PREVENTIVE TECHNIQUES FOR WATER LOGGING BETWEEN SEWRI TO TILAK NAGAR RAILWAY STATION

SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF

BACHELOR OF ENGINEERING

IN

CIVIL ENGINEERING

UNIVERSITY OF MUMBAI

MUMBAI.

SUBMITTED BY

ANSARI MOHD REHAN (18DCE01)

RASALKAR AMMARA MUZAFFAR (17CE07)

SHAIKH ASAD ASGAR (18DCE12)

SHAIKH FAIZAN AHMED (18DCE13)

UNDER THE GUIDANCE OF

PROF. DHAVAL SHAH

DEPARTMENT OF CIVIL ENGINEERING

School of Engineering and Technology

Anjuman-I-Islam Kalsekar Technical Campus, New Panvel.

(Affiliated To Mumbai University 2020-21)

A

PROJECT REPORT

ON

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CERTIFICATE

This is to certify that the thesis entitled, ***"PREVENTIVE TECHNIQUES FOR WATER LOGGING BETWEEN SEWRI TO TILAK NAGAR RAILWAY STATION"*** issubmitted *partial fulfilment of the requirements for the award of* ***Bachelors of Engineering*** *degree in* ***Civil Engineering*** *during 2020-2021 session atthe Anjuman I Islam's Kalsekar Technical Campus, New-Panvel is an authentic work carried outby her under my supervision and guidance.*

NAME OF STUDENT: Ansari Mohd Rehan (18DCE01), Rasalkar Ammara (17CE07), Shaikh Asad (18DCE12), Shaikh Faizan (18DCE13).

PROF. DHAVAL SHAH	**PROF. Dr. R. B. MAGAR**	**Dr. ABDUL RAZZAK HONNUTAGI**
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DEPARTMENT OF CIVIL ENGINEERING

School of Engineering and Technology

Anjuman I Islam's Kalsekar Technical Campus, New-Panvel.

(AFILIATED TO MUMBAI UNIVERSITY)

2020-2021

PROJECT APPROVAL SHEET

The report entitled "***PREVENTIVE TECHNIQUES FOR WATER LOGGING BETWEEN SEWRI TO TILAK NAGAR RAILWAY STATION"*** submitted by **Ansari Mohd Rehan (18DCE01), Rasalkar Ammara (17CE07), Shaikh Asad (18DCE12), Shaikh Faizan (18DCE13)** after presenting histhesis work in form of PowerPoint presentation is hereby approved in partial fulfillment for the award of Degree of Bachelors in Civil Engineering of Mumbai University, Mumbai.

EXAMINERS 1) NAME _____ SIGN

2) NAME _____ SIGN

SUPERVISOR 1) NAME _____

2) NAME _____

Date:

Place: New-Panvel.

ACKNOWLEDGEMENT

It gives us immense pleasure that we would like to express our most sincere heartfelt gratitude to our guide, ***Prof Dhaval Shah***, Dept. of Civil Engineering, Anjuman-I-Islam's Kalsekar Technical Campus, New-Panvel for her mentoring and research support throughout our studies.

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I express my sincere thanks to ***Prof. Dr R. B. Magar***, Head of Civil Engineering Department, Anjuman-I-Islam's Kalsekar Technical Campus, New-Panvel for providing us the necessary facilities in the department. Also, our heartfelt gratitude to all the faculties of Department of the Civil Engineering.

We would like to thank ***our dearest parents*** for making us believe in my dreams and for constantly supporting us to achieve them.

DECLARATION

We declare that this written submission represents ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that; we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus notbeen properly cited or from whom proper permission has not been taken when needed.

ANSARI MOHD REHAN (18DCE01) .....

RASALKAR AMMARA MUZAFFAR (17CE07) .....

SHAIKH ASAD ASGAR (18DCE12) .....

SHAIKH FAIZAN AHMED (18DCE13) .....

Date:-

ABSTRACT

In this project we have discussed about the problem arises on railway track due to submerging of water. This water gets choked up due to having no allowance of proper flow through pipeline available at the side of the railway track .As we done survey on the railway track we saw that there is no proper maintenance done for the drainage system at side of railway track due to which the water gets submerged on the railway causing problem. There are also some pictures showing in our project book about the drainage system conditions.

This research focuses on the rainfall induced flooding that it is caused by high intensity storm, rainfall and runoff in the city area that is inundated due to lack of proper drainage system and inefficient management. It ascertains the water logging problem, its cause and its effects on the environment of the city from the perception of authorities of different organizations and people living in different wards of Kurla Corporation. A field survey has been conducted during 2008 in Kurla Corporation. This water logging becomes a burden for the inhabitants of Kurla and creating adverse social, physical, economic and environmental impacts. Disruption of traffic movement and normal life, damage of structures and infrastructure, destruction of vegetation and aquatic habitats and loss of income potentials are the encountered effects of water logging on city life. The storm water becomes polluted as it mixes with solid waste, clinical waste, silt, contaminants, domestic wastes and other human activities that increase the water born diseases.

CONTENT

Chapter 1

Introduction

1.1 General

This project is about the problems occurring in cities due to water logging. The problems such as submerging of railway track due to water in rainy season. This problem, which throws the lives of lacks in the city off gear, can be attributed to treacherous mounds of domestic garbage, dumped indiscriminately along the tracks. At many streatches along the main and harbour lines, garbage, along with debris and muck, lies brazelny along the track, and are washed out into the tracks with rainwater, choking the lines and forcing water to stagnate, crippling the cities lifeline.

Solution is that as we survey on the railway track we got an idea to increase the rail level which is been submerged due to water level increased on track and by designing pumping system.

Water and water related problems like water quality, water scarcity, drought and flood have always been a major concern all over the world. Global warming has a direct influence on precipitation and heavy rains and it is likely to increase the intensity and frequency of extreme rainfall events in future

Accompanying the change in climate patterns is the rapid urbanisation and growth of cities in the twentieth century. Heavily urbanized megacities in the low-lying deltas of Asia have been identified as “hotspots”, especially vulnerable to climate risks (ADB, 2008; IPCC, 2007). The level of urbanization in India has increased from 27.81% in 2001 to 31.16% in 2011 (Census 2011) **International Panel on Climate Change (IPCC)**

To accommodate accelerating urbanisation more wet lands, open spaces, tanks and wooded areas are converted to urban and suburban areas, thus, the amount of surface area available for water infiltration into the soils decreases.

Home sites, parking lots, buildings, and roadways all decrease the surface area of soil on Earth's surface.The increase in artificial surfaces will increase the flooding frequency due to poor infiltration and reduction of flow resistance.

In Urban drainage system water is redirected into sewage and storm water drains.These drainage systems are presently insufficient to cope with the increase volume of water created from high intensity rainfall and generates flood.

Over the coming decades, the pressures of urbanisation along with climate change will aggravate this situation.There are evidences in recent years where heavy precipitation events have resulted in several damaging floods in India.

A number of major cities and towns in India reported a series of devastating urban floods in the recent decade.

The consecutive flash floods over three major metro cities in the same year, i.e., Mumbai in July 2005, Chennai in October 2005 and again in December 2005 and Bangalore in October 2005 caused heavy damages in economy, loss of life, disruption of transport etc...

PROBLEMS

- There is no way to stop the sea-water from rushing into the drainage system during high tide.
- Choking of drainage system with extreme rainfall causes the additive effect in flooding in City.
- The stagnation of flood water causes damage to the roads, and to sub-grade and sub-soil,loss of lives.
- Flooding of railways has the potential to causes, damage to trains, damage to the railway infrastructure.
- Most of the storm water drains are also choked due to the dumping of garbage by citizens.
- Economic impact of flooding is serious in case of wage earners.
- water logging and sinking of the ground, occur in slum areas which causes damage to huts, hutments and household goods.
- The transport system receive the immediate impact of floods as the storm water drains which are unable to cope the storm water are encountered with blockage and as a result the runoff and submerge the roads and railway tracks.
- The small scale industries are more affected by water logging because of their resource-constraints. The machinery of small scale industries in low lying areas get submerged during intensive flooding causing loss of production for many days.

1.2 Objective

The objective of this study is to undertake the study of flood prone areas and to access the impacts of urban flooding on traffic congestions by using geo-spatial datasets.

The key objectives are:-

- To identify causes and location of repetitive water logging in Kurla by previous data.
- Generate flood risk maps of Mumbai for estimation of the areas which are going to be flooded in the case of different rainfall intensities, duration and volume, with spatial information about the flood water depth.
- Identification of flood hotspots on urban road network.
- To recommend Engineering solutions for preventing water logging in Kurla.
- To prepare environmental management plan for Kurla with reference to water logging.

Chapter 2

Literature Review

Seasonal water logging problem in mega city:A study of kolkata, India, Ria Roy, Md kutubuddin Dhali received on 17th March 2016 accepted 5th april 2016.

Water logging has become a major problem in this metro city Kolkata by which population are effected badly.The increase of the high-rise buildings, which made the land congested and disrupted also. The history of Kolkata‟s evolution is very interesting regard of both physical and cultural aspect. The physical setup like active clay layer, presence of marshy land, on the other hand the social setup like growing urbanisation and high rise, and no of non-biodegradable solid waste are responsible for this devastating situation. The overall studies have identified the main waterlogged zone , ward wise waterlogged situation and its varying depth , waterlogged road and traffic congestion and the people who have been suffered from waterborne diseases(mainly in the slum and the squatter people). K.M.C had provided recommendation for setting up new pumping station and maintaining the drainage and sewerage system. But all of are not materialised properly due to lack of K.M.C„s interest and this worst situation are increase day by day and people are affected badly.
Water logging problems in an urban area of Silchar (Cachar District) And the problem mitigational outcome Documented by team DDMS coachar
The relatively low lying area of the urban area is flood affected from internal rain feed. This is mainly due to blockages and unavailability of proper drainages. Here we can say that non-implementation of land use plan has caused all such ambiguities. There exist few lined drains within the urban area. They are much unplanned and lack in systematic drainage network. Some localized places of the urban area suffer from inundation due to internal storm water drainage congestion, and water logging in few places in absence of adequate gravity drainage provision and routes and also for choked up with solid wastes. After the absorption of the mitigation measures in the real process changes have positively been noticed and ill-effects of water logging have been reduced. Thus, Lack in social awareness is a huge concern for smooth functioning of the same and disaster management should be a part and parcel of every one's life where each one needs to be socially aware that what harm he is causing to the nature and the mankind.
Highway surface drainage system and problem of water logging in road section by Mr.Dipanjan Mukherjee accepted in 15th November 2014.
Mr.Dipanjan Mukherjee has studied that Highway drainage is a process of removing & controlling excess surface water with in ROW. During rains part of the rain water flows on surface and part of it percolates through the soil mass. Some water is retained in the pores of the soil mass and surface of soil particles by surface tension and adsorptive forces, which cannot be drained of natural gravitational methods and this water is termed as held water. Adverse roadway elements contributing to highway accidents were substandard road way alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement center and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route,

haphazard bus shelters/stops, and others are causes of water logging problem in highway. The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime.

Research and the Countermeasures on the Main Waterlogging Points in Jingdezhen City Zhang yifan, a, Wang Haiqi,b and Wang Luhuan

Through the field investigation of Haode lots, Huang Niedou lots, the lots around Chashan Road Jinye Hotel, East Road Jinsha Sunshine Railway Lots, Longjing Road, Xingyuan Road and Jiahe Road intersection, Hejiaqiao lots, the seventeenth primary school-Fuchun garden-Tongbin Road lots, the combination of urban and rural areas after the Changjiang Square, totally 8 streets in Jingdezhen city, this article carried out careful analysis and research on the waterlogging points, and then according to the specific circumstances to put forward the practical solutions to solve the waterlogging problem in some points, in order to get the complete and systematic research on the causes and solutions of the waterlogging problem in Jingdezhen city.

After the investigation of Jingdezhen city waterlogging points, from the terrain, urban structure system, residents living conditions, etc., roughly summarizes the causes leading to Jingdezhen urban water floods in the following:

(1) the terrain ups and downs, many low-lying and hilly lots.

(2) The accumulation of garbage leads to sewer blockage.

(3) large-scale development of urban areas, underground drainage pipeline fragmented.

(4) less drainage outlet, drainage system transformation is not perfect, a single way of rainwater discharge.

(5) residents living functional partition is unreasonable.

(6) urban landscape is less, plant coverage rate in waterlogging area is low.

Establish rainwater garden in the low-lying areas of the city, rain garden is a sponge city water cycle management measures, the use of plants and materials as the main body, the use of landscape design approach to make it integrated with the surrounding urban landscape.in the latter part of the design and planning, we will focus on planning from the big city to analyze the actual situation of the road, combined with the local customs and other factors, to explore how to design, to achieve landscape ecology.

Establishing the comprehensive safety pattern and water safety pattern, the ecological safety pattern, travel and living safety pattern, which is based on the mountain body as the base and the south river system as the core, taking them as the basis of regional ecological protection and green corridor construction.

