Bruhat Bengaluru Mahanagara Palike

Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

MASTER PLAN

Volume – 1: Main Report

October 2010

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OFFICE OF ORIGIN

STUP, BENGALURU

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BRUHAT BENGALURU MAHANAGARA PALIKE

CONTRACTOR

PROJECT

MASTER PLAN FOR REMODELING OF STORM WATER DRAINS IN EIGHT ZONES OF BRUHAT BENGALURU MAHANAGARA PALIKE

TITLE

MASTER PLAN FOR REMODELING OF STROM WATER DRAINS IN EIGHT ZONES OF BBMP AREA

VOLUME - I : MAIN REPORT

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Bruhath Bengaluru Mahanagara Palike

Master Plan Report For Remodelling of Storm Water Drains in Eight Zones of BBMP Area, Bengaluru

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Note: The SWD Master Plan project documents comprises of four main volumes with total 11 booklets. The contents of this volume shall be read in conjunction with the remaining volumes/booklets

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Volume – I

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Volume – I

LIST OF MAPS

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Executive Summary

Master Plan For Remodelling of Primary and Secondary Storm Water Drains in Eight Zones of BBMP Area, Bengaluru

1.0 INTRODUCTION:

Bengaluru, the Capital of Karnataka is nearly 500 years old and has grown from a small time settlement into a sprawling metropolis of 245 Sq.Km of Core Bengaluru and 790 Sq.Km of total administrative area including the 5 new zones with more than 6.8 million people. Bengaluru's temperate climate, high quality educational, scientific and technology institutions coupled with a thriving IT and Bio-Technology and manufacturing industry makes Bengaluru one of the most sought after global destinations.

Bengaluru city which was well known for its open parkland environment with significant number of large traditional tanks with a good network of waterways and thick vegetative cover has been suffering from severe flooding problems during rainy season resulting in submergence of low lying areas, causing water stagnation at several locations, submergence of footpaths restricting pedestrian movements, traffic hold-ups for several hours, extensive damage to both life and property etc. for various reasons, mainly the rapid urbanization due to explosive rate of growth of population in Bengaluru altering the landuse pattern, encroachment of water bodies and drains.

In light of the above incidence, Government of Karnataka (GOK), instructed Bruhath Bengaluru Mahanagara Palike (BBMP) to prepare a Master plan and extend the storm water drains remodelling project to the agglomerated areas in the similar manner as that of core area storm water drain remodelling project prepared earlier and where implementation work is in progress.

In this regard, during November 2009. BBMP invited tenders for engaging the services of consultants for preparation of Master Plan and to provide necessary technical support to set priorities on existing drainage system rehabilitation needs and to explore the potential options for augmenting the carrying capacity of the system, considering future hydraulic design requirements for all the eight zones.

2.0 BACKGROUND:

Bruhath Bengaluru Mahanagara Palike (BBMP), the agency responsible for providing and maintaining the cities infrastructure with an endeavour to obviate the problems faced in its juridristriction has taken up the task in two stages;

Stage - I : Preparation of a comprehensive master plan to remodel the storm water drains in the peripheral areas of the city (i.e., Newly added 5 Zones viz. Rajarajeshwarinagara, Dasarahalli, Yelahanka, Mahadevapura & Bommanahalli Zones, which includes field investigations, detailed survey, system analysis and proposals for improvements required for capacity augmentations of the existing drainage system.

Stage - II : Preparation of detailed project reports for individual zones based on the proposals and recommendations suggested in the Master Plan report.

The stated goal for remodelling of storm water drainage system in city's agglomerated areas, is to improve the carrying capacity of the existing system, for the delivery of storm water without flooding the low lying areas and also to provide improvised environmental sanitation services to the citizens with emphasis on the urban poor and vulnerable groups and within a process of long term environmental, economic, social and institutional sustainability.

However, in order to achieve comprehensive solutions for the flood related problems in the BBMP Area, the proposals formulated in the contract are extended upto the final disposal point irrespective of the administrative boundaries.

As the SWD project is a complex and involves multidisciplinary approach. The project envisages proper coordination from various stake holders to achieve the over all objectives of the project in a comprehensive manner.

Prime Stake holders are;

- Bangalore Development Authority- BDA
- Bangalore Water Supply & Sewerage Board - BWSSB
- Bangalore Electricity Supply Company - BESCOM
- Karnataka State Pollution Control Board - KSPCB
- Karnataka State Slum Clearance Board - KSSCB
- Lake Development Authority - LDA
- Public Representatives
- Citizens

However, along with remodelling of storm water drains, planning for segregation of sewage flow from SWDs, improvement of solid waste management system, improvement to roadside and tertiary drainage network and development of water bodies in and around Bengaluru is being takenup as separate projects proposals which are already there on the anvil of the stake holders are being taken up separately. Further, areas where there are interference to the present initiative is envisaged, measures have been taken during planning and preparation of proposals.

This project report has been prepared as per CPHEEO norms for urban drainage system and based on the guidelines specified by Ministry of Urban Development (MoUD), New Delhi, for Projects sponsored by MoUD, under Jawaharlal Nehru National Urban Renewal Mission (JnNURM).

In the present initiative project proposals has been formulated considering the site findings and analysed results. Site specific structural and non structural measures have been suggested in the present report.

The proposals suggested in master plan report has been discussed in length at various levels in several forms at BBMP central office coordination meeting on 17th April 2010, BWSSB central office coordination meeting on 24th May 2010 and at Vidhana Soudha, on 11th June 2010 & 19th July 2010. Wherein, it was suggested and agreed by all stake holders heads of the departments and public representatives to take up these proposal on priority in stages.

3.0 OBJECTIVES OF THE PROJECT:

The objectives, defined in broad terms are:

To minimise flood runoff.
To ensure free flow of storm water and to minimize flooding in critical flood prone areas.
To improve the health and environmental sanitation conditions in the surrounding vicinity of SWDs and Water bodies.
To address the flooding problems in a comprehensive manner and attain solutions on long term basis duly considering futuristic developmental / proposals aspects in view.
To suggest low cost - high benefit options to address the flooding problems in a sustainable manner.
To formulate guidelines for design, construction, operation and maintenance of the system
To protect the existing waterways and water bodies from environmental degradation.

4.0 STORM WATER DRAIN MASTER PLAN PROCESS:

The storm water drains Master planning process broadly comprising of the following steps;

- Defining problems together with establishing goals and identified constraints
- Assembling data and refining definitions of problems
- Formulating and analysing alternatives
- Identifying more promising alternatives evaluating trade offs among selected alternatives

The above translates into a number of engineering steps involving;

- Identifying sinks for the storm runoff
- Understanding existing system with the allied issues
- Defining planning parameters
- Assessing foreseeable runoff
- Forming a network to collect runoff and quickly evacuate the same upto the sink including Assessing adequacy or otherwise of existing system components
- Determining the additional components of the Masterplan
- Building in devices to regulate flows if and when required
- Defining measures to implement and ensuring the sustainability of the system

Master Plan Process

RECONNAISSANCE SURVEY

- Drain
- Catchment
- Low lying area

DATA COLLECTION

- CDP for land use
- Topo sheet for terrain gradient
- Geotechnical data
- Hydrological data
- Meteorological data
- Flood history data for critical areas
- Water bodies & lake data

EXISTING DRAINAGE SYSTEM DATA

- Primary & Secondary Drain details
- Cross drainage details
- Water quality data
- Sewer network inside & out side drain
- House hold data along drain & low lying areas
- Existing drain maintenance practice
- Water spread area in low lying areas

ANALYSIS

- Rainfall data analysis to arrive at intensity of rainfall
- Catchment area analysis for runoff
- Existing drain adequacy analysis Existing bridge/ culvert hydraulic analysis

PRPOSALS

- Drain sizing for different flood return periods
- Sizing of culverts
- Catchment runoff control measures
- Critical area flood control measures
- Operation & control measures for flood
- Maintenance of drains
- Environmental upgradation measures (Solid waste & sewage)
- Identify additional land requirement for implementation of proposal

COSTING

- Line Estimation for various components proposal
- Approximate costing for land requirement
- Operation cost

PRIORITISING OF WORKS

- From land demarcation to implementation of various components of works
- Implementation Plan

5.0 STUDY AREA

Bruhut Bengaluru Mahanagara Palike comprising city of Bengaluru and contiguous area around was notified in 2007. It extends over 825 sq.km. and includes Bengaluru Core area of 225 Sq.Km together with 5 newly added zones viz. Bommanahalli, Bytarayanapura (Yelahanka), Dasarahalli, Mahadevapura and Raja Rajeshwari Nagara and the extent of Master plan study area is as follows.

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Sl. No	Zone	BBMP Administrative Zonal Area (Ha.)	Hydraulic Catchment Area (Ha.)	2001 Population (000)	Total Drain Length (Km.)	Current Population as published by BBMP
1	East Zone	9,165	10,937	4,033	227.31	18,77,635
2	West Zone	4,590	6,366			16,61,753
3	South Zone	6,734	5,553			9,47,169
8	Rajarajeshwari nagara Zone	7,661	15,365	157	144.75	2,83,936
6	Dasarahalli Zone	5,797	9,505	310	89.24	6,11,056
5	Yelahanka Zone	12,091	14,235	310	113.85	4,61,934
7	Mahadevapura Zone	13,322	23,371	363	172.00	5,19,663
4	Bommanahalli Zone	10,340	16,317	244	109.59	4,31,867
Total		**69,700**	**101,650**	**5,687**	**856.74**	**65,95,013**

Bengaluru is situated in the southeast of Karnataka, at an average elevation of 920m above mean sea level. It is positioned at 12.97°N, 77.56°E and covers an area of 825 sq.km. The Bengaluru North taluk is a relatively level plateau, while the Bengaluru South taluk has an uneven landscape with intermingling hills and valleys. The topography of Bengaluru is flat except for a ridge in the middle running NNESSW. The highest point in Bengaluru is Doddabettahalli, which is 962 m and lies on this ridge. There are no major rivers running through the City.

The land use, drainage pattern, water bodies, solid waste generation and disposal, low lying areas in each of the eight zones of BBMP administrative areas are getting modified with rapid urbanisation resulting in more flooding which needs intervention to prevent from further deterioration.

In recent times, due to lack of planning and rapid changes in the land use, the drainage, lakes etc., have been largely ignored by various stakeholders, service providers and the public in general. In the recent history, there has been no comprehension for the development of primary storm water drainage system in the city by the stakeholders beyond the level of tertiary drains. As a consequence, the drainage system in the catchment areas has developed on an adhoc basis and now they have reached a saturation level and not in a position to prevent the low lying areas from inundation during heavy showers.

Significantly, what is seen over a period is that, number of lakes/achukutu areas which were acting as water balancing have been filled up and converted into residential layouts, busstand, play ground etc. .resulting in critical flooding areas. These areas otherwise would have acted as buffer zones for flood protection. The tank bed and its adjoining areas being the lowest point in the catchment area are always prone for flooding. To prevent flooding in such areas, it requires construction of new drains or expensive mechanical means of pumping arrangement. Therefore, in order to avert such expensive recurring problems & expenditures, it is very much essential to create awareness among public, public representatives and all concerned about the consequences of encroaching tank areas. Restoration of tank areas need to be taken on priority, which in turn would reduce the runoff and flooding problems in some of the adjoining low lying areas to a certain extent.

As known, the storm water drain network in master plan study area flows through dense residential, commercial and few open areas of the city. Due to inappropriate planning procedure adopted by the land use planners, the natural course of the drain is altered at many places and encroached. Further, the carrying capacity of drains is drastically reduced due to dumping of construction debris, municipal solid wastes and also discharging raw sewage into the drains thereby causing siltation problems, inconvenience to the surrounding localities and threatening the health aspects of the communities residing in the close proximity of the waterway.

Even though the sewer lines exist, the sewer out lets from the toilet blocks of residential buildings in some localities are not connected to the sewerage system and they are discharging raw sewage directly into storm drains which is occupying considerable cross sectional area of the drain which is intended for storm water discharge and also distracting the visual aesthetic amenity of waterway, causing odour problem, making the places favourable for mosquito breeding, causing substantial inconvenience to the populace of the surrounding localities, pedestrians and vehicular movement.

Since the topography in some of the catchment areas are undulating & sloping towards the drain and also due to improper solid waste collection and conveyance arrangement in the catchment, all the solid waste generated and the greasy liquid waste from industries & service stations, find their way into the storm drains, further all the floating materials gets clogged with the utility lines laid across storm drains and culverts locations obstructing free flow of water and causing localized flooding problems pose substantial damage to both life and property.

The more extensive tertiary drains that exist are the key elements of the urban drainage system, but due to deficiencies in designs and maintenance practice, the tertiary drains do not exist in the entire catchment areas and where they exist they are not serving upto the intended level of service.

Further, another significant cause of frequent flooding of low-lying areas is due to development of new layouts near the receiving water bodies, below the HFL, large accumulation of sediments and vegetal growth that reduce the carrying capacity of the drains. Similarly, erosion control practices in construction sites, public parklands, private gardens and on the medians and verges of roads are not sufficient to control large silt loads reaching the main drains. These factors, combined with infrequent clearance of drains by concerned authorities, occasionally lead to unsanitary conditions in drains and further worsen the already aggravated situation.

To understand the problem and to arrive at suitable solution, condition assessment survey, basic topographical survey, Base line surveys are carried out and data required like past rain fall, water quality, current solid waste management practices, operation & maintenance practice of drains and sewerage program are collected from the respective departments.

The drainage network in the all the zones is well connected with water bodies. At many reaches original drain alignment is modified and width drastically reduced. Masonry walls have been constructed at certain reaches by erstwhile CMC authorities without adopting any planning and design approach and are in moderate condition.

Total about 718 nos. of cross drains exists in the study area. Wherein 530 nos. are having inadequate vent size and also in structurally unstable condition which requires to be remodelled immediately to facilitate for free flow of water.

Land use pattern has been developed in a haphazard manner and also land development authorities have not formed any service corridors on either side of the storm water drains for laying service lines and facilitate for routine maintenance.

There are 196 water bodies in the study area. All the water bodies are severely silted and raw sewage from unsewered areas is entering the lakes. All lakes in the study area require to be rejuvenated immediately to increase the holding capacity and also to improve the water quality & environmental sanitation conditions in the surrounding vicinity.

About 147 critical low lying areas spread across are experiencing repeated flooding occurrences due to various reasons like development of land below HFL, construction of buildings in tank bed areas, encroachment of main drain, tertiary drain not performing as intended etc.

6.0 PROJECT DESCRIPTION:

Improvements to the existing storm drainage system at BBMP Area is considered to be on priority for five key reasons:

1. To minimise the current localised flooding problems experienced in the entire catchment area.
2. To protect the natural waterway boundary for development of drainage corridor, interlinking of water bodies and prevent receiving water bodies from deterioration.
3. To improve upon the service level bench mark, for the services provided by BBMP in vulnerable areas.
4. To improve and protect the quality of environmental attributes including aesthetic appearance of city's environs.
5. To minimise cost implication on operation and maintenance of the system.

In the present initiative project proposals has been formulated considering the site findings and analysed results, site specific structural and non structural measures have been suggested in the present report.

Depending upon topographic features the study area is demarcated into major and minor water shed catchment areas. Demarcation of these water shed catchment areas is done using available contour maps and Arc view GIS software. Irrespective of demarcation of administrative zone boundaries, the drainage catchment boundary is independent. For study of storm drains entire contributory drainage catchment area is considered. In addition to primary and secondary drains there are tertiary drainage network which are street drains and these drains do not form part of this study.

In the present project the entire study area is demarcated into 68 water shed regions inorder to have a comprehensive approach in providing solutions and also to help in prioritising the works in the study area.

All the outfalls from each of these water shed regions ultimately flows either into the major water bodies that exist in the respective water shed region or directly join the river coarse i.e., Vrishabhavathi river to the South, tributary of Pinakani & Pennar river to the East, tributary of Arkavathi river to the West.

Topographical survey data carried out (i.e., from starting point upto disposal point) using Total Station instruments has been used for formulating the design parameters and formulating proposals. Survey data comprises of drain cross section details at every 25 m. interval, left & right side drain edge levels, drain depth & width etc.

Drain inventory / Condition survey has been carried out for all the drains to gather Information's required for designs and formulating the proposals like flood history, drain side land use, tertiary drains, location of sewage/industrial effluents entering SWD, utility/Service lines details, land use pattern near tank/marshy areas, details about envisaged future proposals, flood damages, casualties etc.

Rainfall data has been collected from Indian Meteorological Department and analysed for 15 min. peak rainfall duration. Intensity Duration Frequency curves prepared for 1, 2, & 5 years return period. CPHEEO Method adopted for analysis.

Land use analysis carried out using BDA CDP 2015 and during reconnaissance the analysed results has been verified for ground realities. Catchment area divided into major catchment & sub catchment boundaries using Arc view G.I.S. for analysis and Land use divided into 6 categories. Computation of runoff using Rational method formula and coefficients assigned as per CPHEEO manual and results analyzed for 1, 2 & 5 year return periods.

Further, the data collected from site and the processed/analyzed data have been compiled together and checked for its adequacy & consistency.

For ease of assessment, and to adopt realistic approach in costing the various works envisaged are categorized as;

Carrying capacity improvement works
Rehabilitation works

7.0 Recommendations Suggested Under Remodeling Project:

To improve the capacity of the drains and to minimize the flooding, various drain improvement methods are suggested viz:-

- Drain De-silting.
- Removal of bottle necks in the drain, due to encroachments.
- Widening & regarding of drains to have designed capacity.
- Reconstruction of inadequate vent way and structurally unstable Culverts / Bridges.
- Remedial measures to minimize localized flooding problems in low lying areas.
- Reconstruction of collapsed & dilapidated SSM drain walls with either SSM / RCC walls.
- Relocation of pipelines, manholes & other service lines which are laid inside the drains and that are obstructing free flow of water.
- Lowering of rocky out crop noticed at several locations to improve the flow conditions.
- Modification / rerouting of drain alignments where necessary.
- Regradation of secondary/tertiary drain bed level to suit as per present primary drain bed levels.
- Construction of detention ponds in open park lands play grounds
- Construction of retention basins along storm water drains to minimise flooding problems in low lying areas and prevent transport of sediments
- Development of existing water bodies as holding ponds by installing regulatory gate
- Setting up of localised sewage treatment plants to treat sewage flowing in drains
- Setting up of automated rain gauge stations with data logger
- Remodelling of inadequate vent size culverts constructed across railway tracks at different reaches
- Remodelling of storm water drains situated in BDA limits beyond BBMP boundary in similar lines to avoid surcharging of water.
- Development of drainage corridor to lay service lines and facilitate for routing maintenance
- Diverting/plugging all sewer outlets discharging sewage directly into storm drains.
- Construction of new diversion / cutoff drains to avoid flooding, near low lying areas.
- Remodeling of tertiary drainage network in critical flood prone areas
- Cavity filling, restoration of eroded stones, providing pointing to the existing drain walls
- Restoring available BS Slab bed & to provide CC bed lining wherever feasible to prevent weed growth & to increase the carrying capacity of the drain.
- Construction of new walls / stone revetment where drain banks are in natural condition in the tail ends / out side City limit.
- Formation of Service roads for routine maintenance.
- Provision for ground water recharging inside the drain to reduce the runoff & ground water recharge once segregation of sewage achieved.
- Providing chain link fence & guard rails at strategic vulnerable locations to prevent dumping of garbage etc. and also to ensure safety of public.

- Setting up of vigilance squad to prevent debris dumping, encroachment of drains, local obstruction, such as, pipe crossing, construction inside the drain, any construction other than required for draining out the storm water.
- Encourage rain water harvesting in institutions, public parks, and open grounds.
- Lowering of manholes and relocating service lines.
- Conduct training & community awareness campaigns
- Segregation of sewage from storm water drains must be taken up on priority.
- Comprehensive study of improving drainage network in agglomerated areas should be taken up on priority to protect the water bodies.
- Improvised solid waste management system should be taken up to improve environmental sanitation in the city.
- Modification/change in bylaw should be enforced to prevent development of land near the water ways/water bodies, encourage rainwater harvesting etc.

To avoid large scale distraction of drain adjoining properties, inconvenience to public, make use of available resources and giving due importance to environmental aspects, suitable site specific & cost effective solutions has been suggested to make the system functional and sustainable to the organization.

Revenue Survey details, Statements & Maps required to progress further in procurement of land for drain widening and formation of service corridor is enclosed with this report**.**

Cost estimates have been prepared, considering current schedule of rates of Karnataka Public Works Department (KPWD), NH. Water Resources Dept. and prevailing market rates.

The following areas related to the project have been discussed in detail and included in the Volume – I project report as per the JnNURM guidelines; viz., Background and purpose of the project, condition of existing system, detailed design and analysis, review of assessment and recommendations, environmental and social impact, sustainability evaluation, institution frame work, financial operating plan, project implementation plan etc.

Master Plan Project Report has been prepared in four volumes and submitted to BBMP for approval:

VOLUME I Master Plan Project Report

VOLUME II Annexure to Main Report

VOLUME III Appendix to Main Report,

a) East Core Zone – Book 1 / 8
b) West Core Zone – Book 2 / 8
c) South Core Zone – Book 3 / 8
d) Bommanahalli Zone – Book 4 / 8
e) Yelahanka Zone – Book 5 / 8
f) Dasarahalli Zone – Book 6 / 8
g) Mahadevapura Zone – Book 7 / 8
h) Rajarajeshwarinagara Zone – Book 8 / 8

VOLUME IV Revenue Survey Details, Statement & Maps for remodelling of storm water drains at BBMP Area.

The structural and non structural proposals suggested for the study area is formulated considering the severity of the problems, probability of occurrences, necessity of effective functionality of the system to minimize the incidences envisaged in each of the individual water shed clusters.

The works required to improve the functionality of the system as envisaged in the master plan project are prioritized into three categories. Though the proposals/activities may be grouped under different priorities but, mostly some of the proposals are interrelated and required to be takenup parallel. The works proposed to be taken up under different priorities are as follows viz;

Priority – I:

- Setting up of project implementation unit
- Verification of land records and demarcation of required water ways along with service corridors.
- Discussion with other stake holders and fixing responsibilities and targets for taking up the respective works.
- Setting up of coordination committee, comprising of members from each department and the committee headed by Commissioner BBMP.
- Setting up of rain gauging stations, flow measuring and data collection centres.
- Setting up of control rooms grievances addressal cell
- Desilting and drain bed regradation / profile modification of entire length of drains
- Remodelling of culverts/bridges
- Removal of encroachments
- Providing drain improvement works in low lying areas
- Restoration of existing walls
- Reconstruction of dilapidated walls
- Development of water bodies as flood retention basins

- Procurement of additional land required for drain remodeling and setting up of STPs etc
- Removal of obstacles and shifting service lines that are obstructing flow

Priority – II:

- Create public awareness
- Drain widening and bank protective works
- Setting up of Sewage Treatment Plants
- Development of flood plains

Priority – III:

- Providing bed protection works
- Rehabilitation of existing culverts/bridges
- Providing fencing
- Formation of service roads for routine maintenance and laying service lines
- Construction of detention ponds, retention basins, silt traps etc.

8.0 PROJECT COST:

All development projects shall aim to make the best use of available financial, physical and institutional resources for implementation in an optimal manner

This is especially true for an infrastructure project like storm drainage for which the available resources for implementation of project are usually limited in relation to the total need. It is therefore very much important to minimize the cost at which services are provided while ensuring that agreed minimum standards are achieved. In the meantime, it is also important to ensure that cost, both capital cost and recurrent cost are affordable to the organization and also as well as agreeable to all the beneficiaries.

The costs considered in the current project are divided into cost of implementation and recurrent cost.

Capital costs are the costs incurred at the beginning of the project between its inception and its completion on the ground. Further the capital cost include,

- The cost of planning and designing the work,
- Construction costs,
- Supervision costs, and
- Overheads.

Recurrent costs are the cost incurred after execution of the project for the routine maintenance and operations of the system.

The cost of various components of work, zone wise are given below.

Sl .No.	Name of the Zone	Amount (Rs. In Crores)
1	East	
2	West	654.22
3	South	
4	Bommanahalli	665.14
5	Yelahanka	655.26
6	Dasarahalli	508.99
7	Mahadevapura	914.91
8	Rajrarajeshwarinagara	759.73
	Total	4,158.25

Apart from the cost incurred for remodeling of storm drains, some of the costs which are not considered in the estimate and which are envisaged to be a large amount are,

- Land Acquisition
- Rehabilitation cost for distracted property owners
- Removal of structures & Disposal of debris
- Permanent shifting of service lines by various agencies
- Sewerage system improvement works
- Restoration of roads and cross drainages after completion of the works
- Cost incurred for asset management
- Maintenance of drains, etc

The cost of acquiring land for the preservation of the integrity of the identified drainage corridor with service roads and fencing, not being considered in the cost of the project, BBMP's particular attention is required on top priority for a policy decision on this aspect for the options like compensation or Transfer of Development Rights or Rehabilitation and Resettlement of Project affected Persons.

9.0 RECURRENT COST:

For maintaining the existing drains in good condition and to have maximum hydraulic carrying capacity, the drainage system has to be maintained in good condition. The general maintenance cost envisaged are given in the below;

Abstract of Cost for Remodelling of Storm Water Drains, Culverts/Bridges & its Appurtenant works in BBMP Area

Sl. No.	Items of Work	Unit	Quantity	Total Amount (Rs. Crores)
1.0	***Carrying Capacity Improvement Works:***			
1.1	Desilting and deepening	Rmt	736971	121.28
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	73085	238.59
	b. RCC independent walls	Rmt	79120	559.62
	c. RCC "U" shaped walls	Rmt	171575	971.62
	d. CRS / SSM masonry walls	Rmt	103395	230.12
	e. RCC box drain	Rmt	45722	369.27
1.3	Bed protection	Rmt	127220	78.75
	Sub Total =			2,569.24
2.0	***Rehabilitation / Strengthening Works:***			
	CRS / SSM wall reconstruction	Rmt	83870	12.90
	CRS / SSM wall restoration			1.59
	Sub Total =			14.49
3.0	***Culverts / Bridges:***			
3.1	Utility support structures / bridges	Nos	23	5.75
3.2	Proposed for remodelling	Nos	886	244.45
3.3	Proposed for rehabilitation	Nos	403	7.22
3.4	Railway Culverts	Nos	10	8.67
	Sub Total =			266.08
4.0	***Allied Drain Works:***			
4.1	Fixing boundary stones along the drains	Nos	44394	1.16
4.2	Development of drains in low lying areas	LOT	147	224.69
4.3	Service road formation	Rmt	415865	187.44
4.4	Fencing	Rmt	101540	61.64
4.5	Detention ponds	Nos	101	16.43
4.6	Retarding basins	Nos	63	8.46
4.7	Development of existing water bodies as holding ponds	Nos	50	96.40
4.8	Silt traps	Nos	348	11.68
4.9	Desilting ramps	Nos	26	5.05
4.10	Inlet / out weir strengthening	Nos	94	35.82
4.11	Setting up of rain gauge stations	Nos	48	2.20
4.12	Shifting of sewers from SWD's	LOT	18408	69.47
4.13	Procurement of desilting machines	Nos	24	24.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	52	5.20
	Sub Total =			749.64
5.0	***Decentralized Sewage Treatment Plants:***			
	Construction of decentralized STP's near lakes	Nos	14	185.00
	Sub Total =			185.00
Total for Str. Works =				3,841.34
6.0	***Other Non Structural Works:***			
6.1	**Consultancy for preparation of DPR and project management services @ 1% of project cost**	**LS**		38.41
6.2	**Rehabilitation and resettlement @ 2%**	**LS**		76.83
6.3	**Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%***	**LS**		56.89
6.4	**Development of green belt adjacent to SWD's @ 0.25%**	**LS**		9.60
6.5	**Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)**	**LS**		192.07
Total for Non Str. Works =				316.91
Total Cost for Master Plan =				4,158.25

***Note : Shifting of other services @ 2% considered only for drains**

Abstract of Cost for Operation and Maintenance of Storm Water Drainage System & its Allied works in BBMP Area

Sl No	Description	East	West	South	Rajarajeshwarinagara	Dasarahalli	Yelahanka	Mahadevapura	Bommanahalli	Total Amount (Rs. In Lakhs)
1	Establishment Charges	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	560.00
2	Cost for purchase of Plants, Machineries & their maintenance	5.03	1.32	2.17	3.55	3.70	8.95	9.82	9.63	44.17
3	Drain desilting works	177.53	107.78	142.71	180.16	144.67	167.74	255.38	187.00	1362.96
4	Maintenance of other allied structure	5.03	1.32	2.17	3.55	3.70	8.95	9.82	9.63	44.17
5	Staff Training, Community Awareness etc	2.52	0.66	1.09	1.78	1.85	4.48	4.91	4.81	22.08
6	Holding pond operator cost	1.44	0.00	0.36	1.08	1.80	3.24	2.88	1.80	12.60
7	STP O & M Cost for 37.5 MLD	300.00	0.00	50.00	150.00	200.00	700.00	700.00	750.00	2850.00
	Total	561.54	181.08	268.49	410.11	425.72	963.35	1052.81	1032.87	4895.98

Table Details of Works Proposed under Master Plan Project in BBMP Area

Sl.	Name of Water Shed	Unit	Core Area (W + E+ S)	Bommanahalli Zone	Yelahanka Zone	Dasarahalli Zone	Mahadevpura Zone	Rajarajeshwarinagara Zone	Total
No.	**Items of Work**		**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**
1.0	**Carrying Capacity Improvement Works:**								
1.1	Desilting and deepening	**Rmt**	227,380	101,005	98,786	79,110	131,770	98,920	736,971
1.2	Drain Widening								
	a. Earthen bund formation	**Rmt**	1,850	10,900	14,070	3,735	41,980	550	73,085
	b. RCC independent walls	**Rmt**	22,890	1,250	10,910	10,005	7,340	26,725	79,120
	c. RCC "U" shaped walls	**Rmt**	7,785	32,305	28,860	36,940	35,335	30,350	171,575
	d. CRS / SSM masonry walls	**Rmt**	3,850	25,225	23,380	9,775	30,415	10,750	103,395
	e. RCC box drain	**Rmt**	5,017	15,535	7,630	300	11,880	5,360	45,722
1.3	Bed protection	**Rmt**	1,800	11,685	38,140	19,110	2,700	53,785	127,220
2.0	**Rehabilitation / Strengthening Works:**								
	CRS / SSM wall reconstruction	**Rmt**	2,755	13,105	24,190	13,485	5,400	24,935	83,870
	CRS / SSM wall restoration								
3.0	**Culverts / Bridges:**								
3.1	Utility support structures / bridges	**Nos**	0	4	4	4	6	5	23
3.2	Proposed for remodelling	**Nos**	59	68	229	133	167	230	886
3.3	Proposed for rehabilitation	**Nos**	0	141	13	69	77	103	403
3.4	Railway Culverts	**Nos**			2		6	2	10
4.0	**Allied Drain Works:**								
4.1	Fixing boundary stones along the drains	**Nos**	15,159	6,626	0	5,521	8,629	8,460	44,394
4.2	Development of drains in low lying areas	**LOT**	58	24	15	17	23	10	147
4.3	Service road formation	**Rmt**	17,000	80,695	74,500	57,160	118,900	67,610	415,865
4.4	Fencing	**Rmt**	14,790	400	33,425	13,660	3,550	35,715	101,540
4.5	Detention ponds	**Nos**	33	10	16	22	10	10	101
4.6	Retarding basins	**Nos**	14	10	6	18	5	10	63
4.7	Development of existing water bodies as holding ponds	**Nos**	7	7	9	6	15	6	50
4.8	Silt traps	**Nos**	0	28	242	18	48	12	348
4.9	Desilting ramps	**Nos**	0	5	5	6	5	5	26
4.10	Inlet / out weir strengthening	**Nos**	15	26	15	8	16	14	94
4.11	Setting up of rain gauge stations	**Nos**	8	11	1	8	14	6	48
4.12	Shifting of sewers from SWD's	**LOT**	4	11	18,365	8	14	6	18,408
4.13	Procurement of desilting machines	**Nos**	4	4	4	4	5	3	24
4.14	Procurement of vehicles for BBMP vigilance squad	**Nos**	4	11	9	8	14	6	52
5.0	**Decentralized Sewage Treatment Plants:**								
	Construction of decentralized STP's near lakes	**Nos**	2	4	3	1	3	1	14

10.0 Implementation Programme:

In order to achieve the overall objectives of the project, it is very much essential to have a proper implementation programme that could ensure better control over the project cost and resources mobilized.

The works proposed for remodeling of storm drains in the study area shall be taken up in a phased manner simultaneously in all the water shed clusters and packages. Since, some of the critical issues which require coordination from other agencies in several instances, community participation, removal of encroachments, acquisition of land from government & public, shifting of utilities, traffic diversion at several places etc., are envisaged in each of the drains.

It is proposed that BBMP shall set up a separate project implementation unit (PIU) for implementations of proposals ensure adoption of good construction practices, project monitoring and reporting the project progress to the project monitoring/funding agencies and complete the project as per the schedule.

11.0 STAGES OF THE PROJECT:

The proposed project is suggested to be implemented over a 10 year period considering the cost of the project. It is suggested that the implementation be over three phases of 3 year each. The first year is considered for forming a Project Facilitation Unit together with the implementation of programmes in the highly critical and vulnerable areas as identified hereunder. The first year may be utilized to consolidate various detailed engineering proposals as developed for the individual zones with detailed Project Reports framed in accordance with the proposed masterplan.

Further, to monitor the work progress and have financial control on expenditures it is suggested to prepare the work programme on quarterly basis.

A brief work programme with a broader perspective has been formulated and enclosed in the report keeping in view the availability of the resources, minimum distraction to the adjoining properties, to cause less inconvenience to the public, considering the environmental aspects, financial capabilities etc., for smooth and successful implementation of the project. The works proposed for remodeling of storm drains at Yelahanka Zone, shall be taken up in a phased manner simultaneously in all the packages. The estimated capital cost is phased over a period of 10 years in three stages and the funding pattern as per guidelines set forth for JnNURM projects is as indicated in the table below;

Investment of Capital Cost

(Cost in Rs Crores)

Name of Zone	Capital Cost	Years			
		Gestation (1 Year-5%)	Stage I (50%)	Stage II (30%)	Stage III (15%)
Core Area	654.22	32.71	327.11	196.27	98.13
Bommanahalli	665.14	33.26	332.57	199.54	99.77
Yelahanka	655.26	32.76	327.63	196.58	98.29
Dasarahalli	508.99	25.45	254.50	152.70	76.35
Mahadevapura	914.91	45.75	457.46	274.47	137.24
Rajarajeshwarinagara	759.73	37.99	379.87	227.92	113.96
Total	**4,158.25**	**207.91**	**2,079.13**	**1,247.48**	**623.74**

Funding pattern for Remodeling of Storm Water Drains in BBMP Area

(Rs. in Crores)

Funding Pattern	Total	Gestation (1 Year)	Stage - I	Stage - II	Stage - III
GOI Grant 35 %	1,455.39	72.77	727.69	436.62	218.31
GOK Grant 15 %	623.74	31.19	311.87	187.12	93.56
BBMP financing 50 %	2,079.13	103.96	1,039.56	623.74	311.87
Total	**4,158.25**	**207.91**	**2,079.13**	**1,247.48**	**623.74**

The funding pattern is based on the guidelines set forth for JnNURM Projects.

However, the storm water drain projects when implemented would not generate additional revenue for the principal implementing agency viz. BBMP. Thus, it is a social infrastructure project attempting to restore the eco-system and relieve the citizens and residents of hardships that they are currently exposed by way of polluted drains, flooding and potential danger of public health hazards. These characteristics of the project lend itself for grants, aid and soft loans. Not withstanding the above social aspects, BBMP needs to provide appropriate support to the project by means of initial seed amount and through budget provision to support the operation and maintenance of the SWDs once constructed.

However, BBMP is examining the possibility of levying a one time collection charges from property owners in the city and extend the same principle to the extended areas towards partial recovery of capital cost that is estimated for the remodeling of the storm water drains. It is under consideration to recover at the maximum ______% of the capital cost through such cess. The recovery would be made over a period of five years from the property owners. This scheme is subject to willingness and affordability criteria of the residents and the approval of the BBMP council and the State Government.

The revenue accrual on account of the proposed cess is summarized below – a total collection of Rs ___________ Crores from the years 2010-11 till 2020-21.

12.0 FACTORS FOR CONSIDERATION DURING IMPLEMENTATION:

Before commencement of the construction activities, all components of the works need to be studied for site suitability and work programme evolved jointly by BBMP, the Consultant and the execution contractor. Particular attention may be given to the examination of the feasibility of taking up the works concurrently.

The following may be considered while preparing the work programme;

- Before inviting the tenders it is suggested to invite expression of interest / tenders to evaluate the financial and technical capabilities of the contracting agencies. The tender forms shall be issued only to the agencies which satisfies all the requirements of the qualifying criteria.
- The implementing agency shall preferably not award more than one package to one contracting agency. However, considering the past experiences and performance track record the criteria shall be reconsidered.
- Before commencement of implementation activity, all relevant project reports, drawings, meeting proceedings, shall be read in conjunction with tender clauses. Ambiguity shall be cleared necessary approvals shall be obtained.
- All components of the work need to be studied for site suitability and work programme evolved jointly by BBMP and the contracting agency.
- Before commencement of any work, detailed work plan has to be prepared for all the packages and get approved by BBMP.
- Additional land required from drain remodeling and formation of service corridors shall be procured and demarcated at site.
- Land records to be verified, encroachment of water way if any shall be cleared before awarding the contracts / commencement of works.
- All work fronts should be clear from all encumbrances, necessary permission/approvals for shifting service lines near/inside SWD, traffic diversion etc. shall be obtained.
- All necessary precautionary and safety measures as per the tender clauses should be ensured at site by the implementing agency and the contracting agency before starting any work at site.
- All ongoing works taken up by implementing agency and stake holders shall be dovetailed with the present comprehensive project proposals.
- All the works considered under remodeling project shall start simultaneously from down stream end of respective packages.
- Vegetation growth noticed inside the drain at various locations shall be removed in all the packages.
- Strengthening of inlet and outlet weir of the tank shall be taken up simultaneously at all the tanks existing in the catchment area.
- Rocky out crops noticed all along the drains at various locations which are obstructing free flow of water & also causing accumulation of silt, garbage etc. needs to be removed/lowered and the work shall be taken up simultaneously in all the packages.
- Shifting of service lines which are noticed all along the drain at various locations, shall be taken up simultaneously in coordination with various agencies in all the packages.
- Stoppage of sewage and other undesirable liquid wastes entry into storm drains which are noticed along the drains shall be taken up simultaneously in all the packages.
- Desilting of drains, removal of debris/solid wastes etc., which are noticed along the drains, shall be taken up simultaneously in all the packages.
- Widening of storm drains at the critical reaches, which are identified at various locations under the project, shall be taken up simultaneously in all the packages.

- Construction of retention basins which are identified at various locations under the project, shall be taken up simultaneously in all the packages.
- Culvert/bridges considered for remodeling under the project, at various locations shall be taken up simultaneously in all the packages.
- Construction of new drains considered for minimizing the flooding problems in low lying areas which are spread over at various locations shall be taken up simultaneously in all the packages.
- Reaches of existing drain walls proposed for reconstruction/restoration under the project at various locations along the drains, shall be taken up simultaneously in all the packages.
- Providing rehabilitation works to existing drain walls and other structures considered under the project at various locations, shall be taken up simultaneously in all the packages.
- Construction of new drain wall / stone revetment in the reaches identified at various locations under the project shall be taken up simultaneously in all the packages.
- Providing pointing, coping concrete, restoration of eroded stones in the existing SSM masonry drain walls shall be taken up simultaneously in all the packages.
- Construction of water recharging structures and development of land along side of the drain shall be taken up simultaneously in all the packages.
- Providing bed protection to the entire length of storm drains shall be taken up simultaneously in all the packages.
- Providing fencing and parapet wall construction to storm drains shall be taken up simultaneously in all the packages.
- Restoration of roads, cross drains and other infrastructure facilities, after completion of the works at various locations, shall be taken up simultaneously in all the packages.
- Providing improvements works at along side of the storm drains, shall be taken up simultaneously in all the packages.
- Periodic maintenance of storm drainage system shall be taken up for the entire length of the drains in all the packages.
- Providing chain link fence at vulnerable locations to prevent dumping of garbage / solid waste materials into SWD.
- Providing rehabilitation work to existing culverts/bridges
- Setting up of emergency squad to provide relief measure at vulnerable locations

13.0 STRATEGIC RECOMMENDATIONS

In addition to the implementation of the various measures listed above, following may also be considered

- Development of flood plains to preserve the integrity of the drainage corridor
- Construction of retention basins and detention ponds,
- Improving the holding capacity of water bodies with automated gates for lakes with remote operation and manual over ride and establishment of interlink between water bodies,
- Segregation of sewage and provision of localised sewage treatment plants for such segregated sewage
- Setting up of automated rain gauge stations in each zone and installation of flood monitoring and control devices,
- Zonewise flood control, monitoring and management system in place
- Rehabilitation and resettlement of distracted properties,
- Administrative reforms
- Enforcement measures like Declaration of flood prone areas as no development zone and development of land above HFL level
- Houses in Flood plains and in critical areas needs to be above Flood level or on stilt.
- Penalties or higher tax for land use violation which are undesirable.
- Incentive for providing flood control measures taken up by individual or institution.
- Develop flood plain as greenery or for temporary utilization.
- For Koramangala area flood relief, provide Bellandur lake sluice, STP, Rejuvenate the lake, lower the Belandur lake level using sluice gate and manage.
- Use play ground / park in low level as temporary detention for flood water.
- Outsource the upkeep of drain to meet the desired outcome.
- Regular co-ordination meetings with other stakeholders like BWSSB, BDA, LDA, Forest Dept, Horticulture, Police etc., on Lakes upkeep, STP, utilization of treated sewage for park etc.,

Vrishabhavathi Valley:

- Pilot drain proposal from Magadi Road near Gopalapura upto Mysore Railway line near Telecom Layout needs to be constructed for minimising flooding problems in Manjunathanagara, Cholarapalya, Padarayanapura and surrounding regions.
- Rocky outcrop noticed near Srirampura Railway track, & Mysore Railway line, Bapujinagara needs to be lowered to facilitate for free flow of water and to avoid surcharging of water into upstream side residential areas.
- Drain reach near Bangalore University Area needs to be widened and service road to be formed for facilitating free flow of water and routine maintenance and also to avoid surcharging of water on upstream side.
- Drain reach along side Mysore Road needs to widened to cater for required flood discharge from Vrishabhavathi catchment area.
- Low lying area internal drainage network arrangement improvement, secondary drain improvement proposals, construction of detention ponds, bed profile regradation, culverts/bridges proposed for remodelling, service road formation etc., proposed in the project report needs to be implemented for having effective flood management system in place.

Challaghatta Valley:

- Drain widening & deepening proposals from Shivajinagara upto Gurudwara bridge needs to be takenup to avoid surcharging of water near Shivajaianagara and its surrounding region.
- Drain widening and alignment modification near KGA Golf Club upto Bellandur Kere needs to be taken up to avoid surcharging of water on upstream side.
- Low lying area internal drainage network arrangement improvement, secondary drain improvement proposals, construction of detention ponds, bed profile regradation, culverts/bridges proposed for remodelling, service road formation etc., proposed in the project report needs to be implemented for having effective flood management system in place.

Hebbal Valley:

- Remodelling of RCC hume pipe inadequate vent size railway culvert near Raja canal STP needs to be remodelled immediately to avoid surcharging of water near Tannisandra, Mariyanapalya, Manayatha Tech Park, Hebbal Region etc.
- Drain widening proposals near Hebbal defence dairy farm land, Mariyannapalya, Manayatha Tech Park, Rampura Kere to Kalkere Kere, Vadarapalya needs to takenup to facilitate for free flow of water.
- Parallel drain construction near TATAnagara upto Hebbal Kere needs to taken immediately to avoid surcharging of water near RMV Extn, Balaji layout, Badarappa layout, Devinagara etc.
- Low lying area internal drainage network arrangement improvement, secondary drain improvement proposals, construction of detention ponds, bed profile regradation, culverts/bridges proposed for remodelling, service road formation etc., proposed in the project report needs to be implemented for having effective flood management system in place.

Koramangala Valley:

- Drain widening and bed profile regradation near L.R. slum, Ejipura, Jakkasandra, H.S.R. Layout, Silk board junction, NGR layout, Bellandur Kere inlet location etc., to be takenup immediately to facilitate for free flow of water.
- Defence land diversion drain construction proposals near S.T. Bed needs to be takenup to avoid surcharging of water in Koramagala layout.
- Low lying area internal drainage network arrangement improvement, secondary drain improvement proposals, construction of detention ponds, bed profile regradation, culverts/bridges proposed for remodelling, service road formation etc., proposed in the project report needs to be implemented for having effective flood management system in place.

14.0 BENEFIT FROM IMPLEMENTATION

The project is expected to result in number of benefits;

- Provision of a properly designed drainage system for a reasonably acceptable return period would ensure reduction in flood incidences.
- Provision and properly maintained drainage system with controls on sewage connections and solid waste dumping will enhance the Environmental quality in the form of reduced pollution of water bodies, ground water and aesthetic appearance of cities environs.
- Provision and proper maintenance of facilities like detention ponds and retention basins will not only attenuate the peak run-offs but also provide recharge of ground water which will improve ground water table.
- Provision and proper maintenance of localized sewage treatment plants and using the treated sewage will reduce the stress on fresh water sources.
- Availability of treated sewage will enable more greenery and fresh water lake gets developed assists reduction in climate change.
- Apart from the environmental benefits there would be economic opportunities in the implementation and maintenance with the private sector operating the systems.

15.0 CONCLUSION:

Implementing the proposals envisaged in the master plan report for all the water shed clusters in all eight zones in a time bound phased manner and by having proper coordination with all the stake holders. Helps the organization in cutting down the initial capital expenditure, avoids overlapping of works, expenses on operation and maintenance of the system, improve the service level bench mark offered to the citizen, minimizes the flooding problems in critical flood prone areas, improves the general health conditions of the community residing in the catchment area, and improves aesthetics appearance and environmental sanitation conditions in the surrounding vicinity in a comprehensive way on a long term basis in a sustainable manner acceptable to the beneficiaries.

CHAPTER – 1

INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION:

Bengaluru, known in the past as Bangalore, is the Capital of Karnataka and is the fifth largest metropolitan city in the country. Bengaluru is nearly 500 years old and has grown from a small time settlement when Kempe Gowda, the architect of Bengaluru, built a mud fort in 1537 and his son marked the city boundaries by erecting four watch towers. Today Bengaluru has grown well beyond those four towers into a sprawling metropolis of 245 Sq.Km of Core Bengaluru and 790 Sq.Km of total area including the 5 new zones with more than 6.8 million people and is referred to as the Silicon Valley of India - accounting for more than 35 percent of India's software exports. Bengaluru's temperate climate, high quality educational, scientific and technology institutions coupled with a thriving IT and Bio-Technology and manufacturing industry makes Bengaluru one of the most sought after global destinations.

Growth of Bengaluru over time is shown in **Table 1.1**

Table 1.1 Growth Profile of Bengaluru

	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001
City population in lakhs	1.63	1.89	2.40	3.10	4.11	7.86	12.06	16.64	29.22	41.30	56.86
Decadal Growth of population (in percent)	-	15.95	26.98	29.17	32.58	91.24	53.44	37.98	75.60	41.34	37.68

Source: CDP/Census of India

Projecting the population on the same basis as the last decade, the CDP indicates 78.28 lacs and 107.79 lacs in 2011 and 2021 respectively.

Bruhut Bengaluru Mahanagara Palike comprising city of Bengaluru and contiguous area around was notified in 2007. It extends over 825 sq.km. and includes Bengaluru Municipal Corporation of 225 Sq.Km together with 7 City Municipal Councils (CMC) viz. Bommanahalli, Byatarayanapura, Dasarahalli, Krishnarajapura, Mahadevapura, Pattanagere, Yelahanka, 1 Town Municipal Council (TMC) of Kengeri.

Table 1.2 shows some salient details of Bengaluru. **Tables 1.3, 1.4 & 1.5 (Source:** Economy, Population and Urban Sprawl - a comparative study of urban agglomerations of Bengaluru and Hyderabad, India, Using Remote Sensing and GIS techniques, **Neelakantan Krishna Iyer, Nairobi 2007)** show, respectively, Demographic Characteristics, Population Components and Landuse/Landcover estimates.

Table 1.2 Some salient details of Bengaluru

Parameter/ Name	*Area (Sq.Km)*	*No. of Wards*	*Population (2001), 000s*	*No. of Households*	*Developed Properties*	*Vacant Land (Ha)*
Core Area	226.2	100	4303	1225307	521939	57993
Bommanahalli	43.6	31	244	65885	41371	37193
Byatrayanapura	47.0	31	210	52813	25800	10167
Dasarahalli	38.0	33	310	91071	26759	20689
Krishna Raja Pura	21.3	35	199	50186	44824	15176
Mahadevapura Raja	46.2	31	164	44927	18186	24575
Rajeshwari Nagara *	66.0	31	112	30073	16715	27300
Yelahanka	38.8	31	100	28953	24110	7555
Kengeri	3.40	23	45	14319	6009	5115
Total	561	232	5686	1603534	725713	205763

* RR Nagara was formerly known as Pattanagere. **Source: CDP 2006 Vol I page 13**

Table 1.3 Demographic Characteristics of Bengaluru Urban area, 1971 – 2001

Bengaluru UA	**1971**	**1981**	**1991**	**2001**
Population size (000s)	**1,654**	**2,922**	**4,130**	5,701
Decadal Growth (000s)	**--**	**1,268**	**1,209**	1,571
%Decadal Growth	**--**	**76.67**	**41.36**	38.04
% Annual Growth Rate (exponential)	**--**	**5.69**	**3.46**	3.22
Area (Sq.Km)	**174.71**	**365.65**	**413.03**	492.55
Density (per Sq.Km)	9,466	7,991	10,000	11,546

Table 1.4 Population Components of Bengaluru Urban area, 1971 - 2001

BENGALURU UA		1971	1981	1991	2001
Bengaluru Municipal Corporation	**Population size (000s)**	**1,540**	**2476**	**3,302**	4,313
	Decadal Growth (000s)	**--**	**936**	**826**	1,011
	%Decadal Growth	**--**	**60.72**	**33.35**	30.61
	% Annual Growth Rate (exponential)	**--**	**4.75**	**2.88**	2.67
	% Share in BUA	**92.58**	**84.76**	**79.95**	75.65
Non BMC: {CMCs,CTS, TMCs, OG}	**Population size (000s)**	**124**	**446**	**828**	1388
	Decadal Growth (000s)	**--**	**322**	**383**	560
	%Decadal Growth	**--**	**260.74**	**85.90**	67.66
	% Annual Growth Rate (exponential)	**--**	**12.83**	**6.20**	5.17
	% Share in BUA	7.42	15.24	20.05	24.35

Table 1.5 Landuse / Landcover estimates the Bengaluru Urban Area (UA), 1971 - 2001

LANDUSE/LANDCOVER %	1971	1981	1991	2001
Mixed Built (Residential & Commercial)	19.69	26.37	38.99	**69.05**
Layout	3.53	1.88	0.00	**0.00**
Airport & Other Transportation	1.88	1.88	1.88	**1.88**
Industrial	0.00	0.00	2.53	**2.53**
Educational	0.00	0.00	2.53	**2.53**
Crop Land	51.53	47.67	10.84	**7.70**
Plantation	0.00	0.00	1.09	**1.09**
Forest	0.05	0.05	0.21	**0.21**
Parks/Gardens/Public-semi public	5.39	5.39	3.01	**3.01**
Barren/Rocky	0.77	0.77	0.40	**0.44**
Scrubland/grasses	7.85	6.69	6.60	**6.56**
Brick Kilns & others	0.00	0.00	0.00	**0.00**
Water	3.49	3.49	3.15	**3.15**
Open land	5.81	5.81	29.37	**0.08**
Defence Land	0.00	0.00	0.00	**0.00**
Total Area in Sq.Km (100%)	**174.71**	**365.65**	**413.03**	**492.55**

It can be seen that in the last 3 decades, there has been a substantial variation in the landuse pattern and the population growth, annual growth rate of non BMC areas far exceeding the same in BMC area.

Fig 1.1 shows the population growth since 1850 while **Fig 1.2** shows the same spatially distributed. urban sprawl of Bengaluru in the time period 1971 and 2001. **Fig 1.3** shows the Landuse/Landcover map of Bengaluru as of 2001 and **Fig. 1.4** shows the Landuse/Landcover map of Bengaluru as of 2003.

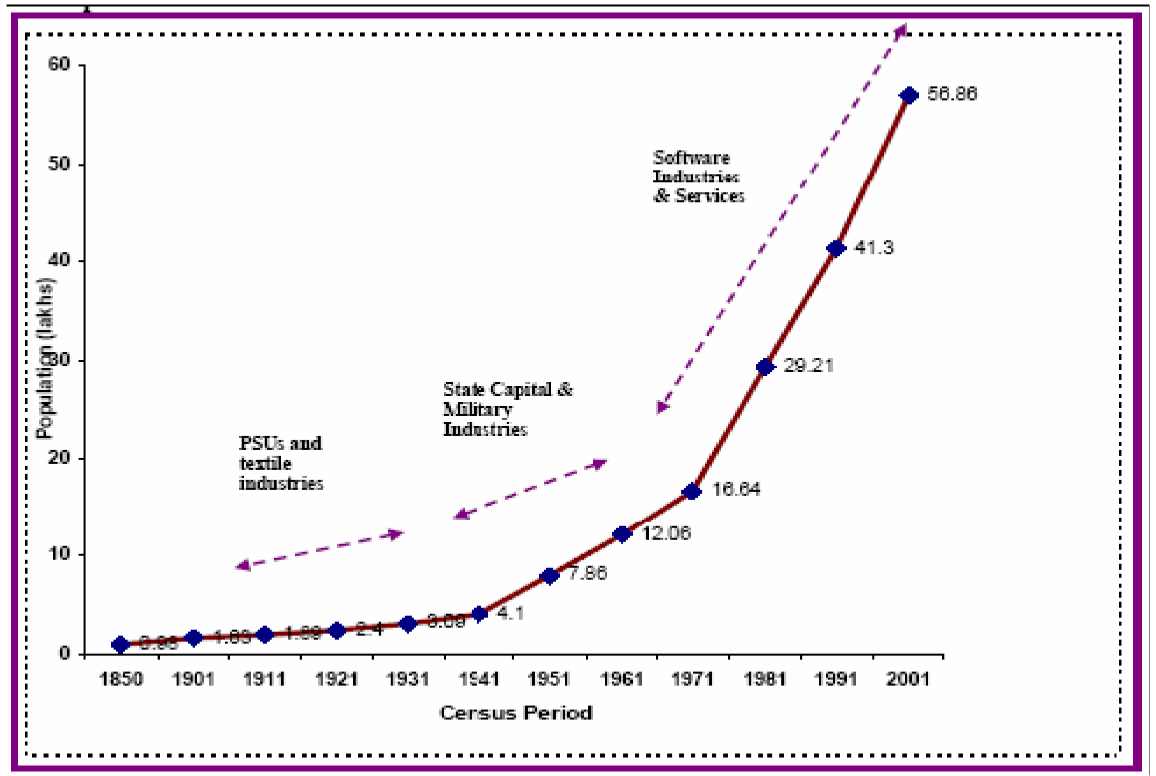


Fig 1.1 Population Growth

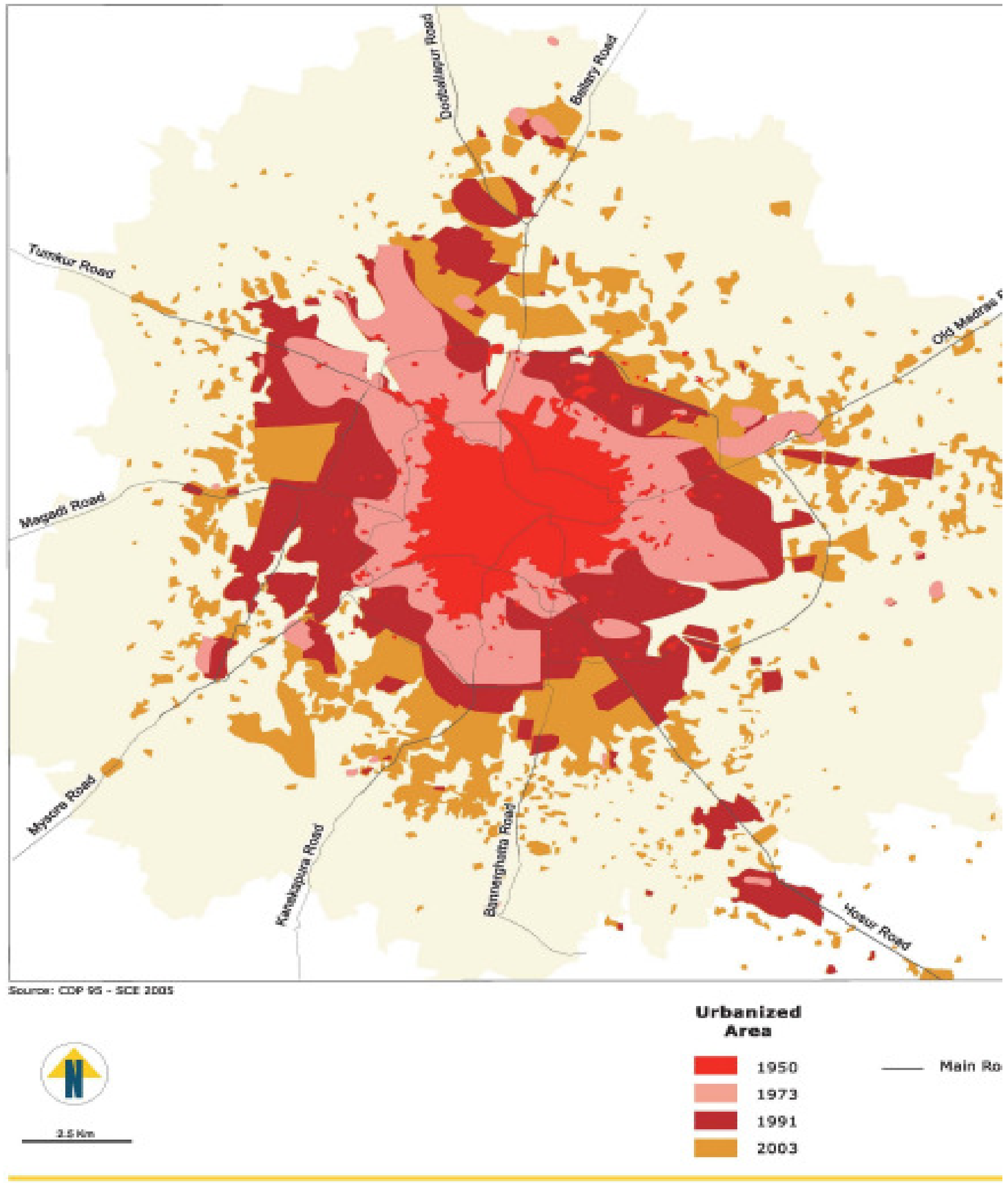


Fig 1.2 Spatial Distribution of Population

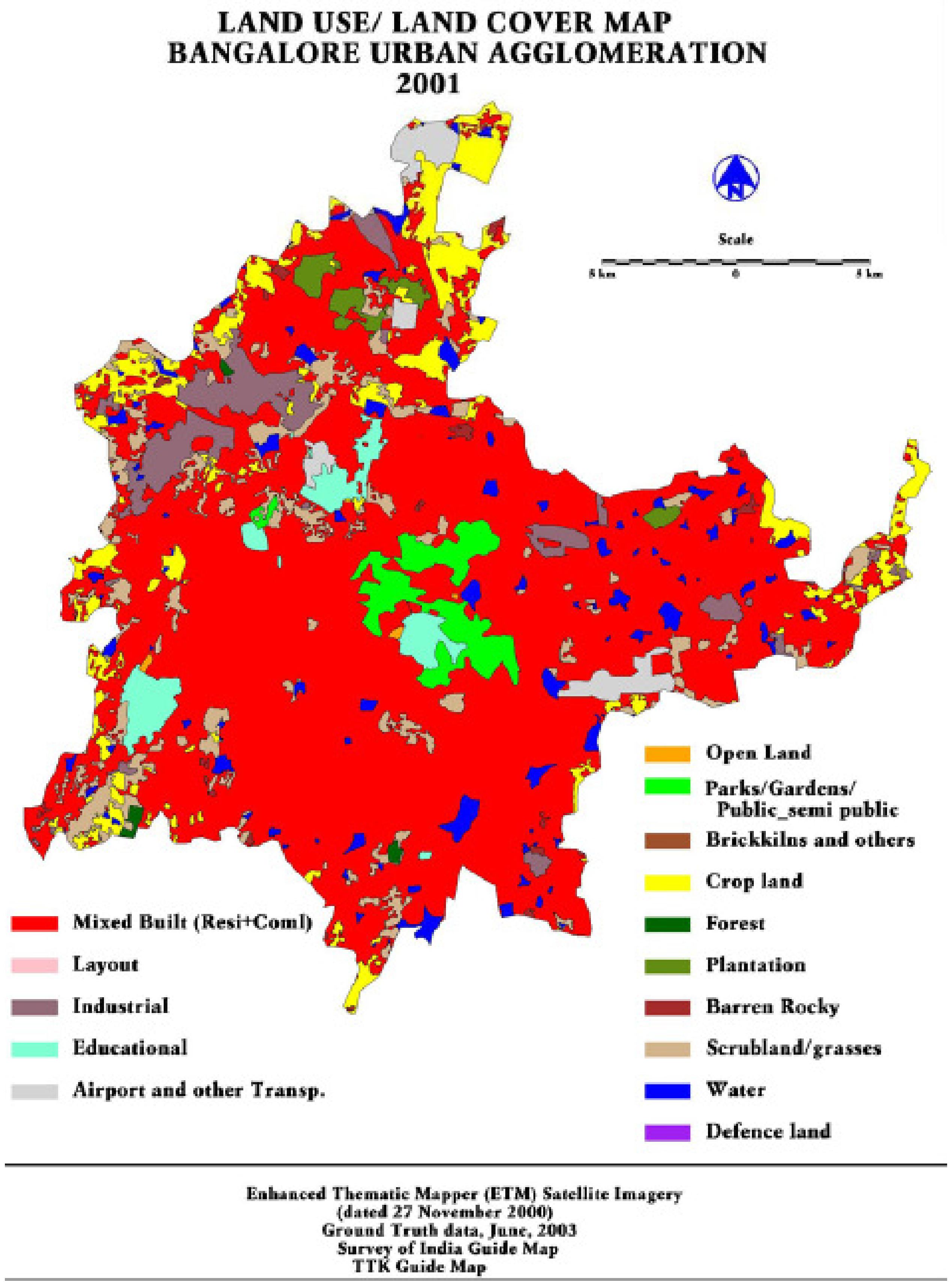


Fig 1.3 Landuse/ Landcover map of Bengaluru as of 2001.

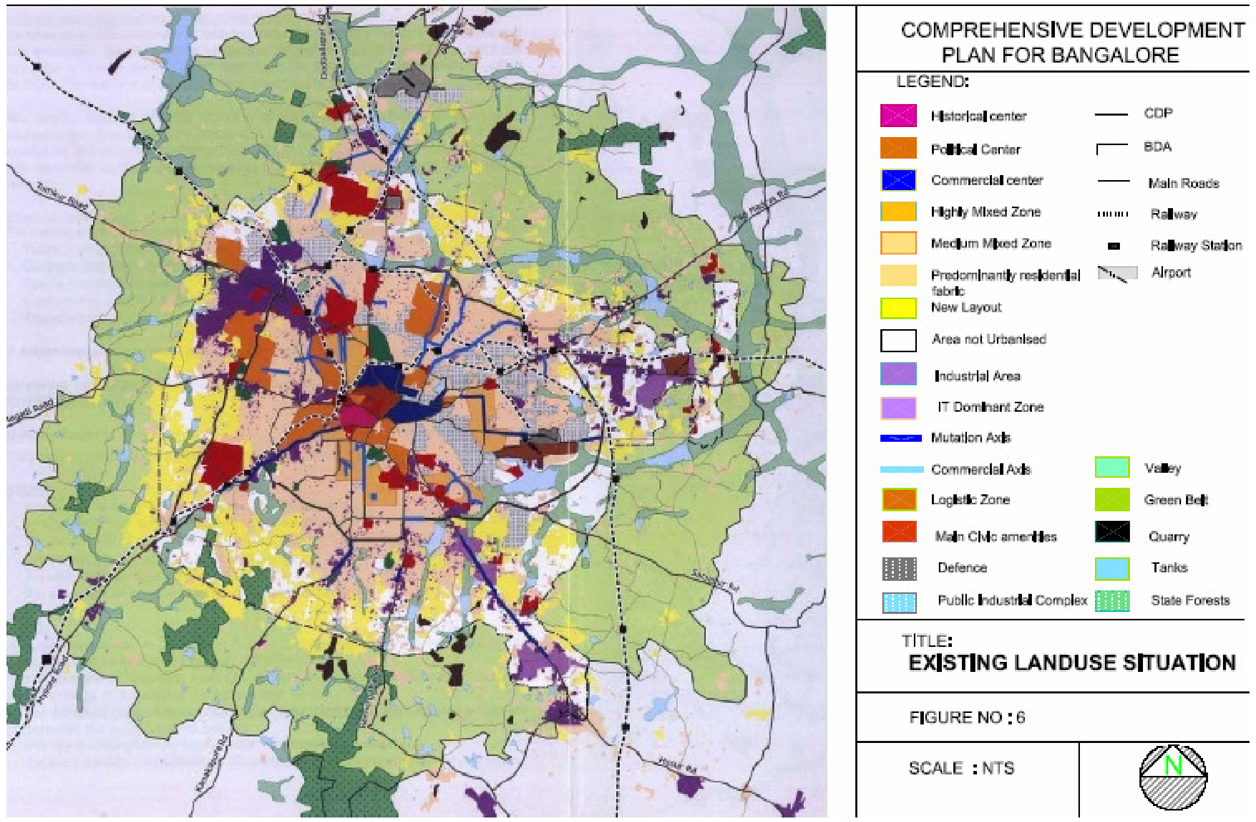


Fig 1.4 Landuse/ Landcover map of Bengaluru as of 2003

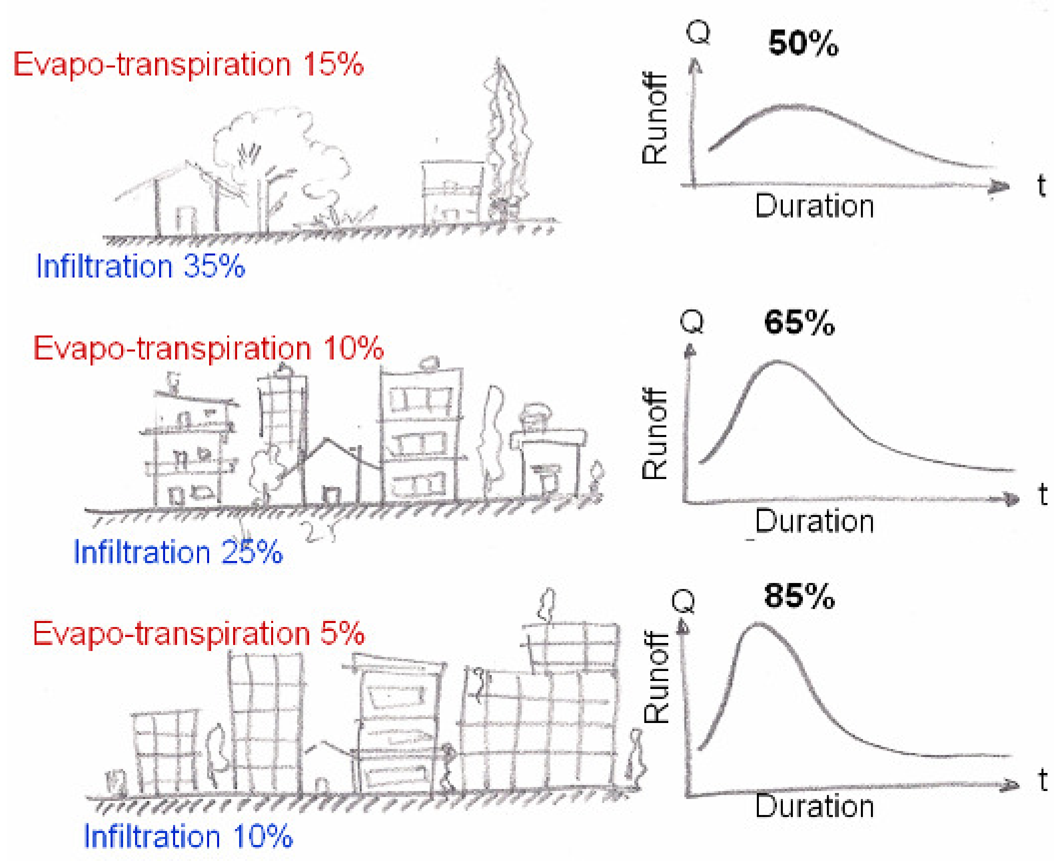


Fig 1.5 Relationship between Imperviousness and Surface Runoff

1.1 FLOODING, CAUSES & CONSEQUENCES

Bengaluru city which was well known for its open parkland environment with significant number of large traditional tanks with a good network of waterways and thick vegetative cover has been suffering from severe flooding problems during rainy season and resulting in submergence of low lying areas, causing water stagnation at several locations, submergence of footpaths restricting pedestrian movements, traffic hold-ups for several hours, extensive damage to both life and property etc. for various reasons, mainly the rapid urbanization due to explosive rate of growth of population in Bengaluru altering the landuse pattern and the imperviousness of surfaces.

Conceptually, if rainfall in a rural setting is assumed to have 35% infiltration and about 15% evapotranspiration results in a surface runoff of the equivalent of 50% of the rainfall, the same in a semi urbanised setting may have 25% infiltration and 10% of evapotranspiration, surface run off may be of the order of 65%; when a highly urbanised area is consider the order of infiltration, evapotranspiration and surface runoff may be respectively 10%, 5% and 85% showing the result of progressively increasing imperviousness as shown in **Fig 1.5**.

During the last few decades, Bengaluru being a chosen as a destination for Software, Biotech and other industrial entrepreneurs, has further escalated the population rise. This has obviously caused additional strain on the already overloaded city's infrastructure facilities. The large scale construction of office premises, commercial establishments and residential accommodations to meet the demands of the rising population has resulted in drastic change in landuse pattern like increase in paved areas, formation of layouts in tank bed areas & also below high flood level, encroachment of primary & secondary water ways, inadequate size of drains & cross drains, increase in sewage generation, improper networking & maintenance of drains, dumping of garbage/debris into the drains, improper gradient, obstructions due to laying of utility lines inside /across water ways, lack of awareness about importance of waterways, discharge of large quantity of sewage and industrial effluent into storm drain thereby polluting the ground water and water bodies etc., Therefore, there is an urgent need to examine the status of existing storm water drainage system, the reasons for the frequent flooding and devise possible remedial measures to alleviate the damage.

Plate 1.1 A family draining out water from their house at Sanjaynagara in Bengaluru at Hebbal Valley in West Zone

Plate1.2 The flooded streets of ITI Layout off the Bengaluru-Mysore highway at Vrishabhavathi Valley in South Zone

Plate 1.3 Evacuating residents from an apartment complex in Garvebavipalya on Hosur Road in Bommanahalli Zone

Plate 1.4 A Bengaluru road after a heavy downpour at Bommanahalli Zone

Water surcharged into residential areas at Badarappa Layout, **at Hebbal Valley in West Zone**

Water stagnation at the residential area,at Tanisandra, near Mariyannapalya in Yelahanka zone

1.2 USER COVERAGE AND ACCESS:

Unlike services like water supply or sewerage there can not be a direct correlation of user coverage and access as storm drainage is area and terrain based and on that basis there is a substantial coverage in the core area. As the core area of the city has expanded and there has been found that the existing systems in the core area have inadequacy, existing drainage system in the new zones need to be studied together to evolve a comprehensive drainage masterplan to have efficient drainage system on the whole to minimise problems associated with frequent urban flooding.

1.3 PROJECTS PROPOSED IN THE CITY DEVELOPMENT PLAN

City Development Plan under JnNURM (2006) envisaged implementation of a number of projects called the "**Valley Projects**" as given below:

- Construction/remodeling/rehabilitation of major storm water drains and road side drains;
- Removing silting;
- Constructing retaining walls;
- Laying of beds;
- Provision of enabling and awareness information architecture; and
- Green area development.

Investment plans included

- Constructing 1,500 km of roadside drains (cost of construction assumed at Rs. 30 lakh per km for a 5-metre drain);
- Extension of the SWD network into CMCs and TMC areas;
- Clearing all encroachments that come in the way of the storm water drain network in the city;
- Aligning the drain network and checking blockage and overflowing of drains;
- Reviewing existing storm water drains, ensuring connectivity of primary, secondary and tertiary drains;
- Redesigning for current load conditions along with building barriers between roads and open drains at crossings
- Estimated capital investment requirement in the JNNURM period and future blocks are given in **Tables 1.6 and 1.7** respectively.

Table 1.6: Investment Plan for Urban Drainage - JNNURM Period, Rs. Crores

Description	2006*07	2007*08	2008*09	2009*10	2010*11	2011*12	Total
Vrishabhavathi Valley	120	86	18	16	11	0	251
Challagatta Valley	66	42	10	10	9	0	137
Hebbal Valley	120	74	12	12	11	0	229
Koramangala Valley	72	42	12	10	9	0	145
Tertiary Drains	6	6	4	4	2	0	22
Roadside Drains	0	17	64	69	71	85	306
O & M Expenses	72	66	30	30	28	21	249
Total	**456**	**333**	**150**	**151**	**141**	**106**	**1339**

Table 1.7: Investment Plan for Urban Drainage - Vision Period, Rs. Crores

Description	2013-17	2018-22	2023-27	2028-31
Capital Expenditure	370	0	0	**0**
Rehabilitation Expenses	37	83	139	**194**
O & M Expenses	111	112	139	**167**
Total	**518**	**195**	**278**	**364**

1.4 NEED FOR THE PROJECT

Bengaluru had some 400 lakes which over the period of time when urbanization was rapid has come down to 64 resulting in the reduction in the attenuation of effects of flood. Preserving and protecting existing waterbodies is seen to be of paramount importance. Also storm drainage being dependent of the terrain and administrative boundaries of adjacent ULBs not withstanding, coordination of connectivity and continuity of action is to be addressed satisfactorily to ensure that the public assets created serve the intended objective. Routine maintenance in terms of desilting and prevention of dumping of solid waste are important issues besides the uncontrolled discharges of sanitary sewage into storm drains. Dumping of solid wastes or the discharge of sewage into storm drains aggravate the problem.

In view of and as seen from the foregoing, there has been a serious threat to the social & environmental attributes. Therefore Bruhath Bengaluru Mahanagara Palike (BBMP) the organization that takes the responsibility of providing infrastructure facilities and their maintenance, with an endeavour to improve the functionality of the water ways and safety aspects of general public and to minimize the flood related problems faced by the city during heavy showers, took up a project for Remodeling of primary and secondary storm water drains in the core area of Bengaluru. The project took into consideration the past initiatives in this sector which are listed below:

i Vrishabhavathi valley by M/s. Kaveri Environmental Center (KEC).
ii Koramangala and Challagatta valley by Sri. G. Aswathnarayana.
iii All the four valleys by M/s. Kirloskar Consultants Limited (KCL).
iv All the four valleys by M/s. Tor Steel Research Corporation.
v Bengaluru Water Supply and Environmental Sanitation Master Plan Project (BWSESMP) – AusAid. - 2005
vi Remodeling of SWD in four major valleys of Bengaluru by M/s. STUP Consultants P. Ltd in November 2006.
vii Revised DPR for four major valleys of Bengaluru by M/s. Arvee Associates P. Limited – in September 2010.

As the scope varied in each of these studies, methodology adopted and the contents of reports generated were different and also none of the above initiatives have extended their study area beyond the core area boundary with the result that there is no assessment/appreciation of the drainage system in the new areas which are integrated into BBMP.

Also, as currently, the new zones which are added into the BBMP area are being studied separately for developing a Detailed Project Reports for Storm Drainage Systems, it becomes necessary to integrate the Storm Drainage Systems of the core area covering the four (4) major valleys and their associated minor valleys with the Drainage Systems proposed for the new zones of Bommanahalli, Bytrayanapura, Dasarahalli, Mahadevapura and Raja Rajeshwari Nagar with a view to develop a comprehensive Drainage Master Plan for the entire BBMP area.

1.5 PROJECT PHASES:

The present study has as its objectives divided into two (2) phases

- **Phase 1** relates to the development of Masterplan for storm water drainage for entire BBMP area on the basis of technical, economical and environmental viability with the main objectives of the study being preparation of a Masterplan for storm water drainage network for entire BBMP areas to take up the work in a phased manner prioritizing the works identifying the deficiencies in the existing storm water drains and measures required to correct the situation together with the proposals for preventing sewage entering storm water drains to the extent possible.

- **Phase II** relates to the preparation of DPRs for the proposals suggested in the master plan report for individual zones, duly considering the approach, methodology and design parameters as per the criteria's / guidelines set forth by MoUD / CPHEEO.

1.6 PROJECT BACKGROUND:

During recent monsoon, the city and its agglomerated municipal administered areas and surrounding villages experienced unusually high intensity rainfall, which resulted in substantial damage to both life and property.

In light of the above incidence, Government of Karnataka (GOK), instructed Bruhath Bengaluru Mahanagara Palike (BBMP) to extend the storm water drains remodelling project to the agglomerated areas in the similar manner as that of core area storm water drain remodelling project prepared earlier and where work is already in progress.

In this regard BBMP invited M/s. STUP Consultants Private Limited and entrusted the work to provide necessary technical support to set priorities on existing drainage system rehabilitation needs, and to explore the potential options for augmenting the carrying capacity of the system, considering future hydraulic design requirements.

In November, 2008 agreement was signed for the project preparation by BBMP and STUP and as per the submittals mentioned in the terms of reference issued to the consultants. Inception report for the project comprising of project background, need of the project, project planning, approach and methodology, design criteria's and support required from BBMP, issues concerned for the project progress etc was narrated in detail and submitted to BBMP and subsequently a power point presentation was organised in BBMP wherein other issues related to the project were discussed in length with Commissioner, BBMP, Special Commissioner, (Projects) BBMP, Chief Engineers (SWD) and other senior technical officials.

Further, Interim report for the project comprising field survey data, site findings, alignment plans, survey formats etc were submitted to BBMP and during monthly review meetings other issues were discussed and proceedings have been drawn in the Chief Engineers (SWD) Office. Several joint site visits along with BBMP engineers, surveyors, and consultants have been done to get acquainted with site conditions and to take up short term works. On receipt of comments / feedback from BBMP revised interim report has been submitted.

The stated goal for remodelling of storm water drainage system in city's agglomerated areas, is to improve the carrying capacity of the existing system, for the delivery of storm water without flooding the low lying areas and also to provide improvised environmental sanitation services to the citizens, with emphasis on the urban poor and vulnerable groups and within a process of long term environmental, economic, social and institutional sustainability.

However, in the present initiative the project report is prepared as per CPHEEO norms for urban drainage system and based on the guidelines specified by Ministry of Urban Development (MoUD), New Delhi, for Projects sponsored by MoUD, under Jawaharlal Nehru National Urban Renewal Mission (JnNURM).

Along with remodelling of primary and secondary storm water drains. Planning for segregation of sewage flow from SWDs by providing UGD facility to newly developed layouts, missing pipeline links, replacement/rehabilitation of chocked/collapsed pipelines/manholes etc., improvement of solid waste management system, improvement to roadside and tertiary drain network and development of water bodies in and around Bengaluru is being taken up as separate projects proposals and which are already there on the anvil of the stake holders. Further, as envisaged considering the present site conditions, the above mentioned project proposals will not have any implication on the present BBMP storm water drains remodelling projects.

The output of this study will provide the basis for developing a comprehensive plan for the drainage system and detailed proposals for selected improvement projects to be implemented by BBMP in the city.

1.7 OBJECTIVES OF THE PROJECT:

The objectives, defined in broad terms are:

- To provide flood free environment to the citizens.
- To ensure free flow of water and to minimize flooding problems in critical flood prone areas.
- To improve the health and environmental sanitation conditions in the surrounding vicinity of SWDs and Water bodies.
- To address the flooding problems in a comprehensive manner and attain solutions on long term basis duly considering futuristic developmental / proposals aspects in view.
- To suggest low cost - high benefit options to address the flooding problems in a sustainable manner.
- To formulate guidelines for design, construction, operation and maintenance of the system.
- To protect the existing waterways and water bodies from environmental degradation.
- To design, develop and implement information architecture to capture and incorporate vector and raster data to be used by multiple agencies on a shared basis. Information architecture is designed to support sustainability.

1.8 REPORT OBJECTIVES:

This report provides brief description about the profile of the study area, existing drainage system, review of assessment and recommendations, frame work for management of drainage assets, techno-commercial analysis, stake holders roles and responsibilities, social survey findings in low lying areas, risk assessment, environmental and social impact, institution frame work, financial operating plan, project implementation plan etc.

- For the report purpose, the studies made are:
  - Identifying the low lying area and reasons for flooding
  - Assessment of existing condition of drainage system
  - Land use analysis, catchment area analysis etc.
  - Evaluation of development options for existing system.
  - Examining option / strategies for the preferred options for local applications.
  - Preparation of cost estimates for works and associated operation and maintenance.
  - Review of existing management of drainage system and the recommendations for institutional improvements.
  - Identification of further studies and investigation required for refinement.

This project report has the following structure:

VOLUME I **Master Plan Project Report**

VOLUME II **Annexure to Main Report**

VOLUME III **Appendix to Main Report,**

a) East Core Zone – Book 1 / 8
b) West Core Zone – Book 2 / 8
c) South Core Zone – Book 3 / 8
d) Bommanahalli Zone – Book 4 / 8
e) Yelahanka Zone – Book 5 / 8
f) Dasarahalli Zone – Book 6 / 8
g) Mahadevapura Zone – Book 7 / 8
h) Rajarajeshwarinagara Zone – Book 8 / 8

VOLUME IV **Land Details, Statement & Maps** for remodelling of storm water drains in Eight zones of BBMP Area.

1.9 SCOPE OF ASSIGNMENT:

A brief scope of assignment to be rendered by the consultants is as given below:

- Preparation of;
  - Inception report
  - Interim report
  - Draft Project Report
  - Final Project Report
- Detailed Scope of services includes;
  - Preparation of comprehensive base map
  - Field investigation
  - Demarcation of catchments
  - Assessment of quantity and quality of drainage discharge
  - Analysis of the existing system
  - Hydraulic designs for 1, 2 & 5 year Return Period
  - Formulation of site specific proposals
  - Identification of service corridors
  - Data capturing in GIS format
  - Prioritization / Phasing of works
  - Preparation of Project Reports,
  - Presentation & Approval

The study concerned with road side drains, tertiary drains and segregation of sewage flow from SWD is outside the current scope and is being addressed separately by BBMP. However, the contributory catchment area from the adjoining agglomerated areas has been accounted for calculating the runoff.

CHAPTER - 2

PROFILE OF THE STUDY AREA

2.0 INTRODUCTION:

This chapter discusses the profile of the study area in terms of broad parameters like landuse, population, road network, water supply level, sewerage and sanitation, drainage, solid waste management, water bodies, low lying areas, sewers inside storm drains etc. Landuse pattern in the study area is categorised on the basis of vacant areas, residential areas, commercial areas, industrial areas, open spaces, agricultural lands, areas occupied by transport facilities, public utilities, areas allotted for public purposes. Road network is categorised into ULB roads, PWD roads and NH roads. Water supply is described in terms of quantity supplied distributed into domestic, commercial and industrial connections. Sewerage and sanitation statistics include number of properties, number of sewer connections and number of septic tanks and soak pits. Existing storm drainage facility is described in terms of length of primary, secondary and tertiary drains. Statistics relating to solid waste include quantity generated and collected, infrastructure to handle and disposal mode. Water bodies listed gives the details of water spread area, use and the agency maintaining the waterbody. Low lying area list gives the location, extent of water spread, properties affected etc. in the surrounding vicinity.

2.1 STUDY AREA:

Bruhut Bengaluru Mahanagara Palike comprising city of Bengaluru and contiguous area around was notified in 2007. It extends over 825 sq.km. and includes Bengaluru Municipal Corporation of 225 Sq.Km together with 7 City Municipal Councils (CMC) viz. Bommanahalli, , Dasarahalli, Krishnarajapura, Mahadevapura, Pattanagere (now known as Raja Rajeshwari Nagara), Yelahanka and 1 Town Municipal Council (TMC) of Kengeri. Though BBMP covers such area, scope of the Masterplan project is confined to the Municipal Corporation area and 5 CMCs with Krishna Raja Pura included in Mahadevapura, Yelahanka included in Bytrayanapura and Kengeri included in Rajarajeshwari Nagara.

In this study, the Municipal Corporation area is labelled Core area of Bengaluru and consists of East, West and South zones and CMC areas of Bommanahalli, Byatrayanapura (since renamed as Yelahanka), Dasarahalli, Mahadevapura and Rajarajeshwarinagara. Though the individual areas are identified by the administrative boundaries, study area extends, in certain cases, beyond the administrative boundaries to account for the contributory catchments.

Extent of study area is as mentioned in **Table - 2.1**

Table - 2.1 Extent of Study Area

Sl. No	Zone	BBMP Administrative Zonal Area (Ha.)	Hydraulic Catchment Area (Ha.)	2001 Population (000)	Total Drain Length (Km.)	Current Population as published by BBMP
1	East Zone	9,165	10,937	4,033	227.31	18,77,635
2	West Zone	4,590	6,366			16,61,753
3	South Zone	6,734	5,553			9,47,169
8	Rajarajeshwarinagara Zone	7,661	15,365	157	144.75	2,83,936
6	Dasarahalli Zone	5,797	9,505	310	89.24	6,11,056
5	Byatarayanapura Zone (Yelahanka Zone)	12,091	14,235	310	113.85	4,61,934
7	Mahadevapura Zone	13,322	23,371	363	172.00	5,19,663
4	Bommanahalli Zone	10,340	16,317	244	109.59	4,31,867
Total		**69,700**	**101,650**	**5,687**	**856.74**	**65,95,013**

Note: Total drain lengths mentioned in the above table is as per actual survey, which also includes the length of drains those are considered for hydraulic analysis purposes only.

The city's topography is characterized by a series of well defined natural valleys, which radiate from a ridge of high ground to the north of the city and fall gradually towards a wide belt of flat cultivated land extending beyond the limits of the B.B.M.P. boundary to the South and South East

The North, North Eastern and South Eastern portion of the city include a portion of West zone and South Zone from the core area, East Zone, Zone (since renamed as Yelahanka Zone), Mahadevapura Zone and Bommanahalli Zone. The topography of these zones slopes towards South Eastern side and form part of contributory catchment area for Ponniyar River basin which flow towards Krishnagiri Dam in Tamil Nadu.

North Western region of the city comprising a portion of Dasarahalli Zone form part of contributory catchment area for Thippagondanahalli Kere, which is a situated in Arkavathi River Basin, near Magadi, which is again a tributory of River Cauvery.

Further, Western region, South Western region and Southern region include a portion of South zone and West zone, portion of Dasarahalli Zone and Rajarajeshwarinagara zone. The topography of these zones, slopes towards Southern side and form part of contributory catchment area for Vrishabhavathi River, which is a situated in Arkavathi River Basin also which is again a tributory of River Cauvery. Vrishabhavathi River flows towards Byramangala Reservoir situated near Bidadi and further joins River Cauvery at Mekedattu near Kanakapura.

Figure - 2.1 and Figure - 2.2 depicts the general divisions of sites' topography and the sinks where the runoff generated from these zones is ultimately discharged.

