing more amount of sewage show presence of sulphide.

- The nano bubble technology operation had caused no significant variation in DO or ORP or BOD values within 2 m distance from the diffuser section. It clearly showed that system will be of little use in heavily polluted Mithi River system.

8. Conclusions and Recommendations: Way Forward

8.1 Comments on various reports and studies

- The recommendations made earlier in various reports (more than 10 years old) need to be looked at carefully as the ground situation of Mithi River has changed significantly due to large scale development and overall degradation of environmental infrastructure deterioration.
- Recent reports by CWPRS, IIT Bombay, Chitale Committee, MPCB have provided variables and at times conflicting recommendations. For example, the recommendations on width, provision of sluice gates, deepening, holding / buffer area, retaining wall etc. are leading to confusion about what is the final vision of Mithi River rejuvenation.
- The widening and deepening has resulted in some minor improvement, especially due to better movement of tidal water.
- The major areas of concern which have still not / fully resolved are :
    - Inputs of untreated sewage
    - Inputs of untreated industrial wastewater
    - Garbage from residential and industrial activities
    - River bank protection
    - Widening and deepening

8.2 Way Forward: NEERI's Suggestions

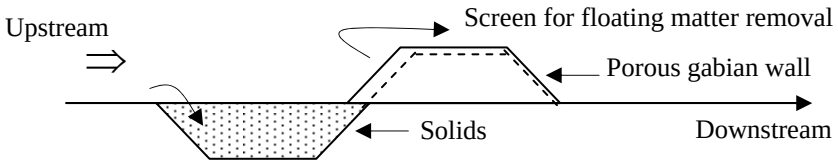
The partial implementation of different committee's recommendations, the clarity on river rejuvenation plan is lost. Therefore, there is a need to undertake fresh assessment of various aspects of implementation such as :

- The status of river width
- Status of river depth including sediment depth
- River flow characteristics along the channel
- Effect of retaining wall, wherever constructed on mangroves or other features
- Water and sediment quality within the river stretch as well as sources discharging into the river.

- Undertake hydraulic modeling coupled with water quality modeling which will provide insight into the effectiveness of implementation till date and its efficacy in future after modified recommended width and depth.
- Even after many years after the 2005 flood, the measures implemented have not led to apparent improvement as desired. Some of the recommendations will take long time to get implemented or may not get implemented due to social, administrative or other factors.

8.2.1 Short Term Recommendations

- In view of urgent need to undertake a measures to show immediate improvement within six months in terms of better hydraulic flow, water quality and odour reduction, following steps can be implemented in BKC stretch :
  - Create a regular solid waste removal channel at about three to four places. Schematic shown below :



  - As shown, across the width, the accumulated solids can be removed every fifteen days and taken to MSW landfill sites.
  - The screen with a gabion wall will allow water to flow through but will capture all floating matter.
  - Create turbulence in river bed during high tide (receding time) to dislodge sediment settled on the river bed. These sediments will be slowly carried away with high tide water.
  - Sediment removal and fresh garbage removal will improve river water quality by at least 50%.
  - Later, in some nearby regions, close to the bank in about 50 m width waste water odour removal technology can be used after checking its efficacy.
  - Odour improvement in BKC can take place only when BOD values are less than 25 mg/l and DO values are about 2 mg/l.
  - Any other option wherein solids and bio-sediments are not removed or minimized, it will have limited success in improving water quality and odour reduction.

- Decomposition of garbage settled on the river bed results in foul odour during low tide hence the entire river must be desludged to remove putrefying matter thoroughly and further wherever possible phytoremediation should be used to revive the river bed.

8.2.2 Long Term Recommendations

- The retaining wall along the whole river stretch is not desirable and should be avoided.
- Retaining wall will train the river and it may result in rapid movement of water thus causing more flooding.
- Decentralized small STP should be established across the length with a good water quality so that the same can be recycled and reused.
- Each action plan should be shared with locals and other stakeholders for each region for monitoring and suggestions.
- River bank up to 50 m on either side of the river must be cleared with view to get natural slope and look of a river. In this zone various grasses or shrubs can be planted for optimizing drainage and percolation. The phytoremediation of some native plants can be used to reduce the erosion as well as to remove oils, fuels and heavy metals accumulated over the years in the soil near banks. This can be achieved by adoption of on phytorid technology developed and patented internationally.
- The pollution load entering into river adversely affects the mangrove vegetation. Therefore, a detailed study for protection of mangrove along the Mithi river must be undertaken.
- Mithi flows during monsoon, however for the rest of the year it may run dry assuming that sewage and effluent disposal is arrested. Therefore, it is highly desirable to keep the river flowing throughout the year. For this purpose water from Powai and Vihar lakes could be used for flushing the river after increasing capacities of these lakes.
- Large quantities of municipal wastes are dumped in to the Mithi river by all those on the banks. These wastes must be collected through the involvement of local communities and creating awareness.
- Provision for decentralized and segregated solid waste management, good sanitation, proper sewerage and water network in slums are important to improve the quality of the river.

These measures should be evaluated and discussed by a group of people from MMRDA, experts and other stakeholders for their implementation.

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