Causes and effects of water logging in Dhaka city, Bangladesh, Professor Jan-Erik Gustafsson, Department of land and water resources engineering

Water logging in Dhaka City is the consequence of unplanned development. Due to rapid urbanization with unplanned construction, most of the storm water drainage have been encroached, filled up, diverted and caused obstruction to the smooth flow of water to the outfall-rivers, creating severe water-logging in the city every year during monsoon incurring huge loss in terms of adverse social, physical, economic and environmental costs. The most recent heavy rainfall that brought Dhaka to a virtual standstill demanded the urgent need for long term planning to overcome water logging problem. We understand the exceptionality of thedeluge and that the

government and development authorities have no control over the weather. Nevertheless, the devastating impact of the downpour that paralyzed Dhaka is a salutary reminder of the severity of the problem, and the necessity for the government to take counteractive measures on a priority basis. Dhaka City could hurtle towards an ecological disaster if destruction of the natural drainage and water bodies isn't stopped and an effective management of urban drainage system isn't set up.

Planning, design, operation and maintenance of urban drainage systems is a challenge for urban authorities because of unplanned development activities, and the effectiveness of storm water management systems can be directly linked to the efficacy of urban management. Therefore, for urban drainage systems to be managed effectively and operationally sustainable, greater emphasis needs to be placed upon:

• Co-ordination between urban authorities and agencies those are responsible for different aspects of urban infrastructure provision and management.

• Collaboration between government and non governmental organizations and promotion of effective partnership with civil society and the private sector.

• Training and human resource development for improved planning, design, and operation of urban drainage systems.

Arunachalam, B. (2005). Drainage problems of Brihan Mumbai. Economic and Political Weekly,XL(36), 3911.

The entire Brihanmumbai territory is divided in seven sewer zones vlz. Colaba, Worli, Bandra, Versova, Malad, Bhandup and Ghatkopar, for the sake of collection, treatment and disposal of the sewage. The treated sewage from Colaba, Worli andBandra Zones is disposed into the Arabian Sea through marine out falls, some three kilometres into the sea.

There are 51 pumping stations for pumping the sewage/waste water from lower level to higher level and there are 68282 manholes for maintenance of 1860 km long network of the sewerage system.Total number of street connections are 275000.Installed capacity of pumping stations 15590 Mld.

The underground drainage pipes of the sewerage system in Mumbai are more than 100 years old and needs renovation. In congested parts, the sewerage lines and water pipelines run together and leakages contaminate drinking water.

The unplanned and unauthorised growth of the city makes it difficult and, at times, impossible to replace old sewerage lines. The problem of sewer lines of small diameters getting choked due to solid waste and silt entering them is rampant. The result is that instead of getting drained, sewage overflows on to the surface.

- It is utmost necessary for BMC provide treatment and disposal methods of waste.
- Rusted water supply lines should be replaced/repaired

2.1 History

2.1.1 Kurla Profile

Geography:-

Kurla is a neighbourhood of East Mumbai, India.
It is the headquarters of the Kurla taluka of Mumbai Suburban district.
It falls under Zone 5, Ward 'L' of the Bombay Municipal Corporation.
It covers an area of 135 square kilometres, covering a total of 29 villages in two circles.

Hydrology:-

Mumbai is bounded by the Arabian Sea to the west. Many parts of the city lie just above sea level, with elevations ranging from 10 m to 15 m.
Kurla
Name: Zone 5 topographic map, elevation, relief.
Coordinates:
Latitude: 18.99165 , 19.12918
Longitude: 72.86356, 72.96060
Barometric Pressure: 101KPa
Minimum elevation: -3 m
Maximum elevation: 305 m
Average elevation: 11 m/36.0892ft. above sea level .
So if the sea rises 2 meters nearby areas will be affected. Flooding will be more common, and the population of nearby coastal areas will have to be relocated.

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		21	66	87

	<1.5m)				
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.

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

The Brihanmumbai Stormwater Disposal System is a project planned to overhaul Mumbai's water drainage system. The estimated budget for implementing the project is Rs. 12 billion (approx. 300 million US dollars) as of August 2005. Such a high-budget project would require funds from the Central Government.
Mumbai has a drainage system, which in many places, are more than 100 years old, consisting of 2,000 km of open drains, 440 km of closed drains, 186 outfalls and more than 30,000 water entrances.The capacity of most of the drains is around 25 mm of rain per hour during low tide, which is exceeded routinely during the monsoon season in Mumbai, which witness more than 1400 mm during June and July.
The drain system works with the aid of gravity, with no pumping stations to speed up the drainage. Most of the storm water drains are also choked due to the dumping of garbage by citizens.
History of failed drainage system in Mumbai The act of 26 July 2005.
The project was conceived after major floods in Mumbai in 1985. Watson Hawksley was appointed as consultants to design the drainage system from Sandhurst Road to Milan subway in 1989.
A proposal was submitted in 1993 for a project which involved replacement of drains, setting up of pumping stations at Worli, Haji Ali and Cleaveland Bandar, construction of a five-metre wide road alongside major drains for desilting, removal of obstructions from the drains and rehabilitation of slum-dwellers . The project was not acted upon due to lack of funds till the catastrophic floods in 2005.
The initial estimated cost of the project was around Rs 6 billion.
Around Rs 1.43 billion was spent on the project till 1998.
By 2005, the project cost had gone up to Rs 12 billion.

Summary of Flood-prone areas in Greater Mumbai

Sl.	Location Name	Remarks
1.	Maratha Mandir, Mumbai Central	This flooding spot is partially eliminated due to improvement works carried out in the past.
2.	Satrasta, Mahalaxmi (E).	
		This flooding spot is

3.	Gandhi Market, King Circle	eliminated due to improvement works carried out in the past.
4.	Rafi Ahmed Kidwai Marg, Sewri, Wadala	This flooding spot is eliminated due to improvement works carried out in the past.
5.	Umarshi Bappa Chowk, Hemu Kalani Marg, Chembur	Sewer lines of small diameter getting chocked due to solid waste and silt entering them and sewage gets overflows on to the surface.
6.	Brahmanwadi, Kurla (W)	Small diameter of pipes and improper drainage system.
7.	Postal Colony, Chembur	This flooding spot is eliminated due to improvement works carried out in the past.
8.	Kurla West Market	Low lying area and blockage of drainage.
9.	Kurla West Station	Blockage of drainage system due to chokeup.
10.	Kapadia Nagar, Kurla(w)	Low lying area results in more water logging causes loss of houses, loss of lives etc.
11.	CST Road , Kurla.	Sewer lines of small diameter getting chocked due to solid waste and silt entering them and sewage gets overflows on to the surface.
12.	Al- Barkat Subway, Kurla	Sewer lines of small diameter getting chocked due to solid waste and silt entering them and sewage gets overflows on to the surface.
13.	Tilak Nagar Station	Low lying area results in more water logging causes loss of houses, loss of lives etc.
14.	Chembur Camp Market	Sewer lines of small diameter getting chocked due to solid waste and silt

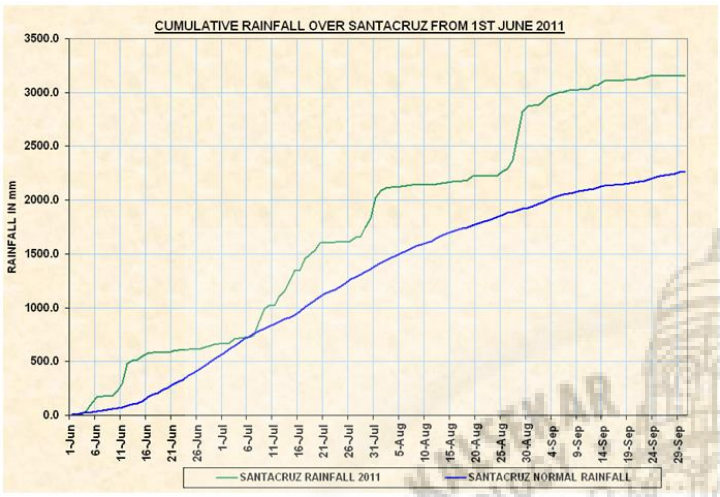
		entering them and sewage gets overflows on to the surface.
15.	Near Mithi river residents	Low lying area results in more water logging

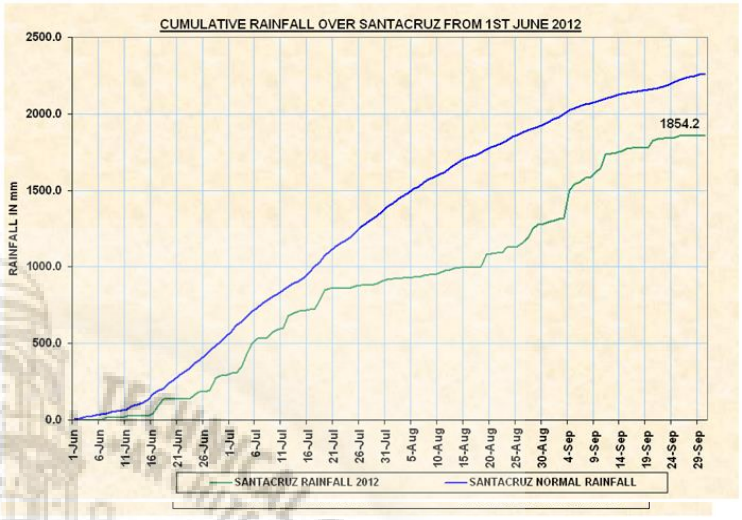
2.1.2. Rainfall Data

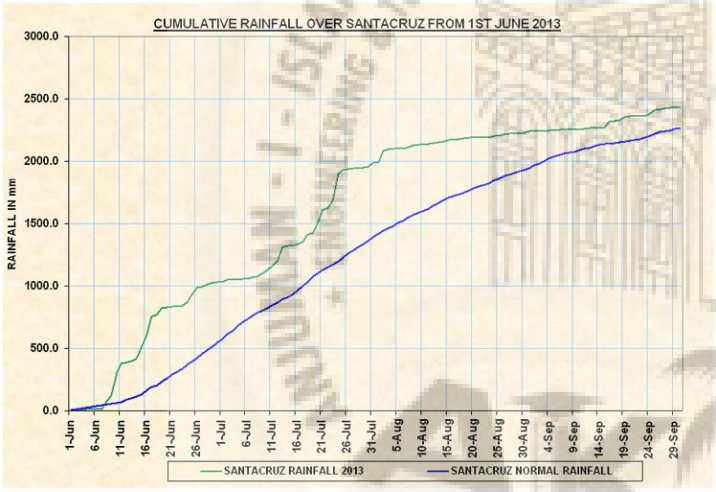
Rainfall is the main driving parameter of urban floods in Mumbai. Since, rainfall intensity, duration and frequency determine the extent and severity of flooding, it is important to analyse the rainfall for the selection of events in the designing process. The rainfall data of Mumbai city measured at Santacruz, Colaba and Dahanu weather stations for the event 26-27 July 2005 is provided by the IMD Mumbai.For the estimation of flooding we need fine time resolution rainfall data. Hourly data was available only for Santacruz station between 26th July 2005, 14:30 IST to 27th July 2005, 02:30 IST. 15 minute rainfall data for other than 26-27 July is collected froBMC AWS. These rainfall data is converted into time series data.

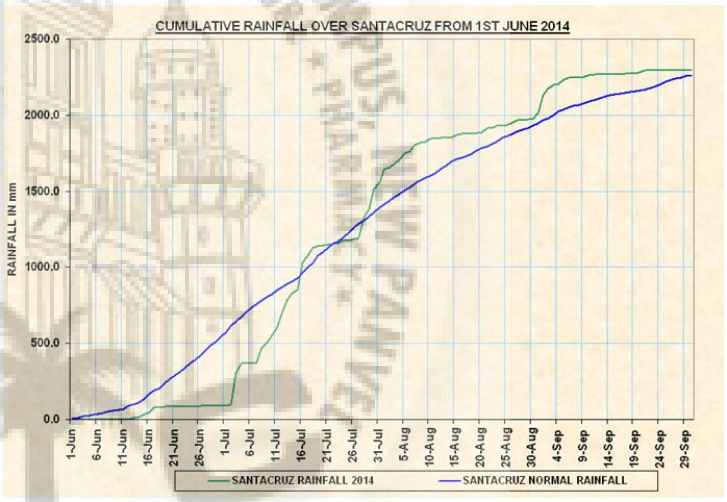
Year/Month	June Rainfall in (mm)	July Rainfall in (mm)	August Rainfall in (mm)	September Rainfall in (mm)	Total Rainfall in (mm)
2007	1007	524	606	121.3	2258.1
2008	936.1	80	629	326.2	2698.2
2009	218.2	1120	293	313.5	1944
2010	719.4	1320	1041	247.6	3327.9
2011	662.6	1427	792	272.4	3153.5
2012	311.9	620	383	551.7	1866.8
2013	1032	95	253	190.1	2433.5
2014	88.9	1555	486	188.4	2318.2
2015	1113	356	156	199.2	1823.2
2016	766	966	452	715.3	2898.7
2017	616	789	938	603.2	2946.3
2018	794	1137	238	70.8	2239.6
2019	455.8	1175.1	988.3	855.8	3475
2020	518.9	1464.8	579.8	115.9	3679.8
Average	638.50	902	559.65	340.81	2902.87