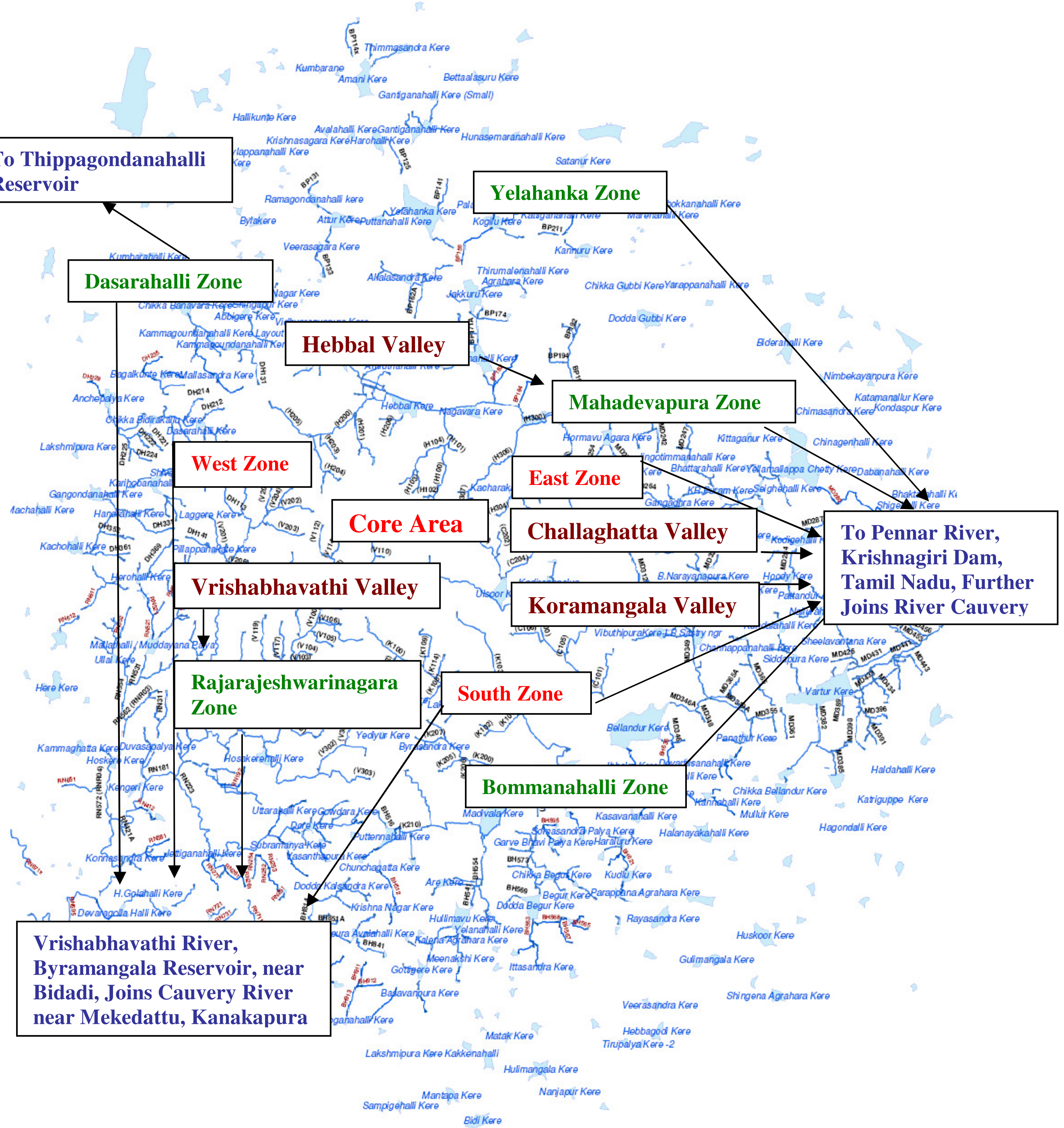
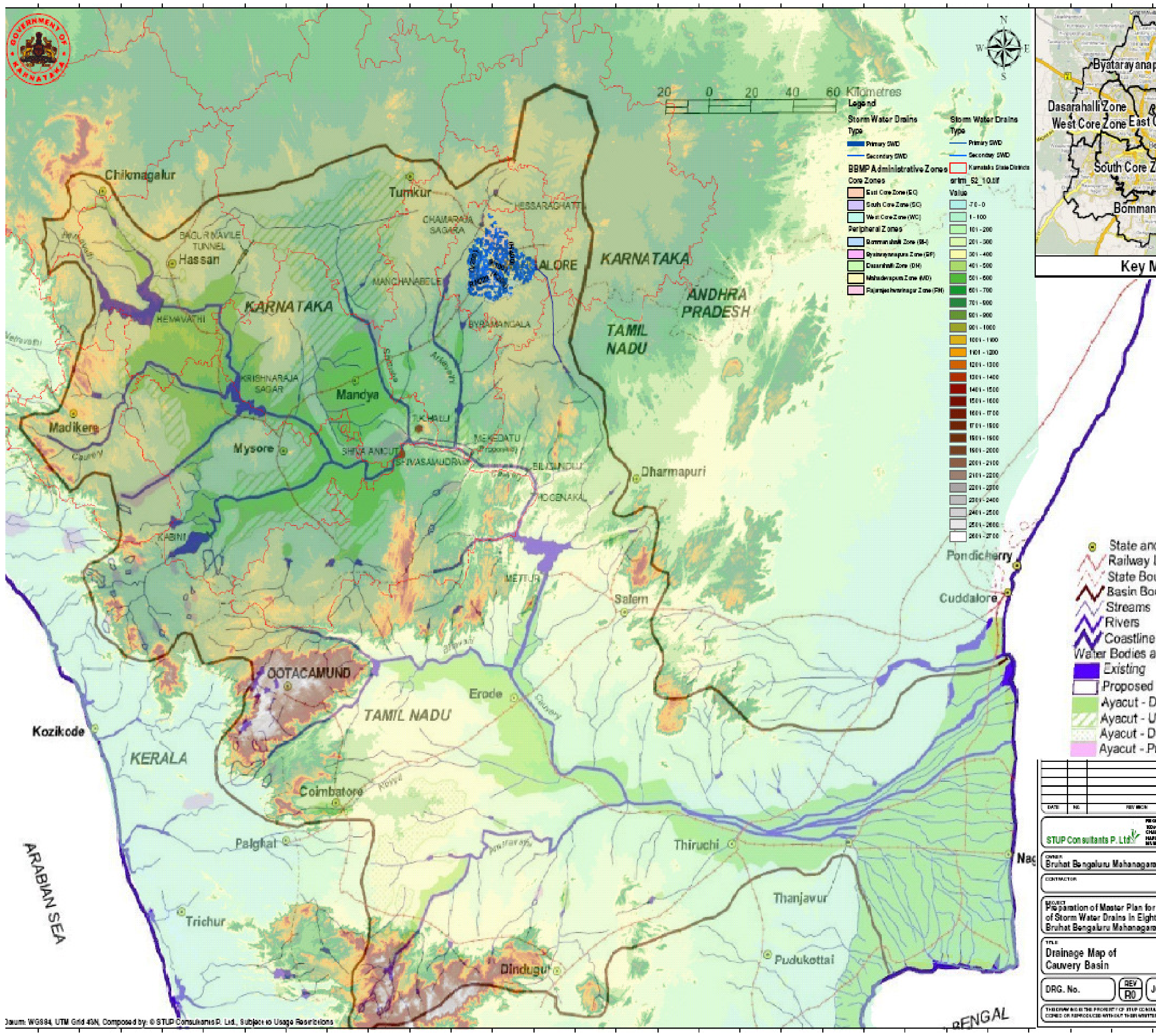


Figure - 2.1 Topography Map Depicting General Flow Directions in the Study Area

Figure - 2.2 Map Showing Cauvery Basin Boundary



2.1.1 Topography

Bengaluru is situated in the southeast of Karnataka, at an average elevation of 920m above mean sea level. It is positioned at 12.97°N, 77.56°E and covers an area of 825 sq.km. Bengaluru Urban District borders with Kolar District in the northeast, Tumkur District in the northwest, Mandya District in the southwest, Chamarajanagara District in the south and the neighboring state of Tamil Nadu in the southeast. The Bengaluru Urban District is divided into three taluks: Bengaluru North, Bengaluru South, and Anekal. The Bengaluru North taluk is a relatively level plateau, while the Bengaluru South taluk has an uneven landscape with intermingling hills and valleys.

The topography of Bengaluru is flat except for a ridge in the middle running NNESSW. The highest point in Bengaluru is Doddabettahalli, which is 962 m and lies on this ridge. There are no major rivers running through the City. The river Arkavathi (a tributary of the Cauvery) passes near Nandi Hills, 60 km North of Bengaluru, while the river Cauvery has its nearest approach near Srirangapatna, southwest of Bengaluru. Bengaluru has a number of freshwater lakes and water tanks, the largest of which are Madivala Kere, Bellandur Kere, Varthur Kere, Yelahanka Kere, Jakkur Kere, Rachenahalli Kere, Nagawara Kere, Hebbal Kere, Rampura Kere, Yelamallappa Chetty Kere, Ulsoor Kere, Subramanyapura, Muddayanapalya Kere and Sankey Tank.

2.1.2 Climate and Rainfall

Due to its high elevation, Bengaluru usually enjoys moderate climate throughout the year, although occasional heat waves can make things very uncomfortable in the summer. The coolest month is January with an average low temperature of 15.1 °C and the hottest month is April with an average high temperature of 33.6 °C. The highest temperature ever recorded in Bengaluru is 38.9 °C and the lowest ever is 7.8 °C (on January 1884). Winter temperatures rarely drops below 12 °C (54 °F), and summer temperatures seldom exceed 36–37 °C (100 °F). Bengaluru receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August, in that order. The summer heat is moderated by fairly frequent thunderstorms, which occasionally cause power outages and local flooding. The heaviest rainfall recorded in a 24-hour period is 179 millimetres (7.0 in) recorded on 1 October 1997. **Table 2.2** gives the profile of temperature and rainfall.

Table 2.2 Temperature and Rainfall Profile

Temperature in C0												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	27	30	32	34	33	29	28	27	28	28	27	26
Min	15	17	19	22	21	20	20	19	19	19	17	16
Rainfall in mm												
	3	7	4	46	120	81	110	137	195	180	64	22

2.2 FIELD ASSESSMENT:

2.2.1 RECONNAISSANCE SURVEY:

Reconnaissance survey has been carried out in all the entire drainage catchment area of BBMP area with a view to obtain the following details, which has bearing on the functionality of the system;

To get acquainted with the existing system, drain alignment and to descriptive the contributory areas of different drains.

Status of land use pattern / type and intensity of development adjoining the drain (i.e., residential, commercial, industrial or vacant land etc.).

Investigate the condition of drains, cross drains, type of construction, extent of bed lining, etc.

Examine feasibility of widening / deepening of the drain to carry the design flow.

Extent of land required for drain widening and formation of service road etc.

To identify the critical locations, which cause obstruction to smooth flow of water, have been identified and photographed.

To assess the extent of drains in natural condition, with masonry / RCC walls, covered/open type drains etc.,

Obstructions for flow, reduction in carrying capacity due to inadequate channel width, inadequate vent size cross drains, silt deposition, utility lines, solid waste/garbage dumping, illegal encroachment, inappropriate land development have be identified.

2.2.2 TOPOGRAPHIC SURVEY DETAILS:

To study the topographical characteristics of the drainage system, topographic survey and its level of accuracy play a very vital role in the preparation of the project. And which is one of the activities which has consumed more of the project period

The following procedure has been adopted while conducting the topographic survey; Survey of the drains has been carried out using total station equipments which produces a three dimensional data. By resorting to total station equipment's, along with levels, names of the roads, localities and important landmarks, physical features has being picked up at site and incorporated in the drawings along with others details.

While carrying out topographic survey of drains from origin point to disposal point, all the information required for the project preparation viz. Drain centre line reduced levels at every 25 m. interval, drain adjoining ground levels on either side capturing all existing physical features (as existing during the survey i.e., March 2009), Having identified the drains, the chainage have been marked along the drain starting from `0' chainage at the upper reaches at every 25 m. interval and continue in the increasing order towards the down stream direction.

Temporary bench marks have been established all along the drains at regular intervals and drain joining locations and marked with enamel paint at site and the details of the same has been referred in the alignment plans. Further, temporary bench marks established at site has been connected to GTS bench marks situated at various locations which is established earlier by Survey of India.

Drain alignment plans depicting the existing scenarios all along the drains viz. condition of existing walls, type of construction, extent requiring reconstruction, rehabilitation, new construction, obstruction locations, sewage entering into SWD locations, water impounding locations, utilities obstructing the flow inside the drains, possibility for drain widening in the bottle neck/reduced drain cross section areas, culvert/bridge locations, details of culverts/bridges like no. of spans, length, carriage way details etc has been identified and incorporated. Longitudinal section drawings and cross sections of individual drains is also prepared for all the drains identified in each of the catchment areas separately and enclosed along with this report as a separate volume.

TBMs established at different locations and drain reaches, during topographic survey for Remodelling of SWD Project in Yelahanka Zone

The details pertaining to culverts/bridges is being collected at site separately like, span, cross sectional details of culvert, carriage way width, abutment details, type and material of piers/columns, slab details and parapet wall details etc. by visual survey The culverts/bridges are serially numbered and included in the drain alignment plan.

Methodology adopted in representing the drains in the drawing:

Drain alignment plans showing information about the drains, land marks, features, bench marks, encroachments, condition of retaining walls, location of bridges/culverts, service roads and utility crossings is been identified (by visual survey) and drawn to a scale of 1:1000 and longitudinal section details of drains in 1:1000 / 1:100 and cross section details is been shown in the same drawing.

For ease of identification, each drain considered for remodelling has been assigned with Zonal names and identification numbers have been assigned individually for each drain and the same are to be read as follows;

Eg. : 1) BP = BP represents Yelahanka Zone

. 2) BP181 = 181 represents drain no. / drain ID no. in Yelahanka Zone

Cross section all along the drains at every 25 m. interval has been made showing drain depths, width, levels at top of the silt, bed level and also at the edges of the drain. Heights were given on top of drain wall and also at the adjoining land. The section also indicates whether the walls / buildings that rests on the drain at that particular section etc.

The topographic survey maps prepared to scale of 1:1000 and cross section details for every 25 m. interval for the entire study area has been collected and made use of to assess the topographic details of each drain in the respective water shed catchment areas.

2.2.3 CONDITION SURVEY DETAILS:

Condition survey of drains and cross drains has been carried out to assess and understand the existing scenario of the storm water drainage system in the entire BBMP Area.

The condition survey activity has been carried out by a team of surveyors and construction Engineers. This activity has been carried out with a view to obtain following details;

i. To get acquainted with the existing system, drain alignment and to descriptive the contributory areas of different drains.

ii. Status of land use pattern / type and intensity of development adjoining the drain (i.e., residential, commercial, industrial or vacant land etc.).

iii. Investigate the condition of drains, cross drains, type of construction, extent of bed lining, etc.

iv. Examine feasibility of widening / deepening of the drain to carry the design flow.

v. Extent of land required for drain widening and formation of service road etc.

vi. To identify extent of drain walls requiring reconstruction, rehabilitation etc.

vii. To identify the critical locations, which cause obstruction to smooth flow of water, have been identified and photographed.

viii. To assess the extent of drains in natural condition, with masonry / RCC walls, covered/open type drains etc.,

ix. Obstructions for flow, reduction in carrying capacity of drains due to inadequate channel width, inadequate vent size cross drains, silt deposition, utility lines obstruction, solid waste/garbage dumping and encroachment etc.,

During the course of the activity separate survey formats for drains, cross drains, flood prone areas, weir details, utility line survey format was prepared and details required for project preparation has been collected and incorporated in the report. In addition digital photographs have also been taken at strategic locations to support the data.

Condition survey details collected for each individual drains and culverts/bridges in each of the water shed catchment areas has been enclosed in this report as separate volume.

Along with total station survey, assessment of silt quantity using crow bar method has being carried out all along the drains at regular intervals. Locations that are prone for dumping debris / garbage by the public are also identified, recorded and photographed separately to help in assessing the quantities and suggest measures. (to prevent the same to the extent possible). .

Summary statement depicting the salient details of the site findings is enclosed in this report separately are given in **Part 1** of **Appendices 1, 2, 3, 4, 5, 6, 7** and **8** respectively for East Core Zone, West Core Zone, South Core Zone, Bommanahalli Zone, Yelahanka Zone, Dasarahalli Zone, Mahadevapura Zone and Raja Rajeshwari Nagara Zone.

2.3 Profile of Zones

BBMP had in the past, takenup a project on priority to remodel all the primary and secondary storm water drains in major valleys viz. Challaghatta Valley, Hebbal Valley, Koramangala Valley and Vrishabhavathi Valley. In May, 2006 Detailed Project Reports for all the four major valleys were prepared by BBMP, as per the guidelines specified by Ministry of Urban Development, New Delhi (MoUD) for JnURM projects. During August 2006, the proposals were submitted to KUIDFC the state level nodal agency for appraisal to State Level Steering Committee (SLSC) and further for onward submission to MoUD for consideration under JnURM Scheme (as four individual projects) at an Estimated Cost of **Rs. 678.93 Crores** (As per 2006-07 price level).

The projects were technically appraised by Central Public Health and Environmental Engineering Organization, MoUD, New Delhi (CPHEEO). The agency nominated by MoUD to study the technical feasibility of the project. During the discussions the site constraints, feasibility of proposals, implementation mechanism and construction methodologies were discussed in detail with senior officials from CPHEEO, KUIDFC and BBMP. Incorporating all the observations raised by CPHHEO, revised DPRs were prepared by BBMP and submitted to MoUD in November 2006 for an Estimated Cost of **Rs. 643.06 Crores** (Final Approved Cost).

Comprehensive Masterplan as being carried out in the current study had overlapping nomenclatures as given in **Table 2.3**.

Table - 2.3 Details of Major Valleys in Core Area

Sl. No.	Core Area Zones	Name of Major Valleys in Core Area	Area of Major Valleys (Ha.)	Drain Length (km.)
1.	East	Portion of Hebbal Valley	3,580	35.27
		Portion of Challaghatta Valley	3,856	30.74
		Portion of Koramangala Valley	3,502	28.38
2.	West	Portion of Hebbal Valley	1,740	15.52
		Portion of Vrishabhavathi	4,626	41.71
3.	South	Portion of Koramangala Valley	928	27.98
		Portion of Vrishabhavathi	4,625	47.71
Total			**22,857**	**227.31**

Detailed assessment of these is presented in Section 2.13.

2.3.1 Description of East Core Zone

East Core Zone is bounded by Mahadevapura in the East, West Zone in the West, Bytrayanapura in the North and both South Zone and Bommanahalli in the South. East Zone spread over an area of about 109 Sq.Km includes Dollars Colony, Sanjay Nagar, Sultan Palaya, Kacharakanahalli and Dodda Banaswadi in the North, B.Channasandra, Nagavrapalaya, Kaggadaspura, Konnena Agrahara in the East, Domalur I stage, Victoria Layout, Jakkasandra, Anapalaya and Gubbonpete in the South and Gubbon Park, Kumara Park and Vyalikaval in the West.

2.3.1.1 Landuse

East core zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 1**. Landuse of East core zone is shown in **Fig EZ-LU-01, Part 4, Appendix 1**.

2.3.1.2 Storm Drainage

Storm drainage network in East core zone includes 94 Km of length made up of 44 drains. Breakup details are given in **Table 2, Part 1, Appendix 1**. Storm drains in East core zone are shown in **Fig EZ-ED-01, Part 4, Appendix 1.**

2.3.1.3 Solid Waste

West core zone has 1125 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 1**.

2.3.1.4 Water bodies

There are 10 waterbodies in East core zone, details of which are given in **Table 4, Part 1, Appendix 1**. Locations of the waterbodies are shown in **Fig EZ-WB-01, Part 4, Appendix 1**.

2.3.1.4 Low Lying Areas

There are 22 identified low lying areas in East core zone, details of which are given in **Table 5, Part 1, Appendix 1**.

2.3.2 Brief description of West Core Zone

West Zone is bounded by East Zone in the East, Dasrahalli in the West, both Bytrayanapura and Dasrahalli in the North and South Zone in the South. West Zone spread over an area of about 64 Sq.Km includes Peenya Industrial Area Phase I, Jalahalli and Mathikere in the North, Mathikere, Malleshwaram and Mamulpete in the East, Sultanpete, Rajaji Nagar and Sane Guruvanahalli in the South and Kamakshi Palaya, Jai Maruthi Nagar and Peenya Industrial Area Phase II in the West.

2.3.2.1 Landuse

West core zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 2**. Landuse of West core zone is shown in **Fig WZ-LU-01, Part 4, Appendix 2.**

2.3.2.2 Storm Drainage

Storm drainage network in West core zone includes 57 Km of length made up of 28 drains. Breakup details are given in **Table 2, Part 1, Appendix 2**. . Storm drains in West core zone are shown in **Fig WZ-ED-01, Part 4, Appendix 2.**

2.3.2.3 Solid Waste

West core zone has 998 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 2**.

2.3.2.4 Water bodies

There are 1 waterbodies in West core zone, details of which are given in **Table 4, Part 1, Appendix 2**. Locations of the waterbodies are shown in **Fig WZ-WB-01, Part 4, Appendix 4**.

2.3.2.5 Low Lying Areas

There are 10 identified low lying areas in West core zone, details of which are given in **Table 5, Part 1, Appendix 2**.

2.3.3 Brief description of South Zone

South Zone is bounded by East Zone and Mahadevapura in the East, Raja Rajeshwari Nagar and Dasrahalli in the West, both West Zone and the East Zone in the North and Bommanahalli in the South. South Zone spread over an area of about 56 Sq.Km includes Sajjepalaya, Thimmenahalli, Goripalaya, Shivaji Nagarand Kumbaragundi in the North, Sudhama Nagar, Wilson Garden, Adugodi and Madiwala in the East, Chikka Madiwala, J.P.Nagar, Sarakki, Kadriguppe and Nayandahalli in the South and Roshan Nagar Nagarbavi and Kamashi Palaya in the West.

2.3.3.1 Landuse

South core zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 3**. Landuse of South core zone is shown in **Fig SZ-LU-01, Part 4, Appendix 3**.

2.3.3.2 Storm Drainage

Storm drainage network in South core zone includes 73 Km of length made up of 28 drains. . Breakup details are given in **Table 2, Part 1, Appendix 3**. . Storm drains in South core zone are shown in **Fig SZ-ED-01, Part 4, Appendix 3.**

2.3.3.3 Solid Waste

South core zone has 500 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 3**.

2.3.3.4 Water bodies

There are 12 waterbodies in South core zone, details of which are given in **Table 4, Part 1, Appendix 3**. Locations of the waterbodies are shown in **Fig SZ-WB-01, Part 4, Appendix 3**

2.3.3.5 Low Lying Areas

There are 25 identified low lying areas in South core zone, details of which are given in **Table 5, Part 1, Appendix 3**.

2.3.4 Brief description of Bommanahalli Zone

Bommanahalli forms the southern boundary of the study area. It is bounded by West and East Core Zones as well as part of Mahadevapura in the North, part of bommanahalli by Mahadevapura in the East while Raj Rajeshwari Nagar forming the western boundary of Bommanahalli. Spread over an area of 163 Sq.Km, Bommanahalli includes Kadriguppe, Adugodi, Jakkasandra, Belandur and Bhogenahalli in the North, Chikka Belandur, Junnasandra, Naganathapurain the East, Kembathanahalli, Basavanpura, Yelanahalli and Beratana agrahara in the South and anjanapura, Vajarahalli, Marasandra and Kadriguppe in the East.

2.3.4.1 Landuse

Bommanahalli zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed break-up is given in **Table 1, Part 1, Appendix 4**. Landuse of Bommanahalli zone is shown in **Fig BH-LU-01, Part 4, Appendix 4**

2.3.4.2 Storm Drainage

Storm drainage network in Bommanahalli zone includes 111 Km of length made up of 126 drains. Breakup details are given in **Table 2, Part 1, Appendix 4**. Storm drains in Bommanahalli zone are shown in **Fig BH-ED-01, Part 4, Appendix 4.**

2.3.4.3 Solid Waste

Bommanahalli zone has 175 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 4**.

2.3.4.4 Water bodies

There are 58 waterbodies in Bommanahalli zone, details of which are given in **Table 4, Part 1, Appendix 4**. Photographs following the table depict the present condition of some of the water bodies in this zone. Locations of the waterbodies are shown in **Fig BH-WB-01, Part 4, Appendix 4**.

2.3.4.5 Low Lying Areas

There are 24 identified low lying areas in Bommanahalli zone, details of which are given in **Table 5, Part 1, Appendix 4**.

2.3.5 Brief description of Yelehanka Zone:

Yelahanka Zone is situated on the northern part of the city. It is bounded partly by Mahadevapura zone in the East, portion of West and East Core Zones in the South and partly by Dasarahalli zone in the West. Yelahanka Zone is spread over an area of about 142 Sq.Km,. It includes Nagaenahalli, Hosahalli, Gantiganahalli and Katigenahalli in the North, Bellahalli, Thirumanahalli, Bileshivale, Horamau Agara, Gedalahalli, Kalkere and Babu Sahib Palya in the East, Thindlu, Nagashettyhalli, Kodegehalli, Badarappa Layout, Balajinagara, Devi Nagara, Dodda Bommasandra, Kempapura, Nagawara, Chalakere in the South and Nagaenahalli, Attur, Singapura, Vidhayaranyapura, Jalahalli Yelahanka New Town, Ramagondanahalli, Vedarahalli and Kuvempu Nagara in the West.

2.3.5.1 Landuse

Yelehanka zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 5**. Landuse of Yelehanka is shown in **Fig YE-LU-01, Part 4, Appendix 5**.

2.3.5.2 Storm Drainage

Storm drainage network in Yelehanka zone includes 114 Km of length made up of 112 drains. Breakup details are given in **Table 2, Part 1, Appendix 5** . Storm drains in Yelehanka zone are shown in **Fig YE-ED-01, Part 4, Appendix 5.**

2.3.5.3 Solid Waste

Yelehanka zone has 185 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 5**.

2.3.5.4 Water bodies

There are 40 waterbodies in Yelehanka zone, details of which are given in **Table 4, Part 1, Appendix 5**. Photographs following the table depict the present condition of some of the water bodies in this zone. Locations of the waterbodies are shown in **Fig YE-WB-01, Part 4, Appendix 5**.

2.3.5.5 Low Lying Areas

There are 15 identified low lying areas in Yelehanka zone, details of which are given in **Table 5, Part 1, Appendix 5**.

2.3.6 Brief description of Dasrahalli Zone:

Dasarahalli forms the western boundary of the study area. It is bounded partly by Bytrayanapura in the North, West Core Zone in the East and Raja Rajeshwari Nagar in the South. Spread over an area of about 95 Sq.Km, Dasrahalli includes Gudddadahalli and Dodda Guddadahalli in the North, Jayachamaraja Nagar, Peenya Industrial area and Kammagondanahalli in the East, Hosahalli Gollarpalaya, Bydarahalli in the South and Hosahalli Gollarpalaya, Byraveshwara Industrial Estate and Dodda Guddadahalli in the West.

2.3.6.1 Landuse

Dasarahalli zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 6**. Landuse of Dasarahalli zone is shown in **Fig DH-LU-01, Part 4, Appendix 6**.

2.3.6.2 Storm Drainage

Storm drainage network in Dasarahalli zone includes 89 Km of length made up of 80 drains. Breakup details are given in **Table 2, Part 1, Appendix 6**. Storm drains in Dasarahalli zone are shown in **Fig DH-ED-01, Part 4, Appndix 6.**

2.3.6.3 Solid Waste

Dasarahalli zone has 165 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 6**.

2.3.6.4 Water bodies

There are 17 waterbodies in Dasarahalli zone, details of which are given in **Table 4, Part 1, Appendix 6**. Photographs following the table depict the present condition of some of the water bodies in this zone. Locations of the waterbodies are shown in **Fig DH-WB-01, Part 4, Appendix 6**.

2.3.6.5 Low Lying Areas

There are 17 identified low lying areas in Dasarahalli zone, details of which are given in **Table 5, Part 1, Appendix 6**.

2.3.7 Brief description of Mahadevapura Zone:

Mahadevapura forms the eastern boundary of the study area. It is bounded partly by Bytrayanapura in the North, East Core Zone in the West and partly by Bommanahalli in the South. Spread over an area of 234 Sq.Km, Mahadevapura includes Babu sahib Palaya, Kallakare, Varanasi and Medihalli in the North, Medihalli, Belatur, Channasandra, Madhranagar and gunjuru in the East, Challgatta, Deverabeesanahalli and Gunjuru in the South and Challagatta, Udaya Nagar, Mukkutam Nagar and Kallakere in the West.

2.3.7.1 Landuse

Mahadevapura zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 7**. Landuse of Mahadevapura zone is shown in **Fig MD-LU-01, Part 4, Appendix 7**.

2.3.7.2 Storm Drainage

Storm drainage network in Mahadevapura zone includes 173 Km of length made up of 185 drains. Breakup details are given in **Table 2, Part 1, Appendix 7**. Storm drains in Mahadevapura zone are shown in **Fig MD-ED-01, Part 4, Appndix 7.**

2.3.7.3 Solid Waste

Mahadevapura zone has 210 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 7**.

2.3.7.4 Water bodies

There are 35 waterbodies in Mahadevapura zone, details of which are given in **Table 4, Part 1, Appendix 7**. Photographs following the table depict the present condition of some of the water bodies in this zone. Locations of the waterbodies are shown in **Fig MD-WB-01, Part 4, Appendix 7**.

2.3.7.5 Low Lying Areas

There are 23 identified low lying areas in Mahadevapura zone, details of which are given in **Table 5, Part 1, Appendix 7.**

2.3.8 Brief description of Raja Rajeshwari Nagara Zone:

Raja Rajeshwari Nagar also forms the western boundary of the study area. It is bounded partly by Dasarahalli and partly by the South core Zone in the North and partly by South Core Zone and pertly by Bommanahalli in the East. Spread over an area of 154 Sq.Km, Raja Rajeshwari Nagar includes Manganahalli, Mallathalli and Melagalu in the North, Nagarbhavi, Vikram Nagar (ISRO Layout) and Gabbaluru in the East, Gabbaluru, Bhanasankari 6 th stage and Varahasandra in the South, Manganahalli, Jnana Ganga Nagar and Kengeri in the West.

2.3.8.1 Landuse

Raja Rajeshwari Nagara zone is essentially a residential area with some interspersed commercial and industrial areas. Detailed breakup is given in **Table 1, Part 1, Appendix 8**. Landuse of Raja Rajeshwari Nagara zone is shown in **Fig RN-LU-01, Part 4, Appendix 8**.

2.3.8.2 Storm Drainage

Storm drainage network in Rajarajeshwarinagara zone includes 148 Km of length made up of 115 drains. Breakup details are given in **Table 2, Part 1, Appendix 8**. . Storm drains in Raja rajeshwari Nagara zone are shown in **Fig RN-ED-01, Part 4, Appndix 8.**

2.3.8.3 Solid Waste

Raja Rajeshwari Nagara zone has 114 Tonnes of Solid waste generated per day. Details of collection and disposal are given in **Table 3, Part 1, Appendix 8**.

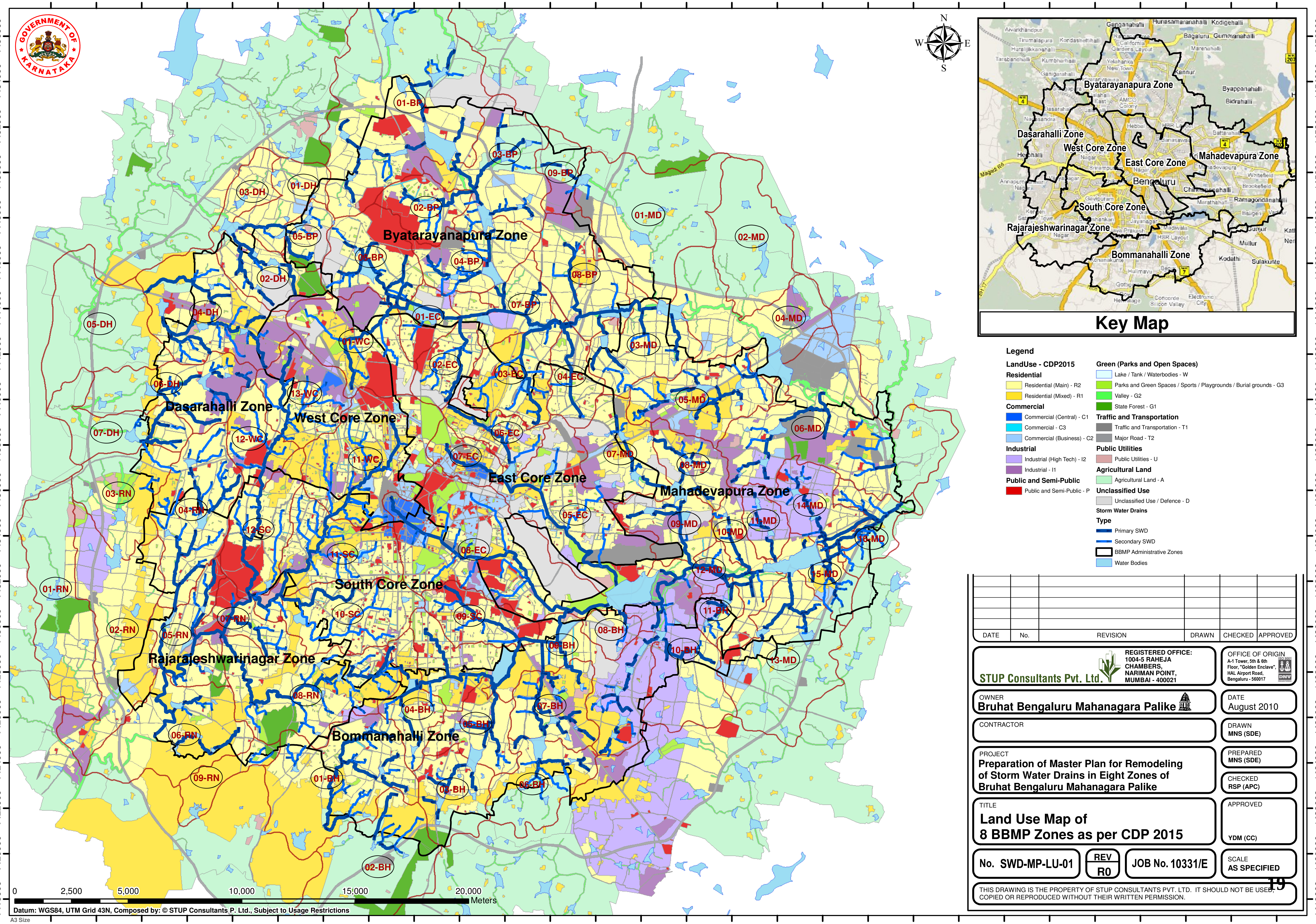
2.3.8.4 Water bodies

There are 24 waterbodies in Raja Rajeshwari Nagara zone, details of which are given in **Table 4, Part 1, Appendix 8**. Photographs following the table depict the present condition of some of the water bodies in this zone. Locations of the waterbodies are shown in **Fig RN-WB-01, Part 4, Appendix 8**.

2.3.8.5 Low Lying Areas

There are 11 identified low lying areas in Raja Rajeshwari Nagara zone, details of which are given in **Table 5, Part 1, Appendix 8**.

Maps depicting land use pattern and storm drainage network in the study areas is as depicted in Fig. SWD MP LU – 01 & SWD MP SD – 01.


GOVERNMENT OF KARNATAKA
Byatarayanapura Zone
Dasarahalli Zone
West Core Zone
East Core Zone
Mahadevapura Zone
South Core Zone
Rajarajeshwarinagar Zone
Bommanahalli Zone
Key Map
Bengaluru
Legend
LandUse - CDP2015
Residential
Residential (Main) - R2
Residential (Mixed) - R1
Commercial
Commercial (Central) - C1
Commercial - C3
Commercial (Business) - C2
Industrial
Industrial (High Tech) - I2
Industrial - I1
Public and Semi-Public
Public and Semi-Public - P
Green (Parks and Open Spaces)
Lake / Tank / Waterbodies - W
Parks and Green Spaces / Sports / Playgrounds / Burial grounds - G3
Valley - G2
State Forest - G1
Traffic and Transportation
Traffic and Transportation - T1
Major Road - T2
Public Utilities
Public Utilities - U
Agricultural Land
Agricultural Land - A
Unclassified Use
Unclassified Use / Defence - D
Storm Water Drains
Type
Primary SWD
Secondary SWD
BBMP Administrative Zones
Water Bodies
DATE No. REVISION DRAWN CHECKED APPROVED
STUP Consultants Pvt. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
OFFICE OF ORIGIN
OWNER
Bruhat Bengaluru Mahanagara Palike
DATE
August 2010
CONTRACTOR
DRAWN
MNS (SDE)
PROJECT
Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike
PREPARED
MNS (SDE)
CHECKED
RSP (APC)
TITLE
Land Use Map of 8 BBMP Zones as per CDP 2015
APPROVED
YDM (CC)
No. SWD-MP-LU-01
REV R0
JOB No. 10331/E
SCALE
AS SPECIFIED
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0 2,500 5,000 10,000 15,000 20,000 Meters
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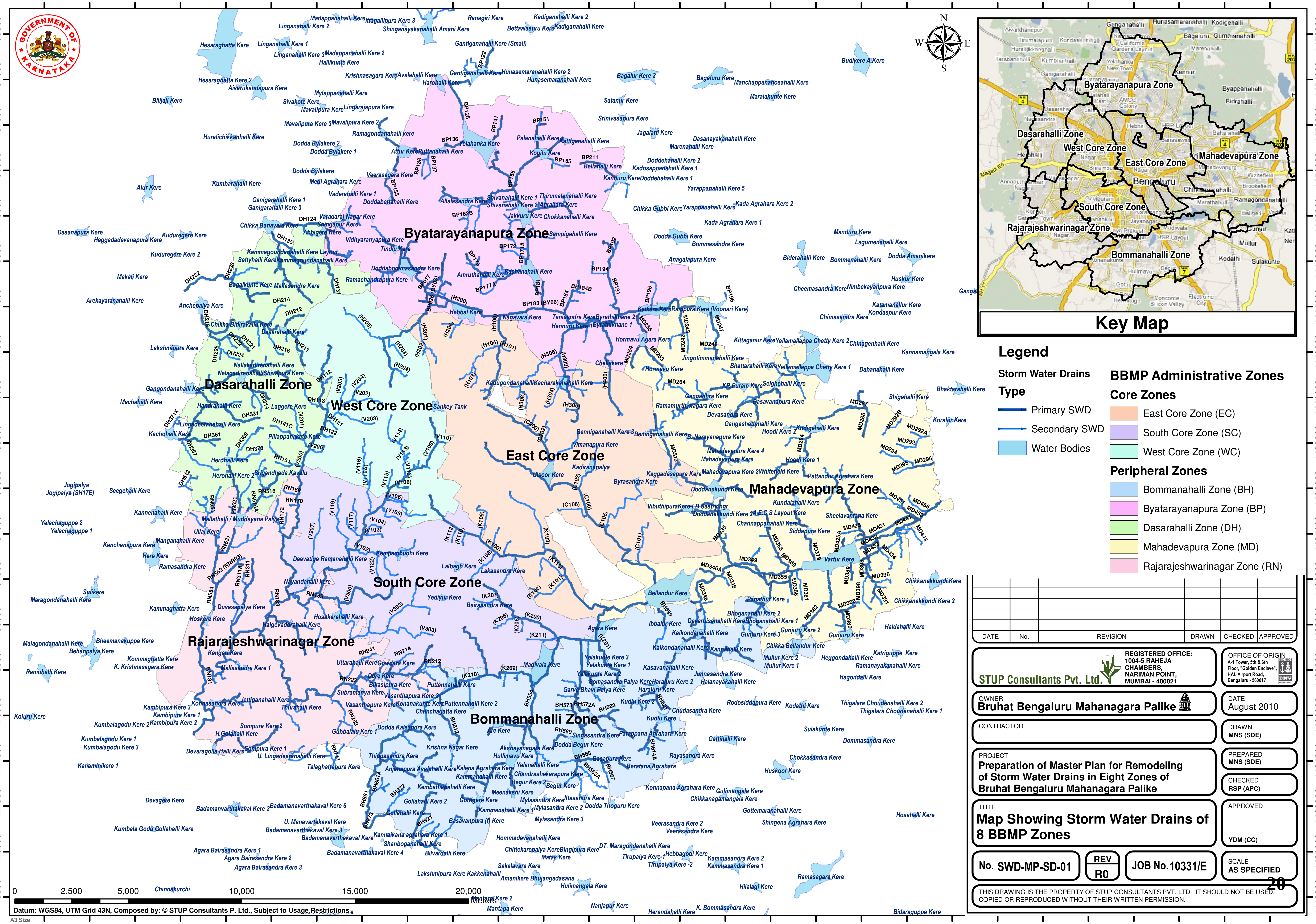
A3 Size


GOVERNMENT OF KARNATAKA
Byatarayanapura Zone
Dasarahalli Zone
West Core Zone
East Core Zone
Mahadevapura Zone
South Core Zone
Rajarajeshwarinagar Zone
Bommanahalli Zone
Key Map
Legend
Storm Water Drains Type
Primary SWD
Secondary SWD
Water Bodies
BBMP Administrative Zones
Core Zones
East Core Zone (EC)
South Core Zone (SC)
West Core Zone (WC)
Peripheral Zones
Bommanahalli Zone (BH)
Byatarayanapura Zone (BP)
Dasarahalli Zone (DH)
Mahadevapura Zone (MD)
Rajarajeshwarinagar Zone (RN)
DATE
No.
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STUP Consultants Pvt. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
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DATE
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PROJECT
Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike
PREPARED
MNS (SDE)
CHECKED
RSP (APC)
TITLE
Map Showing Storm Water Drains of 8 BBMP Zones
APPROVED
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No. SWD-MP-SD-01
REV R0
JOB No.10331/E
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2.4 WATER BODIES:

Water bodies situated in the zone were once used as source of water for domestic and non domestic purposes. Due to rapid urbanization the significant importance of the water bodies and its functionalities is fast diminishing in the urban community. Also, due to non existence of a proper comprehensive developmental plan in place and maintenance of these water bodies from the concerned authorities. Presently almost all existing water bodies are encroached for development of land for various purposes, they are severely silted and condition are very pathetic due to entry of raw sewage, dumping of debris, garbage and in turn aquatic life and the ground water quality is the surrounding region is severely affected.

The achakattu areas near the water bodies which were once acting as flood plains have been developed for various purposes like residential layouts, educational institutions, playgrounds etc and now they are all transformed into low lying flood prone areas.

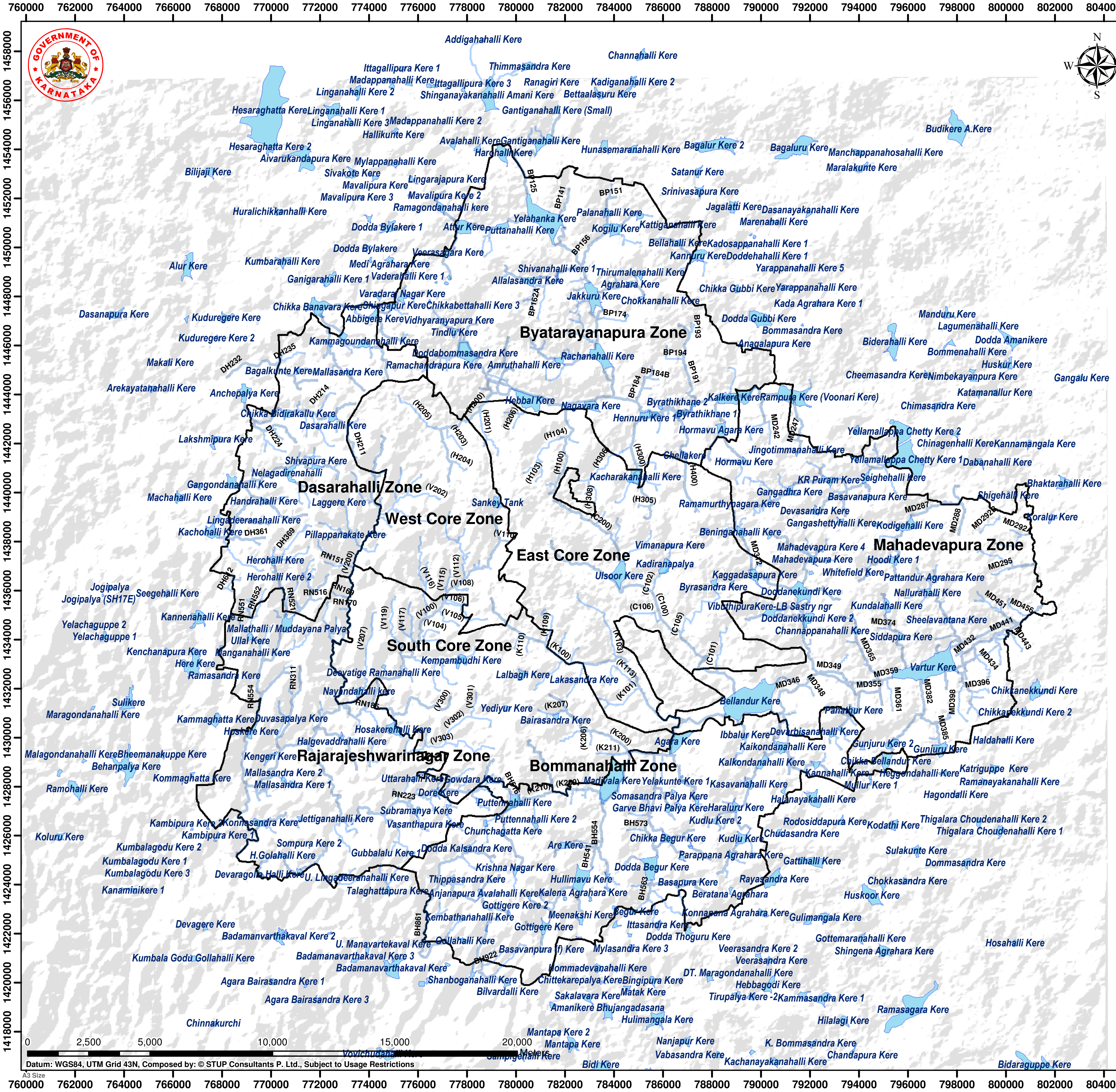
Due to above mentioned facts and many more, the drainage pattern in the water shed region has been drastically modified and transformed the land into flood prone areas and made the situation more complex and expensive to provide solutions to areas.

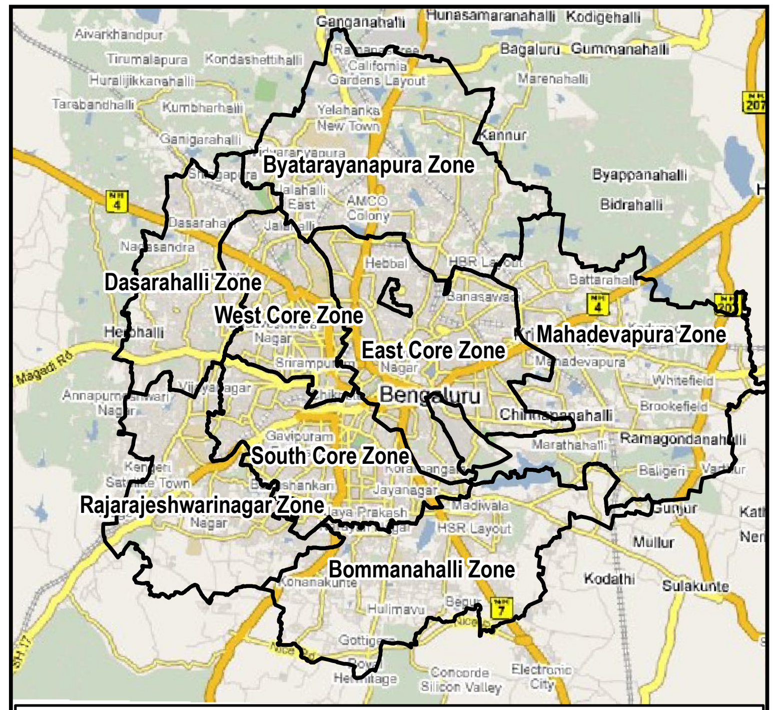
Therefore there is an urgent need from the Government and the Public to restore, protect and maintain the existing water bodies from further degradation and in order to improve the environmental sanitation condition in healthy and sustainable manner.

The details of waterbodies are given in **Table 2.4.** Photographs following the table depict the present condition of some of the water bodies in BBMP Area. Locations of the water bodies are shown in **Fig SWD MP WB 01.**

Table – 2.4 Details of Water Bodies in BBMP Area

<table>
<tr><th>Sl. No.</th><th>Zone</th><th>No. of Water Bodies with BBMP</th><th>No. of Water Bodies with BDA</th><th>No. of Water Bodies with LDA</th><th>No. of Water Bodies with Minor Irrg. & Other Dept.</th><th>Total</th></tr>
<tr><td>1</td><td>East</td><td>10</td><td rowspan="8">195</td><td rowspan="8">30</td><td rowspan="8">15</td><td></td></tr>
<tr><td>2</td><td>West</td><td>1</td><td></td></tr>
<tr><td>3</td><td>South</td><td>12</td><td></td></tr>
<tr><td>4</td><td>Rajarajeshwarinagara</td><td>24</td><td></td></tr>
<tr><td>5</td><td>Dasarahalli</td><td>17</td><td></td></tr>
<tr><td>6</td><td>Byatarayanapura</td><td>40</td><td></td></tr>
<tr><td>7</td><td>Mahadevapura</td><td>35</td><td></td></tr>
<tr><td>8</td><td>Bommanahalli</td><td>58</td><td></td></tr>
<tr><td colspan="2">Total</td><td>197</td><td>195</td><td>30</td><td>15</td><td>437</td></tr>
</table>





Key Map

Legend

Storm Water Drains Type

- Primary SWD
- Secondary SWD
- Water Bodies

BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

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OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: Bruhat Bengaluru Mahanagara Palike

DATE: August 2010

CONTRACTOR:

DRAWN: MNS (SDE)

PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: Map Showing Water Bodies of 8 BBMP Zones

APPROVED: YDM (CC)

No. SWD-MP-WB-01 | REV R0 | JOB No. 10331/E | SCALE AS SPECIFIED

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Site Appreciation - Condition of Water Bodies in East Core Zone:

Hebbal Lake

Ulsoor Lake

Nagavara Lake

Site Appreciation - Condition of Water Bodies in Bommanahalli Zone:

Kalena Agrahara Lake

Hulimavu Lake

Kannahalli Lake

Yelanahalli Lake

Akshayanagara Lake

Arekere

Beguru Lake

Chikka Beguru Lake

Singasandra Lake

Parappana Agrahara Lake

Kudlu Lake

Haraluru Lake

Kasavanahalli Lake

Dodda Kalsandra Lake

Avalahalli Lake

Site Appreciation - Condition of Water Bodies in Yelahanka Zone


Allalasandra Kere


Kogilu Kere


Gantiganahalli Kere

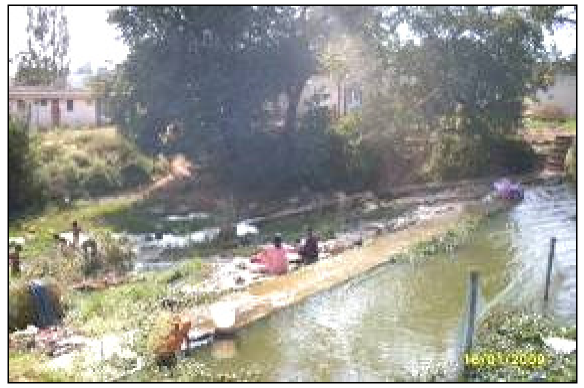

Nagenahalli Kere


Kere


Jakkur Kere


Amruthahalli Kere


Rachenahalli Kere


Kalkere Kere


Chokkanahalli Kere


Nala Kunte Kere


Kannuru Kere


Bellanahalli Kere


Jadebande Kere


Dodda Bommasandra Kere

Site Appreciation - Condition of Water Bodies in Dasarahalli Zone:

Kammagondanahalli Lake

Bagalgunte Lake

Chikka Bidirakallu Lake

Shivapura Lake

Nelakdhirenahalli Lake

Karihobanahalli Lake

Handrahalli Lake

Hosahalli Lake

Herohalli Lake

Site Appreciation - Condition of Water Bodies in Mahadevapura Zone:

Horamavu Agara Lake

Varanasi Lake

Maragondanahalli

Horamavu Lake

Lakshmana Murthy Lake

Kaudenahalli Lake

Kaudenahalli Lake

Vengaina Lake

Devasandra Lake

Bhattarahalli Lake

Banashankari Lake

Sadarmangala Lake

Sadarmangala Lake

Hoodi Lake

Nagara Palya Lake

Kasthuri Nagara Lake

Kaggadasapura Lake

Shettey Lake

Garudacharyapalaya Lake

Doddanekkundi Lake

Doddanekkundi Lake

Garudacharpalya Lake

Vibuthipura Lake

Doddenakundi Lake

Chinnappalli Lake

Kundanahalli Lake

Siddapura Lake

Bellandur Lake

Panathur Lake

Panathur Lake

Varthur Lake

Chikka Bellandur Lake

Nellurhalli Lake

Seemanthahalli Lake

Nellur Halli Lake

Varthur Lake

Immedihalli Lake

Bellandur Lake

Varthur Lake

Vallepura Lake

Site Appreciation - Condition of Water Bodies in Rajarajeshwarinagara Zone:

Kenchanahalli Lake

Kengeri Lake

Dore Kere

Uttarahalli Lake

Muddayanapalya Lake

Ullala Lake

Hosahalli Lake

Dubasipalya Lake

Subramanyapura Lake

Konnasandara Lake

Manchinkatte Lake

Mallathahalli Lake

Dandinapalya Lake

Hemmegipura Lake

2.5 ENVIRONMENTAL CONDITIONS:

Open parks, major waterways and water bodies that exist in the drainage catchment areas of study area are a significant amenity for flood protection. However, in recent times, due to lack of planning and rapid changes in the land use, these amenities have been largely ignored by various stakeholders, service providers and the public in general. In the recent history, there has been no comprehension for the development of primary storm water drainage system in the city by the authorities beyond the level of tertiary drains. As a consequence, the drainage system in the catchment areas has developed on an adhoc basis and now they have reached a saturation level and not in a position to prevent the low lying areas from inundation during heavy showers.

Further, there is much evidence that in areas outside the BBMP, the development authorities do not enforce and adopt even rudimentary practices for planning, construction and maintenance of storm water drains and they lack of resources and technical expertise to adopt best management practices for maintenance of storm drain.

Significantly, what is seen over a period is that, number of lakes/achukutu areas (which were acting as surplus discharge storage areas) existing in the catchment area have been filled up and converted into residential layouts. These areas otherwise would have acted as buffer zones for flood protection. The tank bed and its adjoining areas being the lowest point in the catchment area are always prone for flooding. To prevent flooding in such areas, it requires construction of new drains or expensive mechanical means of pumping arrangement. Therefore, in order to avert such expensive recurring problems & expenditures, it is very much essential to create awareness among public, public representatives and all concerned about the consequences of encroaching tank areas. Restoration of tank areas need to be taken on priority, which inturn would reduce the runoff and flooding problems in some of the adjoining low lying areas to a certain extent.

As is known, the storm water drain network in the study area flows through dense residential, commercial and few open areas of the zone. Due to inappropriate planning procedure adopted by the land use planners, the natural course of the drain is altered at many places and encroached. Further, the carrying capacity of drains is drastically reduced due to dumping of construction debris, municipal solid wastes and also discharging raw sewage into the drains thereby in turn causing siltation problems, inconvenience to the surrounding localities and threatening the health aspects of the communities residing in the close proximity of the waterway.

Although in many drainage basins of the study area, under ground sewerage system has been provided (except in few patchy areas). But, still large quantity of raw sewage is seen flowing in the drains and waterways. This is caused by a various reasons like, combination of wastes discharged from unsewered premises, lateral / sub main sewers not connected to the trunk sewers, and effluent from trunk sewers, which are under capacitated due to siltation or due to increased sewage from higher than planned development densities etc.

Even though the sewer lines exists, the sewer outlets from the toilets blocks of residential buildings in some of the localities are not connected to the sewerage system and they are discharging raw sewage directly into storm drains and inturn distracting the visual aesthetic amenity of waterway, causing odour problem, making the places favourable for mosquito breeding, causing substantial inconvenience to the populace of the surrounding localities, pedestrians and vehicular movement.

Since the topography in some of the catchment areas are undulating & sloping towards the drain and also due to improper solid waste collection and conveyance arrangement in the catchment, all the solid waste generated and the greasy liquid waste from industries & service stations, find their way into the storm drains, further all the floating materials gets clogged with the utility lines laid across storm drains and at culverts locations obstructing free flow of water and causing localized flooding problems and inturn pose substantial damage to both life and property.

The more extensive tertiary drains that exist are the key elements of the urban drainage system, but due to deficiencies in designs and maintenance practice, the tertiary drains do not exist in the entire catchment areas and where they exist they are not serving upto the intended level of service.

Further, another significant cause of frequent flooding of low-lying areas is due to development of new layouts near the receiving water bodies, below the HFL, large accumulation of sediments and vegetal growth that reduce the carrying capacity of the drains. Similarly, erosion control practices in construction sites, public parklands, private gardens and on the medians and verges of roads are not sufficient to control large silt loads reaching the main drains. These factors, combined with infrequent clearance of drains by concerned authorities, occasionally lead to unsanitary conditions in drains and further worsen the already aggravated situation.

BP183 Ch 550m

Waste water stagnation and solid waste accumulation in SWD

RN551B Ch 225 m, Thamanapa Layout

Dumping of Construction debries

DRAIN NO:MD334 CHAINAGE:620.0M
LOCATION: Kalappa Layout
Primary and secondary drains are joining at same bed level. Vegetation growth observed

DRAIN NO. BH576 CHAINAGE :225.0M
LOCATION :Near Ambedkar Colony
Due to insufficient bed gradient largequantity of sewage stagnation observed

DRAIN NO. DH 213 CHAINAGE :278.0M
LOCATION: Vidyanagara
Severely silted, large quantity of sewage flow observed

DRAIN NO. MD359 CHAINAGE :175.0M
LOCATION : Near Panathur-Varthur Road
Large quantity of garbage dumped inside water way,the area is used for garbage dumping

Development of slum area adjacent to SWD near Bandematta area, Kengeri

Hulimavu Kere, Bommanahalli Zone

Development of slum area adjacent to SWD near Varthur Kere,Mahadevapura Zone

Sadarmangala Kere, Mahadevpura Zone

2.6 WATER QUALITY:

The watershed catchment area within BBMP area is having the major problem of domestic sewage and sullage getting into storm water drains contributing to the pollution of the water bodies and the ground water and inaddition indiscriminate dumping of solidwaste in the storm water drains.

The water quality analysis results collected for previous core area SWD project depicts the water quality caracterisitcs of bore wells and open wells situated close to SWD in Hebbal valley catchment area in Byatarayanapura Zone are as follows,

Sampling locations

Hebbal Main Valley (H100):

Sample No. : 1
Source : Bore Well (Public hand pump)
Location : Near V. Nagenehalli Main Road Culvert location.
(situated close to open well).
Remarks : Well is situated about 50 m. from the storm drain, Bore well water is occasionally used by the public, casing pipe appears to be corroded, water level drops during peak summer.

Hebbal Main Valley – I (H200):

Sample No. : 2
Source : Open Well
Location : Balaji layout, near Nagashettyhalli main road.
(situated inside the compound of a Residential building).
Remarks : Well is situated about 70 m. from the storm drain, well water is used for domestic purpose by the owner and there is no such history of drain water entering into the well.

Sample No. : 3
Source : Bore Well (Power Pump) (Private well, recently sunk for construction purpose)
Location : Maruthi layout, near Nagashettyhalli main road.
(situated inside the compound of a Residential building).
Remarks : Well is situated about 150 m. from the storm drain, Bore well water is used for construction purpose.

Hebbal Minor Valley – I (H300)

Sample No. : 4
Source : Open Well
Location : at Hennur quarry cross road, near Gedalahalli main road.
(situated inside the compound of a private property).
Remarks : Well is situated about 300 m. from the storm drain, open well water is used for domestic purpose by the owner and there is no such history of drain water entering into the well.

Sample No. : 5
Source : Bore Well (Power pump) (Private well, sunk for gardening purpose)
Location : Christian missionary premises, near Gedalahalli main road.
(situated inside the compound of missionary premises).
Remarks : Well is situated about 150 m. from the storm drain, Borewell water is used for gardening purpose.

Analysis results of water samples described above are shown in **Table - 2.5**

Table - 2.5 Water Quality Analysis Results

Sl. No.	Constituents	Indian Standards Drinking Water Specifications: IS 10500:1991		Sample Nos.				
		Desirable limit	Permissible limit	1	2	3	4	5
A	**TYPE CATIONS**			Mg/l	Mg/l	Mg/l	Mg/l	Mg/l
1	Calcium (Ca)	75	200	82	181	75	104	96
2	Magnesium (Mg)	30	100	21	23	22	23	19
3	Sodium (Na)	-	-	85	113	56	152	67
4	Potassium (k)	-	-	0.6	0.2	0.1	0.6	0.3
5	Total Iron (Fe)	0.3	1.0	2.96	0.075	1.22	0.03	0.054
B	**TYPE ANIONS**							
1	Bicarbonate (HCO_3)	-	-	251	484	193	258	225
2	Carbonate (CO_3)	-	-	NIL	NIL	NIL	NIL	NIL
3	Chloride (Cl)	250	1000	154	218	137	252	162
4	Fluoride (F)	1.0	1.5	0.61	0.7	0.36	0.87	0.51
5	Nitrate (NO_3)	50	No Relaxation	0.4	0.3	0.77	15	0.9
6	Sulphate (SO_4)	200	400	51	83	45	101	42
C	**Total Dissolved Solids (TDS)**	500	2000	550	900	460	810	540
D	**Specific Conductance (Mnos/cm)**	-	-	950	1580	790	1360	920
E	**Total Hardness**	300	600	288	544	276	352	324
F	**P^H**	6.5 - 8.5	No Relaxation	7.13	7.78	6.84	7.57	7.07
G	**Bacteriological**							
1	**MPN Count**			180	180	180	180	180
2	**Plate Count**			-	-	-	-	-
3	**Differerential Coliform Test**			- ve	- ve	- ve	- ve	- ve

NOTE: Water quality analysis results as on 13/01/2005. Samples analysed in MGD lab and State PHI lab

Conclusion: Sample 1 & 3 – Iron content is more than the desired limit

Sample 2, 4 & 5 – TDS is more than the desired limit

- All 5 samples are not suitable for drinking purpose

Water Quality Analysis Results of Sewage Entering Malathahalli Kere in Rajarajeshwarinagara Zone

Sl. No.	Description	Water Quality
1.	Color	73.70
2.	Total Dissolved Solids, mg/l	794.00
3.	Nitrate Nitrogen, as N, mg/l	1.70
4.	Ammonical Nitrogen, as N, mg/l	31.80
5.	Total Kjeldhal Nitrogen, as N, mg/l	50.80
6.	Phosphates, as PO_4, mg/l	15.70
7.	Biochemical Oxygen Demand, mg/l (for 5 days at 20^O C)	180.00
8.	Chemical Oxygen Demand, mg/l	386.00
9.	Total Alkalinity, as $CaCO_3$, mg/L	533.00
10.	Phenolic compounds, as C_6H_5OH, mg/l	Absent
11.	Manganese, as Mn, mg/l	Nil
12.	Copper, as Cu, mg/l	Nil
13.	Fluoride, as F, mg/l	Nil
14.	Iron as Fe, mg/l	2.00
15.	Chromium, as Cr, mg/l	Nil
16.	Lead, as Pb, mg/l	Nil
17.	Selenium, as Se, mg/l	Nil
18.	Arsenic, as As, mg/l	Nil
19.	Mercury, as Hg, mg/l	Nil
20.	Zinc, as Zn, mg/l	0.18
21	Cadmium, as Cd, mg/l	Nil
22	Chlorophyll A, mg/m^3	Nil

Water Quality Analysis Results of Malathahalli Kere in Rajarajeshwarinagara Zone

Sl. No.	Description	Test results of Water sample from Mallathahalli Kere				Comparison to drinking water standards BIS Spe10500: 1991	
		Concentration, mg/L			Test protocol	Desirable limit	Maximum Permissible limit
		Inlet zone of lake	Middle of lake	Outlet zone of lake			
1	pH	8.76	9.05	8.96	IS:3025(P11)	6.5-8.5	6.5-8.5
2	Colour, True colour units	20.00	20.0	20.00	IS: 3025(P4)	5 Hazen units	25
3	Odour	Odourless	Odourless	Odourless	IS: 3025(P5)	unobjectionable	unobjectionable
4	Turbidity, NTU	9.10	8.90	9.60	IS: 3025(P10)	5	10
5	Total suspended solids, mg/L	52.00	40.00	44.00	IS:3025(P17)	<10	<50
6	Total dissolved solids, mg/L	884.00	452.00	504.00	IS:3025(P16)	500	2000
7	Chlorides, as Cl, mg/L	116.00	116.10	108.40	IS:3025(P32)	250	1000
8	Sulphates, as SO_4, mg/L	45.80	52.30	53.80	IS:3025(P24)	200	400
9	Oil & Grease, mg/L	<1.0	< 1.0	<1.0	IS:3025(P39)	Not specified	Not specified
10	Nitrate Nitrogen, as N, mg/L	0.38	0.84	0.86	IS:3025(P34)	NA	NA
11	Ammonical Nitrogen, as N, mg/L	<0.50	< 0.5	0.76	IS:3025(P34)	<0.05	Not specified
12	Total Kjeldhal Nitrogen, as N, mg/L	<1.0	<1.0	1.10	IS:3025(P34)	<1	<3
13	Nitrate, as NO_3, mg/L	1.70	3.70	3.80	IS:3025(P34)	45	100
14	Total Phosphates, as PO_4, mg/L	0.47 mg/L	0.37 mg/L	0.344 mg/L	IS:3025(P31)	<0.7	<1.0
15	BOD, mg/L (for 5 days at 20^OC)	13.40	7.00	3.30	IS:3025(P44)	<3	<5
16	COD, mg/L	72.00	42.50	21.20	APHA	Not specified	Not specified

Water Quality Analysis Results of Ullala Kere in Rajarajeshwarinagara Zone

Sl. No.	Description	Test results of Water sample from Ullalu Kere			Comparison to drinking water standards BIS Spe10500: 1991	
		Concentration, mg/L		Test protocol	Desirable limit	Maximum Permissible limit
		Middle of lake	Inlet zone of lake			
1	pH	7.71	7.95	IS:3025(P11)	6.5-8.5	6.5-8.5
2	Colour, True colour units	10.0	9.5	IS: 302 (P4)	5 Hazen units	25
3	Odour	Odourless	(no odour)	IS: 3025(P5)	unobjectionable	unobjectionable
4	Turbidity, NTU	0.4	1.1	IS: 3025(P10)	5	10
5	Total suspended solids, mg/L	16.0	-	IS:3025(P17)	<10	<50
6	Total dissolved solids, mg/L	182.0 (conductivity 227)	256.00	IS:3025(P6)	500	2000
7	Chlorides, as Cl, mg/L	15.5	35.70	IS:3025(P32)	250	1000
8	Sulphates, as SO_4, mg/L	1.4	10.80	IS:3025(P24)	200	400
9	Oil & Grease, mg/L	< 1.0	-	IS:3025(P39)	Not specified	Not specified
10	Nitrate Nitrogen, as N, mg/L	0.2	0.61	IS:3025(P34)	NA	NA
11	Ammonical Nitrogen, as N, mg/L	< 0.5	<0.50	IS:3025(P34)	<0.05	Not specified
12	Total Kjeldhal Nitrogen, as N, mg/L	1.1	<1.0	IS:3025(P34)	<1	<3
13	Nitrate, as NO_3, mg/L	0.91	2.70	IS:3025(P34)	45	100
14	Total Phosphates, as PO_4, mg/L	< 0.05	<0.05	IS:3025(P31)	<0.7	<1.0
15	BOD, mg/L (for 5 days at 20^{O} C)	< 1.0	Nil	IS:3025(P44)	<3	<5
16	COD, mg/L	21.2	2.10	APHA	Not specified	Not specified
17	Total Alkalinity, as $CaCO_3$, mg/L	129.6	208.00	IS:3025(P23)	200	800
18	Phenolic compounds, as C_6H_5OH, mg/L	Absent	Absent	IS: 3025(P43)	0.001	0.002
19	Total Hardness, as $CaCO_3$,mg/L	95.7	148.20	IS: 3025(P21)	300	600
20	Calcium, as Ca, mg/L	23.5	19.80	IS:3025(P40)	75	200
21	Magnesium, as Mg, mg/L	8.9	24.00	IS:3025(P46)	Not specified	Not specified
22	Sodium, as Na, mg/L	16.30		IS:3025(P45)	Not specified	Not specified
23	Manganese, as Mn, mg/L	< 0.1	Nil	35 of IS:3025	0.10	0.30

Water Quality Analysis Results of Kommagahatta Kere in Rajarajeshwarinagara Zone

Sl. No	Description	Test results of Water sample from Kommaghatta Kere				Comparison to drinking water standards BIS Spe10500: 1991	
		Concentration, mg/L			Test protocol	Desirable limit	Maximum Permissible limit
		Inlet zone of lake	Middle of lake	Outlet zone of lake			
1	pH	8.27	8.34	8.11	IS:3025(P1)	6.5-8.5	6.5-8.5
2	Colour, True colour units	10.0	10.00	10.00	IS: 3025(P4)	5 Hazen units	25
3	Odour	Odourless	Odourless	Odourless	IS: 3025(P5)	unobjectionable	unobjectionable
4	Turbidity, NTU	0.50	0.40	0.40	IS: 3025(P10)	5	10
5	Total suspended solids, mg/L	18.00	16.00	14.00	IS:3025(P17)	<10	<50
6	Total dissolved solids, mg/L	7.70	318.00	384.00	IS:3025(P16)	500	2000
7	Chlorides, as Cl, mg/L	58.00	54.20	58.00	IS:3025(P32)	250	1000
8	Sulphates, as SO_4, mg/L	19.70	23.80	23.30	IS:3025(P24)	200	400
9	Oil & Grease, mg/L	<1.0	< 1.0	<1.0	IS:3025(P39)	Not specified	Not specified
10	Nitrate Nitrogen, as N, mg/L	0.22	0.43	0.25	IS:3025(P34)	NA	NA
11	Ammonical Nitrogen, as N, mg/L	<0.50	< 0.5	<0.5	IS:3025(P34)	<0.05	Not specified
12	Total Kjeldhal Nitrogen, as N, mg/L	<1.0	<1.0	<1.0	IS:3025(P34)	<1	<3
13	Nitrate, as NO_3, mg/L	1.0	1.90	1.10	IS:3025(P34)	45	100
14	Total Phosphates, as PO_4, mg/L	<0.05 mg/L	<0.05 mg/L	<0.05 mg/L	IS:3025(P31)	<0.7	<1.0
15	BOD, mg/L (for 5 days at 20^{O} C)	<1.0	<1.0	1.10	IS:3025(P44)	<3	<5
16	COD, mg/L	8.50	21.20	17.00	APHA	Not specified	Not specified

Water Quality Analysis Results of Rachenahalli Kere in Yelahanka Zone

Sl. No.	Description	Test results of Water sample from Rachenahalli Kere			Comparison to drinking water standards BIS Spe10500: 1991	
		Concentration, mg/L		Test protocol	Desirable limit	Maximum Permissible limit
		Middle of lake	Inlet zone of lake			
1	pH	7.55	8.25	IS:3025(P11)	6.5-8.5	6.5-8.5
2	Colour, True colour units	9.0	10.5	IS: 302 (P4)	5 Hazen units	25
3	Odour	Odourless	Odourless	IS: 3025(P5)	unobjectionable	unobjectionable
4	Turbidity, NTU	0.5	1.2	IS: 3025(P10)	5	10
5	Total suspended solids, mg/L	18.0	-	IS:3025(P17)	<10	<50
6	Total dissolved solids, mg/L	160.0	316.00	IS:3025(P6)	500	2000
7	Chlorides, as Cl, mg/L	25.5	48.50	IS:3025(P32)	250	1000
8	Sulphates, as SO_4, mg/L	10.5	15.20	IS:3025(P24)	200	400
9	Oil & Grease, mg/L	< 1.0	< 1.0	IS:3025(P39)	Not specified	Not specified
10	Nitrate Nitrogen, as N, mg/L	0.23	0.58	IS:3025(P34)	NA	NA
11	Ammonical Nitrogen, as N, mg/L	< 0.5	<0.50	IS:3025(P34)	<0.05	Not specified
12	Total Kjeldhal Nitrogen, as N, mg/L	<1.0	<1.0	IS:3025(P34)	<1	<3
13	Nitrate, as NO_3, mg/L	0.98	2.95	IS:3025(P34)	45	100
14	Total Phosphates, as PO_4, mg/L	< 0.05	<0.05	IS:3025(P31)	<0.7	<1.0
15	BOD, mg/L (for 5 days at 20^{O} C)	5.85	1.85	IS:3025(P44)	<3	<5
16	COD, mg/L	28.4	9.58	APHA	Not specified	Not specified

As seen in above tables, the drain water is highly polluted with BOD of 180 mg/l, TKN 50.8 mg/l and Phosphate 15.7 mg/l. Entry of raw sewage with such high pollution levels has caused large scale pollution of the lake waters. This has resulted in depletion of oxygen level in lake water which has finally resulted in large scale fish kills in the past.

2.7 RELATIONSHIPS BETWEEN SOLID WASTE AND DRAINAGE

Until recent times, the relationship between solid waste materials and drainage system and its impact on the environmental attributes was not considered significant due to various reasons, even though the responsibility for both drainage and solid waste management in the study area lies with BBMP.

As observed during reconnaissance/condition survey, disposal of bio degradable and non degradable material into the drains is a common practice all along the drain and the associated factors that affect the functionality of the system as noted are explained hereunder.

The entry of house hold garbage, street sweepings and construction debris from the residential areas situated adjacent to drains directly into the drains affect free flow of water, reduces the aesthetic appearance, reduces the quality of environmental attributes in that region. Apart from affecting the flow, solid wastes have particular impact on the smaller tertiary drains, often obstructing flow completely, and causing short term localized flooding that can be especially dangerous to both pedestrians and vehicular movement. Further, to improve the situation in that region improvised method of solid waste collection and conveyance system, community awareness campaigns in these regions is most essential.

The data regarding solid waste management in Bengaluru are obtained from various agencies and reports are given below. The accuracy of the data needs to be verified. Details of collection and disposal are given in **Table 2.6.**

Table - 2.6 Solid Waste Generation

Sl. No	Zone	Population	Solid Waste Generation (Tons per Day)	Solid Waste Collection (Tons per Day)	Treatment/Disposal (Tons per Day)
1	Bengaluru East	18,77,635	1125	70%	1600
2	Bengaluru West	16,61,753	998	70%	
3	Bengaluru South	9,47,169	565	70%	
2	Yelahanka	4,61,934	185	40%	
3	Mahadevapura	5,19,663	210	40%	
4	Bommanahalli	4,31,867	175	40%	
5	R.R.Nagara	2,83,936	114	40%	
6	Dasarahalli	4,11,056	165	40%	

From the above, it is seen that there is a huge gap between solid waste generated and disposed. This may find its way to storm water drain and hamper the hydraulics and create an environmental problem which requires a serious consideration.

BP183, Ch. 700 m.
near Manyatha Tech Park, Mariyyanapalya
Accumulation of solid waste materials inside the SWD

BP155, Ch. 50 m.
Srinivasapura layout, near Kogilu
Street Sweepings finding its way into SWD

DRAIN NO. BH578 CHAINAGE :800.0M
LOCATION : Near Muniyappa Layout
Drain reach is in natural condition, large quantity of garbage observed and road level and drain invert level are in same level

DRAIN NO. BH614A CHAINAGE :360.0M
LOCATION :Near G.K Layout
Drain reach is in natural condition severely silted sewage staganation observed

DRAIN NO. DH 211,211A & B CHAINAGE :725.0M
LOCATION : Near TVS Cross
Large quantity of garbage dumped over culvert Location

DRAIN NO : DH 370 CHAINAGE :1025.0M
LOCATION : Hoysalanagara
Original alignment modified, drain reach is in natural condition, sewage stagnation is observed, building constructed inside water way

DRAIN NO : DH 368 CHAINAGE :400.0M
LOCATION : Near Herohalli Kere
Large quantity of garbage dump observed inside SWD

DRAIN NO. MD349 CHAINAGE :3900.0M
LOCATION : Marathalli Main Road
Large quantity of earth being dumped inside to raise the waterway

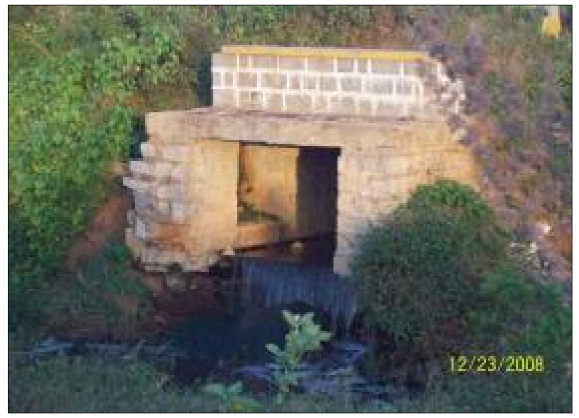
DRAIN NO. MD349 CHAINAGE :200.0M
LOCATION : Near Panathur-Varthur Road
Due to insufficient bed gradient large quantity of Sewage stagnation and weed growth observed

DRAIN NO. MD359 CHAINAGE :175.0M
LOCATION : Near Panathur-Varthur Road
Drain reach is in natural condition, vegetation growth observed, alignment not defined clearly.Large quantity of garbage dumped inside waterway.The area is used for garbage dumping.

DRAIN NO : MD264 CHAINAGE :1100.0M
LOCATION : Ramamurthy Nagar
Due to insufficient bed gradient sewage flow observed in the drain

DRAIN NO. RN181 CHAINAGE :8925.0M
LOCATION :Near Swami Narayana Gurukula Ashram
Drain reach is in natural condition, large quantity of sewage flow is observed, dumped debris Obstructing flow of water.

RN562 , Ch.950m 10th Cross Road, near Bhuvaneshwari nagara
Street Sweepings and Floating materials accumulated in SWD



DRAIN NO. RN 541 CHAINAGE : 2000.0M
LOCATION :Vishveswaraya layout
Due to non existence of sewer network,Raw sewage flow observed in SWD

LLA ID. MDLA089
LOCATION : Nethravathy Layout
RCC hume pipe laid across SWD is completely blocked and water stagnation
Observed due dumping of garbage inside swd

2.8 CONFLICTS BETWEEN SEWERS AND DRAINS:

At present in certain reaches sub mains / trunk sewers laid within drainage channels is occupying substantial cross sectional area of drain and causing hindrances for free flow of water.

Problems that arise from having sewers in drainage channels are numerous and include:

- Reduction in carrying capacity of drains due to space occupied by sewage flow.
- Restrictions on channel augmentation options
- Ready opportunities to relieve excess sewage into channels
- Need for parallel programming, close coordination, increased capital cost and requires skilled work force
- Due to entry of storm water, silt, debris and floating materials into sewerage system – pipelines and manholes gets choked and in turn results in sewage over flow into SWD.
- Due to obstructions created by pipelines and manholes in major SWDs. The functionality of the tertiary drain network gets affected and causes localised flooding problems especially in areas situated adjacent to major SWDs
- Due to corrosion effects, life of SWD assets gets reduced
- Sewage water surcharges of into residential dwelling units especially in low lying areas, due to blockage in pipelines and manholes.
- Water surcharges into residential buildings in low lying areas through sewer outlets, from those connected at bed level of SWDs.
- Sewer networks are not designed for combined flow, which in turn affects collection, conveyance and treatment process,
- Construction of manholes inside SWD cause accumulation of floating materials in SWD and in turn affects free flow of water.
- Sewer pipelines and manholes inside SWD affects routine maintenance process,
- Causes enormous delay and seriously affects SWD projects implementation programme
- Due to mixing of sewage with storm water, water quality in the receiving water bodies gets deteriorated and in turn affects fauna and flora.
- Causes mosquito menace, Odour problems, reduces aesthetic appearance of the citys environs and also reduces the land value adjacent to SWDs.
- Causes serious health problems in labours/workers engaged in SWD construction and maintenance works,

Rehabilitation of either service is proposed;

- Difficult access for sewer maintenance;
- Lack of access to sewers under lined inverts and cross drainage culvert
- Potential damage to the system from drain assets; and
- Poor construction due to difficult access and flow diversion problems.

Benefits are few and include:

- No need for separate sewer easement; and
- Relatively low excavation cost due to shallow depth.

All the above problems mentioned outweigh the benefits accrued in the study area and therefore urgent efforts are required to cleanse the entire system.

During reconnaissance survey and subsequent discussions with BWSSB, the detail of existing trunk sewers that are laid inside storm water drains and proposed to be laid inside SWD and along side SWD at different reaches under various schemes has been collected and the same is as given in the **Table - 2.7.**

Drain wise identification of sewer conflicts in this zone and the details thereof are shown in **FIG. SWD MP SS - 01,**

Table - 2.7 Details of Sewer Pipeline inside & along side Storm Water Drains

Sl. No.	Zone	Total Storm Water Drain Length (Kms.)	Sewer Pipeline Inside SWD (Km.)	Sewer Pipeline Alongside SWD (Km.)
1	East	225.00		
2	West			
3	South			
4	Rajarajeshwarinagara	147.48	34.33	4.35
5	Dasarahalli	89.00	8.93	4.15
6	Yelahanka	114.00	6.92	10.59
7	Mahadevapura	173.13	5.20	2.84
8	Bommanahalli	110.47	5.37	1.85
Total		**859.00**	**60.08**	**23.78**

2.8.1 East Core Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5.** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 1**.

2.8.2 West Core Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5**. Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 1**.

2.8.3 South Core Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5.** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 3**.

2.8.4 Bommanahalli Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5.** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 4**.

2.8.5 Yelahanka Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5.** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 5**.

2.8.6 Dasarahalli Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 6**.

2.8.7 Mahadevapura Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.5** Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 7**.

2.8.8 Raja Rajeshwari Nagara Zone

Drainwise identification of sewer conflict in this zone and the details thereof are given in **Table 2.6**. Locations are shown in **Fig.** SWD MP SS - 01**, Part 4, Appendix 8**.

DRAIN NO. BP161 (BY013) CHAINAGE :420.0 M
LOCATION : Near Yelahanka New town Bus stand
Sewer pipeline laying work inside SWD in progress
debris dumped on wet bed, pipeline with manhole
running longitudinally

DRAIN NO. BP161 (BY013) CHAINAGE: 1100 M
LOCATION :Near Alalsandra Kere
Open natural drain with large quantity of garbages/

DRAIN NO. BP176 CHAINAGE :1225.0M
LOCATION: Sahakara nagara (LHS of Bellary road)
Disused RCC pipes lying inside SWD and severely
Silted

DRAIN NO. BH577 CHAINAGE :25.0M
LOCATION: Near Hongasandra
Drain reach is in natural condition large quantity of
sewage stagnation observed

DRAIN NO. BH528 CHAINAGE: 1400.0M
LOCATION: Near Kammanahalli Main Road
Manhole constructed inside waterway is
Obstructing free flow of water

DRAIN NO. BH614 CHAINAGE: 525.0M
LOCATION: Parappana Agrahara
Drain reach is in natural condition width
Reduced, alignment modified, Manhole exists

DRAIN NO:MD331 CHAINAGE:675.0M
LOCATION: Near Vibuthipura Kere
Sewer outlet from residences directly
Connected to SWD

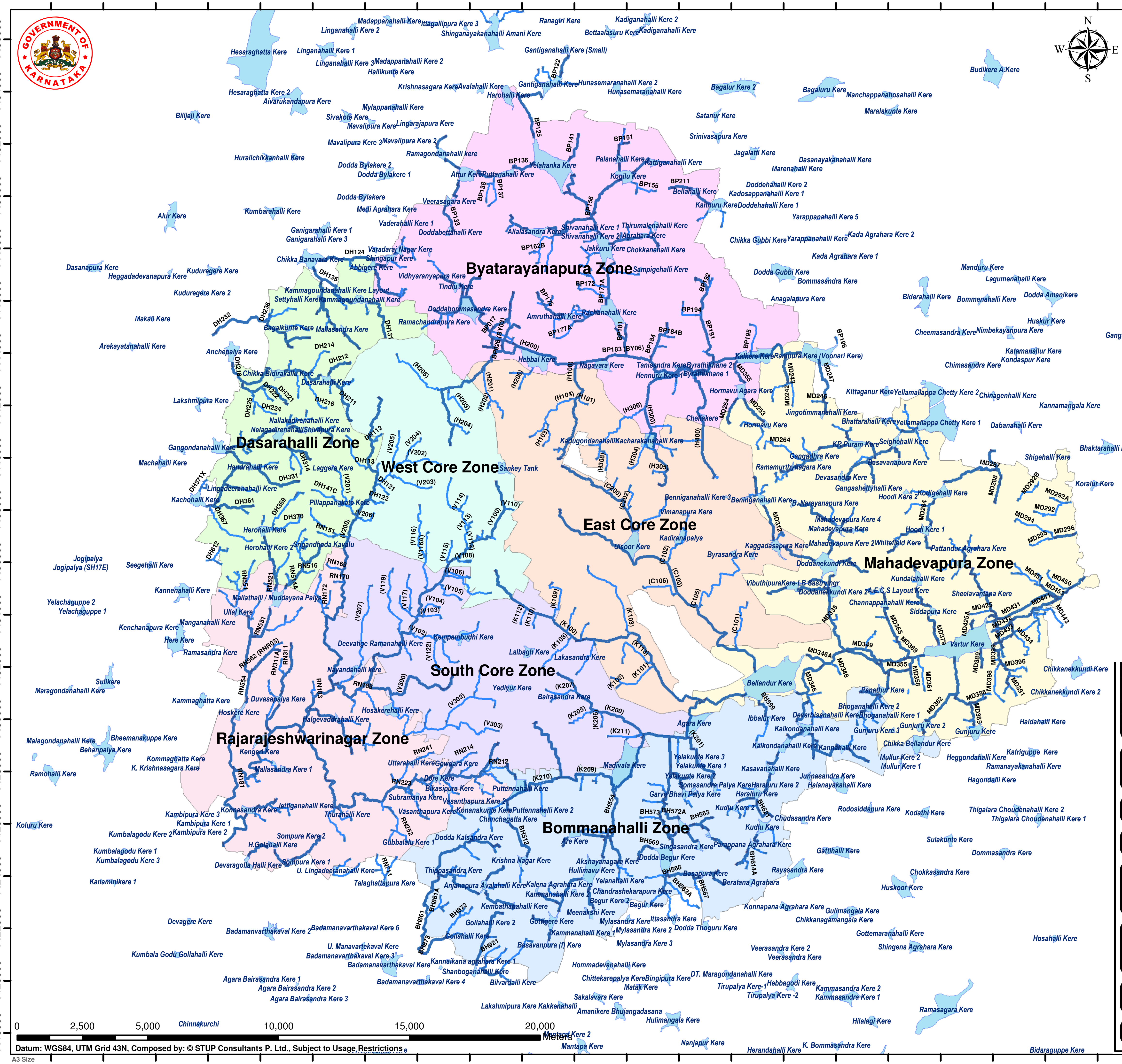
DRAIN NO. MD312 CHAINAGE : 975.0M
LOCATION : Nagara Palya,Benniganahalli
HDPE pipeline laid inside waterway above
bedlevel.

DRAIN NO. RN223 CHAINAGE :8225.0M
LOCATION: BEML Layout
Trunk sewer pipeline is laid across SWD,
i.e., exactly on bedline is obstructing free flow of
warer in turn causing water stagnation
on upstream side

DRAIN NO.RN562A(RNR03) CHAINAGE150M
LOCATION : Jnana Ganga nagara
Buildings constructed upto the edge of the drain
wall, sewer outlets from residential buildings
directly connected to SWD

LLA ID: MDLA084
LOCATION : Near Ashrama Road
Sanitary and water pipe lines laid across
SWD on upstream side

LLA ID: MDLA114
LOCATION : Near Abaya Reddy Layout, Vijnana Nagar
Large quantity of vegetation growth obsewrved inside
SWD Manhole laid inside the drain



Legend

Storm Water Drains Type

- Primary SWD
- Secondary SWD
- Water Bodies

BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: Bruhat Bengaluru Mahanagara Palike

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PREPARED: MNS (SDE)

PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

CHECKED: RSP (APC)

TITLE: **Map Showing Storm Water Drains of 8 BBMP Zones**

APPROVED: YDM (CC)

No. SWD-MP-SD-01 | REV R0 | JOB No.10331/E | SCALE AS SPECIFIED

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2.9 IMPACTS OF POOR STORM WATER DRAINAGE SYSTEM:

The importance of adequate storm water and wastewater drainage, in tandem with sufficient water supply, cannot be over emphasized, if full health benefits from provision of services are to be derived. Inadequate drainage causes inconvenience and losses to both life and property varying in nature ranging from:

i. Inundation of houses and establishments on the floodplains, caused by large scale “valley” flooding from overflow of primary and secondary drains.

ii. local area inundation and water stagnation in residential areas, caused by “local” drainage deficiencies and run-off from adjacent local catchments as in Badarappa layout, Devinagara, TATA nagara, Thannisandra, Mariyyanapalya, Govindapura, Vaddara Palya, Yelahanka New Town, Maruthinagara (Yelahanka), Attur layout, Someshwaranagara in Zone. Annapurneshwwarinagara, Vinayaka layout, Srihari layout, Mallathalli, Halagevadarahalli, Bikasipura, Subramanyapura, Illayas nagara in Rajarajeshwarinagara Zone. Near Abbigere layout, Bhuvaeshwarinagara, Hegganahalli, Bagalgunte in Dasarahalli Zone. Nisarga layout, Triveni nagara, Krishnanagara, RR layout, Pai layout, Kalappa layout in Mahadevapura zone. Kammanahalli, Hongasandra, Parappana Agrahara, Chikka Begur, Harinagara and Garave Bhavipalya in Bommanahalli Zone.

iii. Causes extensive damage to infrastructure works and in turn reduces the aesthetic appearance of the city & reduces the land cost adjacent to drains etc.

iv. Having high solid waste and sewage concentrations, the flood waters which inundate dwellings create particularly very objectionable conditions in catchment area.

v. The frequency and duration of flooding is relatively high in some of the locations, occurring usually during the southwest monsoon period, while valley flooding occurs several times per year in down stream areas. Under these latter conditions, poor drainage causes water stagnation and creates the surrounding area favourable for mosquitoe breeding and in turn leads to unsanitary conditions. Even the water quality in some of the bore wells that are dug adjacent to storm drains are polluted.