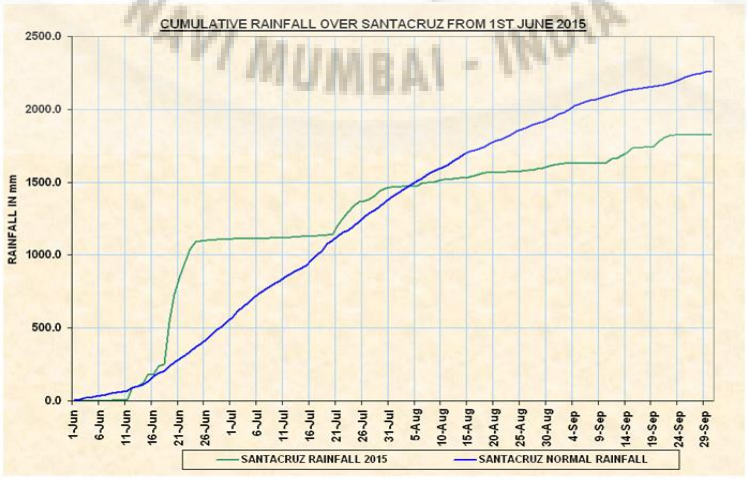
Cumulativ Rainfall Over Santacruz

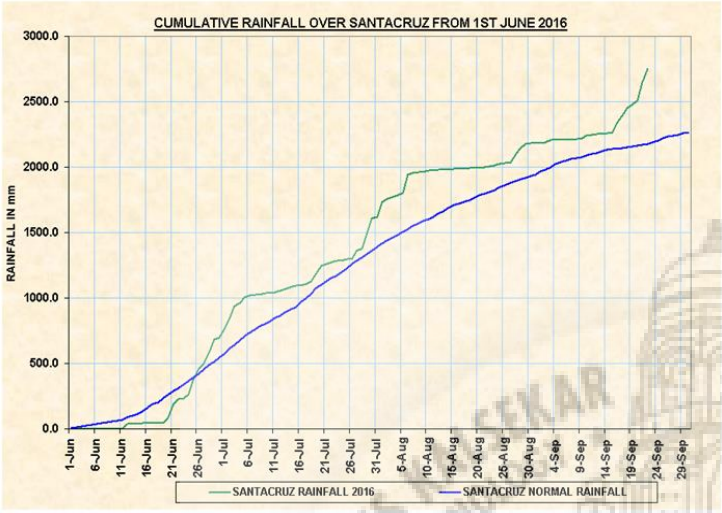


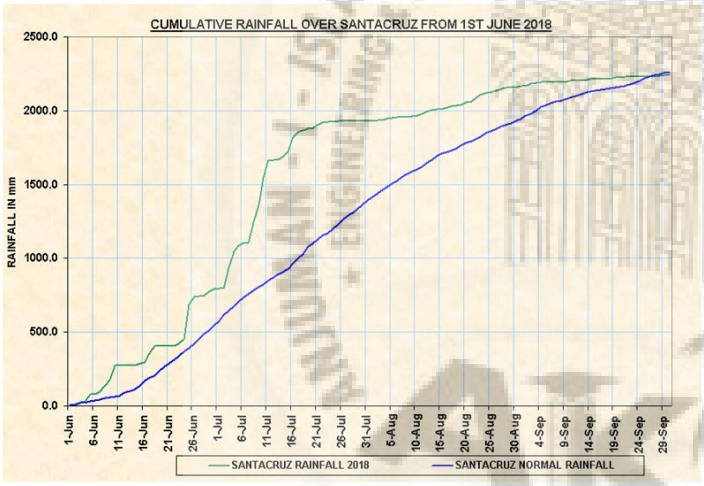









CUMULATIVE RAINFALL OVER SANTACRUZ FROM 1ST JUNE 2016
RAINFALL IN mm
SANTACRUZ RAINFALL 2016
SANTACRUZ NORMAL RAINFALL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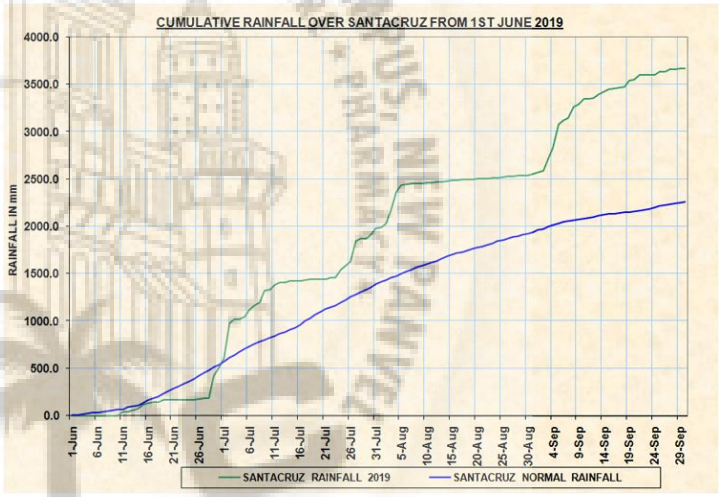
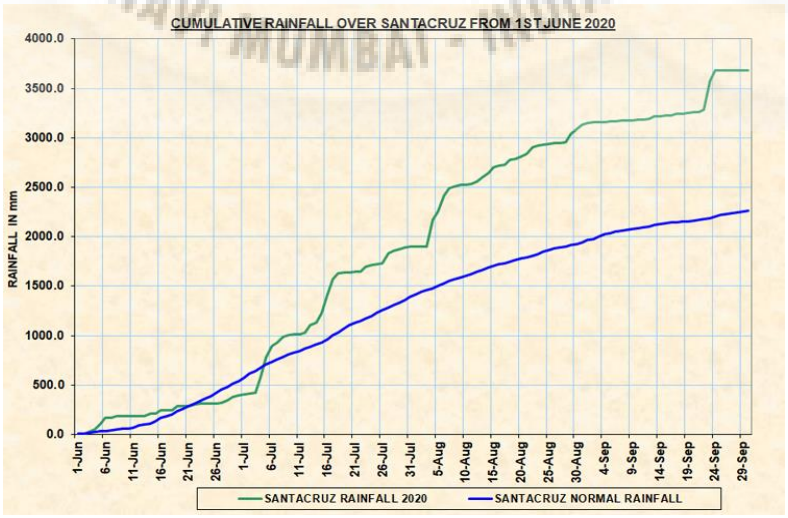
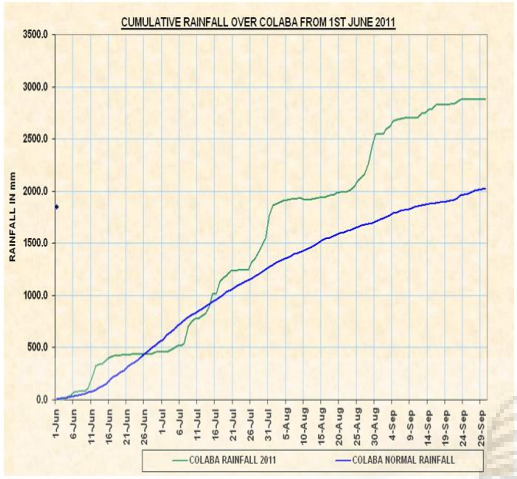
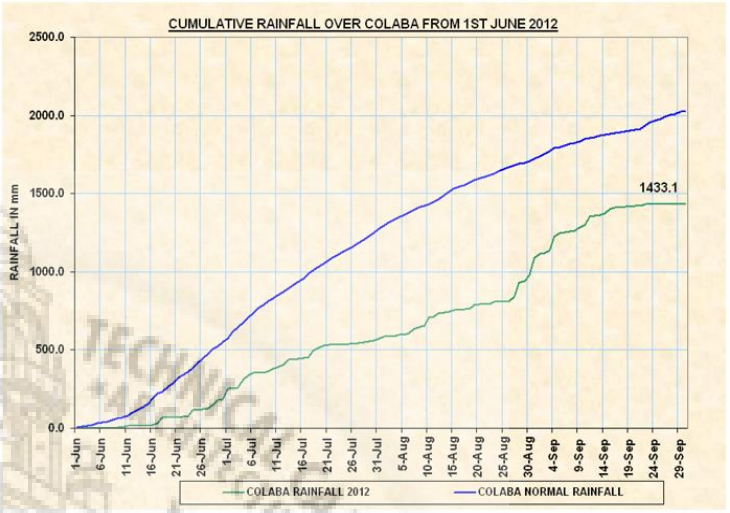
RAINFALL IN mm
SANTACRUZ RAINFALL 2018
SANTACRUZ NORMAL RAINFALL

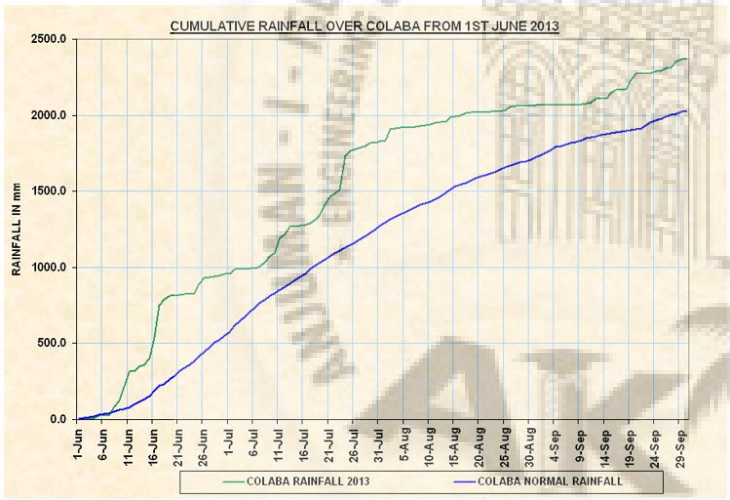

CUMULATIVE RAINFALL OVER SANTACRUZ FROM 1ST JUNE 2019
RAINFALL IN mm
SANTACRUZ RAINFALL 2019
SANTACRUZ NORMAL RAINFALL

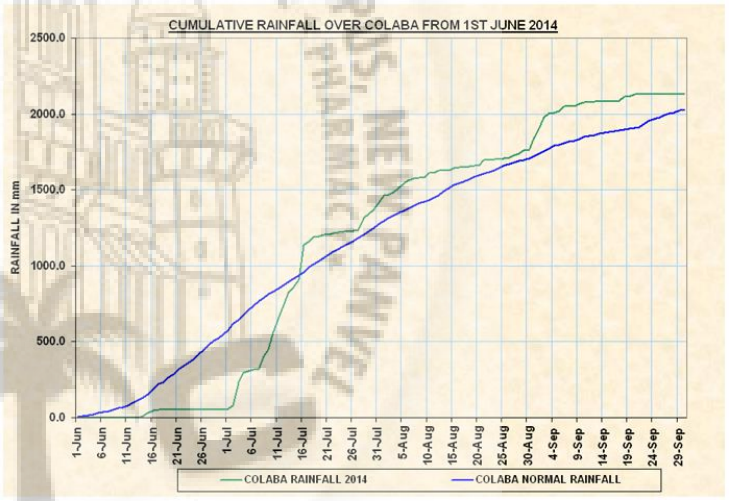

CUMULATIVE RAINFALL OVER SANTACRUZ FROM 1ST JUNE 2020
RAINFALL IN mm
SANTACRUZ RAINFALL 2020
SANTACRUZ NORMAL RAINFALL

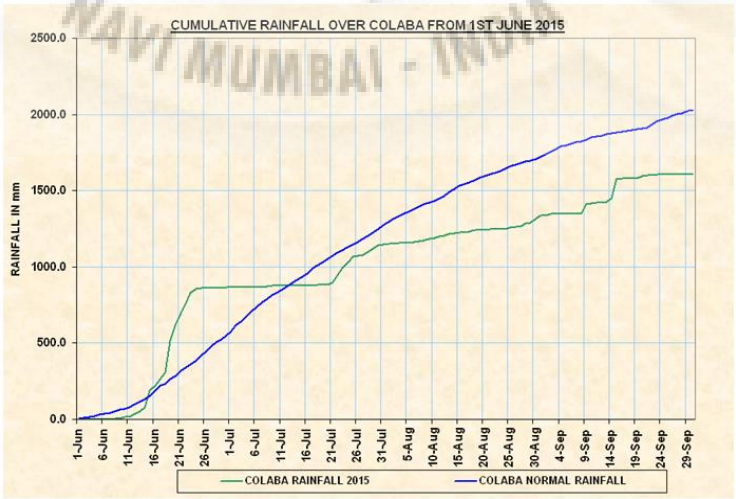
Cumulative Rainfall Over Colaba

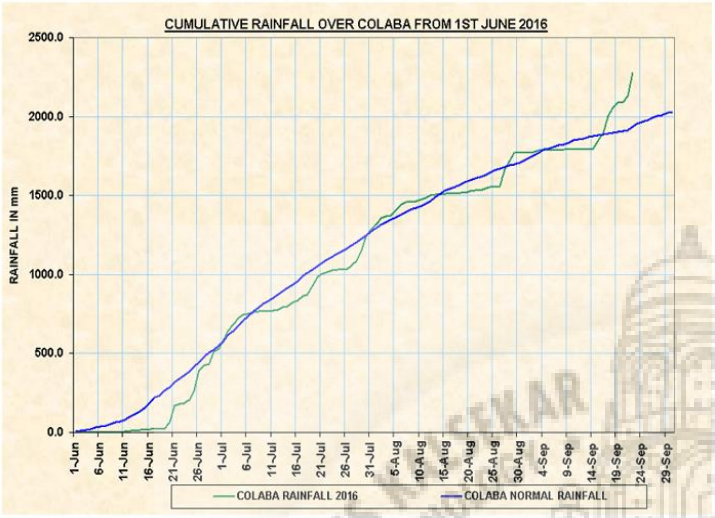


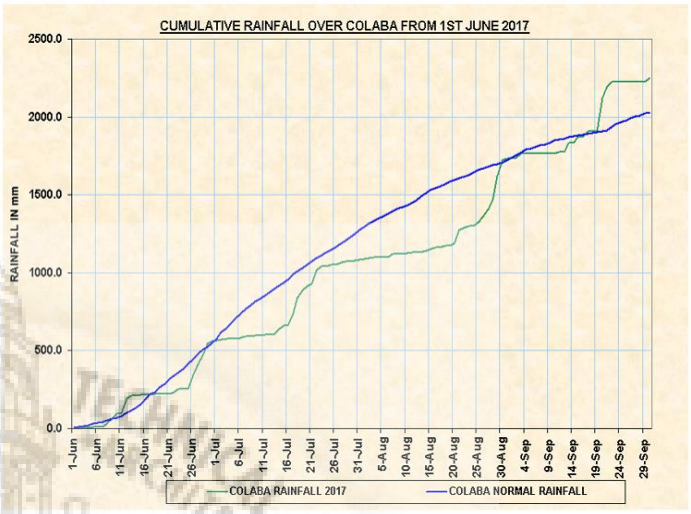


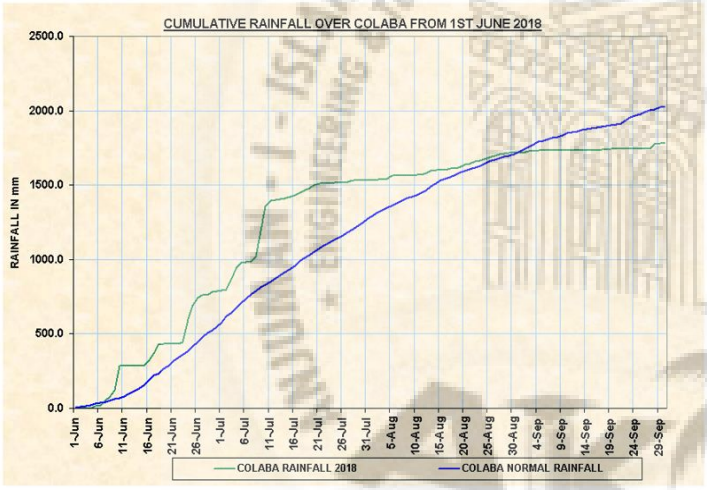


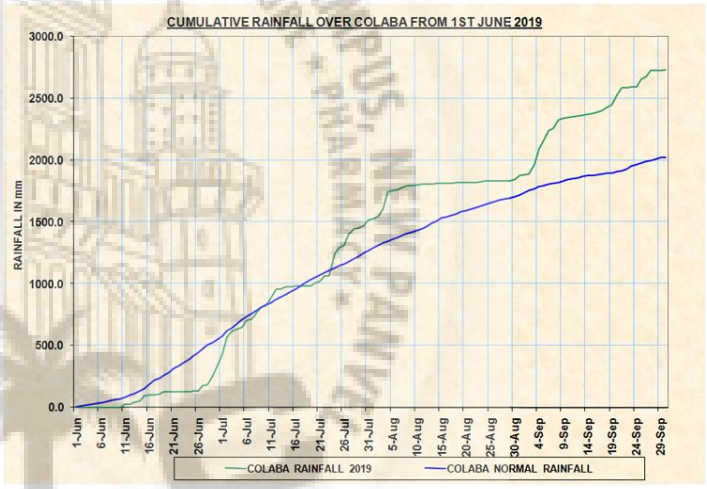




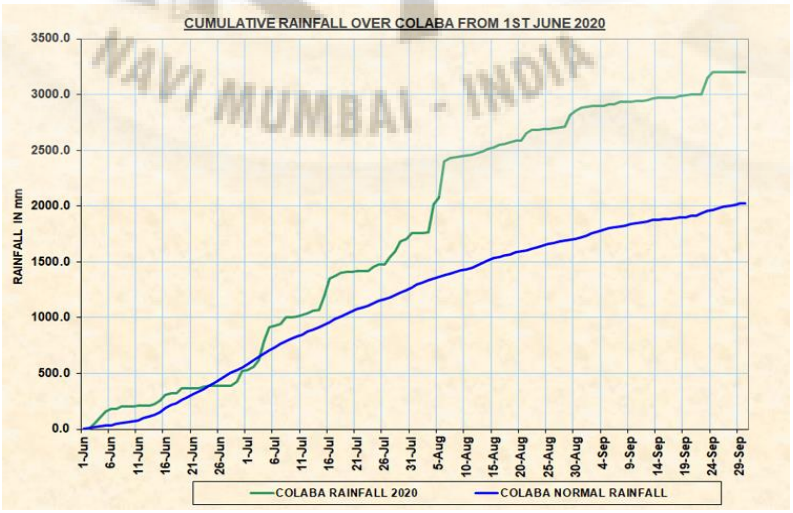


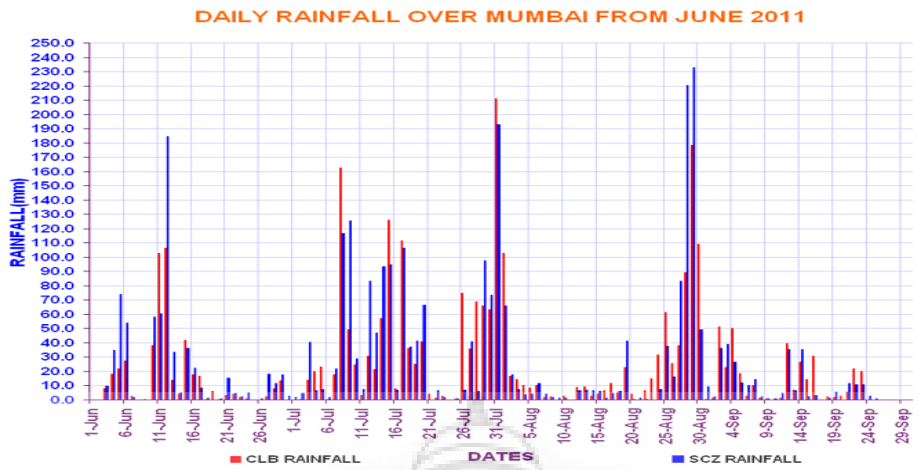


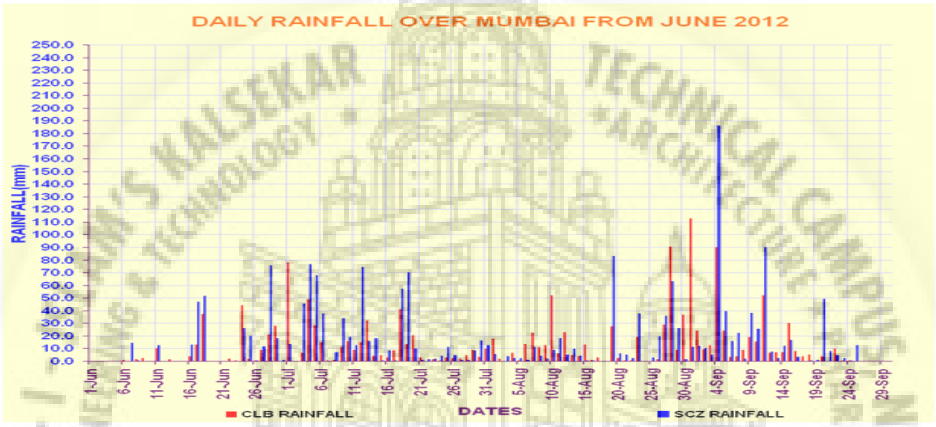


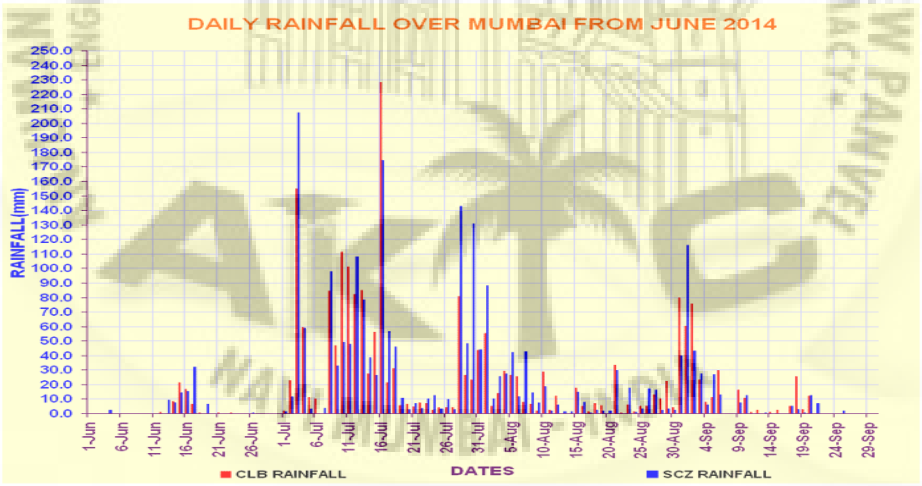


Cumulative Rainfall Over Mumbai




DAILY RAINFALL OVER MUMBAI FROM JUNE 2011
RAINFALL(mm)
DATES
CLB RAINFALL
SCZ RAINFALL


DAILY RAINFALL OVER MUMBAI FROM JUNE 2012
RAINFALL(mm)
DATES
CLB RAINFALL
SCZ RAINFALL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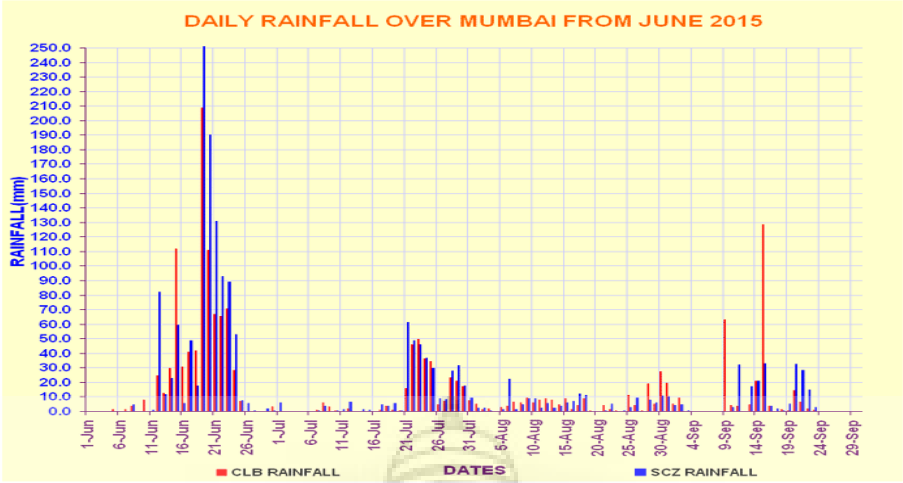
RAINFALL(mm)
DATES
CLB RAINFALL
SCZ RAINFALL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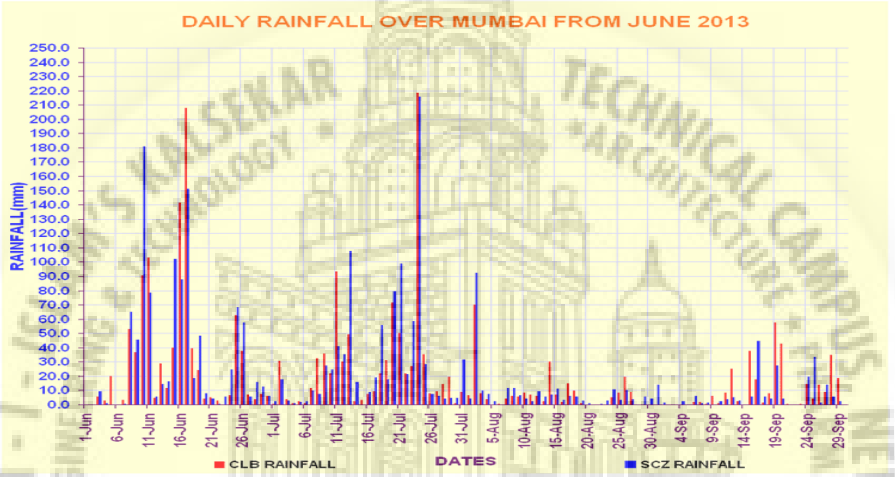
RAINFALL(mm)
DATES
CLB RAINFALL
SCZ RAINFALL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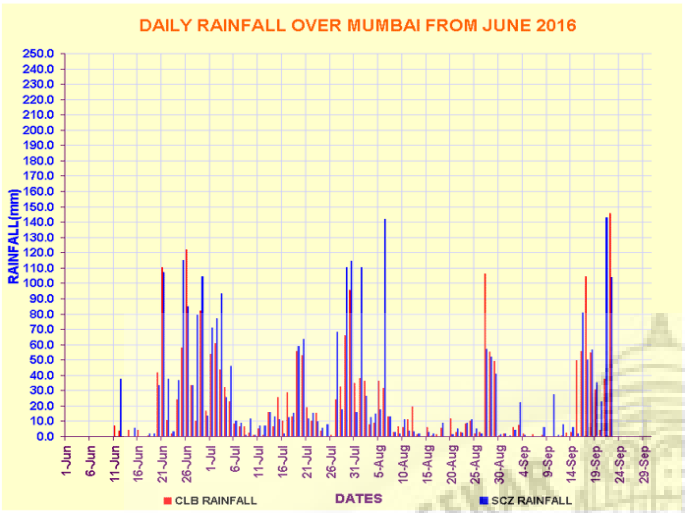
RAINFALL(mm)
DATES
CLB RAINFALL
SCZ RAINFALL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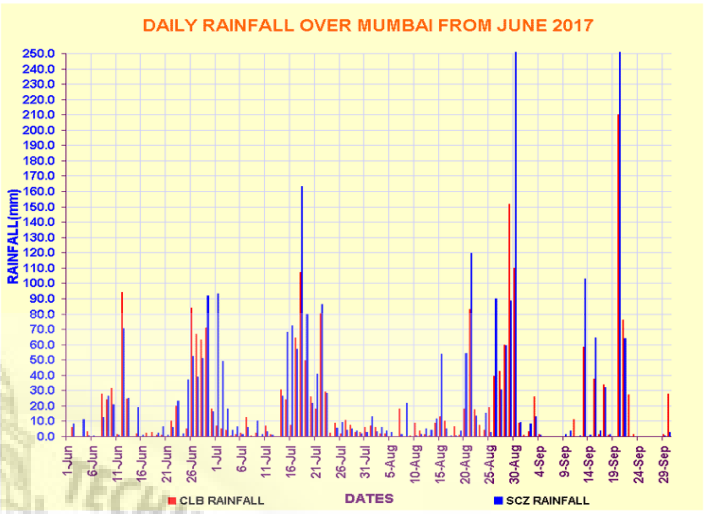
RAINFALL(mm)
CLB RAINFALL
DATES
SCZ RAINFALL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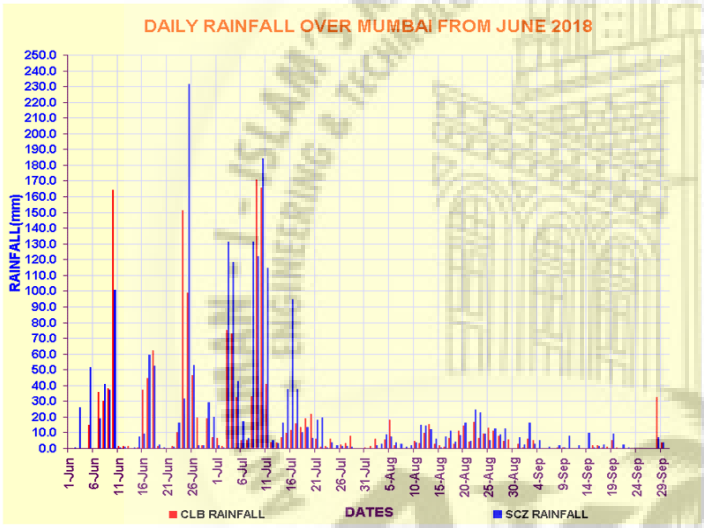