Water stagnation at the residential area
Location: Tanisandra, near Mariyannapalya

Residential building wall collapsed due to surcharging of water during heavy rains in the SWD

Water surcharged into residential areas
Location: Badarappa Layout, Zone

Condition of SWD, at Balaji Layout

Condition of SWD on upstream side of Rampura Kere, near Raja Canal STP at Zone

Condition of SWD, at Tannisandra

Vehicular Traffic disrupted due to water stagnation on the road
Location: Bengaluru - Mysore Road near Rajarajeshwarinagara

2.10 LOW LYING AREAS:

Critical low lying areas which are prone for flooding situated adjacent to storm water drains and also spread out in different parts of the zone have been identified in the entire zone. Identification of such locations has been done using terrain modelling in GIS and the same is cross verified during reconnaissance survey by a team of field engineers and prioritised to inform BBMP to takeup works to minimise flooding problems in such areas. Prioritization is done based on extent of water spread, no. of occurrences, depth of water stagnations, density of population, no. of people affected, criteria on economic loss, health issues etc..

Details on the areas affected, the frequency of flood occurrences, the impacts and the cause of flooding would all be relevant for an effective management of the drainage system, but such records are not kept in the past. During condition survey such information's has been collected from public as first hand information and has been considered during the evaluation of analysed results to improve the existing situation. Subsequently a team consisting of social survey experts and field engineers visited each and every location and conducted house hold survey and also had discussions with BBMP zonal engineers, stake holders departments like Police, BWSSB officials etc., to understand and collect information's on reasons for flooding, views of the public and officials on remedial measures possible / required, no. of properties affected, economic loss, health issues, action initiated by various agencies to minimise the flooding problems etc.

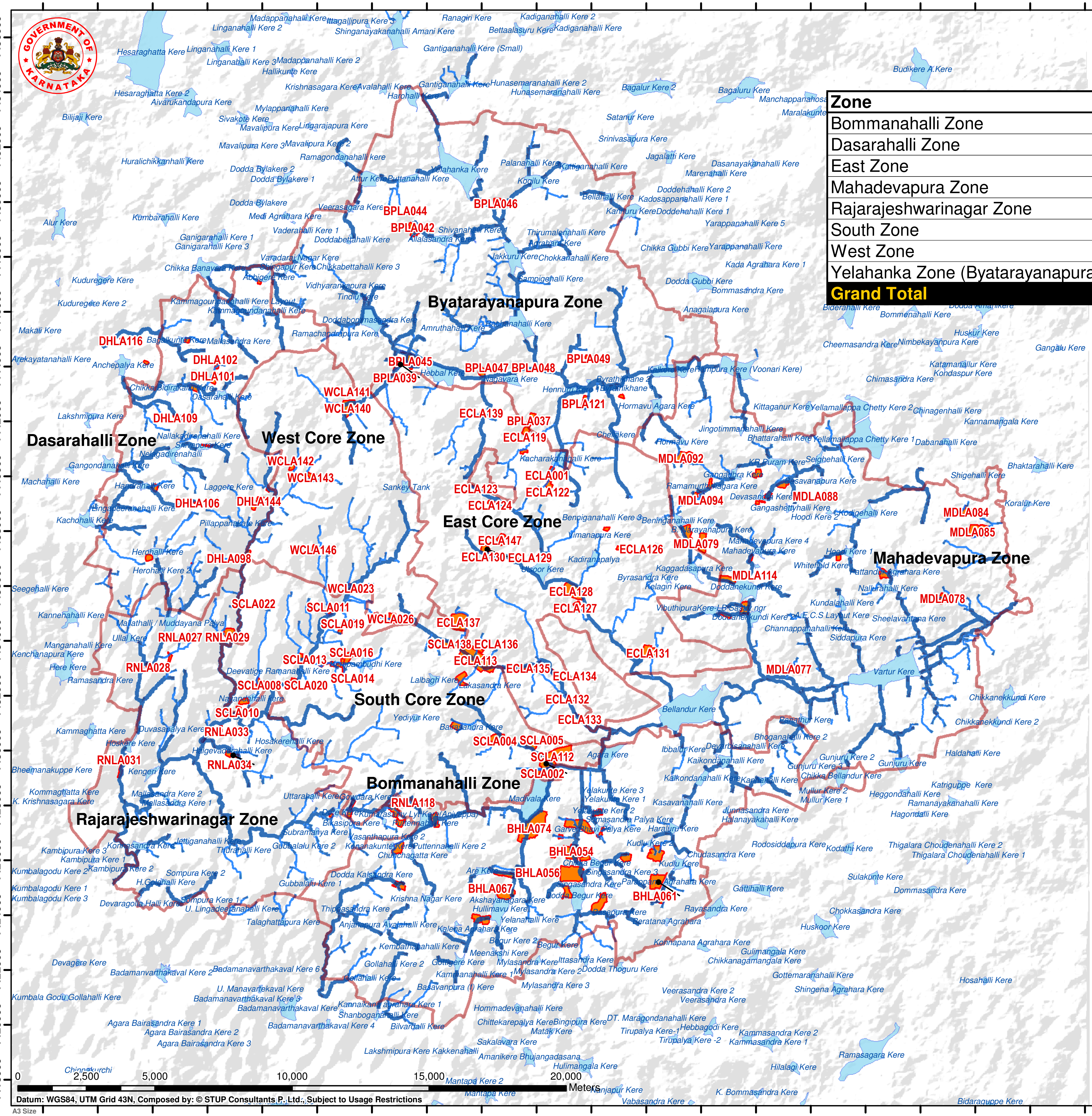
Each low lying area has been physically surveyed and mapped for its extent of water spread, duration of stagnation, depth of water impounding etc, have been collected, photographed. The details of which are given in **Table 2.8**. and the same is depicted in **Fig SWD MP-LLA-01.**

However, flooding problems in some of the low lying areas identified in the core area has been already resolved in the core area SWD project and the remaining areas situated in the study area are being addressed by BBMP.

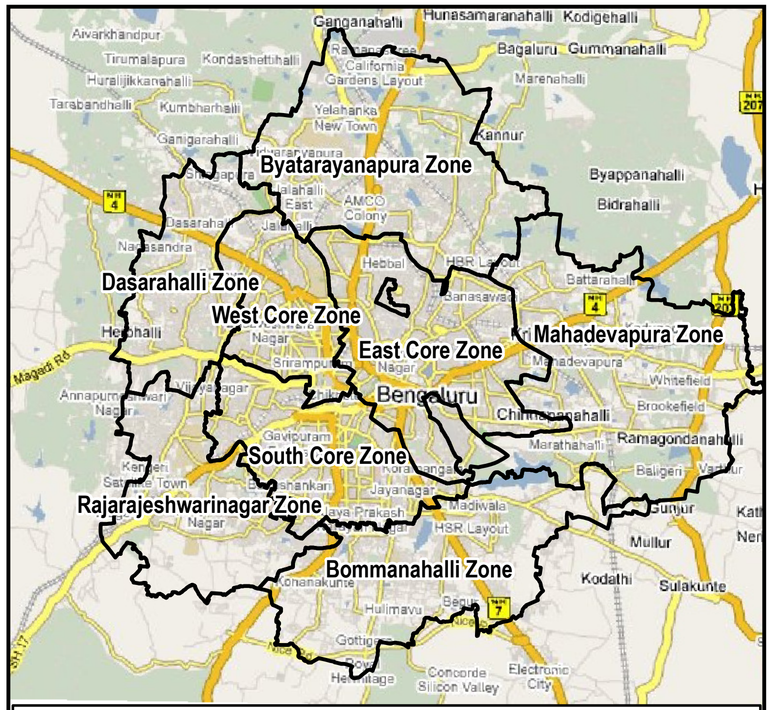
Table 2.8 Details of Low Lying areas in BBMP Aarea

Sl. No.	Zone	No of Locations (Nos.)
1	East	22
2	West	10
3	South	25
4	Rajarajeshwarinagara	11
5	Dasarahalli	17
6	Yelahanka	15
7	Mahadevapura	23
8	Bommanahalli	24
Total		**147**

Field Inventory in Critical Low Lying Areas
by Team of Construction Engineers & Social Survey Team



Zone	Count
Bommanahalli Zone	24
Dasarahalli Zone	17
East Zone	22
Mahadevapura Zone	23
Rajarajeshwarinagar Zone	11
South Zone	25
West Zone	10
Yelahanka Zone (Byatarayanapura)	15
Grand Total	**147**



Key Map

Legend

- BBMP Administrative Zones
- Primary SWD
- Secondary SWD
- Low Lying Areas
- Water Bodies

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

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OWNER: **Bruhat Bengaluru Mahanagara Palike**

DATE: August 2010

CONTRACTOR:

DRAWN: MNS (SDE)

PROJECT: **Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike**

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: **Critical Flood Prone Regions / Low Lying Area of 8 BBMP Zones**

APPROVED: YDM (CC)

No. SWD-MP-LLA-01 | REV R0 | JOB No. 10331/E | SCALE AS SPECIFIED

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2.10.1 SIGNIFICANT OBSERVATIONS IN CRITICAL LOW LYING AREAS:

During reconnaissance survey it is observed that in most of the cases the reasons for flooding were same. Which are as listed below:

- Inappropriate planning and design approach adopted in designing and constructing the drainage system in these areas by the erstwhile administration authorities.
- Blockage of drains in the down stream reaches by dumping debris for development of land.
- Drain reach not properly defined in the down stream reach (out let)
- Encroachment of water ways
- Sever siltation
- Drain width drastically reduced at many places
- Original drain alignment modification at many instances
- Large quantity of sewage flow in drains
- Dumping of garbage into SWD.
- Insufficient longitudinal bed gradient
- Lack of scope for providing drain improvement works.
- Inappropriate maintenance procedure adopted
- Construction of buildings below drain flood level.
- Closed drains
- Main drain and sub drain bed level meets at the same level
- Main drain with insufficient bed gradient, covered, severely silted takes sharp curves (90 degree bends) at many locations
- Stagnation of water on the down stream reach causing flow surcharging in main drain.
- Sewer outs from residential buildings directly connected to SWD.
- Siltation of water bodies

DRAIN NO: BP155 Ch. – 50m.
LOCATION:Srinivasapura, near Kogilu
Sewage flow in drain is occupying major portion of area Covered drain reaching, providing less scope

DRAIN NO: BP026 CHAINAGE: 100m.
LOCATION:BB Nagara, Kodegehalli
Covered drain reaching, providing less scope for drain improvement

DRAIN NO. BH614 CHAINAGE: 130.0M
LOCATION: Parappana Agrahara
Drain width is drastically reduced, building constructed inside the water way

DRAIN NO. BH528 CHAINAGE :1500.0M
LOCATION :Near Hulimavu Kere
Original alignment modified, waterway encroached building constructed inside waterway

DRAIN NO. MD349 CHAINAGE :2350.0M
LOCATION :Near Marathalli Main Road
Original alignment modified, width drastically Reduced.

DRAIN NO. MD313 CHAINAGE: 250.0 M
LOCATION: Kaggadasapura
Drain reach is covered with RCC slab by Apartment developers, width reduced

DRAIN NO: MD423 CHAINAGE:0.0M
LOCATION: Ramagondanahalli
Drain reach is in natural condition, vegetation growth observed, buildings constructed inside waterway

DRAIN NO. RN 553 CHAINAGE: 300.0M
LOCATION: Ambedkar Nagar
Original alignment modified, drain reach in natural condition,residential buildings constructed inside water way

DRAIN NO: RN541 CHAINAGE: 25 m.
LOCATION: 3rd Cross Road to Ring Road, Kengunte Village

DRAIN NO: RN562A (RNR03), CHAINAGE: 150 m
LOCATION: 8th Cross Main, Jnana Ganga Nagara
Water stagnation in the main drain at the outlet
Building constructed over the main drain location

2.11 BASE LINE SOCIAL SURVEY:

Baseline data together with data on social and environmental impact of flooding has been collected during condition survey to ascertain the level of service offered by the existing drainage system at various locations in the BBMP area. Details required for the formulation of schemes viz. areas affected, the frequency of flooding, the impacts and the cause of flooding, measure taken during flooding, extent of damage etc. has been collected from the residents residing in/near the low lying areas.

The Baseline survey provides the following statistics on the incidence, nature and possible cause of flooding:

- 15% of the household in catchment area reported that they faced instances of flooding.
- 10% of households of lower socio-economic status reported that they had faced flooding in the past decade-instances of flooding had been more common in the South Eastern, North Western parts of the zonal area.
- Of the house holds that had experienced flooding, 60% reported such occurrences in the last one year, 15% had experienced flooding in the year 2008, 15% during the period 2000 to 2008, while 10% reported that they had experienced flooding prior to 2000.
- Of the households that had experienced flooding, a majority said that the effects had lasted for one to three days, while 5 % said they had extended beyond a week.
- Two thirds of the households ascribed the reasons for flooding due to blockages in the sewerage system, 10% to ingress of rain water into the house, while 10% said that it had been caused by blocked drains or gutter and 5%due to encroachment of water ways.
- Lower income households and those living in the slums were more vulnerable to flooding caused by blocked drains; and
- All households reported damage to assets and loss of workdays on account of such flooding.

2.12 EXISTING OPERATION AND MAINTENANCE PRACTICE:

During November 2005 BBMP has set up a separate project implementation and management unit (PMU) for implementation of GOI approved, JnNURM funded, SWD projects for core area. Which is headed by Special Commissioner (Projects) followed by Chief Engineers and supported by other senior technical and accounts officers. The project management unit is responsible to identify and prepare projects, implement and maintain the system upto the level of primary and secondary drainage network, invite tenders, checking and recording measurements, conduct coordination meetings, prepare progress reports. Whereas, the existing tertiary drainage network situated in the respective zones is developed and maintained by concerned zonal engineering sections which in turn is supported by SWD unit.

The project management unit is implementing the storm water drain project approved by MoUD under JnNURM scheme since 2005. Which includes large scale program of desilting of all primary and secondary storm water drains in the four valleys of the core area, improving the carrying capacity by means of widening, deepening, wall raising, reconstruction of collapsed walls and strengthening the existing walls by providing pointing, coping concrete, formation of service roads, remodelling of culverts/bridges, development of drainage system in/near flood prone areas, construction of detention ponds etc.

However, some of the proposals indicated in the DPRs at strategic locations is yet to be implemented. Such proposals are there on the anvil of the PMU to implement once the encumbrances are cleared and work front is made available.

As per the directions of GOK, PMU has also taken up several drain improvement works at critical flood prone areas situated in the new zones of BBMP area especially in Rajarajeshwarinagara Zone, Krishnarajapura area in Mahadevapura Zone and Yelahanka Zone under special grant allocated by GOK to BBMP. The works takenup in these areas are nearing completion.

BBMP prepares projects and all the construction and maintenance works are outsourced on tender basis as per KTTP Act.

BBMP has set up emergency squads with truck mounted pumping arrangements, to be available round the clock. For each zone, emergency telephone connections have been setup to overcome any eventuality.

BBMP has also taken up projects like improvements of conservancies, foot paths, rejuvenation of parks, Swacha Bengaluru and Nirmala Bengaluru etc., this inturn has reduced the risk of accumulation of silt and solid waste at tertiary drain level to a certain extent and also in turn enhances the aesthetic appearance of the city.

Covering of tertiary / road side drains by pre cast slabs

Tertiary / road side drain wall construction at low lying area in RR nagara

2.13 DETAILS OF THE VALLEY PROJECTS

To improve the capacity of the drains and to minimize the flooding problems, various drain improvement measures suggested in the DPR included :

- Drain De-silting & deepening (250 Km.).
- Removal of bottle necks in the drain, due to encroachments.
- Widening & regarding of drains to have designed capacity.
- Reconstruction of inadequate vent way and structurally unsound Culverts / Bridges (115 nos.).
- Remedial measures to minimize localized flooding problems in low lying areas by construction of diversion drains, construction of RCC box drains etc.
- Reconstruction of collapsed & dilapidated SSM drain walls with either SSM / RCC walls.
- Relocation of pipelines, manholes & other service lines which are laid inside the drains and that are obstructing free flow of water.
- Lowering of rocky out crop noticed at several locations to improve the flow conditions.
- Modification / rerouting of drain alignments where necessary.
- Regradation of secondary/tertiary drain bed level to suit as per present primary drain bed levels.
- Diverting/plugging all sewer outlets discharging sewage directly into storm drains.
- Cavity filling, restoration of eroded stones, providing pointing and coping concrete to the existing drain walls
- Restoring available BS Slab bed & to provide CC bed lining wherever feasible to prevent weed growth & to increase the carrying capacity of the drain.
- Construction of new walls / stone revetment where drain banks are in natural condition in the tail ends / out side City limit.
- Formation of Service roads for routine maintenance and laying service lines.
- Provision for ground water recharging inside the drain to reduce the flood flow & ground water recharge once segregation of sewage achieved.
- Provision for construction of detention ponds in parks, open lands to reduce the flood flows etc. (107 nos.)
- Providing chain link fence & guard rails at strategic vulnerable locations to prevent dumping of garbage etc. and also to ensure safety of public.
- Construction of well with pumping arrangements.
- Setting up of vigilance squad to prevent debris dumping, encroachment of drains, local obstruction, such as, pipe crossing, construction inside the drain, any construction other than required for draining out the storm water.
- Encourage rain water harvesting in institutions, public parks, and open grounds.
- Lowering of manholes and relocating service lines.
- Community awareness campaigns
- Segregation of sewage from storm water drains must be taken up on priority.
- Comprehensive study of improving drainage network in agglomerated areas should be taken up on priority to protect the water bodies.
- Improvised solid waste management system should be taken up to improve environmental sanitation in the city.
- Modification/change in by law should be enforced to prevent development of land near the water ways/water bodies, encourage rainwater harvesting etc.

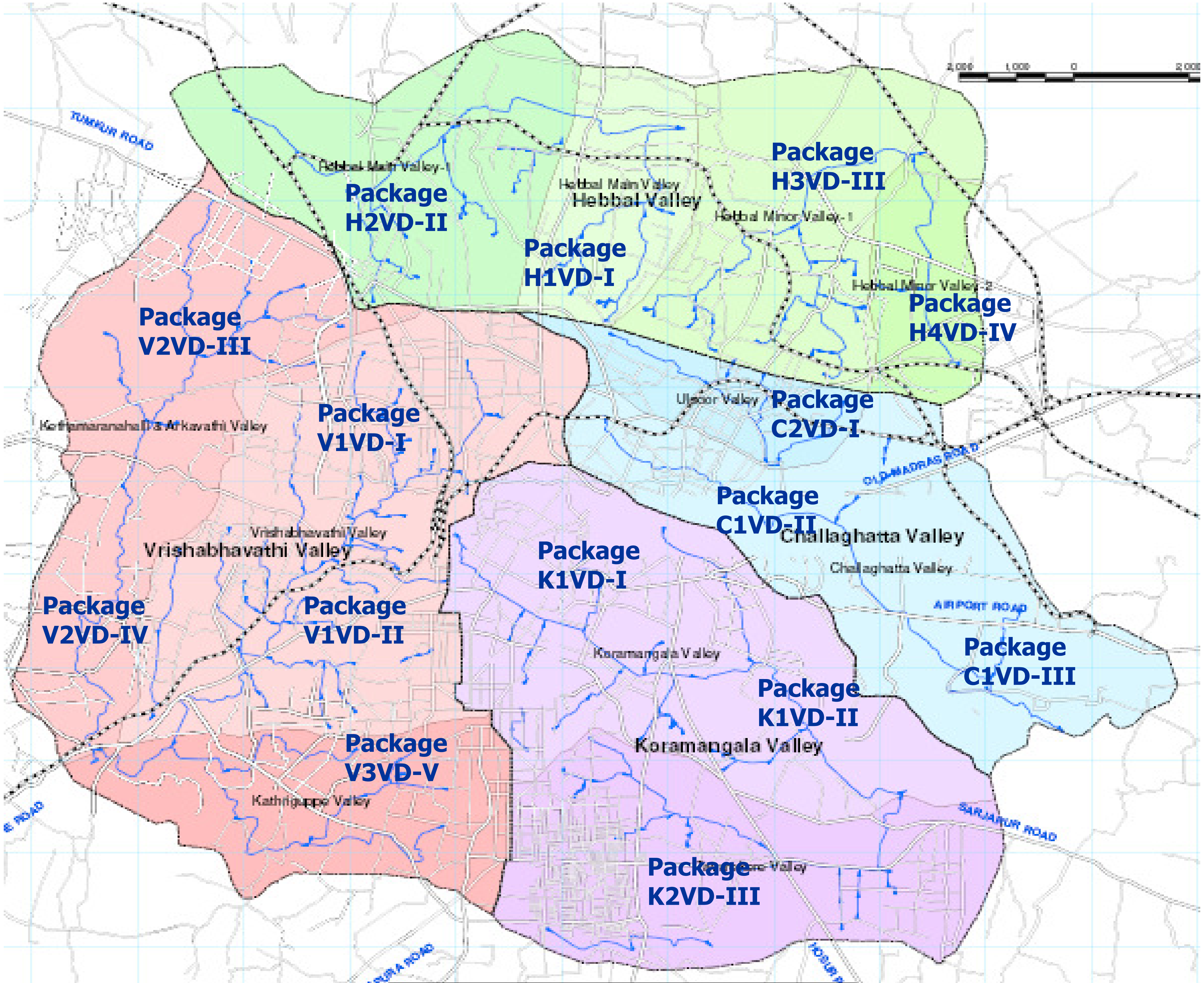
The works envisaged in all the four major catchment areas were grouped into 15 packages each costing about Rs. 20 to 25 Crores and tenders have been invited by BBMP as per KTPP act and works were awarded to different agencies.

The details of tender packages for all the 15 packages are as mentioned in the **Table– 2.9.**

Table – 2.9 Details of Core Area SWD Project Tender Package

Package No.	Particulars	Drain Length (mts.)	
		Primary	Secondary
Koramangala Valley			
K1VD – I	From Majestic Area upto Koramangala 80 ft. Road & its connected Secondary Storm Water Drains	6,600	22,186
K1VD – II	From Koramangala 80 ft. Road upto Bellandur tank & its connected Secondary Storm Water Drains	5,400	6,350
K1VD – III	From Bairasandra Extn., near NIMHANS Hospital upto Bellandur tank & its Connected Secondary Storm Water Drains	7,625	18,875
K1VD – IV	From Koramangala 80 ft. Road upto Bellandur tank via. ASC Centre Golf Course & Defence Dairy Farm Land	3,500	-
Challaghatta Valley			
C2VD – I	From J.C. Nagara, near Munireddypalya upto Ulsoor tank & its connected Secondary Storm Water Drains	4,100	5,425
C1VD – II	From Bengaluru Palace Grounds, near Vasanthanagara upto Airport Road & its connected Secondary Storm Water Drains	7,600	5,765
C1VD – III	From Airport Road upto Bellandur tank & its Connected Secondary Storm Water Drains	4,400	5,150
Hebbal Valley			
H1VD - I	From Matadahalli, near Munireddypalya upto Nagavara tank & its connected Secondary Storm Water Drains	4,425	4,800
H2VD – II	From Mysore lamp warks at Yeshwanthapura upto Hebbal tank & its connected Secondary Storm Water Drains	9,000	10,675
H3VD – III	From Jaibharathnagara, near Lingarajapura upto H.B.R. layout O.R.R. & its Connected Secondary Storm Water Drains	4,775	9,335
H4VD - IV	H300 – Primary drain from H.B.R. layout O.R.R. upto Raja Canal S.T.P. & its Connected Secondary Storm Water Drains & H400 – Primary drain from Banaswadi Main Road upto Raja Canal S.T.P. & its Connected Secondary Storm Water Drains	7,500	950
Vrishabhavathi Valley			
V1VD – I	From Sankey Tank, near Malleshwaram upto Gali Anjaneya Temple at Mysore Road & its connected Secondary Storm Water Drains	8,000	27,320
V2VD - II	From Gali Anjaneya Temple at Mysore Road upto Rajarajeshwarinagara at Mysore Road & its connected Secondary Storm Water Drains	6,000	4,050
V3VD - III	From Tumkur Road, near Peenya Industrial Area upto Magadi Main Road & its Connected Secondary Storm Water Drains	6,500	10,825
V4VD – IV	From Magadi Main Road upto Mysore Road & its Connected Secondary Storm Water Drains	6,800	3,850
V5VD – V	From Srinivasanagara Main Road upto B.W.S.S.B. S.T.P. at Mysore Road & its Connected Secondary Storm Water Drains	5,000	11,400

Note: drain length indicated includes low lying area improvement drains



Tender Package Details of Core Area SWD Project

The funding pattern proposed in the tool kit furnished by MoUD for JNNURM projects in Bengaluru is as follows;

Government of India Contribution – 35 %
Government of Karnataka Contribution – 15 %
Bruhat Bengaluru Mahanagara Palike Contribution – 50 %

Funding pattern under JNNURM scheme for Storm Water Drain Projects in Bengaluru is as mentioned in **Table – 2.10** below;

Table - 2.10 Funding Pattern as per JNNURM Guidelines for Remodeling of Storm Water Drain Project in Bengaluru City (Core Area)

Cost (Rs. In Crore)					
Funding Pattern	**Koramangala Valley**	**Challaghatta Valley**	**Hebbal Valley**	**Vrishabhavathi Valley**	***Total***
MoUD approved Cost (Rs. In Crore)	**111.49**	**118.57**	**184.74**	**228.26**	***643.06***
35 % GOI Grant	39.02	41.50	64.66	79.89	***225.07***
15 % GOK Grant	16.72	17.79	27.71	34.24	***96.46***
50 % ULB/BBMP Fund	55.75	59.29	92.37	114.13	***321.53***
Total	**111.49**	**118.57**	**184.74**	**228.26**	***643.06***

The project was approved by MoUD under JNNURM during November 2006 for **Rs. 643.06 Crores** considering 2006-07 price level. BBMP has commenced the project in the year 2006 and achieved **41.24 %** of financial progress (as on July 2009).

BBMP has issued several notices and also levied penalty to the agencies; those are giving less progress and not performing as per contract agreement. In view of this BBMP has also taken initiative to withdraw some of the works from the main packages in all the valleys and these works are takenup as additional works.

The works which were withdrawn from the main packages are retendered and about 99 Works are completed and about 175 are in progress and 218 nos. are awaiting approval from competent authority, which are essential to achieve physical and financial progress and also to improve environmental sanitation conditions in the city.

2.13.1 Core Area SWD Project Implementation Details:

The works envisaged in all the four major valleyes has been grouped into 15 packages and works entrusted to different agencies. As per the details furnished by BBMP, the below listed works has been takenup and completed under the project; which in turn has yielded substantial relief in flood affected areas and attained the satisfaction of the beneficiaries.

Current study takes into consideration the status of works as of the present.

The nature of works envisaged in the original proposals and as executed at site viz., length of drain desilting, drain widening with RCC walls, masonry walls, earthen bund formation with stone revetment, existing wall restoration, wall raising, bed protection, chain link fencing, service road formation, culvert/bridge remodeling, detention ponds etc., is as mentioned in the statement of works enclosed as

2.13.2 Vrishbhavathy Valley:

The primary and secondary SWDs in the entire Vrishabhavathi valley has been remodelled under the core area SWD remodelling project takenup by BBMP.

The works envisaged in Vrishabhavathi valley has been grouped into five packages and works entrusted to different agencies. As per the details furnished by BBMP the below listed works has been takenup and completed under the project; which in turn has yielded substantial relief in flood affected areas and attained the satisfaction of the beneficiaries in the catchment area.

- Desilting of entire length of SWD except few secondary SWDs and covered reaches
- Providing chain link fence along side SWD at vulnerable locations to prevent dumping of garbage/debris into SWD.
- Construction of RCC box SWD drain from Bull Temple Road upto Kempambudhi Kere.
- Construction of RCC box SWD drain from Samerapura near Bull Temple Road upto Kempambudhi Kere.
- Construction of RCC box SWD drain from Nayanadahalli Kere outlet weir upto Vrishabhavathi valley along Mysore Road near Rajarajeshwarinagara Arch.
- Construction of RCC drain wall from Srinagara bus stand upto Kalidasa layout.
- Construction of RCC drain wall from Magadi Road upto Manuvana near Vijayanagara.
- Lowering of rocky outcrop near Mysore road for drain bed regradation
- Construction of overflow weir near Mysore Road Ring Road Junction for collection of silt
- Shifting of service lines, which were causing obstruction to flow of water.
- Providing rehabilitation works to existing masonry walls,
- Reconstruction of collapsed & dilapidated drain walls has been takenup at several locations
- The Vrishabhavathi main valley primary drain widening work and RCC retaining walls construction in the drain reaches near JakkarayanaKere, Okalipura railway bridge, Telecom layout, Adjacent to Gali Anjaneya Temple, Mysore Road - Ring Road Junction.
- Kethamaranahalli & Arkavathi valley primary SWD widening work and RCC retaining walls construction in the dran reachs near Kempegowdanagara, Laggere, Lakshmidevinagara, Nandhini layout, Annapurnaeshwarinagara, J.C. Nagara, Kamalanagara, Kurabarahalli, Kamakashipalya, Summanahalli, Panchasheelanagara, Pategarapalya, Nagarabhavi 3rd stage, Malagala, Mudalapalya, NGEF layout, Mysore Road junction.
- Kathriguppe valley primary SWD widening work and RCC retaining walls construction in the dran reachs near Banashankari 2nd Stage, Chikkalsandra, Kamakaya layout, Ittamadu, HosaKerehalli, Desouzanagara, Pushpagirinagara, Behind BWSSB STP.
- Remodeling of inadequate vent size and structurally unsound culverts/bridges near Ramachandrapura, Mariyappanapalya, Rajiv Gandhi circle, Sheshadripura Pipline road, Guddadahalli pipeline road, J.C. Nagara, Kamalanagara, Mudalapalya, Kadarenahalli, Kaverinagara, Metro layout near Nayanadahalli.
- As per the directions of Honourable High Court, drain desilting, widening and construction of RCC drain wall along side Mysore Road, near Mailsandra has been takenup. However, the project cost has been funded jointly by Urban Development Department, BBMP and BWSSB.

However due to various reasons, BBMP has not been able to takeup some of the critical / important proposals suggested in the original DPRs, viz.,

- Remodelling of culvert/bridges in M.K.K. Road Prakashanagara, Banashankari 2nd stage Ring Road etc.
- Construction of pilot drain near Padarayanapura,
- Drain widening and deepening to the required proposed bed level near Mysore road,
- Desilting of covered drain reaches in dense builtup areas,
- Providing steel gratings in covered drain reaches for surface flow to enter into SWD.
- Implementation of bed protection works,
- Formation of service roads for routine maintenance of drains,
- Construction of detention ponds in open parks/land,
- Construction of diversion drains,
- Segregation of sewage flow from SWD and lowering of high raised manholes,
- Conducting public awareness campaigns,
- Removal of encroachments / buildings constructed inside waterway,
- Procurement of additional land required for drain widening and other remodelling works,
- Need for adoption of holistic approach in planning and construction methodology.

2.13.3 Koramangala Valley

The primary and secondary SWDs in the entire Koramangala valley has been remodelled under the core area SWD remodelling project takenup by BBMP.

The works envisaged in Koramangala valley has been grouped into three packages and works entrusted to different agencies. As per the details furnished by BBMP the below listed works has been takenup and completed under the project; which in turn has yielded substantial relief in flood affected areas and attained the satisfaction of the beneficiaries in the catchment area.

- Desilting of entire length of SWD except few secondary SWDs and covered reaches
- Providing chain link fence along side SWD at vulnerable locations to prevent dumping of garbage/debris into SWD.
- Construction of RCC box SWD drain near Shanthinagara.
- Construction of RCC box SWD drain near Vinayakanagara.
- Construction of RCC box SWD drain at Venkata reddy layout, near Lalbagh Siddapura.
- Construction of RCC box SWD drain near Dollara colony
- Construction of twin cell RCC box SWD drain near Rank Apartments, Bilakalahalli, Bannergahatta road, Madivala.
- Construction of RCC drain wall near Sudhamanagara, Shanthinagara bus stand K.H. Double Road.
- Construction of RCC drain wall from Shoppers Stop upto Victoria Road
- Shifting of service lines, which were causing obstruction to flow of water.
- Providing rehabilitation works to existing masonry walls,
- Reconstruction of collapsed & dilapidated drain walls has been takenup at several locations.
- The Koramangala main valley primary drain widening work and RCC retaining walls construction in the drain reaches near Hosmat hospital, Austin town, Ejipura, Koramangala, Rajendranagara, S.T. Bed, Jakkasandra,
- The Koramangala main valley primary drain widening work, formation of embankment and side revetment near Shanthinagara housing society at Jakkasandra upto Bellandur Kere.
- TavareKere valley primary SWD widening work and RCC retaining walls construction in the drain reaches near HSR layout - Silk Board Junction, BTM layout, Madivala, J.P. Nagara, Bismillanagara, Bairasandra
- Remodeling of inadequate vent size and structurally unsound culverts/bridges near Victoria Road, Austin Town, Rajendranagara Slum, Maruthinagara, BTM layout

However due to various reasons, BBMP has not been able to takeup some of the critical / important proposals suggested in the original DPRs, viz.,

- Remodelling of culvert/bridges across K.H. Double Road, Journalist colony, J.C. Road, Bannerghatta Road, ORC Road, etc.
- Construction of diversion drain near Ejipura – ASC Centre Defence land,
- Parallel drain on Koramangala 80 ft. Road, Silk Board Junction
- Drain widening and deepening to the required proposed bed level near Double road.
- Desilting of covered drain reaches in dense builtup areas,
- Providing steel gratings in covered drain reaches for surface flow to enter into SWD.
- Implementation of bed protection works,
- Formation of service roads for routine maintenance of drains,
- Construction of detention ponds in open parks/land,
- Segregation of sewage flow from SWD and lowering of high raised manholes,
- Conducting public awareness campaigns,
- Removal of encroachments / buildings constructed inside waterway, J.C. Road
- Procurement of additional land required for drain widening and other remodelling works,
- Need for adoption of holistic approach in planning and construction methodology.

2.13.4 Challagatta Valley

The primary and secondary SWDs in the entire Challaghatta valley has been remodelled under the core area SWD remodelling project takenup by BBMP.

The works envisaged in Challaghatta valley has been grouped into three packages and works entrusted to different agencies. As per the details furnished by BBMP the below listed works has been takenup and completed under the project; which in turn has yielded substantial relief in flood affected areas and attained the satisfaction of the beneficiaries In the Catchment area.

- Desilting of entire length of SWD except few secondary SWDs and covered reaches
- Providing chain link fence along side SWD at vulnerable locations to prevent dumping of garbage/debris into SWD.
- Construction of RCC box SWD drain near Vasanthanagara, Dobhi Ghat, Shivajinagara.
- Construction of RCC drain wall near Vasanthanagara, Mahaveer Jain Hospital, St. Johns Road, Ulsoor Kere, Cambridge layout, Airport Road flyover location, inside HAL airport
- Shifting of service lines, which were causing obstruction to flow of water.
- Providing rehabilitation works to existing masonry walls,
- Reconstruction of collapsed & dilapidated drain walls has been takenup at several locations
- The Challaghatta main valley primary drain widening work, formation of embankment and side revetment near Challaghatta Village upto Bellandur Kere.
- Ulsoor valley primary SWD widening work and masonry retaining walls construction in the drain reaches near MEG Centre.
- Remodeling of inadequate vent size and structurally unsound culverts/bridges near Millers tank bund road, St. Johns Road, Wind Tunnel Road, Opp. Ulsoor Kere view Sri. Ganapathi temple, pottery town.
- Desilting and bed regradation below Gurudwara bridge location.
- Construction of drain near Bandappa colony, Chinnappa garden
- Drain widening and construction of masonry drain wall inside HAL Airport
- Construction of RCC Box drain near K.R. Garden, RCC U shape drain wall near Murgeshpalya.
- Drain improvement works near Domulur layout, Thippasandra, Jeevanbhimanagara, burial ground etc.

However due to various reasons, BBMP has not been able to takeup some of the critical / important proposals suggested in the original DPRs, viz.,

- Remodelling of culvert/bridges across Millers Road, Charminar Masjid Road, ASM Mudaliar Road near Shivajinagara area etc.
- Drain widening and deepening to the required proposed bed level near Shivajinagara, Ulsoor Kere, Gurudwara.
- Drain widening and construction of diversion drain inside KGA Golf Club
- Desilting of covered drain reaches in dense builtup areas,
- Providing steel gratings in covered drain reaches for surface flow to enter into SWD.
- Implementation of bed protection works,
- Formation of service roads for routine maintenance of drains,
- Construction of detention ponds in open parks/land,
- Segregation of sewage flow from SWD and lowering of high raised manholes,
- Conducting public awareness campaigns,
- Drain improvement works near Muniswamappa layout, Murgeshpalya
- Procurement of additional land required for drain widening and other remodelling works,
- Need for adoption of holistic approach in planning and construction methodology.

2.13.5 Hebbal Valley:

The primary and secondary SWDs in the entire Hebbal valley has been remodelled under the core area SWD remodelling project takenup by BBMP.

The works envisaged in Hebbal valley has been grouped into four packages and works entrusted to different agencies. As per the details furnished by BBMP the below listed works has been takenup and completed under the project; which in turn has yielded substantial relief in flood affected areas and attained the satisfaction of the beneficiaries in the catchment area.

- Desilting of entire length of SWD except few secondary SWDs and covered reaches
- Providing chain link fence along side SWD at vulnerable locations to prevent dumping of garbage/debris into SWD.
- Construction of RCC box SWD drain near Nagawara Main Road, HBR layout 80 ft. Road, Doddannanagara, Sanjayanagara - Central Excise Layout.
- Construction of U Shape RCC drain wall near Sanjeevappa garden, RMV Extn., Badrappa layout, Devinagara main road, Balaji layout, Cheeranjeevi layout, Cholanayakanahalli, Lingarajapura, HBR layout, Ambedkar Medical College Campus, Kadugondanahalli railway track area
- Shifting of service lines, which were causing obstruction to flow of water.
- Providing rehabilitation works to existing masonry walls,
- Reconstruction of collapsed & dilapidated drain walls has been takenup at several locations
- The Hebbal main valley primary drain widening work, formation of embankment and side revetment near HBR layout upto Hennuru Road
- Drain widening work near Hebbal tank, Nagawara tank down stream (Mariyyananapalya), Thannisandra, Gedalahalli, Raja Canal STP area, Drain reach between KalKere Kere to Rampura Kere.
- Remodeling of inadequate vent size and structurally unsound culverts/bridges near Munivenkatappa block, Yogeshnagara, Anandanagara, Sanjeevappa garden, RMV Extn., RMV Extn. – Sterling Apartments, Devinagara Main Road, Nagashettyhalli main road, Balaji layout, Bupasandra main road, Arabic college, Hennur Main Road - Gedalahalli

However due to various reasons, BBMP has not been able to takeup some of the critical / important proposals suggested in the original DPRs, viz,

- Widening of existing railway culvert near Hennur Road by box pushing technology.
- Construction of RCC culvert across ORR near BWSSB STP, Hebbal
- Drain widening and deepening to the required proposed bed level near Defence dairy farm land.
- Desilting of covered drain reaches in dense builtup areas,
- Providing steel gratings in covered drain reaches for surface flow to enter into SWD.
- Implementation of bed protection works,
- Formation of service roads for routine maintenance of drains,
- Construction of detention ponds in open parks/land,
- Segregation of sewage flow from SWD and lowering of high raised manholes,
- Conducting public awareness campaigns,
- Procurement of additional land required for drain widening and other remodelling works,
- Need for adoption of holistic approach in planning and construction methodology.

During reconnaissance survey, it is learnt that BBMP has modified the original proposals at certain locations due to various reasons, which has resulted in substantial variations in the project cost and implementation programme.

From the above facts, it can be observed that the balance works as proposed in the original DPRs are yet to be completed to improve the service level of drainage system in the city.

The quantum of works executed at site as against the proposals mentioned in the DPRs valley wise is as mentioned in the **Table - 2.11** below;

Table – 2.11 Comparision of Works Proposed and Executed at site in SWD Project at Bengaluru

Sl. No.	Nature of Works	Unit	Total Quantum of Work (As Per DPR)	Total Quantum of Work (As Executed At Site)
			(Package 1 - 15)	
1	**Drain Widening**			
a	RCC Walls	Rmt.	*33,495*	*28,837*
b	RCC Hume Pipe Drain (m.)	Rmt.	*0*	*0*
c	Earthwork	Rmt.	*0*	*15,010*
d	Pre Cast RCC Box With Road	Rmt.	*0*	*4,809*
e	Masonry Walls	Rmt.	*2,655*	*19,686*
f	Stone Revetment lining	Rmt.	*47,170*	*7,640*
2	**Desilting & Deepening**	Rmt.	*192,898*	*147,140*
3	**Existing masonry wall raising**	Rmt.	*7,550*	*6,661*
4	**Bed protection works**	Rmt.	*167,155*	*63,549*
	OGEE Spillway	Nos.	*0*	*1*
5	**Reconstruction of existing deliapted walls**			
a	RCC Walls	Rmt.	*4,667*	*31,623*
b	Masonry Walls	Rmt.	*2,455*	*28,144*
6	**RCC Box Drain**		*4,240*	*8,325*
a	RCC Cover Slab	Rmt.	*0*	*75*
b	Box Drain using Precast Elements	Rmt.	*0*	*0*
7	**Restoration of Ex. Masonry walls**	Rmt.	*118,548*	*20,101*
8	**Service Road formation**	Rmt.	*33,575*	*0*
9	**Culverts/Bridges**	Nos.	*130*	*100*
10	**Chain link fencing**	Rmt.	*0*	*14,475*
11	**Installation of Trash Barriers**	Nos.	*0*	*0*
12	**Detention Ponds**	Nos.	*0*	*0*
13	**Improvement of Drains In Low Lying Areas**	Nos.	*0*	*0*
14	**Procurement Of Desilting Machine**	Nos.	*3*	*0*
15	**Utility shifting**	LS	*0*	*500*
16	**Traffic Diversion**	LS	*0*	*0*
17	**Laying RCC Sewer Pipeline**	Rmt.	*0*	*2,000*
18	**Construction of mini STP's**	Nos.	*0*	*20*

CHAPTER - 3

EXISTING DRAINAGE SYSTEM

3.0 INTRODUCTION

The natural topographic of project area within BBMP boundary is undulating in nature. Depending upon topographic features the study area is demarcated into major and minor water shed catchment areas. Demarcation of these water shed catchment areas is done using available contour maps and Arc view GIS software.

All the outfalls from each of these water shed regions ultimately flows either into the major water bodies that exist in the respective water shed region or directly join the river coarse i.e., Vrishabhavathi river to the South, tributary of Pinakani & Pennar river to the East.

Irrespective of demarcation of administrative zone boundaries, the drainage catchment boundary is independent. For study of storm drains entire contributory drainage catchment area is considered. In addition to primary and secondary drains there are tertiary drainage network which are street drains and these drains do not form part of this study.

3.1 WATER SHED AREAS:

In the present initiative the entire study area is demarcated into different water shed regions in order to have a comprehensive approach in providing solutions and also to help in prioritising the works in the respective zones.

The details of major and minor water shed catchment areas of Bangalore is as mentioned in **Table – 3.1** and base map showing major and minor water shed catchment boundaries are shown in **Fig. SWD MP WS – 01**.

Table – 3.1 Details of Major & Minor Water Shed Catchment Areas

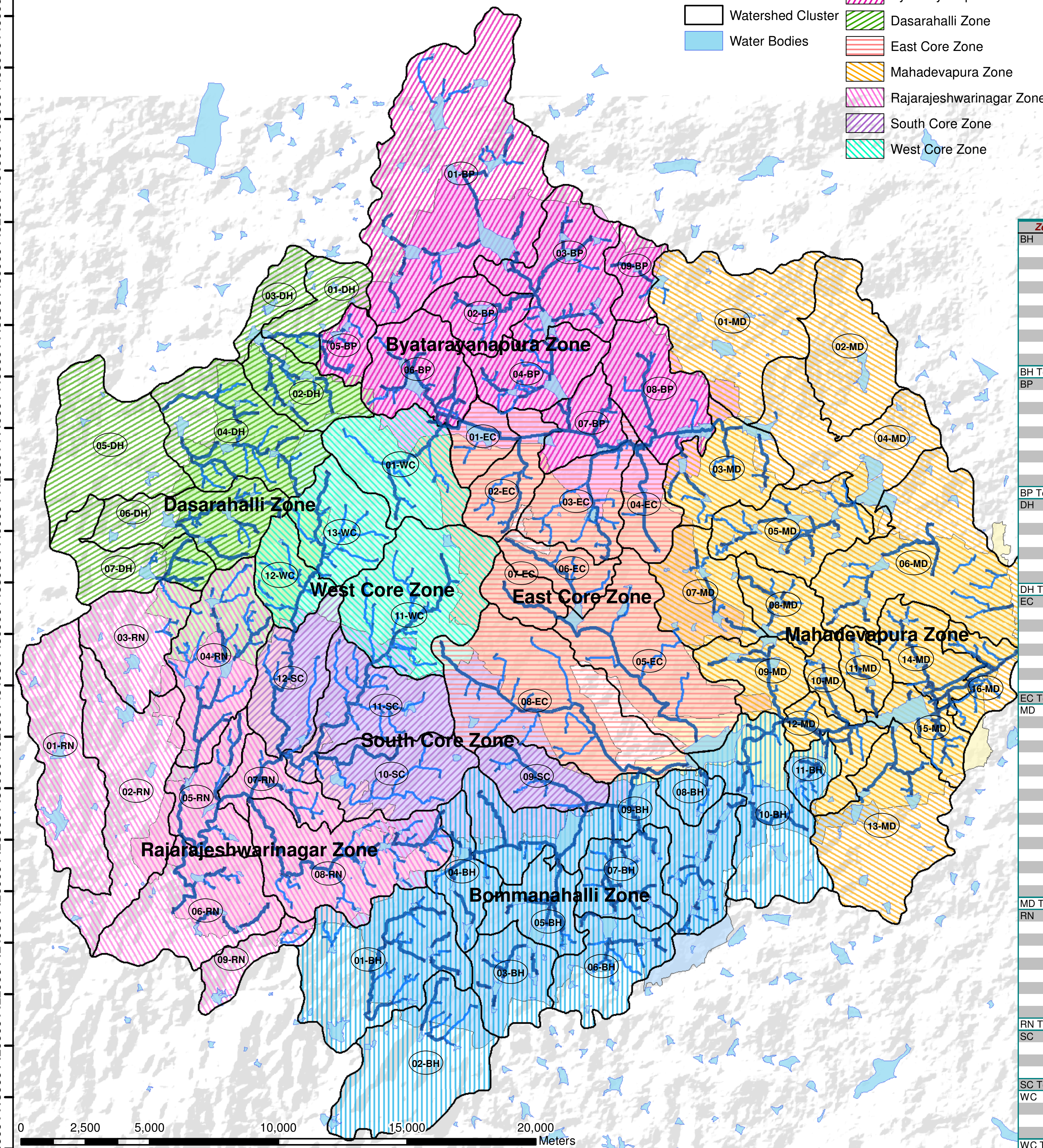
Sl. No.	Zone	Total Water Shed Catchment Area (Ha.)	No. of Major Water Shed Catchment Areas	No. of Minor Water Shed Catchment Areas	Total Drain Length (Km.)
1	East Zone	10,937	8	134	227.31
2	West Zone	6,366	4	87	
3	South Zone	5,553	4	69	
4	Rajarajeshwarinagara Zone	15,365	9	118	144.75
5	Dasarahalli Zone	9,505	7	94	89.24
6	Byatarayanapura Zone	14,235	9	129	113.85
7	Mahadevapura Zone	23,371	11	236	172.00
8	Bommanahalli Zone	16,317	16	300	109.59
Total		**101,650**	**68**	**1167**	**856.74**

Note: Total drain lengths mentioned in the above table is as per actual survey, which also includes the length of drains those are considered for hydraulic analysis purposes only.

Based on topography, core area zones are encompassed with four major valleys viz; Vrishabhavathi valley, Koramangala Valley, Challaghatta Valley and Hebbal Valley.

Three of the major valleys in the Core area viz. Vrishabavathi (V-Valley), Koramangala (K-Valley) and Challaghatta (C-Valley), runs generally in a North to South direction and divide the greater part of the metropolitan area which lies to the South of the ridge into three separate and distinct drainage zones. A fourth major valley in the Core area, referred to as the Hebbal series, forms the drainage zone to the north of the ridge and runs in Northeast direction.

The details of each of the valleys constituting in respective zones East, West and South zones of BBMP core area are given in **Table – 3.2** and are discussed in the subsequent sections.



Datum: WGS84, UTM Grid 43N, Composed by: © STUP Consultants P. Ltd., Subject to Usage Restrictions

A3 Size

Legend

Storm Water Drains

Type

- Primary SWD
- Secondary SWD
- Watershed Cluster
- Water Bodies

Zone Wise Catchment Boundary

Zone Name

- Bommanahalli Zone
- Byatarayanapura Zone
- Dasarahalli Zone
- East Core Zone
- Mahadevapura Zone
- Rajarajeshwarinagar Zone
- South Core Zone
- West Core Zone

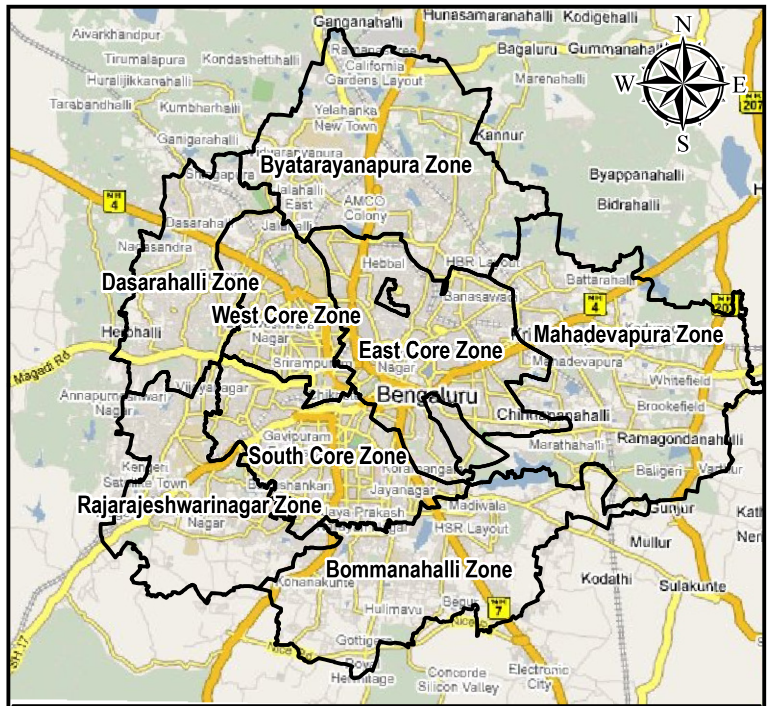
BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)



Key Map

No. of Minor Watershed

Zone	Cluster ID	Watershed Name	Area (Ha)	Total
BH	01-BH	Thalaghattapura Kere	2694.701	37
	02-BH	Shanboganahalli Kere	2498.689	29
	03-BH	Hulimavu Kere	1051.977	17
	04-BH	Puttenahalli Kere	816.776	10
	05-BH	Madivala Kere	960.175	13
	06-BH	Dodda Begur Kere	1298.142	15
	07-BH	Chikka Begur Kere	1150.621	25
	08-BH	Ibalur Kere	383.056	2
	09-BH	Kaikonadanahalli Kere	2934.499	50
	10-BH	Bellandur Kere	2134.569	26
	11-BH	Panathur Kere	394.051	12
BH Total				236
BP	01-BP	Yelahanka Kere	5607.618	28
	02-BP	Allalsandra Kere	779.928	7
	03-BP	Jakkur Kere	1863.937	21
	04-BP	Rachenahalli Kere	1222.784	11
	05-BP	Shingapura Kere	479.819	9
	06-BP	Dodda Bommasandra Kere	1427.11	25
	07-BP	Geddalahalli STP	804.095	9
	08-BP	Kalkere Kere	1501.721	14
	09-BP	Bellahalli Kere	548.429	5
BP Total				129
DH	01-DH	Abbigere Kere	835.12	12
	02-DH	Kammagoundanahalli Kere	984	12
	03-DH	Chikka Banavara Kere	535.21	7
	04-DH	Anchepalya Kere	2246.029	26
	05-DH	Lakshmipura Kere	2129.825	6
	06-DH	Gangondanahalli Kere	1590.475	17
	07-DH	Kachohalli Kere	1184.04	14
DH Total				94
EC	01-EC	Hebbal Kere	572.058	7
	02-EC	Nagwara Kere	926.535	9
	03-EC	Kacharakanahalli Kere	1326.914	22
	04-EC	Hennuru Bande	753.664	6
	05-EC	Ulsoor Kere	2565.61	35
	06-EC	Bharathinagara	730.919	7
	07-EC	Millers tank	558.749	8
	08-EC	Lalbagh Kere	3502.452	40
EC Total				134
MD	01-MD	Doddagubbi Kere	2776.075	25
	02-MD	Biderahalli Kere	1774.081	13
	03-MD	Hormavu Agara Kere	1389.174	22
	04-MD	Rampura Kere (Voonari Kere)	2142.509	32
	05-MD	Seighehalli Kere	1605.078	25
	06-MD	Kodigehalli Kere	3986.259	39
	07-MD	Kaggadasapura Kere	1298.521	10
	08-MD	B.Narayanapura Kere	789.662	7
	09-MD	Vibuthipura Kere LB Sastry ngr	942.579	13
	10-MD	Channappanahalli Kere	426.458	6
	11-MD	Kundalahalli Kere	493.705	14
	12-MD	Kadabeesanahalli	754.209	18
	13-MD	Chikka Bellandur Kere	2515.025	19
	14-MD	Sheelavantana Kere	1050.576	25
	15-MD	Varthur Kere	707.095	17
	16-MD	Valepura	720.317	15
MD Total				300
RN	01-RN	Sulikere Kere	2239.741	1
	02-RN	Kammaghatta kere	2663.871	11
	03-RN	Herehalli Kere	1428.63	6
	04-RN	Muddayana Palya Kere	1960.293	30
	05-RN	Hosahalli Kere	1071.556	11
	06-RN	Konnasandara Kere	2147.022	12
	07-RN	Halge Vadarahalli Kere	799.185	12
	08-RN	Subramanyapura Kere	2474.632	32
	09-RN	Kamayanapalya	580.405	3
RN Total				118
SC	09-SC	Byrasandra Kere	927.803	11
	10-SC	Yediyur Kere	1563.221	11
	11-SC	Kempambudhi Kere	1685.162	28
	12-SC	Nayandanahalli Kere	1376.603	19
SC Total				69
WC	01-WC	Mattikere Kere	1739.869	24
	11-WC	Sankey Kere	2527.239	32
	12-WC	Laggere Kere	808.29	11
	13-WC	Nandini Layout	1290.896	20
WC Total				87
Grand Total				1167

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: **Bruhat Bengaluru Mahanagara Palike**

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PROJECT: **Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike**

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: **Map Showing Watershed Clusters of 8 BBMP Zones**

APPROVED: YDM (CC)

No. SWD-MP-WS-01 | REV R0 | JOB No. 10331/E

SCALE: AS SPECIFIED

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Table – 3.2 Details of Major Valleys in Core Area

Sl. No.	Core Area Zones	Name of Major Valleys in Core Area	Area of Major Valleys (Ha.)	Drain Length (km.)
1.	East	Portion of Hebbal Valley	3,580	35.27
		Portion of Challaghatta Valley	3,856	30.74
		Portion of Koramangala Valley	3,502	28.38
2.	West	Portion of Hebbal Valley	1,740	15.52
		Portion of Vrishabhavathi	4,626	41.71
3.	South	Portion of Koramangala Valley	928	27.98
		Portion of Vrishabhavathi	4,625	47.71
Total			**22,857**	**227.31**

3.1.1 EAST CORE ZONE

In the present study for ease of assessment, East Core zone is demarcated into eight water shed regions as detailed in **Table – 3.3** and the same depicted in **Fig EZ-WS-01** in **Part 4, Appendix 1**.

Table 3.3 Watershed Clusters in East Core Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
1	Hebbal Kere	572	7	2	1.79
2	Nagawara Kere	927	9	5	10.51
3	Kacharakanahalli Kere	1,327	22	9	16.79
4	Hennuru Bande	754	6	3	6.19
5	Ulsoor Kere	2,566	35	7	18.31
6	Bharathinagara	731	7	5	8.43
7	Millers tank	559	8	1	4.00
8	Lalbagh Kere	3,502	40	12	28.38
	Sub Total	**10,937**	**134**	**44**	**94.39**

The details of each of the above listed water shed regions are as narrated below in subsequent sections.

3.1.1.1 Hebbal Kere Water Shed Region:

Hebbal Kere water shed region is situated on the Northern Western region of East zone. The topography of the terrain generally slopes from South to North average slope of the terrain vary from 5% to 10%. The total catchment area is about 572 hectares. There are about 2 nos. of drains comprising a total drain length of about 1,790 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Sanjayanagara, Central Excise Layout, Boopasandra, UAS Campus, Badarappa Layout, Balaji nagara forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Ring Road, IT companies etc., in turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, RCC box drain and box culverts have been constructed near Boopasandra Main Road. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Sanjayanagara. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1 Part 1, Appendix 1**.

3.1.1.2 Nagawara Kere Water Shed Region:

Nagawara Kere water shed region is situated on the Northern region of East zone. The topography of the terrain generally slopes from South to North average slope of the terrain vary from 10% to 15%. The total catchment area is about 927 hectares. There are about 5 nos. of drains comprising a total drain length of about 10,505 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Defence Area near Mekri Circle, J.C. Nagara, Mattadahalli, R.T. Nagara, Ganganagara, Anandanagara, Thimmaiah Garden, Gundappa Block, Venkatappa Block, Dinnur Main Road, Buvaneshwarinagara, Chamundeshwarinagara, CIA layout, Hebbal Kempapura, Yogeshnagara forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Ring Road, IT companies etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD.

Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, RCC drain walls constructed near Mariyananapalya Railway track, CIA layout, White horse apartments and box culverts/bridge near Gangaranagara, Ganesh Temple near Ananadanagara have been constructed and Yogeshnagara bridge (under construction). Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near J.C. nagara. Masonary wall reconstruction and restoration work carriedout near Matadahalli. Chainlink all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1.**

3.1.1.3 Kachakarakkanahalli Kere Water Shed Region:

Kachakarakkanahalli Kere water shed region is situated on the Northern region of East zone. The topography of the terrain generally slopes from South to North average slope of the terrain vary from 10% to 15%. The total catchment area is about 1,327 hectares. There are about 9 nos. of drains comprising a total drain length of about 16,790 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Lingarajapura, Devarajeevanahalli, Bagalur layout, Kadudondanahalli, Shampura, Tannery Road, Sultanpalya, Kacharakkanahalli, HRBR Layout, Govindapura, Hennur forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Ring Road, IT companies etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD.
Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, RCC box drain has been constructed near Nagawara Main Road level crossing, Doddanagara near Devarajeevanahalli, RCC U shape wall near Ambedkar Medical College, RCC box drain construction near HBR layout 80 ft. road (work in progress). Drain widening and RCC wall construction near HBR layout, bund and service road formation near HBR layout beyond Hennur Ring Road. RCC box culvert/bridge near NP factory, Gedalahalli Main Road (work in progress), Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Lingarajapura. Masonary wall reconstruction and restoration work carriedout near HBR layout. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1.**

3.1.1.4 Hennur Bande Water Shed Region:

Hennur Bande water shed region is situated on the Northern region of East zone. The topography of the terrain generally slopes from South to North East average slope of the terrain vary from 10% to 15%. The total catchment area is about 754 hectares. There are about 4 nos. of drains comprising a total drain length of about 6,185 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Hennur, Challakere, Kalayananagara, Maruthi Seva nagara,, portion of HBR layout, Govindapura, Babu Sahib Palya and Horamavu forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to BIAL Airport Road, educational institutions, Ring Road, IT companies etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD. Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Lingarajapura. Masonary wall reconstruction and restoration work carriedout near HBR layout. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is enclosed given in **Section, Part 1, Appendix 1.**

3.1.1.5 Ulsoor Kere Water Shed Region:

Ulsoor Kere water shed region is situated on the East Central region of East zone. The topography of the terrain generally slopes from North West to South East average slope of the terrain vary from 10% to 15%. The total catchment area is about 2,566 hectares. There are about 7 nos. of drains comprising a total drain length of about 18,310 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Ulsoor, Jogpalya, Baiyyappanahalli, Kadariyanapalya, MEG Centre campus, Krishinaiyanapalya, Indiranagara, Domlur, Cambridge layout, Gauthampura, Murgeshaplya, Jeevanbhimanagara, Thippasandra, KGA Golf Club, HAL Airport, forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to HAL Airport Road, educational institutions, Ring Road, IT companies, Hytech hospitals, Defence establishments etc., im turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD. Portion of bridge reconstruction near Diamond District needs to be taken up immediately to avoid stagnation and water surcharging into upstream areas during heavy rains. Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Murgeshpalya, Domlur. Masonary drain wall construction near Bandappa colony, MEG Centre, Nanjareddy colony near Murgeshpalya. RCC drain wall construction near Cambridge layout, Diamond District Airport Road flyover, RCC box drain near KR Garden, RCC Ushape wall near Murgeshpalya, Inside HAL Airport, wind tunnel road bridge reconstruction, drain widening and bund formation beyond HAL Airport. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1**.

3.1.1.6 Bharathinagara Water Shed Region:

Bharathinagara water shed region is situated on the West Central region of East zone. The topography of the terrain generally slopes from North West to South East average slope of the terrain vary from 10% to 15%. The total catchment area is about 731 ha. There are about 5 nos. of drains comprising a total drain length of about 8,425 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Munireddypalya, Cooke Town, Jeevanahalli, Frazer Town, Cox Town, Benson Town, Pottery Town, Bharathinagara forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Hytech hospitals, office establishments, Defence establishments etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD. Culvert remodelling near Wheelers road needs to be taken up immediately to avoid stagnation and water surcharging into upstream areas during heavy rains. Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Munireddypalya, Jeevanahalli, Frazer Town. Masonary drain wall constructed near Chinnappa Garden, MEG Centre. RCC drain wall construction near .S.K. Garden, Culvert remodelling Ganesh Temple near Ulsoor Kere, Pottery Town SK Garden, Chinnappa Garden. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1**

3.1.1.7 Miller's Tank Water Shed Region:

Miller's Tank water shed region is situated on the Western region of East zone. The topography of the terrain generally slopes from West to South East average slope of the terrain vary from 10% to 15%. The total catchment area is about 559 hectares. There are about 1 nos. of drains comprising a total drain length of about 4,000 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Vasanthanagara, Jayamahal, Bangalore Palace Grounds, Shivajinagara, High Grounds and Commercial Street surrounding areas forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Hytech hospitals, office and commercial establishments, Market and shoping malls, Defence establishments etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD. Culvert remodelling Millers Road, near Shivajinagara, ASM Road near RBMS College needs to be taken up immediately to avoid stagnation and water surcharging into upstream areas during heavy rains. Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Vasanthanagara. RCC U shape drain wall construction near Mahaveer Jain Hospital, Jasma Bhavan Road, Ajantha Theater, Ulsoor Lake. Culvert remodelling Ganesh Temple near Ulsoor Kere, Miller's tank bund road, St. John's Road. RCC Box drain construction near Shivajinagara, Covering of SWD near Ulsoor Kere for vehicular parking. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1**

3.1.1.8 Ejipura / LalBagh Kere Water Shed Region:

Ejipura water shed region is situated on the Western region of East zone. The topography of the terrain generally slopes from North West to South East average slope of the terrain vary from 10% to 15%. The total catchment area is about 3,502 hectares. There are about 14 nos. of drains comprising a total drain length of about 28,380 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Shanthinagar, Richmond Road, Langford gardens, Austin Town, Ashokanagara, MG Road, Neelasandra, Ejipura, Rajaendranagara, Koramangala S.T. Bed, Jakkasandra, KHB Colony Adugodi, LR Nagara, MICO factory surrounding areas forms part of the contributory areas of this catchment.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Hytech hospitals, office and commercial establishments, Market and shoping malls, Defence establishments etc., in turn resulting in discharge of raw sewage and large quantity of solid waste materials into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches. No. of manholes have been constructed exactly at culvert vent locations in turn obstructing free flow of water and causing accumulation of garbage and silt. Sewer outlets from residential buildings have been directly connected to SWD. Culvert remodelling JC Road, KH Double Road, Bannerghatta Road, Inner Ring Road, ORC Road needs to be taken up immediately to avoid stagnation and water surcharging into upstream areas during heavy rains. Drain improvement works in some of the critical low lying areas is still required to be takenup in this region.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Existing storm water drains are mostly lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near MG Road. RCC drain wall construction near Hosmat Hospital, Kenderia Vidhayalaya, National Games Village, Infant Jesus Church Bridge location. Culvert remodelling Victoria Road, Austin Town , Rajendranagara. Masonary drain wall construction near ST Bed. Drain widening and bund formation near Jakkasandra. Chainlink fence all along the drains has been provided to prevent dumping of garbage into SWD. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 1.**

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The details of the drains considered for remodelling at East Core Zone is as indicated in the **Table – 1, Part 2, Appendix 1**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig. EZ-ED-01 shows the extent, catchments, primary and secondary drains in East Core Zone.

3.1.2. WEST CORE ZONE

In the present study for ease of assessment, West Core zone is demarcated into eight water shed regions as detailed in **Table – 3.4** and the same depicted in **Fig WZ-WS-01** in **Part 4, Appendix 2**.

Table 3.4 Watershed clusters in West Core Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
West Zone					
1	MattiKere Kere	1,740	24	6	15.52
2	Sankey Kere	2,527	32	14	23.21
3	Laggere Kere	808	11	11	5.79
4	Nandini Layout	1,291	20	5	12.71
	Sub Total	**6,366**	**87**	**36**	**57.23**

The details of each of the above listed water shed regions are as narrated below in subsequent sections.

3.1.2.1 Mattikere Kere Water Shed Region:

Mattikere Kere water shed region is situated on the Northern Western region of West zone. The topography of the terrain generally slopes from North West to South east, average slope of the terrain vary from 15% to 20%. The total catchment area is about 1,740 hectares. There are about 6 nos. of drains comprising a total drain length of about 15,520 mTs. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Jalahalli, Thannirhalli, Mohan Kumar Nagara, Sanjeevappa Garden, Mattikere, Gowthampura, MS Ramiah Hospital, Kamala Nehru Extn. Subedarapalya, forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Railway station, Ring Road, hytech hospitals, defence establishments, IT companies etc., in turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction, and box culverts have been constructed near ISRO, RMV Extn.. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near RMV Extn.. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 2**

3.1.2.2 Sankey Kere Water Shed Region:

Sankey Kere water shed region is situated on the North Central region of West zone. The topography of the terrain generally slopes from North to South, average slope of the terrain vary from 15% to 20%. The total catchment area is about 2,527 hectares. There are about 14 nos. of drains comprising a total drain length of about 23,210 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Subramanyapura, Mariyyanapalya, Rajajajinagara, Milk Colony, Vyalikaval, Sadashivanagara, Saneguravanahalli, Gopalpura, Srirampura, Okalipura, Sheshadripura, Kumarapark forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to educational institutions, Railway station, central bus station, central business area, hytech hospitals, defence establishments, IT companies etc. in turn resulting in discharge of raw sewage and solid waste into SWD. Drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with masonry walls. The road side drains are usually covered in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction have been constructed near Jakkrayanakere, Hanumanthappa colony, Okalipura, Srirampura, SJR College. RCC box culvet near Swimming pool extn., Sheshadripura, Rajiv Gandhi Circle, Jakkarayanakere, Mariyappapalya, Prakashnagara. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Ranganatha colony. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 2**

3.1.2.3 Laggere Kere Water Shed Region:

Laggere Kere water shed region is situated on the South Western region of West zone. The topography of the terrain generally slopes from North to South, average slope of the terrain vary from 20% to 25%. The total catchment area is about 808 hectares. There are about 9 nos. of drains comprising a total drain length of about 5,790 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Kempegowdanagara, Nandini Layout, Kurabarahalli, Kamalanagara, Kamakashipalya, Basaveshwaranagara and portion of Dasrahalli Zone forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to Ring Road, Industrial area, APMC market yard, educational institutions, Railway station, central business area, hytech hospitals, defence establishments etc. In turn resulting in discharge of raw sewage and solid waste into SWD. Drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid trunk sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with masonry walls. The road side drains are usually covered in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction have been constructed near Kurabarahalli, J.C. Nagara, Laggere Kamakashipalya, Magadi Road. RCC slab bridge Laggere, Kurabarahalli. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Nandini layout. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 2.**

3.1.2.4 Nandini Layout Water Shed Region:

Nandini Layout water shed region is situated on the North Western region of West zone. The topography of the terrain generally slopes from North to South, average slope of the terrain vary from 20% to 25%. The total catchment area is about 1,291 hectares. There are about 7 nos. of drains comprising a total drain length of about 12,710 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Peenya Industrial area, Siddeshwaranagara, Shankaranagara, Ashokapura, Lakshmidevinagara, Nandini Layout, Kurabarahalli, Kamalanagara, Kamakashipalya, Basaveshwaranagara and portion of Dasrahalli Zone forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to Ring Road, Industrial area, APMC market yard, educational institutions, Railway station, central business area, hytech hospitals etc. In turn resulting in discharge of raw sewage and solid waste into SWD. Drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid trunk sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with masonry walls. The road side drains are usually covered in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC/Masonry drain wall construction have been takenup near K.G. Layout. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Shankarnagara. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 2**

The details of the drains considered for remodelling at West Core Zone is as indicated in the **Table – 1, Part 2, Appendix 2**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig. WZ-ED-01 shows the extent, catchments, primary and secondary drains in West Core Zone.

3.1.3 SOUTH CORE ZONE

In the present study for ease of assessment, South Core zone is demarcated into eight water shed regions as detailed in **Table – 3.5** and the same depicted in **Fig SZ-WS-01** in **Part 4, Appendix 1**.

Table 3.5 Watershed Clusters in South core Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
South Zone					
1	Byrasandra Kere	928	11	11	27.98
2	Yediyur Kere	1,563	11	4	15.86
3	Kempambudhi Kere	1,685	28	11	21.43
4	Nayandanahalli Kere	1,377	19	2	10.43
	Sub Total	**5,553**	**69**	**28**	**75.70**

The details of each of the above listed water shed regions are as narrated below in subsequent sections.

3.1.3.1 Byrasandra Kere Water Shed Region:

Byrasandra Kere water shed region is situated on the South Eastern region of South zone. The topography of the terrain generally slopes from North West to South east, average slope of the terrain vary from 15% to 20%. The total catchment area is about 928 hectares. There are about 11 nos. of drains comprising a total drain length of about 27,980 mTs. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Portion of Jayanagara, Bairasandra, Saduguntepalya, Maruthinagara, Portion of Madivala, Chikka Madivala, Tavarekere area forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Railway station, Ring Road, hytech hospitals, defence establishments, IT companies etc. In turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction, and box culverts have been constructed near Maruthinagara, Bairasandra fire station, Bismillahanagara, Madivala. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Bairasandra, Jayanagara 3rd Block, Madivala. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 3.**

3.1.3.2 Yediyur Kere Water Shed Region:

Yediyur Kere water shed region is situated on the Southern region of South zone. The topography of the terrain generally slopes from North East to South West, average slope of the terrain vary from 15% to 20%. The total catchment area is about 1,563 hectares. There are about 4 nos. of drains comprising a total drain length of about 15,860 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Portion of Jayanagara, Yediyur, Srinivasanagara, Tyagarajanagara, N.R. Colony, Channmanakere, Shastrinagara, Hosakerehalli, Girinagara, Ittamadu, Desouzanagara, Pushpagirinagara area forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Railway station, Ring Road, hytech hospitals, IT companies etc. In turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction, and box culverts have been constructed near Padmanabhanagara, Kaderenahalli, Ragavendra colony, Hosakerehalli, Ittamadu, Desouzanagara, Banashankari Ring Road. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Srinivasanagara, Girinagara, Channamanakere, Ittamadu. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 2.**

3.1.3.3 Kempambudhi Kere Water Shed Region:

Kempambudhi Kere water shed region is situated on the South Western region of South zone. The topography of the terrain generally slopes from North East to South West, average slope of the terrain vary from 30% to 40%. The total catchment area is about 1,685 hectares. There are about 11 nos. of drains comprising a total drain length of about 21,431 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Padarayanapura, Gudadahalli, Kempegowdanagara, Hanumanthanagara, Srinagara, Kalidasa layout, Gavipura, Avalahalli, Bapujinagara, Hosahalli, Vijayanagara, Chandra layout, Attiguppe, RPC layout, Hampinagara, Cholarapalya, Telecom layout, Timber yard layout, Sanjaya Gandhi Slum, Bytarayanapura area forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Railway station, Ring Road, hytech hospitals, IT companies etc. In turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction, and RCC Box culverts / Box drains have been constructed near Srinagara, Kalidasa layout, Kempegowdanagara, Samerapura, Bull temple road, Gandhi bazaar, Padarayanapura, Gopalapura, Manuvana, Agrahara Dasarahalli, Vijayanagara, Telecom Layout, Kavika factory, Mysore Road – Ring Road Junction, Nanjanarasappa layout, Chandra layout, near Hampinagara swimming pool, Kaveripura, Kamakashipalya. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Padarayanapura, Agrahara Dasarahalli, Bapujinagara, Kempegowdanagara, Hanumanthanagara, Srinagara. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 3.**

3.1.3.4 Nayanadahalli Kere Water Shed Region:

Nayanadahalli Kere water shed region is situated on the South Western region of South zone. The topography of the terrain generally slopes from North to South, average slope of the terrain vary from 30% to 40%. The total catchment area is about 1,377 hectares. There are about 2 nos. of drains comprising a total drain length of about 10,425 mts. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Basaveshwaranagara, Kamakashipalya, Govindarajanagara, Mudalpalya, Chandra layout, Vijayanagara, Marenahalli, Mutta Chari Indl. Area. Nayandahalli forms part of the contributory areas of this catchment

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to educational institutions, Railway station, Ring Road, hytech hospitals, Global Village IT Tech Park etc. In turn resulting in discharge of raw sewage and solid waste into SWD, drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. Due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches.

Existing storm water drains are lined with masonry wall, drain walls are in moderate condition, coping concrete and drain wall pointing is damaged at many locations. Sewer pipeline and manhole exists inside SWD.

Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has takenup several drain improvement works in this catchment area under project. Recently, drain desilting, RCC drain wall construction, and RCC Box culverts / Box drains have been constructed near Marenahalli, Mysore Road Club, Nanjanarasappa layout, Chandra layout, Kaveripura, Kamakashipalya. Drain reach covered with BS/RCC slabs have been opened at regular interval and desilting work has been carriedout near Agrahara Dasarahalli, Nayanadahalli. However, various works takenup in the Zone/Valley under the project is narrated in subsequent sections of this report.

The details of existing storm water drain and CD works as assessed during reconnassiance survey in the respective water shed region is given in **Section 1, Part 1, Appendix 3.**

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The details of the drains considered for remodelling at South Core Zone is as indicated in the **Table – 1, Part 2, Appendix 3**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig. SZ-ED-01 shows the extent, catchments, primary and secondary drains in East Core Zone.

3.1.4 BOMMANAHALLI ZONE

In the present study for ease of assessment, Bommanahalli Zone is demarcated into eleven water shed regions as detailed in **Table – 3.6** and the same depicted in **Fig BH-WS-01** in **Part 4, Appendix 4**.

Table – 3.6 Details of Major Water Shed Regions in Bommanahalli Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
1	Thalaghattapura Kere	2,695	37	27	28.72
2	Shanboganahalli Kere	2,499	29	12	10.49
3	Hulimavu Kere	1,052	17	6	5.24
4	Puttenahalli Kere	817	10	7	7.29
5	Madivala Kere	960	13	11	9.14
6	Dodda Begur Kere	1,298	15	11	10.30
7	Chikka Begur Kere	1,151	25	19	14.96
8	Ibalur Kere	383	2	2	1.95
9	Kaikonadanahalli Kere	2,934	50	18	10.00
10	Bellandur Kere	2,135	26	5	5.63
11	Panathur Kere	394	12	8	5.89
	Total	**16,317**	**236**	**126**	**109.59**

* Drain lengths indicated includes drain beyond BBMP Boundary which is considered only for hydraulic analysis purpose.

However, in the present project for formulating the proposals, prepration of budget cost estimates and drawing purpose, all the above listed eleven water shed catchment areas have been considered. Details of site conditions in each of the water shed regions are as narrated below;

3.1.4.1 Thalaghattapura Kere Water Shed Region:

Thalaghattapura Kere is situated on the South Western region of the Bommanahalli Zone. The over flow from Thalaghattapura Kere, Doddakalsandra Kere, and Avalahalli Kere flows into Doddi Kere, near Tatguni. It covers a major portion of South Western region of the Bommanahalli Zone. Due to change in land use and development of layouts, IT companies, Hitech Hospitals, Appartments, Villas in the surrounding region, the achukatta areas are disappeared and the water bodies are used only as storage ponds. The topography of the catchment area is undulating in nature, generally slopes from North East to South. Average slope of the terrain vary from 10% to 15%. The total catchment area is about 2,695 hectares. There are about 27 nos. of drains comprising a drain length of about 28,715 mts.

The drains situated in the catchment area are silted, vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water bodies are in pathetic situation and require immediate attention of the authorities for rejuvenation and protection. At many locations flows from SWD is diverted and utilised for agricultural activity. Condition of overflow weir is in condition. Original drain alignment is modified and buildings constructed over the drains near Doddakalsandra. Drain reach flowing through densely developed areas are severely silted.

Konnanakunte, Doddakalsandra, Avalahalli, Anjanapura, Vajarahalli, Thalaghattapura, Uttarahalli Manavartekaval and BMICA Township surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of pervious, Open land with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, and close proximity to educational institutions, IT companies, Hytech Hospitals, Ring road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.2 Shanboganahalli Kere Water Shed Region:

Shanboganahalli Kere is situated on the Southern region of the Bommanahalli Zone. The runoff from BMICA Township area and Kembathanahalli flows into Shanboganahalli. Shanboganahalli Kere is used as storage pond which is severely silted and weed growth observed. Due to change in land use and development of layouts, in the surrounding region, the achukatta area is disappeared. The topography of the catchment area is moderately undulating in nature, generally slopes from North to South. Average slope of the terrain vary from 10% to 15%. The total catchment area is about 2,499 hectares. There are about 12 nos. of drains comprising a drain length of about 10,485 mts.

The drains situated in the catchment area are mostly in natural condition, silted, vegetation growth observed, At many locations flows from SWD is diverted and utilised for agricultural activity.

Shanboganahalli, Amruthanagara, BMICA Township and Kambathanahalli, surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of pervious, Open land with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, and close proximity to well developed residential layouts, IT companies, Hytech Hospitals, Ring road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Appendix 4.**

3.1.4.3 Hulimavu Kere Water Shed Region:

Hulimavu Kere is situated on the Southern region of the Bommanahalli Zone. The over flow from Gottigere Kere, Kalena Agrahara Kere, Basavanapura Kere and Meenakashi Kere flows into Hulimavu Kere and further flows towards Madivala Kere. It covers a major portion of densly developed Southern region of the Bommanahalli Zone. Due to change in land use and development of residential layouts, IT companies, Hitech Hospitals, Appartments, Villas, ring road in the surrounding region, the achukatta areas are disappeared and the water bodies are used only as storage ponds. The topography of the catchment area is moderately undulating in nature, generally slopes from South to North. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,052 hectares. There are about 6 nos. of drains comprising a drain length of about 5,240 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water bodies are in very pathetic situation and require immediate attention of the authorities for rejuvenation and protection. Condition of overflow weir is in moderate condition. Original drain alignment is modified and buildings constructed over the drains at many locations. Drain reach flowing through densely developed areas are severely silted, covered with RCC slabs. Original alignment is modified at many locations while formation of residential layouts. Drain reach passes through private property at many locations; water flow is obstructed by constructing compound wall. Many locations buildings have been constructed inside waterway.

Basavanapura, weaver's colony, Gottigere, Kampatanahalli, Meenakashi temple surrounding areas, Kammnahalli, Hulimavu, Kalena Agrahara form the contributory catchment areas. The development of land in these localities lies in the category of pervious, open land with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, and close proximity to new residential layouts, educational institutions, IT companies, Hytech Hospitals, Ring road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.4 Puttenahalli Kere Water Shed Region:

Puttenahalli Kere is situated on the West Central region of the Bommanahalli Zone. The over flow from Krishnanagara Kere, Chunchaghatta Kere, Puttenahalli Kere flows into Sarakki Kere and further flows towards Madivala Kere. It covers a major portion of densly developed West Central region of the Bommanahalli Zone. Due to change in land use and development of residential layouts, residential apartments, educational institutions, IT companies, Hitech Hospitals, Villas, ring road in the surrounding region, the achukatta areas are disappeared and the water bodies are used only as storage ponds. The topography of the catchment area is moderately undulating in nature, generally slopes from South West to North East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 817 hectares. There are about 7 nos. of drains comprising a drain length of about 7,285 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water bodies are in very pathetic situation and require immediate attention of the authorities for rejuvenation and protection. However, Sarakki Kere has been recently regunivated by BDA. Conditions of overflow weirs are in moderate condition. Original drain alignment is modified and buildings constructed over the drains at many locations. Drain reach flowing through densely developed areas are severely silted, covered with RCC/BS slabs. Original alignment is modified at many locations while formation of residential layouts. Drain reach passes through private property at many locations; water flow is obstructed by constructing compound wall. Many locations buildings have been constructed inside waterway. Recently BBMP has takenup RCC box drain construction near 22nd Main Road Puttenahalli to avert flooding problems in the surrounding region. Large quantity of industrial effluent and raw sewage is being directly discharged into SWD near Yelachenahalli.

Sarakki, Yelachenahalli, Chunchaghatta, Konnakunte, Puttenahalli and Kothanur form the contributory catchment areas. The development of land in these localities lies in the category of impervious, dense builtup area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, and close proximity to new residential layouts, educational institutions, IT companies, Hytech Hospitals, Ring road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe and BS slab culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.5 Madivala Kere Catchment:

Madivala Kere is situated on the Northern region of the Bommanahalli Zone. The over flow from Madivala Kere flows into Agara Kere and further flows towards Bellandur Kere. It covers the major portion of the North and North Central region of the Bommanahalli Zone. Six minor tank catchments, viz., Hulimavu Kere, Jaraganahalli Kere, Are Kere, Puttenhalli Kere, Akashyanagara Kere, Yelanahalli Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of raw sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city’s environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. Recently Madivala Kere has been rejunivated but due to sewage entry into lake dense weed growth is observed and water quality is detoirated.

The topography of the terrain in this catchment generally slopes from West to East direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 960 hectares. There are about 11 nos. of drains comprising a drain length of about 9,140 mts.

Hulimavu, Akashyanagara, Yalenahalli, Are Kere, Puttenahalli, Devachikkanahalli, Madivala, Bilakalahalli, JP Nagara Dollars Colony and Bannerghatta Road surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT Companies, Hytech Hospitals, Ring Road, Apartments, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. However, BWSSB has constructed sewage treatment plant near Madivala tank. Many locations, during formation of residential layouts, original alignment is modified and width drastically reduced.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.6 Dodda Begur Kere Catchment:

Dodda Begur Kere is situated on the South Eastern region of the Bommanahalli Zone. The over flow from Ittasandra Kere and Malasandra Kere flows into Dodda Begur Kere and further flows towards Agara Kere and further flows towards Bellandur Kere. It covers the major portion of the Southern region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of raw sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment generally slopes from South to North direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 1,298 hectares. There are about 11 nos. of drains comprising a drain length of about 10,300 mts..

Mallasandra, Ittasandra, Vittasandra, and Dodda Beguru surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to IT Companies, Hytech Hospitals, Ring Road, Apartments, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. Many locations, during formation of residential layouts, original alignment have been modified and width drastically reduced.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Appendix 4.**

3.1.4.7 Chikka Begur Kere Catchment:

Chikka Begur Kere is situated on the South Eastern region of the Bommanahalli Zone. Beggur Kere, Singasandra Kere, Chikka Begur Kere, Garve Bhavi Palya Kere, Somasandrapalya Kere catchment area form part of contributory catchment area. The over flow from Dodda Begur Kere and above listed water bodies' flows towards Agara Kere and further flows towards Bellandur Kere. It covers the major portion of the South Eastern region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts, industrial centresin the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, tank area encroached, large quantity of raw sewage and industrial effluent flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. The topography of the terrain in this catchment generally slopes from South to North direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 1,151 hectares. There are about 19 nos. of drains comprising a drain length of about 14,960 mts.

BTM layout IV stage, Electronic City, Chikka Begur, Singasandra, Chikka Begur, MICO Layout, Garve Bhavi Palya, Somasandrapalya, Hongasandra, and Devarachikkanahalli and Mangamanapalya surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to IT Companies, Ring Road, Apartments, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers and IT companies. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. Many locations, during formation of residential layouts, original alignment has been modified and width drastically reduced. However, after recent incident of flooding, BDA and BBMP has taken up drain improvement works at several locations. Due to insufficient bed gradient large quantity of sewage stagnation observed at many locations. Effective solid waste management system in the surrounding regions of Chikka Begur Kere catchment area needs to be improved immediately.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.8 Ibbalur Kere Catchment:

Ibbalur Kere is situated on the North Eastern region of the Bommanahalli Zone. The over flow from Ibbalur Kere flows towards Bellandur Kere. It is having a small catchment area in the North Eastern region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts, industrial centres in the surrounding region, the achukatta area is disappeared and this water body is used only as storage pond.

The water body situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, tank area encroached, large quantity of raw sewage and industrial effluent flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of this water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. The topography of the terrain in this catchment generally slopes from South to North East direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 383 hectares. There are about 2 nos. of drains comprising a drain length of about 1,950 mts.

HSR Layout and Ibbalur surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to IT Companies, Ring Road, Apartments, Industrial and defence establishments etc., in turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers and IT companies. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. Many locations, during formation of residential layouts, original alignment has been modified and width drastically reduced.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.9 Kaikondanahalli Kere Catchment:

Kaikondanahalli Kere is situated on the North Eastern region of the Bommanahalli Zone. Parapana Agrahara Kere, Kudulu Kere, Haraluru Kere, Kasavanahalli Kere, Kaikondanahalli Kere and inaddition Madivala Kere, Hulimavu Kere and Agara Kere form part of catchment area. Whereas, the over flow from Agara Kere and Kaikondanahalli Kere flows towards Bellandur Kere. It is having a small catchment area in the North Eastern region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of residential layouts, industrial centres in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water body situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, tank area encroached, large quantity of raw sewage and industrial effluent flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of this water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. The topography of the terrain in this catchment generally slopes from South to North East direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 2,934 hectares. There are about 18 nos. of drains comprising a drain length of about 10,000 mts.