RAINFALL(mm)
CLB RAINFALL
DATES
SCZ RAINFALL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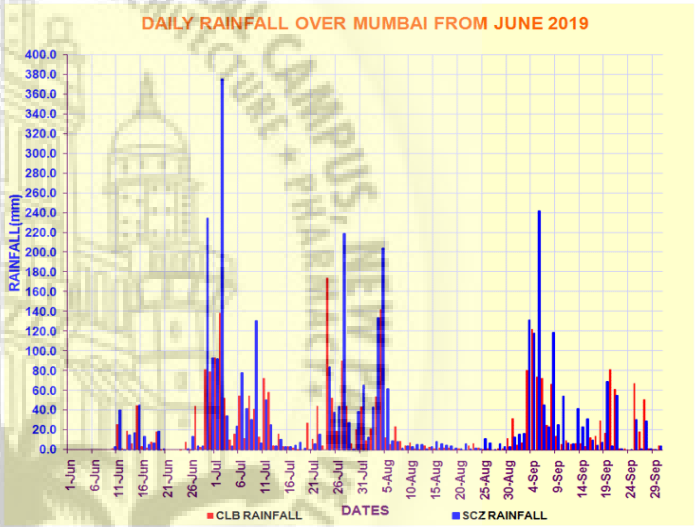
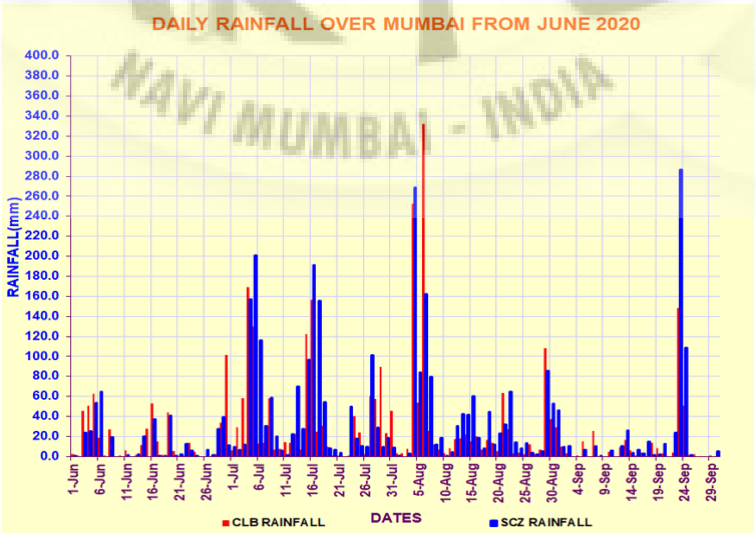
RAINFALL(mm)
CLB RAINFALL
DATES
SCZ RAINFALL


DAILY RAINFALL OVER MUMBAI FROM JUNE 2019
RAINFALL(mm)
CLB RAINFALL
DATES
SCZ RAINFALL


DAILY RAINFALL OVER MUMBAI FROM JUNE 2020
RAINFALL(mm)
CLB RAINFALL
DATES
SCZ RAINFALL

The rainfall data can be analysed and presented in many ways.Here, we have analysed the rainfall data of Mumbai provided by IMD.

Table I Rainfall Events

Events	Total Rainfall (mm)	Total Duration	Return Period
26-07-2005	**944.42**	**24 Hrs**	**>200 years**
30-06-2007	**314.45**	**18 Hrs 30 min**	**>10 years**

Extreme Event of 2005, highest rainfall event ever recorded over Mumbai.

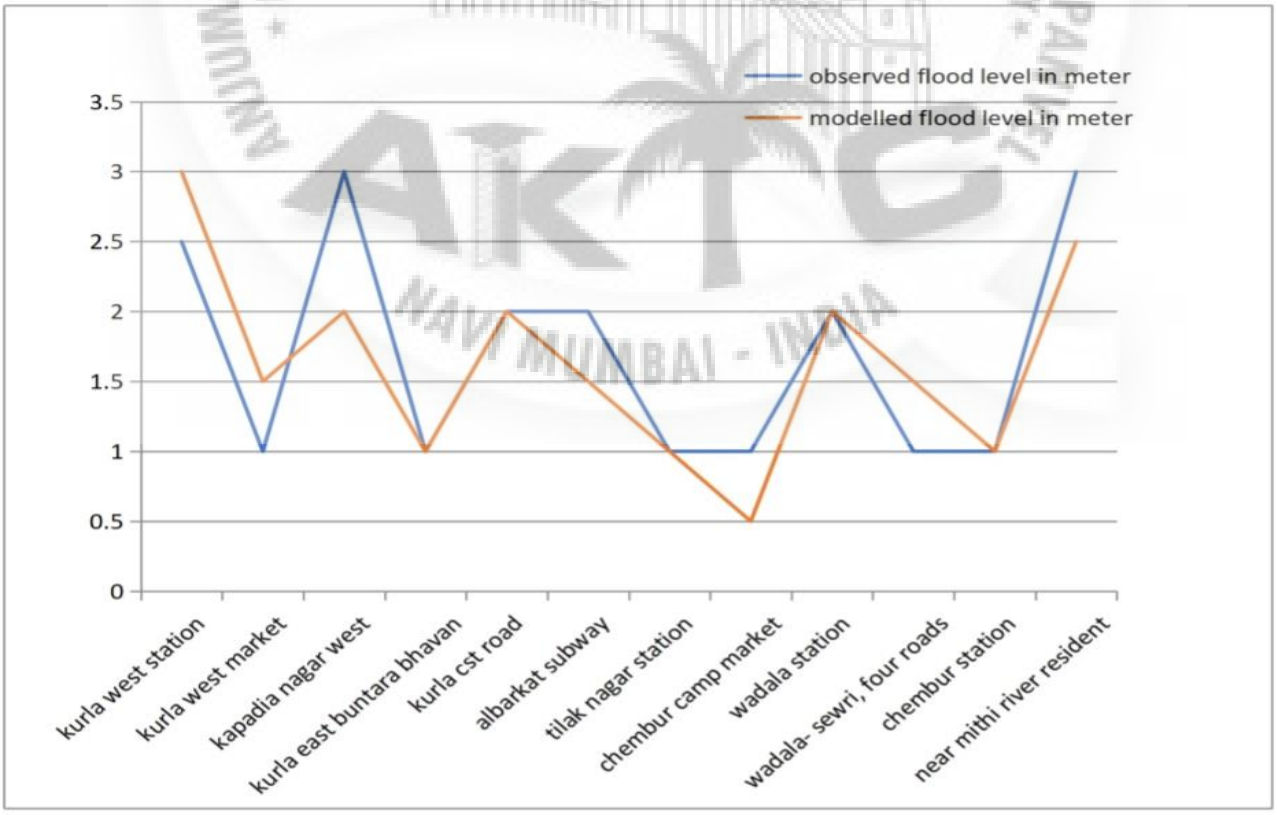
Model Simulation

Simulation of the model is based on Accuracy analysis.Observed flooded points in Kurla are taken from the Greater Mumbai Disaster management action plan report and the local residents public.

Flood points were taken for the validation from the different part of the Kurla which includes slums, roads, junction, subways, railway stations and proper settlements. The figure bellow shows the correlation between modelled vs observed values, with significant accuracy.

Result And Analysis

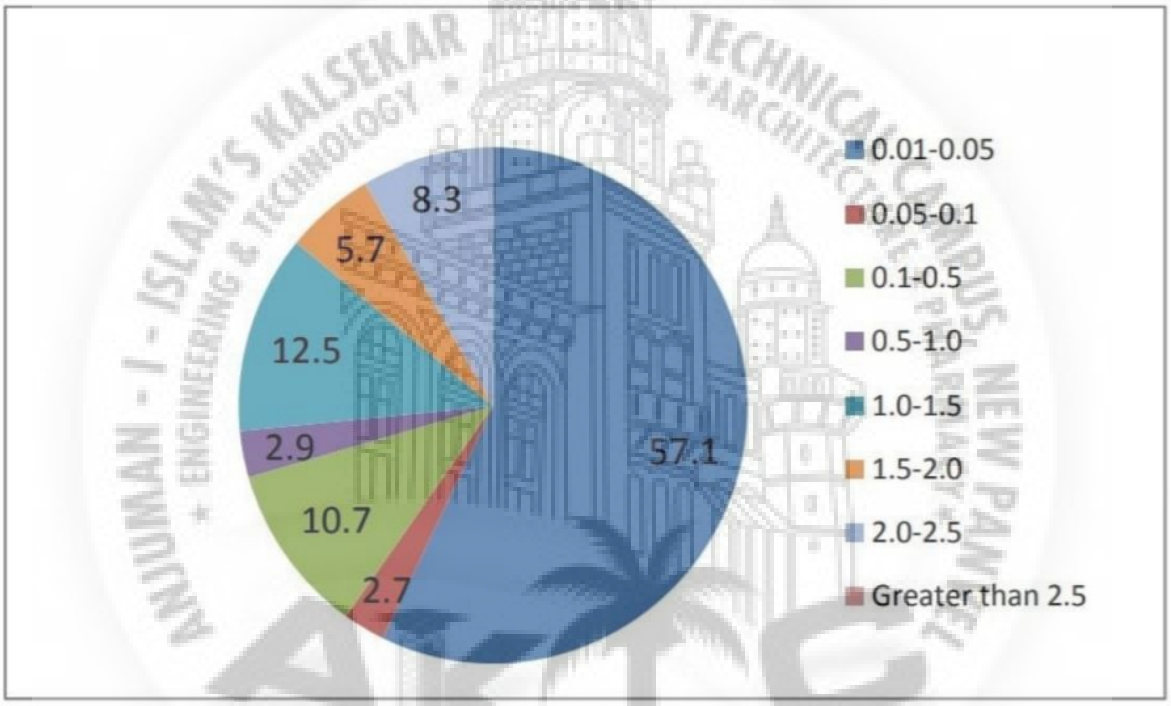
The model is simulated and the results were obtained for every 15 minute interval. The maximum flood level map at the end of the simulation has been analyzed for both the events selected for simulation.



The results indicate that the extent of flooding is wide spread and in some places the water level is alarmingly high.Areas nearby the drainage lines are most affected followed by the road cross sections and low lying areas.The low lying areas are worst flood affected areas in terms of flood level height and heavy rain fall.

Flood Level Over Road Network

Kurla is in the Zone 5 of Mumbai. Kurla recorded 57.1 % of road length to be flooded in the range 0.01-0.05m. water level followed by 2.7 % and 10.7% of flooded road length in the range 0.05-0.1 and 0.1-0.5 respectively. 2.9% of flooded road length are in the range of 0.5-1m water level. The maximum flooded road length of 12.5% was recorded in the range 1.0-1.5m water level. The water level greater than 1.5m constitutes about 14.1% of flooded road length.



Chapter 3

Methodology

3.1. Working Of Water Pumping Station

These devices can supply water to canal, circulate water in treatment systems and can even drain water from low lying land.
The Pumping Station must provide enough pressure to overcome the force of the gravity on the water. When this pressure level is met, there will be enough pressure to move liquid at the flow rate that is needed. This is a simple maths equation and pumps are designed to be programmable so that the water flow rate can be adjusted easily.
An electronic controller that is either directly attached to the pumping station itself, or operated from a remote site, is used to input the required data. The equation is calculated by taking into account all of the pipes (their dimensions), additional fittings, changes in elevation and any other parts that might have an effect on the pressure of the water system. It's important to look at the pipe entrance dimensions, any directional changes in the piping (45 and 90- degree bands), different types of valves as well as dimensions of any outlet along the system must all be taken into account when calculating the pressure needed to overcome the system pressure get the water moving.
In this calculation, it's also important to look at the various properties of the liquid that is to be pumped. So, for water, it's crucial to check the roughness factor as well as the friction that the liquid exerts on the piping. Liquid such as water will have very little friction, however, sewage and chemicals might be viscous and as such will need stronger pressure to move them through the piping.

3.1.1. Procedure Of Water Pumping Station

- **Station Design**

1-a. Station Capacity:-

Pumping station capacity requirements are normally determined by the hydraulics engineer in accordance with establishing pumping requirements for the maximum andMinimum river stages, and the maximum water stages permissible in the protected area. The latter will be referred to the station location and will establish the Maximum allowable water surface elevation in the station Sump. The hydraulic data provides the basic information Needed for the selection of equipment and, in turn, the Layout of the station. In those special instances where an Increase in pumping capacity can be definitely expected at Some future date, consideration should be given to a station design which facilitates the installation of increased Capacity in a manner that will give the greatest overall Economy. Alternate studies of pumping stations satisfying The required pumping capacity should be made for all Pumping station projects. As a minimum, the studies Should include station location, station site layout, all Equipment, sizing of pumps, type of operation, and. Operation and maintenance costs and first costs.

1-b. Station Location:-

a. General. Experience has shown that a pumping Station should be located or sited in such a manner to Produce the most direct inflow possible. Any

location That produces asymmetrical flow into the pump bays Causes problems with circulation, uneven velocity distribution, vortices, and generally poor pump performance.

This is true for inflow confined within an inlet channel, Sewer, or a large ponding area. Additional engineering Studies and/or physical modelling may be required when Circumstances exist that prevent recommended station

Siting. Gravity flow structures, when provided, can be Located in an offset position without additional cost and Still perform adequately.

b. Line of protection. The location of stations with Respect to the line of protection should be selected for Safe operation. Construction of the station integral with a Concrete floodwall will, in general, minimize the hazard Of discharge line failure. On projects with an earth level Or where right-of-way restrictions exist, the station may Be located at the landside toe of the levee. More hazard- Ouse locations (riverside of protective works) may be con- Sidered if a definite operational or economic advantage is Presented. Vehicle access to stations at all flood eleva- Tinos should be carefully considered in station location, And minimum but adequate provision should be made to Permit safe operation of service vehicles bringing in Equipment during construction and operation and Maintenance

c. Operating floor elevation. The operating floor Elevation should reduce the possibility of damage, caused

By flooding, to the pumping equipment. This elevation is Dependent upon the hydraulics and hydrology criteria, the Location, and the physical layout of the pumping station.

1.When the pumping station is located on the line Of protection, the elevation of the operating floor will Depend on whether the pumping station is subject to the Discharge pool elevations, or is protected by a flood wall Or a discharge chamber. When the pumping station is Subject to the discharge pool elevations, the operating Floor should be no lower than the top of the levee. When The pumping station is protected by a flood wall or a disharge chamber, the operating floor elevation should be Located at least 0.3 m (1 ft.) above the interior level of Design protection.

2.When the pumping station is not located on the Line of protection, the elevation of the operating floor Should be at least 0.3 m (1 ft.) above the interior level of Design protection.

1-c. Station Type:-

Floodwater pumping stations. These stations Should be of the wet-pit (sump) type employing vertical Mixed-flow or axial-flow pumps in practically all cases. These pumping units may also be of the submersible type (Plate 1). Floodwater pumping stations usually pump Directly from open storage ponds, ditches, or stormwater Sewers. When practical, provision should be made for Exclusion of water from the pump sump and for maintaining the sump in a dry condition during inoperative

Periods. A typical station for pumping water from an Extensive open ponding area is shown in Plates 2 and 3. This station is located at the edge of the ponding area, Adjacent to the gravity drainage structure discharging Through the levee. The station's inlet sump is at an Elevation considerably lower than the gravity flow stream Requiring the sump to be pumped dry when the station is Not in use. A large pumping station that pumps from an Open sump is shown in Plates 4 and 5. A typical storm-Water pumping station that pumps from a stormwater Sewer is shown in Plates 6 and 7. Occasionally stations Will be located over streams or drainage canals and in Such instances pumps must be protected from damage by Runoff during inoperative periods. Since the liquids Pumped by stormwater pumping stations are generally not Of a particularly corrosive nature, a wider latitude in Selection of materials is permitted.

- **Electric Power Supply**

2-a. Power Supply:-

Construction required. All facilities and construction necessary to supply the electric power required To operate the pumping stations will be provided as part Of the flood protection project. The cost of these facilities Will be included in the project costs. The construction Required may vary from the simple overhead service drop At utilization voltage to extensive installations involving Transmission lines, switching, and transformer equipment. The power line should be available at the time that the Construction contractor needs temporary power to construct the pumping station. Power costs and temporary Substation costs incurred during construction should be Borne by the pumping station contractor. The substation Should be located and constructed so that access is available to the electric utility for maintenance and repair.

Power for lighting and auxiliary services. A Continuous electric supply for lighting, heating devices, And miscellaneous control or protective devices is Required. The power supply for these auxiliary services May be separate from the main power supply to eliminate The necessity to have continuous energizing of main transformers and switchgear.

Emergency power supply facilities. In general Flood protection pumping stations should be considered Emergency facilities. Equipment and power supply should Be selected primarily on the basis of reliability under Emergency conditions. Additional emergency or standby Power supply facilities should not be provided unless the Power supply is considered unreliable

.

- **Equipment Selection**

3-a. Number And Size Of Pump:-

The design should obtain the desire Operations at the lowest possible cost. The cost used to Determine the pumping station design should be based on An annualized cost which should consider both first cost, Operating and maintenance cost, and cost of equipment Replacement over the life of the project. Generally, the Lowest cost is obtained with a minimum number of Pumps. However, a minimum of two pumps is

recommended. Baseflow for combined-flow stations should Have sufficient capacity for peak domestic and industrial Flows, seepage, and runoff due to light rains.

Economic study. The number and resulting size Of stormwater pumps must be determined by an economic Study. This study should consider the consequences and Related costs due to flooding if one pump malfunction During a flood event. The greater the number of pumps The smaller the reduction of the total station capacity if One pump malfunctions. This increased protection, how-Ever, results in higher equipment, facility, and operationutreod, And maintenance costs. The need to reduce the impact if One pump malfunctions will most likely be appropriate in Urban areas where a pump failure could cause significant Property damage and raise ponding more rapidly to life-Threatening depths. The extra costs cannot normally be Justified in areas where there are adequate flood warnings at Or no life threat. Any decision to add more pumps or More capacity to reduce pumping time and/or pondingStage in the event one pump malfunctions must be well Justified and the justification well documented. An economist will normally perform the economic study, closely Coordinated with the hydraulics and pumping station Design engineers associated with the project.

Pump size. The size of the sump may affect the Selection of sizes and number of pumps with regard to the Minimum desirable operating cycle. For a given sump Size, the number and size of pumps should be such that The minimum operating cycle would be 6 min for submersible pumps, 20 min for wet-pit pumps with motor size up To and including 75 kW (100 hp), and 30 min between Starts for pumps over 75 kW (100 hp). Pumping units Over 375 kW (500 hp) should be started according to data Furnished by the motor manufacturer. Where bypasses or Variable discharge pumps are to be used, the size of the pump has little effect on the size or number of pumps.

- **Discharge Arrangement**

4-a. Pressure Discharge Lines

Installing pumping station discharge lines under Through levees or floodwalls and subjecting these lines to Flow under pressure should be avoided whenever possible It is realized, however, that conditions may exist which Require or dictate their use. As an example, a large discharge line may be carried under a floodwall when right-Of-way for a pumping station would necessitate severa Bends. When it is not practicable to avoid a pressure line Under the levee or wall, the pipe will have ample strength And be provided with joints that will provide flexibility With restraint to limit axial movement. Whenever it is Necessary to install discharge lines under or through levees or floodwalls, seepage protection should be provided
As required

- **Design Steps:-**

5-a. Selection Of Pumps

The selection of pump for particular application is influenced by system requirements, System layouts, water characteristics, intended life, energy cost and material of construction. Basically, a pump is expected to,

- Pump a given capacity in given length of time.
- Overcome the resistance in the form of head of pressure imposed by the system.

While calculating and selecting the type and size of pumps, the following hydraulic Data is required to be taken into consideration.

- Type of source viz., natural/artificial, perennial/seasonal.
- Average yield.
- Total daily requirement from the source.
- Data of static water level and infiltration level below ground level during (a) Monsoon or wet season (b) Dry season.
- Diameter of pipe proposed to be used for suction side and delivery side as well as The length of the delivery.
- No. Of bends and valves and general layout of the pipe. No valves should be used On suction side.
- Height of the overhead tank from the ground level as well as the total storage Capacity to be provided.

It is also necessary for checking the piping layout. It is not uncommon that whenever an Old pump is replaced by a new pump, the discharge of the pump at the overhead tank is much Below the rated capacity. This may be due to scale formation inside the pipe line, thereby Reducing the diameter of pipe line.
A good method of testing the discharge of the pump is to measure the discharge over a Specified time in the overhead tank by closing all the delivery, system of the tank. After taking Number of such readings, calculate discharge per hour. This may be compared with the discharge At ground level by disconnecting the main delivery line and then computing the discharge at overhead tank level from the pump characteristic overhead tank level from the pump Characteristics curves.
Water characteristics such as turbidity, contents of chlorides and total solids, PH value, Temperature and sp. Gravity are also important factors for consideration. The handling of water with different characteristics may present problems in the selection of pump. The characteristics of clear, cold and fresh water specified in IS: 1710 – 1981 are given below.

Turbidity	50 ppm (silica, scale) max.
Chlorides	500 ppm max.
Total solids	3000 ppm max.
PH	6.5 to 8.5
Temperature	33°C, max.
Specific gravity	1.004 max.

If the range of PH value of the water pumped is between 6.5 and 7.5 and also the Chloride content is less than 100 ppm, the pump may be made of any bronze. However, if the Construction shall be permitted.

The power required to drive the pump and suction lift depend on the sp. Gravity of Water. The suction life also gets reduced with the rise in temperature of the liquid. If any other Characteristics of the water differ from those mentioned above, the pump details will have to be Agreed between the manufacturer or supplier and the user and shall be specified in the order.
Materials are affected by both the water and environment. Resistance to corrosion and Wear are the two important properties in this regard. Suitable material for pump can be selected Keeping in mind the purpose and operating conditions.

5-b. Selection Of Suction/Delivery Pipe:-

The route of the suction and delivery pipes should be measured and their diameter determined. The pipe lines should be free from scales, welding residuals etc. Note is to be made of every fitting on the suction and delivery pipe such as foot valve, strainer, non-return valve, T-bend, right angle bend etc. Use of long radius bends is strongly recommended for use in suction as well as delivery pipes. No point of suction line should be at a higher level than the suction eye of the impeller as this will form air pockets.

The diameter of pipes through which the water is pumped, is of great importance Specially for long pipes. Assuming the velocity of flow for suction and delivery pipes the nearest Diameter of pipes can be found out from table 1 given below.