Naganathapura, Kudulu Village, Parapana Agrahara, Haraluru, Parangipalya, entire Madival Kere, Agara Kere catchment area and HSR Layout and Ibbalur surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to developed residential layouts, IT Companies, Ring Road, Apartments, Industrial and defence establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers and IT companies. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. Many locations, during formation of residential layouts, original alignment has been modified and width drastically reduced.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.10 Agara Kere Catchment:

Agara Kere is situated on the Northern region of the Bommanahalli Zone. The over flow from Agara Kere flows into Bellandur Kere and further towards Varthur Kere. It covers the major portion of the South, Central and North Western region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and IT companies and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. Recently, BDA had takenup rejunivation of Agara Kere, but dense vegetation growth is observed. Also BDA & BBMP has taken up drain and culvert remodelling work in this catchment to avert flooding problems near Central Silk Board Junction, BTM layout Dollars Colony and HSR layout.

The topography of the terrain generally slopes from South to North direction. The average slope of the terrain varies from 5% to 10%. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software parks, industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint, authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Bommanahalli CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.11 Bellandur Kere Catchment:

Bellandur Kere is situated on the North Eastern peripheral region of the Bommanahalli Zone. The over flow from Bellandur Kere further flows towards Varthur Kere and further onto Dakashina Pinakini River. It covers the major portion of the South, South Western region of the Bommanahalli Zone. The catchment areas of Agara Kere, Madivala Kere, Parapana Agrahara Kere, Kaikondanahalli Kere and Ibbalur Kere and in addition Koramangala & Challaghatta Valley Catchment areas of Core Bangalore forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds. The total catchment area is about 2,135 hectares. There are about 5 nos. of drains comprising a drain length of about 5,625 mts.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of raw sewage flow into water body is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in very pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. However, several studies have been done and plans prepared by the concerned authorities for improvement of Bellandur Kere. But physical project work needs is yet to be takenup at site. ;arge scale dumping of earth on the down stream of Bellandur Kere is being done by private land developers to raise the adjoining ground level which in turn drain width is getting reduced, concerned authorities needs to have a look on these issues immediately to protect the main water ways and avert flooding in the surrounding regions. Alignment of drain is not clearly defined which needs to be demarcated immediately considering futureistic hydraulic requirements.

The topography of the terrain generally slopes from West to East direction. The average slope of the terrain varies by 5%. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Industrial and Defence establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

3.1.4.12 Panathuru Kere Catchment:

Panathuru Kere is situated on the North Eastern region of the Bommanahalli Zone. Adjacent to Mahadevapura Zone. Halanayakanahalli Kere, Kannahalli Kere, Devarabisanahalli Kere form part of catchment area. Whereas, the over flow from Panathuru Kere flows towards down stream of Bellandur Kere. It is having a small catchment area in the North Eastern region of the Bommanahalli Zone. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of residential layouts, industrial centres in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water body situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, tank area encroached, large quantity of raw sewage and industrial effluent flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of this water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. The topography of the terrain in this catchment generally slopes from South to North East direction. The gradient is very flat; the average slope of the terrain varies from 5% to 10%. The total catchment area is about 394 hectares. There are about 8 nos. of drains comprising a drain length of about 5,890 mts.

Hadosiddapura, Chudasandra, Junnasandra, Kasavanahalli Devarabeesanahalli, Bhoganahalli, Kannahalli and Panathur surrounding regions, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to well developed residential layouts, IT Companies, Ring Road, Apartments, Industrial and defence establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Many locations drain reach is covered with RCC / BS slabs by apartment developers and IT companies. Residential layouts have been developed below high flood levels and due to insufficient bed gradient and reduced drain width water is surcharging into residential buildings and causing water stagnation for long hours. Due to non functioning of the existing sewerage system in the entire catchment large quantity of raw sewage flow is observed in the SWD. Many locations, during formation of residential layouts, original alignment has been modified and width drastically reduced.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with BS slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 4.**

The details of the drains considered for remodelling at Bommanahalli Zone is as indicated in the **Table – 1, Part 2, Appendix 4**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig. BH-ED-01 shows the extent, catchments, primary and secondary drains in Bommanahalli Zone.

3.1.5 YELAHANKA ZONE:

In the present study for ease of assessment, Yelehanka Zone is demarcated into fifteen water shed regions as detailed in **Table – 3.7** and the same depicted in **Fig YE-WS-01** in **Part 4, Appendix 5**.

Table 3.7 Details of Major Water Shed Regions in Yelahanka Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
1	Yelahanka Kere	5,607	28	24	28.03
2	Allallasandra Kere	781	7	6	7.54
3	Jakkuru Kere	1,863	21	18	14.57
4	Rachenahalli Kere	1,221	11	16	14.52
5	Bellahalli Kere	548	5	5	5.26
6	KalKere Kere	1,502	14	8	12.72
7	Shingapura Kere	480	9	9	4.94
8	Dodda Bommasandra Kere	1,426	25	18	16.65
9	* MattiKere Kere	1,740	24	6	15.52
10	* Hebbal Kere	573	7	2	1.79
11	* Kacharakkanahalli Kere	1,328	22	9	16.79
12	* Nagawara Kere	927	9	5	10.51
13	Gedalahalli	804	9	8	8.71
14	* Hennuru Bande	754	6	3	6.19
15	Horamavu Agara Kere	1,389	22	12	10.81
	Total	**20,943**	**219**	**149**	**174.55***

***** Drain lengths indicated includes drain beyond BBMP Boundary which is considered only for hydraulic analysis purpose.

However, in the present project for formulating the proposals, prepration of budget cost estimates and drawings purpose, following ten water shed catchment areas have been considered. The balance five water shed regions have been already included in core area SWD project only the drains which have not been included will be considered in the present project.

1. Yelahanka Kere water shed region, - 01-BP
2. Allallasandra Kere water shed region, - 02-BP
3. Jakkuru Kere water shed region, - 03-BP
4. Rachenahalli Kere water shed region, - 04-BP
5. Shingapura Kere water shed region. - 05-BP
6. Dodda Bommasandra Kere water shed region. - 06-BP
7. Gedalahalli water shed region. - 07-BP
8. KalKere Kere water shed region, - 08-BP
9. Bellahalli Kere water shed region, - 09-BP
10. Horamavu Agara Kere water shed region, - 03-MD

3.1.5.1 Yelahanka Kere Water Shed Region:

Yelahanka Kere is situated on the Northern region of the city. The over flow from Yelahanka Kere flows into Jakkur Kere and further onto Rachenahalli Kere and further flows towards Rampura Kere. It covers the major portion of the North and North Western region of the Yelahanka Zone. Nine minor tank catchments, viz., Ammani Kere, Gantiganahalli Kere, Veerasagara Kere, Ramagondanahalli Kere, Harohalli Kere, Avalahalli Kere, Krishnasagara Kere, Attur Kere, Puttenahalli Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment, generally slopes from North to South direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 5,607 hectares. There are about 24 nos. of drains comprising a drain length of about 28,025 mts.

Avalahalli, Ganteganahalli, Nagenahalli, Harohalli, Ramagondanahalli, Ananthapura, Attur, Puttenahalli, Kenchanahalli, Hosahalli, CRPF area, BSF Area, Wheel & Axel Plant area, Yelahanka Gandhinagara and Yelahanka Old Town, forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, in turnational airport etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Yelahanka CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.2 Allalasandra Kere Water Shed Region:

Allalasandra Kere is situated on the North Central region of the Yelahanka Zone near to Doddaballapura road. The over flow from Allalasandra Kere flows into Jakkur Kere. It covers the major portion of the Central region of the zone. The topography of the catchment area generally slopes from West towards East average slope of the terrain vary from 5% to10%. The total catchment area is about 781 hectares. There are about 6 nos. of drains comprising a drain length of about 7,540 mts..

The development of land in these localities lies in the category of pervious, built up area with sparse vegetal cover. Portion of the catchment area in the central region comprises of GKVK Campus, Mother Dairy premises etc.,

Allalasandra Village, GKVK Campus, Yelahanka New Town, Judicial Layout forms the contributory areas of this catchment

The water body situated in the catchment area viz., Allalasandra Kere is severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of Allalasandra Kere is in very pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Since, most of the drains in this catchment area passes through densely developed areas, Buildings have been already constructed on either side upto the edge of the drain, large number of utility crossing observed in almost at every location, drastic modification of natural alignment of drains and encroachment of Raja Kaluves at many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, street sweeping and dumping of waste materials into/near the water ways near the Market area and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides is lined with masonry walls and bed unlined. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Culverts/bridges have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth & garbage accumulation is observed in the drains.

There is no provision made by the urban development authorities plans for formation of service roads on either side for routine maintenance of the drains and for laying of service lines except in few reaches. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.3 Jakkuru Kere Water Shed Region:

Jakkuru Kere water shed region is situated on the Central region of the zone. The over flow from Yelahanka Kere and Allalasandra Kere flows into Jakkuru Kere and further flows towards Rachenahalli Kere. It covers the major portion of the Central region of the zone. Four minor tank catchments, viz., Palanahalli Kere, Kattiganahalli Kere, Kogilu Kere, Thirumanahalli Kere and Agrahara Kere forms part of this catchment area. The topography of the terrain generally slopes from North towards South average slope of the terrain vary from 10% to 15%. The total catchment area is about 1,863 hectares. There are about 18 nos. of drains comprising a total drain length of about 14,570 mts.

The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover except in few reaches.

Yelahanka (Nehru Nagara), Kattigenahalli, Kogilu, Agrahara layout, Chokkanahalli, and Thirumanahalli forms the contributory areas of this catchment

The water bodies situated in the catchment area viz. Palanahalli Kere, Kattiganahalli Kere, Kogilu Kere, Thirumanahalli Kere and Agrahara Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, hospitals, IT companies etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides are in natural condition. In some places in the initial reaches the drain sides are lined with masonry walls and bed unlined especially in recently developed residential layouts. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Culverts/bridges have been constructed at number of locations have been constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by BWSSB or erstwhile Municipal authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.4 Rachenahalli Kere Water Shed Region:

Rachenahalli Kere is situated on the central region of the Yelahanka Zone. The over flow from Rachenahalli Kere flows into Rampura Kere further flows towards Yellamallappa Chetty Kere. It covers the major portion of the North, Central and North Western, & North Eastern region of the Yelahanka Zone. One minor tank catchment, viz., Amruthhalli Kere forms part of this catchment area.

The water body situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city’s environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from North to South East direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 1,221 hectares. There are about 16 nos. of drains comprising a drain length of about 14,520 mts.

G.K.V.K. Campus, Amruthahalli, Shakaranagara, Rachenahalli, Sampigehalli, Srirampura, Telecom Layout, Byatarayanapura Village, Portion of Arkavathi layout, Ashwathnagara, Tannisandra and Mariyyanapalya forms the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, in turnational airport etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint, authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.5 Bellahalli Kere Water Shed Region:

Bellahalli Kere is situated on the North Eastern region of the Zone situated close to Hennuru-Devanahalli Road. Bellahalli Kere is an isolated tank and it is used only as storage pond. The topography of the catchment area is moderately undulating in nature and slopes from North to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 548 hectares. There are about 5 nos. of drains comprising a drain length of about 5,255 mts.

The development of land in these localities lies in the category of pervious, sparse built up area with sparse vegetal cover. Kogilu layout, Mittaganahalli, Bellahalli area forms the contributory areas of this catchment.

The water body situated in the catchment area viz., Bellahalli Kere is severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life.

Since, most of the drains in this catchment area passes through old Village areas the development has already taken place on either side upto the edge of the drain, large number of utility crossing observed in almost at every location, drastic modification of natural alignment of drains and encroachment of Raja Kaluves at many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, dumping of waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides is in natural condition Culverts/bridges have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.6 Gedalahalli Water Shed Region:

Gedalahalli is situated on the South Eastern region of the city. The over flow from Nagavara Kere, Yelahanka Kere and Rachenahalli Kere confluences near Gedalahalli – Hennur Main Road and further flows into KalKere Kere and further on to Rampura Kere. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared. The topography of the catchment area is moderately undulating in nature and slopes from North to South. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 804 hectares. There are about 8 nos. of drains comprising a drain length of about 8,710 mts.

The drain reach situated in this catchment area is severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life.

The topography of the terrain generally slopes from Northwest to Southeast direction. The average slope of the terrain is very very flat.

Telecom employees layout, Thannisandra, Portion of Arkavathi layout, Byrathi, Gedalahalli, Bille Shivale, Hennur bande surrounding areas form the contributory catchment areas in addition to the catchment areas of Nagavara Kere, Hebbal Kere, Yelahanka Kere and Rachenahalli Kere forms the total contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, in turnational airport etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.7 Shingapura Kere Water Shed Region:

Shingapura Kere is situated on the North Western region of the city. The over flow from Shingapura Kere flows into Chikka Banavara Kere. It covers the major portion of the North Western region of the Yelahanka Zone. Two minor tank catchments, viz., Varadarajanagara Kere, Singapura Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment, generally slopes from East to West direction. The average slope of the terrain vary from 5% to 10%. The total catchment area is about 480 hectares. There are about 9 nos. of drains comprising a drain length of about 4,935 mts.

Varadarajanagara, Singapura, Shingapura Kuvempunagara forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.8 Dodda Bommasandra Kere Water Shed Region:

Dodda Bommasandra Kere is situated on the Western region of the city. The over flow from Dodda Bommasandra Kere flows into Hebbal Kere. It covers the major portion of the North Western region of the Yelahanka Zone. Two minor tank catchments, viz., Varadarajanagara Kere, Singapura Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment, generally slopes from North to East direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 1,426 hectares. There are about 18 nos. of drains comprising a drain length of about 16,645 mts.

Vidayaranyapura, Sonappa layout, Kempegowdanagara, Jalahalli forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.9 KalKere Kere Water Shed Region:

KalKere Kere is situated on the South Eastern region of the city. The over flow from Nagavara Kere, Yelahanka Kere and Rachenahalli Kere flows into KalKere Kere and further on to Rampura Kere and further flows towards Yellamallappa Chetty Kere. It covers the major portion of the North, East, West and Southern region of the Yelahanka Zone. Four major tank catchments, viz., Hebbal Kere, Nagavara Kere, Yelahanka Kere and Rachenahalli Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds. The topography of the catchment area is moderately undulating in nature and slopes from North to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,502 hectares. There are about 8 nos. of drains comprising a drain length of about 12,720 mts.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from Northwest to Southeast direction. The average slope of the terrain is very flat. The total catchment area is about 7000 hectares.

Hegde Nagara, Nagareshwara Nagenahalli, Byrathi, Gedalahalli, Kyalasanahalli, Kottanur Narayanapura, Bille Shivale, HBR Layout, Lingarajpura, Horamavu, KalKere, Hennur form the contributory catchment areas in addition to the catchment areas of Nagavara Kere, Yelahanka Kere and Rachenahalli Kere forms the total contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, in turnational airport etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

3.1.5.10 Horamavu Agara Kere Water Shed Region:

Horamavu Agara Kere is situated on the South Eastern region of the city. The over flow from Horamavu Agara Kere flows into KalKere Kere and further onto Rampura Kere and further flows towards Yellamallappa Chetty Kere. It covers a small portion of the Eastern region of the Yelahanka Zone. One major tank catchment viz., Horamavu Agara Kere catchment forms part of this catchment area. Due to stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature and slopes from South to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,389 hectares. There are about 10 nos. of drains comprising a drain length of about 10,810 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from South towards East direction. The average slope of the terrain is very flat. The total catchment area is about 7000 hectares.

Horamavu Agara, KalKere and Hennur bande surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, in turnational airport etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 5.**

Whereas, flow generated from Hebbal Valley Catchment Area also contributes for Yelahanka zone main stream. Since these drains have been already included under Core Area SWD Project only the missing drains will be identified and included in the present project and also only the discharge from each of the Hebbal valley drains will be considered for hydraulic analysis.

The details of the drains considered for remodelling at Yelahanka Zone is as indicated in the **Table – 1, Part 2, Appendix 5**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig YE-ED-01, Part 4, Appendix 5 shows the extent, catchments, primary and secondary drains in Yelehanka Zone.

3.1.6 DASARAHALLI ZONE

In the present study for ease of assessment, Dasarahalli Zone is demarcated into fifteen water shed regions as detailed in **Table – 3.8** and the same depicted in **Fig DH-WS-01** in **Part 4, Appendix 6**.

Table – 3.8 Details of Major Water Shed Regions in Dasarahalli Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Kms.)
1	Abbigere Kere	835	12	5	5.52
2	Kammagoundanahalli Kere	984	12	9	10.24
3	Chikka Banavara Kere	535	7	-	-
4	Anchepalya Kere	2,246	26	21	28.36
5	Lakshmipura Kere	2,130	6		
6	Gangondanahalli Kere	1,590	17	20	18.75
7	Kachohalli Kere	1,184	14	8	10.33
8	*Laggere Kere			4	2.92
9	*Nandini layout			5	4.27
10	*Herehalli Kere			8	8.86
	Total	**9,505**	**94**	**80**	**89.24**

***** Drain lengths indicated includes drain beyond BBMP Boundary which is considered only for hydraulic analysis purpose.

However, in the present project for formulating the proposals, preparation of budget cost estimates and drawings purpose, following five water shed catchment areas have been considered. Remaining two water shed regions are situated beyond zonal boundary. However, runoff generated from these two water shed regions have been considered for hydraulic analysis purposes.

1. Abbigere Kere watershed region 01-DH,
2. Kamagowdanahalli Kere watershed region 02-DH,
3. Anchepalya Kere watershed region 04-DH,
4. Ganagondanahalli Kere watershed region 06-DH
5. Kachohalli Kere watershed region 07-DH,

3.1.6.1 Abbigere Kere Catchment:

Abbigere Kere is situated on the Northern region of the Dasarahalli Zone. The over flow from Shingapura Kere, Varadarajanagara Kere flow into Abbigere Kere and further flow towards Chikka Banavara Kere. It covers the major portion of the North region of the Dasarahalli Zone. Two minor tank catchments, viz., Abbigere Kere, Vaderahalli Kere, catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment generally slopes from East to West direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 835 hectares. There are about 5 nos. of drains comprising a drain length of about 5,520 mts.

Abbigere, Lakshmipura, Vaderahalli and Somashettyhalli form part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, moderately dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 6.**

3.1.6.2 Kamagondanahalli Kere Catchment:

Kamagondanahalli Kere is situated on the Northern region of the Dasarahalli Zone. The over flow from Mallasandra Kere, flow into Kamagondanahalli Kere and further flow towards Chikka Banavara Kere. It covers the major portion of the North region of the Dasarahalli Zone. Two minor tank catchments, viz., Kamagondanahalli Kere, Mallasandra Kere, catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment generally slopes from East to North-West direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 984 hectares. There are about 9 nos. of drains comprising a drain length of about 10,240 mts.

Mallasandra, MEI Employees Housing Colony, Kamagondanahalli, Guddadahalli, BHEL Mini Colony and Chikkasandra form part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, moderately dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed and are of mainly Hume pipe. They are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains. Buildings have been constructed upto the edge of the drain at many locations. Sewer outlets from residential buildings have been connected directly to SWD. SWD is covered with RCC slab at few reaches.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 6.**

3.1.6.3 Anchepalya Kere Catchment:

Anchepalya Kere is situated on the Western region of the Dasarahalli Zone. The over flow from Anchepalya Kere flows further towards Arkavathi River. It covers the major portion of the North, Central and North Western, & North Eastern region of the Dasarahalli Zone. Four minor tank catchments, viz., Dasarahalli Kere, Bagalgunte Kere, Chikka Bidarukalau Kere and Dodda Bidarukalau Kere forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from East to West direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 2,246 hectares. There are about 21 nos. of drains comprising a drain length of about 28,360 mts.

Anchepalya, Bagalgunte, Chikka Bidarakallu, Defence Colony, Mallasandra Gutte, Hesaraghatta pipeline road forms the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover. The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint, authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Dasarahalli CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

Drain reach in dense built-up area is covered with RCC/BS slabs, Most of the culverts are of RCC Hume pipe, severely silted, large quantity of sewage flow and garbage dumps observed inside SWD, sewer outlets from residential buildings are directly connected to SWD.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 6.**

3.1.6.4 Gangagondanahalli Kere Catchment:

Gangagondanahalli Kere is situated on the South western peripheral region of the Dasarahalli Zone. The over flow from Gangagondanahalli Kere further flows towards Machohalli Kere and further onto Arkavathi River. It covers the major portion of the South Western region of the Dasarahalli Zone. Five minor tank catchments, viz., Shivapura Kere, Karihobanahalli Kere and Andarahalli Kere forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from East to Southwest direction. The average slope of the terrain varies by 5%. The total catchment area is about 1,590 hectares. There are about 20 nos. of drains comprising a drain length of about 18,750 mts.

Shivapura, Peenya 2nd Stage, Nelagaderanahalli, Karihobanahalli, Tigalarapalya, Hegganahalli, Andarahalli, Kachohalli and Golarapalya Hosahalli forms the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, industrial areas etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Dasarahalli CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain. Balance portion of the catchment on the southern side flow independently towards Herrohalli Kere, Muddayanapalya Kere & Kachohalli Kere.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 6.**

3.1.6.5 Kachohalli Kere Catchment:

Kachohalli Kere is situated on the Western region of the Dasarahalli Zone. It covers the major portion of the Western region of the Dasarahalli Zone.

The water body situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment generally slopes from East to West direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 1,184 hectares. There are about 8 nos. of drains comprising a drain length of about 10,325 mts.

Machohalli, Hosahalli Gollarapalya, Handarahalli, Srigandada Kaval, Vidhyamannagara, Bayandahalli form part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, moderately dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Industrial areas, Ring Road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed and are of mainly RCC slab inside the park area. They are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains. Buildings have been constructed upto the edge of the drain at many locations. Sewer outlets from residential buildings have been connected directly to SWD. SWD is covered with RCC slab at few reaches.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain. Weathered rocky outcrops are observed at many places.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 6.**

The details of the drains considered for remodelling at Dasarahalli Zone is as indicated in the **Table – 1, Part 2, Appendix 6**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig DH-ED-01, Part 4, Appendix 6 shows the extent, catchments, primary and secondary drains in Dasarahalli Zone.

3.1.7 MAHADEVAPURA ZONE

In the present study for ease of assessment, Mahadevapura Zone is demarcated into Sixteen water shed regions as detailed in **Table – 3.9** and the same depicted in **Fig MD-WS-01** in **Part 4, Appendix 7**.

Table – 3.9 Details of Major Water Shed Regions in Mahadevapura Zone

Sl. No.	Name of Water Shed Regions	Water Shed Catchment Area (Ha.)	No. of Micro Catchments in the Water Shed Regions (Nos.)	No. of Storm Drains in the Water Shed Region (Nos.)	Total Length of Storm Drains in the Water Shed Region (Mts.)
1	Doddagubbi Kere	2,776	25	7	14.12
2	Biderahalli Kere	1,774	13	2	5.20
3	Hormavu Agara Kere	1,389	22	13	10.81
4	Rampura Kere	2,143	32	6	11.58
5	Seighehalli Kere	1,605	25	22	17.55
6	Kodigehalli Kere	3,986	39	18	27.43
7	Kaggadasapura Kere	1,299	10	7	5.31
8	B.Narayanapura Kere	790	7	10	6.06
9	Vibuthipura Kere	943	13	7	7.15
10	Channappanahalli Kere	426	6	7	4.29
11	Kundalahalli Kere	494	14	8	3.64
12	Kadabeesanahalli	754	18	10	9.10
13	Chikka Bellandur Kere	2,515	19	8	7.17
14	Sheelavantana Kere	1,051	25	19	12.78
15	Varthur Kere	707	17	18	10.35
16	Valepura	720	15	17	14.83
17	Bellandur Kere			6	4.70
	Total	**23,371**	**300**	**185**	**172.04**

* Drain lengths indicated includes drain beyond BBMP Boundary which is considered only for hydraulic analysis purpose.

However, in the present project for formulating the proposals, prepration of budget cost estimates and drawings purpose, following thirteen water shed catchment areas have been considered. Remaining three water shed regions are situated beyond zonal boundary. However, runoff generated from these three water shed regions have been considered for hydraulic analysis purposes.

1. Hormavu Agara Kere water shed region 03-MD,
2. Seighehalli Kere water shed region 05-MD,
3. Kodigehalli Kere water shed region 06-MD,
4. Kaggadasapura Kere water shed region 07-MD,
5. B.Narayanapura Kere water shed region 08-MD,
6. Vibuthipura Kere water shed region 09-MD,
7. Channappanahalli Kere water shed region 10-MD,
8. Kundalahalli Kere water shed region 11-MD,
9. Kadabeesanahalli Kere water shed region 12-MD,
10. Chikka Bellandur Kere water shed region 13-MD,
11. Sheelavantana Kere water shed region 14-MD,
12. Varthur Kere water shed region 15-MD,
13. Valepura Kere water shed region 16-MD.

3.1.7.1 Horamavu Agara Kere Water Shed Region:

Horamavu Agara Kere is situated on the North Eastern region of the city. The over flow from Horamavu Agara Kere flows into KalKere Kere and further onto Rampura Kere and further flows towards Yellamallappa Chetty Kere. It covers a small portion of the Eastern region of the Yelahanka Zone. One major tank catchment viz., Horamavu Agara Kere catchment forms part of this catchment area. Due to stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature and slopes from South to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,389 hectares. There are about 13 nos. of drains comprising a drain length of about 10,810 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from South towards North East direction. The average slope of the terrain is very flat. The total catchment area is about 7000 hectares.

Horamavu Agara, KalKere and Hennur bande surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Mahadevapura and Byatarayanapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.2 Segihalli Kere Water Shed Region:

Segehalli Kere is situated on the North Eastern region of the city. The over flow from Ganagashetty Kere, Devasandra Kere and Nagara Kere flows into Segihalli Kere and further flows towards Battarahalli Kere and further onto Yellamallappa Chetty Kere. It covers a major portion densely developed Eastern region of the Mahadevapura Zone. Five minor tanks catchment viz., Ganagashetty Kere, Devasandra Kere, Vengaiana Kere, Ramamurthynagara Kere, K.R. Pura Kere and Bhattarahalli Kere catchment forms part of this catchment area. Due to stoppage of agricultural activity, change in land use and development of layouts, IT companies in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from West to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,605 hectares. There are about 22 nos. of drains comprising a drain length of about 17,550 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain generally slopes from West towards North East direction. The average slope of the terrain is very flat. The total catchment area is about 1,605 hectares.

Vigneshwara layout, Pappamma Layout, Mukkutamnagara, Nagappa Reddy Layout, Vijinapura, ITI Colony, Devasandra, Haledevasandra, Basavanapura, Gokul Extn. and Bhatarahalli surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, NH and Rind Road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Large no of culverts are of RCC Hume pipe type and are severely silted and completely chocked and require reconstruction. Due to insufficient bed gradient sewage stagnation observed at many locations.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Mahadevapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.
The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.3 Kodigehalli Kere Water Shed Region:

Kodigehalli Kere is situated on the Eastern region of the city. The over flow from Hoddy Kere, and White Field Kere flows into Kodigehalli Kere and further flows towards Main Stream i.e., Down stream of Yellamallappa Chetty Kere. It covers a major portion densely developed Eastern region of the Mahadevapura Zone. Three minor tanks catchment viz., Hoddy Kere, White Field Kere and Kodigehalli Kere catchment forms part of this catchment area. Due to stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from West to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 3,986 hectares. There are about 18 nos. of drains comprising a drain length of about 27,430 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Kaveri nagara, Hoodi, Sadaramangala, Iyyappanagara, Sathya Sai Baba Asharama, Kadugodi village, Kadugodi Colony, Kadugodi Industrial Area, Garduacharapalya, Thigalarapalya, Maruthinagara, RHB Colony, Ambedkarnagara, Belathur, Channasandra, Happy valley, Koralur and Thirumala Settihalli surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, NH and proposed peripheral Rind Road etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.4 Kaggadasapura Kere Water Shed Region:

Kaggadasapura Kere is situated on the Western region of the Mahadevapura Zone The over flow from Benniganahalli Kere, and Kelageri Kere flows into Kaggadasapura Kere and further flows towards Doddanekundi Kere and further on to down stream of Bellandur Kere. It covers a major portion densly developed Western region of the Mahadevapura Zone. Three minor tanks catchment viz., Benniganahalli Kere, Kelageri Kere and Kaggadasapura Kere catchment forms part of this catchment area. Due to stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from North West to South. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,299 hectares. There are about 7 nos. of drains comprising a drain length of about 5,310 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Portion of Banaswadi, Bytaguttapalya, Gurijiya gutta, Kasturi nagara, Channasandra Railway good yard, Krishnaiyyanapalya, Benniganahalli, NGEF layout, Baiyyappanahalli, Pai Layout, Nagawarapalya, Udayanagara, DRDO Township, Kaggadasapura, Vigínananagara, GM Palya, BEML Layout, CV Ramana nagara, Suddaguntepalya and Binnamangala surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, NH and Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains passes through open private cultivation lands. At many locations drain reach is covered with RCC slabs by apartment developers.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.5 B. Narayanapura Kere Water Shed Region:

B Narayanapura Kere is situated on the Western region of the Mahadevapura Zone. The over flow from B Narayanapura Kere, flows into Doddanekundi Kere and further onto down stream of

Bellandur Kere. It covers a major portion densly developed Western region of the Mahadevapura Zone. Due to change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from North West to South. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 790 hectares. There are about 10 nos. of drains comprising a drain length of about 6,055 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Mahadevapura, DRDO Phase - II, B Narayanapura, Visveshwariah Industrial Estate and KIADB EPIA surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. At many locations drain reach is covered with RCC slabs by apartment developers.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.6 Vibuthipura Kere Water Shed Region:

Vibuthipura Kere is situated on the South Western region of the Mahadevapura Zone. The over flow from Doddanekundi Kere further flows towards downstream of Bellandur Kere and further onto Varthur Kere. It covers the major portion of the Western and South Western region of the Mahadevapura Zone. Two minor tank catchments, viz., Vibuthipura Kere and Doddanekundi Kere catchment forms part of this catchment area. Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The topography of the terrain in this catchment generally slopes from Northwest to south direction. The average slope of the terrain varies from 5% to 10%. The total catchment area is about 943 hectares. There are about 7 nos. of drains comprising a drain length of about 7,145 mts.

Doddanekkundi, Vibuthipura, Vijinapura, CV Raman Nagara, Sanjayanagara, Annasandrapalya, Jagadishanagara and LBS nagara catchment forms the part of the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, moderately dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, Industrial area etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by erstwhile Krishnarajapura CMC authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.7 Channappanahalli Kere Water Shed Region:

Channappanahalli Kere is situated on the South Central region of the Mahadevapura Zone. The over flow from Channappanahalli Kere, flows into Siddapura Kere and further onto down stream of Varthur Kere. It covers a major portion densly developed South Central region of the Mahadevapura Zone. Due to change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from North West to South. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 426 hectares. There are about 7 nos. of drains comprising a drain length of about 4,290 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. However, authorities have taken up Channappanahalli Kere restoration work, which is in progress.

Kundalahalli Colony, AECS Layout, Channappanahalli, Munnekolala, Gandhinagara, Munnekolala Extension surrounding area form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, Ring road, Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. At many locations drain reach is covered with BS/RCC slabs by the authorities and apartment developers.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.8 Kundalahalli Kere Water Shed Region:

Kundalahalli Kere is situated on the South Central region of the Mahadevapura Zone. The over flow from Kundalahalli Kere, flows into Siddapura Kere and further onto down stream of Varthur Kere. It covers a major portion densely developed South Central region of the Mahadevapura Zone. Due to change in land use and development of layouts and in the surrounding region, the achukatta area is disappeared and the water body is used only as storage pond. The topography of the catchment area is moderately undulating in nature, generally flat and slopes from North to South East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 494 hectares. There are about 8 nos. of drains comprising a drain length of about 3,642 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. At several locations drains original flowing software company campus have modified/diverted and remodelled by constructing RCC walls and covering the same with RCC slabs etc.

Kundalahalli AECS Layout and Thubarahalli surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, software companies, Ring road, Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. At many locations drain reach is covered with BS/RCC slabs by the authorities and apartment developers and inside IT company campus.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.9 Kadubeesanahalli Kere Water Shed Region:

Kadubeesanahalli Kere is situated on the Southern region of the Mahadevapura Zone. It covers a major portion sparsely developed Southern region of the Mahadevapura Zone. Due to change in land use and development of layouts and IT parks in the surrounding region, the achukatta area is disappeared. The topography of the catchment area is moderately undulating in nature, generally very flat and slopes from West to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 754 hectares. There are about 10 nos. of drains comprising a drain length of about 9,100 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. At several locations drains flows through open cultivation lands, wherein alignment is not clearly defined. Many locations RCC Hume pipe culverts are severely silted completely chocked and culverts require immediate reconstruction. Large scale dumping of earth to raise the adjoining the ground level near the waterway is in progress at many locations. At many locations land adjoining to SWD is used as sanitary landfill site.

Kadubeesanahalli, Kariammana Agrahara and Panathur surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Ring road, Industrial and Defence establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. At many locations drain reach is covered with BS/RCC slabs by the authorities and apartment developers and inside IT company campus.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.10 Chikka Bellandur Kere Water Shed Region:

Chikka Bellandur Kere is situated on the Southern region of the Mahadevapura Zone. It covers a major portion sparsely developed Southern region of the Mahadevapura Zone. The over flow from Chikka Bellandur Kere flows towards Varthur Kere. The topography of the catchment area is moderately undulating in nature, generally very flat and slopes from South to North. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 2,515 hectares. There are about 8 nos. of drains comprising a drain length of about 7,165 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area. The condition of the water body is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. At several locations drains flows through open cultivation lands, wherein alignment is not clearly defined. Many locations RCC Hume pipe culverts are severely silted completely chocked and culverts require immediate reconstruction. Large scale dumping of earth to raise the adjoining the ground level near the waterway is in progress at many locations.

Gubjurpalya, Gunjur, Chikka Bellandur and Balagere surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of pervious, open land with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost and close proximity to IT companies, Ring road, Industrial and Defence establishments etc. In turn resulting in drastic modification of natural alignment of drains in many locations, at many reaches, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.11 Sheelavanthana Kere Water Shed Region:

Sheelavanthana Kere is situated on the South Eastern region of the Mahadevapura Zone. The over flow from Pattandur Agrahara Kere and Nallurahalli Kere flows into Sheelavanthana Kere and further flows towards down stream of Varthur Kere. It covers a major portion densely developed South Eastern region of the Mahadevapura Zone. Due to change in land use and development of layouts, IT companies, Hitech Hospitals, Apartments, Villas in the surrounding region, the achukatta area is disappeared and the water bodies are used only as storage ponds. The topography of the catchment area is moderately undulating in nature, generally very flat and slopes from North to South East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,051 hectares. There are about 19 nos. of drains comprising a drain length of about 12,775 mts.

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. At several locations original alignment of drains which flow between residential villas have been modified/diverted and remodelled by constructing RCC walls and covering the same with RCC slabs etc. At many locations flows from SWD is diverted and utilised for agricultural activity.

Pattandur Agrahara, Sathya Sai Hospital Surrounding area, Nallurahalli, White Field, Gandipura, Hagaduru, Siddapura and Happy Valley surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT companies, Hytech Hospitals, Ring road, Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. At many locations drain reach is covered with BS/RCC slabs by the authorities and apartment and villas developers.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.12 Varthur Kere Catchment:

Varthur Kere is situated on the Southern peripheral region of the Mahadevapura Zone. The over flow from Varthur Kere flows further towards Pennar River. It covers the major portion of the Central and North Eastern region of the Mahadevapura Zone. Four minor tank catchments, viz., Vibuthipura Kere, White Field Kere, Kundalahalli Kere, Siddapura Kere Catchment forms part of this catchment area. In addition to Bellandur Kere catchment (Koramangala & Challaghatta Valley of Core Area). Due to breaching of ponds on the upstream side, stoppage of agricultural activity, change in land use and development of layouts, IT companies, hi-tech hospitals, apartments, defence establishments etc in the surrounding region, the achukatta area is disappeared and these water bodies are used only as storage ponds.

The water bodies situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. The topography of the terrain generally slopes from North to South direction. The average slope of the terrain varies from 5% to 10%. Many drains flows through open cultivation lands. Arch bridge constructed near Varthur is in bed condition, flow from SWD is diverted and utilised for cultivation. River training works required at many locations to regulate the flow. Weir strengthening works required at many locations. Due to insufficient bed gradient, severe siltation, vegetation growth water stagnation observed at many locations. The total catchment area is about 707 hectares. There are about 18 nos. of drains comprising a drain length of about 10,350 mts.

Munnekolala, Balagere, Panathur, Gunjurpalya, Siddapura, and Varthur forms part of this catchment. In addition to Bellandur Kere catchment forms the contributory areas of this catchment. The development of land in these localities lies in the category of impervious, highly dense built up area with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, IT parks, defence and industrial areas etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many locations in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

3.1.7.13 Valepura Kere Water Shed Region:

Valepura Kere is situated on the South Eastern region of the Mahadevapura Zone. The over flow from Chikkanekundi Kere flows into Valepura Kere and further flows towards down stream of Varthur Kere. It covers a major portion of South Eastern region of the Mahadevapura Zone. Due to change in land use and development of layouts, IT companies, Hitech Hospitals, Apartments, Villas in the surrounding region, the achukatta area is disappeared and the water bodies are used only as storage ponds. The topography of the catchment area is moderately undulating in nature, generally very flat and slopes from West to East. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 720 hectares. There are about 17 nos. of drains comprising a drain length of about 14,825 mts..

The drains situated in the catchment area are severely silted, dense vegetation growth, dumping of debris, development of land upto edge of water way, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of the water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection. At many locations flows from SWD is diverted and utilised for agricultural activity. Condition of overflow weir is in moderate condition, river training works required at many locations to regulate the flow.

Sorhunase, Valepura, Madhuranagara and Ajagondahalli and Thimmadahalli surrounding areas form the contributory catchment areas. The development of land in these localities lies in the category of pervious, open land with sparse vegetal cover.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, and close proximity to educational institutions, IT companies, Hytech Hospitals, Ring road, Industrial and Defence Establishments etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum / low income housing areas without proper infrastructure facilities adjacent to water ways, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment. Few drains pass through open private cultivation lands. The drains situated in this region are not properly defined and majority of them are unlined. Culverts/bridges have been constructed at number of locations and are constructed without studying the hydraulic requirements of the entire catchment in detail. Existing culverts are mostly of RCC Hume pipe culverts. Due to lack of maintenance, large quantity of silt and garbage accumulation is observed at many culvert locations. Many Humepipe culverts are in bad condition require reconstruction. Due to insufficient bed gradient sewage stagnation inside SWD is observed.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Large number of cross drains is with multiple spans and raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 7.**

The details of the drains considered for remodelling at Mahadevapura Zone is as indicated in the **Table – 1, Part 2, Appendix 7**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig MD-ED-01, Part 4, Appendix 7 shows the extent, catchments, primary and secondary drains in Mahadevapura.

3.1.8 RAJA RAJESHWARI NAGARA ZONE

In the present study for ease of assessment, Raja Rajeshwari Nagara Zone is demarcated into Ten water shed regions as detailed in **Table – 3.10** and the same depicted in **Fig RN-WS-01** in **Part 4, Appendix 8**.

Table 3.10 Details of Major Water Shed Regions in Rajarajeshwarinagara Zone

Sl. No.	Name of Watershed Regions	Watershed Catchment Area (Ha.)	No. of Micro Catchments in the Watershed Regions (Nos.)	No. of Storm Drains in the Watershed Region (Nos.)	Total Length of Storm Drains in the Watershed Region (Kms.)
1	SuliKere Kere	2,240	1	1	7.00
2	Kammaghatta Kere	2,664	11	10	18.00
3	Herehalli Kere	1,429	6	5	6.00
4	Muddayannapalya Kere	1,960	30	31	30.21
5	Hosahalli Kere	1,072	11	10	10.20
6	Konnasandra Kere	2,147	12	11	28.01
7	Halagevadarahalli Kere	799	12	11	8.58
8	Subramanyapura Kere	2,475	32	31	32.11
9	Kamayanapalya Kere	580	3	2	2.15
10	Nayanandahalli Kere	1,377	19	2	10.43
	Total	**16,743**	**107**	**114**	**152.69**

* Drain lengths indicated includes drain beyond BBMP Boundary which is considered only for hydraulic analysis purpose.

However, in the present project for formulating the proposals, preparation of budget cost estimates and drawings purposes, following six water shed catchment areas have been considered. Remaining four water shed regions are situated beyond zonal boundary. However, runoff generated from these four water shed regions have been considered for hydraulic analysis purposes.

1. Muddayanna Palya Kere watershed region 04-RN,
2. Hosahalli Kere watershed region 05-RN,
3. Konnasandra Kere watershed region 06-RN,
4. Halagevadarahalli Kere watershed region 07-RN,
5. Subramanyapura Kere watershed region 08-RN
6. Kamayanapalya Kere watershed region 09-RN,

3.1.8.1 Muddayanapalya Kere Water Shed Region:

Muddayyanapalya Kere water shed region is situated on the Northern region of the zone. The over flow from Muddayyanapalya Kere flows into Subashnagara Kere and further on to Hosahalli Kere and further flows towards Vrishabhavathi river near Mysore road. It covers the major portion of the Northern region of the zone. Two minor tank catchments, viz., Ullala Kere and Subashnagara Kere forms part of this catchment area. The topography of the terrain generally slopes from North to South average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,960 hectares. There are about 31 nos. of drains comprising a total drain length of about 30,205 mts.

Major portion of the catchment area comes under the jurisdiction of BDA. The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover.

Annapurneshwarinagara, Ullalla, Ullalla upnagara, Malathalli, Ghanabharathi badavane, Vieshwariah Layout, Subashnagara, Hosahalli, Railwaymen layout, Kengeri & Kengeri upanagara forms the contributory areas of this catchment

The water bodies situated in the catchment area viz. Muddayanapalya Kere, Ullalla Kere, and Subashnagara Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides are lined with masonry walls and bed unlined especially in recently developed residential layouts. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Also, drain reach is in natural condition at certain patches. Culverts/bridges have been constructed at

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by BWSSB or erstwhile Municipal authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has taken up several drain improvement works in this catchment area under GOK funds. RCC side wall construction, CC bed protection and culverts remodelling has been taken up at certain reaches and which is nearing completion. Due to which few low lying areas viz., Malathalli, Ullalla Main Road, Subashnagara in the region have been averted from the problem of flooding.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

3.1.8.2 Halagevaddarahalli Kere Water Shed Region:

Halagevaddarahalli Kere is situated on the South Central region of the Rajarajeshwarinagara Zone near to Mysore road. The over flow from Halagevaddarahalli Kere flows into Kenchanahalli Kere and further joins Vrishabhavathi River near Janapriya Apartments situated on Mysore road. It covers the major portion of the Central and south eastern region of the zone. One minor tank catchment, viz., Kenchanahalli Kere forms part of this catchment area. The topography of the catchment area generally slopes from East towards West average slope of the terrain vary from 10% to15%. The total catchment area is about 799 hectares. There are about 11 nos. of drains comprising a drain length of about 8,575 mts..

The development of land in these localities lies in the category of pervious, built up area with sparse vegetal cover. Portion of the catchment area in the central region comprises of Sri. Rajarajeshwari Temple complex, Sri. Nimeshamba Temple, open parks, IT park (Global Village) etc.,

Rajarajeshwarinagara, Halagevadarahalli, Kenchanahalli, Ideal Home Layout, BEML Layout forms the contributory areas of this catchment

The water bodies situated in the catchment area viz., Halagevaddarahalli Kere and Kenchanahalli Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of Halagevaddarahalli Kere is better compared to Kenchanahalli Kere since it is recently rejuvenated and maintained by the authorities. But the condition of Kenchanahalli Kere is in very pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Since, most of the drains in this catchment area passes through densely developed areas, Buildings have been already constructed on either side upto the edge of the drain, large number of utility crossing observed in almost at every location, drastic modification of natural alignment of drains and encroachment of Raja Kaluves at many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, street sweeping and dumping of waste materials into/near the water ways near the Market area and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides is lined with masonry walls and bed unlined. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Culverts/bridges have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth & garbage accumulation is observed in the drains.

There is no attempt made by the urban development authorities for formation of service roads on either side for routine maintenance of the drains and for laying of service lines except in few reaches. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

3.1.8.3 Subramanyapura Kere Water Shed Region:

Subramanyapura Kere water shed region is situated on the South Eastern region of the zone. The over flow from Subramanyapura Kere flows towards Vrishabhavathi river near Mysore road. It covers the major portion of the South Eastern region of the zone. Four minor tank catchments, viz., Uttarahalli Kere, Dore Kere, Bikasipura Kere and Vasanthapura Kere forms part of this catchment area. The topography of the terrain generally slopes from East towards South average slope of the terrain vary from 10% to 15%. The total catchment area is about 2,475 hectares. There are about 31 nos. of drains comprising a total drain length of about 32,110 mts.

The development of land in these localities lies in the category of impervious, built up area with sparse vegetal cover except in few reaches.

Kumaraswamy layout, Uttarahalli, Samurudhinagara, LIC colony, Vasanthapura, Gowdanapalya, Sarabhumanagara, Poorna Pragna Layout, ISRO layout, Chikkasandra, and Subramanyapura forms the contributory areas of this catchment

The water bodies situated in the catchment area viz. Uttarahalli Kere, Dore Kere, Bikasipura Kere, Subramanyapura Kere and Vasanthapura Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of these water bodies are in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

The landuse pattern in this catchment area is changing in a very fast pace, due to better appreciation of land cost, planned layouts with necessary infrastructure and close proximity to educational institutions, hospitals, IT companies etc. In turn resulting in drastic modification of natural alignment of drains and encroachment of Raja Kaluves in many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, sediment transport, dumping of construction debris and other waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides are in natural condition. In some places in the initial reaches the drain sides are lined with masonry walls and bed unlined especially in recently developed residential layouts. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Culverts/bridges have been constructed at number of locations have been constructed without studying the hydraulic requirements of the entire catchment in detail and even without adopting rudimentary engineering practices. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains.

There is no provision made in the development plans by the urban development authorities and private land developers for formation of service roads on either side for routine maintenance of the drains and for laying of service lines, except at few locations in this region. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Manholes constructed by BWSSB or erstwhile Muncipal authorities is protruding above the drain bed level and causing accumulation of floating materials inside the drains. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

However, BBMP has taken up several drain improvement works in this catchment area under GOK funds. RCC side wall construction, CC bed protection and culverts remodelling has been taken up at certain reaches and which is nearing completion. Due to which few low lying areas viz., Samrudinagara etc has been averted from the problem of flooding.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

3.1.8.4 Hosahalli Kere Water Shed Region:

Hosahalli Kere is situated on the South Central region of the Zone situated close to Mysore-Bangalore Railway line. The over flow from Hosahalli Kere joins Kengeri Kere on Mysore road and further flows towards Vrishabhavathi river. It covers the major portion of the Central and southern region of the Zone. One minor tanks catchment, viz., Kukarahalli Kere forms part of this catchment area. The topography of the catchment area generally slopes from North to South average slope of the terrain vary from 5% to 10%. The total catchment area is about 1,072 hectares. There are about 10 nos. of drains comprising a drain length of about 10,200 mts.

The development of land in these localities lies in the category of pervious, dense built up area with sparse vegetal cover.

Hosahalli, Kengeri Village, Kengeri New Town, Bandematta area forms the contributory areas of this catchment.

The water bodies situated in the catchment area viz., Hosahalli Kere and Kengeri Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life. The condition of Kengeri Kere is better compared to Hosahalli Kere since it is recently rejuvenated and maintained by the authorities. But the condition of Hosahalli Kere is in pathetic situation and requiring immediate attention of the authorities for rejuvenation and protection.

Since, most of the drains in this catchment area passes through old areas of the Kengeri town the development has already taken place on either side upto the edge of the drain, large number of utility crossing observed in almost at every location, drastic modification of natural alignment of drains and encroachment of Raja Kaluves at many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, industrial and commercial establishments discharging raw effluents into SWD, street sweeping and dumping of waste materials into/near the water ways near the Market area and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides is lined with masonry walls and bed unlined. Condition of the drain walls are in moderate condition at many locations, coping concrete and drain wall pointing is damaged at many locations. Culverts/bridges have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains.

There is no attempt made by the urban development authorities for formation of service roads on either side for routine maintenance of the drains and for laying of service lines. Development of buildings upto the edge and even over the drain walls at certain instances is observed. Tertiary drain bed level and main drain bed levels are same at many locations, result of which water surcharges into residential areas from the main drain and stagnates for long hours during heavy showers. Large number of cross drains is with multiple spans and also having number of cables / utility lines crossing the drains is observed. Raw sewage from unsewered areas and slum areas is finding its way directly into SWD and also at many locations sewage outlets from residential buildings are directly connected to SWD. Manholes are damaged / chocked at many locations and sewage allowed into SWD.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

3.1.8.5 Konnasandra Kere Water Shed Region:

Konnasandra Kere is situated on the Southern region of the Zone situated close to Mysore-Bangalore State Highway - 17. The over flow from Konnasandra Kere flows towards Vrishabhavathi river. It covers the major portion of the southern region of the Zone. Three minor tanks catchment, viz., Jettiganahalli Kere, H Gollahalli Kere and Devara Gollahalli Kere forms part of this catchment area. The topography of the catchment area is moderately undulating in nature and slopes from North to South. Average slope of the terrain vary from 5% to 10%. The total catchment area is about 2,147 hectares. There are about 11 nos. of drains comprising a drain length of about 28,010 mts.

The development of land in these localities lies in the category of pervious, sparse built up area with sparse vegetal cover.

Konnasandra Village, Gollahalli area and along side Mysore Road area forms the contributory areas of this catchment.

Vrishabhavathi river flows through this water shed region. The river course is in natural condition without side lining, dense vegetation growth, large quantity of debris dumping, and sewage flow is observed.

The water bodies situated in the catchment area viz., Konnasandra Kere, H. Gollahalli Kere and Devara Gollahalli Kere are severely silted, dense vegetation growth, dumping of debris, encroachment of tank area, large quantity of sewage flow is observed in turn resulting in deterioration of ground water quality, endangering the city's environs and aquatic life.

Since, most of the drains in this catchment area passes through old Village areas the development has already taken place on either side upto the edge of the drain, large number of utility crossing observed in almost at every location, drastic modification of natural alignment of drains and encroachment of Raja Kaluves at many locations, development of slum areas without proper infrastructure facilities adjacent to water ways, due to space constraint authorities have laid sewer pipelines and manholes inside SWD at many reaches, dumping of waste materials into/near the water ways and ultimately reaching the water bodies is seen at many locations in this catchment.

The majority of storm water drain sides are in natural condition Culverts/bridges have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth and garbage accumulation is observed in the drains.

Road side drains are lined with burnt stone slabs in certain reaches and with masonry walls in certain reaches in few layouts and in some they are in natural condition. The road side drains are usually covered at certain reaches in the developed and busy commercial areas, which are filled with garbage and sediment deposits which ultimately enter into the main drain.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

3.1.8.6 Kamayanapalya Kere Water Shed Region:

Kamayanapalya Kere catchment is situated on the Southern region of the zone situated near Kanakapura road. The topography of the catchment area generally slopes from North East to South direction average slope of the terrain vary from 5% to 10%. The total catchment area is about 580 hectares. There are about 2 nos. of drains comprising a drain length of about 2,150 mts.

This is the smallest of the watershed regions. The development of land in these localities lies in the category of pervious, sparse built up area with sparse vegetal cover. A small portion of the catchment area i.e., on the southern side of the catchment is still under cultivation Kamayanapalya Village forms the contributory areas of this catchment

The majority of storm water drain sides are in natural condition Culverts have been constructed at number of locations with multiple spans and BS slabs. Due to lack of maintenance, large quantity of silt, vegetation growth & garbage accumulation is observed in the drains.

The existing details of each storm water drain and CD works in the respective water shed region are given in **Section 1, Part 1, Appendix 8.**

The details of the drains considered for remodelling at Rajarajeshwarinagara Zone is as indicated in the **Table – 1, Part 2, Appendix 8**. The length and no. of drains indicated in the table is prepared based on actual topographic survey and physical survey carried out at site.

Fig RN-ED-01, Part 4, Appendix 8 shows the extent, catchments, primary and secondary drains in Rajarajeshwarinagara Zone.

CHAPTER - 4

PLANNING PROCESS

4.0 INTRODUCTION:

Until the recent times, urban storm drainage design served only to devise measures to protect urban development from storm water. It usually consisted of evaluating the peak runoff rate and designing a network of drains and ditches to collect and convey the storm water downstream, just away from the urbanised area. Stream flood plains and sewerage systems were considered separately, and urban run off was regarded merely an adjunct consideration in land use planning. The urban development and industrialisation that is taking place cumulatively in the past yielded new public demands and policies which require the use of true comprehensive planning including integrated land and water management with greater emphasis placed on the total impact of projects and the overall optimal solution as opposed to optimising individual devises for presumed sets of criteria Thus urban drainage policy and design practices are currently undergoing a transition period with focus on new storm water management techniques and related costs and environmental concerns. Some of the new methods being used or proposed are yet to be proven on by practical application since the transition to new techniques is a long term, continual process

An orderly urban growth is dependent on a well defined urban storm drainage policy in terms of a master plan. Dual drainage system concept comprising a major drainage system and a minor system is increasingly considered in addressing drainage problems. A master plan can provide a drainage development guide covering the major system which includes major channels (natural or manmade) and a definition of any corresponding flood plains with the aim that the capacity of the major system being sufficient to minimize loss of life and major damage. In the current study, the major drainage system is considered to include the primary and secondary drains together with the inter linked water bodies while the minor drainage system is considered to be the tertiary urban drainage comprising street drains and inlets. The protection provided by minor system is generally to reduce localized flooding and complaints from residents with whatever flooding that occurs not resulting in major economic loss on an individual basis or loss of human life and therefore the minor system being designed to handle the more frequent, less intense storms. The required extent of the minor system is obviously a function of the design of the major drainage system and is essentially dependent on the distance to the outfall to the major system and its hydraulic interaction with the minor system. Therefore, the design of the major system can significantly affect the design and extent of the minor system. The main benefit of using the dual drainage concept is the possibility of reducing the size and extent of expensive storm sewer installations.

4.1 GENERAL PRINCIPLES FOR STORM WATER MANAGEMENT:

Unlike in the past when the trend was towards removing storm rainfall from urban areas to the receiving water body as quickly as possible which invariably resulted in rechannelization, straightening, lining, or conversion to storm sewers of natural streams in many urban areas and as the natural easement for flow could only be denied with great effort resulting in relatively expensive storm water drainage systems, current trend in design is towards the use of temporary storage facilities which reduce the peak storm water runoff and hence the reduced size and extent of downstream drainage requirements. Temporary storage can be provided not only by means of artificial facilities but also by maintaining the natural stream conditions wherever possible.

Besides encouraging the use of natural channels and artificial storage facilities other methods like discharge of roof drains onto pervious surfaces or temporary storage, construction of minor roadways with adequate slope to act as drainage plane, encouragement of site grading patterns that increase overland flow distances over pervious surfaces are also considered for implementation; use of such methods, however requires accurate methods of accounting for the quantity of runoff in both time and space for specific storm events. This requires the use of hydrograph methods as opposed to the Rational method which only gives peak flows.

4.2 STAGES IN PLANNING AND DESIGN:

The planning process may be seen to comprise broadly a number of steps comprising;

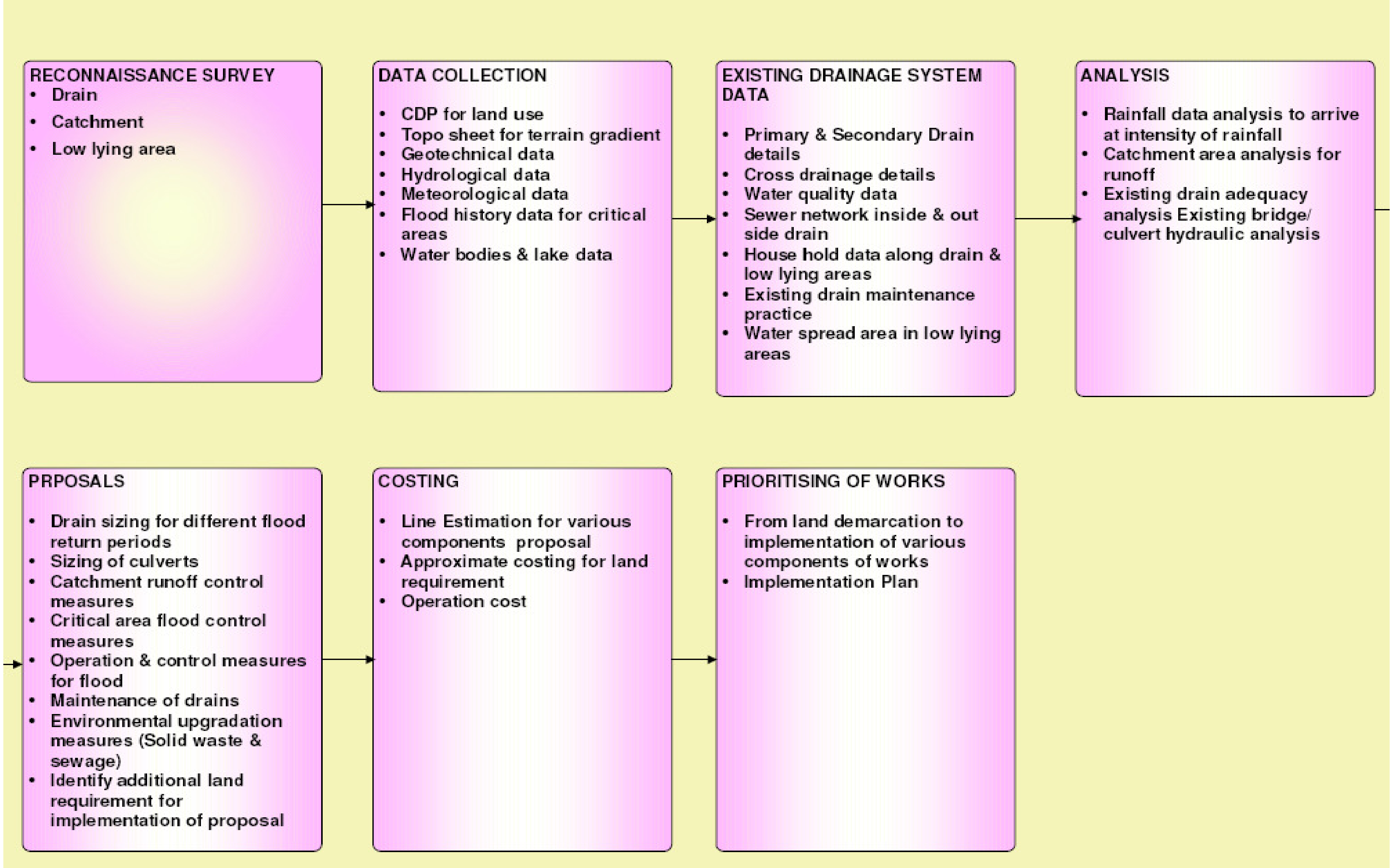
- Defining problems together with establishing goals and identified constraints
- Assembling data and refining definitions of problems
- Formulating and analysing alternatives
- Identifying more promising alternatives evaluating trade offs among selected alternatives

Foregoing translated into a number of engineering steps involves;

- Identifying sinks for the storm runoff
- Understanding existing system with the allied issues
- Defining planning parameters
- Assessing foreseeable runoff
- Forming a network to collect runoff and quickly evacuate the same upto the sink including Assessing adequacy or otherwise of existing system components
- Determining the additional components of the Masterplan
- Building in devices to regulate flows if and when required
- Defining measures to implement and ensuring the sustainability of the system

Masterplanning process followed is schematically shown in **Fig. 4.1.**

Fig. 4.1: Master Plan Process



4.2.1 IDENTIFYING SINKS FOR THE STORM RUNOFF:

Description of the Study Area being given in Section 2.1 together with the topography and **Fig. 2.1** showing the general directions of flow, ultimate sinks considered therein shows the following:

The North, North Eastern and South Eastern portion of the city which include a portion of West zone and South Zone from the core area, East Zone, Bytarayanapura Zone, Mahadevapura Zone and Bommanahalli Zone have the topography sloping towards South Eastern side and form part of contributory catchment area for Ponniyar River basin which flow towards Krishnagiri Dam in Tamil Nadu.

North Western region of the city comprising a portion of Dasarahalli Zone form part of contributory catchment area for Thippagondanahalli Kere, which is a situated in Arkavathi River Basin, near Magadi, which is again a tributary of River Cauvery.

Western region, South Western region and Southern region which include a portion of South zone and West zone, portion of Dasarahalli Zone and Rajarajeshwarinagara zone have the topography sloping towards Southern side and form part of contributory catchment area for Vrishabhavathi River, which is a situated in Arkavathi River Basin also which is again a tributary of River Cauvery. Vrishabhavathi River flows towards Byramangala Reservoir situated near Bidadi and further joins River Cauvery at Mekedattu near Kanakapura. While the macro picture is aforementioned, details on micro level vary as described under appropriate watersheds.

4.2.2 UNDERSTANDING EXISTING SYSTEM WITH THE ALLIED ISSUES:

Based on the natural topography of the project area and depending upon topographic features the study area is demarcated into major and minor water shed catchment areas with the demarcation of these water shed catchment areas using available contour maps and Arc view GIS software is described in Chapter 2. There are 8 Major Watersheds and 134 Minor Watersheds in the East Core Zone, 4 Major Watersheds and 87 Minor Watersheds in the West Core Zone, 4 Major Watersheds and 69 Minor Watersheds in the South Core Zone, 11 Major Watersheds and 236 Minor Watersheds in the Bommanahalli Zone, 9 Major Watersheds and 129 Minor Watersheds in the Bytrayanapura Zone, 7 Major Watersheds and 94 Minor Watersheds in the Dasarahalli Zone, 16 Major Watersheds and 300 Minor Watersheds in the Mahadevapura Zone and 9 Major Watersheds together with 118 Minor Watersheds in the Rajarajeshwarinagara Zone.

Assessment of the existing drainage system in terms of water bodies, low lying areas, impact of poor drainage system, impact of solid waste on drainage system, conflicts between sewers and storm drains, environmental conditions etc., are discussed in Chapter 2 while detailed description of the individual watersheds are given in Chapter 3.

4.2.3 DEFINING PLANNING PARAMETERS:

4.2.3.1 Planning Horizon:

Present Masterplan of a storm drainage system covers the entire urban area of BBMP indicating the existing conditions as well as different future development and implementation stages upto the planning horizon. Planning in drainage studies is best done on watershed basis and not administrative or other basis.

Considering the relatively long design life of drainage structures, it is necessary to consider development factors in the watershed being analysed. Such factors include the population trends, comprehensive land use and zoning plans, location of future roads, development of land for industrial, commercial and residential purposes which may affect the drainage design. Because of large uncertainties in projections of development trends and the resulting uncertainties in the need and utilisation of physical facilities, the planning process may be considered more as an art than a science.

The planning may be undertaken at two levels short term and a long term planning. Short term plans relate to the drainage facilities planned for the proposed development plans of the immediate foreseeable future while the long term planning reflects the ultimate development of the watershed and is based on the longer development period. The short term plans, which should be consistent with the long term plans, need to be updated periodically to account for the actual development taking place and to reflect changes in technology and engineering practices.

While the planning horizon reflects the envisaged land use projected for a certain number of years the Design period of drainage structures indicates the expected level of protection against such phenomenon as flooding, health hazards or the deterioration of quality in the receiving waters; besides the desired level of protection, the design period depends on construction cost and damage losses from system failures. Thus while there is only one planning horizon, the design periods may differ for the individual components of the system.

4.2.3.2 Design Return Period:

Urban storm sewers and drainage ditches are generally designed based on the concept of the design storm of a selected return period. In general the selection of the design event return period is affected by the design life of structures involved, construction cost and damage cost resulting from the system failure. Drainage structures are typically characterized by long design life and so the ideal design period should be one for which the total annual drainage costs, defined as the sum of annual construction and drainage failure costs are minimal.

While the foregoing may be true for major system, urban storm drainage system being minor system does not warrant a detailed analysis of construction and failure costs but must evaluate acceptable risk caused by the failure of the system, depending on whether it is a major or minor drainage system.

Major drainage system comprises natural streams and valleys as well as man made elements such as swales, channels, and ponds. The system should accommodate runoff from infrequent storms with long return periods. Damage caused by the failure of a major drainage system and the associated risks are loss of agricultural yield, damage to properties and even loss of life. Minor drainage system consists of swales, streets gutters, catch basis, storm sewers and surface and subsurface detention facilities. The minor system, designed to convey runoff from frequent storms with return periods i.e. from one to two years, primarily reduces the frequency of inconvenience caused by storm water ponding to both pedestrians and motorists. The consequences of failure of minor drainage are often insignificant provided the connected major drainage system is properly functioning.

Thus the selection of design return period for urban storm sewer depends on the importance of area to be drained. Commercial and industrial areas have to be subjected to less frequent flooding. Recommendations given in the Manual on Sewerage and Sewage Treatment published by the Ministry of Urban Development are shown in **Table – 4.1**

Table – 4.1 Recommended Return Periods for Storm drainage Design

Type of Area	***Return Period or Frequency***
Peripheral Residential areas	Twice a year
Central and comparatively high priced areas	Once a year
Commercial and high period areas	Once in two years

As the study area is fairly developed (with or without appropriate planning guidelines), the division between long and short term planning being a very thin line, it is considered in this study that the planning horizon and design period is taken as 5 years. However, base on discussions with BBMP while reviewing the Interim Report, 1, 2 & 5 year return periods are considered to reflect Short Term, Mid Term and Long Term Design Periods.

In deterministic hydrological calculations, it is assumed that the relationship between many interactive factors affecting the water balance can be defined analytically and numeric values used to quantify the movement and storage of water are called parameters. Runoff coefficients adopted in urban storm drainage design are considered as the aggregate values taking into account such process parameters like infiltration rates, depression storage, roughness of transport elements etc.

4.2.4 ASSESSING FORESEEABLE RUNOFF:

Construction of Intensity - Duration - Frequency curves is an essential activity for the formulation of the planning of storm drainage system in the study area. Rainfall data pertaining to Bangalore were collected from the Indian Meteorological Department for the period 1976 to 2008. Of these, data for the period 1976 to 2000 give short term rainfall duration in intervals of 15 minutes while the data for the period 2002 to 2008 are hourly rainfalls.

4.2.4.1 Analysis of Data:

Methods used for the analysis of available data relate to the quality and length of data and include IMD Method, CPHEEO Manual Method, California Method of Ranking, Gumbel's Distribution Method etc. As hourly rainfall data and rainfall of 15 minutes duration are available, for different periods, following methods were used for the analysis of data.

When Daily Rainfall Data are available

From the available data daily rainfall information was extracted and used in this analysis. Procedure followed is as given below:

- Collect the Daily rainfall data of as many years (from 1976 to 2008)
- Extract the Maximum value for each year, which forms an annual series of 24 hrs maximum rainfall values.
- Convert the maximum values series into shorter durations (1hr, 2hr, 3hr,……12hr) using IMD's reduction formula.

$$P_t = P_{24} (t / 24)^{1/3} \quad \text{------- Equation -1}$$

Where, P_t Rainfall depth for 1, 2, 3……. Hrs

t Duration in hrs

- Now, it is required to fit the above rainfall series into a suitable frequency distribution
- Some of the commonly used frequency distribution functions for the prediction of extreme values are:
  Gumbel's Extreme – Value distribution (EV-1).
  Log-Pearson Type-III distribution
  Log Normal Distribution.

- Calculate the mean precipitation (Pm) & Standard deviation (s) for each series.
- From the above, calculate the values of location(u) and scale parameters(α).

$$\alpha = \frac{\sqrt{6}}{\pi} s \qquad u = P_m - 0.5772\alpha$$

where u and α are location and scale parameters.

- Then the rainfall series will be ranked in increasing order of magnitude and find out the Plotting positions. For this analysis the unbiased plotting position for Gumbel (EV1) distribution, developed by Gringorten was used with Plotting Position (Fi) & Reduced variate (Yi).

$$F_i = \frac{i - 0.44}{N + 0.12} \qquad y_i = -\ln(-\ln(F_i))$$

- Calculate the Precipitation by using the EV-1 distribution plot. Pi = u + α Yi for each hour.
- Plot a Graph between Yi & Pi and P(observed).
- Calculate the Extreme Rainfall depth for a specific return period(T^r) by using EV-1 frequency factor (K_r)
  $P_d = P_m + K_r * s$;
  Where P_m= Mean Precipitation in 'mm', s = Std. dev.
  K_r = - (Sqrt(6)/3.14) * [0.5772 + Ln(-Ln(1- 1/T_r))]
- Calculate the Mean intensity Im= (P/duration) mm/hr.
- The inter dependency of Intensity-Duration-Return period commonly expressed as
  $I = C(T)^m / (t)^n = a / (t)^n$.
- Where as T= return period, t = duration of the Storm, C,m,n are regional parameters

Following the procedure given above, analysis made is given in **Annexure - 1** along with IDF curves drawn for 1 year, 2 year, 5 year and 10 year Return Periods.

When Hourly Rainfall Data are available;

Hourly rainfall data as available was used following the procedure as given below:

- Collect the hourly rainfall data. (from 2002 to 2008)
- Prepare the Total Wet Inventory (by deleting the zero rainfall).
- Identify the heavy rainfall data (Generally any rainfall equal to 3 mm or less accumulated in one hr has been considered negligible).
- Tabulate the heavy rainfall data into total rainfall groups of specified storm durations (spells) i.e. 1hr, 2hr, 3hr…….12hr. Also group the rainfall intensities (3-4.99, 5-9.99, 10 – 15.99 etc..
- Compute the number of occurrences for different categories of rainfall intensities.
- Determine the number of storms of stated intensity (mm/hr.) or more with respect to duration for a particular year
- Determination of no of occurrences of flood for different frequencies. i.e 6 months storm occurrence in a 30 year data =30 x 12/6 = 60 times in 30 years.
- The time intensity values are interpolated from these data by finding:

a) For each specified duration, the intensity that is equaled or exceeded by the desired storm frequency.

b) For each specified intensity, the duration that is equaled or exceeded by the desired storm frequency.

Using simple interpolation method outlined above, the intensity duration values for different pre-determined storm frequencies can be computed

Following the procedure given above, analysis made is given in **Annexure - 1** along with IDF curves drawn for 1 year, 2 year, 5 year and 10 year Return Periods.

When Short Term Heavy Rainfall Data are available;

Rainfall data collected for the period 1976 to 2000 give rainfall volumes measured in 15 minute intervals. These data are considered as short term rainfall data. Procedure followed is as given below:

- Collect the available rainfall data (from 1976 to 2000)
- Identify the heavy rainfall data.
- Construct a frequency distribution table of intensities and durations
- Identify time ranges for specified intensities and number of occurrences, occurrences being

defined the length of record divided by the return period (A 2 year return period in a 30 year record will be 30/2 = 15)

- Construct Intensity versus Duration by interpolation.
- Develop Intensity – Duration Curve for each return period in the form

$$i = \frac{a}{t^n}$$

Following the procedure given above, analysis made is given in **Annexure - 1** along with IDF curves drawn for 1 year, and 2 year, 5 year and 10 year Return Periods.

Analysis of Results:

Intensity – Duration computations by methods as discussed above are discussed below:

Tables –4.2, 4.3 & 4.4 shows the comparison of Intensity – Duration equations for 2, 5 & 10 year return periods developed as Power, Logrithmic and Polynomial equations.

Table – 4.2 Comparison of Results of Analysis – 2 Year Return Period

SL.No.	Basis Data	Intensity - Duration Equations	R^2	Calculated intensities, mm/hr for 60 mins duration
1	Daily	$Y=363.66X^{-0.67}$	1.0000	23
		$Y=2347.20X^{-0.8523}$	0.6919	71.6
2	Hourly	$Y=-17.669Ln(X)+123.29$	0.9093	50.9
		$Y=2E^{-6}X^2-0.0751X+48.77$	0.9799	44.3
		$Y=137.02X^{-0.2619}$	0.9067	46.9
3	Short Duration	$Y=-13.92Ln(X)+104.13$	0.9456	47.1
		$Y=-1E^{-4}X^2-0.3792X+70.13$	0.9901	47.4

Table – 4.3 Comparison of Results of Analysis – 5 Year Return Period

SL.No.	Basis Data	Intensity - Duration Equations	R^2	Calculated intensities, mm/hr for 60 mins duration
1	Daily	$Y=478.85X^{-0.67}$	1.0000	31
		$Y=669.07X^{-0.539}$	0.6557	73.6
2	Hourly	$Y=-16.852Ln(X)+130.15$	0.8260	61.2
		$Y=-1E^{-5}X^2-0.0571X+57.33$	0.9521	53.9
		$Y=219.61X^{-0.3506}$	0.9234	52.3
3	Short Duration	$Y=-20.41Ln(X)+137.07$	0.9698	53.5
		$Y=0.002X^2-0.6711X+88.18$	0.9795	55.1

Table – 4.4 Comparison of Results of Analysis – 10 Year Return Period

SL.No.	Basis Data	Intensity - Duration Equations	R^2	Calculated intensities, mm/hr for 60 mins duration
1	Daily	$Y=589.65X^{-0.67}$	1.0000	38
		$Y=240.10X^{-0.3148}$	0.7637	66.16
2	Hourly	$Y=-12.855Ln(X)+114.49$	0.7870	61.9
		$Y=-6E^{-6}X^2-0.0478X+59.63$	0.9271	56.7
		$Y=189.04X^{-0.2855}$	0.9555	58.7
3	Short Duration	$Y=-18.356Ln(X)+134.92$	0.9799	59.6
		$Y=0.0024X^2-0.674X+92.32$	0.9946	60.6

Foregoing analysis has only power equation for the daily rainfall. Hourly and 15 minute rainfalls are analysed with power, logarithmic and polynomial equations because of the variations seen between methods.

Comparison of results and selection of an IDF curve is made based on the rainfall curves given by IMD, variation measured in terms of R^2 and consistency between methods.

Maximum Hourly Rainfall contours issued by Indian Meteorological Department given in **Figure – 4.2** & **Figure – 4.3** shows a rainfall intensity of about 4cm/hr for a 2 year Return Period and 5cm/hr for a 5 year Return Period.

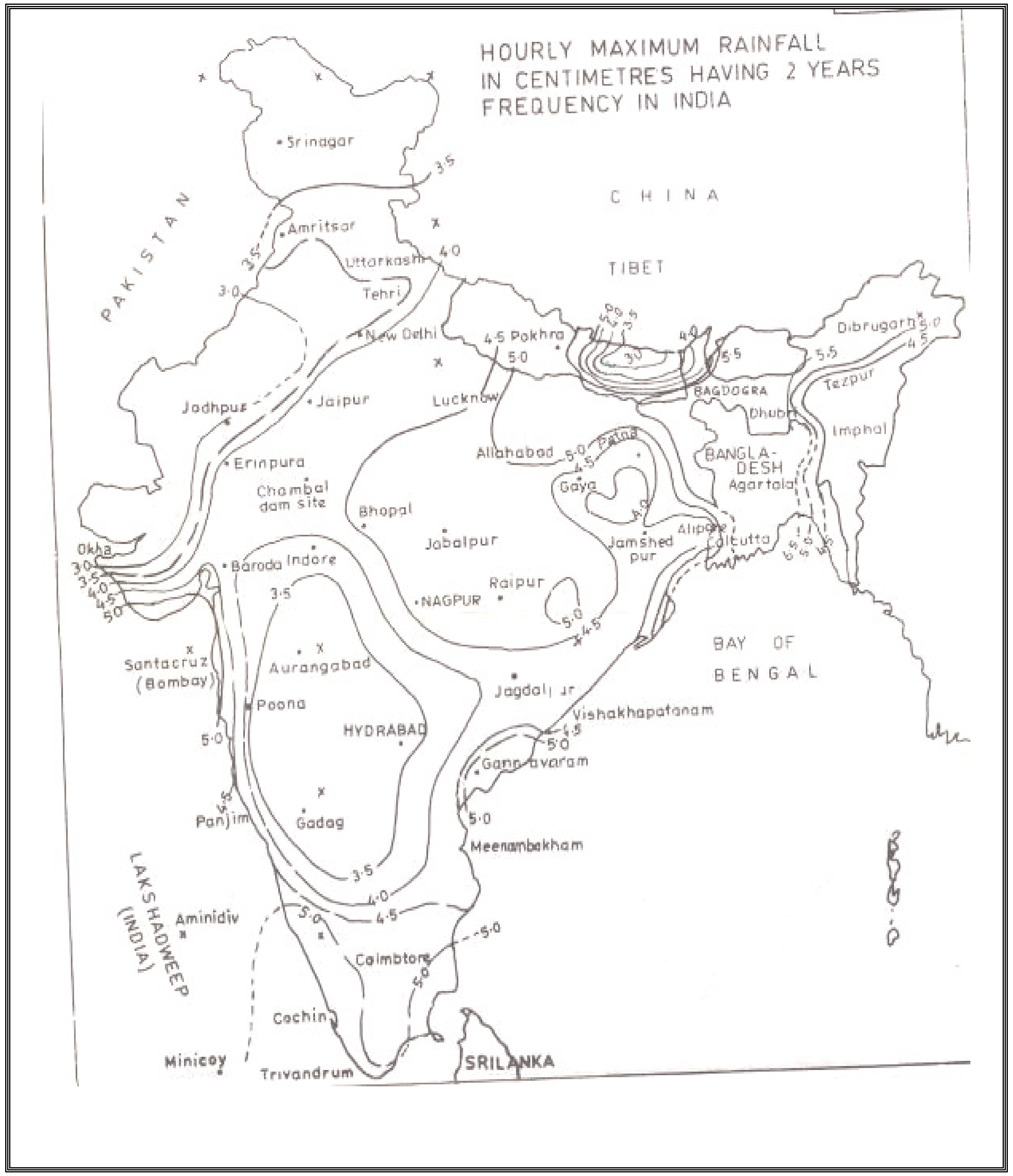


Figure – 4.2 - Hourly maximum Rainfall of 2 year Return Period

Analysis of daily rainfall data based on power equation does not compare well with the IMD curves and so is not considered.

Analysis based on hourly rainfall data show a wide variation between methods used and so is not considered.

Analysis based on short duration rainfall data show a fair degree of consistency between the different forms of the equations, especially for a 2 year Return Period (which Return Period will be considered for the design of drainage system in most locations treating the locations as high priced) and so is considered for further investigation, though this consistency is seen to be not applicable for a 10 year return period. But as the design of storm drainage system is unlikely to consider a 10 year Return Period, this limitation is not of significance.

Polynomial form of an IDF, although gives a best fit, is generally not used and so is not considered. Both the logarithmic and power equations are acceptable. But logarithmic form of the equation gives lower values of intensities for very short durations like 5, 10 and 15 minutes which will result in drains corresponding to 5, 10 or 15 minutes' time of concentration being under sized. Moreover, the power form of the equation is generally adopted in urban drainage system design.

Conclusions:

Adopting the power form of equation, Intensity – Duration for various Return Periods are given in **Table – 4.5** and **Figure – 4.4.**

Table – 4.5 intensity Duration for Different Return Periods

Time (min)	Intensity (mm/hr)		
	2 year	5 year	10 year
5	89.9	124.9	119.4
10	75.0	98.0	98.0
15	67.4	85.0	87.3
20	62.5	76.8	80.4
25	59.0	71.0	75.4
30	56.2	66.6	71.6
35	54.0	63.1	68.5
40	52.1	60.3	65.9
45	50.6	57.8	63.8
50	49.2	55.7	61.9
55	48.0	53.9	60.2
60	**46.9**	**52.3**	**58.7**

Hourly rainfall for 2 and 5 year Return Periods compare well with IMD curves.

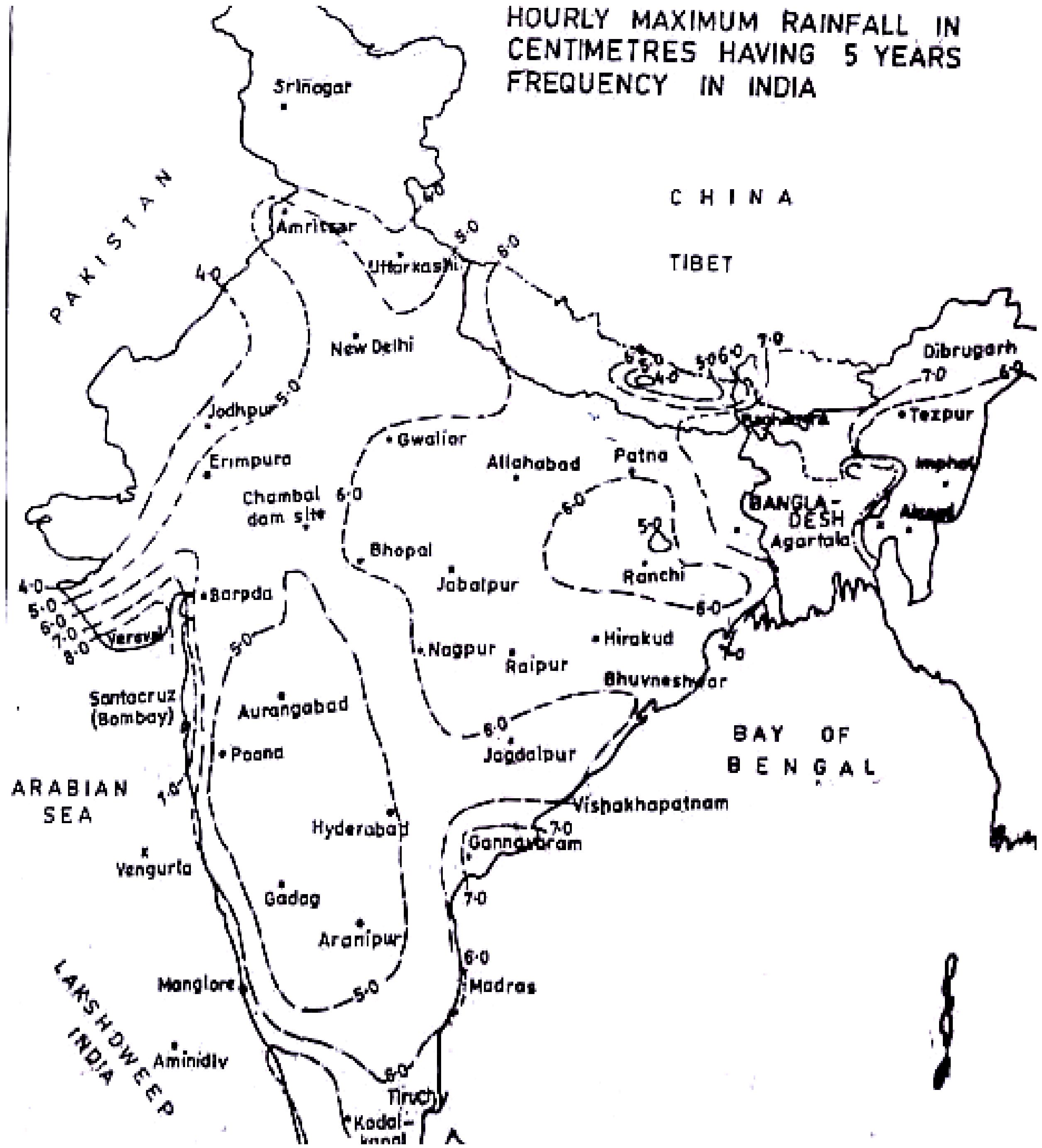


Figure – 4.3 - Hourly maximum Rainfall of 5 year Return Period

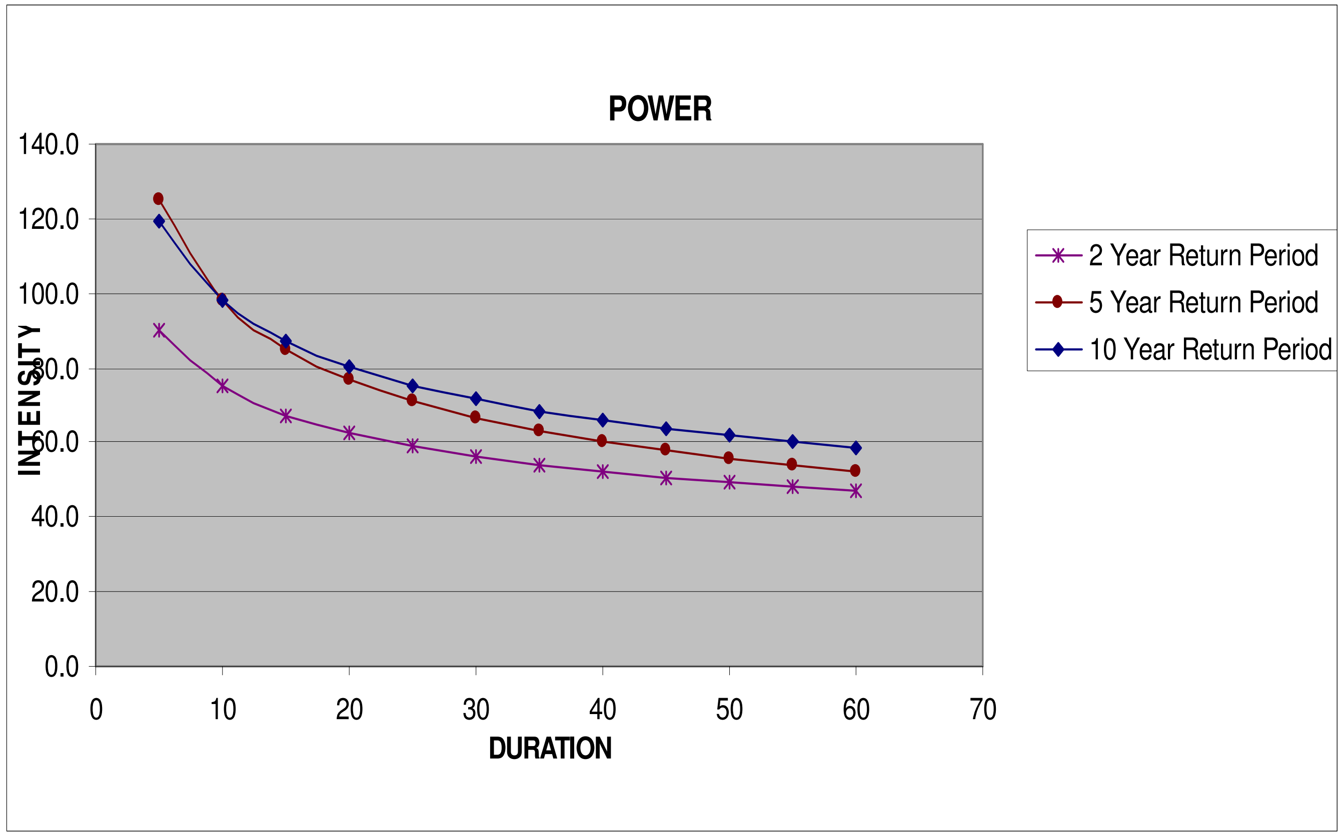


Figure – 4.4 Intensity – Duration – Frequency Curves for different Return Periods

4.2.5 WATER SHED CATCHMENT AREAS:

For the purpose of planning and designing storm drainage system, topographical features such as contour ridge lines, water bodies, depression areas, drainage network, land use pattern, slope profile, soil characteristics, water quality etc., have been collected from primary and secondary sources and has been explained in subsequent sections of this chapter.

In the present project, the zonal boundary is demarcated into major water shed catchment areas and each water shed catchment areas is further sub classified into micro water shed catchment areas.

Water shed catchment areas have been demarcated based on 10 m. contour interval maps prepared by Survey of India and the same is digitized using Arc View GIS Software. The entire zonal area is demarcated into different water shed regions in order to have a comprehensive approach in providing solutions to the problematic areas and also help in prioritising the works.

Unique numbers have been assigned to each major and micro water shed catchment areas for easy identification. The details of each major water shed catchment areas, zone wise is as given below.

4.2.5.1 East Core Zone:

There are 8 Major Watershed Catchments and 134 Minor Watershed Catchments with 44 drains of a total length of 94.38 Km. Details are given in **Table 1, Part 2, Appendix 1.** Map of Major Watershed Catchment is given in **Fig. EZ-WS-01, Part 4, Appendix 1**.

4.2.5.2 West Core Zone:

There are 4 Major Watershed Catchments and 87 Minor Watershed Catchments with 28 drains of a total length of 57.23 Km. Details are given in **Table 1, Part 2, Appendix 2.** Map of Major Watershed Catchment is given in **Fig. WZ-WS-01, Part 4, Appendix 2**.

4.2.5.3 South Core Zone

There are 4 Major Watershed Catchments and 69 Minor Watershed Catchments with 28 drains of a total length of 75.69 Km. Details are given in **Table 1, Part 2, Appendix 3.** Map of Major Watershed Parchment is given in **Fig. SZ-WS-01, Part 4, Appendix 3**.

4.2.5.4 Bommanahalli Zone:

There are 11 Major Watershed Catchments and 236 Minor Watershed Catchments with 126 drains of a total length of 109.59 Km. Details are given in **Table 1, Part 2, Appendix 4.** Map of Major Watershed Parchment is given in **Fig. BH-WS-01, Part 4, Appendix 4**.

4.2.5.5 Yelahanka Zone:

There are 9 Major Watershed Catchments and 129 Minor Watershed Catchments with 112 drains of a total length of 113.85 Km. Details are given in **Table 1, Part 2, Appendix 5.** Map of Major Watershed Parchment is given in **Fig. BP-WS-01, Part 4, Appendix 5**.

4.2.5.6 Dasarahalli Zone:

There are 7 Major Watershed Catchments and 94 Minor Watershed Catchments with 80 drains of a total length of 89.24 Km. Details are given in **Table 1, Part 2, Appendix 6.** Map of Major Watershed Parchment is given in **Fig. DH-WS-01, Part 4, Appendix 6**.

4.2.5.7 Mahadevapura Zone:

There are 16 Major Watershed Catchments and 300 Minor Watershed Catchments with 185 drains of a total length of 172.00 Km. Details are given in **Table 1, Part 2, Appendix 7.** Map of Major Watershed Parchment is given in **Fig. MD-WS-01, Part 4, Appendix 7**.

4.2.5.8 Raja Rajeshwari Nagara Zone:

There are 9 Major Watershed Catchments and 118 Minor Watershed Catchments with 115 drains of a total length of 144.88 Km. Details are given in **Table 1, Part 2, Appendix 8.** Map of Major Watershed Parchment is given in **Fig. RN-WS-01, Part 4, Appendix 8**.

4.2.6 MINOR CATCHMENTS AND LANDUSE ANALYSIS:

4.2.6.1 Minor Catchment Area:

To study the hydrological conditions and drainage characteristics of the catchment, the following procedure has been adopted to demarcate the minor/sub catchments and land use pattern:

1. Identification of ridgeline and demarcation of water shed / catchment boundaries
2. Demarcation of drains into primary and secondary
3. Demarcation of micro/sub catchments.
4. Identification of flow regions, within micro catchments
5. Characterization of the entire catchment in terms of various land use categories.
6. Assignment of the degree of imperviousness to rainfall for the above categories.
7. Computation of weighted average imperviousness for each of the flow region

The catchment boundaries in and around BBMP area are demarcated based on the information available on the contour map prepared by survey of India. Details obtained from these maps are digitized to obtain the area of major and micro water shed catchments using GIS software.

Further, to fix up the inlet time and time of concentration the major/micro catchments are segmented into different flow regions based on terrain slope and other aspect derived from contour information.

East Core Zone:

Map of 134 Minor Watershed Catchment is given in **Fig. EZ-WS-02, Part 4, Appendix 1**.

West Core Zone :
Map of 87 Minor Watershed Catchment is given in **Fig.WZ-WS-02, Part 4, Appendix 2**.

South Core Zone:
Map of 69 Minor Watershed Catchment is given in **Fig. SZ-WS-02, Part 4, Appendix 3**.

Bommanahalli Zone :
Map of 236 Minor Watershed Catchment is given in **Fig.BH-WS-02, Part 4, Appendix 4**.

Yelahanka Zone:
Map of 129 Minor Watershed Catchment is given in **Fig.YE-WS-02, Part 4, Appendix 5**.

Dasarahalli Zone:
Map of 94 Minor Watershed Catchment is given in **Fig.DH-WS-02, Part 4, Appendix 6**.

Mahadevapura Zone:
Map of 300 Minor Watershed Catchment is given in **Fig.MD-WS-02, Part 4, Appendix 7**.

Raja Rajeshwari Nagara Zone:
Map of 118 Minor Watershed Catchment is given in **Fig.RN-WS-02, Part 4, Appendix 8**.

4.2.6.2 Primary and Secondary Drains:

Based on the ridgelines, demarcation of water shed / catchment boundaries are made and within the boundary of each minor catchment primary and secondary drains demarcated together with the identification of flow regions. Unique IDs are given for each of the drains following a numbering system as given below:

A drain is in the 5 new zones is identified by a two alpha character referring the zone and three digit referring the particular. (RN541 refers to a drain with the id 541 in Raja Rajeshwari Nagara zone. If the drain has been studied in the zonal DPR project, the old number is given in parenthesis (RN562 in the masterplan project is also RNR03 in the DPR for Raj Rajeshwari Nagara and is represented by RN562 (RNR03)). For simplicity, drains in the core Zones of East, West and South are referred by the old number as was used in the four Valley project given in parenthesis (e.g H100 a drain in the Hebbal Valley is in East Core Zone and is represented as (H100))

East Core Zone:

Details of the 44 drains in the East Core Zone are given in **Table 2, Part 1, Appendix 1.** Locations of these drains are shown in **Fig. EZ-WS-01, Part 4, Appendix 1** and **Fig. EZ-WS-02, Part 4, Appendix 1**.

West Core Zone:

Details of the 28 drains in the West Core Zone are given in **Table 2, Part 1, Appendix 2.** Locations of these drains are shown in **Fig. WZ-WS-01, Part 4, Appendix 2** and **Fig. WZ-WS-02, Part 4, Appendix 2**.

South Core Zone:

Details of the 28 drains in the South Core Zone are given in **Table 2, Part 1, Appendix 3.**

Locations of these drains are shown in **Fig. SZ-WS-01, Part 4, Appendix 3** and **Fig. SZ-WS-02, Part 4, Appendix 3**.

Bommanahalli Zone:

Details of the 126 drains in the Bommanahalli Zone are given in **Table 2, Part 1, Appendix 4.** Locations of these drains are shown in **Fig. BH-WS-01, Part 4, Appendix 4** and **Fig. BH-WS-02, Part 4, Appendix 4**.

Yelahanka Zone:

Details of the 112 drains in the Bytrayanapura Zone are given in **Table 2, Part 2, Appendix 5.** Locations of these drains are shown in **Fig. YE-WS-01, Part 4, Appendix 5** and **Fig. BP-WS-02, Part 4, Appendix 5**.

Dasarahalli Zone:

Details of the 80 drains in the Dasarahalli Zone are given in **Table 2, Part 1, Appendix 6.** Locations of these drains are shown in **Fig. DH-WS-01, Part 4, Appendix 6** and **Fig. DH-WS-02, Part 4, Appendix 6**.

Mahadevapura Zone:

Details of the 185 drains in the Mahadevapura Zone are given in **Table 2, Part 2, Appendix 7.** Locations of these drains are shown in **Fig. MD-WS-01, Part 4, Appendix 7** and **Fig. MD-WS-02, Part 4, Appendix 7**.

Raja Rajeshwari Nagara Zone:

Details of the 115 drains in the Raja Rajeshwari Nagara Zone are given in **Table 2, Part 2, Appendix 8.** Locations of these drains are shown in **Fig. RN-WS-01, Part 4, Appendix 8** and **Fig. RN-WS-02, Part 4, Appendix 8**.

4.2.6.3 Land Use Analysis:

Using digital image processing technique and also by visual interpretation, City Development Plan (CDP) 2015 prepared by BDA for GOK is used as reference to analyze the catchments and categorise the same for various land use categories as listed below and further at strategic locations the processed results are cross verified at site and accordingly range of percentage imperviousness is assigned for each category.

1. Highly / Dense built up area
2. Medium built up area
3. Open space with no vegetal cover
4. Open space with vegetal cover
5. Parks / Vegetation
6. Water bodies
7. Industrial Area

While categorising the land use pattern, the newly formed layouts situated in the peripheral areas of the city is considered as medium built-up area for the future as at present there is no development observed.

East Core Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 1** and the same is depicted in **Fig. EZ – LU - 01**.

West Core Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 2** and the same is depicted in **Fig. WZ – LU - 02**.

South Core Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 3** and the same is depicted in **Fig. SZ – LU - 01**.

Bommanahalli Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 4** and the same is depicted in **Fig. BH – LU - 01**.

Yelahanka Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 5** and the same is depicted in **Fig. YE – LU - 01**.

Dasarahalli Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 6** and the same is depicted in **Fig. DH – LU - 01**.

Mahadevapura Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 7** and the same is depicted in **Fig. MD – LU - 01**.

Raja Rajeshwari Nagara Zone:

The categorization of land use in each of the major water shed catchment areas is as given in **Table – 3, Part 2, Appendix 8** and the same is depicted in **Fig. RN – LU - 01**.

Weighted Average Percent Imperviousness:

Further, in order to compute the weighted average percent imperviousness for each, the highest runoff percent imperviousness assigned is 80 - 95 % for the land where settlement density is very high (>90%) and all roads are paved. The lowest runoff percent imperviousness assigned is 5 -20 % for parks with medium dense vegetation.

The details of area and assigned percent imperviousness are shown in **Table – 4.6** In order to compute the weighted average percent imperviousness for each flow region, intersection of flow region boundaries with settlement density boundaries is done. A composite plan for the entire drainage catchment area is generated by incorporating the drainage lines, ridge lines, flow region boundaries and the land use and land cover categories.

The weighted average percent imperviousness (IW) for each flow region is computed and is given by

$$IW = \frac{I_1 A_1 + I_2 A_2 + I_3 A_3 + I_4 A_4 \dots}{A_1 + A_2 + A_3 + A_4 \dots}$$

Where, I_1 , I_2 , I_3 , I_4 are assigned imperviousness (%) for each of the land cover category within the flow region and A_1 , A_2, A_3, A_4 are the corresponding areas.

Table – 4.6 Land Use Categories and Assigned Percentage of Imperviousness

Sl. No.	Land Cover Characteristics	East Zone	West Zone	South Zone	Rajarajeshwari nagara	Dasarahalli	Yelahanka	Mahadevapura	Bommanahalli	Assigned % Imperviousness
		Area (Ha)								
1.	Highly / Dense built up Main Residential, Central Commercial area with sparse vegetal cover	3,962	2,088	3,090	7,726	3,220	9,886	7,410	5,709	60 - 75
2.	Major & Minor Road Surface area, built up area with more open space as well as fairly dense vegetal cover	721	396	342	4,398	1,388	1,051	2,229	3,757	60 - 75
3.	Dense built up Mixed Residential, Business Commercial, Public / Semi Public Utility Areas, Defence area with medium / thick vegetal cover	4,481	2,544	1,647	784	386	3,886	1,231	740	35 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	346	104	19	51	12	248	732	28	10 – 20
5	Agricultural land, Parks, Open spaces, Play grounds, Burial ground, State Forest, Valleys	844	404	222	2,676	3,508	3,939	7,267	3,170	10 – 20
6	Industrial, Industrial high tech. Area	315	810	167	757	255	1,079	2,226	2,167	70 - 90
7	Lake, Tank, Water Bodies	268	21	63	351	736	854	889	746	100
	Total	**10,937**	**6,367**	**5,553**	**16,743**	**9,505**	**20,943**	**21,984**	**16,317**	

4.2.8 COMPUTATION OF STORM WATER RUN-OFF:

There are different methods of computing runoff, the most appropriate of which can be chosen only if the assumptions, limitations and data input requirements of the basic approaches are well understood. For instance, the sophistication and accuracy of calculations by means of detailed methods are defeated if input requirements are not met with a detail and accuracy similar to that of calculation procedure adopted.

The hydraulic sizing of drainage and conveyance structures in urban settings always requires estimation of peak flow rates. Historically, the venerable ''*Rational method*'' has been the tool of choice for most practicing engineers around the world. The concept is attractive and easy to understand. If rainfall occurs over a basin at a constant intensity for a period of time that is sufficient to produce steady state runoff at the outlet or design point, then the peak outflow rate will be proportional to the product of rainfall intensity and basin area. The assumptions involved in the application of the Rational; Formula include

- The rainfall intensity is constant over a period that equals the time of concentration of the basin.
- The rainfall intensity is constant throughout the basin.
- The frequency distribution of the event rainfall and the peak runoff rate are identical (this assumption is true for all event-based computations).
- The time of concentration of a basin is constant and is easily determined (this assumption is also shared by other event based methods).
- Despite the natural temporal and spacial variability of abstractions from rainfall, the percentage of event rainfall that is converted to runoff (the runoff coefficient, *C*) can be estimated reliably.
- The runoff coefficient is invariant, regardless of season of the year or depth or intensity of rainfall.

The SCS curve number method is a simple, widely used and efficient method for determining the approximate amount of runoff from a rainfall event in a particular area. The requirements for this method are very low viz. rainfall amount and curve number. The curve number is based on the area's hydrologic soil group, land use, treatment and hydrologic condition. Curve number which is the important variable and which is based on soil grouping is a limitation for application to conditions obtained in the current study.

When watersheds are large, that is, when they are comprised of two or more smaller watersheds whose stream flow at the confluence with common collector channel can be expected to be displaced in time, where storage influences the time distribution of flow in a stream, or where storage is a part of the design problem, peak flow methods are inappropriate for hydrologic design. In these instances, it is necessary to estimate the entire flow hydrograph. A number of computer programs (models) are available to do the requisite hydrologic and hydraulic computations. Most of these programs have a number of options for each element of the process that begins with rainfall and ends with a hydrograph at some point in the system. Conceptually, the process starts with rainfall over a sub watershed(s) at the periphery of a larger system. The rainfall is transformed into a hydrograph of direct runoff at the outlet of the sub watershed. The hydrograph is then combined with a hydrograph from an adjacent basin and/or is routed through a channel to the next downstream point of interest.

The unit hydrograph is defined as the hydrograph of direct runoff that results from unit of excess rainfall that is generated uniformly over a watershed at a constant rate during a specified time. The unit hydrograph is the transfer function that is used to convert a hyetograph of excess rainfall into a design hydrograph. If one assumes that an idealized (simple geometry) watershed behaves similarly to a linear reservoir, it is a comparatively simple matter to demonstrate that effective rain from storms of a constant intensity and the same duration will produce hydrographs of direct runoff that have identical times to peak and identical durations of runoff. The flow rate ordinates are in proportion to one another. If the ordinates are known for a hydrograph that results from unit excess rain, then the hydrograph ordinates that result from a storm with any other depth of excess can be computed, provided all of the storms have the same effective duration.

Because there is a severe paucity of basins with the paired stream gauges and rainfall gauges that are requisite for deriving unit hydrographs from actual rain-runoff events, hydrologic design depends on methods of synthetic hydrograph formulation. Basically, this means that someone in a region or in a state analyzes existing paired rainfall-runoff records and develops relationships that relate unit hydrograph ordinates to various basin parameters that can be measured from or estimated using information from topographic mapping. Typically, these parameters include basin area, and indirectly, slope of the stream, but other features may be included as well. Thus, synthetic unit hydrographs are extrapolations from other people's analysis of actual data

Based on the forgoing discussions, it is considered in this study that the Rational Method would be used for assessing the peak rate of flow.

4.2.8.1 RATIONAL METHOD:

Quantity of storm water run-off is calculated using the rational formula:

$$Q = 10\ C.\ i\ .\ A.$$

Where, Q = run-off in m^3/hr
c. = coefficient of run-off
i. = intensity of rainfall in mm/hr
A = area of drainage segment in hectares

Coefficient of run-off (c) is arrived at by interpolation of values given in Homer's table with respect to time of concentration (Tc) and for weighted imperviousness.

As per CPHEEO guide lines, the inlet time, which depends on the distance of the farthest point in the drainage basin to the inlet drain, the shape, characteristics and topography of the basin and this may generally vary from 5 to 20 minutes. The inlet time in the present case will be the time taken for the storm water to flow through a network of roadside drains (roads parallel to the main drain and perpendicular to the main drain) until it reaches either a secondary drain or a primary drain. The range of velocities obtained for the secondary/primary drains considering the ground slope and the drain sections as per the existing uncleaned / silted condition of drain, works out to 2.0 to 6.0 m/sec. The mean velocity of flow in the primary drain for 0 to 1000 m distance for clean condition of drain and silted up condition of drain is found to be 2.0 m/sec and 3.5 m/sec respectively. Keeping this velocity in view, a velocity of flow 1.2 m/sec to 2.0 m/sec for terrain and maximum of 5.2 m/sec in drain was chosen to estimate the time of flow (considering cleaned drain with moderate siltation / vegetation).

Intensity of Rainfall:

When using the rational formula one must assume that the rate of flow, owing to certain rainfall intensity over the drainage area, is produced by that rainfall which is maintained for a time equal to the period of concentration of flow at the point under consideration. Theoretically this is the Time of Concentration. It is the time required for the rain water to flow over the ground surface from the remotest part of drainage basin to reach the point being considered i.e. is the under consideration. Time of concentration (tc) is equal to inlet time. For uniform rainfall intensity this would be the time of equilibrium at which the rate of rate of runoff is equal to rate of rainfall. For small drainage basins with simple drainage pattern the time of concentration may be very close to the lag time of peak flow. The inlet time depends on the distance of the farthest point in the drainage basin to the inlet manhole, the shape, characteristics and topography of the basin and may generally varies from 5 to 30 minutes. In highly developed sections, the inlet time may be as low as 3 minutes. The time of flow is determined by the length of the sewer and velocity of flow in the sewer. It is to be computed for each length of sewer to be designed. (Vide Hand Book of Applied Hydrology by VEN TE CHOW Ch. 14 Page7). Intensity of rainfall considered is based on the Rainfall analysis as given earlier.

Coefficient of Runoff:

Coefficient of runoff is the relative capacity of the drainage area to shed of the storm in the form of runoff. This depends upon the imperviousness and shape, tributary area apart from the duration of storm.

Imperviousness:

The percent imperviousness of the drainage area can be obtained from the records of a particular district. In absence of such data, the following ranges may serve as a guide.

Type of Area	Percentage of Imperviousness
Commercial and industrial area	70 to 90
Residential area:	
• High density	60 to 75
• Low density	35 to 60
Parks and undeveloped areas	10 to 20

The weighted average imperviousness of drainage basin for the flow concentrating at a point may be estimated using

$$I = (A_1I_1+A_2I_2+ ...) / (A1+ A2+...)$$

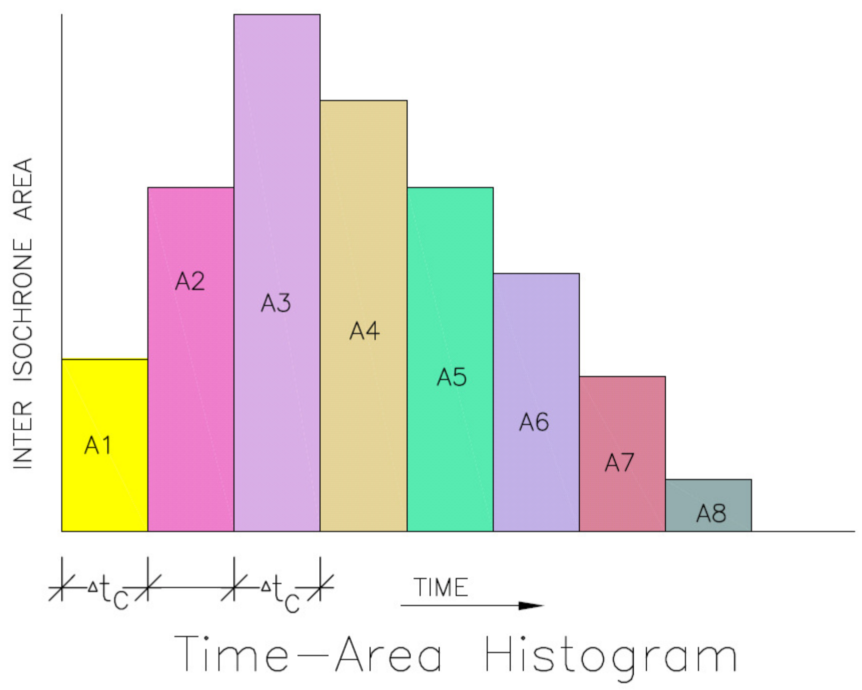
Where, A_1, A_2 = Drainage areas tributary to the section under consideration
I_1, I_2 = Imperviousness respective areas and
I = Weighted average imperviousness of the total drainage basin.

4.2.8.2 UNIT HYDROGRAPH METHOD:

A unit Hydrograph is defined as the hydrograph of direct runoff resulting from one unit depth (1cm) of rainfall excess occurring uniformly over the basin and at a unit rate for a specified duration (D h). The term unit here refers to a unit depth of rainfall excess which is usually taken as 1 cm. A typical analysis is given below:

Clark's Method for IUH

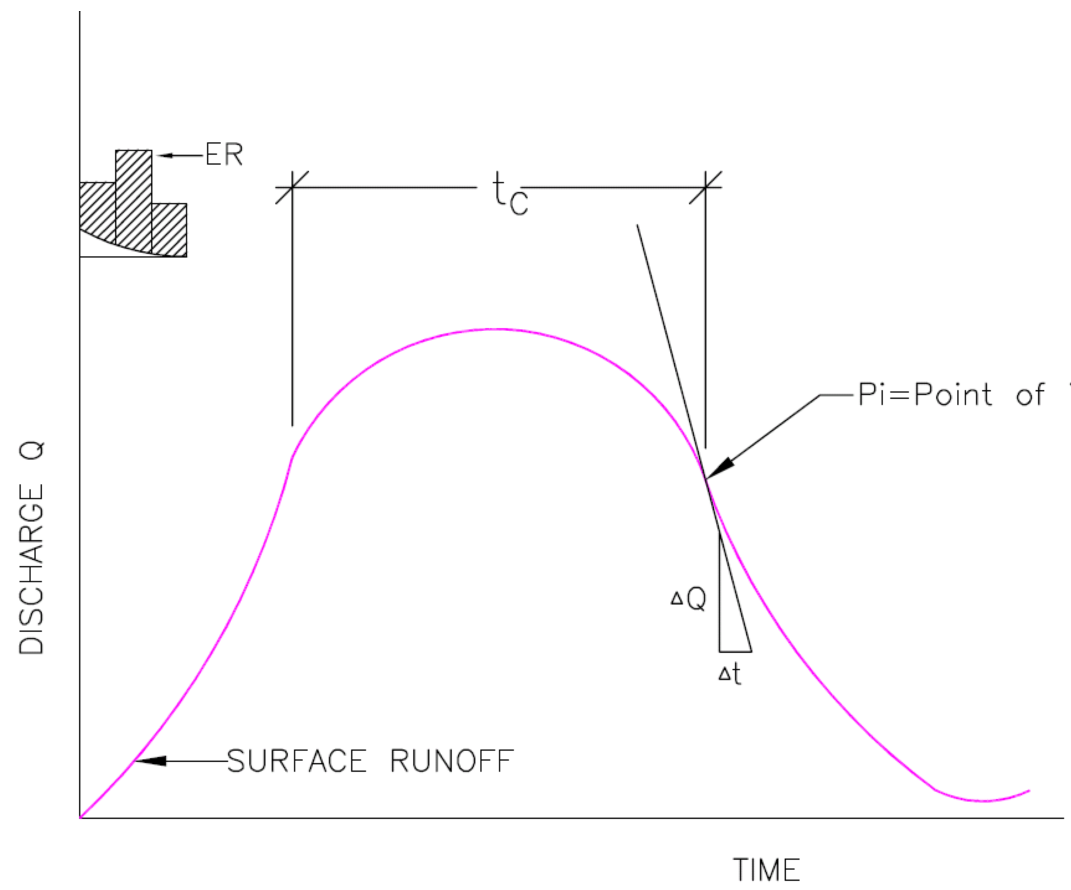
Clark's method also known as Time-Area Histogram method aims at developing an IUH due to an instantaneous rainfall excess over a catchment. It is assumed that rainfall excess first undergoes pure translation and then attenuation. Translation is achieved by time – area histogram and the attenuation by routing the results of the above through a linear reservoir at the catchment outlet.



Time–Area Histogram

Time – Area Curve:

- Calculate the Total catchment area (>25Km2) and drain length.
- Calculate the Time of concentration Tc using California Equation (Empirical Equation)
- If points on the area having equal time of travel (say t_1 h where $t_1 < t_c$), are considered and located on a map of the catchment, a line joining them is called an Isochrone
- The total Catchment area is being divided into (N =)sub areas by isochrones having an equal time of interval
- To assist in drawing isochrones, the longest water course is chosen and its profile plotted as elevation vs distance from the outlet
- The distance is then divided into N parts and the elevations of the subparts measured on the profile transferred to the contour map of the catchment.
- The inter-isochrone areas A_1, A_2, …..A_N are used to construct a travel time-area histogram.
- If a rainfall excess of 1 cm occurs instantaneously and uniformly over the catchment area, this time- area histogram represents the sequence in which volume of rainfall will be moved out of the catchment and arrive at the outlet.
- In sub area A_r Km^2 represents a volume of A_r Km^2 of 1cm = $A_r \times 10^4 m^3/s$ moving out in time $\Delta t_c = t_c/N$ hrs
- The hydrograph of outflow obtained by this figure while accounting for the sequence of arrival of flows, do not provide for the storage proerties of the catchment.
- To overcome this deficiency , Clark assumed a linear reservoir to be hypothetically available at the outlet to provide the requisite attenuation



Surface Runoff of a Cachment

Routing:

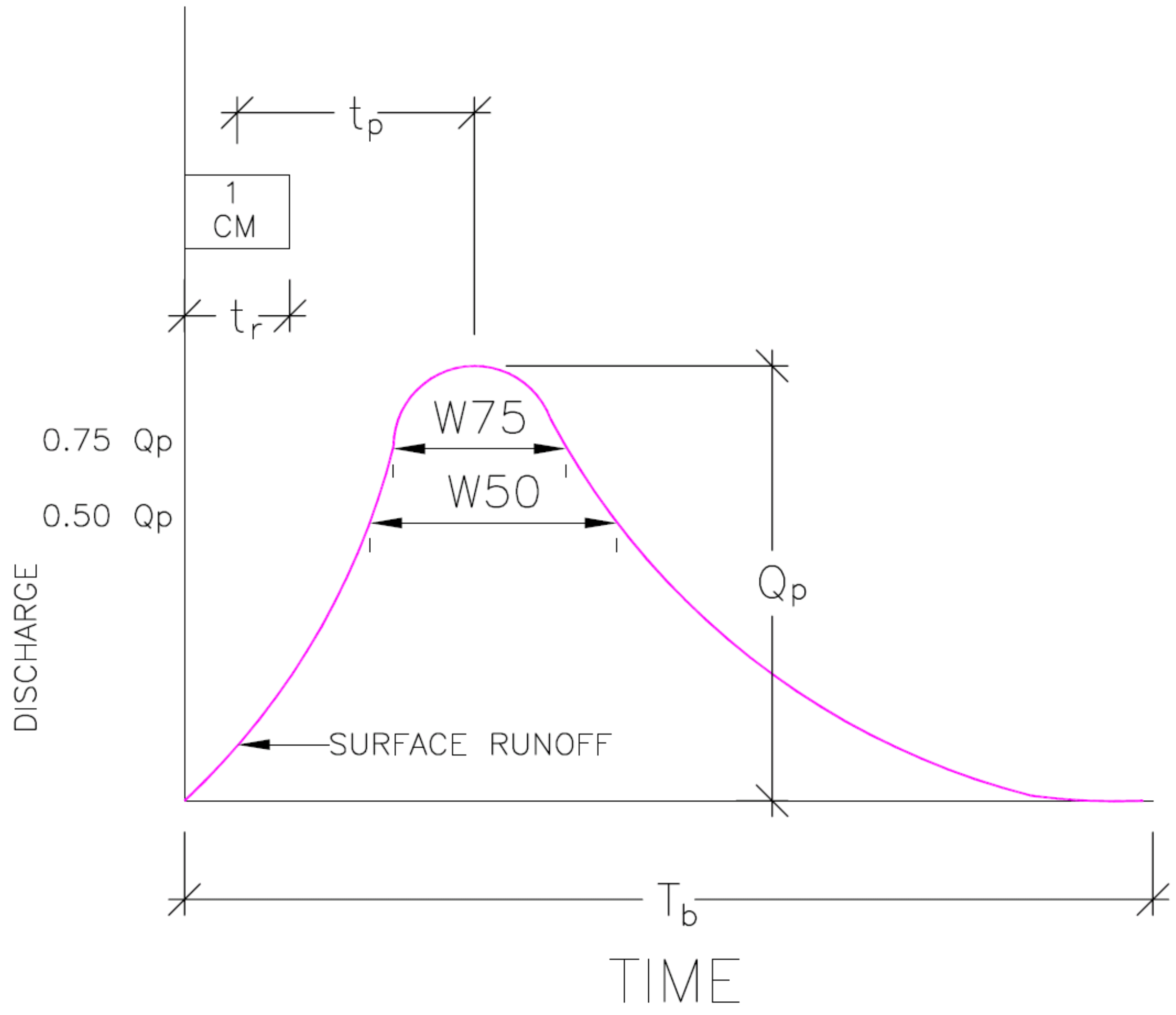
- The linear reservoir at the outlet is assumed to be S = KQ, K is the storage time constant.
- The value of K can be estimated by considering the point of inflection Pi of a surface runoff hydrograph.
- At this point the inflow into the channel has ceased and beyond this point the flow is entirely due to withdrawal from the channel storage.

The inflow rate between an inter-isochrone area A_r Km^2 with time interval $\Delta\ t_c$

$$Q = 2.78 \times \frac{Ar}{\Delta t_c} \quad m^3/s$$

Storage Coefficient calculation (for Cauvery River Basin):

The following relationships have been derived for estimating the 1-hour unitgraph parameters of a catchment in the Kaveri subzone:



Elements of Unit Hydrograph (Based on Cauvery River Basin- CWC)

$t_p = 0.553(LLc/\sqrt{S})^{0.405}$

$q_p = 2.043 / tp^{0.572}$

$W_{50} = 2.197 / qp^{1.067}$

$W_{75} = 1.325 / qp^{1.055}$

$WR_{50} = 0.799 / qp^{1.135}$

$WR_{75} = 0.536 / qp^{1.109}$

$T_B = 5.083(tp)^{0.733}$

$Qp = q_p \times A$

In the above equations,

L – Length of the longest stream,

Lc – Length of longest stream opposite the centre of gravity of the catchments to the point under study

S – Equivalent Stream Slope

t_p – Time from the centre of rainfall excess (1.0 cm) in 1-hr. unit duration to the U.G peak in hours

q_p – peak discharge of U.G per unit area (cumes per sq.km)

Qp – peak discharge of U.G (cumes)

W_{50} – Width of the U.G measured at 50% of peak discharge ordinate (1hr.)

W_{75} – Width of the U.G measured at 75% of peak discharge ordinate (1hr.)

WR_{50} – Width of the U.G on the rising side at 50% of peak discharge ordinate (hr)

WR_{75} – Width of the U.G on the rising side at 75% of peak discharge ordinate (hr)

T_B – Base width of the U.G

4.2.8.3 Hydraulic Designs:

Flow capacity of open channels is calculated for each stretch of drain, with different bed slope using Manning's formula.

$$V = [(l/n)] \times [R^{2/3} S^{1/2}]$$

For flow calculation, the values of coefficients of roughness is adopted based on data collected during condition survey/reconnaissance survey like type of construction, type of lining, obstructions etc. and the value of"n" for different type of construction are as below;

The Manning’s co-efficient 'n' for various drain surfaces are Masonry with;

Neat cement plaster	0.013
Sand and cement plaster	0.015
Concrete, steel troweled	0.014
Concrete, wood troweled	0.015
Brick in good condition	0.017
Masonry in bad condition	0.020
Stone work;	
(a) Smooth, dressed ashlar	0.015
(b) Rubble set in cement	0.017
(c) Fine, well packed gravel	0.020
Earth;	
(a) Regular surface in good condition	0.020
(b) In-ordinary condition	0.025
(c) With stones and weeds	0.030
(d) In poor condition	0.035
(e) Partially obstructed with debris or weeds	0.050

The results obtained from the analysis of design parameters are correlated with the site data and the same is used to check the adequacy of the system to cater for the required return period flood discharge.

Further, the adequacy analysis has been carried out for all the drains considered in the present study at different reaches and the reaches have been identified at strategic locations. The adequacy analysis results for each drain have been enclosed report and the same will be used for suggesting remedial measures required to make the system adequate and perform as intended

4.3 ADEQUACY ANALYSIS OF DRAINAGE NETWORK:

Assessment of the existing system for its adequacy has been made. The adequacy of the existing system has been analysed and correlated for different year return periods.

Further, these analysis results have been once again correlated with the situation and specific site condition to verify the accuracy of the results and to suggest the strategic improvements required at that particular location.
The focus of this section is solely on

- Storm drains
- Cross drains

4.3.1 Storm Water Drains:

The localities, which contribute, and the existing condition of these drains is detailed in Chapter 2. Cross section data of the existing drains at every 20 m. apart was collected. Computer models & spreadsheets were developed in house to analyse for their carrying capacity both for “unclean” and “clean” conditions. Unclean conditions refer to conditions existing in the present being caused by silting, inadequate drain width, obstruction to flow caused by encroachment and inadequate vents at CD works. When improvements are implemented and properly maintained, conditions may be termed clean. Proposals are made on the basis of designs considering clean conditions of the drains. The analysis has been done for different year return periods.

4.3.1.1 Drains in East Core Zone:

Adequacy analysis and design of drainage network covers 46 drains. Details are appended as under:

Section 1, Part 2, Appendix 1	Hebbal Kere
Section 2, Part 2, Appendix 1	Nagwara Kere
Section 3, Part 2, Appendix 1	Kacharakanahalli Kere
Section 4, Part 2, Appendix 1	Hennuru Bande
Section 5, Part 2, Appendix 1	Ulsoor Kere
Section 6, Part 2, Appendix 1	Bharathinagara
Section 7, Part 2, Appendix 1	Miller Tank
Section 8, Part 2, Appendix 1	Lalbagh Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.2 Drains in West Core Zone:

Adequacy analysis and design of drainage network covers 36 drains. Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 2	Mattikere Kere
Section 2, Part 2, Appendix 2	Sankey Kere
Section 3, Part 2, Appendix 2	Laggere Kere
Section 4, Part 2, Appendix 2	Nandini Layout

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.3 Drains in South Core Zone:

Adequacy analysis and design of drainage network covers 24 drains. Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 3	Byrasandra Kere
Section 2, Part 2, Appendix 3	Yediyur Kere
Section 3, Part 2, Appendix 3	Kempebudi Kere
Section 4, Part 2, Appendix 3	Narayanahalli Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.4 Bommanahalli Zone:

Adequacy analysis and design of drainage network covers 119 drains**.** Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 4	Thalaghattapura Kere
Section 2, Part 2, Appendix 4	Shanboganahalli Kere
Section 3, Part 2, Appendix 4	Hulimavu Kere
Section 4, Part 2, Appendix 4	Puttenahalli Kere
Section 5, Part 2, Appendix 4	Madivala Kere
Section 6, Part 2, Appendix 4	Dodda Begur Kere
Section 7, Part 2, Appendix 4	Chikka Begur Kere
Section 8, Part 2, Appendix 4	Ibalur Kere
Section 9, Part 2, Appendix 4	Kaikonadanahalli Kere
Section 10, Part 2, Appendix 4	Bellandur Kere
Section 11, Part 2, Appendix 4	Panathur Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.5 Yelehanka Zone:

Adequacy analysis and design of drainage network covers 80 drains**.** Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 5	Yelahanka Kere
Section 2, Part 2, Appendix 5	Allalsandra Kere
Section 3, Part 2, Appendix 5	Jakkur Kere
Section 4, Part 2, Appendix 5	Rachenahalli Kere
Section 5, Part 2, Appendix 5	Shinghapura Kere
Section 6, Part 2, Appendix 5	Dodda Bommasandra Kere
Section 7, Part 2, Appendix 5	Geddalahalli STP
Section 8, Part 2, Appendix 5	KalKere Kere
Section 9, Part 2, Appendix 5	Bellahalli Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.6 Dasarahalli Zone:

Adequacy analysis and design of drainage network covers 55 drains. Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 6	Abbigere Kere
Section 2, Part 2, Appendix 6	Kammagoundanahalli Kere
Section 3, Part 2, Appendix 6	Chikka Banabana Kere
Section 4, Part 2, Appendix 6	Anchepalya Kere
Section 5, Part 2, Appendix 6	Lakshmipura Kere
Section 6, Part 2, Appendix 6	Gangondanahalli Kere
Section 7, Part 2, Appendix 6	Kachohalli Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.7 Mahadevapura Zone:

Adequacy analysis and design of drainage network covers 119 drain. Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 7	Doddagubbi Kere
Section 2, Part 2, Appendix 7	Biderahalli Kere
Section 3, Part 2, Appendix 7	Hormavu Agara Kere
Section 4, Part 2, Appendix 7	Rampura Kere
Section 5, Part 2, Appendix 7	Seighehalli Kere
Section 6, Part 2, Appendix 7	Kodigehalli Kere
Section 7, Part 2, Appendix 7	Kaggadasapura Kere
Section 8, Part 2, Appendix 7	B.Narayanapura Kere
Section 9, Part 2, Appendix 7	Vibuthipura Kere
Section 10, Part 2, Appendix 7	Channappanahalli Kere
Section 11, Part 2, Appendix 7	Kundalahalli Kere
Section 12, Part 2, Appendix 7	Kadabeesanahalli
Section 13, Part 2, Appendix 7	Chikka Bellandur Kere
Section 14, Part 2, Appendix 7	Sheelavantana Kere
Section 15, Part 2, Appendix 7	Varthur Kere
Section 16, Part 2, Appendix 7	Valepura

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.3.1.8 Raja Rajeshwari Nagara Zone:

Adequacy analysis and design of drainage network covers 98 drains. Hydraulic Designs are appended as given below:

Section 1, Part 2, Appendix 8	SuliKere Kere
Section 2, Part 2, Appendix 8	Kammaghatta Kere
Section 3, Part 2, Appendix 8	Herehalli Kere
Section 4, Part 2, Appendix 8	Muddayannapalya Kere
Section 5, Part 2, Appendix 8	Hosahalli Kere
Section 6, Part 2, Appendix 8	Konnasandra Kere
Section 7, Part 2, Appendix 8	Halagevadarahalli Kere
Section 8, Part 2, Appendix 8	Subramanyapura Kere
Section 9, Part 2, Appendix 8	Kamayanapalya Kere

While the detailed designs are given in appendix as mentioned above, summary of analyses of clean and unclean conditions is given in **Annexure 2.**

4.4 FLOW REGULATION COMPONENTS:

Increasing urbanization is associated with increase in the volume and peak rate of runoff requiring construction of expensive drainage facilities. The use of storage as a means of reducing peakflows is well recognized in flood control on rural catchments but is only now becoming more widely used in the field of urban drainage. Reduction of peak flows results in a more economical drainage network design and also is an effective means of reducing the possibility of downstream flooding. Other advantages of on-site detention storage include use of the stored runoff for multipurpose uses or for supplementary water supplies, for erosion control, for aesthetic purposes and for recreational activities.

A method for computing the time distribution of runoff for a particular real storm event or design storm is an essential requirement for a correct design of storage facilities. The required storage volume is a function of the capacity of the outlet structure and also depends on economic and safety considerations, which are generally accounted for by a judicious selection of the design storm return frequency. For large ponds, a method of routing the inflow through the reservoir is required in order to accurately estimate the storage volume.

Flow regulation can be effected on runoff both prior to the same entering the drainage network or downstream of the network both being either onsite or off site. Possible upstream storage facilities include Rooftops, Parking lots, Recreation areas, Parks and on site ponds. Of these Rooftop ponding is dependent on the structural design of the building; surface detention on paved parking lot areas considered from allowable depth which is dependent on safety and convenience to users as well as temporary storage under parking areas which can be locally consumed for gardening and watering lawns as applicable; as Parks and recreational fields contribute little runoff during moderately intense storms and such areas can also be designed to detain water temporarily followed by a rapid drainage after the end of the storm;

The design and use of any of the above mentioned temporary upstream storage facilities are site specific and selection of a method depends on merits of individual cases.

Downstream retention or detention storage facilities are located downstream from the drainage area and are supplementary to upstream storage facilities. Such facilities are particularity applicable to flat areas of minimum hydraulic head. The use of hydrograph methods for design is essential in order to account for the distribution of runoff and the resulting reservoir fluctuations.

Types of facilities include channel storage and onstream and offstream ponds. Open channel storage is particularly effective in flat areas where the flood wave is relatively slow moving. As the flow increases, the depth and storage increases, resulting in reduced peaks downstream.

Offstream storage facilities generally operate only during peakflows by utilizing side-channel spillways. Such facilities are therefore infrequently inundated and are ideal for multipurpose uses such as parks and recreational fields.

Onstream storage facilities such as ponds and reservoirs are generally more common, and provide various benefits. In addition to reducing the peak flow downstream, the ponds act as settling basins for sediment and debris, thereby improving downstream water quality. Also, by storing the water or re-using it in the watershed, the quantity of nutrients released to the receiving water may be reduced

In the design stage, it is important to evaluate the disadvantages associated with each alternative, such as sediment removal, safety, general maintenance, etc.

4.5 LOCALISED WASTEWATER TREATMENT PLANTS:

The quality of water in a number of lakes in the BBMP area is of an unacceptable nature. This is likely to be caused by indiscriminate discharge of sewage into storm drains, surplussing or leakages from sewers laid within the storm drains or unsanitary conditions around the lakes. Although there exists technical feasibility of rerouting sewers in storm drains, implementation of the same may be fraught with practical problems viewed in the light of functioning of existing systems and the financial implications. As an alternative, providing interceptor sewers alongside storm drains in which sewers run creating a new network of sewers, sewage from which can be treated in localised wastewater treatment plants. Treated sewage may be discharged into adjoining lakes. In order to identify locations where such plants may be considered, data published by Lake Development Authority are used. Such of the lakes where the water quality indicates high BOD are assumed to be highly polluted by sewage flowing through the upper catchment of the lakes.

Assuming that there is a base flow in the drains leading to the said lakes all through the year and that the base flow is all sewage, there stands a reasonable justification for providing for treatment of such sewage flow. Sewage treatment plants based on a technology which occupies minimum footprint area, operated with more of automatic controls and offering flexibility to meet varied inflow rates may be located upstream of such lakes, subject to land being available.

Foregoing analysis of options are further discussed in Chapter 5.

CHAPTER - 5
RECOMMENDATIONS

5.0 INTRODUCTION:

This chapter on review of assessment has been prepared to identify the reasons for the failure of the system components, during the recent years. Depending on the nature and extent of the system failure, the approach for improving the carrying capacity and rehabilitation methodologies vary accordingly. Therefore, a generic grouping of approach and methodologies in achieving the objective and proper functionality of the system for different applications are needed.

To identify and prioritize rehabilitation needs, a systematic approach in planning and investigation of most problematic areas is much needed and this will intern involve, establishment of guidelines to observe the system performance and levels of service offered etc., from which decisions can be consistently based.

As the implementation of a systematic approach to planning and investigation involve significant resource commitments, both in personnel and financial terms, it is proposed that the BBMP shall progressively improve towards achieving this long-term objective.

Further, Improvements to the existing storm drainage system in BBMP area is considered to be on priority for five key reasons:

- To minimise the current localised flooding problems experienced in the catchment area.
- To protect the natural waterway boundary for development of drainage corridor, interlinking of water bodies and prevent receiving water bodies from deterioration.
- To improve upon the service level bench mark, for the services provided by BBMP in vulnerable areas.
- To improve and protect the quality of environmental attributes including aesthetic appearance of city's environs.
- To minimise cost implication on operation and maintenance of the system.

A Master Plan is an important tool to help identify projects and policies for implementation either as remedial or as preventive. In either case, the plans help guide new land development projects to be consistent with overall objective of flood mitigation measures, improvement of storm water quality needs and help to identify and acquire land and rights-of-way for future capital improvements, for waterway maintenance and for floodplain preservation.

Consistent with the foregoing, discussions with BBMP on the draft report categorised various measures into short term, medium term and long term proposals and broadly outlined the measures to include reconstruction of side walls which are in dilapidated condition, remodeling of culverts/bridges having inadequate vent size and structurally unstable condition, removal of bottle necks in the drains, encroachments and structures over or within the drain causing hindrance to free flow of water, shifting of service lines, widening of drains wherever necessary, strengthening of side walls, installation of flood monitoring and control devices, construction of diversion drains, RCC box drains, fixing of fence, improving the holding capacity of water bodies and establishment of interlink between water bodies, widening the drains to cater for the required / designed flood discharge, side bank protection works, remodeling of inadequate vent size major cross drains, shifting of major service lines inside water way, rehabilitation and resettlement of distracted properties, formation of service corridors, development of flood plains, construction of retention basins and detention ponds in open park lands, administrative reforms, enforcement measures etc.

Also suggested to be included in the masterplan were Automated rain gauge stations in each zone, Zonewise flood control, monitoring and management system in place to improve the functionality of the system and improve the service level, Declaration of flood prone areas as no development zone / development of land above HFL level and Automated flood control gates for lakes with remote operation and manual over ride.

Adequacy analysis having been carried out and additional components identified as given in the previous chapter. Proposed masterplan is envisaged to comprise of structural and non structural measures. Structural measures dealing with modifications to drains and culverts, provision of detention/retention basins and infiltration trenches, flow regulation from lakes besides source control while non structural measures deal with land use policies and prohibition of flood plain occupancy together with management aspects of such measures. Appropriate solutions need to be practical and selection of preferred alternative should include reviewing the list of storm drainage inadequacies, assessing possible solutions to the problems, screening alternatives based on feasibility, empirical cost functions and public acceptance.

Following sections describe Master Plan Measures and Maintenance Requirements. Various aspects considered in the development of the Masterplan proposals are shown in **Fig. 5.1**.

Based on the proposals suggested and guidelines/criteria's set forth in the TOR. Planning & engineering designs has been worked out, considering the site findings and analysed results, site specific structural and non structural measures have been suggested in the subsequent sections below in **Fig. 5.1.**

FIG. 5.1: STORM WATER DRAIN PROJECT PROPOSAL UNDER MASTER PLAN

STRUCTURAL MEASURES

A : DRAIN REMODELLING WORKS

I - Carrying Capacity Improvement Work
a) Drain desilting and bed profile regradation
b) Widening
c) Back protection work
d) Bed protection
e) Culverts/ bridges remodelling
f) Constructing of parallel box drain
g) Removal of obstructs

II - Rehabilitation/ Strengthening Works
a) Ex wall restoration
b) Dilapidated wall reconstruction
c) Rehabilitation of Culverts/ bridges

III - Operation and Maintenance

B : CATCHMENT AREA

a) Runoff and Sediment transport control
b) Development of water bodies on holding ponds
c) Construction of detension ponds
d) Retaining basins
e) Soak away infiltration
f) Segregation of sewage & setting up of STPs
g) Development of flood plains

C : LOW LYING AREA

a) Construction of diversion drains
b) Improvement of internal drains
c) Construction of sump with mobile pumping station
d) Rise the plinth level
e) Land development control measures

NON STRUCTURAL MEASURES

A : CAPACITY BUILDING

a) For implementation of proposal
b) For operation & maintenance of flood control measures
c) For cess collection

B : REGULATORY CONTROL

a) Land use control
b) Catchment flood control for property (holding ponds/ recharge tanks)
c) Building Plan approval with plinth level above HFL
d) Lake water level control
e) Sewage treatment for lakes

C : MANAGEMENT

I - Carrying Capacity Improvement Work
a) Rain guage station, data procurement & complitation
b) Planning, engineering & project preparation
c) Land use planning
d) Runnoff & flow control measures
e) Drainage corridor delination
f) Institutional frame work
g) Operation & Maintenance
h) Environmental management plan
i) Risk management plan

D : IEC ACTIVITY BY BBMP

a) Education & Awarness
b) On Environment up keep
c) Information on encroachment of flood protection

E : RISK & DISASTER MANAGEMENT

a) Educate people in flood prone areas
b) Educate school children
c) Alarm during flood
d) Disaster Management Squad

5.1 STRUCTURAL MEASURES:

5.1.1 Carrying Capacity Improvements to Drains and Culverts:

To improve the capacity of the drains to convey the runoff flow and to minimize the flooding problems, various drain improvement measures that are possible are:

1 De-silting of drains to achieve full capacity of the drains

2 Removal of encroachments on the drains.

3 Widening of drains as required

4 Modifying longitudinal gradient of drains to have designed capacity.

5 Construction of diversion drains / parallel drains.

6 Reconstruction of collapsed & dilapidated SSM drain walls with either SSM / RCC walls.

6 Lowering of rocky out crop noticed at several locations to improve the flow conditions.

7 Modification / rerouting of drain alignments where necessary.

8 Regradation of secondary/tertiary drain bed level to suit as per present primary drain bed levels.

9 Cavity filling, restoration of eroded stones, providing pointing and coping concrete to the existing masonry drain walls

10 Restoring available BS Slab drain bed & to provide fresh CC bed lining wherever feasible to prevent weed growth & to alter the hydraulic properties to increase the carrying capacity of the drains.

11 Construction of new walls / stone revetment where drain side banks are in natural condition especially in the tail ends / outside city limits.

12 Reconstruction of inadequate vent way and structurally unsound Culverts / Bridges

13 Diverting/plugging all sewer outlets discharging sewage directly into storm drains

14 Relocation of pipelines, manholes & other service lines which are laid inside the drains and that are obstructing free flow of water.

15 Provision for ground water recharging inside the drain to reduce the flood flow & ground water recharge potentiality once segregation of sewage achieved.

16 Providing chain link fence & guard rails at strategic vulnerable locations to prevent dumping of garbage etc. and also to ensure safety of public.

17 Formation of service roads on either side of the drains for routine maintenance and laying service lines.

18 Construction of well/sumps with pumping arrangements in low lying pockets.

5.1.1.1 Drains & Culverts in East Core Zone:

East Core Zone includes Challaghatta Valley, Part of Hebbal Valley and part of Koramangala Valley. Remodelling study report of primary and secondary drains has recommended certain proposals of which some have been implemented and some are under progress. These aspects have been taken into consideration in the current study and proposals made here are additionally required in the overall context of the Masterplan.

Modifications of drains and culverts proposed, as appropriate from the above in East Core Zone are detailed and given along with cost in **Tables 1 to 11, Part 3, Appendix 1.**

Drawings showing the modifications in East Core Zone as listed below are given in **Part 4, Appendix 1**.

EZ-ZM-MD-01	**RCC Retaining Walls**
EZ-ZM-MD-02	**CRS/SSM Walls**
EZ-ZM-MD-03	**Earthen Embankment**
EZ-ZM-MD-04	**Bed Protection**
EZ-ZM-MD-05	**Desilting**
EZ-ZM-MD-06	**Service Roads**
EZ-ZM-MD-07	**Chainlink Fencing**
EZ-ZM-MD-08	**Drainage Corridor Widths**
EZ-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.2 Drains & Culverts in West Core Zone:

West Core Zone includes part of Hebbal Valley and part of Vrishbavathy Valley. Remodelling study report of primary and secondary drains has recommended certain proposals of which some have been implemented and some are under progress. These aspects have been taken into consideration in the current study and proposals made here are additionally required in the overall context of the Masterplan.

Modifications of drains and culverts proposed, as appropriate from the above in West Core Zone are details and given: **Tables 1 to 11, Part 3, Appendix 2.**

Drawings showing the modifications in West Core Zone as listed below are given in **Part 4, Appendix 2**.

WZ-ZM-MD-01	**RCC Retaining Walls**
WZ-ZM-MD-02	**CRS/SSM Walls**
WZ-ZM-MD-03	**Earthen Embankment**
WZ-ZM-MD-04	**Bed Protection**
WZ-ZM-MD-05	**Desilting**
WZ-ZM-MD-06	**Service Roads**
WZ-ZM-MD-07	**Chainlink Fencing**
WZ-ZM-MD-08	**Drainage Corridor Widths**
WZ-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.3 Drains & Culverts in South Core Zone:

South Core Zone includes part of Vrishabavathy Valley and part of Koramangala Valley. Remodelling study report of primary and secondary drains has recommended certain proposals of which some have been implemented and some are under progress. These aspects have been taken into consideration in the current study and proposals made here are additionally required in the overall context of the Masterplan.

Modifications of drains and culverts proposed, as appropriate from the above in South Core Zone are details and given **Tables 1 to 11, Part 3, Appendix 1.**

Drawings showing the modifications in South Core Zone as listed below are given in **Part 4, Appendix 3**.

SZ-ZM-MD-01	**RCC Retaining Walls**
SZ-ZM-MD-02	**CRS/SSM Walls**
SZ-ZM-MD-03	**Earthen Embankment**
SZ-ZM-MD-04	**Bed Protection**
SZ-ZM-MD-05	**Desilting**
SZ-ZM-MD-06	**Service Roads**
SZ-ZM-MD-07	**Chainlink Fencing**
SZ-ZM-MD-08	**Drainage Corridor Widths**
SZ-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.4 Bommanahalli Zone:

Various measures required in Bommanahalli Zone are;

1 Desilting and bed regradation work is proposed for full length of the drain in the entire zone.

2 Existing drain is in natural condition and original alignment of the drain is modified at several locations. Bank protection works have been proposed like RCC independent wall, RCC U shaped wall in builtup areas and earthen bund formation with CC lining in outskirts areas.

3 Drain width is drastically reduced by land developers near the entry location of Madivala tank. It is proposed to widen and construct RCC box drain.

4 The original alignment of the drain is modified at several locations. Drain width is drastically reduced and developer has constructed walls accordingly to suit their planning requirements. This has resulted in reducing the carrying capacity of drains and intern causing water stagnation and surcharging into low lying areas on the upstream reaches. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

5 Drain width is drastically reduced near Garabhavipalya, Hulimavu, Gottigere, Arakere, Begur area and Parapana Agrahara and original alignment is modified. Existing holding ponds areas are reduced. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

6 Drain reach near Anjanapura, Basavanapura, Doddakalsandra, Kembathanahalli, drain reach is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and service road formation is proposed considering futuristic requirements.

7 Drain reaches in localities developed by the erstwhile CMC authorities is not having any type of wall so there is no scope for drain widening. In such places, RCC ‘U’ shaped walls are proposed.

8 Existing RCC hume pipes culverts / bridges constructed by the erstwhile CMC authorities have been identified and considered for remodelling / replacement with RCC box culverts.

9 Service roads are proposed on either side of the drain where land is available to facilitate for routine maintenance and laying service line along the valleys.

10 Drain reach near Begur, Varuthur, Doddakenahalli, Parapana Agrahara where IT companies have modified the original alignment as per their requirements and constructed RCC walls / covered without studying the network in a comprehensive manner. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

11 Chain Link fence is proposed at vulnerable locations where people have the tendency to dump debris and garbage into the Storm water drain.

12 Drain walls in densely built-up areas and locations where there is less scope for widening the drains in such places RCCU shape walls are proposed.

13 At many locations in developed areas where masonry walls have been constructed by erstwhile CMC areas is in dilapidated / moderate condition and in such locations, it is proposed to replace the existing masonry walls with either new masonry or RCC wall.

14 To retain the existing masonry wall that are in moderate condition, such reaches have been identified and strengthening works have been proposed.

15 Open drain reaches running parallel to busy / main roads. It is proposed to construct RCC Box drain in such location to avoid reduction in road/footpath width and cause less inconvenience to road users.

16 Silt trap and trash barriers are proposed near the water body locations to prevent sediment /silt transport.

17 Residential layout approved by erstwhile CMC authorities have modified original alignment and drastically reduced the drain width. This has resulted in surcharging the water into low lying pockets and causing water stagnation. In such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

18 ITI layout, Chika Begur area, Singasandra, Hongasandra, MICO Layout, etc., in many places, drain walls are constructed by erstwhile CMC authorities and further beyond drain reaches have been left unattended beyond the developed areas. Whereas in the proposed Masterplan it is proposed to widen the drains and construct drain walls upto water bodies.

19 In certain regions due to formation of Ring roads and railway lines, the alignment has got modified and reduced the drain width. In such places RCC walls have been proposed in the Masterplan in order not to reduce the road width. Also culverts constructed across SWD with RCC hume pipes are causing water stagnation. Such locations have been identified and proposed for remodelling.

20 Drain reaches in layouts developed by BDA, near J P Nagar, 9th Phase, Anjanapura, Banshankari VI stage the condition of the existing masonry walls are in moderate condition and drain bed is eroded at certain locations. In such locations wall restoration and bed restoration works are proposed in the Masterplan.

Based on the foregoing, details of modifications on drains and culverts are given in **Tables 1 to 11, Part 3, Appendix 4.**

Drawings showing the modifications in Bommanahalli Zone as listed below are given in **Part 4, Appendix 4**.

BH-ZM-MD-01	**RCC Retaining Walls**
BH-ZM-MD-02	**CRS/SSM Walls**
BH-ZM-MD-03	**Earthern Embankment**
BH-ZM-MD-04	**Bed Protection**
BH-ZM-MD-05	**Desilting**
BH-ZM-MD-06	**Service Roads**
BH-ZM-MD-07	**Chainlink Fencing**
BH-ZM-MD-08	**Drainage Corridor Widths**
BH-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.5 Yelahanka Zone:

Various measures required in Yelahanka Zone are;

1 It is proposed to develop flood plain alongside storm water drain near Arkavathi layout from Raja canal STP to d/s of Rampura kere.

2 Desilting and bed regradation work is proposed for full length of the primary drains in the entire zone.

3 Existing drain is in natural condition and original alignment of the drain is modified at several locations. Bank protection works have been proposed like RCC independent wall, RCC U shaped wall in builtup areas and earthen bund formation with CC lining in outskirts areas.

5 The original alignment of the drain is modified at several locations. Drain width is drastically reduced and developer has constructed walls accordingly to suit their planning requirements. This has resulted in reducing the carrying capacity of drains and intern causing water stagnation and surcharging into low lying areas on the upstream reaches. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

6 Drain width is drastically reduced near Mariyannapalya, Jakkur Kere, Rachenahalli, Kogilu, Allasandra, Dodda Bommasandra, Atturu, Puttenahalli and original alignment is modified. Existing holding pond areas are reduced. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

7 Drain reach near Gantiganahalli, drain reach is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and service road formation is proposed considering futuristic requirements.

8 Drain reaches in localities developed by the erstwhile CMC authorities is not having any type of wall so there is no scope area for drain widening. In such places, RCC ‘U’ shaped walls are proposed.

9 Existing RCC hume pipes culverts / bridges constructed by the erstwhile CMC authorities

have been identified and considered for remodelling / replacement with RCC box culverts.

10 Service roads are proposed on either side of the drain where land is available to facilitate for routine maintenance and laying service line along the valleys.

11 Drain reach near Manayatha Tech Park, Gedalahalli. Where IT companies & apartment developers have modified the original alignment as per their requirements and constructed RCC walls / covered without studying the network in a comprehensive manner. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

12 Chain Link fence is proposed at vulnerable locations where people have the tendency to dump debris and garbage into the Storm water drain.

13 Drain walls in densely built-up areas and locations where there is less scope for widening the drains in such Places RCC U shape walls are proposed.

14 At many locations in developed areas where masonry walls have been constructed by erstwhile CMC areas is in dilapidated / moderate condition and in such locations, it is proposed to replace the existing masonry walls with either new masonry or RCC wall.

15 To retain the existing masonry wall that are in moderate condition, such reaches have been identified and strengthening works have been proposed.

16 Open drain reaches running parallel to busy / main roads. It is proposed to construct RCC Box drain in such location to avoid reduction in road/footpath width and cause less inconvenience to road users.

17 Silt trap and trash barriers are proposed near the water body locations to prevent sediment /silt transport.

18 Residential layout approved by erstwhile CMC authorities have modified original alignment and drastically reduced the drain width. This has resulted in surcharging the water into low lying pockets and causing water stagnation. In such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

19 Near Allasandra, Rachenahalli, Mariyannapalya in many places, drain walls are constructed by erstwhile CMC authorities within the village limits and further beyond drain reaches have been left unattended beyond the developed areas. Whereas in the proposed Masterplan it is proposed to widen the drains and construct drain walls upto water bodies.

20 In certain regions due to formation of Ring roads and railway lines, the alignment has got modified and reduced the drain width. In such places RCC walls have been proposed in the Masterplan in order not to reduce the road width. Also culverts constructed across SWD with RCC hume pipes are causing water stagnation. Such locations have been identified and proposed for remodelling in the master plan project.

21 Drain reaches in layouts developed by CMC authorities and private developers / society the condition of the existing masonry walls are in moderate condition and drain bed is eroded at certain locations. In such locations wall restoration and bed restoration works are proposed in the Masterplan.

Based on the foregoing, details of modifications on drains and culverts are given in **Tables 1 to 11, Part 3, Appendix 5.**

Drawings showing the modifications in Yelehanka Core Zone as listed below are given in **Part 4, Appendix 4**.

YE-ZM-MD-01	**RCC Retaining Walls**
YE-ZM-MD-02	**CRS/SSM Walls**
YE-ZM-MD-03	**Earthern Embankment**
YE-ZM-MD-04	**Bed Protection**
YE-ZM-MD-05	**Desilting**
YE-ZM-MD-06	**Service Roads**
YE-ZM-MD-07	**Chainlink Fencing**
YE-ZM-MD-08	**Drainage Corridor Widths**
YE-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.6 Dasarahalli Zone:

Various measures required in Dasarahalli Zone are;

1 Drain reaches at Chowdeshwari nagara, Jaimaruthinagara, Narasimhaswamy layout, Hoyasala Nagara, Mahadeshwara Nagara, Herehalli, Sanjeevininagara, Kanobanahalli, Bagalkunte area, Nithyanagara, etc., drain reach is in natural condition and houses have been developed upto edge of water way. In such places, RCC U shaped wall and Box drains are proposed.

2 Drain reach in Chikkabidarakalu area, Gangadonahalli, Kachohalli areas is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and Service road formation is proposed.

3 Desilting and bed regradation work is proposed for full length of the primary drains in the entire zone.

4 Existing drain is in natural condition and original alignment of the drain is modified at several locations. Bank protection works have been proposed like RCC independent wall, RCC U shaped wall in builtup areas and earthen bund formation with CC lining in outskirts areas.

6 The original alignment of the drain is modified at several locations. Drain width is drastically reduced and developer has constructed walls accordingly to suit their planning requirements. This has resulted in reducing the carrying capacity of drains and intern causing water stagnation and surcharging into low lying areas on the upstream reaches. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

7 Drain width is drastically reduced near Dasarahalli, Kammagondanahalli, Bagagunte, Chikka Bidara Kalu area original alignment is modified. Existing holding pond areas are reduced. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

8 Drain reach near Anchepalya drain reach is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and service road formation is proposed considering futuristic requirements.

9 Drain reaches in localities developed by the erstwhile CMC authorities is not having any type of wall so there is no scope area for drain widening. In such places, RCC 'U' shaped walls are proposed.

10 Existing RCC hume pipes culverts / bridges constructed by the erstwhile CMC authorities have been identified and considered for remodelling / replacement with RCC box culverts.

11 Service roads are proposed on either side of the drain where land is available to facilitate for routine maintenance and laying service line along the valleys.

12 Drain reach near Chikka Banawara, Abbigere, Where small scale industrialist and apartment developers have modified the original alignment as per their requirements and constructed RCC walls / covered without studying the network in a comprehensive manner. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

13 Chain Link fence is proposed at vulnerable locations where people have the tendency to dump debris and garbage into the Storm water drain.

14 Drain walls in densely built-up areas and locations where there is less scope for widening the drains in such places RCC U shape walls are proposed.

15 At many locations in developed areas where masonry walls have been constructed by erstwhile CMC areas is in dilapidated / moderate condition and in such locations, it is proposed to replace the existing masonry walls with either new masonry or RCC wall.

16 To retain the existing masonry wall that are in moderate condition, such reaches have been identified and strengthening works have been proposed.

17 Open drain reaches running parallel to busy / main roads. It is proposed to construct RCC Box drain in such location to avoid reduction in road/footpath width and cause less inconvenience to road users.

18 Silt trap and trash barriers are proposed near the water body locations to prevent sediment /silt transport.

19 Residential layout approved by erstwhile CMC authorities have modified original alignment and drastically reduced the drain width. This has resulted in surcharging the water into low lying pockets and causing water stagnation. In such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

20 The drain walls have been constructed within the village limits by erstwhile CMC authorities and further beyond drain reaches have been left unattended. Whereas in the proposed Masterplan it is proposed to widen the drains and construct drain walls upto water bodies.

21 In certain regions due to formation of Ring roads and railway lines, the alignment has got modified and reduced the drain width. In such places RCC walls have been proposed in the Masterplan in order not to reduce the road width. Also culverts constructed across SWD with RCC hume pipes are causing water stagnation. Such locations have been identified and proposed for remodelling in the master plan project.

22 Drain reaches in layouts developed by CMC authorities and private developers / society the condition of the existing masonry walls are in moderate condition and drain bed is eroded at certain locations. In such locations wall restoration and bed restoration works are proposed in the Masterplan.

Based on the foregoing, details of modifications on drains and culverts are given along with cost in **Tables 1 to 11, Part 3, Appendix 6.**

Drawings showing the modifications in Dasarahalli Core Zone as listed below are given in **Part 4, Appendix 6**.

DH-ZM-MD-01	**RCC Retaining Walls**
DH-ZM-MD-02	**CRS/SSM Walls**
DH-ZM-MD-03	**Earthen Embankment**
DH-ZM-MD-04	**Bed Protection**
DH-ZM-MD-05	**Desilting**
DH-ZM-MD-06	**Service Roads**
DH-ZM-MD-07	**Chainlink Fencing**
DH-ZM-MD-08	**Drainage Corridor Widths**
DH-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.7 Mahadevapura Zone:

Various measures required in Mahadevapura Zone are;

1. It is proposed to develop flood plain alongside Storm water drain near Whitefield area from Rampura Kere to D/s of Varthur kere and near ORR from D/s of Bellandur kere to D/s of Varthur kere.

2. Desilting and bed regradation work is proposed for full length of the primary drains in the entire zone.

3. Existing drain is in natural condition and original alignment of the drain is modified at several locations. Bank protection works have been proposed like RCC independent wall, RCC U shaped wall in builtup areas and earthen bund formation with CC lining in outskirts areas.

4. The original alignment of the drain is modified at several locations. Drain width is drastically reduced and developer has constructed walls accordingly to suit their planning requirements. This has resulted in reducing the carrying capacity of drains and intern causing water stagnation and surcharging into low lying areas on the upstream reaches. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

5. Drain width is drastically reduced near Ramamurthynagara, Seegehalli, Devasandra, Vibuthipura, Kaggadasapura, Doddanekundi, Marathahalli, Kundalahalli and original alignment is modified. Existing holding pond areas are reduced. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

6. Drain reach near white field, Immedihalli, Sorahunase drain reach is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and service road formation is proposed considering futuristic requirements.

7. Dumping of debris/earth inside the waterway and reducing the drain width is observed at many locations near downstream on Bellandur tank, Varthur and Whitefield areas, etc., and in order to prevent dumping of debris, bank protection works, drain widening, bund formation and corridor development is proposed at many locations near Nallurahalli, Immedihalli, Whitefield, Chennapanahalli, Munnekollala and Varthur region.

8. Drain reaches in localities developed by the erstwhile CMC authorities is not having any type of wall so there is no scope area for drain widening. In such places, RCC ‘U’ shaped walls are proposed.

9. Existing RCC hume pipes culverts / bridges constructed by the erstwhile CMC authorities have been identified and considered for remodelling / replacement with RCC box culverts.

10. Service roads are proposed on either side of the drain where land is available to facilitate for routine maintenance and laying service line along the valleys.

11. Drain reach near Kundalahalli, Nalurahalli, White field, Thurabahalli. Where IT companies & apartment developers have modified the original alignment as per their requirements and constructed RCC walls / covered without studying the network in a comprehensive manner. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

12. Chain Link fence is proposed at vulnerable locations where people have the tendency to dump debris and garbage into the Storm water drain.

13. Drain reach near Taruhunse, Thimagondanahalli, Immedihalli, etc., is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and Service road formation is proposed.

14. At many locations in developed areas where masonry walls have been constructed by erstwhile CMC areas is in dilapidated / moderate condition and in such locations, it is proposed to replace the existing masonry walls with either new masonry or RCC wall.

15. To retain the existing masonry wall that are in moderate condition, such reaches have been identified and strengthening works have been proposed.

16. Open drain reaches running parallel to busy / main roads. It is proposed to construct RCC Box drain in such location to avoid reduction in road/footpath width and cause less inconvenience to road users.

17. Silt trap and trash barriers are proposed near the water body locations to prevent sediment /silt transport.

18. Residential layout approved by erstwhile CMC authorities have modified original alignment and drastically reduced the drain width. This has resulted in surcharging the water into low lying pockets and causing water stagnation. In such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

19. Near K.R.Pura, Devasandra, Ramamurthynagara, Vibuthipura drain walls are constructed by erstwhile CMC authorities within the village limits and further beyond drain reaches have been left unattended. Whereas in the proposed Masterplan it is proposed to widen the drains and construct drain walls upto water bodies.

20. In certain regions due to formation of Ring roads and railway lines, the alignment has got modified and reduced the drain width. In such places RCC walls have been proposed in the Masterplan in order not to reduce the road width. Also culverts constructed across SWD with RCC hume pipes are causing water stagnation. Such locations have been identified and proposed for remodelling in the master plan project.

21. Drain reaches in layouts developed by CMC authorities and private developers / society the condition of the existing masonry walls are in moderate condition and drain bed is eroded at certain locations. In such locations wall restoration and bed restoration works are proposed in the Masterplan.

Based on the foregoing, details of modifications on drains and culverts are given in **Tables 1 to 11, Part 3, Appendix 7.**

Drawings showing the modifications in Dasarahalli Core Zone as listed below are given in **Part 4, Appendix 7**.

MD-ZM-MD-01	**RCC Retaining Walls**
MD-ZM-MD-02	**CRS/SSM Walls**
MD-ZM-MD-03	**Earthen Embankment**
MD-ZM-MD-04	**Bed Protection**
MD-ZM-MD-05	**Desilting**
MD-ZM-MD-06	**Service Roads**
MD-ZM-MD-07	**Chainlink Fencing**
MD-ZM-MD-08	**Drainage Corridor Widths**
MD-ZM-MD-09	**Culverts identified for Modifications**

5.1.1.8 Raja Rajeshwari Nagara Zone:

Various measures required in Raja Rajeshwari Nagara Zone are;

1. It is proposed to develop flood plain alongside Storm water drain near Mailasandra for Vrishabhavathi River from RR Nagara Arch to Kumbalgodu and extend upto Byramangala Kere in similar lines at later date.

2. Desilting and bed regradation work is proposed for full length of the primary drains in the entire zone.

3. Existing drain is in natural condition and original alignment of the drain is modified at several locations. Bank protection works have been proposed like RCC independent wall, RCC U shaped wall in builtup areas and earthen bund formation with CC lining in outskirts areas.

4. The original alignment of the drain is modified at several locations. Drain width is drastically reduced and developer has constructed walls accordingly to suit their planning requirements. This has resulted in reducing the carrying capacity of drains and intern causing water stagnation and surcharging into low lying areas on the upstream reaches. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

5. Drain width is drastically reduced near Subramanyapura, Purna Pragna layout, Uttarahalli, Duvaspalya, Kodipalya, Beedi Karmikara Colony near Kengeri, Nagadevanahalli, Pattanagere, Kenchanahalli, near Kendriya Nagara, Anapoornashenvinagar, Dore kere area, Banshankari Vth stage, Yelachinahalli, Samrudhinagar, Bhagegowda layout, University layout, etc., where original drain alignment is modified. Existing holding pond areas are reduced. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

6. Drain reach near Golahalli, Konnasandra drain reach is in natural condition and the land adjoining is under cultivation in nature, therefore earthen bund formation with CC lining and service road formation is proposed considering futuristic requirements.

7. Dumping of debris/earth inside the waterway and reducing the drain width is observed at many locations along Mysore Road, Subramanyapura, Kengeri, Kodipalya etc., and in order to prevent dumping of debris, bank protection works, drain widening, bund formation and corridor development is proposed.

8. Drain reaches in localities developed by the erstwhile CMC authorities is not having any type of wall so there is no scope area for drain widening. In such places, RCC ‘U’ shaped walls are proposed.

9. Existing RCC hume pipes culverts / bridges constructed by the erstwhile CMC authorities have been identified and considered for remodelling / replacement with RCC box culverts.

10. Service roads are proposed on either side of the drain where land is available to facilitate for routine maintenance and laying service line along the valleys.

11. Drain reach near Kengeri, Rajarajeshwarinagara, Banashankari 6th Stage layout, BEML layout, Halagevadarahalli. Where IT companies & apartment developers have modified the original alignment as per their requirements and constructed RCC walls / covered without studying the network in a comprehensive manner. Therefore, in such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

12. Chain Link fence is proposed at vulnerable locations where people have the tendency to dump debris and garbage into the Storm water drain.

13. At many locations in developed areas where masonry walls have been constructed by erstwhile CMC areas is in dilapidated / moderate condition and in such locations, it is proposed to replace the existing masonry walls with either new masonry or RCC wall.

14. To retain the existing masonry wall that are in moderate condition, such reaches have been identified and strengthening works have been proposed.

15. Open drain reaches running parallel to busy / main roads. It is proposed to construct RCC Box drain in such location to avoid reduction in road/footpath width and cause less inconvenience to road users.

16. Silt trap and trash barriers are proposed near the water body locations to prevent sediment /silt transport.

17. Residential layout approved by erstwhile CMC authorities have modified original alignment and drastically reduced the drain width. This has resulted in surcharging the water into low lying pockets and causing water stagnation. In such places it is proposed to verify the land records, procure the additional land required for widening the drain and construct RCC drain walls / box drains and development of service corridor.

18. Near Kengeri, Kenchanahalli, Rajarajeshwarinagara, Nagadevanahalli etc., drain walls are constructed by erstwhile CMC authorities within the village limits and further beyond drain reaches have been left unattended. Whereas in the proposed Masterplan it is proposed to widen the drains and construct drain walls upto water bodies.

19. In certain regions due to formation of Ring roads and railway lines, the alignment has got modified and reduced the drain width. In such places RCC walls have been proposed in the Masterplan in order not to reduce the road width. Also culverts constructed across SWD with RCC hume pipes are causing water stagnation. Such locations have been identified and proposed for remodelling in the master plan project.

20. Drain reaches in layouts developed by CMC authorities and private developers / society the condition of the existing masonry walls are in moderate condition and drain bed is eroded at certain locations. In such locations wall restoration and bed restoration works are proposed in the Masterplan.

21. Silt trap and trash barriers are proposed near ll the water body location to prevent sediment /silt transport.

Based on the foregoing, details of modifications on drains and culverts are given in **Tables 5.1 & location details etc., is given in Table 1 to Table 11, Part 3, Appendix 5.**

Drawings showing the modifications in Rajarajeshwarinagara Zone as listed below are given in **Part 4, Appendix 8**.

RN-ZM-RN-01	**RCC Retaining Walls**
RN-ZM-RN-02	**CRS/SSM Walls**
RN-ZM-RN-03	**Earthen Embankment**
RN-ZM-RN-04	**Bed Protection**
RN-ZM-RN-05	**Desilting**
RN-ZM-RN-06	**Service Roads**
RN-ZM-RN-07	**Chainlink Fencing**
RN-ZM-RN-08	**Drainage Corridor Widths**
RN-ZM-RN-09	**Culverts identified for Modifications**

Typical cross section details considered for implementation are as shown in **Fig. 5.2 to 5.6.**

Table 5.1 Details of Works Proposed under Master Plan Project

Sl.	Name of Water Shed	Unit	Core Area (W + E+ S)	Bommanahalli Zone	Yelahanka Zone	Dasarahalli Zone	Mahadevpura Zone	Rajarajeshwarinagara Zone	Total
No.	**Items of Work**		**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**
1.0	**Carrying Capacity Improvement Works:**								
1.1	Desilting and deepening	**Rmt**	227,380	101,005	98,786	79,110	131,770	98,920	736,971
1.2	Drain Widening								
	a. Earthen bund formation	**Rmt**	1,850	10,900	14,070	3,735	41,980	550	73,085
	b. RCC independent walls	**Rmt**	22,890	1,250	10,910	10,005	7,340	26,725	79,120
	c. RCC "U" shaped walls	**Rmt**	7,785	32,305	28,860	36,940	35,335	30,350	171,575
	d. CRS / SSM masonry walls	**Rmt**	3,850	25,225	23,380	9,775	30,415	10,750	103,395
	e. RCC box drain	**Rmt**	5,017	15,535	7,630	300	11,880	5,360	45,722
1.3	Bed protection	**Rmt**	1,800	11,685	38,140	19,110	2,700	53,785	127,220
2.0	**Rehabilitation / Strengthening Works:**								
	CRS / SSM wall reconstruction	**Rmt**	2,755	13,105	24,190	13,485	5,400	24,935	83,870
	CRS / SSM wall restoration								
3.0	**Culverts / Bridges:**								
3.1	Utility support structures / bridges	**Nos**	0	4	4	4	6	5	23
3.2	Proposed for remodelling	**Nos**	59	68	229	133	167	230	886
3.3	Proposed for rehabilitation	**Nos**	0	141	13	69	77	103	403
3.4	Railway Culverts	**Nos**			2		6	2	10
4.0	**Allied Drain Works:**								
4.1	Fixing boundary stones along the drains	**Nos**	15,159	6,626	0	5,521	8,629	8,460	44,394
4.2	Development of drains in low lying areas	**LOT**	58	24	15	17	23	10	147
4.3	Service road formation	**Rmt**	17,000	80,695	74,500	57,160	118,900	67,610	415,865
4.4	Fencing	**Rmt**	14,790	400	33,425	13,660	3,550	35,715	101,540
4.5	Detention ponds	**Nos**	33	10	16	22	10	10	101
4.6	Retarding basins	**Nos**	14	10	6	18	5	10	63
4.7	Development of existing water bodies as holding ponds	**Nos**	7	7	9	6	15	6	50
4.8	Silt traps	**Nos**	0	28	242	18	48	12	348
4.9	Desilting ramps	**Nos**	0	5	5	6	5	5	26
4.10	Inlet / out weir strengthening	**Nos**	15	26	15	8	16	14	94
4.11	Setting up of rain gauge stations	**Nos**	8	11	1	8	14	6	48
4.12	Shifting of sewers from SWD's	**LOT**	4	11	18,365	8	14	6	18,408
4.13	Procurement of desilting machines	**Nos**	4	4	4	4	5	3	24
4.14	Procurement of vehicles for BBMP vigilance squad	**Nos**	4	11	9	8	14	6	52
5.0	**Decentralized Sewage Treatment Plants:**								
	Construction of decentralized STP's near lakes	**Nos**	2	4	3	1	3	1	14

Fig 5.2 Typical RCC U Shaped Retaining Wall

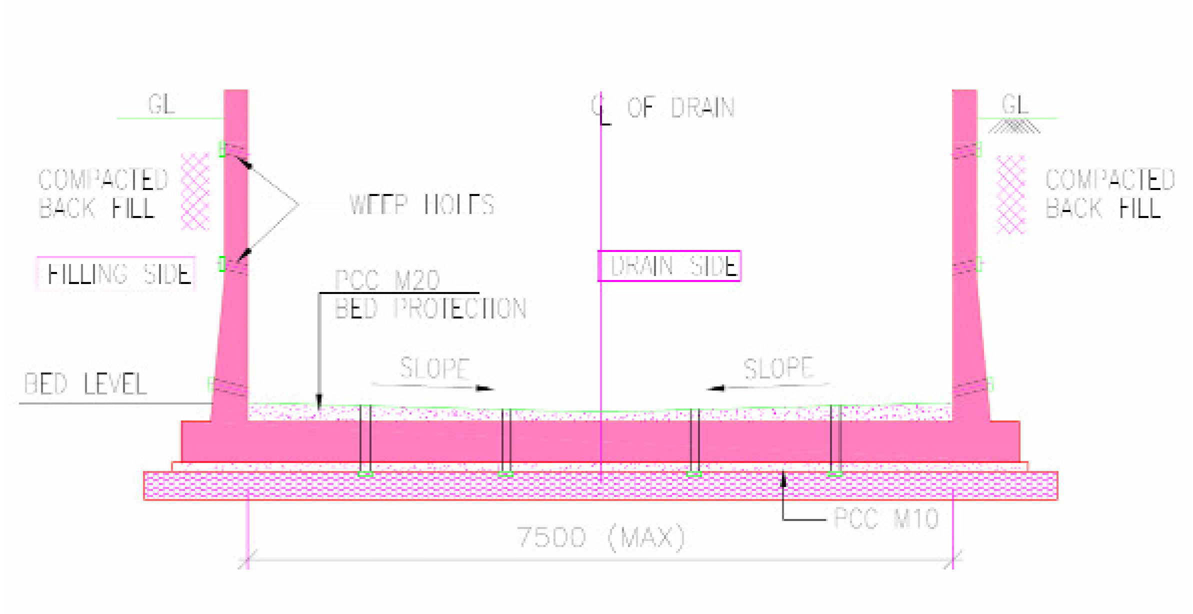


Fig 5.3 Typical Single Cell RCC Box Culvert

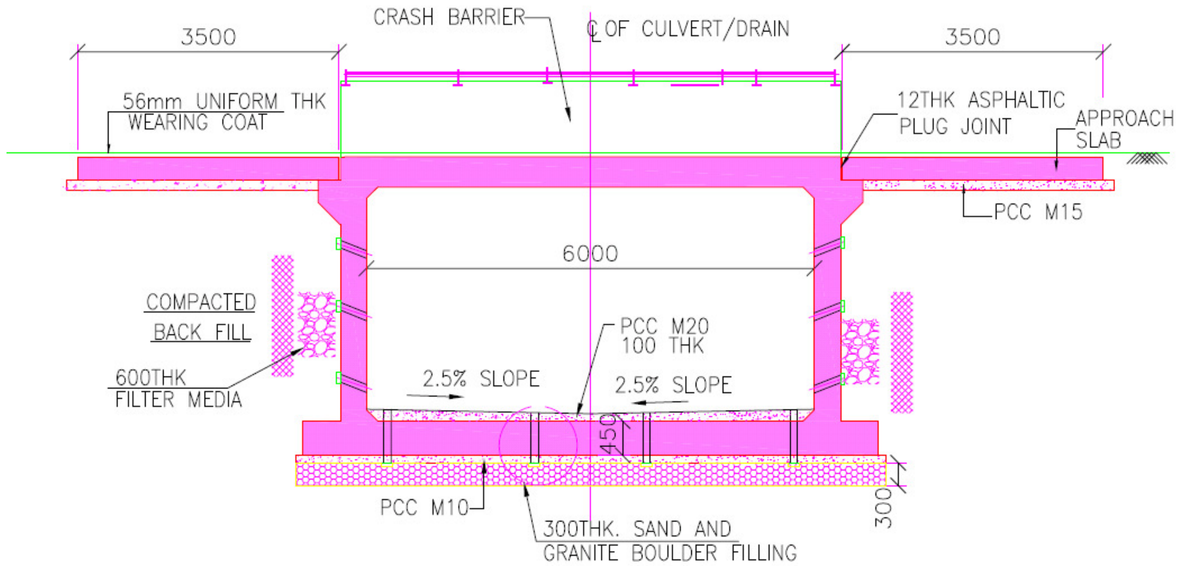


Fig 5.4 Typical Bridge With Pile and Open Foundation Arrangement

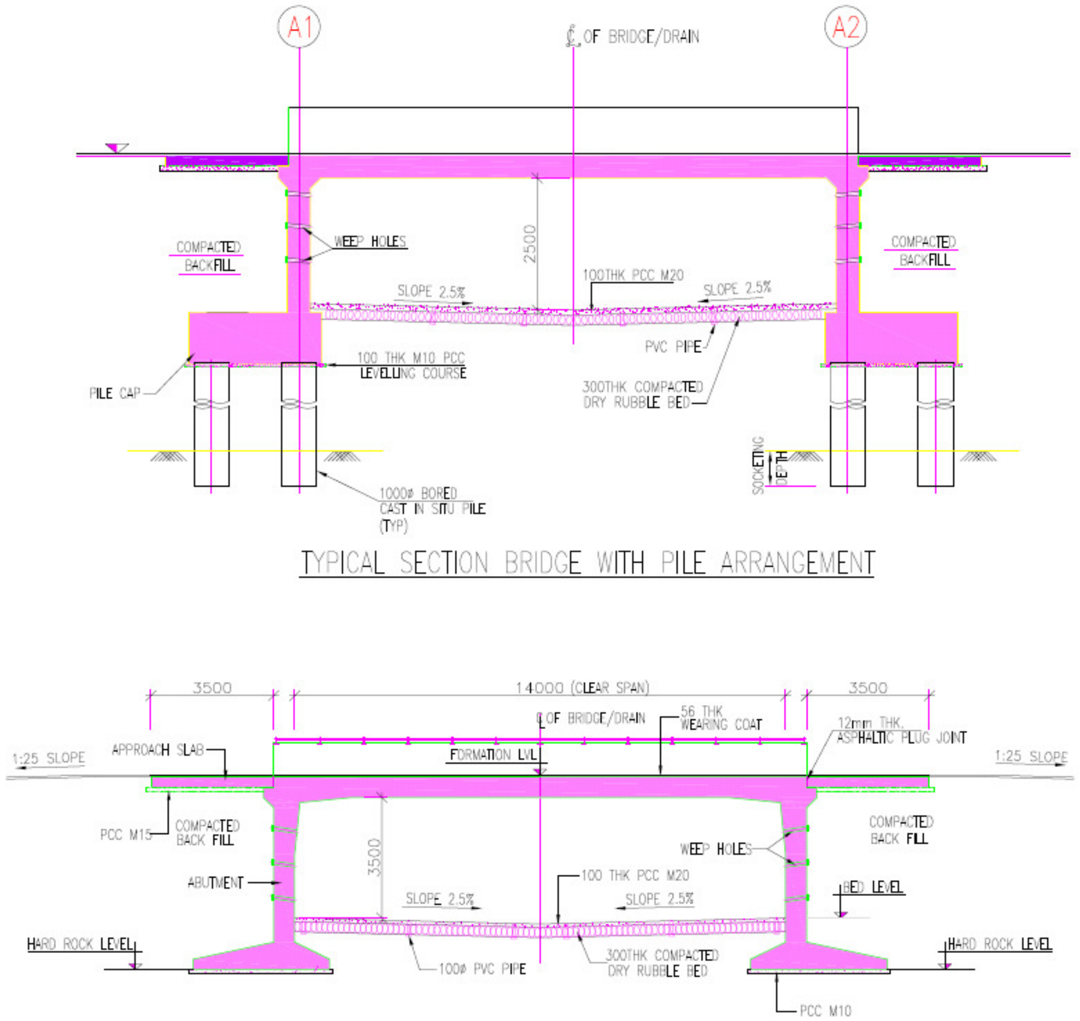


Fig 5.5 Earthen Embankment with service Road

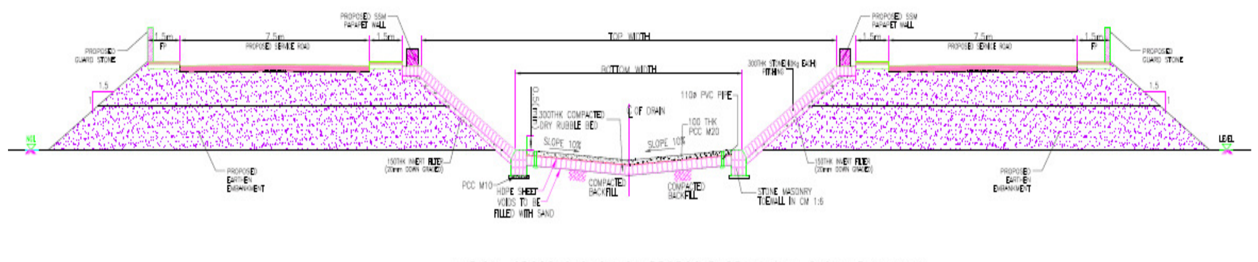
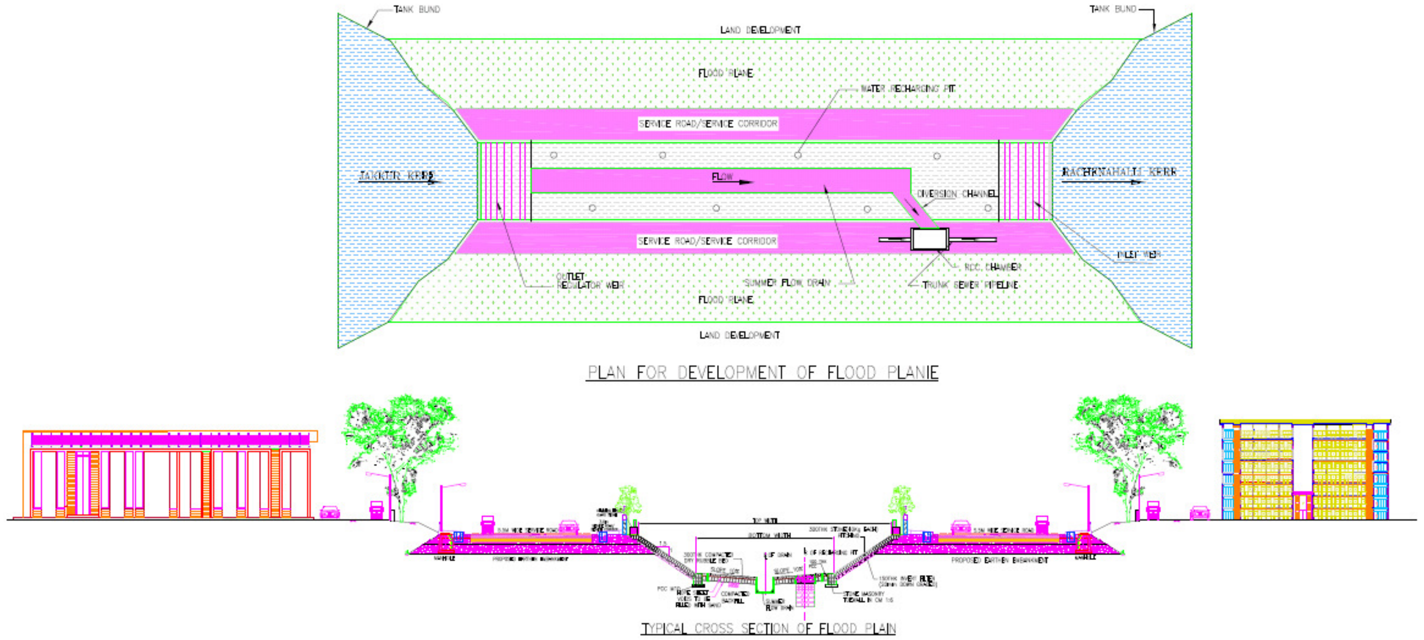
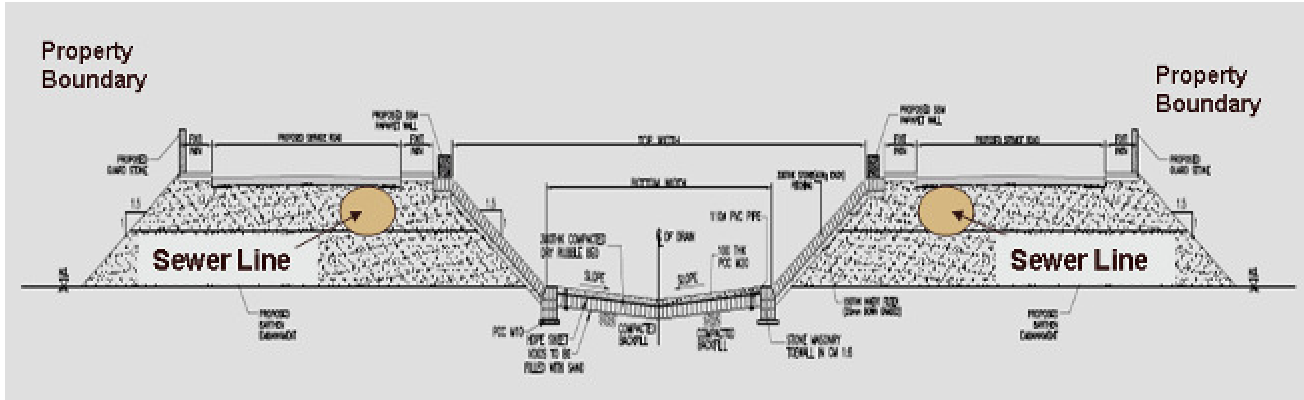
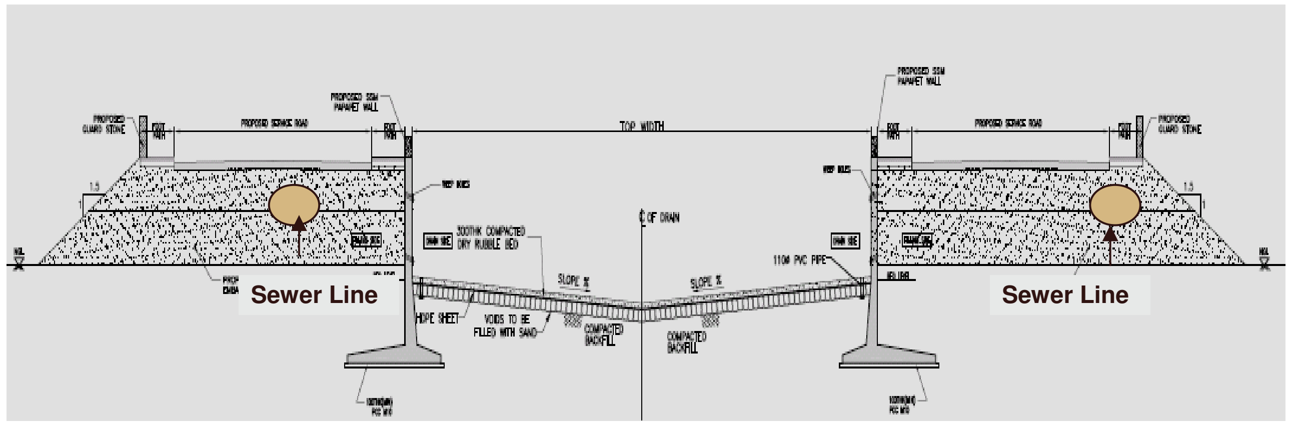
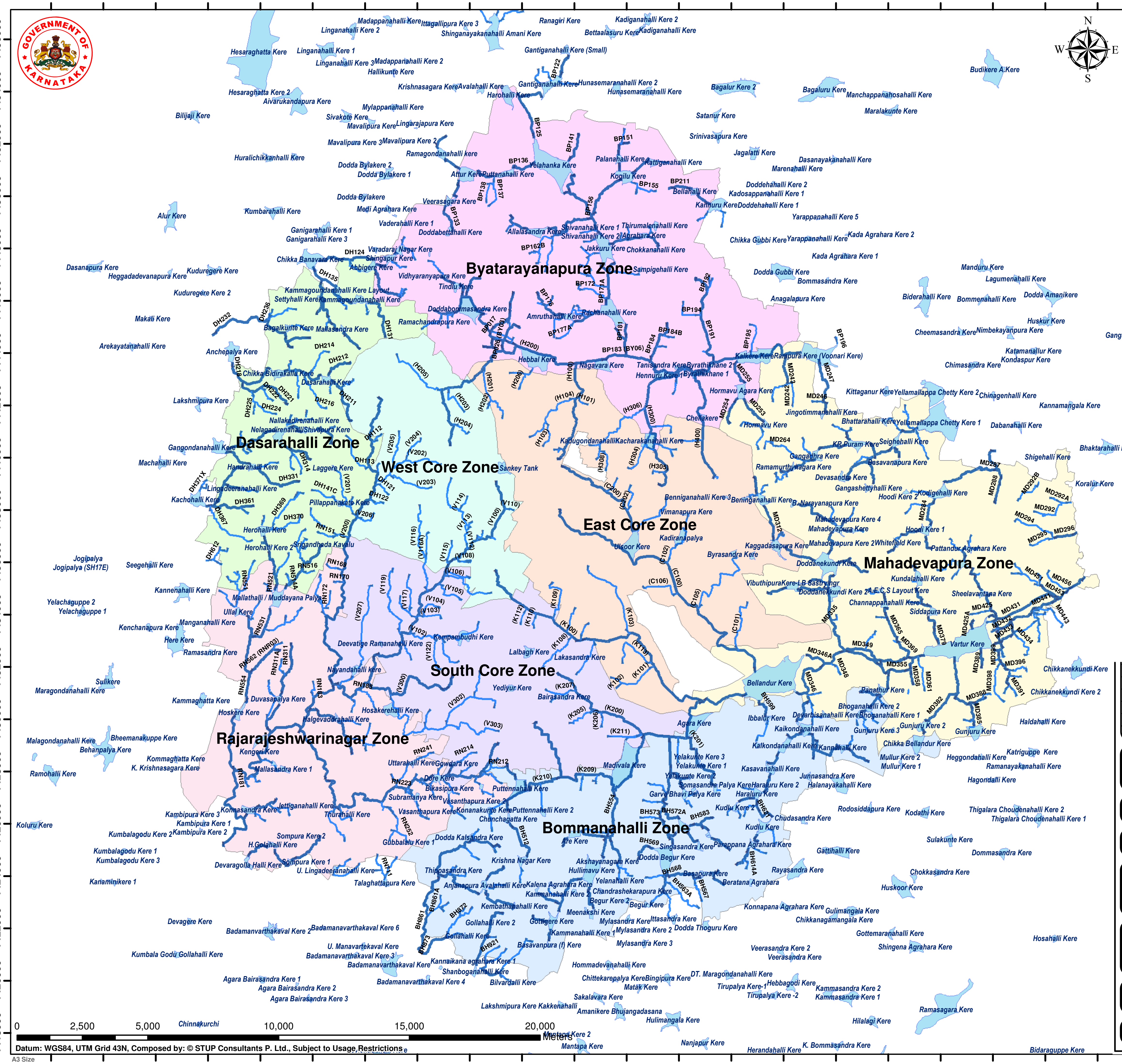