Pipe Dia (in mm)	Velocity (metre/sec)
100	0.75 to 0.91
150	0.81 to 1.22
200	0.91 to 1.32
250	0.99 to 1.52
320	1.09 to 1.52
400	1.27 to 1.83
500	1.40
650	1.69
800	1.92
900	1.95
1000	2.00

If the velocity of flow is very low, settlement of silt is likely to take place, the economic And self-clearing velocity of 3-4 feet/sec, is usually recommended for average pipe diameters.
The frictional head in such cases, can be reduced by selecting larger diameter pipes, but Cost of pipeline will increase. In such cases, diameter of pipes should be chosen after careful
Study to achieve economical pumping installations. Table – 2 gives the recommended economic Diameters for pumping mains.

Discharge. (lts/hr.thousand)	Pipe Diameter (in mm)
0.12 to 0.24	50

0.24 to 0.42	65
0.42 to 0.72	80
0.72 to 1.32	100
0.32 to 2.40	125
2.40 to 27.0	150
54	225
109	250
163	300
215	350
295	400
445	500
590	600
900	700

5-c. Selection Of Motor:-

To determine the horse power of the electric motor or engine used in driving a pump, it Is necessary to know the efficiency of the pump, type of drive, type of power unit, head under Which the pump operates and the losses in the pumping system. The BHP of the motor as well as The input HP of a pump set can be assessed with the application of following formulae.

Water Horse Power (WHP)

It is the theoretical power required for pumping. It is expressed as,

$$\text{Water Horse Power (WHP)} = \frac{\text{Discharge in GPH x 10 (lbs) x total head}}{33000 \times 60}$$

Or

$$\frac{\text{Discharge in Lps x head in mtrs}}{75}$$

Shaft Horse Power (SHP)

It is the horse power required at the pump shaft. It is expressed as,

$$\text{Shaft Horse Power (SHP)} = \frac{\text{Water house power}}{\text{Pump efficiency}}$$

Brake Horse Power (BHP)

It is the actual horse power to be supplied by the engine or electric motor for driving a Pump. In case of monoblock and other direct driven pumps, the BHP is

equal to SHP, assuming The drive efficiency to be 100%. In case of belt or other indirect drives,

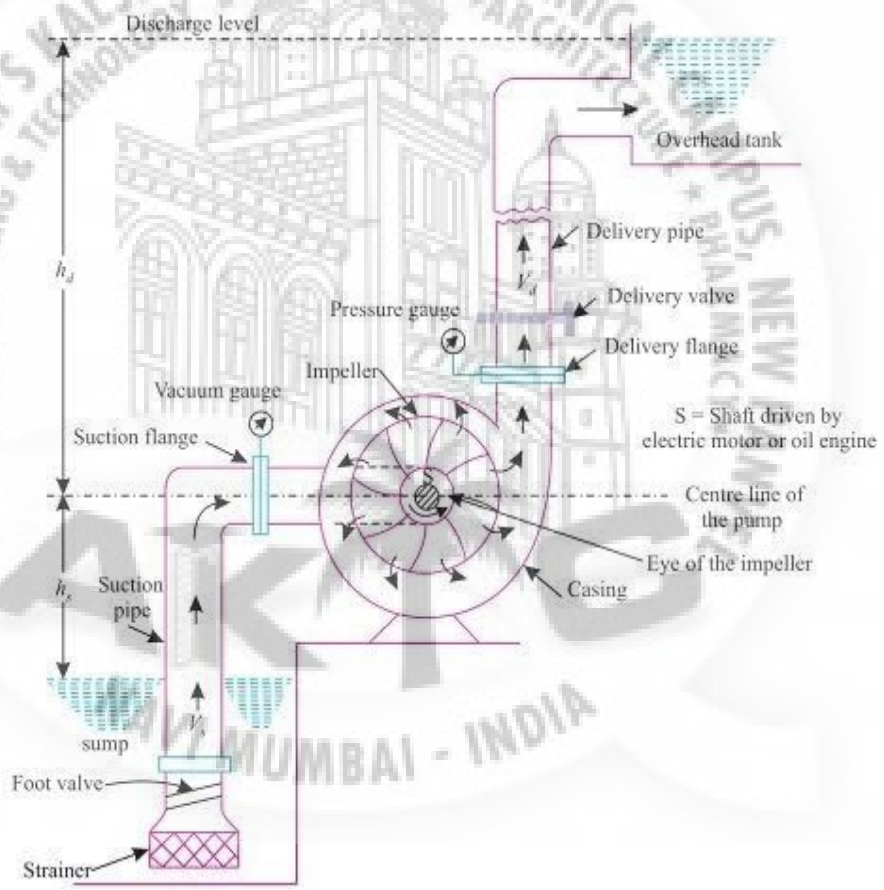
$$WHP = \frac{VHP}{\text{Pump efficiency x Drive efficiency}}$$

Input Horse Power (IHP)

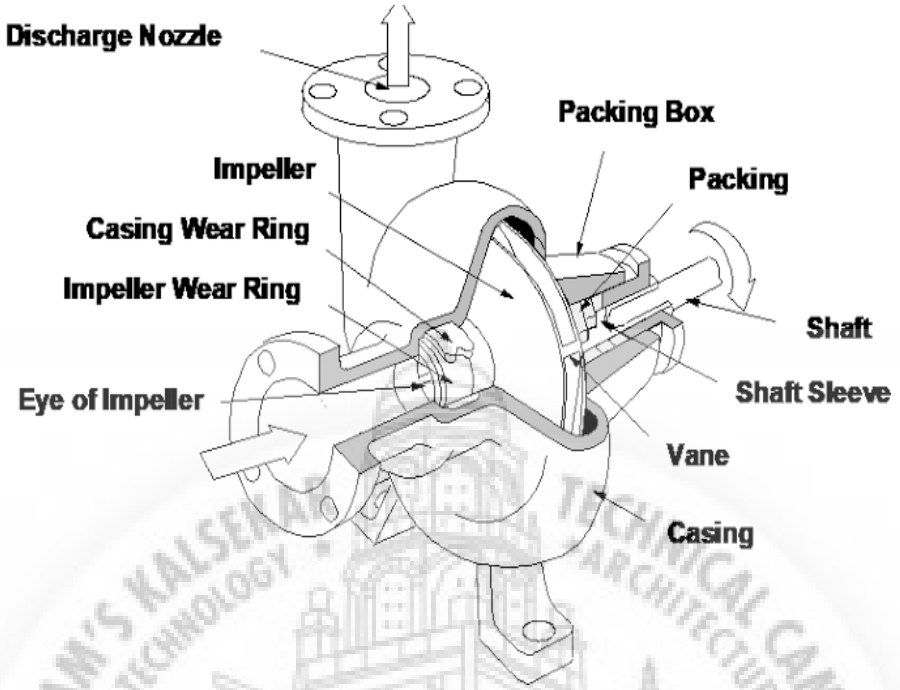
It is expressed as follows

$$IHP = \frac{WHP}{\text{Pump efficiency x Drive efficiency x Motor/Engine efficiency}}$$

KW input to electric motor = IHP x 0.746



Section Of Centrifugal Pump



- **Station Auxiliaries**

6-a. Heating And Ventilation:-

a.

b. Heating:-In general, space heating of the super Structure should be provided in flood control pumping Stations located in colder climates. The space heater Should be sized to maintain a minimum temperature of 12.8C (55 °F).

c. Ventilation:- Proper ventilation of pumping stations is an Important design consideration. A means should be pro Vided for gravity ventilation of the sump at all times to Prevent concentrations of vapors or gases which may Result in damage to the structure or injury to personnel. Forced ventilation should be used when pumping water May contain sewage. The superstructure should have Ventilation to remove heat produced by the equipment.Power-driven roof or wall fans can be used to ventilate The superstructure. All power ventilation equipment controls should Be located adjacent to the entrance door. All ventilation Should be rated for operating in an explosive atmosphere**.**

Suggestions for Environmental Management Plan

- BMC should collect data regarding generation, collection and disposal of bio-medical waste.
- BMC should take steps to improve the efficiency of the sewage treatment plants.
- Budgetary provision for storm water drainage should be adequately enhanced.
- A stormwater drain inventory should be maintained and a project for such drainage should be planned and implemented.
- A programme of shifting utilities in the watercourses should be pursued vigorously.
- Segregation of solid waste into bio-degradable and recyclable wastes should be enforced at every level and rules be framed for providing penalties.
- Community awareness and capacity building program for solid waste disposal should be taken up in association with NGO.
- Adequate bins should be provided and frequency of transportation of containers of solid waste should be increased.
- Centers should be opened for collection of bio-medical waste from private clinics and public.
- Data on generation and disposal of bio-medical wastes should be collected.
- Program should be taken up for stopping leakages from joints of sewerage lines and water supply lines.
- Sewerage plan for the city and a plan for treatment and disposal of sewerage should be prepared.
- A cell should be created in Water Dept at Head Office to monitor and rectify leakages in water supply lines.
- Rusted water supply lines should be replaced/repaired.
- Capacity building programs should be taken in association with NGOs to control epidemics.
- Slum dwellers in and around watercourses should be rehabilitated under a project of nalla development or under SRA/SRD, whichever is applicable.
- BMC should initiate action for setting up a Standing Committee to establish co-ordination with Central Railway for modification and maintenance of railway culverts.
- BMC should design formation levels for all roads with due regard to HFL of surrounding water bodies.
- Rainwater harvesting technique by taking bores in roadside drains should be used to minimizerun-offs.
- Even during monsoon potholes on the roads should be temporarily repaired.
- BMC should undertake study of possibility of interlinking all lakes for flood assimilation.
- New development should be 0.6m above HFL and any new development of plot should be not less than 4.9m(GTS).
- Any new development between design width of once in 2 years and once in 10 years should be free of structures.

- Any new development in area with design width of once in 10 years and once in 100 years should be with stilt arrangement.
- Wet land and mangroves should be protected and a program for plantation of mangroves should be taken up.
- A plan and map showing minimum level of reclamation should be prepared and enforced.
- Plantation of trees near the origins of watercourses in the forest land should be taken up to reduce soil erosion.
- Contour trenches should be provided at appropriate places on the hills to arrest entry of boulders into the watercourses.
- Also provision of geo-fabrics to stop entry of boulders into the watercourses should be thought of as an alternative and cost thereof should be worked out.
- Insurance companies may consider evolving ‘deluge' risk insurance and BMC may consider subsidizing its premium.

Engineering Solutions

- Design criteria of rainfall intensity of once in 10 years should be used to improve carrying capacity by training the major watercourses.
- Pumping stations should be provided in the requisite area for pumping out the run-off.
- Wherever even manual cleaning is not possible, on-line submersible pumps should be provided for cleaning of watercourses.
- Every road should have side-drains with sufficient fall and free flow.
- It should be made mandatory for architects to submit plans for development levels of front roads, locations and levels of watercourses, internal storm water drainage arrangement and plinth levels.
- Proposed development level of any plot in BMC area should not be less than 4.9m (GTS).
- All utilities in the watercourses should be shifted in next 3 years and in case of utilities crossing the road, separate duct should be provided.
- BMC should design and provide a complete sewerage scheme for entire area.

Effects Of Water Logging In Kurla City

Effects On Infrastructure And Services :

- **ROADS :**
  The stagnation of flood water causes damage to the roads, and to sub-grade and sub-soil. Water logging and damaged roads are a major cause of increasing accidents during monsoon.
- **WATER SUPPLY :**
  The overflowing ETPs cause mixing of untreated wastewater with water bodies. This also contaminates ground water. Contamination of water increases on account of intermittent water supply and crossing of sewage

lines. Shock loads of turbidity and contamination of water result in non-potable water.

- **TRANSPORT**
  Damaged roads and potholes on the roads affect tyres, suspension springs and break liners of vehicles. In case of State transport buses in Kurla reduction in milage cover is observed from 40, 000 km per day to 36,000 km per day. Other effects of flooding are increase in operation and maintenance cost, and traffic jams resulting in loss of time and loss of fuel.
- **EDUCATION**
  Educational institutes in low lying areas get affected. Damage to furniture and educational equipments results from this water logging. The loss of time in teaching and learning causes rescheduling of the time table.
- **RAILWAYS**
  Culvert below railway tracks at Bandra to Mahim, King Circle and Wadala are not enough to carry the runoff in High Flooded times. Water logging occurs in railway tracks at Tilak Nagar, Kurla, Chunabhatti, Sewri.The water logging affects the timings of the trains. It also increases the O & M cost of railway tracks.

EFFECT ON INDUSTRIES AND SLUMS :

- **INDUSTRIES**
  Services such as transport, electricity, water supply, removing industrialwaste are crucial to the efficient working of industry. Since they are affected, industry in turn is affected in the service to the customers.The small scale industries are more affected by water logging because of their resource-constraints. The machinery of small scale industries in low lying areas get submerged during intensive flooding causing loss of production for many days.
- **SLUM**
  Slum dwellers constitute a significant source of man power. When they are themselves trapped in adverse circumstances due to water logging, their efficiency to discharge their services to the community is reduced. Water logging affects the services provided to the slum area more than in other places. Landslides, water logging and sinking of the ground, occur in slum areas particularly in between Kurla East railway station and Chunabhatti . Deficiencies in construction aggravate this condition. Low lying area results in more water logging particularly in the slums, which causes damage to huts, hutments and household goods.
- **LOSS OF HUMAN & BOVINE LIFE**
  Water logging results in loss of human and bovine life. Poor people having no shelter or rendered shelterless by flood fall victims to natural's furies. Epidemics make their life worse causing loss of human life before medical services reach poor locality.
- **ENVIRONMENTAL LOSSES**
  The surrounding in which people have to live under the conditions of water logging lead to lack of hygiene,water pollution, air pollution, disruption in

services, and outbreak of various diseases. Insanitary conditions continue for long time. Mosquitoes, flies and water logging go together.