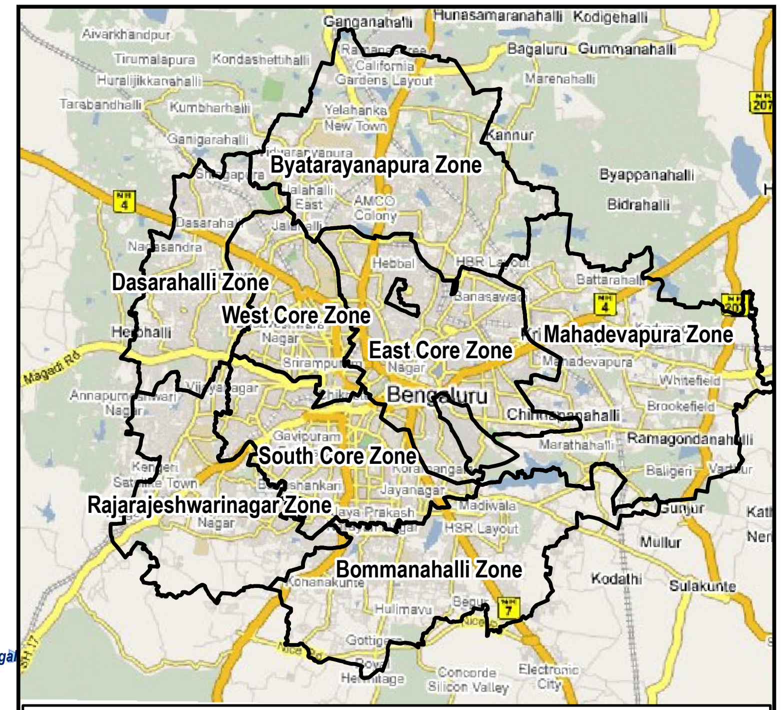
Fig 5.6 Drainage Corridor











Key Map

Legend

Storm Water Drains Type

- Primary SWD
- Secondary SWD
- Water Bodies

BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: **Bruhat Bengaluru Mahanagara Palike**

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PROJECT: **Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike**

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: **Map Showing Storm Water Drains Proposed for Remodeling of 8 BBMP Zones**

APPROVED: YDM (CC)

No. SWD-MP-SD-01 | REV R0 | JOB No.10331/E | SCALE AS SPECIFIED

151

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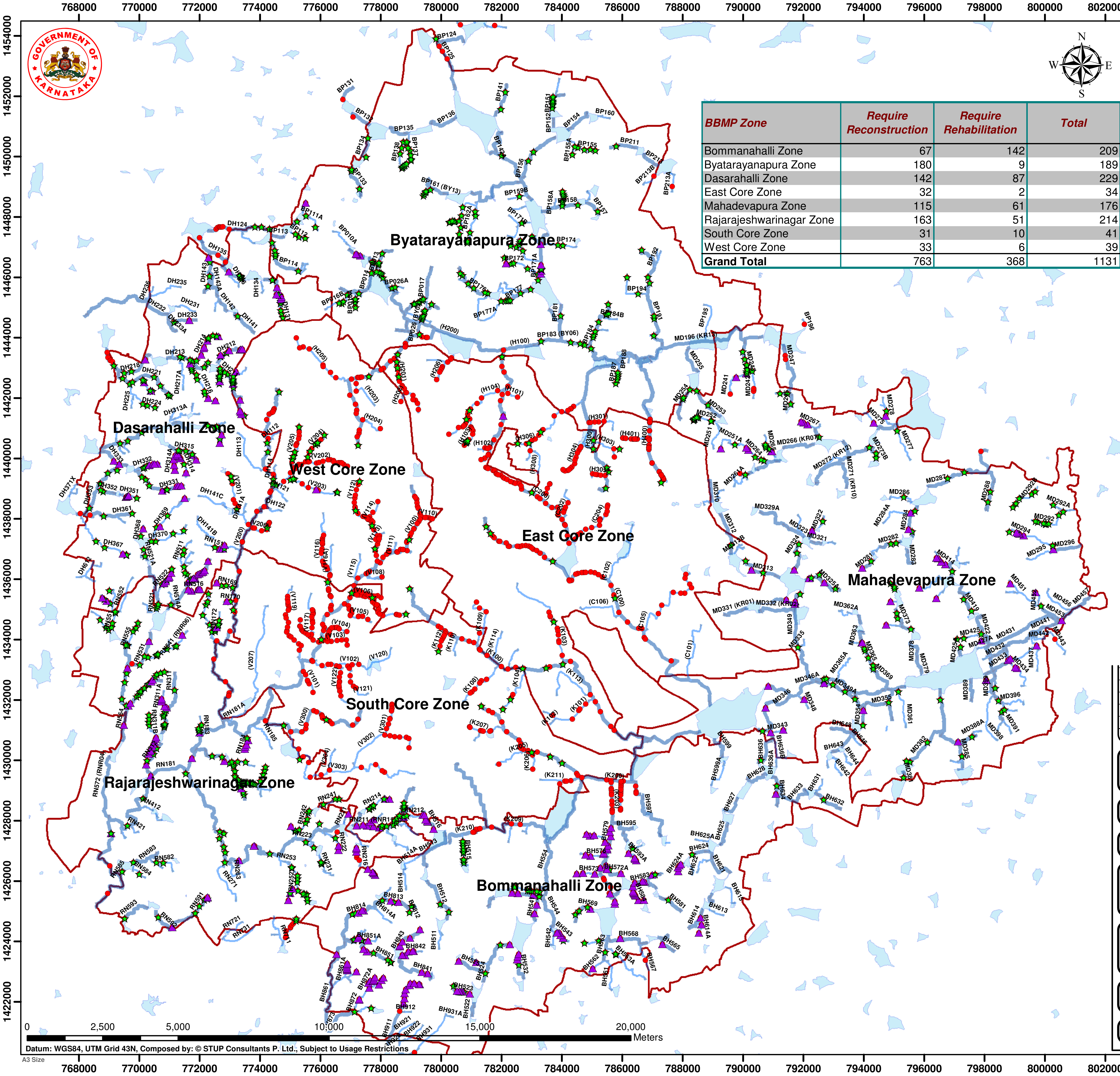
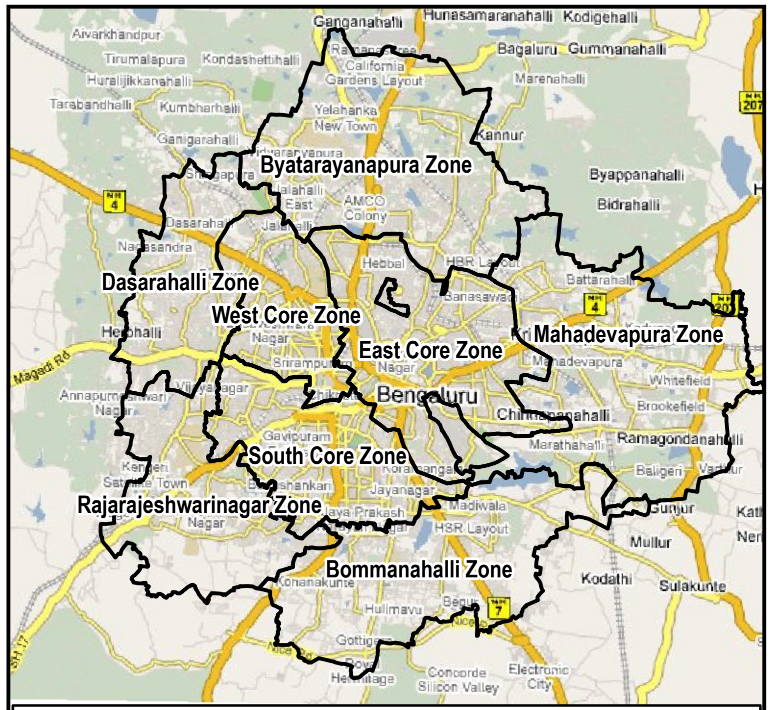
A3 Size



BBMP Zone	Require Reconstruction	Require Rehabilitation	Total
Bommanahalli Zone	67	142	209
Byatarayanapura Zone	180	9	189
Dasarahalli Zone	142	87	229
East Core Zone	32	2	34
Mahadevapura Zone	115	61	176
Rajarajeshwarinagar Zone	163	51	214
South Core Zone	31	10	41
West Core Zone	33	6	39
Grand Total	763	368	1131



Key Map

Legend

- Culverts
- Require Rehabilitation
- Require Reconstruction
- Primary SWD
- Secondary SWD
- BBMP Administrative Zones
- Water Bodies

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: Bruhat Bengaluru Mahanagara Palike

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: Map Showing Culvert Locations Along Drains of 8 BBMP Zones

APPROVED: YDM (CC)

No. SWD-MP-CB-01 | REV R0 | JOB No. 10331/E | SCALE AS SPECIFIED

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A3 Size

5.2 Roles and Responsibilities of Stake Holders:

Bangalore Development Authority:

- Shall ensure landuse development as per CDP in the peripheral areas.
- Earmark land for development of detention ponds to hold flash flood water.
- Demarcate land for development of service corridor on either side of the drain
- Regain the encroached water ways, water bodies and its achkatu areas.
- Enforce rainwater harvesting.
- Enforce, to reduce ground coverage areas in large plots.
- Ensure houses that are constructed in flood plains and in critical areas are above high flood level.
- Enforce quality construction procedures
- Ensure implementation of master plan proposals.
- Considering futuristic requirements, UGD works to be provided to the entire layout.
- To develop flood plain areas as green zone or for temporary utilization like fairs / playgrounds etc.
- Shall ensure the following during formation of new layouts / according approvals for layouts developed by private entrepreneurs;
  - Filling up of swampy / depression areas not allowed,
  - Avoid sanctioning/approving layouts in tank bed /achukatu areas
  - Demarcation of low lying areas as flood prone zones
  - Modification of original drain alignment not permitted,
  - Ensure formation of service roads on either side of the valley
- BWSSB, BDA & LDA shall interface all its implementation proposals with BBMPs project proposals to avoid repetition of works at later date.

Bangalore Water Supply and Sewerage Board:

- Trunk sewer pipelines of required capacity to be laid on either side of the drain
- BWSSB, BDA & BBMP shall work hand in hand to procure land for demarcation of service corridor along the valley
- Shall identify and reconstruct all collapsed manholes to prevent entry of sewage into SWD
- Shall relocate manholes constructed exactly at culvert vent location to provide access to free flow of water
- Enforce rainwater harvesting as mandatory.
- Considering futuristic requirements, UGD works/missing links to be provided to the entire layout.

Lake improvement works taken up by BDA, LDA & BBMP shall include;

- Size of all drains connecting to the water bodies shall be maintained as per the proposals in the Master Plan report.
- Tank desilting, deepening and fixing regulatory gates to maintain required water level in the water body before monsoon based on the data received from Automated rain gauge station
- Channel constructed to release excess water to be connected to SWD
- Proposals for Inlet/outlet weir strengthening works
- Proposals to procure land for setting up of STP, Pump houses & recycling plants etc.
- Proposals to stop entry of undesired flows into the lakes

Bruhath Bengaluru Mahanagara Palike:

- Houses in flood plains and in critical areas needs to be constructed above high flood level or on stilt.
- Penalties or higher tax for land use violation which are undesirable.
- Incentive for providing flood control measures taken up by individual or institution.
- Develop flood plain as greenery or for temporary utilization.
- Use play ground / park in low level as temporary detention for flood water.
- Outsource the upkeep of drain to meet the desired outcome.
- Regular co-ordination meetings with other stakeholders like BWSSB, BDA, LDA, Forest Dept, Horticulture, Police etc., on Lakes upkeep, STP, utilization of treated sewage for park etc.,
- Enforce rainwater harvesting.
- Enforce, to reduce ground coverage.
- Demarcate more open space required for ground water percolation.
- Earmark land for detention ponds to hold flash flood water.
- Protect the existing water bodies.
- Regain the encroached water ways, water bodies and its achkatu areas.
- Conduct Public awareness campaigns
- Enforce quality construction procedures
- BWSSB & BDA to work hand in hand with BBMP to enforce rainwater harvesting as mandatory as part of source control measures
- BBMP, BDA, BWSSB, BESCOM & KSSCB shall jointly take up the task of land acquisition for development of drainage corridor along side SWDs.

Bangalore Electricity Supply Company:

- BESCOM shall shift all service lines, electric poles, transformers etc., coming in the way of implementation of the project proposals - prior to commencement of works

Karnataka State Slum Clearance Board:

- KSSCB shall relocate all hutments constructed inside the water way – prior to commencement of works
- KSSCB shall make provisions in its proposals to provide UGD system to the entire slum area in order to prevent entry of sewage into SWDs.
- KSSB shall initiative action to shift all hutments constructed inside water way / below drain HFL.

Karnataka State Pollution Control Board:

- KSPCB shall enforce stringent policy / initiate stringent action against industries / establishments resorting in discharge of undesired liquid / solid waste materials into SWDs.

Lake Development Authority:

- Lake improvement works takenup by BDA, LDA & BBMP shall include;
- Size of the drains connecting to the water bodies shall be maintained as per the designs included in the Master Plan report.
- Tank desilting, deepening and fixing regulatory gates to maintain required water level in the water body before monsoon
- Proposals for Inlet/outlet weir strengthening works
- Proposals to procure land for setting up of STP, Pump houses & recycling plants etc.
- Proposals to stop entry of undesired flows into the lakes

Public representative:

- Create awareness among public about importance of SWD projects and its objectives
- Conduct awareness campaigns
- Support the authorities by modification of bylaws / passing resolutions etc

Citizens:

- Create awareness
- Should be vigilant & prevent dumping of debris/garbage into SWDs and encroachment of water ways and alignment modifications if any.
- Identify and report to the authorities about issues and irregularities pertaining to SWDs

5.3 STRATEGIC MEASURES FOR MINIMISING FLOODING PROBLEMS AT CRITICAL LOW LYING AREAS IN BBMP AREA:

1. Large quantity of vegetal growth, silt & garbage accumulation noticed near the tanks to be cleared immediately.
2. Primary drain bed needs to be lowered and tertiary drain network in the surrounding area needs to be regarded to match with the new drain bed level.
3. Side walls to be constructed to avoid water gushing into residential area during heavy showers.
4. Dumping of debris & garbage into SWD to be stopped immediately.
5. Provision of cut off drain (bypass drains) around the low lying area to prevent adjoining area water entering into the low lying area and construction of sump for pumping out water at a location closer to the main drains (downstream end) and also it should be located in such a way that it should be easily accessible by vehicles that are mounted with pump.
6. The improvement shall be taken up from the down stream of the valley. If remodeling works are commenced from upstream side, situation at the downstream end may get further aggravated.
7. Culverts with inadequate vent way to be remodeled immediately to avoid heading up of water. Desilting of existing secondary & tertiary drains needs to be attended immediately.
8. Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.
9. Construction of residential buildings very close to water way & also below HFL level needs to be avoided.
10. Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management
11. Sewerage system and solid waste management system in this area needs to be improved.
12. Emergency squad, equipped with truck mounted pumping arrangement and standby power generator should be readily made available during rainy season, to evacuate the water from the intake well / lowest point and discharge it to outside main drain.

Critical Low Lying Areas Identified under Master Plan Project in BBMP Area

Sl. No.	Zone	Count
1	East	22
2	West	10
3	South	25
4	Bommanahalli	24
5	Dasarahalli	17
6	Yelahanka	15
7	Mahadevapura	23
8	Rajarajeshwarinagara	11
	Total	**147**

In the East Core Zone, there are 22 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.2.**

Table 5.2 Locations of Low Lying areas in East Core Zone

1	Ambedkar Nagar Near Old Byappanahalli
2	Ankappa Block, Munireddy Palya
3	Ashwini Layout
4	Bamboo Bazaar
5	Bandappa Colony Near New Byappanahalli
6	Basavana Nagar Near Kadugondanahalli
7	Bharathi Nagar Near Armstrong Road
8	Cambridge Layout
9	Chinnappa Garden
10	Ejipura
11	Jogupalya & Saraswathipuram
12	Karamchand Layout Near Kariyanna Palya- Ward No.24
13	LR Slum
14	Murugeshpalya
15	PWD Quarters Wilson Garden
16	Rajiv Gandhi Colony Near Queens Road
17	S.T.Bed Layout
18	Sampangirama Nagara
19	Seethappa Layout Near R.T Nagar
20	Shampura Slum
21	Shanthi Nagar Near K.H Road
22	Thammanna Layout Near Lingarajapuram

Table 5, Part 1, Appendix 1 lists the details of Low Lying areas in East Core Zone. **Drg**s. **EZ-FC-LL-01** shows the details of the same.

In the West Core Zone, there are 10 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.3**

Table 5.3 Locations of Low Lying Areas in West Core Zone

1	12th Cross ,Gubbanna Layout Industrial Area Rajaji
2	8th Cross 6th Block Sankarappa Garden, Rajajinagar
3	Bhakshi Garden
4	Brindavan Nagar
5	Kamala Nagar
6	Kanteerava Nagar
7	Naganna Nagara Near Binny Mill Road
8	Saneguruvanahalli
9	Sanjeevappa Garden
10	Shankar Nagar

Table 5, Part 1, Appendix 2 lists the details of Low Lying areas in West Core Zone. **Drg**s. **WZ-FC-LL-01** shows the details of the same.

In the South Core Zone, there are 25 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.4**

Table 5.4 Locations of Low Lying Areas in South Core Zone

1	14th Cross, P.N.T Colony Cholurpalya
2	1st Main to 8th Cross N.R Garden Cholurpalya
3	Bismillanagar
4	BMK Layout
5	BTM Layout
6	Club House- Ward No.131, Nayandahalli
7	Dollars Colony BTM Layout Lakkasandra
8	Gori Palya
9	JJR Nagar
10	Kalidasa Layout
11	LIC Colony Near Byrasandra
12	Maruthi Nagar
13	Maruthi Nagar Near Bapuji Nagara
14	Metro Layout -Ward No.131, Nayandahalli
15	Moodalapalya
16	Ranganatha Layout Near BHEL Circle
17	Rudrappa Garden
18	Samruddi Nagar- Ward No.184, Uttarahalli
19	Sanjay Nagar Slum Timber Yard Layout
20	Sarvabouma Nagar- Ward No.131, Nayandanahalli
21	Silk Board Junction Nera Someshwara Colony
22	Sudhama Nagar
23	V.R Nagara, Siddapura
24	Vittal Nagar Near ISRO Layout- Ward No.184, Uttara
25	Vittal Nagara

Table 5, Part 1, Appendix 3 lists the details of Low Lying areas in South Core Zone. **Drg**s. **SZ-FC-LL-01** shows the details of the same.

In the Bommanahalli Zone, there are 24 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.5**

Table 5.5 Locations of Low Lying Areas in Bommanahalli Zone

1	Ambedkar Colony Near Hongasandra
2	Astha Laxmi Layout Puttenahalli
3	B.T.R Garden
4	BDA Layout
5	Begur Kere Area
6	G.K.Layout
7	Ganapathipura Near Chunchaghatta Main Road
8	Garve Bhavi Palya
9	Hari Nagara Near Konanakunte
10	Hongasandra Munisubbareddy Layout
11	Illias Nagar- Ward No.181, Kumaraswamy Layout
12	Kodichikkanahalli
13	Krishna Layout Near Hulimavu Kere
14	Kudlu Village
15	Lakshmi Layout Raghavendra Slum Colony
16	Mico Layout
17	Munireddy Layout Near Mangammana Palya
18	Noba Nagar Canara Bank Officers Colony
19	Parappana Aggrahara
20	Puttenahalli
21	Royal Meridian Layout
22	Subhash Nagar
23	Vishwapriya Nagar Near Begur Main Road
24	Vyshya Bank Colony Near Arekere

Table 5, Part 1, Appendix 4 lists the details of Low Lying areas in Bommanahalli Zone. **Drg**s. **BH-FC-LL-01** shows the details of the same.

In the Yelahanka Zone, there are 15 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.6.**

Table 5.6 Locations of Low Lying Areas in Yelahanka Zone

1	Atture Near Dairy Circle- Ward No.3
2	Balaji Layout Near Tata Nagar- Ward No.7
3	Bhadrappa Layout, N.S. Halli- Ward No.19 (Sanjay N
4	Devi Nagar - Ward No.8, Kodigenahalli
5	EWS 3rd Stage, Yelahanka Satellite Town- Ward No.
6	Govindapura- Ward No.23, Nagavara
7	Gurudarshan Layout (Ward No-10)
8	JRD Tata Nagara- Ward No.8, Kodigenahalli
9	Kempapura- Ward No.21, Hebbal
10	Mariyanna Palya- Ward No.23, Nagavara
11	Maruthi Nagara, Sankrappa Layout- Ward No.1
12	Prakruthi Layout Near HBR Layout
13	Someshwara Nagar- Ward No.4, Yelahanka New Town
14	Telecom Layout, Ashwath Nagara- Ward No.6, Tanisan
15	Vaddara Palya Near Hennur Bande- Ward No.24, H.B.R

Table 5, Part 1, Appendix 5 lists the details of Low Lying areas in Yelalhanka Zone. **Drg**s. **YE-FC-LL-01** shows the details of the same.

In the Dasarahalli Zone, there are 17 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.7**

Table 5.7 Locations of Low Lying Areas in Dasarahalli Zone

1	Abbigere (Ward No.12)
2	Anjana Nagar Near Anjaneya Temple (Ward No. 72)
3	Bagalkunte (L. Narasimhaya Layout) - Ward No.14
4	Bhuvaneshwari Nagar (Ward No.15)
5	Byreshwara Nagar, Hegganahalli (Ward No. 71)
6	Chikkabidrekal Near Madhavapura Grama Panchayat (W
7	Chowdeshwari Nagara Near Rajiv Gandhi Circle, Lagg
8	Freedom Fighter Nagar
9	Kalika Nagara Main Road (Ward No.41)
10	Kempegowda Nagara (Ward No.15)
11	Kottigepalya, Near Magadi Road (Ward No. 73)
12	Narasimha Swami Layout Near Laggere Bridge (Ward N
13	Near Zindal, Anchepalya (Ward No.39)
14	Nelegadarana Halli Layout Near Udayavani Paper God
15	Rukmini Nagara Near 8th Mailu, Tumkur Road (Ward N
16	Shivananda Nagara (Ward No. 71)
17	Shivapura Kere (Ward No. 39) Near NTF Road

Table 5, Part 1, Appendix 6 lists the details of Low Lying areas in Dasarahalli Zone. **Drgs**. **DH-FC-LL-01** shows the details of the same.

In the Mahadevapura Zone, there are 23 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.8.**

Table 5.8 Locations of Low Lying Areas in Mahadevapura Zone

1	Abaya Reddy Layout, Vijnana Nagar
2	Ambedkar Nagara Near Vijinapura
3	Behind Sri Sai Baba Ashrama Kadugudi
4	Chinnappa Layout, Vijnana Nagar
5	Gandhipura, Whitefield
6	Garudacharapalya, Basavanagara
7	Hoysala Nagar, K.R Puram
8	Kallappa Layout Near Basavanagara
9	Kasi Vishwanath Layout Near K.R. Pura
10	Krishna Nagara Near Chikkadevasandra
11	Laxmana Murthy Nagara
12	Nethravathy Layout
13	Pai Layout Near A. Narayanpura
14	Pattalamma Layout Near Kadugudi Main Road
15	Pattandur Agrahara Near ITPL
16	R.R.Layout, Vijinapura
17	Sanjay Nagara Slum, Near K.R Puram
18	Siddartha Layout, Kadugudi
19	SJR Dental College Main Road, Martahalli
20	Thalakaveri Layout Near HAL Airport
21	Triveni Nagara Near K.R.Puram
22	Udayanagara, A.Narayanpura
23	Vinayaka Layout Near Basavanapura Main Road

Table 5, Part 1, Appendix 7 lists the details of Low Lying areas in Mahadevapura Zone. **Drg**s. **MD-FC-LL-01** shows the details of the same.

In the Raja Rajeshwari Nagara Zone, there are 11 locations where Low Lying Areas which are critical being vulnerable to flooding which are listed in **Table 5.9.**

Table 5.9 Locations of Low Lying Areas in Raja Rajeshwari Nagara Zone

1	Dore Kere-Ward No.184, Uttarahalli
2	Halagevaddarahalli & Shivanna Layout -Ward No.
3	Janapriya Apartments- Ward No.160, Rajarajeshwari
4	Kanaka Nagar - Ward No.181, Kumaraswamy Layout
5	Kenchenahalli- Ward No.160, Rajarajeshwari Nagara
6	Kuguntu Near Mallathalli- Ward No.130
7	Near Vidhyaniketan School, Ullal- Ward No.130
8	Sri Hari Layout- Ward No.129, Jnanabharathi Layout
9	Vinayaka Layout Near Nagarabavi Bridge-Ward No.128
10	Yelechenahalli -Ward No.185
11	Dore Kere-Ward No.184, Uttarahalli

Table 5, Part 1, Appendix 8 lists the details of Low Lying areas in Raja Rajeshwari Nagara Zone. **Drg**s. **RN-FC-LL-01** shows the details of the same.

The details of zone wise flood water level & ground formation levels in as shown in **Table 5.10**

Table 5.10 Flood Water Level & Ground Formation Details for Critical Flood Prone Areas in New Zones of BBMP Area

Sl. No.	Low Lying Area ID	Location	Name of the Water Shed Cluster	No of Properties Affected (Nos.)	Water Spread Area (sqm)	Water Stagnation Depth (m.)	Drain ID	Chainage (m.)	Ex. Drain Bed / Invert Level (m.)	Ex. Avg. Ground Level (m.)	Ex. Drain Depth (m.)	Flood Water Level (m.)	Reqd. Drain Depth (m.)	Building Plinth Level from Ex. GL (m.)	Proposed Avg. Ground Formation Level (m.)	Nearest TBM Level w.r.t GTS Bench Mark (m.)
Note: 1) The levels indicated are w.r.t. to GTS levels 2) Properties affected, water spread area, depth of water stagnation etc., indicated is based on the information's received from the public during reconnaissance survey.																
	Yelahanka Zone:															
1	BPLA037	Govindapura, Near Nagavara - Ward No.23	Kacharakanahalli Kere	447	89,490	0.91	(H306)	2450	882.82	884.19	1.38	884.32	1.50	1.00	885.19	0.00
2	BPLA038	Gurudarshan Layout, Near Dodda Bommasandra	Dodda Bommasandra Kere	56	11,188	0.61	BP012	25	904.11	904.75	0.63	905.11	1.00	1.00	905.75	903.41
3	BPLA039	Devi Nagara, Kodigenahalli - Ward No.8	Dodda Bommasandra Kere	296	59,251	0.61	(H200)	5125	894.00	894.80	0.80	895.00	1.00	1.00	895.80	894.79
4	BPLA040	JRD Tata Nagara, Near Kodigenahalli	Dodda Bommasandra Kere	52	10,468	0.30	BP020 (BY01)	400	895.29	895.49	0.20	897.45	2.16	2.46	897.95	895.18
5	BPLA041	Bhadrappa Layout, Nagashettyhalli	Hebbal Kere	52	10,421	0.61	(H200)	5800	893.05	895.30	2.25	895.30	2.25	1.00	896.30	895.47
6	BPLA042	Someshwara Nagara, Yelahanka New Town	Allalsandra Kere	194	38,762	0.91	BP161 A	50	908.66	910.25	1.59	910.81	2.15	1.06	911.31	908.73
7	BPLA043	EWS Housing Colony 3rd Stage, Yelahanka New Town	Allalsandra Kere	167	33,329	0.61	BP161 (BY13)	175	906.74	908.06	1.32	908.82	2.08	1.26	909.32	908.73
8	BPLA044	Attur, Near Dairy Circle	Yelahanka Kere	110	21,969	0.91	BP138	0	917.20	918.30	1.11	918.63	1.43	1.00	919.30	917.63
9	BPLA045	Balaji Layout, Near Tata Nagara - Ward No.7	Dodda Bommasandra Kere	714	142,716	0.40	BP020 (BY01)	700	894.16	894.44	0.27	896.03	1.87	2.10	896.53	895.16
10	BPLA046	Maruthi Nagara, Sankrappa Layout - Ward No.1	Jakkur Kere	369	73,840	0.61	BP142 (BY09)	975	889.36	889.91	0.55	891.17	1.81	1.76	891.67	892.38
11	BPLA047	Kempapura, Near Hebbal - Ward No.21	Nagwara Kere	309	61,829	0.91	(H100)	4375	885.16	885.83	0.67	886.16	1.00	1.00	886.83	886.43
12	BPLA048	Mariyanna Palya, Near Nagavara	Nagwara Kere	90	17,912	0.61	BP183 (BY06)	125	884.62	885.88	1.26	887.56	2.94	2.18	888.06	885.66
13	BPLA049	Telecom Layout, Ashwath Nagara, Thannisandra	Geddalahalli STP	241	48,219	0.61	BP184 B	0	905.87	906.62	0.75	906.87	1.00	1.00	907.62	899.11
14	BPLA050	Vaddara Palya, Near Hennur Bande, H.B.R Layout	Hennuru Bande	88	17,535	0.61	(H400)	4225	878.73	880.04	1.31	880.23	1.50	1.00	881.04	878.62
15	BPLA121	Prakruthi Layout, Near HBR Layout	Kacharakanahalli Kere	327	65,411	0.60	BP187		883.28	884.35	1.07	884.38	1.10	1.00	885.35	880.55

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	East Core Zone:															
1	ECLA001	Karamchand Layout, Near Kariyanna Palya	Kacharakanahalli Kere	339	67,715	0.30	(H304)	900	898.49	899.25	0.76	899.49	1.00	1.00	893.61	894.91
2	ECLA113	PWD Quarters, Near Wilson Garden	Lalbagh Kere	3,194	638,853	0.60	(K107)	450	885.60	886.10	0.50	887.10	1.50	1.50	887.60	886.76
3	ECLA119	Shampura Slum	Kacharakanahalli Kere	277	55,395	0.61	(H306)	1825	884.06	885.82	1.76	885.82	1.76	1.00	885.75	888.16
4	ECLA120	Basavana Nagara, Near Kadugondanahalli	Kacharakanahalli Kere	150	30,084	0.61	H306	1825	890.81	890.99	0.17	891.81	1.00	1.33	885.75	888.18
5	ECLA122	Thammanna Layout, Near Lingarajapura	Kacharakanahalli Kere	261	52,201	0.40	(H304)	250	901.31	902.55	1.24	902.55	1.24	1.00	893.61	894.91
6	ECLA123	Ankappa Block, Munireddy Palya	Bharathinagara	199	39,745	0.30	(C100)	0	911.84	913.84	2.00	913.84	2.00	1.00	914.84	923.63
7	ECLA124	Chinnappa Garden	Bharathinagara	177	35,360	0.50	(C200)	1000	907.68	908.42	0.74	908.68	1.00	1.00	909.42	913.27
8	ECLA125	Ambedkar Nagara, Near Old Byappanahalli	Ulsoor Kere	122	24,302	0.40	C104	0	894.15	895.00	0.85	895.15	1.00	1.00	896.00	889.03
9	ECLA126	Bandappa Colony, Near New Byappanahalli	Ulsoor Kere	87	17,416	0.70	C103	0	895.54	896.39	0.85	896.54	1.00	1.00	897.39	889.03
10	ECLA127	Cambridge Layout	Ulsoor Kere	153	30,586	0.30	C100	6150	881.57	884.01	2.44	884.01	2.44	1.00	885.01	885.00
11	ECLA128	Jogupalya & Saraswathipura	Ulsoor Kere	1,488	297,509	0.40	(C100)	5000	884.22	886.71	2.49	886.72	2.50	1.00	884.42	884.66
12	ECLA129	Bharathi Nagara, Near Armstrong Road	Bharathinagara	88	17,632	0.30	C100	2400	893.92	894.75	0.83	894.92	1.00	1.00	895.75	895.03
13	ECLA130	Rajiv Gandhi Colony, Near Queens Road	Millers tank	369	73,822	0.30	(C100)	975	902.21	905.85	3.64	905.85	3.64	1.00	906.85	904.37
14	ECLA131	Murugeshpalya	Ulsoor Kere	1,036	207,122	0.30	(C101)	1040	878.27	879.72	1.45	879.72	1.45	1.00	880.72	877.18
15	ECLA132	Ashwini Layout	Lalbagh Kere	169	33,747	0.30	K100	8700	876.74	878.51	1.77	878.51	1.77	1.00	876.11	880.22
16	ECLA133	Srinivagilu Tank Bed Layout, Koramangala	Lalbagh Kere	185	36,995	0.30	(K100)	9275	874.54	876.80	2.26	876.80	2.26	1.00	877.80	878.53
17	ECLA134	Ejipura	Lalbagh Kere	293	58,671	0.30	(K100)	7825	879.11	879.84	0.73	880.11	1.00	1.00	880.84	880.11
18	ECLA135	Lakshman Rao Nagara	Lalbagh Kere	556	111,114	0.30	(K100)	6000	881.69	883.26	1.57	883.26	1.57	1.00	879.58	882.50
19	ECLA136	Shanthi Nagara, Near Kengal Hanumanthaiah Road	Lalbagh Kere	272	54,347	0.30	(K114)	975	884.26	886.26	2.00	886.26	2.00	1.00	884.26	885.20
20	ECLA137	Sampangirama Nagara	Lalbagh Kere	1,506	301,182	0.40	(K109)	200	898.09	898.61	0.52	899.09	1.00	1.00	899.61	895.61
21	ECLA139	Seethappa Layout, Near Ravindranatha Tagore Nagara	Nagwara Kere	137	27,427	0.30	H100	2600	890.86	892.93	2.08	892.93	2.08	1.00	891.35	893.90
22	ECLA147	Bamboo Bazar	Millers tank	440	88,061	0.30	(C100)	1950	896.28	897.50	1.22	897.50	1.22	1.00	898.50	898.19

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	West Core Zone:															
1	WCLA023	8th Cross 6th Block Sankarappa Garden, Rajajinagara	Sankey Kere	151	30,132	0.61	(V100)	4500	861.84	862.60	0.76	862.84	1.00	1.00	863.60	878.97
2	WCLA024	12th Cross, Gubbanna Layout Industrial Area Rajajinagara	Sankey Kere	36	7,290	0.30	(V115)	700	862.37	865.02	2.65	865.02	2.65	1.00	866.02	878.97
3	WCLA025	Naganna Nagara, Near Binny Mill Road	Sankey Kere	41	8,140	0.61	(V106)	1025	876.87	877.87	1.00	877.87	1.00	1.00	878.87	894.32
4	WCLA026	Bhakshi Garden	Sankey Kere	364	72,889	0.30	(V106)	0	889.71	892.68	2.97	892.68	2.97	1.00	893.68	894.32
5	WCLA140	Brindavan Nagara	Mattikere Kere	1,122	224,381	0.91	(H200)	2750	905.53	906.03	0.50	906.53	1.00	1.00	898.90	901.60
6	WCLA141	Sanjeevappa Garden	Mattikere Kere	83	16,585	0.61	(H200)	3400	897.93	899.68	1.75	899.68	1.75	1.00	900.68	900.74
7	WCLA142	Kanteerava Nagara	Nandini Layout	211	42,183	0.30	(V205)	500	877.88	879.81	1.93	879.81	1.93	1.00	880.81	882.43
8	WCLA143	Shankar Nagara	Nandini Layout	306	61,264	0.61	(V202)	1050	882.93	885.11	2.18	885.11	2.18	1.00	886.11	887.59
9	WCLA145	Kamala Nagara	Laggere Kere	62	12,420	0.61	(V200)	6325	842.18	843.98	1.80	843.98	1.80	1.00	844.98	849.01
10	WCLA146	Saneguruvanahalli	Sankey Kere	133	26,692	0.30	(V116)	962	891.49	892.69	1.20	892.69	1.20	1.00	893.69	900.36

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	South Core Zone:															
1	SCLA002	BTM Layout Dollars Colony, Lakkasandra	Byrasandra Kere	731	146,296	0.61	(K204)	200	879.89	881.25	1.36	881.25	1.36	1.00	882.25	881.50
2	SCLA003	LIC Colony, Near Byrasandra	Byrasandra Kere	457	91,379	0.61	(K208)	25	904.15	904.15	0.40	905.15	1.00	1.10	905.25	901.09
3	SCLA004	Bismillanagara	Byrasandra Kere	734	146,792	0.61	(K200)	1775	887.97	888.87	0.90	888.97	1.00	1.00	889.87	886.61
4	SCLA005	Maruthi Nagara, Sankrappa Layout	Byrasandra Kere	418	83,694	0.61	(K200)	3125	881.14	883.41	2.27	883.41	2.27	1.00	884.41	882.78
5	SCLA006	Venkatta Reddy Nagara, Siddapura	Lalbagh Kere	576	115,134	0.61	(K108)	625	896.5	898.15	1.65	898.15	1.65	1.00	899.15	897.50
6	SCLA007	Samruddi Nagara, Near Uttarahalli	Subramanyapura Kere	188	37,590	0.61	RN215	0	868.15	868.61	0.46	869.15	1.00	1.04	869.65	879.69
7	SCLA008	Metro Layout -Ward No.131, Near Nayandahalli	Nayandanahalli Kere	315	62,905	0.40	(V207)	3700	816.9	817.79	0.89	817.90	1.00	1.00	818.79	816.08
8	SCLA009	Sarvabouma Nagara - Ward No.131, Nayandanahalli	Nayandanahalli Kere	287	57,425	0.30	(V207)	3618	857.26	859.65	2.39	859.65	2.39	1.00	807.40	810.60
9	SCLA010	ITI Layout, Near The Club Nayandahalli	Nayandanahalli Kere	119	23,732	0.40	RN181	1400	785.85	786.22	0.37	789.05	3.20	3.33	789.55	799.56
10	SCLA011	14th Cross, P.&.T Colony, Cholarapalya	Sankey Kere	63	12,608	0.60	(V116)	3610	857.26	859.65	2.39	859.65	2.39	1.00	860.65	850.91
11	SCLA012	1st Main to 8th Cross N.R Garden, Cholarapalya	Sankey Kere	8	1,674	0.40	(V116)	3179	859.723	861.92	2.20	861.92	2.20	1.00	862.92	865.24
12	SCLA013	Sanjay Nagara Slum, Near Timber Yard Layout	Kempambudhi Kere	278	55,512	0.30	(V102)	380	848.540	849.70	1.16	849.70	1.16	1.00	850.70	850.91
13	SCLA014	Kalidasa Layout	Kempambudhi Kere	232	46,305	0.61	(V122)	1275	849.24	850.92	1.68	850.92	1.68	1.00	851.92	850.91
14	SCLA015	Rudrappa Garden	Kempambudhi Kere	116	23,269	0.30	(V102)	250	848.428	852.68	4.26	852.68	4.26	1.00	853.68	850.91
15	SCLA016	Vittal Nagara, Near Kempegowdanagara	Kempambudhi Kere	271	54,160	0.30	(V102)	75	854.194	856.71	2.52	856.71	2.52	1.00	857.71	850.91
16	SCLA017	BMK Layout	Kempambudhi Kere	70	14,024	0.30	(V102)	425	847.35	849.94	2.59	849.94	2.59	1.00	850.94	850.91
17	SCLA018	Gori Palya	Kempambudhi Kere	99	19,729	0.30	(V104)	0	865.935	869.10	3.16	869.10	3.16	1.00	870.10	850.91
18	SCLA019	Jagajeevanramnagara	Kempambudhi Kere	142	28,374	0.91	(V105)	275	873.106	877.74	4.63	877.74	4.63	1.00	878.74	850.91

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19	SCLA020	Ranganatha Layout, Mysore Road Near BHEL Circle	Kempambudhi Kere	256	51,221	0.61	(V100)	9190	827.805	830.81	3.01	830.81	3.01	1.00	831.81	808.14
20	SCLA021	Maruthi Nagara, Near Bapuji Nagara	Kempambudhi Kere	202	40,305	0.61	(V119)	2800	837.297	839.15	1.85	839.15	1.85	1.00	840.15	852.31
21	SCLA022	Mudalapalya	Nayandanahalli Kere	76	15,215	0.61	(V200)	8700	832.015	833.03	1.01	833.03	1.01	1.00	834.03	834.21
22	SCLA111	Someshwara Colony, Near Silk Board Junction	Byrasandra Kere	155	31,036	0.50	(K204)	25	882.910	884.25	1.34	884.25	1.34	1.00	885.25	886.33
23	SCLA112	BTM Layout	Byrasandra Kere	1,871	374,150	0.30	(K204)	600	879.75	880.40	0.65	880.75	1.00	1.00	881.40	881.08
24	SCLA117	Vittal Nagara, Near ISRO Layout, Uttarahalli	Subramanyapura Kere	191	38,242	0.30	RN211 (RNR11)	2850	855.9	860.63	4.73	860.63	4.73	1.00	861.63	879.69
25	SCLA138	Sudhama Nagara	Lalbagh Kere	534	106,772	0.30	(K100)	2650	887.56	889.42	1.86	889.42	1.86	1.00	890.42	890.05

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	Bommanahalli Zone:															
1	BHLA051	Illiyas Nagara, Kumaraswamy Layout	Subramanyapura Kere	59	11,818	0.61	RN212	900	882.93	883.79	0.86	884.16	1.23	1.00	878.03	879.69
2	BHLA052	Munisubbareddy Layout, Hongasandra	Chikka Begur Kere	1,532	306,460	0.40	BH578	225	884.50	885.23	0.73	885.83	1.33	1.10	886.33	884.94
3	BHLA053	Ambedkar Colony, Near Hongasandra	Chikka Begur Kere	113	22,525	0.61	BH576	175	888.11	889.19	1.07	889.90	1.79	1.22	890.40	888.48
4	BHLA054	MICO Layout	Chikka Begur Kere	1,253	250,520	0.61	BH573	425	886.98	887.17	0.19	888.24	1.26	1.57	888.74	884.65
5	BHLA055	Royal Meridian Layout	Chikka Begur Kere	164	32,841	0.30	BH573	0	899.19	899.94	0.76	900.94	1.75	1.49	901.44	888.48
6	BHLA056	Vishwapriya Nagara, Near Begur Main Road	Chikka Begur Kere	2,099	419,810	0.30	BH572	150	890.62	890.64	0.02	892.45	1.83	2.31	892.95	890.37
7	BHLA057	Begur Kere Area	Chikka Begur Kere	491	98,121	0.30	BH569	975	891.55	892.22	0.67	893.56	2.01	1.84	894.06	893.09
8	BHLA058	Subhash Nagara	Dodda Begur Kere	1,102	220,395	0.61	BH568	350	895.99	896.69	0.70	897.12	1.13	1.00	897.69	895.57
9	BHLA059	Garve Bhavi Palya	Chikka Begur Kere	165	33,058	0.40	BH593A	225	889.51	890.11	0.61	890.87	1.36	1.25	891.37	886.30
10	BHLA060	G.K. Layout	Kaikonadanahalli Kere	382	76,345	0.30	BH614A	175	910.61	911.18	0.57	911.61	1.00	1.00	912.18	911.09
11	BHLA061	Parappana Aggrahara	Kaikonadanahalli Kere	1,167	233,307	0.61	BH614	1077	913.04	913.30	0.26	914.71	1.67	1.91	915.21	906.94
12	BHLA062	Kudlu Village	Kaikonadanahalli Kere	1,140	228,027	0.61	BH624B	0	906.43	906.79	0.35	907.43	1.00	1.15	907.93	902.63
13	BHLA063	B.T.R Garden Layout	Chikka Begur Kere	438	87,556	0.61	BH583	0	903.71	903.98	0.27	905.37	1.66	1.89	905.87	902.63
14	BHLA064	Raghavendra Slum, Near Lakshmi Layout	Chikka Begur Kere	407	81,423	0.30	BH572A	0	889.64	890.05	0.41	890.64	1.00	1.09	891.14	890.37
15	BHLA065	Munireddy Layout, Near Mangammana Palya	Chikka Begur Kere	312	62,456	0.30	BH595	0	888.83	889.45	0.62	889.83	1.00	1.00	890.45	881.18
16	BHLA066	Vyshya Bank Colony, Near Arekere	Madivala Kere	441	88,121	0.40	BH552A	175	895.13	895.45	0.32	896.13	1.00	1.18	896.63	890.80
17	BHLA067	Krishna Layout, Near Hulimavu Kere	Madivala Kere	1,032	206,440	0.30	BH541	0	895.93	897.41	1.47	897.90	1.97	1.00	898.41	892.56
18	BHLA068	Canara Bank Officers Colony, Near Noba Nagara	Hulimavu Kere	420	83,937	0.30	BH524	1150	899.47	900.18	0.72	900.56	1.09	1.00	901.18	900.44

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19	BHLA069	BDA Layout	Hulimavu Kere	411	82,216	0.91	BH524	1450	898.59	899.10	0.51	900.02	1.43	1.42	900.52	897.67
20	BHLA070	Puttenahalli	Puttenahalli Kere	108	21,614	0.30	(K210)	575	898.04	899.01	0.97	899.04	1.00	1.00	892.64	894.26
21	BHLA071	Astha Laxmi Layout, Puttenahalli	Puttenahalli Kere	402	80,415	0.61	(K210)	575	898.04	899.01	0.97	899.04	1.00	1.00	892.64	894.26
22	BHLA072	Ganapathipura, Near Chunchaghatta Main Road	Puttenahalli Kere	599	119,868	0.61	BH514	475	903.90	904.55	0.64	905.11	1.21	1.07	905.61	901.42
23	BHLA073	Hari Nagara, Near Konanakunte	Thalaghattapura Kere	460	92,075	0.91	BH811	0	917.16	917.35	0.19	918.28	1.12	1.43	918.78	916.13
24	BHLA074	Kodichikkanahalli	Madivala Kere	3,014	602,716	0.30	BH554	1025	883.15	884.89	1.74	886.06	2.91	1.67	886.56	884.81

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	Yelahanka Zone:															
1	BPLA037	Govindapura, Near Nagavara - Ward No.23	Kacharakanahalli Kere	447	89,490	0.91	(H306)	2450	882.82	884.19	1.38	884.32	1.50	1.00	885.19	0.00
2	BPLA038	Gurudarshan Layout, Near Dodda Bommasandra	Dodda Bommasandra Kere	56	11,188	0.61	BP012	25	904.11	904.75	0.63	905.11	1.00	1.00	905.75	903.41
3	BPLA039	Devi Nagara, Kodigenahalli - Ward No.8	Dodda Bommasandra Kere	296	59,251	0.61	(H200)	5125	894.00	894.80	0.80	895.00	1.00	1.00	895.80	894.79
4	BPLA040	JRD Tata Nagara, Near Kodigenahalli	Dodda Bommasandra Kere	52	10,468	0.30	BP020 (BY01)	400	895.29	895.49	0.20	897.45	2.16	2.46	897.95	895.18
5	BPLA041	Bhadrappa Layout, Nagashettyhalli	Hebbal Kere	52	10,421	0.61	(H200)	5800	893.05	895.30	2.25	895.30	2.25	1.00	896.30	895.47
6	BPLA042	Someshwara Nagara, Yelahanka New Town	Allalsandra Kere	194	38,762	0.91	BP161A	50	908.66	910.25	1.59	910.81	2.15	1.06	911.31	908.73
7	BPLA043	EWS Housing Colony 3rd Stage, Yelahanka New Town	Allalsandra Kere	167	33,329	0.61	BP161 (BY13)	175	906.74	908.06	1.32	908.82	2.08	1.26	909.32	908.73
8	BPLA044	Attur, Near Dairy Circle	Yelahanka Kere	110	21,969	0.91	BP138	0	917.20	918.30	1.11	918.63	1.43	1.00	919.30	917.63
9	BPLA045	Balaji Layout, Near Tata Nagara - Ward No.7	Dodda Bommasandra Kere	714	142,716	0.40	BP020 (BY01)	700	894.16	894.44	0.27	896.03	1.87	2.10	896.53	895.16
10	BPLA046	Maruthi Nagara, Sankrappa Layout - Ward No.1	Jakkur Kere	369	73,840	0.61	BP142 (BY09)	975	889.36	889.91	0.55	891.17	1.81	1.76	891.67	892.38
11	BPLA047	Kempapura, Near Hebbal - Ward No.21	Nagwara Kere	309	61,829	0.91	(H100)	4375	885.16	885.83	0.67	886.16	1.00	1.00	886.83	886.43
12	BPLA048	Mariyanna Palya, Near Nagavara	Nagwara Kere	90	17,912	0.61	BP183 (BY06)	125	884.62	885.88	1.26	887.56	2.94	2.18	888.06	885.66
13	BPLA049	Telecom Layout, Ashwath Nagara, Thannisandra	Geddalahalli STP	241	48,219	0.61	BP184B	0	905.87	906.62	0.75	906.87	1.00	1.00	907.62	899.11
14	BPLA050	Vaddara Palya, Near Hennur Bande, H.B.R Layout	Hennuru Bande	88	17,535	0.61	(H400)	4225	878.73	880.04	1.31	880.23	1.50	1.00	881.04	878.62
15	BPLA121	Prakruthi Layout, Near HBR Layout	Kacharakanahalli Kere	327	65,411	0.60	BP187		883.28	884.35	1.07	884.38	1.10	1.00	885.35	880.55

Sl. No.	Low Lying Area ID	Location	Name of the Water Shed Cluster	No of Properties Affected (Nos.)	Water Spread Area (sqm)	Water Stagnation Depth (m.)	Drain ID	Chainage (m.)	Ex. Drain Bed / Invert Level (m.)	Ex. Avg. Ground Level (m.)	Ex. Drain Depth (m.)	Flood Water Level (m.)	Reqd. Drain Depth (m.)	Building Plinth Level from Ex. GL (m.)	Proposed Avg. Ground Formation Level (m.)	Nearest TBM Level w.r.t GTS Bench Mark (m.)
Note: 1) The levels indicated are w.r.t. to GTS levels 2) Properties affected, water spread area, depth of water stagnation etc., indicated is based on the informations provided by the public during reconnassiance survey.																
	Dasarahalli Zone:															
1	DHLA097	Byraveshwara Nagara, Hegganahalli (Ward No. 71)	Muddayana Palya Kere	10	1,928	0.30	RN511	475	883.16	885.23	2.07	885.44	2.28	1.00	886.23	899.25
2	DHLA098	Kottigepalya, Near Magadi Road (Ward No. 73)	Laggere Kere	102	20,328	0.30	RN151	550	859.91	861.72	1.81	862.47	2.56	1.25	862.97	849.01
3	DHLA099	Rukmini Nagara, Near 8th Mile, Tumkur Road	Anchepalya Kere	306	61,259	0.60	DH216	1675	879.03	880.87	1.84	881.27	2.24	1.00	881.87	877.68
4	DHLA100	Kalika Nagara Main Road (Ward No.41)	Gangondanahalli Kere	230	45,915	0.30	DH332	500	884.18	884.81	0.63	885.98	1.80	1.67	886.48	883.45
5	DHLA101	Kempegowda Nagara (Ward No.15)	Anchepalya Kere	317	63,336	0.91	DH214	550	893.98	895.42	1.44	895.73	1.75	1.00	896.42	894.57
6	DHLA102	Bhuvaneshwari Nagara (Ward No.15)	Anchepalya Kere	107	21,391	0.91	DH214	175	899.35	900.51	1.16	901.03	1.68	1.02	901.53	899.63
7	DHLA103	Bagalkunte (L. Narasimhaya Layout) - Ward No.14	Anchepalya Kere	124	24,833	0.30	DH231	550	876.90	878.15	1.26	879.06	2.16	1.41	879.56	875.38
8	DHLA104	Anjana Nagara, Near Anjaneya Temple (Ward No. 72)	Muddayana Palya Kere	240	47,996	0.60	DH367	0	875.89	876.87	0.99	877.38	1.49	1.00	877.88	878.48
9	DHLA105	Shivapura Kere (Ward No. 39) Near NTF Road	Gangondanahalli Kere	90	18,020	0.30	DH311	975	899.87	902.12	2.25	904.50	4.63	2.88	905.00	908.10
10	DHLA106	Shivananda Nagara (Ward No. 71)	Gangondanahalli Kere	96	19,250	0.30	DH331	0	910.17	911.37	1.21	911.88	1.71	1.00	912.38	915.49
11	DHLA107	Chowdeshwari Nagara Near Rajiv Gandhi Circle, Lagg	Nandini Layout	176	35,142	0.30	(V200)	5075	850.43	853.62	3.19	853.93	3.50	1.00	854.62	870.12
12	DHLA108	Narasimha Swamy Layout, Near Laggere Bridge	Nandini Layout	72	14,453	0.30	DH113	1800	870.87	871.62	0.75	872.08	1.21	1.00	872.62	871.67
13	DHLA109	Nelegadaranahalli Layout, Near Udayavani paper godown	Anchepalya Kere	121	24,196	0.30	DH221	0	897.52	897.97	0.44	898.52	1.00	1.06	899.02	895.31
14	DHLA110	Abbigere (Ward No.12)	Abbigere Kere	73	14,647	0.61	DH125	0	882.01	883.50	1.49	884.13	2.12	1.13	884.63	883.87
15	DHLA115	Chikkabidrakal, Near Madhavapura Grama Panchayat office	Anchepalya Kere	88	17,560	0.61	DH218	0	872.20	874.19	2.00	876.96	4.76	3.26	877.46	870.59
16	DHLA116	Anchepalya, Near Jindal (Ward No.39)	Anchepalya Kere	106	21,154	0.30	DH218	2375	854.87	857.23	2.36	858.11	3.24	1.38	858.61	858.57
17	DHLA144	Swathantra Yodhara Nagara	Nandini Layout	286	57,265	0.30	(V200)	4300	854.71	856.90	2.18	857.71	3.00	1.32	858.21	859.56

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Note: 1) The levels indicated are w.r.t. to GTS levels 2) Properties affected, water spread area, depth of water stagnation etc., indicated is based on the informations provided by the public during reconnassiance survey.																
	Mahadevapura Zone:															
1	MDLA075	Kallappa Layout, Near Basavanagara	Vibuthipura Kere	593	118,578	0.61	MD332A	0	873.19	874.62	1.43	875.04	1.85	1.00	875.62	876.70
2	MDLA076	Thalakaveri Layout, Near HAL Airport	Vibuthipura Kere	208	41,506	0.30	MD332 (KR02)	25	879.24	880.50	1.26	881.22	1.98	1.22	881.72	876.70
3	MDLA077	SJR Dental College Main Road, Maratahalli	Kadabeesanahalli	250	50,069	0.61	MD365A	225	872.16	873.18	1.02	873.56	1.40	1.00	874.18	877.39
4	MDLA078	Gandhipura, Near Whitefield	Sheelavantana Kere	502	100,481	0.40	MD451	200	874.36	874.71	0.35	875.36	1.00	1.15	875.86	880.68
5	MDLA079	Udayanagara, Near A.Narayanpura	Kaggadasapura Kere	818	163,583	0.30	MD312C	0	892.83	892.95	0.12	893.83	1.00	1.38	894.33	894.25
6	MDLA080	Pai Layout, Near A. Narayanpura	Kaggadasapura Kere	672	134,461	0.30	MD312	25	890.87	890.91	0.04	893.39	2.52	2.98	893.89	891.23
7	MDLA081	Chinnappa Layout, Vijnana Nagara	B.Narayanapura Kere	107	21,408	0.30	MD324	25	880.94	883.21	2.27	883.82	2.88	1.11	884.32	884.03
8	MDLA082	Garudacharapalya, Basavanagara	Kodigehalli Kere	162	32,350	0.61	MD282	400	882.50	883.26	0.76	884.05	1.55	1.29	884.55	889.13
9	MDLA083	Pattandur Agrahara, Near ITPL	Sheelavantana Kere	488	97,672	0.40	MD414	325	880.02	881.36	1.34	881.98	1.96	1.12	882.48	881.43
10	MDLA084	Behind Sri Sai Baba Ashrama Kadugudi	Kodigehalli Kere	476	95,177	0.30	MD292B	575	860.70	862.03	1.33	862.46	1.76	1.00	863.03	858.99
11	MDLA085	Pattalamma Layout, Near Kadugudi Main Road	Kodigehalli Kere	799	159,785	0.30	MD292	100	868.75	868.80	0.04	869.75	1.00	1.46	870.25	858.99
12	MDLA086	Siddartha Layout, Kadugudi	Kodigehalli Kere	253	50,524	0.30	MD292	1200	857.74	858.02	0.28	859.53	1.79	2.01	860.03	860.77
13	MDLA087	Triveni Nagara, Near K.R.Pura	Seighehalli Kere	71	14,112	0.61	MD272 (KR12)	50	883.42	885.20	1.78	885.84	2.42	1.14	886.34	884.87
14	MDLA088	Krishna Nagara, Near Chikkadevasandra	Seighehalli Kere	206	41,222	0.40	MD271 (KR10)	200	880.56	880.79	0.22	882.89	2.33	2.61	883.39	884.50
15	MDLA089	Nethravathi Layout	Seighehalli Kere	208	41,582	0.30	MD272 (KR12)	50	883.42	885.20	1.78	885.84	2.42	1.14	886.34	884.87
16	MDLA090	Vinayaka Layout, Near Basavanapura Main Road	Seighehalli Kere	390	77,946	0.30	MD272 (KR12)	700	877.98	879.01	1.03	879.52	1.54	1.01	880.02	876.13

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Note: 1) The levels indicated are w.r.t. to GTS levels 2) Properties affected, water spread area, depth of water stagnation etc., indicated is based on the informations provided by the public during reconnassiance survey.																
17	MDLA091	Kasi Vishwanath Layout, Near K.R. Pura	Seighehalli Kere	357	71,404	0.40	MD266	825	878.35	879.74	1.39	879.75	1.40	1.00	880.74	879.51
18	MDLA092	Hoysala Nagara, K.R Pura	Seighehalli Kere	974	194,896	0.30	MD251A	100	905.52	906.88	1.36	907.02	1.50	1.00	907.88	899.22
19	MDLA093	Laxmana Murthy Nagara	Seighehalli Kere	209	41,792	0.30	MD262 (KR06)	0	890.58	891.74	1.16	892.52	1.94	1.28	893.02	890.74
20	MDLA094	R.R.Layout, Near Vijinapura	Seighehalli Kere	210	42,062	0.50	MD261	0	897.65	898.79	1.14	899.09	1.44	1.00	899.79	897.48
21	MDLA095	Ambedkar Nagara, Near Vijinapura	Seighehalli Kere	207	41,413	0.91	MD261	25	897.45	898.15	0.70	898.50	1.05	1.00	899.15	897.01
22	MDLA096	Sanjay Nagara Slum, Near K.R Pura	Seighehalli Kere	49	9,861	0.60	MD272 (KR12)	50	883.42	885.20	1.78	885.84	2.42	1.14	886.34	884.87
23	MDLA114	Abaya Reddy Layout, Vijnana Nagara	Kaggadasapura Kere	523	104,624	0.61	MD313	800	876.75	877.50	0.76	878.25	1.50	1.24	878.75	876.70

Sl. No.	Low Lying Area ID	Location	Name of the Water Shed Cluster	No of Properties Affected (Nos.)	Water Spread Area (sqm)	Water Stagnation Depth (m.)	Drain ID	Chainage (m.)	Ex. Drain Bed / Invert Level (m.)	Ex. Avg. Ground Level (m.)	Ex. Drain Depth (m.)	Flood Water Level (m.)	Reqd. Drain Depth (m.)	Building Plinth Level from Ex. GL (m.)	Proposed Avg. Ground Formation Level (m.)	Nearest TBM Level w.r.t GTS Bench Mark (m.)
Note: 1) The levels indicated are w.r.t. to GTS levels 2) Properties affected, water spread area, depth of water stagnation etc., indicated is based on the informations provided by the public during reconnassiance survey.																
	Rajarajeshwarinagara Zone:															
1	RNLA027	Kengunta, Near Mallathalli- Ward No.130	Muddayana Palya Kere	177	35,458	0.30	RN541 (RNR06)	0	846.40	847.91	1.51	848.74	2.34	1.33	849.24	0.00
2	RNLA028	Near Vidhyaniketan School, Ullal-Ward No.130	Muddayana Palya Kere	307	61,326	0.90	RN531	1075	817.45	820.72	3.27	821.07	3.62	1.00	821.72	822.68
3	RNLA029	Vinayaka Layout, Near Nagarabavi	Nayandanahalli Kere	543	108,682	0.61	RN172	400	832.62	835.16	2.54	835.63	3.01	1.00	836.16	0.00
4	RNLA030	Sri Hari Layout, Near Jnanabharathi Layout	Muddayana Palya Kere	136	27,300	0.30	RN541 (RNR06)	1350	828.40	829.56	1.17	831.04	2.64	1.97	831.54	0.00
5	RNLA031	Bandemata- Ward No.159, Kengeri	Hosahalli Kere	415	82,963	0.30	RN181	8875	759.61	760.30	0.69	761.61	2.00	1.81	762.11	773.88
6	RNLA032	Janapriya Apartments, Rajarajeshwarinagara	Halge Vadarahalli Kere	59	11,818	0.30	RN181	3325	777.64	782.33	4.69	782.75	5.11	1.00	783.33	798.53
7	RNLA033	Kenchenahalli- Ward No.160, Rajarajeshwari Nagara	Halge Vadarahalli Kere	332	66,361	0.30	RN181	2425	781.10	781.60	0.50	785.59	4.49	4.49	786.09	798.53
8	RNLA034	Shivanna Layout, Near Halagevaddarahalli	Halge Vadarahalli Kere	269	53,799	0.40	RN191	1450	809.11	809.60	0.49	810.48	1.37	1.38	810.98	810.78
9	RNLA035	Dore Kere-Ward No.184, Uttarahalli	Subramanyapura Kere	74	14,853	0.61	RN223	150	846.75	849.36	2.61	850.37	3.62	1.51	850.87	833.00
10	RNLA036	Yelechenahalli -Ward No.185	Subramanyapura Kere	311	62,268	0.91	RN212	25	893.77	895.80	2.03	896.25	2.48	1.00	896.80	895.86
11	RNLA118	Kanaka Nagara - Ward No.181, Kumaraswamy Layout	Subramanyapura Kere	479	95,777	0.91	RN212	775	879.60	881.22	1.62	881.72	2.12	1.00	882.22	885.16

5.4 BEST MANAGEMENT PRACTICES:

Implement pollution prevention methods.

Designate and implement minimum best management practices to protect water quality.

Implement a maintenance schedule for all structural controls designed to reduce pollutant discharges and the storm water conveyance system, to include:

Inspection & removal of waste between May 1st and Sept. 30th.
Additional cleaning between October 1st and April 30th.
Records of cleaning and waste removal quantity.
Proper waste disposal.

- Measures to eliminate discharges during maintenance & cleaning.
- Limit infiltration from sanitary sewer to storm drains through routine maintenance.
- Implement an Educational Program for all pertinent target audiences.
- Inspect and clean catch basins and keep appropriate records.
- Remove trash and debris from open channels and properly dispose of these materials to prevent them from being washed into receiving waters.
- Report prohibited non-storm water discharges observed during the course of normal daily activities so they can be investigated, contained and cleaned up or eliminated.
- Review maintenance activities to verify that appropriate storm water maintenance practices are being utilized.
- Educate employees for pollution prevention techniques.
- Inspect and clean as needed all inlets/catch basins at least once every other year (at least 50% of the entire system inspected and cleaned each year)
- Inspect and clean as needed all inlets/catch basins in known problem areas at least once a year.
- Inspect and clean as needed all storm drain lines in known problem areas at least once a year.
- Inspect and clean as needed sumps and debris racks at pump stations, detention basins, drainage ditches and debris basins throughout the year.
- Cleaning activities may occur on a year round basis, however, known problem areas shall be targeted prior to the rainy season.
- Inspect and clean as needed all storm drain facilities that have been affected by emergency response activities.
- Additional cleanings shall be conducted as necessary during the non rainy season (Oct. 1st through April 30th).
- Slide and Embankment Repair of Channels.
- Set-up a vigilance squad to prevent debris dumping, encroachment of drains, local obstruction, such as, pipe crossing, construction inside the drain, any discharges other than storm water.
- Encourage rain water harvesting in institutions, public parks, open grounds, etc.,

5.5 Allied Works:

The objective of storm water management, among many, is to attenuate the peak runoff rate from a developing area at or below the pre-development rate to control flooding, soil erosion, sedimentation, and pollution. Measures used to achieve the objective include detention/retention facilities or infiltration trenches with the former being used to control the peak flow rate while the latter for peak flow volume.

Storm water quantity control facilities can be classified by function as either detention or retention facilities. The primary function of detention is to store and gradually release or attenuate storm water runoff by way of a control structure or other release mechanism. True retention facilities provide for storage of storm water runoff, and release via evaporation and infiltration only.

The choice of design return period should be consistent with the efficient performance for multiple design periods, for a system designed for runoff from a single return period may be ineffective in controlling the runoff from a longer return period. Also to be considered is the availability of place for implementing such facilities in a highly urbanized and densely habitated city like Bengaluru.

The three fundamental parameters which must be considered during design are Release Timing, Safety and maintenance.

The timing of releases from storm water control facilities can be critical to the proper functioning of overall storm water systems as the storm water quantity control structures reduce the peak discharge and increase the duration of flow events and this shifting of flow peak times and durations in some instances can cause adverse effects downstream especially where multiple detention facilities have been installed within developing watersheds,

Storm water quantity control facilities need to be located and designed in such a way that safety precautions like preventing public trespass, providing emergency escape aids and eliminating other hazards are accounted. Removable, hydraulically-efficient grates and bars may be considered for all inlet and outlet where a safety hazard is perceived. Fences may be needed to enclose ponds under some circumstances.

Storm water management facilities must be properly maintained if they are to function as intended over a long period of time. Maintenance tasks include periodic inspections, mowing to prevent vegetation growth and removal of sediments and litter together with repairs of inlet and outlet structures.

Infiltration facilities are retention ponds with pervious bottom with the area to suit sufficient infiltration capability to drain the basin in a reasonable amount of time so that it will have the capacity needed for another event based on geological studies assessing infiltration capacity. Infiltration practices are essential to the stormwater management programs in many urbanised areas globally. While Infiltration practices have the ability to remove watershed borne pollutants, to reduce the runoff volume, to provide groundwater recharge, the primary goal of infiltration practices in stormwater management is to maintain the post development runoff characteristics, as nearly as possible to the pre-development. Stormwater infiltration devices may include Infiltration beds. Infiltration beds, Percolation subdrains, Sand filter and dry well, Porous pavement, Infiltration trench, Infiltration pond or basin etc.

Detention ponds are proposed to open lands like education institutions, Defence establishments, open parks, playgrounds, etc., to collect the run-off water generated from the roof top to the detention pond and connected to further nearby storm water drain. This will help in reduction of sudden load on main storm water drain and since this water is not mixed with sewage and helps in recharging the ground water.

Retention basins are proposed along the storm water drain where two drains are confluenceing and open lands are available which will help to temporarily store the water and release gradually which in turn helps in optimizing the drain cross section and minimize sediment transport.

5.6 Detention Ponds:

The objective of construction of Detention ponds is to;

1) Attenuate runoff generated from open park lands, play grounds, college campus, defence establishments, within their premises which intern to reduce the shock load on tertiary / secondary drainage network.

2) Enhance the ground water recharge potential as the runoff is not mixed with any type of pollutants.

3) Helps in control of sediment transport to drainage network from open lands etc.

The runoff generated from the building rooftops and within the campus internal drainage network is conveyed into the detention ponds through open channels. The number of detention ponds and its size shall be depending up the quantity of runoff generated from the campus. The holding capacity of the pond shall be at least equivalent to half hour storage of the runoff generated for peak intensity of rainfall.

The ponds shall be constructed at the lowest point within the campus and also near the tertiary / secondary drain so as to convey the runoff water by gravity. The sides of the ponds shall be lined with stone revetment, bottom filled with graded filter materials and surrounding region cordoned with barbed wire fence with appropriate caution sign boards.

The maintenance of these ponds shall be done on periodic basis, before and after monsoon considering the environmental and health aspect in view.

Construction of detention ponds in all educational institutions, government office and industrial establishments etc shall be made compulsory as part of building bylaw and in public parks on the basis of private partnership.

Typical sketch depicting construction of detention pond in residential school campus is as depicted in **Fig. 5.7.**

The zone wise list indicating the possible locations where Detention Ponds can be constructed are as mentioned below and the same is depicted in **Fig.. SWD MP DP- 01.**

Detention Ponds Proposed under Master Plan Project in BBMP Area

Sl. No.	Zone	Count
1	East	18
2	West	7
3	South	5
4	Bommanahalli	10
5	Dasarahalli	22
6	Yelahanka	19
7	Mahadevapura	10
8	Rajarajeshwarinagara	10
	Total	**101**

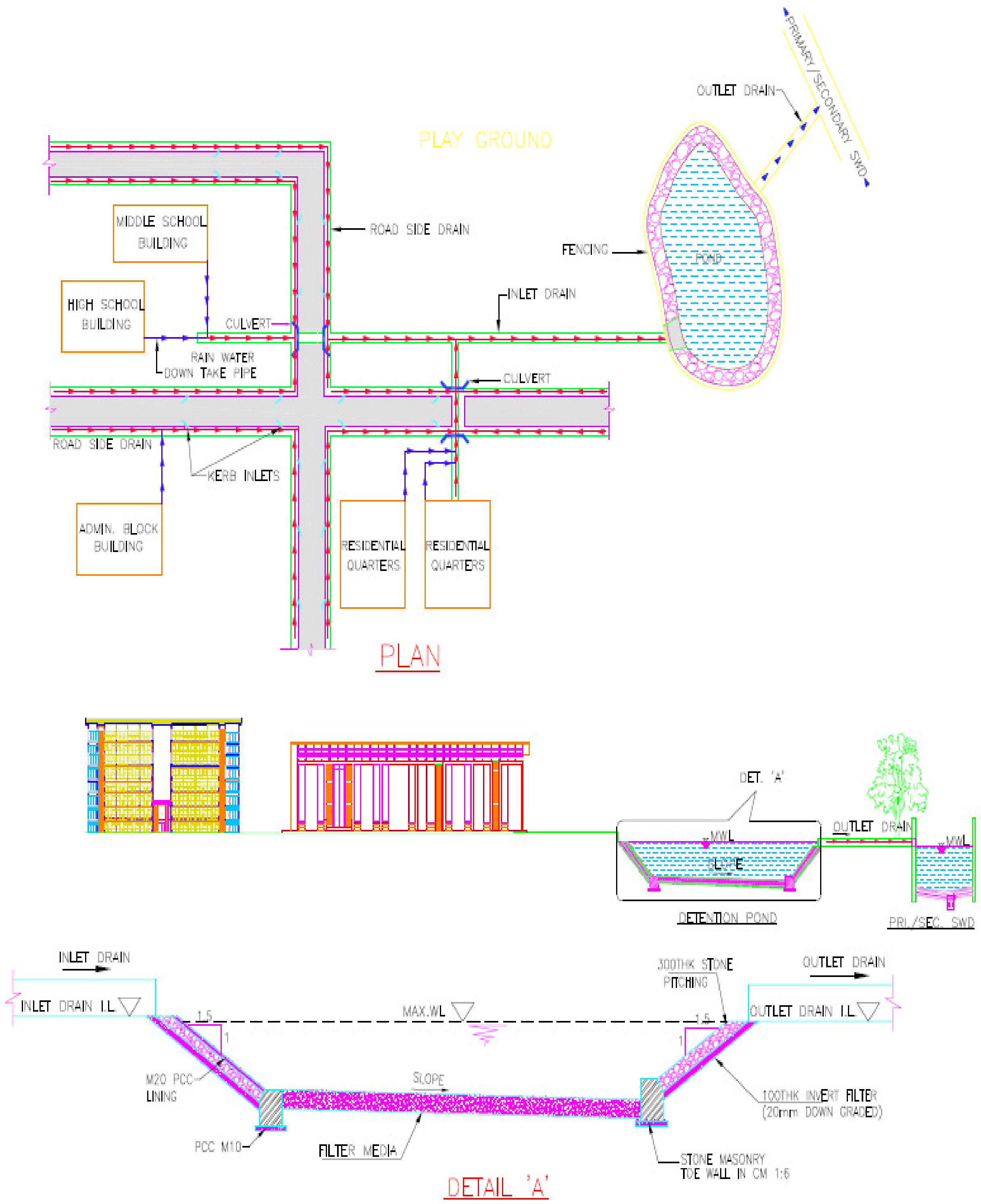


Fig 5.7 Typical Detention pond in Open Park and play grounds

5.6.1 East Core Zone

In the East Core Zone, there are 18 locations where Detention Ponds may be located as listed in **Table 5.11.**

Table 5.11 Locations of Detention Ponds in East Core Zone

1	ADE Campus, Thippasandra
2	Airforce Campus Mekri Circle
3	Airforce Quarters, Gouthampura
4	ASC Centre, Koramangala
5	BEML Campus, C.V. Ramannagara
6	Defence Area, Ganganagara
7	Defence Land R.T. Nagara
8	Defence Land, near Sarvagnanagara
9	DRDO Campus, Kaggadasapura
10	HAL Airport Road flyover
11	ISRO Campus, RMV Extn.
12	Kadugondanahalli, HBR Layout
13	MEG Centre, near Ulsoor Kere
14	NGEF Campus
15	Open Land, near Banaswadi Main Road
16	Ramana Maharashi Park, Mekri Circle
17	Sena Vihar, Maruthisevanagara
18	UAS Campus, Boopasandra

Table 6, Part 3, Appendix 1 lists the details of Detention Ponds in East Core Zone. **Drg**s. **EZ-FC-DP- 01** show the details of the same.

5.6.2 West Core Zone

In the West Core Zone, there are 7 locations where Detention Ponds may be located as listed in **Table 5.12.**

Table 5.12 Locations of Detention Ponds in West Core Zone

1	BEML Campus, Yeshawanthapura
2	HMT Factory Campus, Jalahalli
3	IISC Campus
4	Kirloskar Factory Campus, Mahalakshmi Layout
5	Open Land, Khata Nagara
6	Open Land, Near Platinum City, Tumkur Road
7	Open Land, Near Siddhartha Nagara

Table 6, Part 3, Appendix 2 lists the details of Detention Ponds in West Core Zone. **Drg**s. **WZ-FC-DP- 01,** show the details of the same.

5.6.3 South Core Zone

In the South Core Zone, there are 5 locations where Detention Ponds may be located as listed in **Table 5.13.**

Table 5.13 Locations of Detention Ponds in South Core Zone

1	Forest Land , near Govindarajanagara
2	Open Land, Near Ittamadu
3	Open Land, Near Kumarswamy Layout
4	Open Land, Near Samuruddhinagara
5	Open Land, near Yarabnagara Main Road Junction

Table 6, Part 3, Appendix 3 lists the details of Detention Ponds in South Core Zone. **Drg**s. **SZ-FC-DP- 01,** show the details of the same.

5.6.4 Bommanahalli Zone

In the Bommanahalli Zone, there are 10 locations where Detention Ponds may be located as listed in **Table 5.14.**

Table 5.14 Locations of Detention Ponds in Bommanahalli Zone

1	Forest Land, Near Thalaghatta Pura
2	Muneshwaranagara
3	Open Land, Hongasandra
4	Open Land, Near Devarachikkanahalli
5	Open Land, Near Kothanur - Bannerghatta Road Junction, Hulimavu
6	Open Land, Near Krishnaraju Layout, J.P. Nagara Dollars Colony
7	Open Land, Near Muneshwaranagara
8	Open Land, near Quarry Area, Bettadasanapura
9	Open Land, Near Quarry area, Gottigere
10	Open Land, near Quarry Area, Singasandra

Table 6, Part 3, Appendix 4 lists the details of Detention Ponds in Bommanahalli Zone. **Drgs. BH-FC-DP- 01,** show the details of the same.

5.6.5 Yelehanka Zone

In the Yelahanka Zone, there are 19 locations where Detention Ponds may be located as listed in **Table 5.15.**

Table 5.15 Locations of Detention Ponds in Yelahanka Zone

1	CRPF Campus, Doddaballapura Road
2	Forest Land, HBR Layout, near ORR
3	GKVK Campus
4	Jalahalli Airforce Campus
5	JNNARC Campus, Rachenahalli
6	Manayatha Tech Park
7	Open Land, Jalahalli East
8	Open Land, Kuvempunagara, near Shingapura
9	Open Land, near Bilishivale
10	Open Land, near CQAL Layout
11	Open Land, Near Hennur- Bagalur Road, Gedalahalli
12	Open Land, Near Jalahalli East - 1
13	Open Land, Near JNNARC, Arkavathi Layout
14	Open Land, Near Kuvempunagara
15	Open Land, near Yelahanka Tiles Factory
16	Open Land, Varadarajanagara
17	Open Land, Vinayakanagara
18	Rail Wheel & Axel Plant
19	Vadarapalya, near Horamavu Agara

Table 6, Part 3, Appendix 5 lists the details of Detention Ponds in Yelalhanka Zone. **Drg**s. **YE-FC-DP- 01,** show the details of the same.

5.6.6 Dasarahalli Zone

In the Dasarahalli Zone, there are 22 locations where Detention Ponds may be located as listed in **Table 5.16.**

Table 5.16 Locations of Detention Ponds in Dasarahalli Zone

1	Jalahalli Airforce Training School
2	Kaverinagara, Near Laggere
3	Narashimaraja Colony, Kottigepalya
4	Open Land, Beggers Colony
5	Open Land, Kammagondahalli
6	Open Land, Maheshwarinagara
7	Open Land, Near Anjananagara
8	Open Land, near Chikka Banavara
9	Open Land, Near Chikka Banavara Rly. Stn.
10	Open Land, Near Defence Colony, Bagalagunte
11	Open Land, Near Herohalli
12	Open Land, Near Pappareddy Layout
13	Open Land, near Prasanan Layout
14	Open Land, Near Quarrry Area, Hegganahalli
15	Open Land, Near Sunkadakatte
16	Open Land, Near UBMEC Layout, Peenya Indl. Area
17	Open Land, Near Vidhyamanyanagara
18	Open Land, Near Vieshwariah Layout

19	Open Land, Shingapura
20	Open Land, SrigandadaKaval
21	Open Land,, Near Janakalsiddeshwaranagara, Nandnii Layout
22	Prasanna Layout

Table 6, Part 3, Appendix 6 lists the details of Detention Ponds in Dasarahalli Zone. **Drgs**. **DH-FC-DP- 01** show the details of the same.

5.6.7 Mahadevapura Zone

In the Mahadevapura Zone, there are 10 locations where Detention Ponds may be located as listed in **Table 5.17.**

Table 5.17 Locations of Detention Ponds in Mahadevapura Zone

1	HAL Airport Complex
2	ITI Campus
3	Open Land near Railway Loco Shed, Krishnarajapura
4	Open Land, near B. Narayanapura Kere
5	Open land, near Doddanekundi Railway track
6	Open Land, near HAL Quarters Area
7	Open Land, near Krishanarajapura Flyover
8	Open Land, Near LBS Nagara
9	Quarry Area, near Battarahalli
10	Railway Goods Yard, Ramamurthynagara

Table 6, Part 3, Appendix 7 lists the details of Detention Ponds in Mahadevapura Zone. **Drg**s. **MD-FC-DP- 01** shows the details of the same.

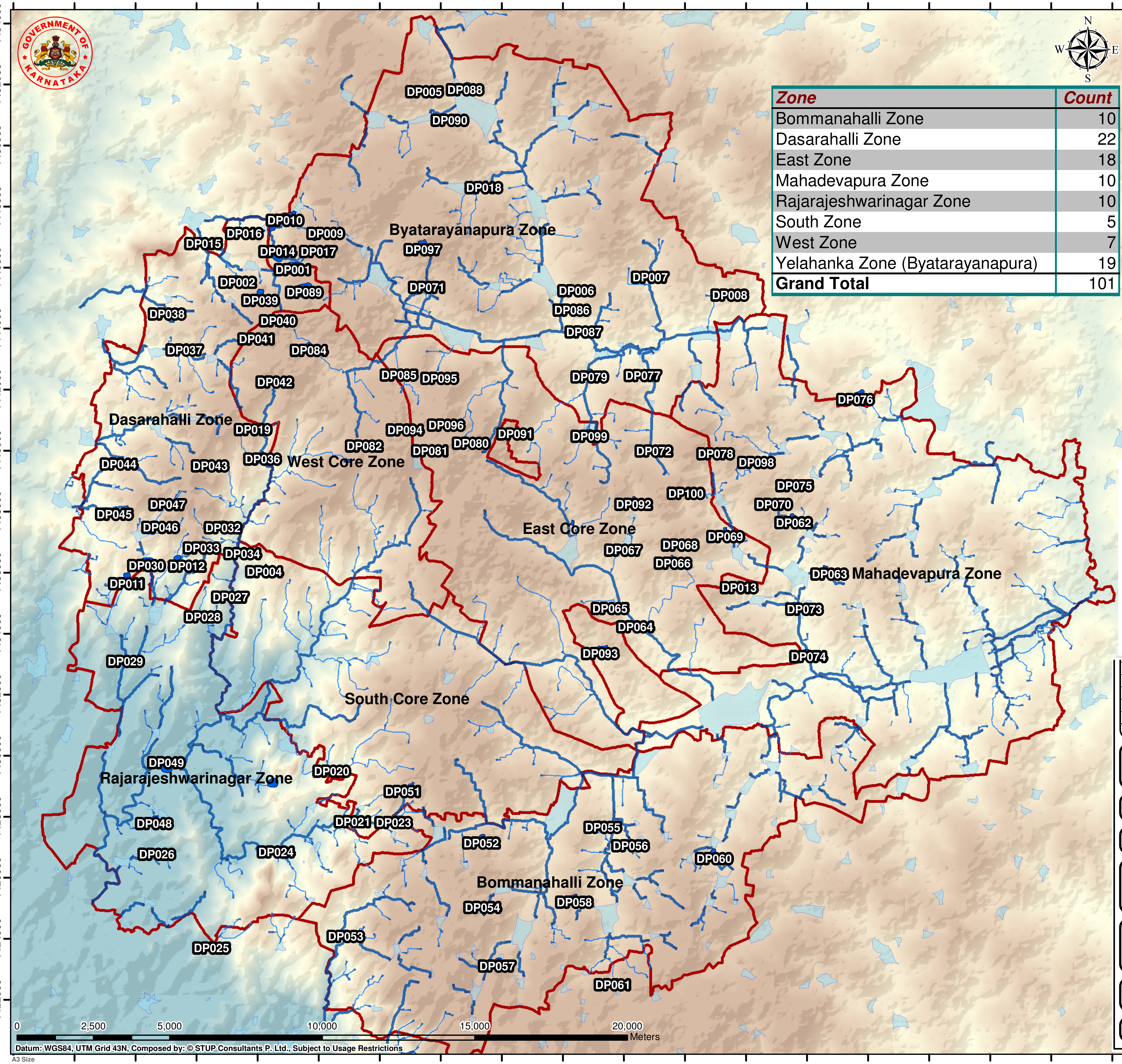
5.6.8 Raja Rajeshwari Nagara Zone

In the Raja Rajeshwari Nagara Zone, there are 10 locations where Detention Ponds may be located as listed in **Table 5.18.**

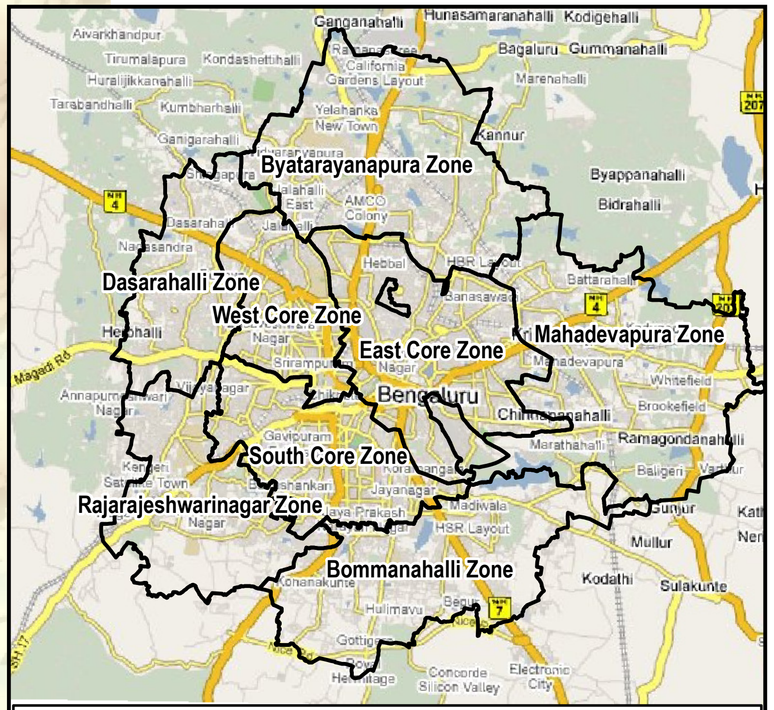
Table 5.18 Locations of Detention Ponds in Raja Rajeshwari Nagara Zone

1	Open Land, Banashankari 6 th Phase
2	Open Land, Behind Ambedkar Engg. College
3	Open Land, Behind Mailasandra STP, Mysore Road
4	Open Land, Near Annapurneshwarinagara
5	Open Land, near Kodipura
6	Open Land, Near Mudalapalya
7	Open Land, Near Pavamanpura
8	Open Land, near Purnapragna Layout
9	Open Land, Near Purnapragna Layout - 1
10	Open Land, Near Yelachenahalli

Table 6, Part 3, Appendix 8 lists the details of Detention Ponds in Raja Rajeshwarinagara Zone. **Drg**s. **RN-FC-DP- 01** shows the details of the same.



Zone	Count
Bommanahalli Zone	10
Dasarahalli Zone	22
East Zone	18
Mahadevapura Zone	10
Rajarajeshwarinagar Zone	10
South Zone	5
West Zone	7
Yelahanka Zone (Byatarayanapura)	19
Grand Total	**101**



Key Map

Legend

- Detention Pond
- Primary SWD
- Secondary SWD
- BBMP Administrative Zones
- Water Bodies

Terrain Value

High : 996.095

Low : 693.259

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN
A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER
Bruhat Bengaluru Mahanagara Palike

DATE
August 2010

CONTRACTOR

DRAWN
MNS (SDE)

PROJECT
Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

PREPARED
MNS (SDE)

CHECKED
RSP (APC)

TITLE
Map Showing Detention Ponds Locations of 8 BBMP Zones

APPROVED
YDM (CC)

No. SWD-MP-DP-01 | REV R0 | JOB No. 10331/E

SCALE
AS SPECIFIED

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5.7 Retention Basins:

The objective of construction of Retention Basins is to;

1. Attenuate / reduce the shock load from secondary drainage network onto the primary drainage system.

2. Enhance the ground water recharge potential as the runoff is either nil / mixed with minimal pollutant concentration.

3. Helps in control of sediment transport / floating materials for full length of the drain etc.

The retention basins are proposed at locations where two / three secondary drains confluence with the main drain, where abundant open land and approach road is available adjacent to main drain and at locations where velocity of flow in the drain is mild. The location where all three conditions satisfy is the ideal location for construction of retention basins.

The flow in the drain is temporarily obstructed by constructing a vented weir of suitable height across the main drain. By creating a local depression in the drain bed and increasing the width of the drain. The sediments transported and other floating materials gets deposited and can be collected and conveyed at one point rather that allowing it to get transport further for full length.

The holding capacity of the basin shall be at least equivalent to half hour storage of the runoff generated for peak intensity of rainfall.

The sides of the drains at shall locations be lined with either masonry / RCC wall, bottom filled with graded filter materials, arrangements for installation of mechanical rackers and screens with proper access to approach road and surrounding region cordoned with barbed wire fence with appropriate caution sign boards.

The maintenance of these basins shall be done on periodic basis, before and after monsoon and also depending of specific site conditions/requirements considering the environmental and health aspect in view.

Typical sketch depicting construction of retention basin along SWD near open park land is as depicted in **Fig. 5.8.**

The zone wise list indicating the possible locations where Retention basin can be constructed are as mentioned below and the same is depicted in **Fig.. SWD MP RB- 01.**

Retentions Basins Proposed under Master Plan Project in BBMP Area

Sl. No.	Zone	Count
1	East	18
2	West	7
3	South	5
4	Bommanahalli	10
5	Dasarahalli	22
6	Yelahanka	19
7	Mahadevapura	10
8	Rajarajeshwarinagara	10
	Total	**101**

Typical Retention Basin

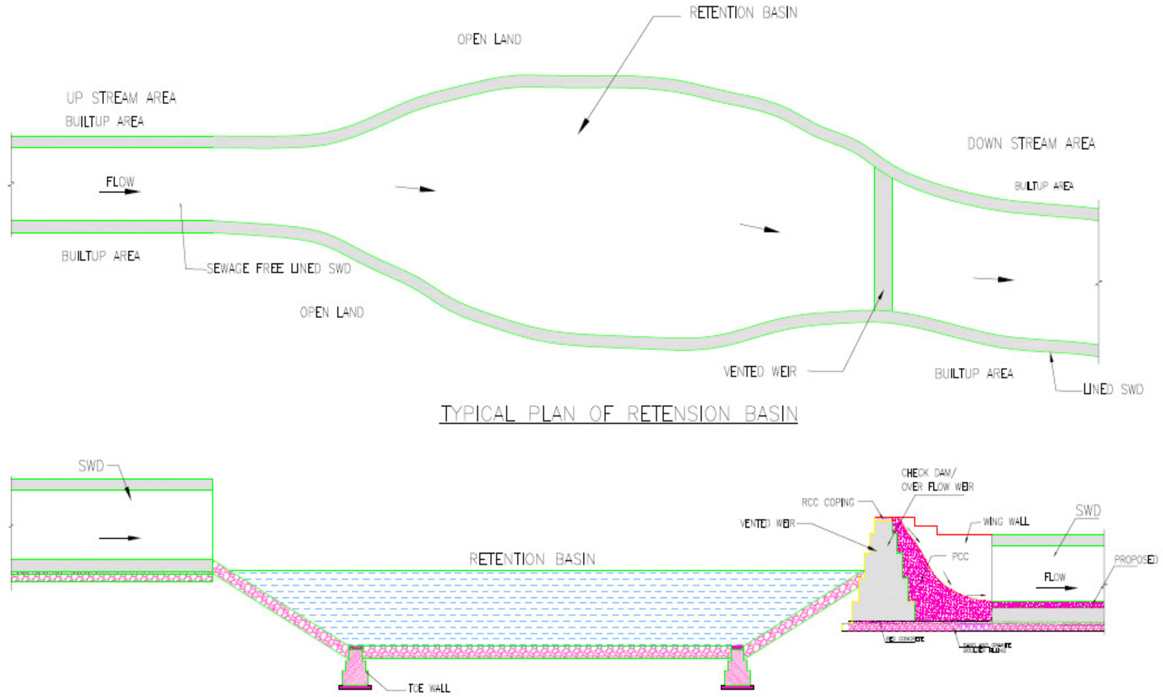


Fig 5.8 Typical Retention Basin along SWD

In the East Core Zone, there are 6 locations where Retention Basins may be located as listed in **Table 5.19**

Table 5.19 Locations of Retention Basins in East Core Zone

1	Airforce Quarters, Gouthampura
2	Defence Land, near Sarvagnanagara
3	HAL Airport Road flyover
4	Kadugondanahalli, HBR Layout
5	MEG Centre, near Ulsoor Kere
6	Open Land, near Banaswadi Main Road

Table 7, Part 3, Appendix 1 lists the details of Retention Basins in East Core Zone. **Drg**s. **EZ-FC-RB-01** shows the details of the same.

In the West Core Zone, there are 3 locations where Retention Basins may be located as listed in **Table 5.20**

Table 5.20 Locations of Retention Basins in West Core Zone

1	Open Land, Khata Nagara
2	Open Land, Near Platinum City, Tumkur Road
3	Open Land, Near Siddhartha Nagara

Table 7, Part 3, Appendix 2 lists the details of Retention Basins in West Core Zone. **Drg**s. **WZ-FC-RB-01** show the details of the same.

In the South Core Zone, there are 4 locations where Retention Basins may be located as listed in **Table 5.21**

Table 5.21 Locations of Retention Basins in South Core Zone

1	Open Land, Behind Mailasandra STP, Mysore Road
2	Open Land, Near Kumarswamy Layout
3	Open Land, Near Samuruddhinagara
4	Open Land, near Yarabnagara Main Road Junction

Table 7, Part 3, Appendix 3 lists the details of Retention Basins in South Core Zone. **Drg**s. **SZ-FC-RB-01** shows the details of the same.

In the Bommanahalli Zone, there are 10 locations where Retention Basins may be located as listed in **Table 5.22.**

Table 5.22 Locations of Retention Basins in Bommanahalli Zone

1	Mangamanapalya, near HSR Layout
2	Open Land, Hongasandra
3	Open Land, Near Devarachikkanahalli
4	Open Land, near Hongasandra - 1
5	Open Land, Near Kothanur - Bannerghatta Road Junction, Hulimavu
6	Open Land, Near Krishnaraju Layout, J.P. Nagara Dollars Colony
7	Open Land, Near Muneshwaranagara
8	Open Land, near Quarry Area, Bettadasanapura
9	Open Land, Near Quarry area, Gottigere
10	Open Land, near Quarry Area, Singasandra

Table 7, Part 3, Appendix 4 lists the details of Retention Basins in Bommanahalli Zone. **Drg**s. **BH-FC-RB-01** show the details of the same.

In the Yelahanka Zone, there are 7 locations where Retention Basins may be located as listed in **Table 5.23.**

Table 5.23 Locations of Retention Basins in Yelahanka Zone

1	Open Land, Jalahalli East
2	Open Land, Near Hennur- Bagalur Road, Gedalahalli
3	Open Land, Near JNNARC, Arkavathi Layout
4	Open Land, Near Kuvempunagara
5	Open Land, near Yelahanka Tiles Factory
6	Open Land, Vinayakanagara
7	Quary area, Vadera Palya near Horamavu Agara

Table 7, Part 3, Appendix 5 lists the details of Retention Basins in Yelahanka Zone. **Drg**s. **YE-FC-RB-01** shows the details of the same.

In the Dasarahalli Zone, there are 18 locations where Retention Basins may be located as listed in **Table 5.24.**

Table 5.24 Locations of Retention Basins in Dasarahalli Zone

1	Kaverinagara, Near Laggere
2	Narashimaraja Colony, Kottigepalya
3	Open Land Near Prasanna Layout
4	Open Land, Kammagondahalli
5	Open Land, Maheshwarinagara
6	Open Land, Near Anjananagara
7	Open Land, near Chikka Banavara
8	Open Land, near Chikka Banavara Rly. Station
9	Open Land, Near Defence Colony, Bagalagunte
10	Open Land, Near Herohalli
11	Open Land, Near Pappareddy Layout
12	Open Land, Near Quarrry Area, Hegganahalli
13	Open Land, Near Sunkadakatte
14	Open Land, Near UBMEC Layout, Peenya Indl. Area
15	Open Land, Near Vidhyamanyanagara
16	Open Land, Shingapura
17	Open Land,, Near Janakalsiddeshwaranagara, Nandnii Layout
18	Prasanna Layout

Table 7, Part 3, Appendix 6 lists the details of Retention Basins in Dasarahalli Zone. **Drgs**. **DH-FC-RB-01** shows the details of the same.

In the Mahadevapura Zone, there are 5 locations where Retention Basins may be located as listed in **Table 5.25.**

Table 5.25 Locations of Retention Basins in Mahadevapura Zone

1	HAL Airport Complex
2	Open Land, near B. Narayanapura Kere
3	Open land, near Doddanekundi Railway track
4	Open Land, near HAL Quarters Area
5	Railway Goods Yard, Ramamurthynagara

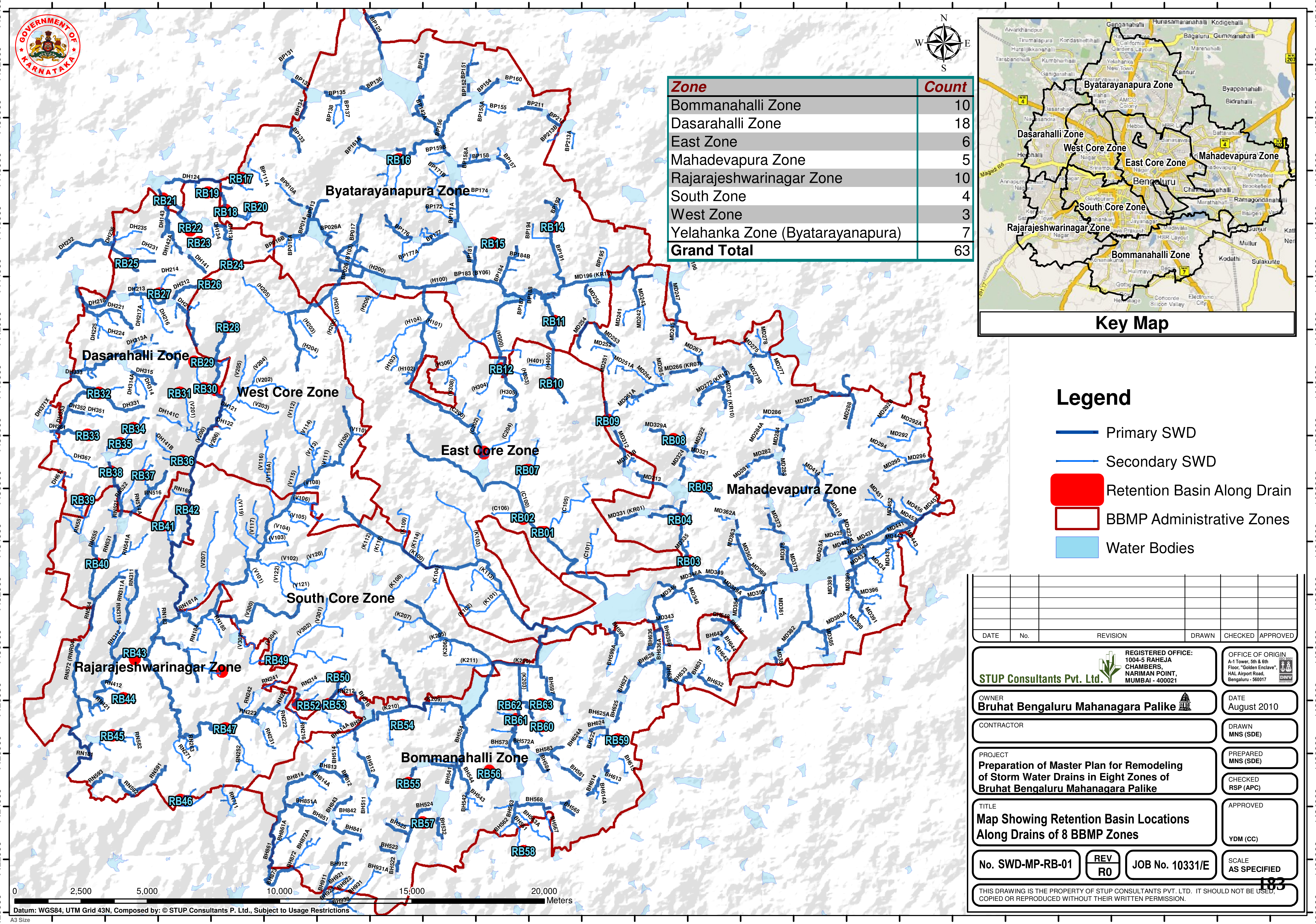
Table 7, Part 3, Appendix 7 lists the details of Retention Basins in Mahadevapura Zone. **Drg**s. **MD-FC-RB-01** shows the details of the same.

In the Raja Rajeshwari Nagara Zone, there are 10 locations where Retention Basins may be located as listed in **Table 5.26**

Table 5.26 Locations of Retention Basins in Raja Rajeshwari Nagara Zone

1	Open Land Near Kodipura
2	Open Land, Banashankari 6 th Phase
3	Open Land, Behind Ambedkar Engg. College
4	Open Land, Behind Mailasandra STP, Mysore Road
5	Open Land, Near Annapurneshwarinagara
6	Open Land, Near Mudalapalya
7	Open Land, Near Pavamanpura
8	Open Land, near Purnapragna Layout
9	Open Land, Near Purnapragna Layout - 1
10	Open Land, Near Yelachenahalli

Table 7, Part 3, Appendix 8 lists the details of Retention Basins in Raja Rajeshwari Nagara Zone. **Drg**s. **RN-FC-RB-01** shows the details of the same.



Zone	Count
Bommanahalli Zone	10
Dasarahalli Zone	18
East Zone	6
Mahadevapura Zone	5
Rajarajeshwarinagar Zone	10
South Zone	4
West Zone	3
Yelahanka Zone (Byatarayanapura)	7
Grand Total	**63**

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: **Bruhat Bengaluru Mahanagara Palike**

DATE: August 2010

CONTRACTOR:

DRAWN: MNS (SDE)

PROJECT: **Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike**

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: **Map Showing Retention Basin Locations Along Drains of 8 BBMP Zones**

APPROVED: YDM (CC)

No. SWD-MP-RB-01 | REV R0 | JOB No. 10331/E

SCALE: AS SPECIFIED

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5.8 Flow Regulation from Lakes:

As per the LDA information, number of lakes in Bengaluru has come down from 280 in 60s to 80 in 1993. Of the several freshwater lakes and water tanks, the notable are the Madiwala Lake, the Hebbal Lake, the Ulsoor Lake and the Sankey Tank. Use of the lakes to absorb some of the runoff quantity and with a facility for regulating the outlet may be one of the flow control measures to attenuate peak runoff.

Development of existing large lakes as holding ponds involves the assessment of the existing status of the lakes and providing measures for strengthening the inlet and out let and treatment measures to rejuvenate the water quality.

All existing water bodies are severely silted with dense vegetation growth observed intern has reduced the holding capacities of the water bodies to a large extent and which also has resulted in surcharging of water during heavy showers into residential areas/localities situated adjacent / near the water bodies causing havoc. Therefore, in order to minimize flooding problems in such localities and optimize the drain cross sectional areas of the drains situated on the downstream side, reaches, it is proposed to deepen the tank bed and install sluice weir and control to maintain water level in the tank.

Existing weirs constructed for water bodies are in dilapidated condition and severe siltation and dense vegetation growth is observed at the entry location of all water bodies. In order to facilitate for water to enter freely into the water bodies, it is proposed to desilt, widen the drains, regrade the drain bed at the entry locations, clear all obstacles and reconstruct/strengthen the inlet/outlet weirs near the entry locations of water bodies.

Details of water bodies considered for development of water bodies as holding ponds in BBMP Area is as mentioned in **Table 5.27** and the typical schematic sketch of the regulatory gate arrangement proposed is shown in **Fig. SWD MP HP- 01**

The modus of operation of regulatory gate is narrated in the subsequent section of this chapter.

Typical sketch depicting development of water bodies as holding ponds is as shown in **Fig. 5.9.**

Holding Ponds Proposed under Master Plan Project in BBMP Area

Sl. No.	Zone	Count
1	East	2
2	West	0
3	South	1
4	Bommanahalli	6
5	Dasarahalli	5
6	Yelahanka	9
7	Mahadevapura	7
8	Rajarajeshwarinagara	6
	Total	**36**

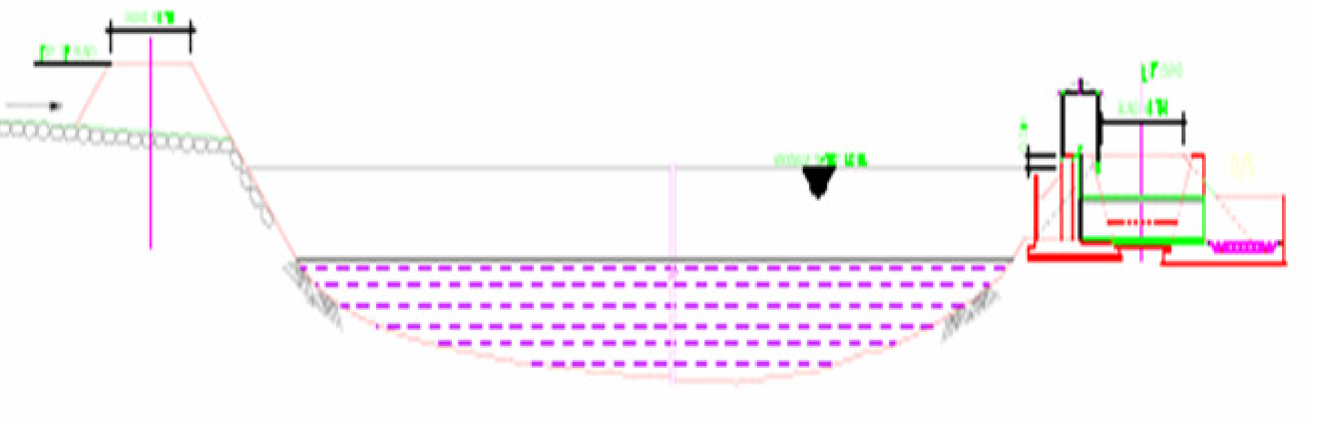
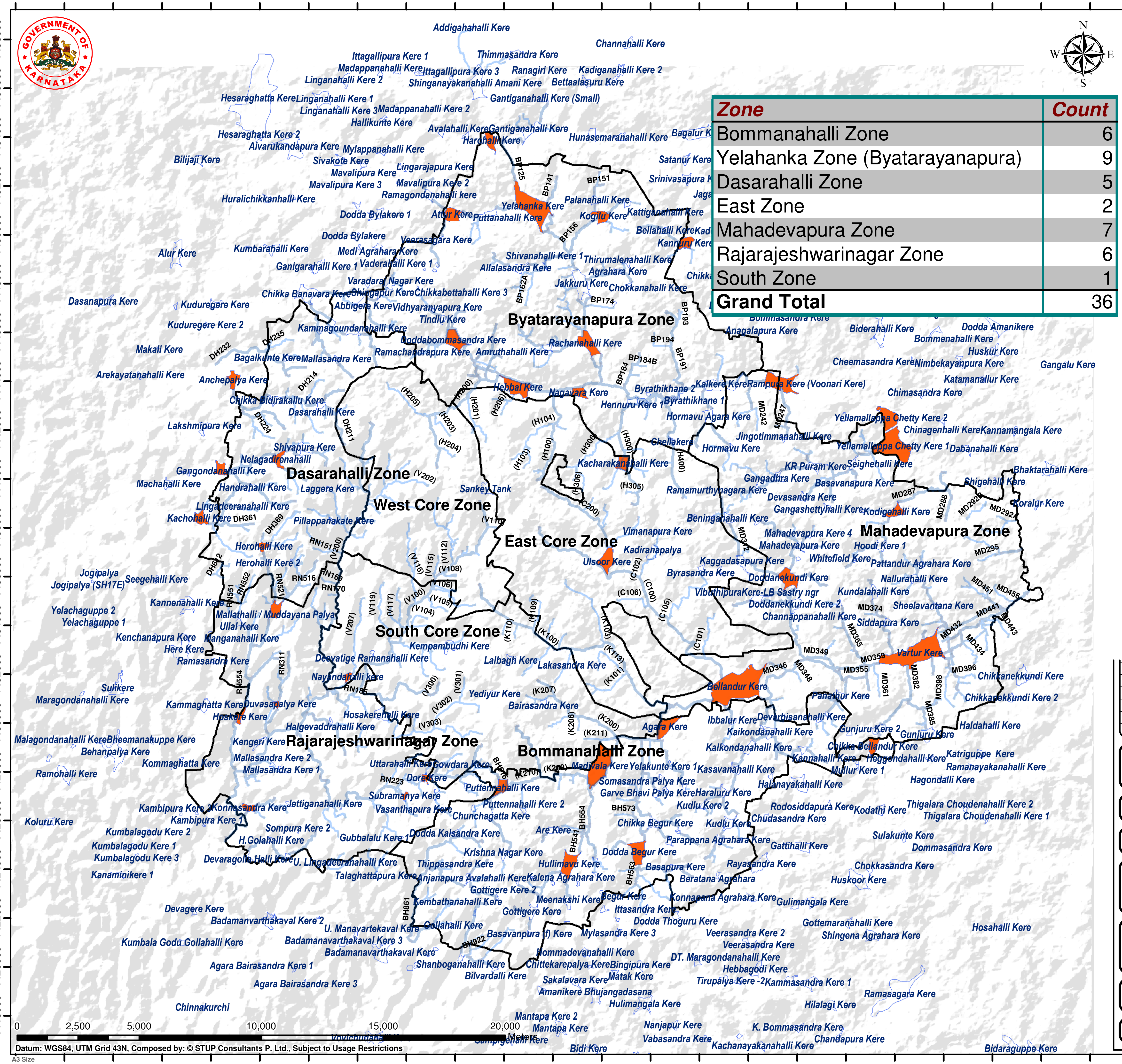


Fig. 5.9 Typical Sketch showing Water Bodies as Holding Ponds

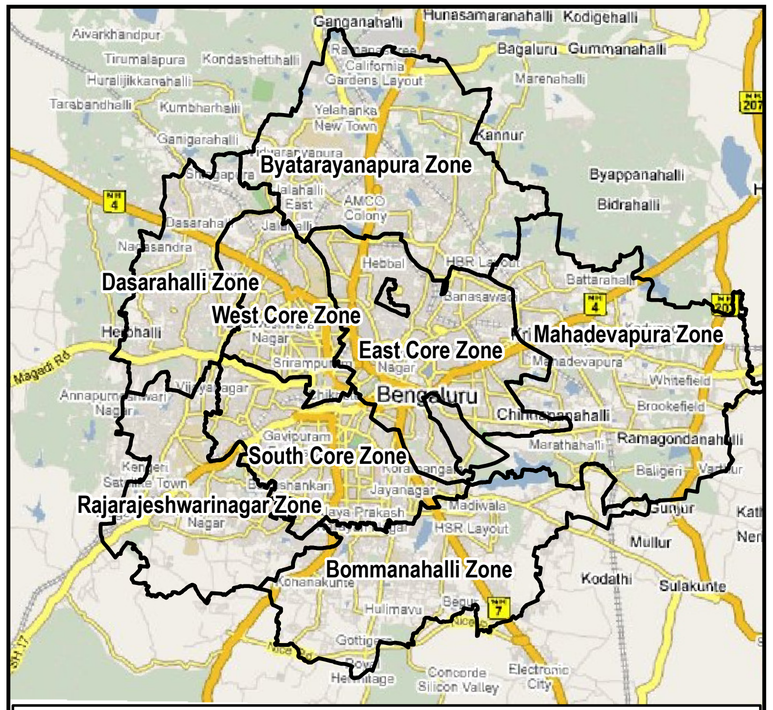
Table 5.27 Water Bodies Considered for Development as Holding Ponds in BBMP Area

Sl. No.	Name of the Water Body	Total Catchment Area (Ha.)	Extent of Lake water spread area (Ha.)	Total Inflow Discharge (Cum.) (5 yrs. R.P)	Outflow Discharge (Considered) (Cum.)
East Zone:					
1	Ulsoor Kere	1,505	40.22	131.64	105.31
2	Kacharakanahalli Kere	901.56	23.98	33.60	26.88
3.	Byrathikhane Kere	16,729.66	8.61	571.51	457.21
4.	Hebbal Kere	2,134.06	54.18	248.31	198.65
West Zone:					
-	-	-	-	-	-
South Zone:					
1	Kempambudhi Kere	364.92	16.04	32.48	25.98
Bommanahalli Zone:					
1	Chikka Begur Kere	296.62	12.00	23.88	19.10
2	Chikka Bellandur Kere	1,224.70	22.00	25.01	20.01
3	Dodda Begur Kere	842.47	45.00	28.55	22.84
4	Hulimavu Kere	991.36	44.00	41.43	33.14
5	Kaikondanahalli Kere-1	443.86	14.00	46.08	36.86
6	Kaikondanahalli Kere-2	443.86	0.77	46.08	36.86
7	Kudlu Kere	399.32	14.00	13.99	11.19
8	Agra Kere	2,764.82	39.40	306.00	244.80
9	Madiwala Kere	1,245.89	95.27	104.10	83.28
Yelahanka Zone:					
1	Attur Kere	1,026.30	28.76	74.36	59.49
2	Puttenahalli Kere	1,760.90	12.72	91.93	73.54
3	Yelahanka Kere	5,039.70	115.35	137.66	110.13
4	Kogilu Kere	334.62	22.61	35.74	28.60
5	Jakkur Kere	5,600.58	45.64	173.11	138.49
6	Rachenahalli Kere	8,147.30	44.51	208.35	166.68
7	Dodda Bommasandra Kere	1,034.99	43.11	70.88	56.71
8	Hebbal Kere	5,281.41	54.18	248.31	198.65
9	Nagavara Kere	4,676.56	19.56	275.52	220.42

Sl. No.	Name of the Water Body	Total Catchment Area (Ha.)	Extent of Lake water spread area (Ha.)	Total Inflow Discharge (Cum.) (5 yrs. R.P)	Outflow Discharge (Considered) (Cum.)
Dasarahalli Zone:					
1	Chikka Bidirakallu Kere	791.55	13.00	48.11	38.49
2	Dasarahalli Kere	417.54	7.00	28.94	23.15
3	Nelagadirenahalli Kere	72.90	19.00	4.35	3.48
4	Shivapura Kere	114.07	7.00	6.89	5.51
5	Kammagoundanahalli Kere	369.84	12.00	23.30	18.64
6	Herohalli Kere	257.44	12.00	12.73	10.18
Mahadevapura Zone:					
1	Mahadevapura Kere	96.81	7.00	20.63	16.50
2	Vartur Kere	15,452.74	165	756.00	604.80
3	Gunjuru Kere	614.34	21	15.95	12.76
4	Gunjuru Kere 2	1,509.63	14.00	45.18	36.14
5	Doddanekundi Kere	2,432.88	43.00	51.91	64.89
6	Hoodi Kere 1	454.95	11.00	37.32	46.65
7	Kodigehalli Kere	931.45	23.00	70.53	56.42
8	Kundalahalli Kere	123.47	10.00	8.42	6.73
9	Siddapura Kere	273.50	7.00	20.28	16.19
10	Gangadhra Kere	62.66	10.00	4.63	3.70
11	K R Puram Kere	104.25	16.00	20.79	16.63
12	Seighehalli Kere	1,334.48	9.00	68.38	54.70
13	Nallurahalli Kere	266.86	11.00	26.10	20.88
14	Doddanekundi Kere 2	2,088.15	19.00	122.69	98.15
15	Vibuthipura Kere LB Sastry Ngr	263.39	14.00	10.73	8.58
Rajarajeshwarinagara Zone:					
1	Dore Kere	621.74	30.00	42.14	33.71
2	Subramanyapura Kere	128.29	25	11.56	9.25
3	Hosakere Kere	1,694.23	10.83	116.14	92.91
4	Dubasipalya Kere	202.22	23.00	7.93	6.34
5	Konnasandra Kere	279.64	43.11	16.30	13.04
6	Muddayyanapalyya Kere	512.56	23.00	48.27	38.62



Zone	Count
Bommanahalli Zone	6
Yelahanka Zone (Byatarayanapura)	9
Dasarahalli Zone	5
East Zone	2
Mahadevapura Zone	7
Rajarajeshwarinagar Zone	6
South Zone	1
Grand Total	**36**



Key Map

Legend

Storm Water Drains Type

- Primary SWD
- Secondary SWD
- Other Water Bodies
- Holding Ponds

BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: Bruhat Bengaluru Mahanagara Palike

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

APPROVED: YDM (CC)

PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

TITLE: Map Showing Water Bodies (Holding Ponds) of 8 BBMP Zones

No. SWD-MP-HP-01 | REV R0 | JOB No. 10331/E | SCALE AS SPECIFIED

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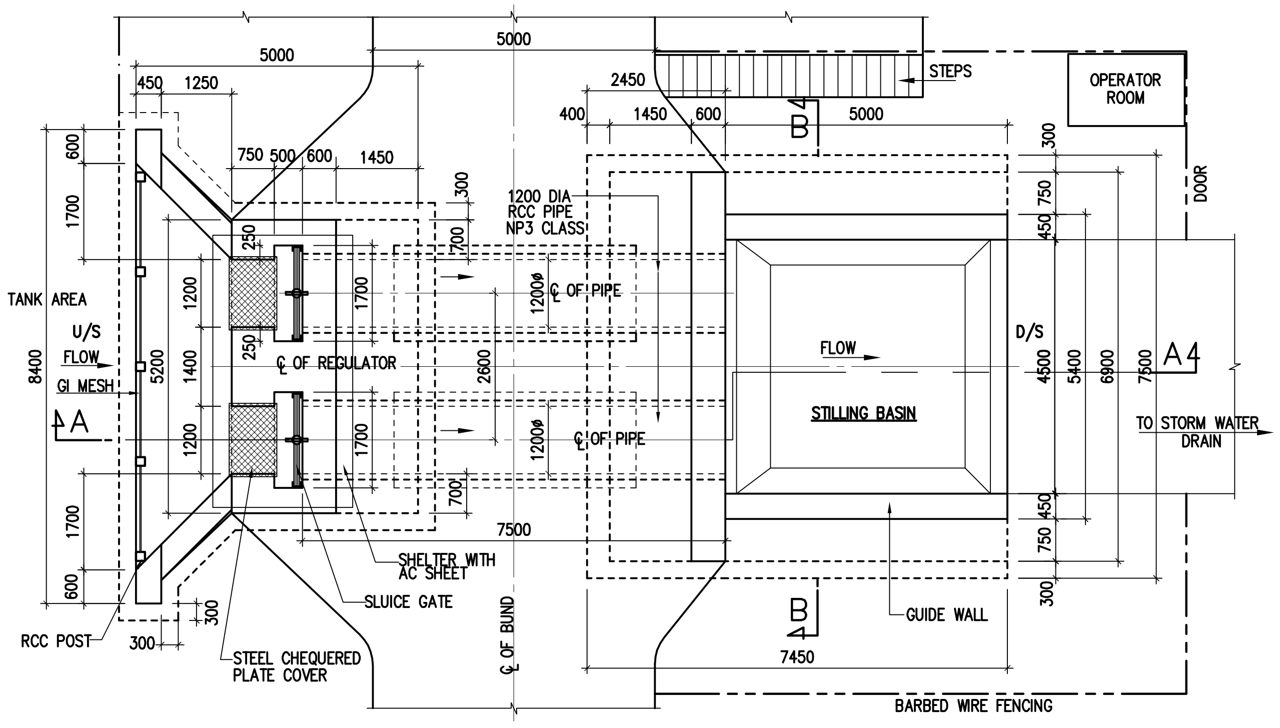

PLAN AT BUND LEVEL
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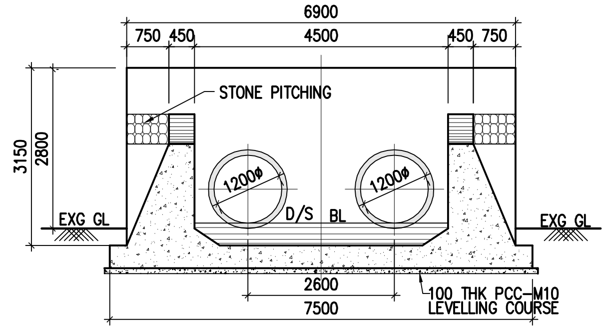

SECTION B–B
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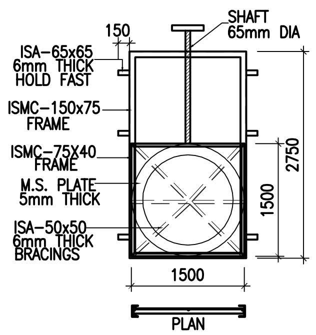
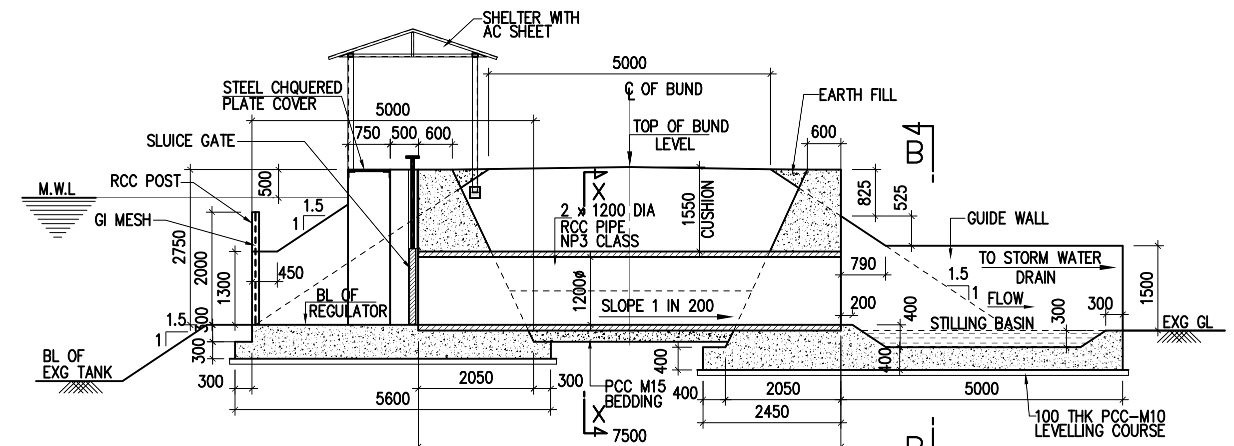


ELEVATION OF SLUICE GATE
SCALE 1:75



SECTION A–A
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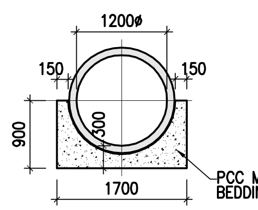

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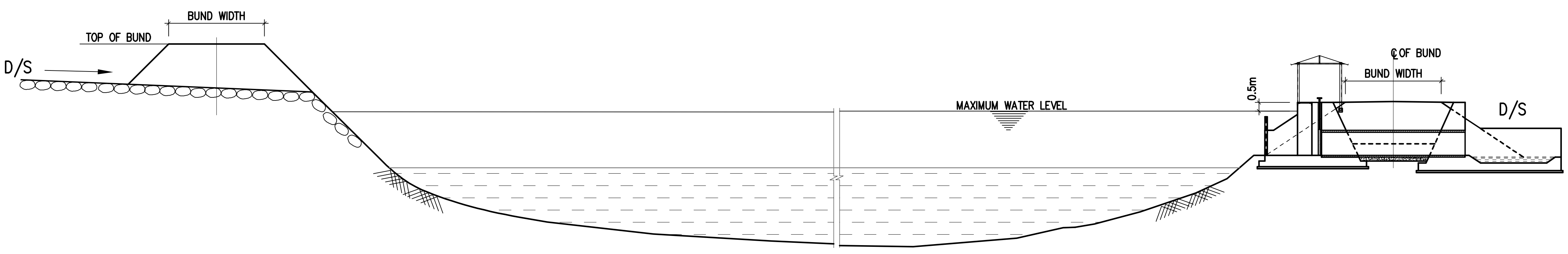

CROSS SECTION OF TANK
SCALE 1:200

NOTES:

1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN M
2. DO NOT SCALE THE DRAWING FOLLOW WRITTEN DIMENSIONS ONLY.

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OFFICE OF ORIGIN : A-1 TOWER, 5th & 6th FLOOR, "GOLDEN ENCLAVE" HAL AIRPORT ROAD BENGALURU-560 017. Tel: 080-40397979

OWNER: BRUHATH BENGALURU MAHANAGARA PALIKE

DATE: MARCH 2010

CONTRACTOR: .

DRAWN: NRM

PROJECT: PREPARATION OF MASTER PLAN FOR REMODELING OF STORM WATER DRAINS IN EIGHT ZONES OF BRUHATH BENGALURU MAHANAGARA PALIKE

PREPARED: PC

CHECKED: RSP

TITLE: GENERAL ARRANGEMENT DRAWING AND DIMENSION DETAILS FOR CONSTRUCTION FLOOD CONTROL GATE ARRANGEMENT

APPROVED: YDM

DRG.NO.: DD-TYP-09 SHT 9 OF 10 | REV. RO | JOB.NO.:10331/E

SCALE: AS NOTED

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A2

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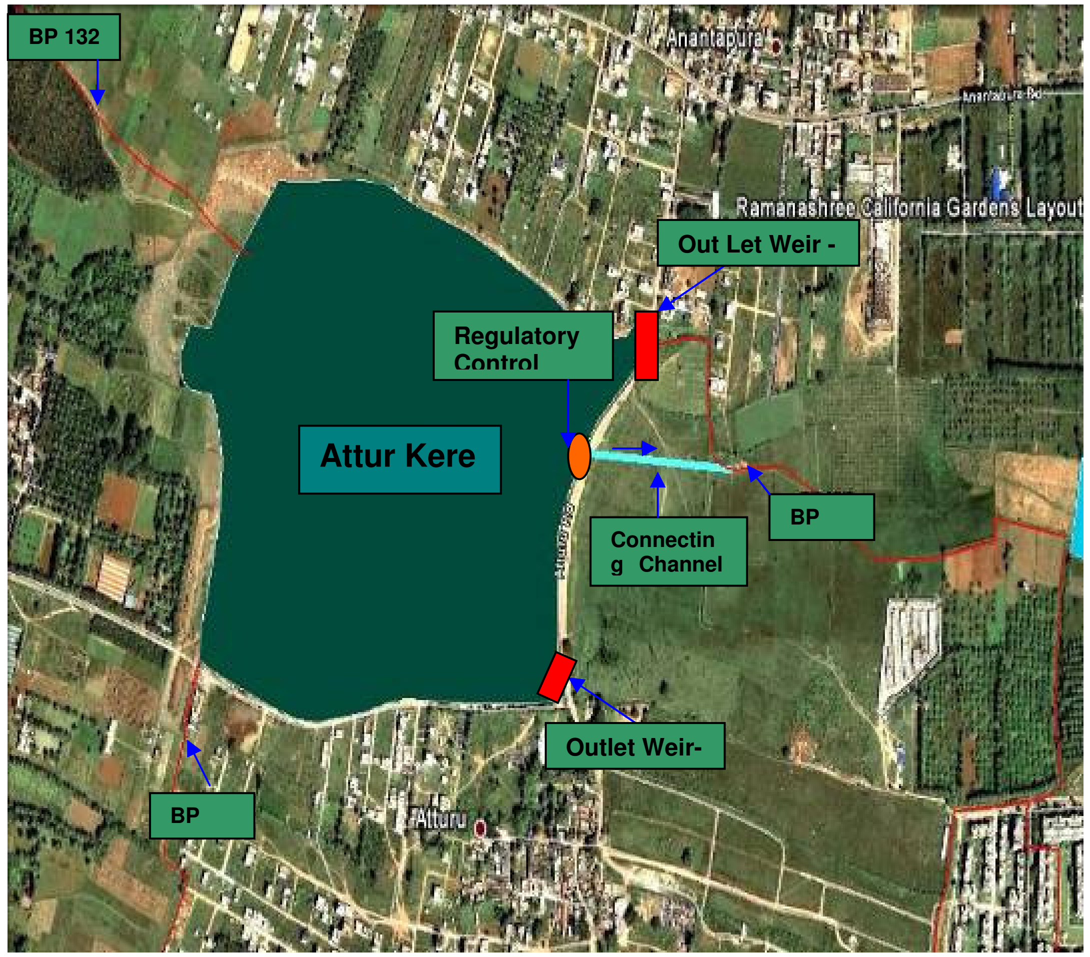
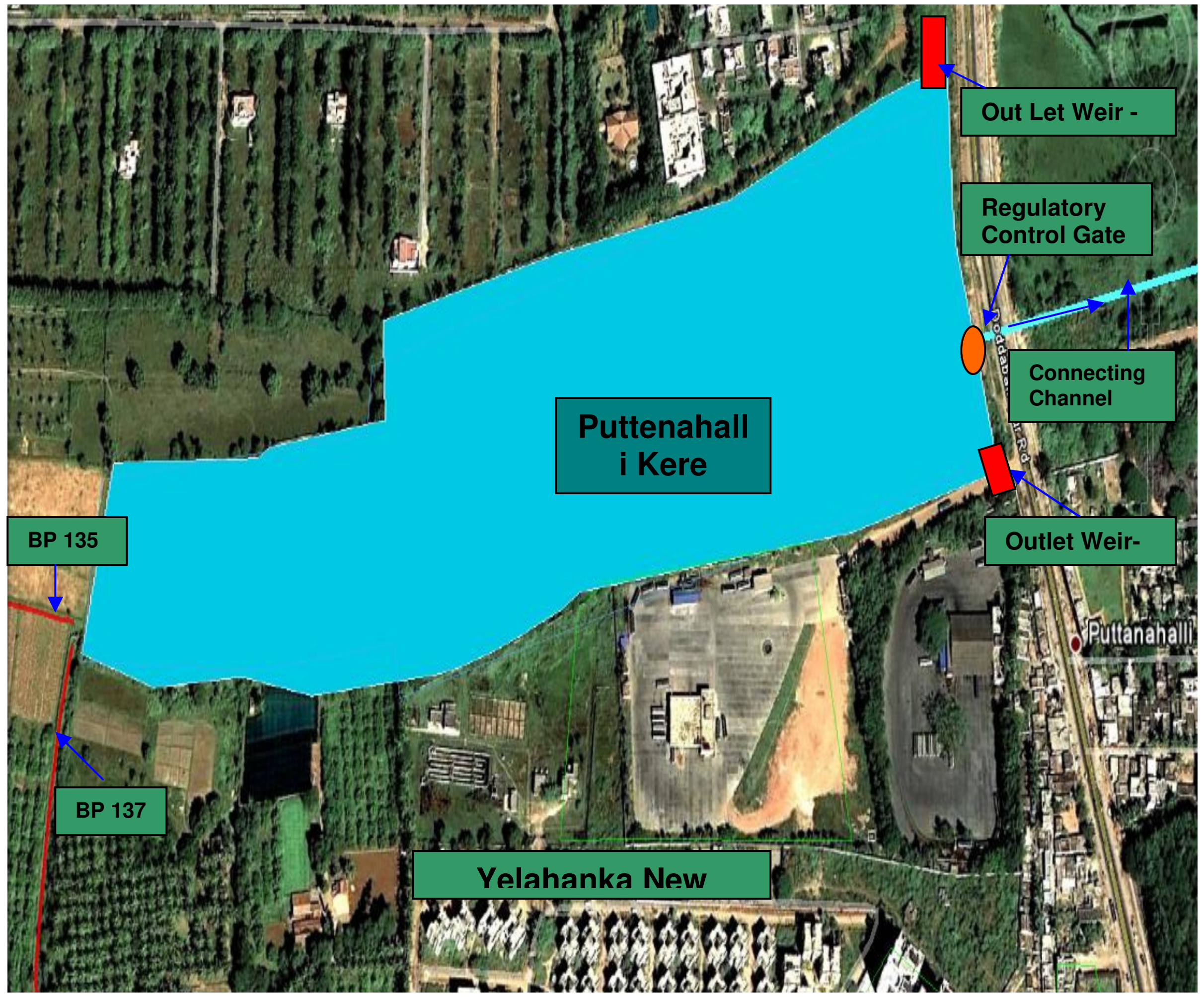
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Attur Kere**
Total Catchment Area (Ha.)	: 1026.3
Extent of Lake water spread area (Ha.)	: 28.76
Inflow from Drains	: BP132, BP134
Total Inflow Discharge (Cum.)	: 61.92 (2 Yr.), 74.36 (5 Yr)
Outflow Into Drains	: BP135
Outflow Discharge (Considered) (Cum.)	: 49.54 (2 Yr), 59.49 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP135, near Ch. 253 m.



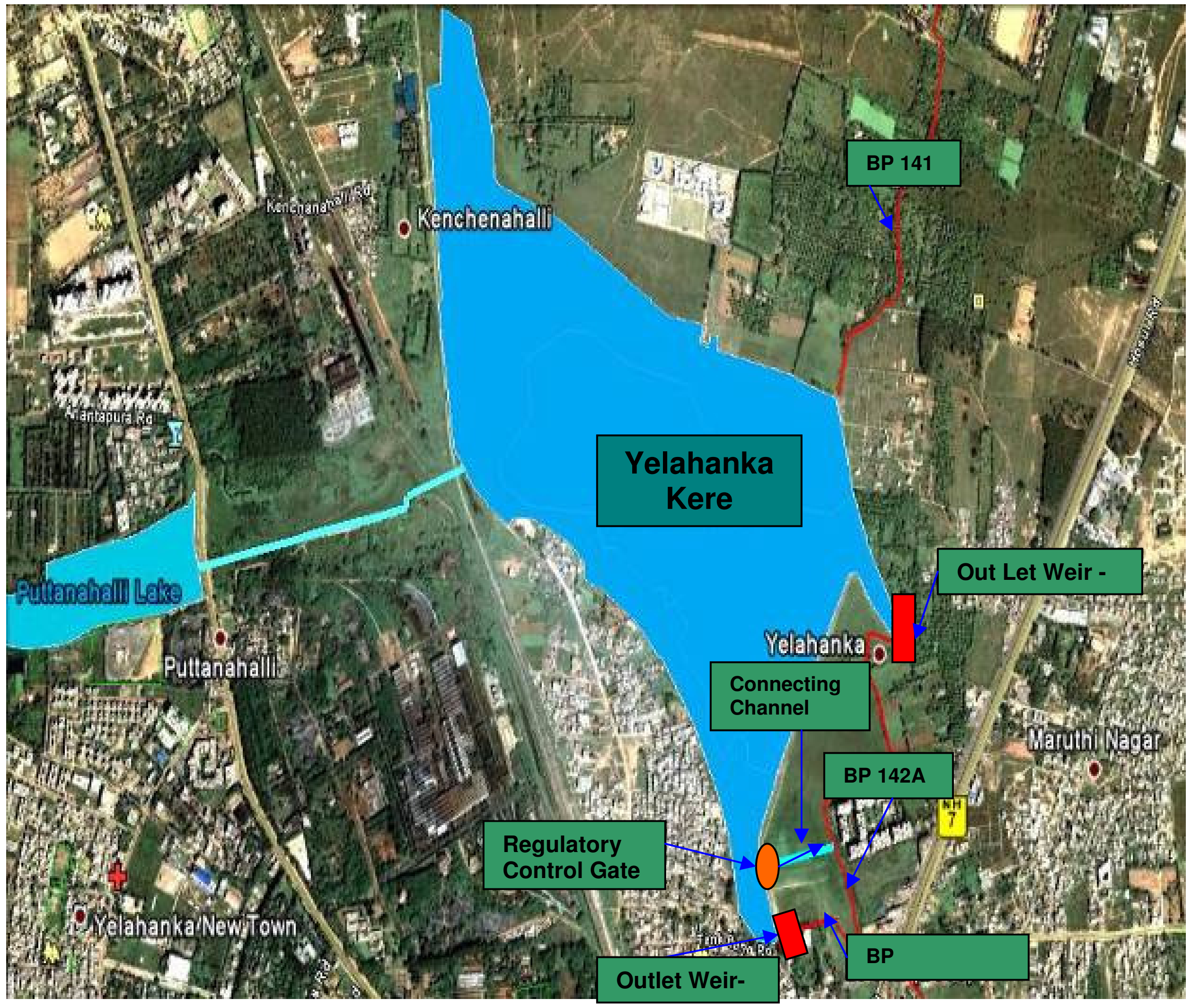
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Puttenahalli Kere**
Total Catchment Area (Ha.)	: 1760.9
Extent of Lake water spread area (Ha.)	: 12.72
Inflow from Drains	: BP135, BP137
Total Inflow Discharge (Cum.)	: 75.66 (2 Yr), 91.93 (5 Yr)
Outflow Into Drains	: BP136
Outflow Discharge (Considered) (Cum.)	: 60.53 (2 Yr), 73.54 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 1000 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: Yelahanka Kere



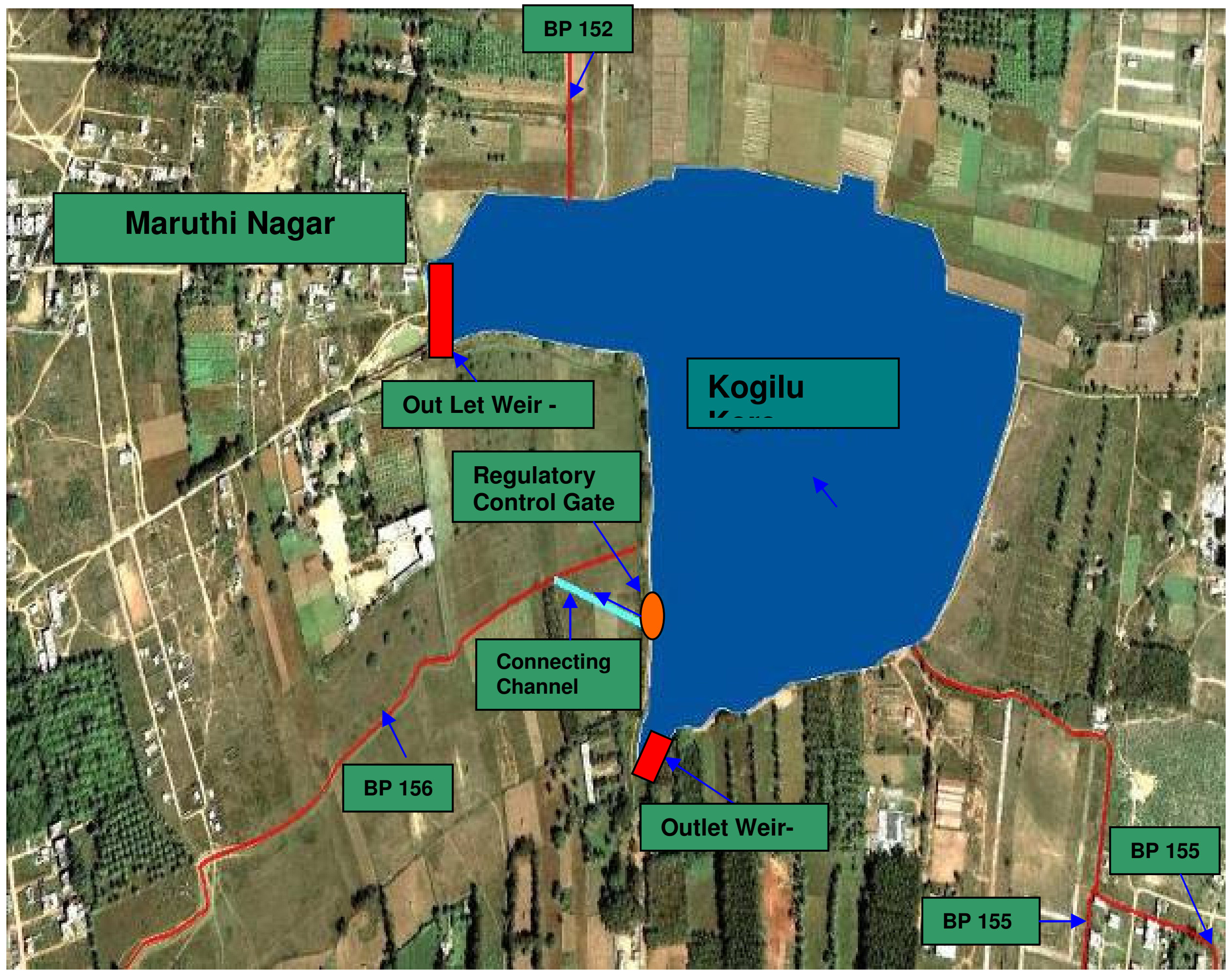
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Yelahanka Kere**
Total Catchment Area (Ha.)	: 5039.70
Extent of Lake water spread area (Ha.)	: 115.35
Inflow from Drains	: BP125, BP136, BP141
Total Inflow Discharge (Cum.)	: 123.56 (2 Yr), 137.66 (5 Yr)
Outflow Into Drains	: BP142A, BP142 (BY09)
Outflow Discharge (Considered) (Cum.)	: 98.85 (2 Yr), 110.13 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP142A, near Ch. 729 m.



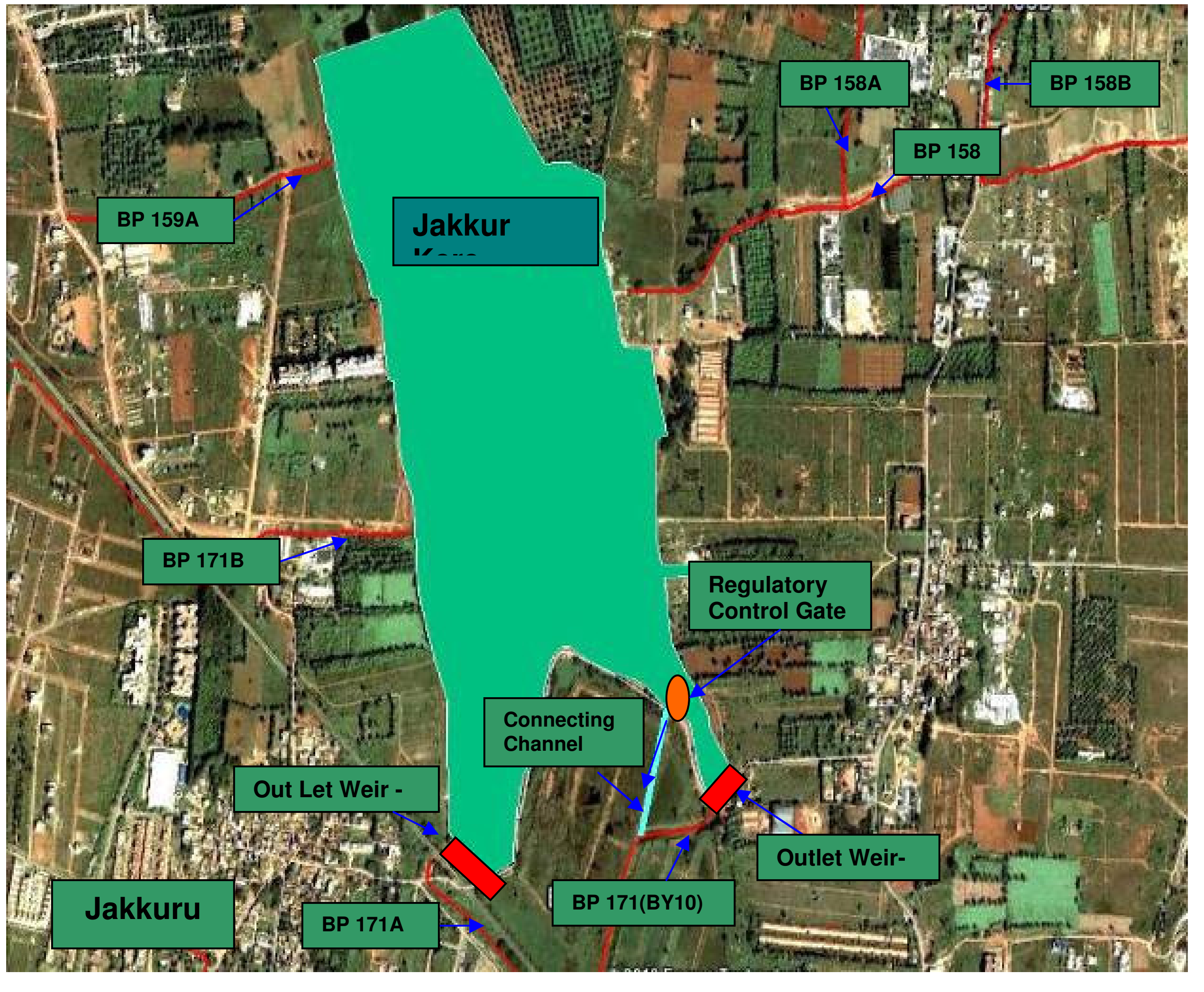
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Kogilu Kere**
Total Catchment Area (Ha.)	: 334.62
Extent of Lake water spread area (Ha.)	: 22.61
Inflow From Drains	: BP152, BP154, BP155
Total Inflow Discharge (Cum.)	: 29.62 (2 Yr), 35.74 (5 Yr)
Outflow Into Drains	: BP156
Outflow Discharge (Considered) (Cum.)	: 23.70 (2 Yr), 28.60 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP156, near Ch. 108 m.



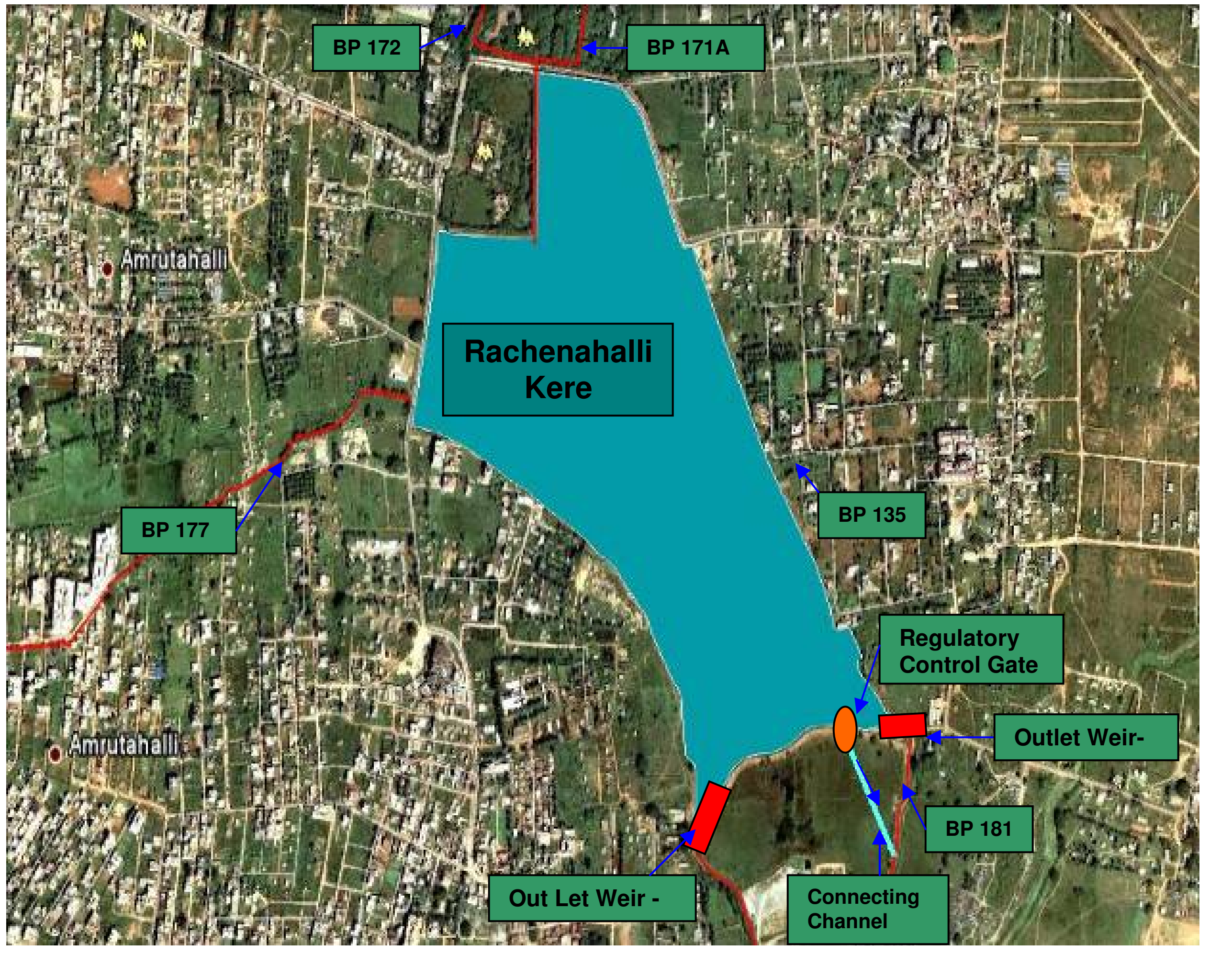
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Jakkur Kere**
Total Catchment Area (Ha.)	: 5600.58
Extent of Lake water spread area (Ha.)	: 45.64
Inflow From Drains	: BP142 (BY09), BP158, BP159A, BP171B
Total Inflow Discharge (Cum.)	: 155.31 (2 Yr), 173.11 (5 Yr)
Outflow Into Drains	: BP171 (BY10), BY171A
Outflow Discharge (Considered) (Cum.)	: 124.25 (2 Yr), 138.49 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP171 (BY10), near Ch. 164 m.



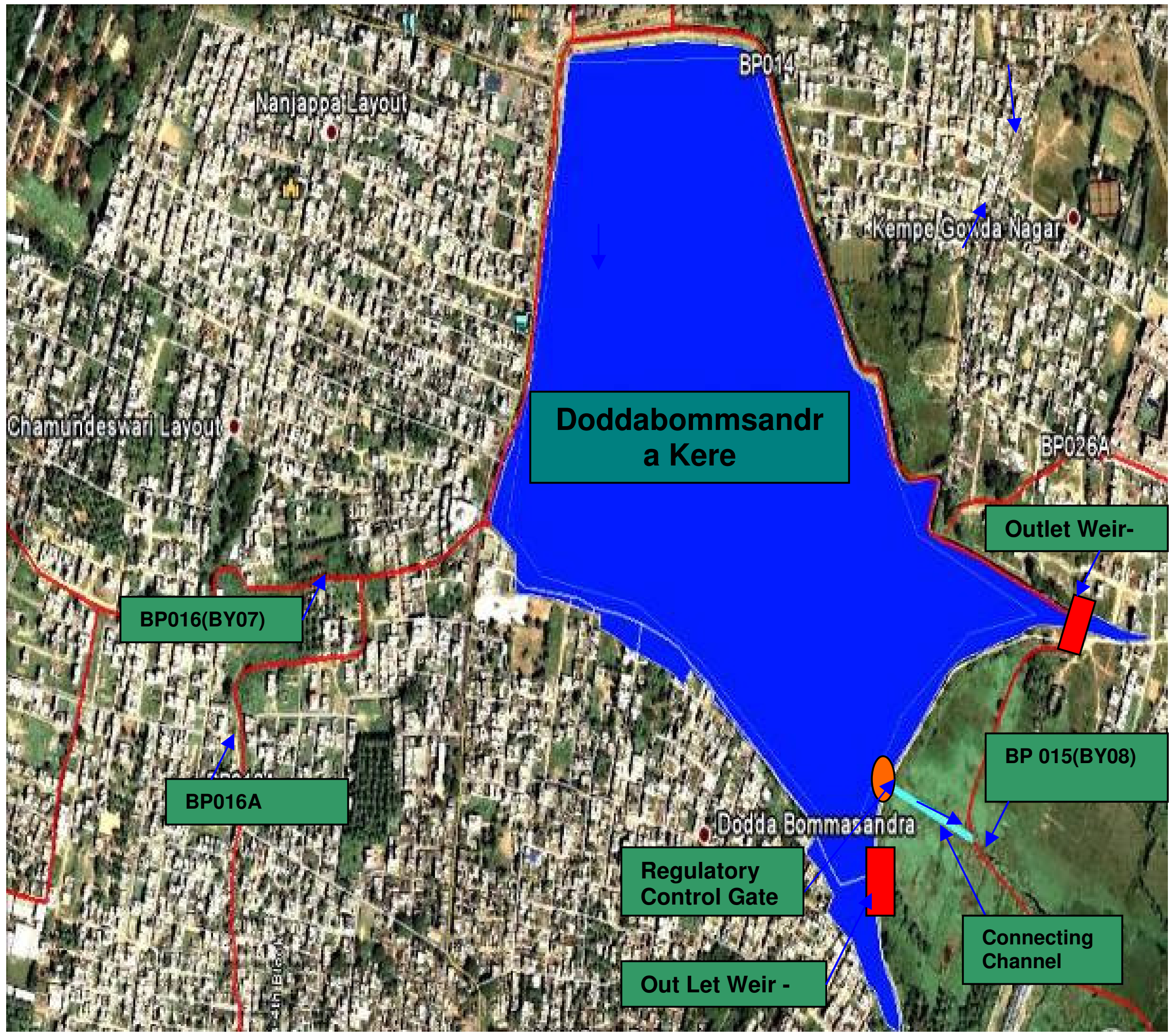
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Rachenahalli Kere**
Total Catchment Area (Ha.)	: 8147.30
Extent of Lake water spread area (Ha.)	: 44.51
Inflow From Drains	: BP171A, BP177
Total Inflow Discharge (Cum.)	: 180.33 (2 Yr), 208.35 (5 Yr)
Outflow Into Drains	: BP181, BP181A (BY11)
Outflow Discharge (Considered) (Cum.)	: 144.26 (2 Yr), 166.68 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP181, near Ch. 191 m.



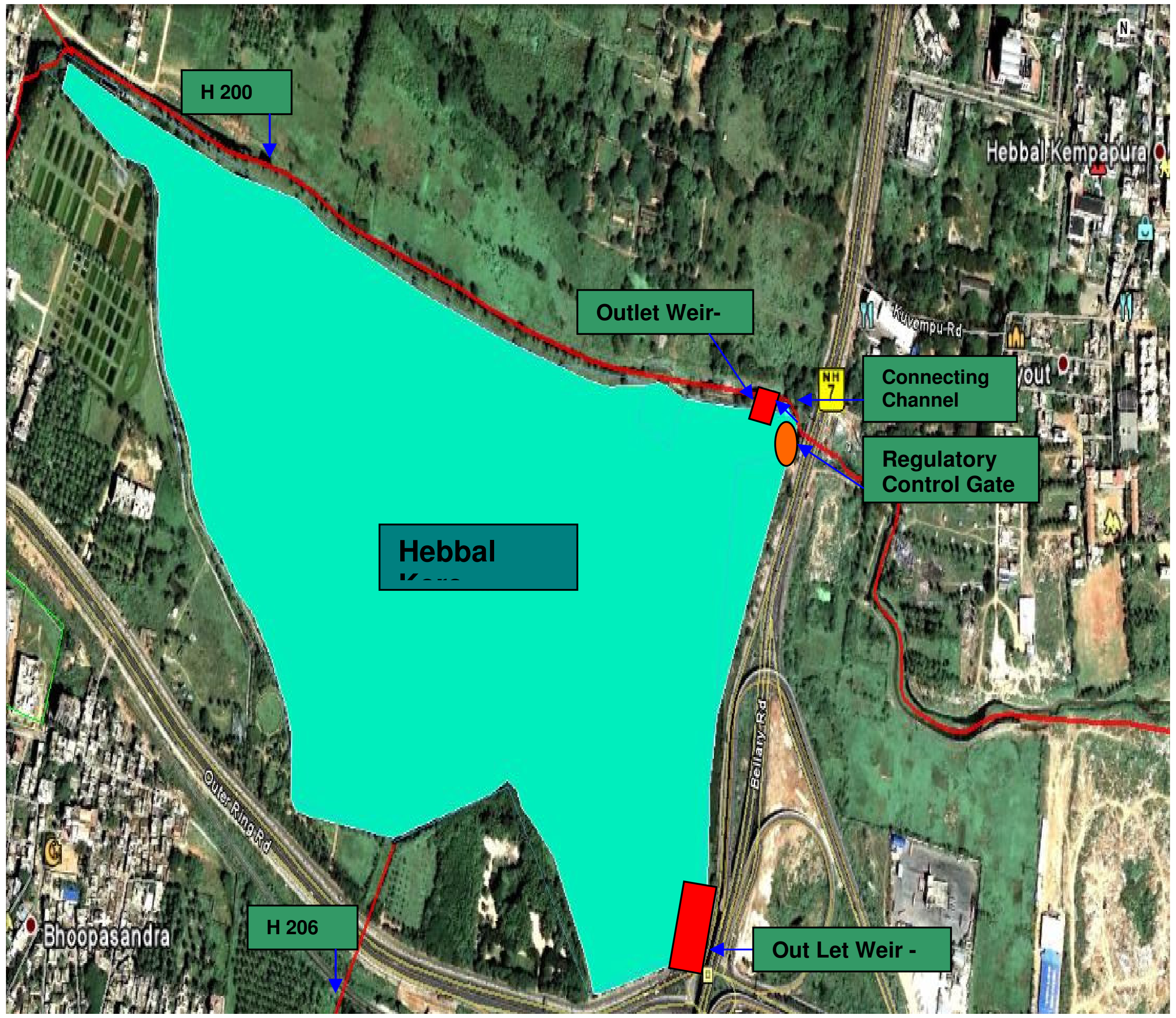
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Doddabommasandra Kere**
Total Catchment Area (Ha.)	: 1034.99
Extent of Lake water spread area (Ha.)	: 43.11
Inflow From Drains	: BP014
Total Inflow Discharge (Cum.)	: 58.75 (2 Yr), 70.88 (5 Yr)
Outflow Into Drains	: BP015 (BY018)
Outflow Discharge (Considered) (Cum.)	: 47.00 (2 Yr), 56.71 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 250 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP15 (BY08), near Ch. 308 m.



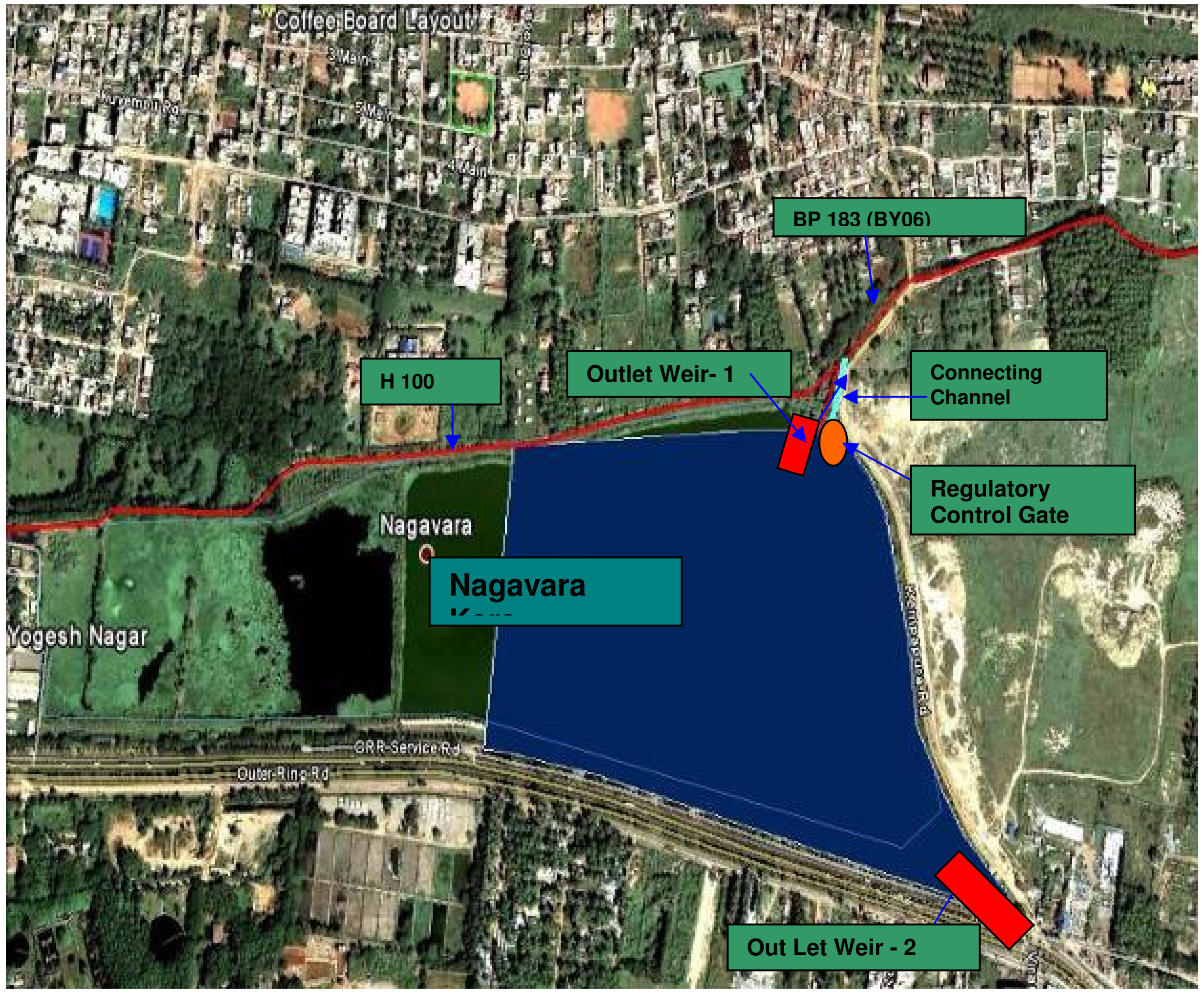
Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Hebbal Kere**
Total Catchment Area (Ha.)	: 5281.41
Extent of Lake water spread area (Ha.)	: 54.18
Inflow From Drains	: H200
Total Inflow Discharge (Cum.)	: 195.02 (2 Yr), 248.31 (5 Yr)
Outflow Into Drains	: H200
Outflow Discharge (Considered) (Cum.)	: 156.01 (2 Yr), 198.65 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 100 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: H 200, near Ch. 7840 m.



Development of Water Bodies as Holding Pond in Yelahanka Zone

Name of the Water Body	: **Nagavara Kere**
Total Catchment Area (Ha.)	: 4676.56
Extent of Lake water spread area (Ha.)	: 19.56
Inflow From Drains	: H100
Total Inflow Discharge (Cum.)	: 215.91 (2 Yr), 275.52 (5 Yr)
Outflow Into Drains	: BP183 (BY06)
Outflow Discharge (Considered) (Cum.)	: 172.73 (2 Yr), 220.42 (5 Yr)
Regulatory Control Gate	: Type- I (1 Nos.)
Length of Connecting Channel (m.)	: 100 m
Connecting Channel Size	: RCC Hume Pipe -1200 mm. Dia.
Connecting Channel Joins	: BP183 (BY06), near Ch. 83 m.



5.9 Extension of Storm Water Drains Remodelling Project beyond BBMP Boundary:

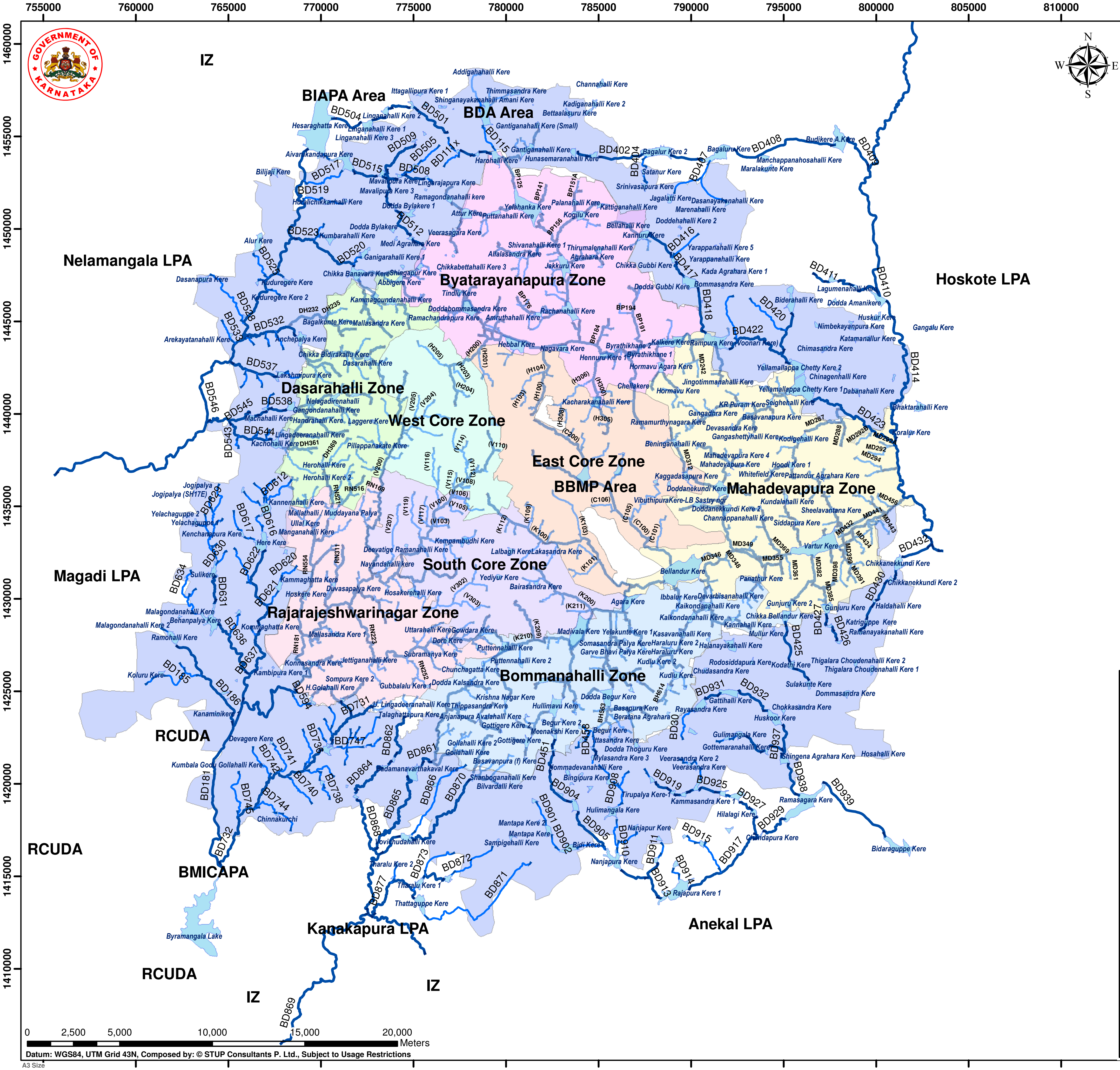
The storm water drains network pattern in Bengaluru radiates from core area towards peripheral area and further flows towards natural stream. Also since development of land has been taking place in rapidly in all direction and inorder to address the flooding problems within BBMP area in a comprehensive way. It is necessary to do river training works, demarcate the service corridor on either side and maintain the drain cross section of minimum 10 year return period for drains situated in BDA limits.

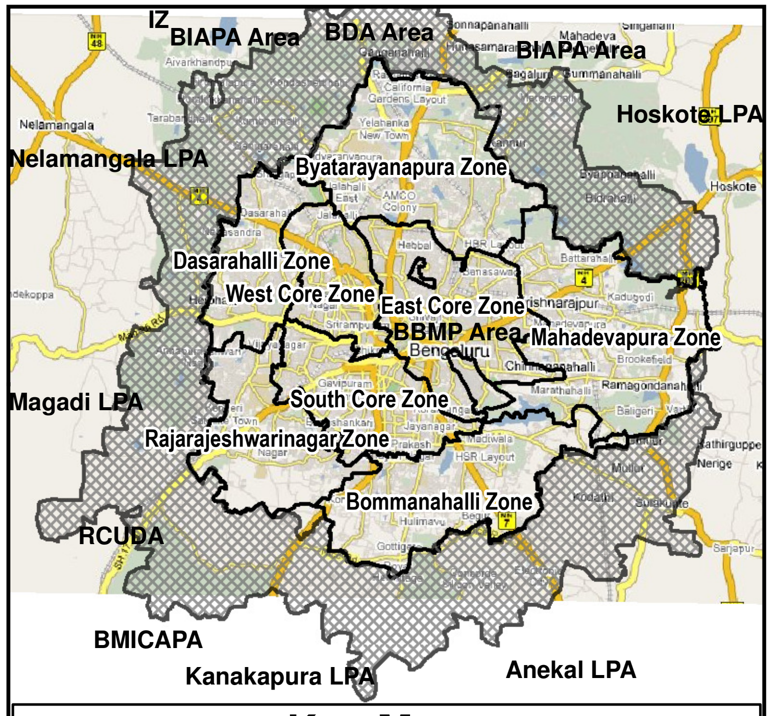
Map depicting major storm water drains in BDA limits which receives runoff water from BBMP area and which requires immediate attention of the authorities for widening and development is enclosed in this report as **Fig.. SWD MP EA - 01.**

List of Storm Water Drains in BDA Limits which require immediate attention of authorities is listed in **Table 5.28.**

Table 5.28 Details of SWDs in BDA Area requiring immediate improvement works.