- **ECOLOGICAL LOSSES**
  Stormy weather and heavy rains during water logging sometimes result in uprooting of trees. The broken branches increase water logging. Unclean surroundings and pollutants pose a threat to plants and crops.

SOCIO-ECONOMIC-LOSSES :

- **SOCIAL**
- Social relations are disturbed because of failure of communication systems due to irregular electricity supply and transport problems in the wake of water logging depression or boredom may result on account of deprivation of social life Cultural and intellectual quality is affected because of lack of social life.
- **ECONOMIC**
- Water logging causes extensive economic losses. As Indicated by the Resource Persons interviewed by the Experts Committee, the estimated losses caused by water logging in various services are as follows:
- The BMC is required to spend about Rs.3.5 to 4 crores annually to control and prevent spreading of diseases in flood prone areas.
- Economic impact of flooding is serious in case of wage earners.
- Water logging results in people spending more on medical services.
- Revenue loss to State Transport amounts to Rs.One lakh per day.
- Operation and maintenance cost of S.T.buses increases by about Rs. Two crores per year.
- Repairs and maintenance losses of Rs.10 lakhs per year is borne by MSEB in Mumbai.
- Additional maintenance cost of Rs.One and half lakh is incurred by MTNL, BKC Kurla.
- Railways have to spend about Rs.60 lakhs per year for rehabilitation of tracks within BMC area.
- Loss in terms of production by small scale industry amounts to about Rs.10 crores per annum.
- Loss in maintenance of sub-merged machinery in industries is about Rs.2 crore per annum.
- Removal of silt in industrial installations takes about 8 days resulting in loss of Rs.3.5 crores per year.

Environmental Management Plan (EMP)

PURPOSE OF EMP :

a] Preventing or reducing the repetitive water logging in BMC area.
b] Mitigation of hardships caused by water logging.

STORM WATER MANAGEMENT (action : BMC)

- The BMC should plan and implement the program of de-silting of all watercourses up to invert level thrice in a year in the months of November,February & May.

- The program of shifting of utilities may be continued vigorously in respect all the watercourses.
- The BMC should plan and execute the programs of training of watercourses for improved carrying capacity for frequency of 1 in 10 years with suitable concentration time and duration.
- Roadside drains should be designed for higher intensity and less duration and the construction thereof should be implemented in a phased manner.
- A complete storm-water drain inventory with analysis should be maintained for monitoring and revision of the system.
- Before monsoon every year, a cell may be created at H.O. level to continuously monitor rainfall predictions of meteorological department and this cell should report to the City Engneer and the Municipal Commissioner.
- The BMC should conduct technical studies to find out expected quantum of flood in relation to runoff and high tides in different locations of BMC area.The study reports may be published every year during monsoon. The position at different locations should be monitored.
- A storm water drainage project should be prepared and implemented in next five years. This will also include demolition of structures in and on the banks watercourses, keeping in view possible rehabilitation of residents and shopping units in such structures.
- The budgetary provision for storm water drainage should to be suitably stepped up for implementing the suggestions made above.

SOLID WASTEMANAGEMENT (action: BMC and suitable NGO)

- The segregation of solid waste into bio-degradable & recyclable wastes should be enforced scrupulously at the level of individual households/shops/units, at collection machinery and at final disposal level.It may be necessary to frame rules for providing penalties for lapses in this regard.
- At the locations where 'Ghantagadi' can not go for garbage collection,adequate no. of litter bins should be provided and arrangements made to collect the garbage before it overflows.
- The frequency of transportation of container should be such that dustbin sites are cleared before they start overflowing.
- All organic/biodegradable waste may be composted by following suitable methods.
- Domestic hazardous waste, such as, used batteries, containers for chemicals and pesticides, etc, be disposed of by scientific land filling or any other suitable method.
- BMC should take up community capacity building and awareness program in association with suitable NGOs to nullify entry of any type of solid waste into road side drains and watercourses.
- With a view to avoiding entry of dung generated by cattleheds into the watercourses, owners should be prevailed upon to treat and produce manure or energy from dung.

BIO-MEDICALWASTE (Action: BMC & NGO to be identified by BMC)

- BMC should plan opening of collection centers at appropriate places, such as hospitals, cluster of clinics, road squares, etc, for bio-medical wastes

generated by private clinics, nursing homes and public at large and to plan for its collection and final disposal.

- BMC should initiate steps to prepare programs to make public aware of the hazards of bio-medical waste and of proper disposal of such waste.

TMC should arrange for collection of data regarding generation and disposal of bio-medical waste.

SEWERAGE (Action: BMC)

- A time-bound program to stop leakages from joints should be worked,prepared out and implemented vigorously
- BMC should finalise the sewerage plan for the entire city to avoid entry of sewage in open watercourses and to avoid body connection in sewer lines. The implementation of this plan should be ensured
- With due consideration to the assimilative capacities of water bodies and treatment standards of MPCB, a plan for treatment and disposal of sewage should be prepared and implemented in a phased manner
- A status report on sewage treatment plan should be prepared and steps should be taken to improve its efficiency.

WATER SUPPLY (Action: BMC)

- Priority is given to identify locations of contamination in the water supply distribution system and take preventive measures before monsoon.
- Identification of leakages in the water mains and distribution systems and their rectification should be attended to on a priority basis.
- BMC should also take up a program of identifying rusted pipes in the distribution system and prepare a plan for their replacement/rectification in a phased manner.
- A cell should be created in the Water Department at Head Office to monitor the program of leakage identification and rectification.
- A communication network for identification and reporting of leakage in the water supply distribution system may be created and published.

HEALTH (Action:BMC & NGOs/hospitals)

- BMC should develop ‘capacity building programs' to take preventive measures to control epidemics. Assistance of NGOs, Rotary Clubs, Private doctors, Pathological laboratories etc, should be taken for testing of samples,house to house survey, free medical checkup, etc.
- Periodic meetings of NGOs, Rotary Clubs, etc, associated with the capacity building programs of Health Department should be convened to monitor programs.
- A plan for shifting of cattle sheds out of town should be drawn up and implemented.

SLUMS (Action: BMC)

- The slum dwellers in and around watercourses, water bodies and on slopes of hills should be rehabilitated in a planned way to minimize losses of lives and structures due to floods and land slides.
- BMC should take immediate action to prevent further erection of unauthorized structures including slums in and around watercourses and water bodies.

RAILWAYS (Action: Central Railway and BMC)

- BMC should take a lead in setting up a Standing Committee to establish co-ordination at all levels between Central Railway and BMC for modification and maintenance of all the railway culvert.
- Maintenance of the railway culverts should be done well before monsoon.

ROADS(Action: BMC)

- BMC should identify and design formation levels for all roads in the city
- While designing road level, due regard should be given to HFL of all surrounding water bodies instead of only local watercourse in front
- The HR Dept. of BMC should convene seminars/conferences of personnel in different departments and of architects, engineers, etc, concerned with construction of roads and buildings so as to update their knowledge and for mutual exchange of knowledge and information
- The efforts to maximize the concrete roads should be continued
- New technologies should be adopted for longer durability of tar roads even in flood prone areas
- Rainwater harvesting technique by taking bores in the roadside drains could be used to minimize run-off going to the watercourses
- BMC should prepare plan for promptly repairing the potholes even during monsoon, even though such repairs are of temporary nature.

TRANSPORT :

- Available modern technology should be adopted so as to minimize damages to the tyers, suspension springs, break liners, etc, during flooding.
- A plan of upkeep and maintenance of the entire fleet of vehicles before onset of monsoon should be drawn and implemented with a view to keeping efficiency of vehicles at high level during monsoon.

ELECTRIC SUPPLY: (Action: MSEDCL)

- MTNL should raise the height of pillars above HFL in/and around water logging spots.
- The MTNL has been using modern technology for upgradation of cable joints to avoid leakages and to minimize disruption in services during flooding.

WATER BODIES (Action : BMC)

- BMC should study the possibility of interlinking all lakes in Mumbai city for flood assimilation as well as for improvement in groundwater level.
- A study of the extent of pollution, dilution, advection, convection in case of estuaries and dilution during runoff in lakes should be carried out.
- Catchment area development to avoid pollution of flooding in water bodies and lakes should be taken up.

DEVELOPMENT PLAN (Action: BMC)

- Any new development in BMC area should be 0.6 m (2 feet) above HFL in relation to surrounding water bodies. Any development level of the plot should not be less than 4.9m (GTS).
- Any new development in BMC falling between design width of once in 2 years and once in 10 years should be free of any structures. Similarly,any development in area with design width of once in 10 years and once in 100 years should be provided with stilt arrangement.

- In case of existing structures affected by backwater due to ‘once in 100 years intensity', the developers/housing societies may be persuaded to convert the ground floor into stilt area.
- BMC should prepare a plan for showing minimum level of reclamation and this plan should be enforced. No piecemeal reclamation should be resorted to.
- Some area in open spaces should be earmarked to act as holding capacities for abnormal storm run-off and ingress of seawater
- For conservation of mangroves to work as buffers and for hydraulic assimilation, the BMC should ensure that wet land and mangroves are protected.
- Growth of unauthorized habitats in violation of civic regulations is strictly prohibited.
- Appropriate steps are taken for identifying and acquiring land for dumping and disposal of civic garbage taking into consideration the needs of at least next 25 years.
- A well planned program for plantation of mangroves should be taken up by BMC
- Plantation of trees in the forest area and provision of suitable contour trenches should be taken up to reduce soil erosion and entry of boulders into the watercourses.
- Provision of geo-fabrics to stop entry of boulders into the watercourses should also be considered.

RISK AND INSURANCE (Action - BMC Insurance Companies)

- Data pertaining to structures at risk due to water logging may be compiled and a risk management plan may be evolved.
- Study of risk assessment factors such as, hazards identification, hazards,analysis, consequence analysis, risk determination, risk evaluation may be carried out.
- Insurance companies may consider evolving deluge' risk insurance. While private people are expected to take such insurance, BMC may consider subsidizing the premium of 'deluge insurance policies.

ENGINEERING SOLUTIONS

CONTROL BY TOWN PLANNING AND DEVELOPMENT DEPARTMENT OF BMC

- It should be made mandatory for the architects to submit plans of formation level of roads in front, location of watercourses, invert levels of watercourses,proposed width of watercourses, proposed development levels, internal storm water drainage arrangement and proposed plinth levels
- The proposed development level of any plot in BMC area should not be less than 4.9 m (GTS).
- A plan showing proposed formation levels of roads in BMC area should be released.
- A plan showing areas covered with mangroves should be released by BMC.

- All these requirements should be incorporated in the Commencement Certificate issued by BMC for any structure.
- The BMC should design and incorporate locations of detention ponds on the development plan ofBMC.

DEVELOPMENT OF LOW LYING AREAS AND SLUMS

- In near future, BMC should implement development of slums and of low lying areas so that sullage from slums is not let out in the watercourses and storm water is not accumulated in such areas
- The necessary provisions for SRD/SRA application on the lines of BMC should be made for these schemes.

SEWERAGE NETWORK

- It is utmost necessary for BMC to design and provide for a complete sewerage scheme with treatment and disposal methods.
- As a temporary solution in slum area, construction of shallow sewer to collect sullage from slums should also be considered.
- If required, short outfalls for disposal of effluents from STPs may be considered by BMC.
- For the above purpose pollutant carrying capacities of Mahim creek should be worked out.

HYDRAULIC MODELLING OF CREEKS :

- All Corporations and Councils abutting Mahim and Mahul creek to study rainfall, run-off and estuarine mechanisms of the creeks.
- The agency like CWPRS may be appointed by all the above Corporations and councils jointly with NIO and NEERI to carry out such studies.

TUNNELING (AS OPTION) :

- A deep interceptor or tunneling option with under ground reservoir and use of storm water for dilution of sewage may be studied on macro basis.
- This option will be quite costly. However, cost comparison may be kept on record.

INTERLINKING OF LAKES :

- The topography of BMC is suitable for preservation of lakes which are absorbent of run-off.
- Interlinking of lakes may be studied with due regards to surrounding creeks.
- The block cost of such a project may be worked out and kept on record.

CONCLUSION

Water logging has become a major problem in Have Mumbai, Kurla city, by which -population are affected badly. The chocking of drainage system, low lying areas with extreme rainfall Causes the additive effect flooding. The overall studies have identified The main water logged zone, Ward wise waterlogged situation & its varying Past few years rainfall data. BMC has Provided recommendation for improving technique depth. in new pumping station of maintaining one drainage of sewerage System. But all of are not materialised properly due to lack of BMC's interest and this worst situation are increased day by day & people are affected badly.

Depending our case study of "water logging Problems in between Kurla, Tilak Nagar to Sewri Railway station. Also we Suggested Some environmental & engineering Solution to overcome these problems.
By our data analysis and study of research papers we conclude that for Kurla region approximately 40-45 number of pumps are required for proper drainage of rain water.

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