Sl.No	Drain ID	Location	Length (Kms.)
1	BD112x	Avalahalli Kere	0.93
2	BD114	Amani Kere	0.83
3	BD115	Shinganayakanahalli	1.71
4	BD116	Krishnasagara Kere	0.96
5	BD117	Harohalli Kere	0.74
6	BD181	Vrishabhavathi River, near Devaragollahalli	16.72
7	BD415	Outlet Weir of Kannur Kere	2.03
8	BD417	Outlet Weir of Chikka Gubbi Kere	1.19
9	BD418	Outlet Weir of Dodda Gubbi Kere	2.80
10	BD422	Outlet Weir of Rampura Kere	4.90
11	BD423	Outlet Weir of Yellamalla Chetty Kere	14.64
12	BD424	Near Sulikunte	1.22
13	BD425	Inlet Weir of Chikka Bellandur Kere	2.45
14	BD426	Outlet Weir of Hagondalli Kere	0.94
15	BD427	NA	0.68
16	BD428	Inlet Weir of Katriguppe Kere	0.57
17	BD429	Outlet Weir of Katriguppe Kere	1.08
18	BD430	Outlet Weir of Haldahalli Kere	1.37
19	BD431	Near Chikkanakkundi	0.55
20	BD432	Near Chikkanakkundi	1.82
21	BD433	Outlet Weir of Rampura Kere	0.86
22	BD451	Outlet Weir of Rampura Kere	1.14
23	BD452	Inlet Weir of Meenakshi Kere	0.64
24	BD453	Inlet Weir of Myllasandra Kere	0.51
25	BD454	Outlet Weir of Myllasandra Kere	0.77
26	BD455	NA	0.62
27	BD456	NA	0.20
28	BD457	NA	0.45
29	BD458	NA	0.88
30	BD511	Near Vaderahalli	0.77
31	BD512	Near Muddayanapalya	2.08
32	BD513	Near Bylakere	0.93
33	BD514	Near Mvalipura	1.02
34	BD515	Outlet Weir of Sivakote Kere	1.53
35	BD516	Near Fishers Institute	0.52
36	BD517	Kere near Aivarukandapura	2.84
37	BD523	Outlet Weir of Chikka Banavara Kere	4.44
38	BD532	Outlet Weir of Anchepalya Kere	4.07
39	BD534	Inlet Weir of Lakshmipura Kere	1.21
40	BD537	Outlet Weir of Lakshmipura Kere	3.05
41	BD538	Outlet Weir of Gangondanahalli Kere	1.12
42	BD540	Outlet Weir of Lakshmipura Kere	0.79
43	BD544	Outlet Weir of Kachohalli Kere	3.21
44	BD545	Outlet Weir of Machahalli Kere	3.40
45	BD546	Near Kaderanahalli	31.78
46	BD594	Outlet Weir of Devaragollahalli Kere	1.58
47	BD612	Kere near Kannehalli	2.24
48	BD616	Kere near Kannehalli	1.19
49	BD620	Outlet Weir of Kamaghatta Kere	1.48
50	BD622	Outlet Weir of Here Kere	5.27
51	BD637	NA	5.58
52	BD731	Near Pavamanapura	3.85
53	BD732	Kere near Agara	10.89
54	BD861	NA	1.08
55	BD862	Outlet Weir of Thalaghattapura Kere	3.02
56	BD863	NA	0.34
57	BD864	Kere near Kanakapura road,Talguni	2.92
58	BD865	Kere near Khodays factory	6.69
59	BD867	NA	1.79
60	BD868	NA	8.66
61	BD869	NA	12.91
62	BD870	Outlet Weir of Shanboganahalli Kere	6.12
		Grand Total	**202.57**





Key Map

Legend

Storm Water Drains

Type

- Primary SWD
- Secondary SWD
- Water Bodies

BBMP Administrative Zones

Core Zones

- East Core Zone (EC)
- South Core Zone (SC)
- West Core Zone (WC)

Peripheral Zones

- Bommanahalli Zone (BH)
- Byatarayanapura Zone (BP)
- Dasarahalli Zone (DH)
- Mahadevapura Zone (MD)
- Rajarajeshwarinagar Zone (RN)
- BDA Area

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.

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OWNER: Bruhat Bengaluru Mahanagara Palike

DATE: August 2010

CONTRACTOR

DRAWN: MNS (SDE)

PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

PREPARED: MNS (SDE)

CHECKED: RSP (APC)

TITLE: **Map Showing Storm Water Drains Beyond BBMP Boundary**

APPROVED: YDM (CC)

No. SWD-MP-EA-01 | REV R0 | JOB No.10331/E | SCALE AS SPECIFIED

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5.10 Remodelling of Railway Culverts Constructed across Storm Water Drains:

During reconnaissance survey of storm water drains it is observed that at 60 locations the railway line crosses the storm water drains in the city. Provisions have been made by the railway authorities in the embankment for passage of water by means of RCC hume pipe or RCC slab culverts.

Due to rapid urbanization and development of achakutu areas into paved areas on the upstream side, the runoff in the storm water drains has increased into considerable number of folds. Therefore the vent size provided for free flow of water at these crossing locations has become inadequate and also these culverts provide less scope for drain widening and bed profile regradation. Which intern causes, water stagnation and surcharging into adjoining residential area, in addition causing accumulation of garbage, sediment deposition etc.

Considering futuristic hydraulic flow requirements it is proposed to create additional vent way or replace the inadequate vent size hume pipe culverts entirely by RCC Box / RCC Slab Culverts of suitable vent size or equivalent to the size of the drains.

Depending upon site conditions it is proposed to adopt pipe jacking method or box pushing technology to create additional water way without disturbing the rail traffic.

The details of railway culverts are as furnished in **Table 5.29** and the same is depicted in **Fig.. SWD MP RC - 01.**

General Arrangement Drawing for railway culvert proposed for remodelling across major storm water drain near Raja Canal STP in Yelahanka Zone by box pushing technique is enclosed with this report as **Fig.. YZ-RC- 02.**

Railway Culverts Across SWD in BBMP Area

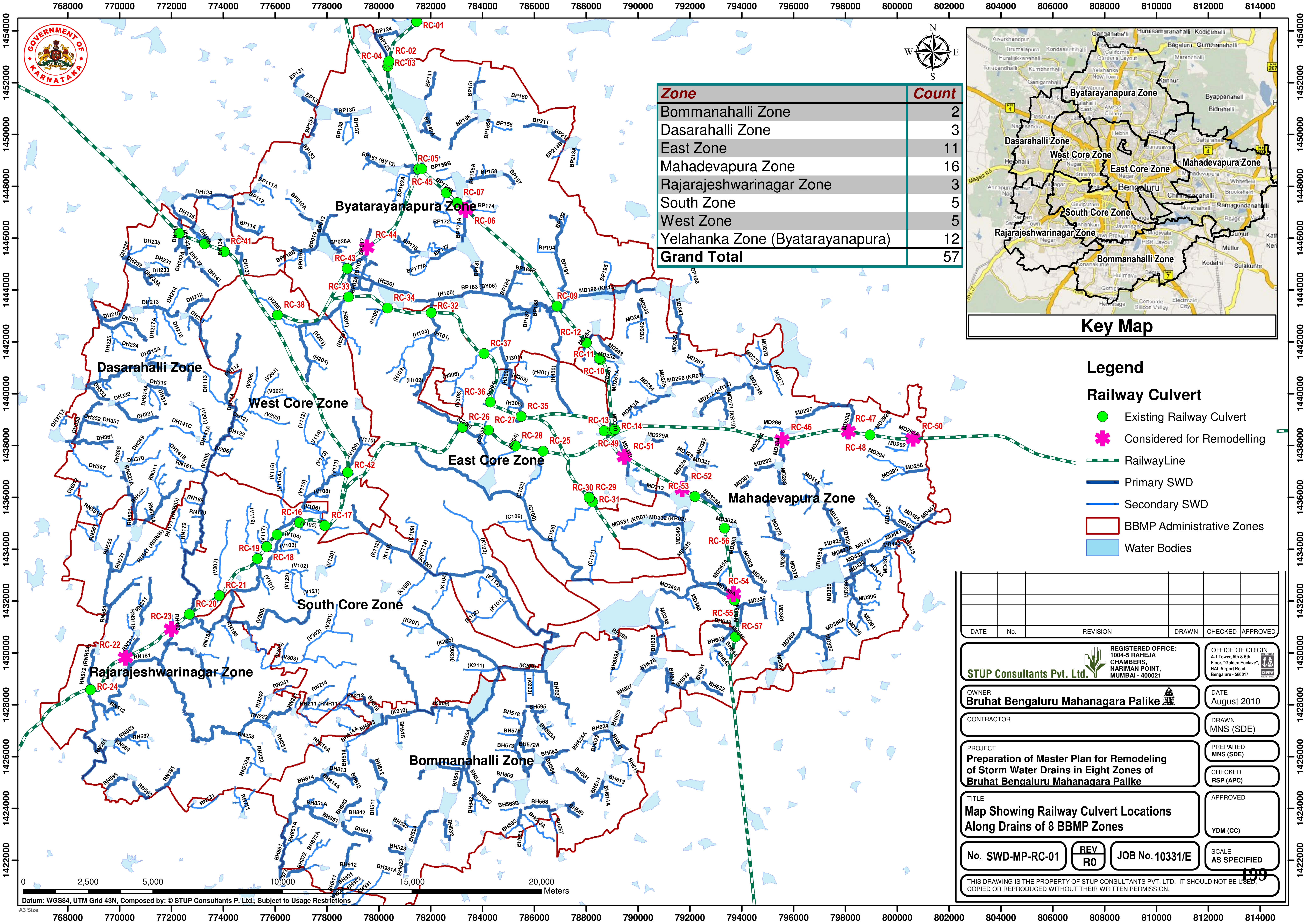
Sl. No.	Zone	Count
1	East	12
2	West	4
3	South	6
4	Bommanahalli	2
5	Dasarahalli	3
6	Yelahanka	10
7	Mahadevapura	17
8	Rajarajeshwarinagara	3
	Total	**57**

Railway Culvert having inadequate vent way constructed across Storm Water Drain in Yelahanka Zone is causing obstruction for free flow of water

Table 5.29 Details of Railway Culverts/Bridges Constructed Across Major SWD in BBMP Area

Sl No	Water Shed Cluster	Drain ID	Chainage in m.	Location	Existing Details	Retained / Prop for Remodeling	Proposed Details
	East Core Zone						
1	Ulsoor Kere	(C104)	59			Retained	
2	Bharathinagara	(C200)	2201	Fraser town Road		Retained	
3	Bharathinagara	(C202)	487	Cox Town / Frasertown road		Retained	
4	Bharathinagara	(C204)	630	Ulsoor	1No X 4.3W X 2.5H RCC Box type	Retained	
5	Ulsoor Kere	(C105)	376			Retained	
6	Ulsoor Kere	(C105)	392			Retained	
7	Nagwara Kere	(H100)	3897	V Nagenahalli M V Road R T Nagara		Retained	
8	Hebbal Kere	(H206)	974	Hebbal Railway station		Retained	
9	Kacharakanahalli Kere	(H300)	428			Retained	
10	Kacharakanahalli Kere	(H304)	325	Near Lingaraj puram		Retained	
11	Kacharakanahalli Kere	(H306)	2268	Near Kadagondanahalli		Retained	
12	Kaggadasapura Kere	(C105)	589			Retained	
	West Core Zone						
1	Sankey Kere	(V100)	2482	Sri Ramapuram	3No X 9 W X 3.5 H Steel Girder Bridge	Retained	
2	Sankey Kere	(V105)	1106	Bhuvaneshwari Nagara	1 X 2W X 2.0H RCC Box type	Retained	
3	Mattikere Kere	(H200)	4996	R M V II nd Stage		Retained	
4	Mattikere Kere	(H205)	1473	MES Railway bridge Jalahalli	2No X 3.6W X 2.4H RCC Box type	Retained	
	South Core Zone						
1	Kempambudhi Kere	(V100)	6575	Vijayanagara	1 X 8.4W X 3.0H RCC Box type	Retained	
2	Sankey Kere	(V106)	1010	Markandeshwara Nagara	Pipe culvert	Retained	
3	Kempambudhi Kere	(V118)	868	Vijayanagara IInd Stage		Retained	
4	Kempambudhi Kere	(V119)	2818	14th Cross Vijayanagara RPC Layout		Retained	
5	Nayandanahalli Kere	(V200)	14115			Retained	
6	Nayandanahalli Kere	(V207)	3300			Retained	
	Yelahanka Zone						
1	Yelahanka Kere	BP122A	800	Suggatta village	2 X 4.5 X 3.0 RCC Slab Bridge	Retained	
2	Yelahanka Kere	BP125	1295	Near Herohalli village KEB Layout	3 X 9.5 W X 3.5 H Steel Girder Bridge	Retained	
3	Allalsandra Kere	BP163 (BY12)	950	Near Bellary Road	3 X 6W X 3.0 H RCC Box Culvert	Retained	
4	Allalsandra Kere	BP163 (BY12)	1105	Near Surabhi Layout	2 X 6 W X 3.0 H RCC Box Culvert	Retained	
5	Rachenahalli Kere	BP171 (BY10)	496	Near Jakkur Kere	RCC Hume pipe Culvert Pipe Dia 1.2 Mtr	Consierd for Remodelling	2 X 7.5 X 3 X15.0 Mtr RCC Box pushing-Type
6	Jakkur Kere	BP171B	493	Near Arkavathi Layout	1 X 3 X 3 RCC sloab Culvert		
7	Rachenahalli Kere	BP171A	0	Near Jakkur Kere	RCC Hume pipe Culvert Pipe Dia 1.2 Mtr	Retained	
8	Dodda Bommasandra Kere	BP015 (BY08)	983			Retained	
9	Dodda Bommasandra Kere	BP017	61	Kodigahalli Rail way Station		Consierd for Remodelling	1 X 4.0W X 3.0 HX15.0 Mr Barrel RCC Box pushing
10	Allalsandra Kere	BP163 (BY12)	952		3.0X4.0	Retained	
	Bommanahalli Zone						
1	Panathur Kere	BH646	202	Bhoganahalli		Retained	

Sl No	Water Shed Cluster	Drain ID	Chainage in m.	Location	Existing Details	Retained / Prop for Remodeling	Proposed Details
	Dasarahalli Zone						
1	Kammagoundana halli Kere	DH136	125	Shetty Halli		Retained	
2	Kammagoundana halli Kere	DH143	834	Chikkasandra		Retained	
3	Kammagoundana halli Kere	DH134	6			Retained	
	Mahadevapura Zone						
1	Kalkere Kere	MD196 (KR13)	16			Retained	
2	Hormavu Agara Kere	MD252	276			Retained	
3	Hormavu Agara Kere	MD252A	37			Retained	
4	Hormavu Agara Kere	MD254	777	Balaji Layout	1 X 5.0W X 3.0H RCC Box type	Retained	
5	Kaggadasapura Kere	MD311	490	Kasturi Nagara	1 X 4.0W X 3.0H RCC Box type	Retained	
6	Kaggadasapura Kere	MD310A	561	Kaggadasapura		Retained	
7	Kodigehalli Kere	MD284	942	Sadaramangala	1No X 4W X 2.7H RCC slab type	Consierd for Remodelling	1 X 4.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
8	Kodigehalli Kere	MD288	308	Saptagiri Layout	1No X 4W X 3.5H RCC slab type	Consierd for Remodelling	1 X 3.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
9	Kodigehalli Kere	MD292B	71		1No X 4W X 3.0H RCC slab type	Retained	
10	Kaggadasapura Kere	MD311	143	Nagarapalya	2No X 2W X 3.0H RCC slab type	Retained	
11	Kodigehalli Kere	MD292	1491	Siddartha Layout	1No X 2W X 3.0H RCC slab type	Consierd for Remodelling	1 X 3.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
12	Kaggadasapura Kere	MD312	708	Pai Layout	1No X 4W X 3.0H RCC slab type	Consierd for Remodelling	1 X 8.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
13	B.Narayanapura Kere	MD324	1091	Doddenakundi	1No X 3W X 3.0H RCC slab type	Consierd for Remodelling	1 X 4.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
14	B.Narayanapura Kere	MD325	448	Doddenakundi	1No X 6W X 3.0H RCC slab type	Retained	
15	Kadabeesanahalli	MD349	4424	Doddenakundi	1No X3W X 3.0H RCC slab type	Consierd for Remodelling	2 X 7.5 X 3 X15.0 Mtr Barrel RCC Box pushing-
16	Panathur Kere	MD349A	1529			Retained	
17	Channappanahalli Kere	MD362A	349	Channappanahalli	1No X3W X 3.0H RCC slab type	Retained	
	Rajarajeshwari Nagara Zone						
1	Hosahalli Kere	RN312	968	Bangalore Mysore Road	1No X 2W X 2.0H RCC Box type	Consierd for Remodelling	1 X 5.0W X 3.0 H X 15.0 Mtr Barrel RCC Box pushing
2	Halge Vadarahalli Kere	RN183	696	Bhagyagowdara Layout	1No X 2W X 2.0H RCC Box type	Consierd for Remodelling	1 X 4.0W X 3.0 H X15.0 Mtr Barrel RCC Box pushing
3	Hosahalli Kere	RN572 (RNR04)	1758	Bangalore Mysore Road		Retained	



Zone	Count
Bommanahalli Zone	2
Dasarahalli Zone	3
East Zone	11
Mahadevapura Zone	16
Rajarajeshwarinagar Zone	3
South Zone	5
West Zone	5
Yelahanka Zone (Byatarayanapura)	12
Grand Total	**57**

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants Pvt. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
OFFICE OF ORIGIN: A-1 Tower, 5th & 6th Floor, "Golden Enclave", HAL Airport Road, Bengaluru - 560017

OWNER: Bruhat Bengaluru Mahanagara Palike
DATE: August 2010
CONTRACTOR
DRAWN: MNS (SDE)
PROJECT: Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike
PREPARED: MNS (SDE)
CHECKED: RSP (APC)
TITLE: Map Showing Railway Culvert Locations Along Drains of 8 BBMP Zones
APPROVED: YDM (CC)
No. SWD-MP-RC-01
REV R0
JOB No. 10331/E
SCALE AS SPECIFIED

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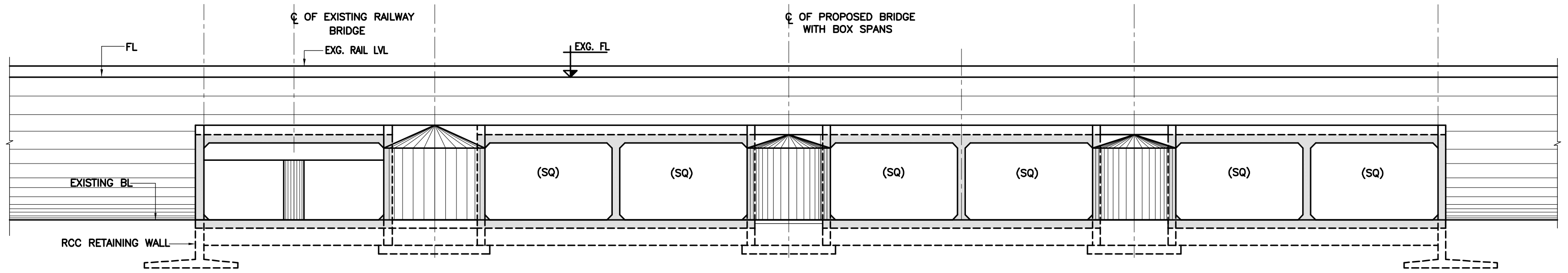
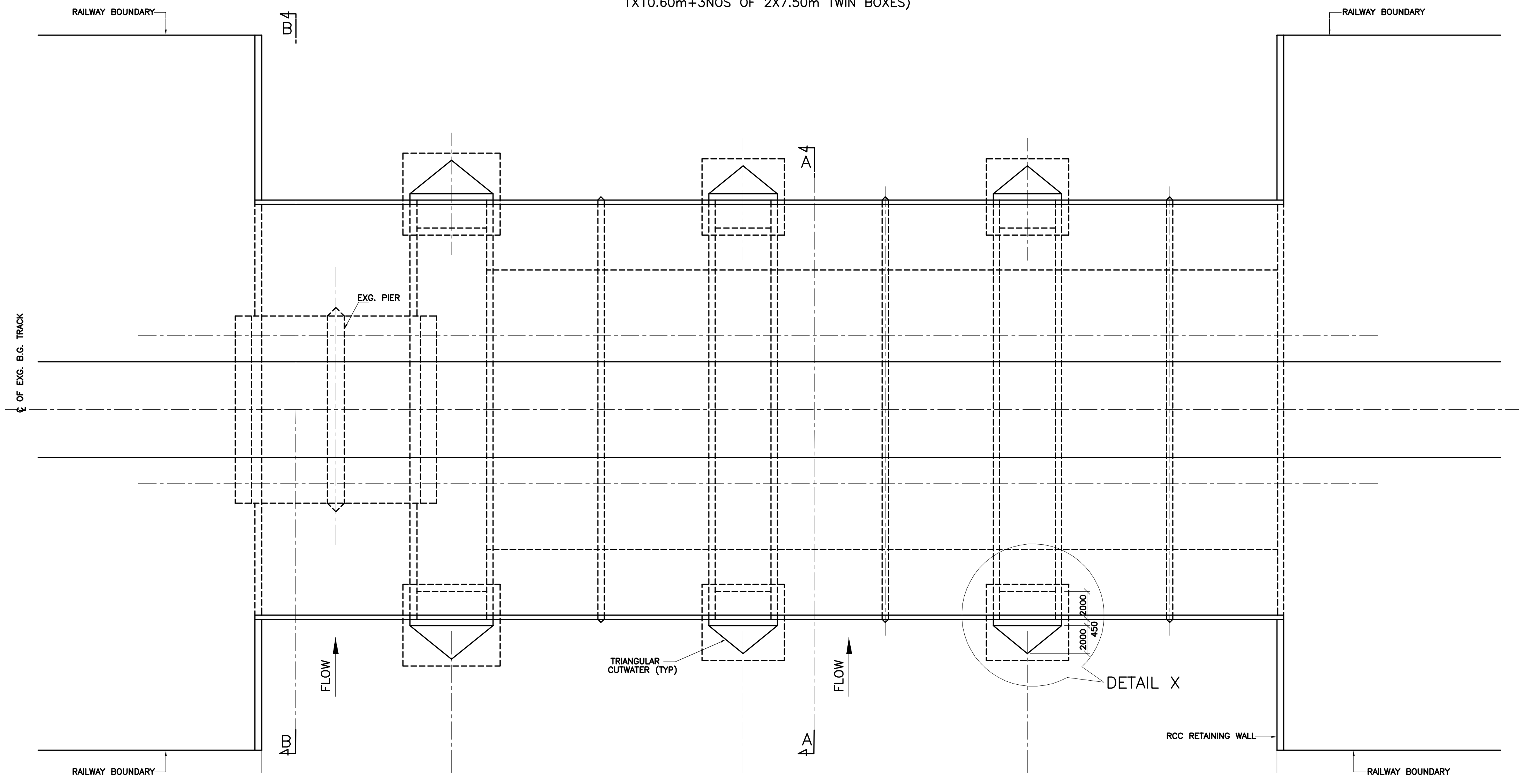
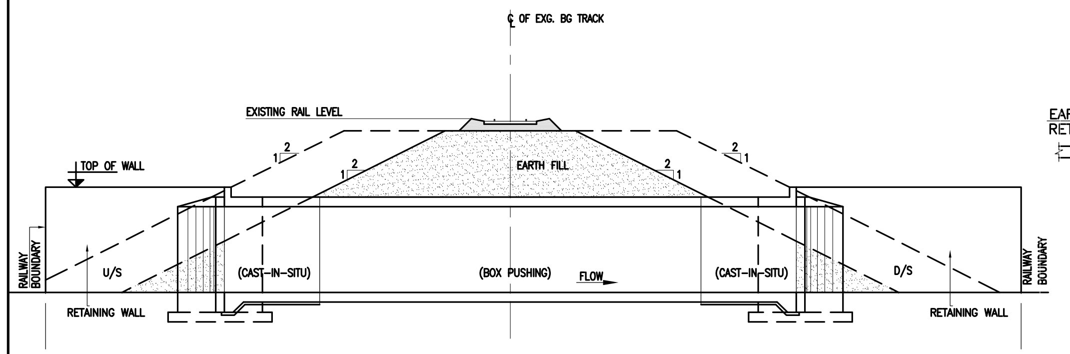


ELEVATION
(SCALE 1:200)
(PROPOSED ELEVATION OF BRIDGE WITH 1X10.60m+3NOS OF 2X7.50m TWIN BOXES)



PLAN AT TOP
(SCALE 1:200)



SECTION A–A
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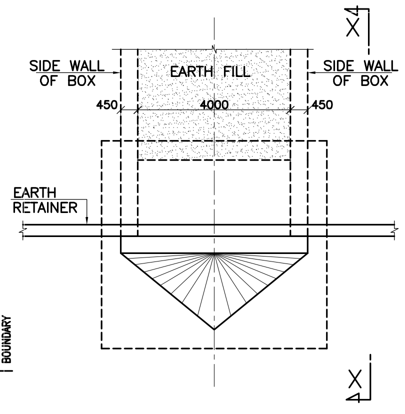
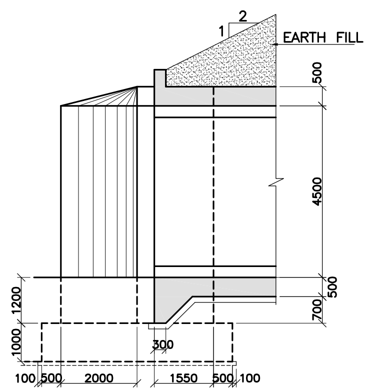
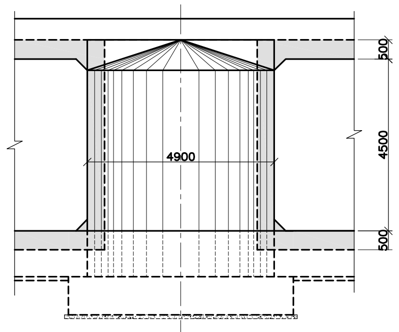


DETAIL X (PLAN)
(SCALE 1:100)



VIEW X–X
(SCALE 1:100)



ELEVATION
(SCALE 1:100)

NOTES :–

01. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
02. FOLLOW FIGURED DIMENSIONS ONLY.
03. REFER RELEVANT REPORTS AND DRAIN ALIGNMENT PLAN
04. THE EXISTING UTILITIES AND SERVICES, IF ANY, AT THE WIDENED PORTION OF BRIDGE SITE SHALL BE REROUTED SUITABLY.
05. ALL DIMENSIONS, LEVELS SHOWN ARE TENTATIVE AND SUBJECTED TO CORRECTION, OMISSION, ALTERATION ETC. AT THE TIME OF EXECUTION.

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

REGISTERED OFFICE : 1004–5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI–400 021.

OFFICE OF ORIGIN : A–1 TOWER, 5th & 6th FLOOR, "GOLDEN ENCLAVE" AIRPORT ROAD BANGALORE–560 017.

OWNER: BRUHAT BANGALORE MAHANAGARA PALIKE

DATE: AUGUST 2010

CONTRACTOR CLIENT:

DRAWN: NRM

PROJECT: PREPARATION OF MASTER PLAN FOR REMODELING OF STORM WATER DRAINS IN EIGHT ZONES OF BRUHATH BENGALURU MAHANAGARA PALIKE

PREPARED: PC

CHECKED: RSP

TITLE: TYPICAL GENERAL ARRANGEMENT DETAILS OF BRIDGE BY BOX PUSHING TECHNIQUE FOR RAILWAY BRIDGES.

APPROVED: ATS

DRG.NO.: | REV. R0 | JOB.NO.: 10331/E | SCALE: AS SHOWN

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5.11 Removal of Debris From Storm Water Drains:

The main objective of this arrangement is to arrest floating materials, debris and sediments from getting transported all along the drain and enter into water bodies. It is a mechanically operated facility which can be operated round the clock and its functionality is based on setting water level and timer. Sediments deposited in silt traps are collected by means of racking arrangement and conveyed to refuse bins placed on rails. Refuse bins are loaded onto dumpers and transported to designated dump sites. Usually such arrangements are suitable for installations near primary drains were entry of large quantity of floating materials and sediment transport is envisaged. Velocity of flow in the drains shall be very minimum will be advantageous.

In addition chain link fence shall be erected to a height of about 2.0 m. on the drain walls at vulnerable locations to prevent dumping of garbage and street sweepings into SWD. Steel gratings shall be fixed to street kerb inlets to arrest entry of fine silt through tertiary drain network into main storm water drains. Construction, operation and maintenance of this facility can be outsourced on long term contract basis and it can be taken up as part of regular maintenance activity which intern minimise the burden on annual maintenance cost of the drainage system and also improves the aesthetics of the city drainage system and water bodies.

Typical sketch depicting mechanically operated silt / debris removal system from SWD

is as shown in **Fig. 5.10.**

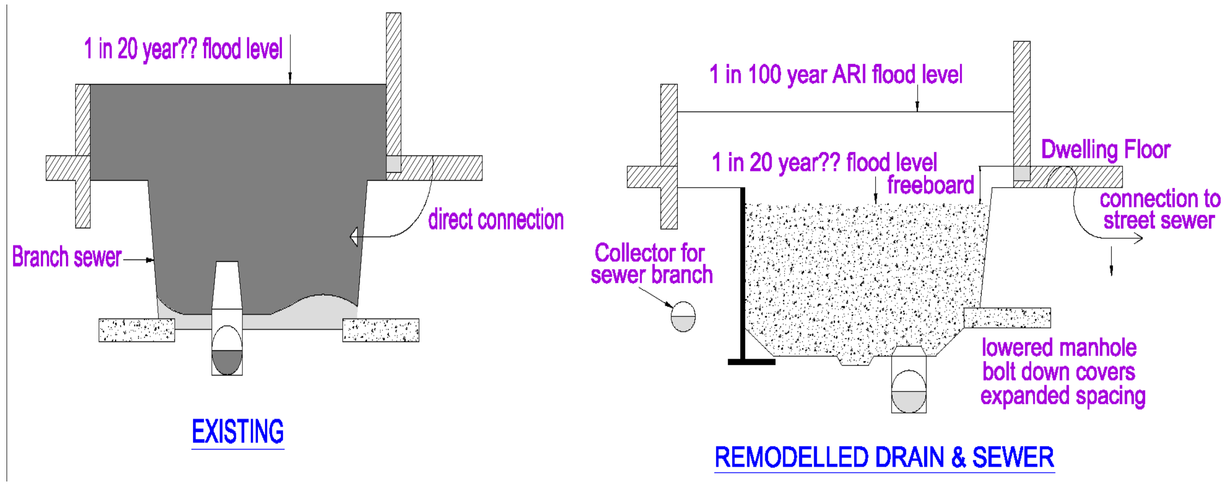
Fig. 5.10 Typical sketch depicting mechanically Operated Silt / Debris Removal System from SWD

5.12 Sewage Flow Interception to Lakes

The threats that the lakes of Bengaluru are facing is entry of untreated sewage, dumping of solid waste, debris, sediment transport, illegal encroachment of lake property by land grabbers, development of slums without basic amenities around the lakes etc. Sewage / effluent entry into lakes through storm water drains is causing large scale damage to the lake environment and polluting the lake water. Sedimentation of solids and silt reduces the water storage area and shrinks the lake volume. This has resulted in non availability of buffer storage volume in lakes to prevent flash floods / sudden surcharging of water in downstream areas. The productivity of lakes decreases which is essential to support flora and fauna of the lake ecosystem. The lakes lose aesthetic value and tourism potential decreases. The water quality of ground water sources around the lakes also gets affected. Lakes become breeding grounds for mosquito. The water quality results of lakes analyzed has shown presence of high concentrations of organic pollutants in the lake water.

Considering the nature of the problem, some of the alternative options considered for the segregation of sewage from storm drains are shown schematically in **Figs 5.11, 5.12 5.13** and **5.14.**

Fig. 5.11 Lowering of high Raised Manholes inside SWD



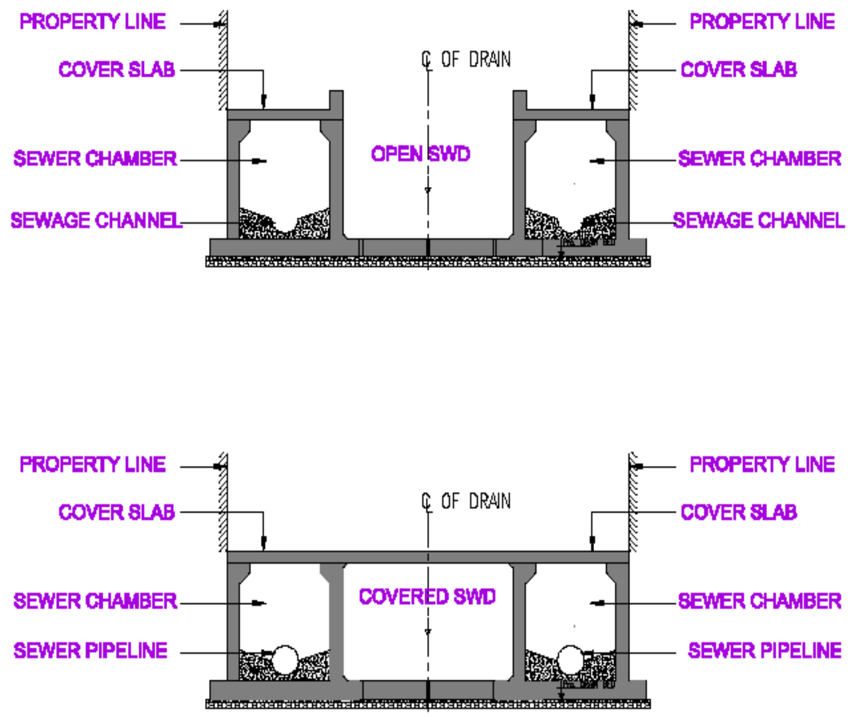


Fig. 5.12 Combined Parallel Sewer Pipeline

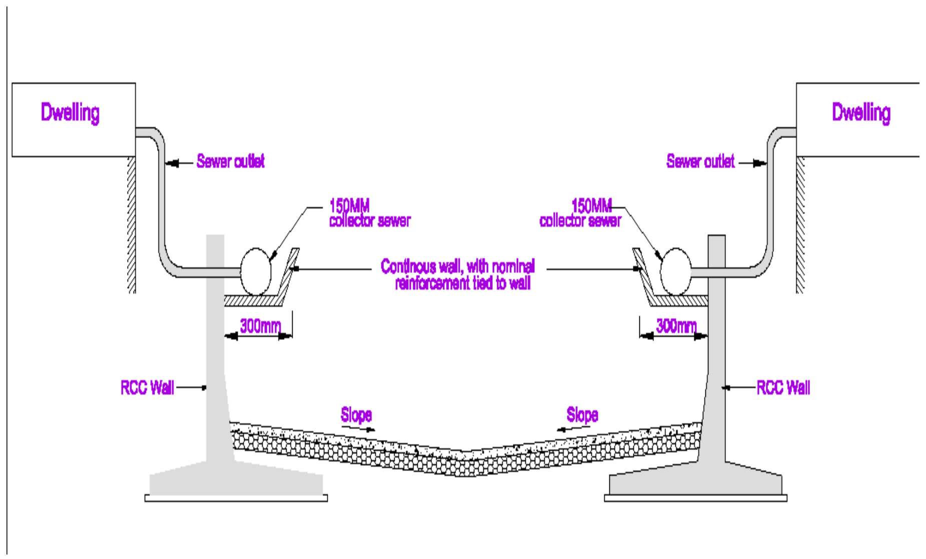


Fig. 5.13 Sewer outlets from dwelling units connected to main SWD

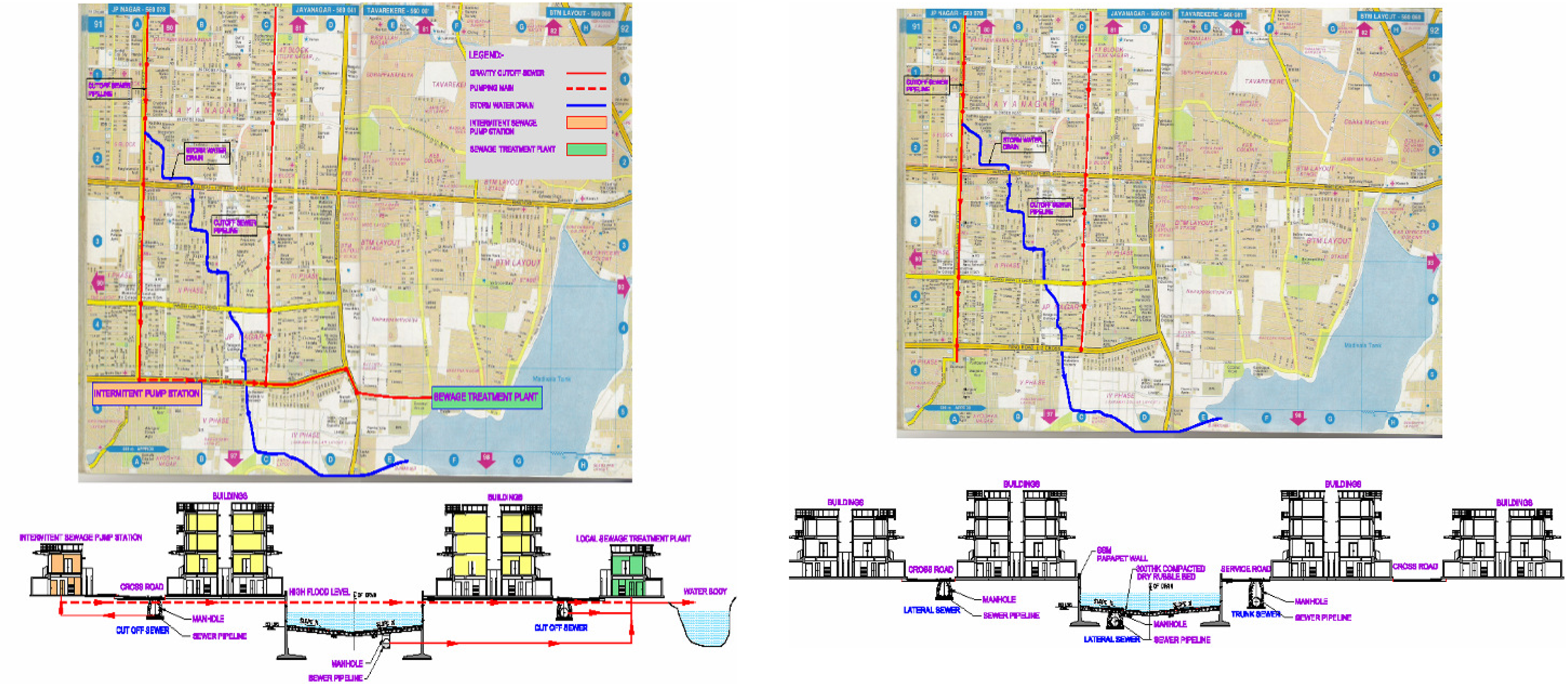


Fig. 5.14 Cutoff / Parallel Sewer Pipeline

5.13 Sewer pipeline shifting from Storm Water Drains:

BWSSB project proposals for taking up implementation of sewerage projects in the peripheral areas were discussed at various levels in length during project review meetings and subsequent coordination meetings held at BBMP and BWSSB offices.

During the discussion the project consultants were asked to prepare a proposal for smoother implementation of both the projects and to avoid repetition of works at later date. Accordingly the details as furnished by BWSSB have been obtained and storm water drain project proposals have been compiled and enclosed with this report.

The proposal has been formulated considering the following two aspects;

1. Identify the drain reaches where BBMP proposes to widen the drains & regrade the drain bed profile and BWSSB proposes to lay trunk sewer pipeline inside SWD mentioning non availability of land as constraint.

2. Identify the drain reaches where BBMP proposes to widen the drains and BWSSB proposes to lay trunk sewers along side existing service roads and mentioning later gets inside the storm water drain due to drain widening.

Separate proposal statements have been prepared compiling both sewerage project proposals and storm water drain project proposals to identify the drain reaches considering the above two aspects wherein extent of land required, revenue survey details etc., have been obtained from land records department web site and compiled and enclosed with this report in **Table 5.30** & **Table 5.31** and the same is depicted in **Fig. SWD MP SS - 01.**

The rehabilitation and resettlement proposal for the project affected people has been discussed separately in subsequent sections of this chapter.

Table 5.30 Proposal for Shifting Sewer Pipeline from Storm Water Drain (From Inside)

Data Source: BWSSB

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
Bommanahalli Zone																				
1	Byrasandra Kere	K209	5,050	8,175	Ranka Apartments, Bannerghatta Road	Rupena Agrahara	3,125	1800	6.0	12.0	7.5	7.5	883.04	879.92	Kodi chikkanahalli-21,22,23,24,65,27, 5,6,26 Roopena agarahara-5,11,9,7,8,4	BA	42,132	41,980		
2	Chikka Beguru Kere	BH577	0	490	Hongasandra	Muniyappa Layout	490	1000	5.0	13.0	7.5	7.5	879.48	878.49	Hongasandra-61,62,63,65,15,20, 14	BA	6,876	6,525		
3	Chikka Beguru Kere	BH574	0	760	Devarchikkanahalli	Hongasandra	760	900	5.0	13.0	7.5	7.5	880.76	879.48	Hongasandra-67,65,69,68,75,76 Begur-191,185,192	BA	10,350	10,595		
4	Chikka Beguru Kere	BH572	675	925	Near Chikkabegur Tank	_	250	450	2.0	13.0	7.5	7.5	882.22	881.42	Begur-233,200,199,201,230	BA	3,545	3,455		
	Chikka Beguru Kere		1,000	1,238	Begur Road	MICO Layout	238	900	6.0	13.0	7.5	7.5	881.27	880.80	Begur-193,192	BA	3,271	3,340		
5	Chikka Beguru Kere	BH578	900	1,011	Hongasandra	Muniyappa Layout	111	900	5.0	3.0	7.5	7.5	878.68	878.46	Hongasandra-3,4,5,6,62	BA	830	818		
6	Puttenahalli Kere	BH513	900	1,300	Sarakki Kere	Puttenahalli Kere	400	1000	2.5	_	7.5	7.5	_	_	Puttenahalli-5 Sarakki Kere-0	_	_	_		
In Open / Vacant Land							**0**													
In Builtup Area							**5,374**										**67,004**	**66,713**		
Sub Total							**5,374**										**67,004**	**66,713**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
Yelahanka Zone																				
1	Geddalahalli STP	BP183 (BY06)	850	1,725	Mariyanna Palya near nagavara Kere	Saraya Palya	875	1600	10.5	24.0	7.5	7.5	879.87	877.96	nagavara-99,112,124, 125,128,129	BA	19,588	19,016		
			1,725	3,500	Saraya Palya	Geddalahalli	1,775	300	12.0	33.0	7.5	7.5	877.96	878.10	Tanisandra-47,46,45,44,43,42,41,40,32,31,30,29,27,26,23,22,21, 20,18	BA	39,120	38,614		
			3,500	4,094	Geddalahalli	Geddalahalli Rly.Track	594	350	25.0	36.0	7.5	7.5	878.10	875.96	Geddalahalli-20,19	BA	14,729	15,541		
2	Rachenahalli Kere	BP177	0	725	Near Amruthalli Kere	Amruthalli Kere	725	450	3.5	6.0	7.5	7.5	892.68	886.70	Amruthahalli-86,87,88,72,71,70,67,68,69,60,61,62,59	OL	3,076	5,350		
			725	1,118	Amruthalli Kere	Rachenahalli Kere	393	600	5.5	9.0	7.5	7.5	886.70	885.09	Dasarahalli-56,57,58	OL	4,886	2,792		
3	Rachenahalli Kere	BP176	1,175	1,375	Sahakar nagara	Amruthahalli Kere	200	300	6.0	8.0	7.5	7.5	895.52	894.88	Byatarayanapura-21,24,20	BA	1,083	1,076		
			1,375	1,675	Amruthalli Kere	Amruthahalli Kere	300	300	7.0	8.0	7.5	7.5	894.88	893.60	Amruthalli-107,116,117,118, 119,120,121,122	OL	2,165	2,267		
4	Rachenahalli Kere	BP020 (BY01)	0	765	Kodigehalli	_	765	300	3.0	7.0	7.5	7.5	894.62	891.27	Kodigehalli-147,148,121,92,124,93, 125,121,	BA	8298	8,200		
5	Dodda Bommasandra Kere	BP026 (BY03)	1,060	1,450	Koti Hosahalli	Hebbal Kere	390	450	6.0	6.0	7.5	7.5	892.90	892.11	Kodigehalli-51,52,53,54,55,56,61,62,64,65,66,67,68,69,70,71	OL	3,330	3,129		
6	Dodda Bommasandra Kere	H200	5,725	6,625	Badrappa Layout	Near Impact Polytechnic, Koti Hosahalli	900	1000	5.0	10.0	7.5	7.5	891.66	889.81	Kodigehalli 57,56,37	BA	14,750	14,813		
In Open / Vacant Land							**1,808**										**13,457**	**13,539**		
In Builtup Area							**5,109**										**97,568**	**97,260**		
Sub Total							**6,917**										**111,025**	**110,799**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
Dasarahalli Zone																				
1	Kammagoundanahalli Kere	DH136	0	720	Shettihalli	Medarahalli	720	400	6.0	6.0	_	_	892.18	887.28	Settyhalli-0,,9,77,75,57,56,61,33	OL	6,118	6,300		
2	Kammagoundanahalli Kere	DH135	720	1,800	Chikka Banavara Railway Station	Near Chikka Banavara Kere	1,080	450	5.5	8.0	7.5	7.5	873.23	865.94	Chikkasandra-37 Myadharahalli-13,5,8,9,6,4,10,12,30,34,33,31,66,64,57,67	OL	12,150	12,328		
3	Kammagoundanahalli Kere	DH143A	0	984	Chikkasandra	Near Engg.College	984	450	3.0	7.0	7.5	7.5	881.54	871.18	Mallasandra-6 Settyhalli-37,0,50,49,44,25	OL	10,685	10,783		
4	Kammagoundanahalli Kere	DH143	975	1,575	Near Engg.College	Chikka Banavara Railway Station	600	600	4.0	8.0	7.5	7.5	870.85	865.65	Myadharahalli-43,44,45	BA	6,750	6,924		
5	Kammagoundanahalli Kere	DH131	1,500	2,014	Kammagondana halli	Kammagondanahalli Kere	514	300	4.0	6.0	7.5	7.5	889.04	886.76	Kammagondanahalli-23,48,47,58,13,6,16,26,24,14,7,25,43,44,45,46	OL	12,429	12,675		
6	Anchepalya Kere	DH213	0	1,150	Vidya nagara	Near Tumkur Road	1,150	600	7.0	8.0	7.5	7.5	887.61	875.01	Dasarahalli-0,26,19,27,37,20,25,28 Nagasandra-34,36,31,35	BA	13,150	13,200		
7	Gangondanahalli Kere	DH314	200	1,100	Hegganahalli	Peenya IInd Stage	900	300	6.0	4.5	_	_	903.75	881.61	Hegganahalli-66,67,68	BA	1,806	1,750		
8	Gangondanahalli Kere	DH315	950	1,140	Peenya IInd Stage	Near Vaddrapalya	190	300	4.0	5.5	7.5	7.5	882.68	881.41	Nallakadirenahalli-88,89	BA	1,520	1,619		
9	Laggere Kere	DH141C	575	1,100	Chowdeshwari nagara	_	525	400	5.5	5.5	_	_	895.45	877.41	Srigandhada kavalu-70,78	BA	19,000	18,775		
10	Laggere Kere	DH141D	0	175	Near Magadi Road	Near Chowdeshwari nagara	175	350	4.0	4.0	5.5	5.5	_	_	Srigandhada kavalu-49,63	BA	438	450		
11	Laggere Kere	DH141A	550	1,046	Sunkadakatte	4th Cross Road of Chowdeshwarinagara	496	300	_	3.5	_	_	_	_	Laggere-51,52,53	BA	_	_		
12	Laggere Kere	V201	225	1,150	Beggars Colony	Chowdeshwari nagara	925	900	5.0	6.0	5.5	5.5	882.94	865.91	Laggere-108,55,56,57,58,59	BA	7,750	7,867		
In Open / Vacant Land							**3,298**										**41,382**	**42,086**		
In Builtup Area							**4,961**										**50,413**	**50,584**		
Sub Total							**8,259**										**91,795**	**92,670**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
Mahadevapura Zone																				
1	Seigehalli Kere	MD269	0	250	Sanntammana halli	Vengaiahana Kere	250	350	8.0	9.0	7.5	7.5	878.91	876.61	Sonnathammana halli-27,47	BA	2,985	2,853		
2	Seigehalli Kere	MD262 (KR06)	650	1,037	Duravani nagara	Kaudenahalli Kere	387	900	5.0	6.0	7.5	7.5	885.28	883.75	Kavudenahalli-27	OL	4,031	3,945		
3	Seigehalli Kere	MD264	575	775	Ramamurthy nagara	Santosh Reddy Layout	200	400	5.0	3.5	_	_	891.42	888.87	Kavudenahalli-0, 27	BA	250	277		
4	Kaggadasapura Kere	MD313	425	1,452	Kaggadasapura	Doddanekundi Kere	1,027	800	8.5	10.0	7.5	7.5	877.25	873.96	Kaggadasapura-113,114,25,155,115,62,55,56,116,85,54,60,63	BA	12,533	12,734		
5	Sheelavantana Kere	MD427	0	363	Varthur Road,Kodi	Varthur Kodi, Ramagonda nahalli	363	400	20.0	40.0	7.5	7.5	857.94	857.70	Ramagondanahalli-0 Bellandur amanikere-319	BA	10,520	10,426		
6	Sheelavantana Kere	MD431	0	500	Varthur Road,Kodi	Varthur	500	800	4.0	7.5	7.5	7.5	857.34	855.89	Bellandur amanikere-365,360,20,357,359,356	OL	5,378	5,476		
7	Channapanahalli Kere	MD365	0	1,070	Gandhi nagara, Munekolalu	Ambedkar Sangha, Munekolalu	1,070	700	3.0	6.0	7.5	7.5	871.89	865.37	Munnekolala-33,49,31,17,34,35,19,16,15,3,55,69	OL	11,342	11,256		
8	Vibuthipura Kere	MD331 (KR01)	725	850	L.B.Shastri Nagara	L.B.Shastri Nagara Kere	125	500	2.5	4.0	7.5	7.5	882.20	881.45	Vibhuthipura-111,108	OL	1,523	1,605		
9	Kodigehalli Kere	MD282	425	525	Near Doddenakundi Industrial Estate	Basava Nagar	100	400	2.5	6.0	7.5	7.5	881.71	880.93	Hoodi-138,164	OL	953	948		
10	Kodigehalli Kere	MD284	375	1,075	Tigalarahalli	Sadaramangala Kere	700	500	4.5	6.0	7.5	7.5	874.70	871.85	Hoodi-121,127,123,126,125	OL	8,756	8,891		
11	Kodigehalli Kere	MD286	500	975	Near Sadarmangala Kere	Sadaramangala Kere	475	400	4.0	7.0	5.5	5.5	872.84	871.13	Hoodi-103,96,97,100,99,89,46,61	OL	4,280	4,275		
In Open / Vacant Land							**3,357**										**36,262**	**36,396**		
In Builtup Area							**1,840**										**26,288**	**26,290**		
Sub Total							**5,197**										**62,550**	**62,686**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
Rajarajeshwarinagara Zone																				
1	Nayandanahalli Kere	RN181	225	725	Javaran Doddi	Halgevaddarahalli	500	300	20.5	46.0	7.5	7.5	791.65	787.07	Pantharapalya-86,87,89,90,38	BA	15,689	14,237		
			725	1,825	Rajarajeshwarinagar II Stage 3rd Block (Kenchenahalli)	Mysore Road, Kenchenahalli	1,100	300	16.5	46.0	7.5	7.5	787.07	781.01	Halagevaderahalli-37,36,34,33,32,27,26,28	BA	38,638	40,909		
			1,825	3,575	Mysore Road, Kenchenahalli	RV College Of Engineering	1,750	300	26.0	54.0	7.5	7.5	781.01	775.59	Kenchehahalli-12,13,14,15,16,17,18,40,23,24,25,2627,28,	BA	56,001	54,143		
			3,575	5,025	RV College Of Engineering	Railway Station, Kengeri	1,450	300	20.2	56.0	7.5	7.5	775.59	772.10	Pattanagere-39,40,57,25,27,28	BA	31,775	32,346		
			5,025	5,975	Railway Station, Kengeri	Kodipalya	950	300	18.3	56.0	7.5	7.5	772.10	769.60	Valagerahalli-70,71,78,79,80,81,82,84,99,101,83	BA	4,500	4,500		
			5,975	10,575	Kodipalya	Chowdenapura	4,600	300	23.0	60.0	7.5	7.5	769.60	758.82	Kengeri-16,17,21,22,29,30,31,50,51,52,53,54,55,85,86,87,88,89,90,91,92,96,97,107,115,116,117,118,	BA	78,000	74,916		
2	Hosahalli Kere	RN311	1,425	1,850	nagadevnahalli Main Road	Kengeri	425	300	5.0	6.0	7.5	7.5	811.93	809.60	nagadevanahalli-4,31,32,33,36	BA	4,008	4,472		
3	Muddayana Palya Kere	RN554	1,075	1,750	Ullalu	Ullalu	675	1000	10.0	12.0	7.5	7.5	811.75	805.92	Ullalu-122,123,129,126,128,127,139,140,149	BA	9,438	9,024		
			1,750	2,525	Ullalu	Sir M V Layout, nagadevanahalli	775	1000	11.0	12.0	7.5	7.5	805.92	799.02	Sonnenahalli-4,5,6,10,8	OL	10,284	10,237		
			2,525	3,000	Sir M V Layout, nagadevanahalli	nagadevanahalli	475	1000	11.0	12.0	7.5	7.5	799.02	797.18	nagadevanahalli-20,50	OL	6,387	6,101		
4	Muddayana Palya Kere	RN541 (RNR06)	750	2,000	Mallathalli	Mallathalli	1,250	450	6.5	7.0	5.5	5.5	833.86	818.70	Mallathahalli-35,50,51,49,55,47,56,62,63,64,46,67,69,	BA	14,126	14,912		
5	Konnasandara Kere	RN572 (RNR04)	0	2,428	Oddarahalli	Near Mysore Road	2,428	1200	14.0	16.0	7.5	7.5	770.60	746.49	Kengeri-210,211,213,214,215,216,217,218,219,224,207,225,193,192,194,195,196,197,198,199,200,172,174,175,133,130,107	BA	33,612	33,674		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed Inside SWD (m.)	Sewer Diameter (mm.)	Ex.Varying Avg. Drain Width (m.)	Pro.Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To					RHS	LHS	Start	End		OL / BA	RHS	LHS		
6	Subramanyapura Kere	RN223	0	1,550	Gaudanapalya	Near Bharata HBCS Layout	1,550	400	4.0	6.0	7.5	7.5	848.98	833.91	Uttarahalli-20,21,25,24,29,25,26,28,30,31,34,37,38,39,57,56,60,66,65,68,69,70	BA	27,451	27,423		
			1,550	3,750	Near Bharata HBCS Layout	Banashankari VI Stage	2,200	450	4.5	12.0	7.5	7.5	833.91	819.78	Uttarahalli-5,6,7,8,9,10,11,13,18,21,19,28,29,28,17	BA	28,801	28,500		
			3,750	5,250	Near Channasandra	Channasandra	1,500	700	10.0	15.0	7.5	7.5	819.78	809.99	Uttarahalli 82,83 Channasandra 4,5,14,13 Thurahalli 30,31,33,35,38,57	OL	22,991	22,500		
			5,250	5,650	Channasandra	Ganakallu	1,500	700	10.0	15.0	7.5	7.5	809.99	808.33	Channasandra 15,16	OL	4,000	4,110		
			5,650	7,775	Ganakallu	Near JSS Academy Of Techical Education	2,125	300	12.0	16.0	7.5	7.5	808.33	797.29	Ganakallu 3,4,5,6,17,16,15	BA	31,856	31,502		
			7,775	9,900	Near JSS Academy Of Techical Education	Pattanagere	2,125	800	12.0	16.0	7.5	7.5	797.29	782.79	Pattanagere 55,61,9,60,58,10,11,13,30,29,28	BA	36,732	36,653		
7	Muddayana Palya	RN514 (RNR01)	475	1,150	Mallathalli	_	675	350	4.0	5.0	7.5	7.5	860.67	851.48	Srigandhada kavalu-30,38,37	BA	7,342	7,200		
8	Nayandanahalli Kere	V200	7,325	14,275	Katigepalya	Railway Station, Mysore Road	6,950	1200	24.5	26.5	7.5	7.5	834.30	790.55	Pantarapalya (P) 92,94,95128,130,14,	BA	165,000	157,013		
In Open / Vacant Land							**4,250**										**43,662**	**42,947**		
In Builtup Area							**30,078**										**582,970**	**571,424**		
Sub Total							**34,328**										**626,632**	**614,371**		
Total In Open / Vacant Land							12,713										134,763	134,968		
Total In Builtup Area							47,362										824,243	812,271		
Total							60,075										959,006	947,240		

Table 5.31 Proposal for Shifting Sewer Pipeline from Storm Water Drain (From Along side)

Data Source: BWSSB

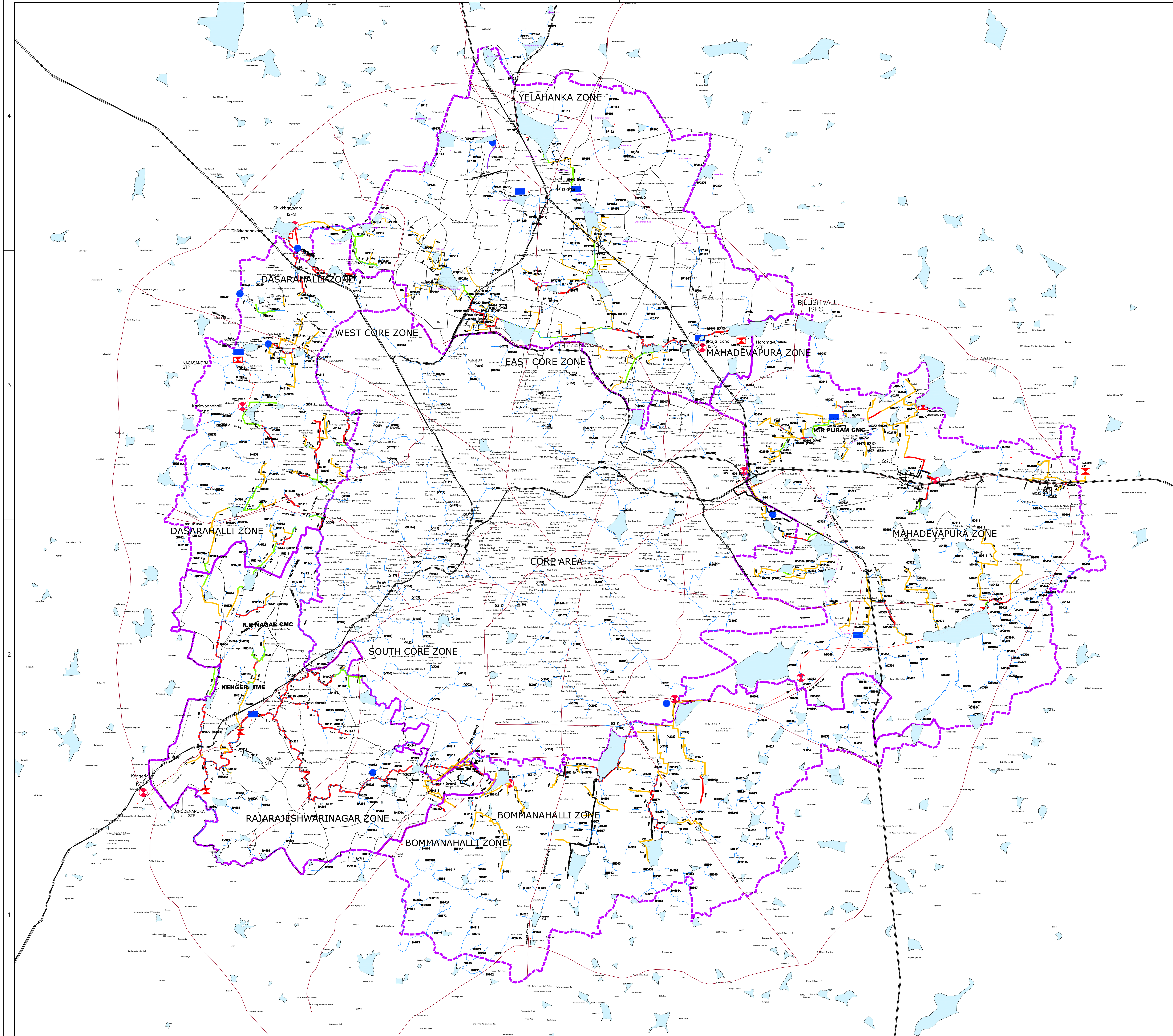
Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed along SWD (m.)	Sewer Diameter (m.)	Ex.Varying Avg. Drain Width (m.)	Existing Service Corridor Width (m.)		Pro. Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To				RHS	LHS		RHS	LHS	Start	End		OL / BA	RHS	LHS		
Bommanahalli Zone																						
1	Byrasandra Kere	K209	4,050	5,000	Ranka Apartments	N.S. Palya, BTM 2nd Stage	950	1,000	9.0	–	–	12.0	7.5	7.5	885.59	883.09	Bilekahalli-178,11,60,175,12,52,54,64,50,45,44,13,15,16,17,20	BA	13,245	13,565		
2	Puttenahalli Kere	BH513	0	900	Near Kanakapura Road	Ranka Apartments	900	1,000	2.5	–	–	–	–	–	–	–	Chunchaghatta-28 Jaraganahalli-7 Kottanuru-103 Puttenahalli-5	BA	–	–		
In Open / Vacant Land							**0**												**0**	**0**		
In Builtup Area							**1,850**												**13,245**	**13,565**		
Sub Total							**1,850**												**13,245**	**13,565**		

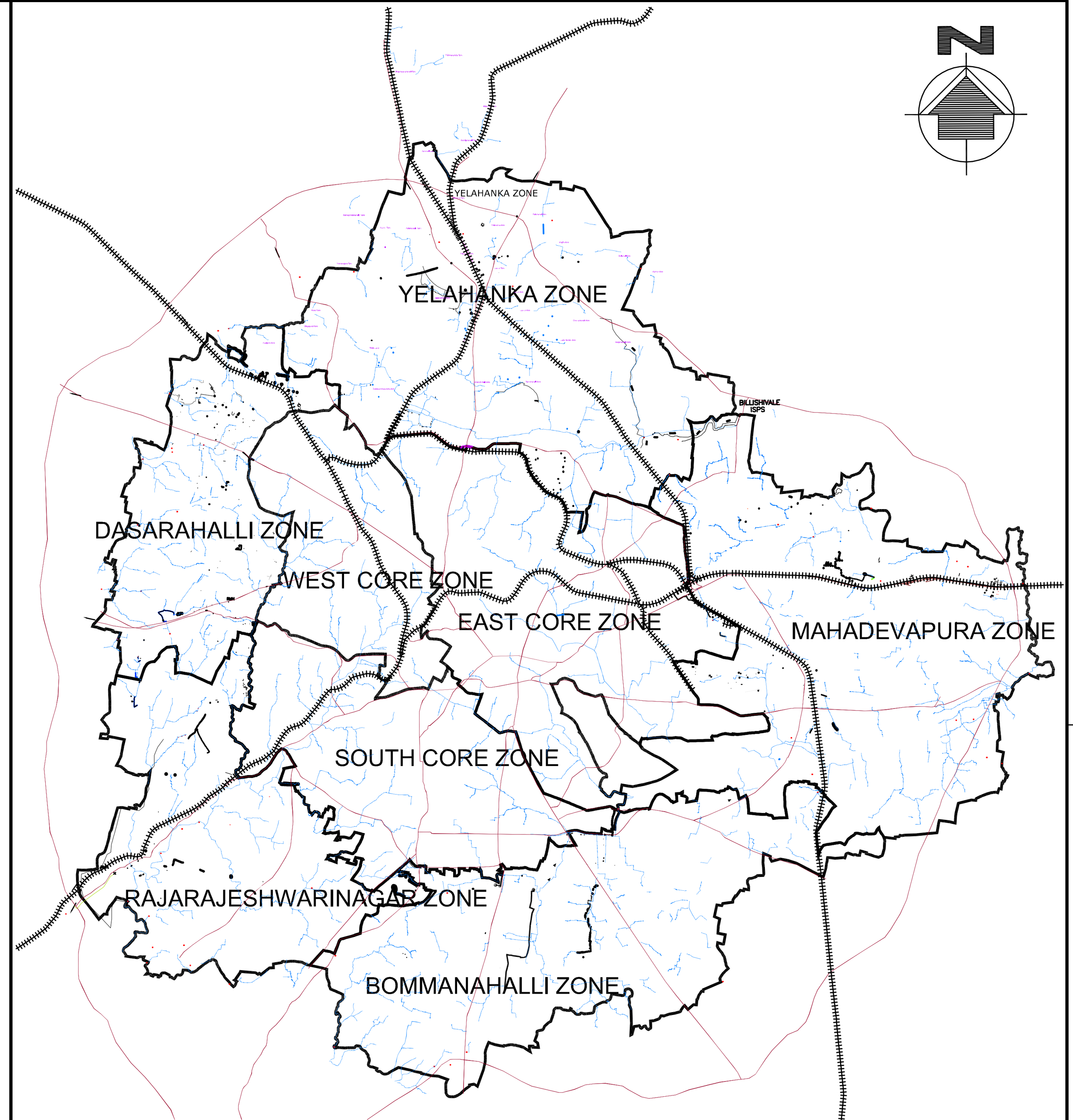
Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed along SWD (m.)	Sewer Diameter (m.)	Ex.Varying Avg. Drain Width (m.)	Existing Service Corridor Width (m.)		Pro. Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To				RHS	LHS		RHS	LHS	Start	End		OL / BA	RHS	LHS		
Yelahanka Zone																						
1	Dodda Bommasandra Kere	BP014	500	1,300	Near Tindlu Kere	Vidhyaranyapura main road	800	800	4.5	_	7.0	6.0	7.5	7.5	899.45	898.30	Thindlu - 56,55,68,51,52	BA	9,095	8,959		
			1,300	1,800	Vidhyaranyapura main road	Dodda Bommasandra Kere	500	800	7.0	_	_	6.0	7.5	7.5	898.30	897.91	Kodigehalli - 181,180,179	BA	5,877	6,320		
2	Dodda Bommasandra Kere	BP015 (BY08)	0	1,005	Dodda Bommasandra Kere	Kodigehalli	1,005	700	3.0	_	_	7.0	7.5	7.5	899.36	894.80	Kodigehalli - 177,176,173,172,169,168,167,156,155,154,153,152,151,150,148	BA	11,127	10,989		
3	Dodda Bommasandra Kere	H200	6,600	9,150	Hebbal Kere	Hebbal Kempapura	2,550	1,200	10.0	_	_	24.0	7.5	7.5	889.85	885.23	Kodigehalli - 37	BA	47,076	48,369		
4	Geddalahalli STP	BP183	0	850	nagavara Kere	Mariyanna Palya	850	300	15.0	_	_	24.0	7.5	7.5	884.57	875.96	nagavara - 59,60,94,96,98	OL	17,770	17,033		
5	Rachenahalli Kere	BP171A	450	1,768	Agragami Academic College & VSM Aerospace	Gandhi Institute Of Rural Energy And Development	1,318	600	17.0	5.0	5.0	20.5	7.5	7.5	885.20	883.34	Jakkuru - 42,43,45,46,61,60,59,58,57,56,55,54,51,77,78,79	BA	14,342	11,577		
6	Shingapura Kere	BP114	0	1,794	Kuvempu nagara (Shingapura)	Abbigere Kere	1,794	450	2.2	8.0	_	7.0	7.5	7.5	901.67	881.75	Shingapura - 109,66,67,69,70,93	BA	12,976	13,165		
7	Hennuru Bande	H300	3,800	3,950	Arabic College,nagavara	Byrappa Layout (nagavara)	150	300	12.0	7.5	_	12.0	7.5	7.5	879.64	879.22	Kacharakanahalli - 194,195,198	BA	1,807	1,904		
			3,950	5,575	Byrappa Layout (nagavara)	Near Health Centre,Geddalahalli	1,625	600	14.8	7.5	7.5	14.8	7.5	7.5	879.22	876.00	Hennuru - 52,53,85,,70,71,67,72,75,74,85,90,91,92	BA	26,930	25,700		
In Open / Vacant Land							**850**												**17,770**	**17,033**		
In Builtup Area							**9,742**												**71,026**	**67,624**		
Sub Total							**10,592**												**88,797**	**84,657**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed along SWD (m.)	Sewer Diameter (m.)	Ex.Varying Avg. Drain Width (m.)	Existing Service Corridor Width (m.)		Pro. Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To				RHS	LHS		RHS	LHS	Start	End		OL / BA	RHS	LHS		
Dasarahalli Zone																						
1	Abbigere Kere	DH124	0	850	Abbigere	Somashettihalli	850	600	5.5	_	_	6.0	7.5	7.5	879.81	870.08	Abbigere-70,71,72,73,74,65,66,67,68 Somashettyhalli-29 Lakshmipura-23,24,33,34	BA	8,750	8,842		
2	Anchepalya Kere	DH233	300	1,300	Bagalkunte	Bagalagunte Kere	1,000	350	4.0	_	_	6.0	7.5	7.5	881.50	872.65	Bagalakunte-35,65,64,57,31,74,34,83,32,67	BA	10,570	10,631		
3	Anchepalya Kere	DH216	1,075	1,450	Chokkasandra	Near Rukmininagara	375	300	4.5	_	_	4.0	5.5	5.5	883.44	880.29	Chokkasandra-44,45,50 Nagasandra-28,30	BA	2,630	2,835		
4	Herehalli Kere	DH370	675	1,545	Near Magadi Road	Herohalli Kere	870	400	5.0	_	_	5.0	5.5	_	891.89	881.61	Herohalli-24,22,26,28,27,25,99	BA	6,725	6,950		
5	Herehalli Kere	DH369	1,075	2,125	Near Sunkadakatte Main Road	Herohalli Kere	1,050	500	5.5	_	_	5.5	5.5	5.5	892.48	882.06	Herohalli-10,14,15,17,18,5,4,99	BA	9,620	9,734		
In Open / Vacant Land							**0**												**0**	**0**		
In Builtup Area							**4,145**												**38,295**	**38,991**		
Sub Total							**4,145**												**38,295**	**38,991**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed along SWD (m.)	Sewer Diameter (m.)	Ex.Varying Avg. Drain Width (m.)	Existing Service Corridor Width (m.)		Pro. Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To				RHS	LHS		RHS	LHS	Start	End		OL / BA	RHS	LHS		
Mahadevapura Zone																						
1	Seigehalli Kere	MD266 (KR07)	0	625	Kaudenahalli	K.R.Puram	625	900	5.0	_	_	7.5	7.5	7.5	883.24	878.33	Kavudenahalli-27	OL	7,138	7,200		
2	Kodigehalli Kere	MD282	350	425	Doddenakundi Industrial Estate	Basava nagar	75	400	2.5	_	_	6.0	7.5	7.5	881.81	881.71	Hoodi-181	BA	788	760		
			525	847	Tigalarahalli	Giddana Kere	322	450	2.5	_	_	6.0	7.5	7.5	880.93	879.25	Hoodi-138,170,169,166	OL	3,349	3,230		
3	Kundalahalli Kere	MD379	0	724	Turbarhalli	Varthur Kere	724	450	4.5	_	_	8.0	7.5	7.5	864.44	861.12	Siddapura-38,48,54 Bellandur amanikere-319,333,334,335,477	OL	8,210	8,370		
4	Channapanahalli Kere	MD369	0	1,090	Munnekolalu	Varthur Kere	1,090	700	7.0	_	_	8.0	7.5	7.5	865.22	861.49	Munnekolala-56,69,58,57,64,62,61 Thubarahalli-59 Bellandur amanikere-280,281,282,289	OL	12,100	12,552		
In Open / Vacant Land							**2,761**												**30,797**	**31,352**		
In Builtup Area							**75**												**788**	**760**		
Sub Total							**2,836**												**31,586**	**32,112**		

Sl. No.	Water Shed Cluster	Drain ID	Chainage (m.)		Location		Length of Sewers Proposed along SWD (m.)	Sewer Diameter (m.)	Ex.Varying Avg. Drain Width (m.)	Existing Service Corridor Width (m.)		Pro. Varying Avg. Drain Width (m.)	Proposed Service Corridor Width (m.)		Proposed Drain Invert Level (m.)		Revenue Survey Nos.	Type of Land Use	Extent of Additional Land Reqd. for Drain Widening & SR. Formation (Sq.m.)		Nos. of Properties affected (Nos.)	Remarks
			From	To	From	To				RHS	LHS		RHS	LHS	Start	End		OL / BA	RHS	LHS		
Rajarajeshwarinagara Zone																						
1	Hosahalli Kere	RN311	775	1,450	Mariappanapalya Main Road	nagdevanahalli Main Road,Muddayanapalya	675	300	7.5	_	_	6.0	7.5	7.5	823.01	811.84	nagadevanahalli - 105,123,28,123,27,5	OL	6,420	6,461		
			1,825	2,025	nagadevanahalli	Duvasapalya Kere	200	350	4.0	_	_	6.0	7.5	7.5	809.67	809.10	nagadevanahalli - 32,36,66	BA	1,900	1,976		
2	Hosahalli Kere	RN311A	225	725	Muddayanapalya	Mallathalli	500	300	1.5	_	7.0	3.0	_	_	824.68	814.25	nagadevanahalli - 77,78,5,6,7	BA	3,600	3,674		
3	Muddayana Palya Kere	RN551	1,000	1,718	Muddayanapalya	Ullala Kere	718	700	6.0	15.0	_	8.0	5.5	5.5	836.86	831.25	Ullalu - 43,50,51,52,53,20,19,18,17,16,15,14,12	BA	6,727	6,774		
4	nayandanahalli Kere	RN181	0	250	Near Jawaregowda nagara	Jawaregowda nagara	250	300	32.0	14.0	_	46.0	7.5	7.5	792.10	756.25	Pantharapalya - 86,87	BA	7,497	7,400		
5	Kempambudhi Kere	V100	11,525	11,780	Javaran Doddi	Pantarapalya	255	300	24.0	_	_	36.0	7.5	7.5	800.17	798.97	Pantharapalya - 81,82	BA	7,220	7,306		
6	Yediyur Kere	V300	3,850	4,175	Koti Halla	Pantarapalya	325	300	9.0	_	_	14.0	7.5	7.5	881.52	801.30	Hosakerehalli-0	BA	7,522	7,500		
7	Muddayana Palya	RN514 (RNR01)	1,150	1,625	Viranpalya	Near Giddadakanahalli	475	350	4.0	_	_	5.0	7.5	7.5	851.48	843.96	Srigandhada kavalu-37,36,35	BA	4,625	4,714		
			2,025	2,375	Giddadakanahalli	Mudayanapalya Kere	350	450	4.0	8.0	_	7.0	7.5	7.5	841.44	837.44	Srigandhada kavalu-30,31	BA	3,932	3,820		
8	Muddayana Palya	RN551	450	1,050	Muddayanapalya	Vishweshwaraiah nagara	600	600	5.5	10.0	_	7.0	5.5	5.5	843.23	835.65	Herohalli-65 Ullalu-0,37,38,40,44	OL	4,924	4,850		
In Open / Vacant Land							**1,275**												**11,344**	**11,311**		
In Builtup Area							**3,073**												**43,023**	**43,162**		
Sub Total							4,348												54,367	54,474		
Total In Open / Vacant Land							**4,886**												**59,912**	**59,696**		
Total In Builtup Area							**18,885**												**166,378**	**164,103**		
Total							**23,771**												**226,289**	**223,799**		





KEY PLAN
NTS

LEGEND:–

- PROPOSED STP
- PROPOSED ISPS
- EXISTING STP
- EXISTING ISPS
- PROPOSED TRUNK SEWER PIPELINE INSIDE THE SWD
- PROPOSED TRUNK SEWER PIPELINE ALONG THE ROAD
- PROPOSED TRUNK SEWER PIPE LINE ALONG SIDE THE DRAIN
- PROPOSED PUMPING MAIN
- EXISTING PUMPING MAIN
- EXISTING TRUNK SEWER
- ZONE BOUNDARIES
- VILLAGE BOUNDARIES
- MAJOR ROADS
- RAILWAY TRACK

SOURCE:–

BWSSB SEWERAGE PROJECT DATA

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED
.	.	.	.	.	.
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STUP Consultants P. Ltd.

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OFFICE OF ORIGIN : A–1 TOWER, 5th & 6th FLOOR, "GOLDEN ENCLAVE" HAL AIRPORT ROAD, BENGALURU–560 017.

OWNER CLIENT: BRUHATH BENGALURU MAHANAGARA PALIKE

DATE: JULY 2010

CONTRACTOR

DRAWN: LH

PROJECT: PREPARATION OF MASTER PLAN FOR REMODELLING OF STORM WATER DRAINS IN EIGHT ZONES OF BRHUT BENGALURU MAHANAGARA PALIKE

PREPARED: RSP

CHECKED: RSP

TITLE: PROPOSED BWSSB TRUNK SEWER NETWORK SYSTEM IN EIGHT ZONES OF BBMP AREA

APPROVED: YDM

DRG.NO.: SWD MP SS–01 | REV. R0 | JOB.NO.: 10331/E | SCALE 1:70000

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5.14 Localised Sewage Treatment Plants:

Prior to 1960 Bengaluru City had as many as 262 numbers of lakes which were used in the past for the storage of flood waters during rainy seasons and for cultivation in agricultural fields. The lakes ensured high level of groundwater table in the city and maintained pleasant climatic conditions. In recent years many lakes of Bengaluru have been lost in the process of various anthropogenic activities and urbanization leading to unplanned development of land and change in landuse. The surviving lakes are also suffering from severe pollution due to discharge of untreated sewage, discharge of raw effluents from industries and dumping of solid wastes, improper maintenance of lakes. Many lakes have been put to alternative use in the past such as bus stands, stadiums, preparation of housing layouts etc.

Sewage / effluent entry into lakes through storm water drains is causing large scale damage to the lake environment and polluting the lake water. Sedimentation of solids and silt reduces the water storage area and shrinks the lake volume. This has resulted in non availability of buffer storage volume in lakes to prevent floods in downstream areas. The productivity of lakes decreases which is essential to support flora and fauna of the lake ecosystem. The lakes lose aesthetic value and tourism potential will decrease. The water quality of ground water sources around the lakes will get affected. Lakes will become breeding grounds for mosquito. The water quality results of lakes analyzed has shown presence of high concentrations of organic pollutants in the lake water. The analysis of dry weather flow in lakes has also shown presence of polluted water in drain flow

The Lakshman Rao Committee setup in 1985 has listed 127 numbers of lakes in Bengaluru. It is reported that out of the 127 numbers of surviving lakes of the city only 81 numbers of lakes are in healthy condition and remaining are severely affected due to pollution and encroachment.

In recent years various Govt. Departments i.e. BBMP, BDA, Lake Development Authority (LDA), Forest Department etc. have taken up lake development works for few of the existing lakes of the city. About 25 Nos. of lakes have been already developed which includes Hebbal, Doddabommasandra, Madivala, Vengaihnakere, Sarakki (Jaraganahalli), Nagavara, Agara, Benniganahalli, Lalbagh, Ulsoor, Yediyur, Sankey Tank, Kempambudhi, Byrasandra, Tavarekere, Mathikere, Hennur, Vasanthapura, Kengeri, Challakere, Narasipura 1 & 2, Akshayanagar, Doddakalsandra and Halagevaddarahalli. In addition to above, presently BBMP, BDA and LDA have taken up developmental works for few of the remaining lakes.

In the proposal made by BWSSB centralized waste water collection, conveyance and treatment has been considered wherein sewage from large parts of core area and extended areas is collect through a gravity sewer network routed along the natural valleys and conveyed either directly to a STP located outside the core area or connected to an intermediate sewage pumping system which is further connected to STP. The STP's proposed by BWSSB are of large capacity, which are very much essential for meeting growing needs of the city. Though BWSSB is making all efforts to prevent sewage flow in storm water drains by collecting sewage generated from all the areas and connecting the same to a sewer network, raw untreated sewage is still flowing in drains from illegal discharges, unauthorized slums, unsewered areas etc. Though storm water drains are meant for conveying only flood waters during rains, raw sewage also flowing in drains. Sewage flow in storm water drains has reduced the carrying capacity of drains considerably for flood flow and this is causing inundation of areas adjoining the drains. Also percolation of sewage into sub surface is polluting the ground water. As per BWSSB's new proposal sewage from all the areas coming under BBMP area will be tapped and conveyed to an STP located at one point. Through this proposal entry of untreated sewage into lakes will be prevented. Though the above proposal prevents entry of untreated sewage in to lakes, the proposal does not ensure continuous inflow into lakes to meet seepage, evaporation and other losses. As lakes are spread throughout the city, the water bodies can be used as good recharge structures, water reuse ponds etc. by ensuring inflow to lake during all time of the year. Hence in order to ensure continuous inflow into lakes even during summer months, new local decentralized sewage treatment plants have been proposed at the entry point of storm water drains / BWSSB sewer near lake for all the major lakes. The STP's are selected such that sewage tapped and treated from an upstream location feeds series of lakes on downstream location. While selecting new STP's the location and capacity of existing / proposed STP's by BWSSB and other agencies have also been taken into consideration such that there is no repetition. During initial years the proposed new localized STP's shall receive sewage flow from storm water drains only and on completion of BWSSB sewerage works the nearest outfall sewer shall be connected to inlet of STP.

The raw sewage shall be treated to tertiary quality to meet lake disposal and reuse standards. Part of the treated sewage shall be used for replenishing series of lakes for meeting evaporation and percolation losses and remaining quantity shall be used for meeting the water requirement of public gardens, parks, landscaped areas, tree plantation, street washing, etc. The treated water after mixing with lake water shall be used for non potable tertiary uses such as construction, industrial use, washing, toilet flushing etc. By providing STP's near lakes the added advantage of replenishing the ground water table in surrounding areas can be achieved through recharging from lake. Also water level in the lakes can be maintained at full tank level (FTL) at all times including peak summer months thereby creating recreational facility throughout the year for the public. Since water is being replenished each day continuously throughout the year there will not be stagnation in lake water and there will be improvement in water quality.

As part of the treated water is used for maintaining the parks and gardens in the surrounding area, this will give much needed relief to fresh water sources of the city which are already over stressed due to growing water demand. Bengaluru receives fresh potable water mainly from Cauvery River which is located more than 100 Kms. away from the city and intake point is more than 100 m below. About 810 MLD of water is being supplied to the city presently from four different stages of Cauvery Water Supply Schemes. In addition to above, a new project is under execution i.e. Cauvery Water Supply Scheme, Stage - 4, Phase - II wherein additional 500 MLD of water will be brought from Cauvery River. There is a considerable capital and operation and maintenance cost involved to bring potable water from Cauvery River to the city. As large quantity of fresh potable water will be saved by recycling of treated sewage for gardening and other non potable uses, there will considerable savings in terms of capital cost and O & M cost. The quantity fresh potable water thus saved can be supplied to other domestic / commercial consumers and additional revenue can be generated. The STP's already existing and now proposed by BWSSB are large capacity plants and are mostly scattered away from proximity of the lakes. The STP's proposed hereunder are small capacity decentralized STP's near lakes designed for meeting evaporation and percolation losses of lakes and water requirement of surrounding gardens, parks, non potable demand etc. The establishment of above small STP's will in no way affect the operation of the existing and proposed BWSSB STP's as BWSSB plants will be required to meet ever growing future requirements of the city.

The sizing of decentralized STP's has been done considering quantity of expected sewage flow from immediate upstream catchment area, quantity of water required for meeting evaporation and percolation losses of series of lakes, land requirement, quantity tertiary treated water required for gardening, waster spread area of the lake etc. While selecting the lakes where decentralized STP's are proposed, lakes with larger water spread area are only considered wherein lake water can be used for reuse effectively and considerable ground water recharge can be achieved. Also the STP's are equally distributed within the city area such that the proposed plants including existing plants cover entire area.

As seen in said table, in all 14 Nos. of new decentralized local STP's have been proposed near lakes at the entrance of SWD's / BWSSB sewer with total capacity of STP's being 76.50 MLD. The STPs' are of 1.00 MLD (1 No.), 2.00 MLD (2 Nos.), 3.00 MLD (3 Nos.), 5.00 MLD (2 Nos.), 7.50 MLD (4 Nos.), 10.00 MLD (1 No.) and 12.50 MLD (1 No.).

The major existing lakes not included in above list shall be served from existing / proposed new STP's by BWSSB / other agencies. This includes lakes at Allalsandra, Jakkur, Kalkere, Rampura, Horamavu Agara, Yellamallappa Chetty, Varthur, Bellandur etc.

Details of localised sewage treatment plants proposed in BBMP area are listed in **Table 5.32** and a typical General Arrangement Drawings depicting various treatment units etc is enclosed as **Fig. SWD MP TP - 01** and detailed write up about the treatment technologies, cost etc narrated in detail and is appended in **Annexure 3.**

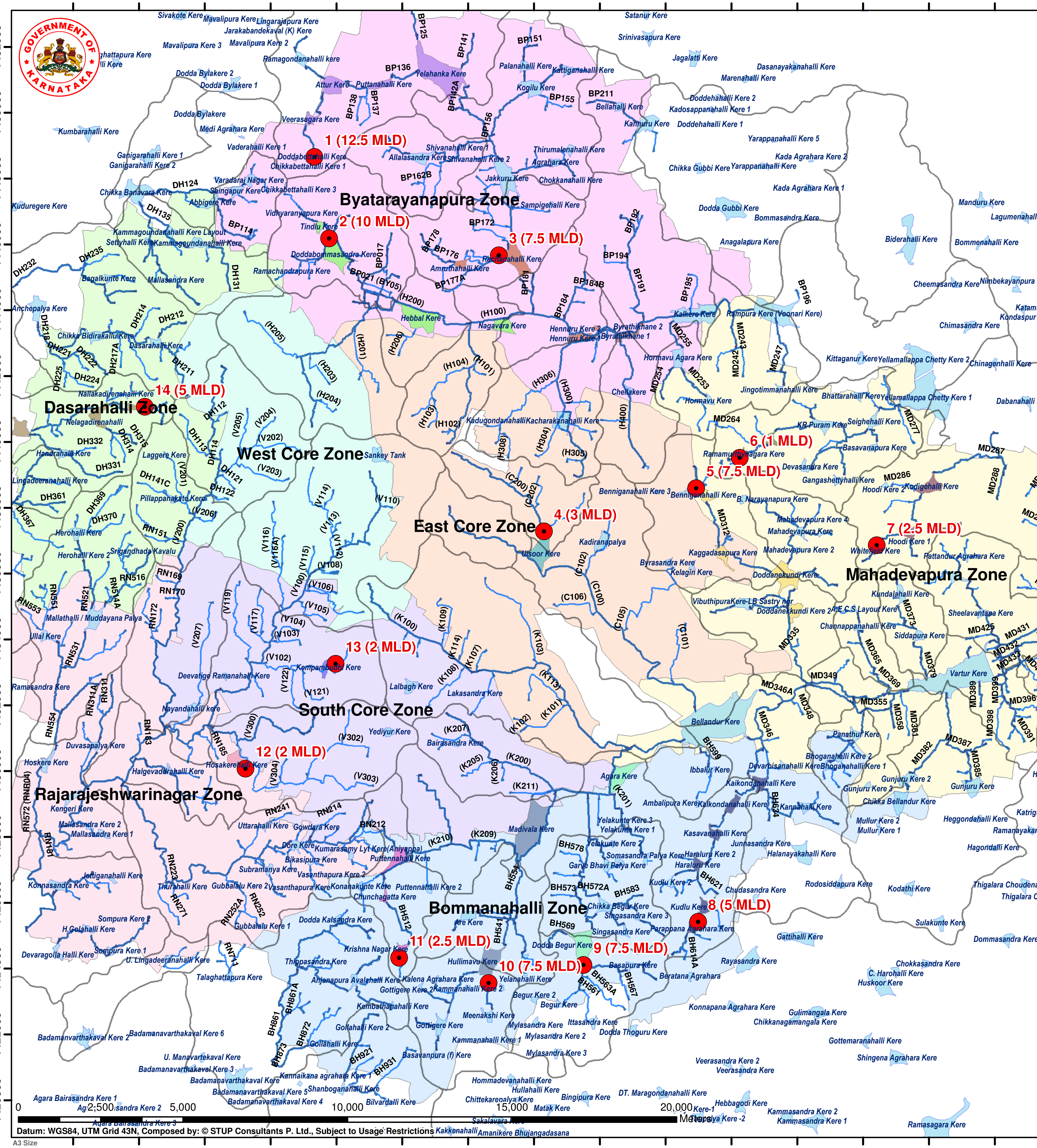
This STP proposal has been prepared at a macro level with available secondary data and a separate project proposals needs to be prepared with detailed designs and drawings for implementation during actual implementation.

Localised STPs Proposed under Master Plan Project in BBMP Area

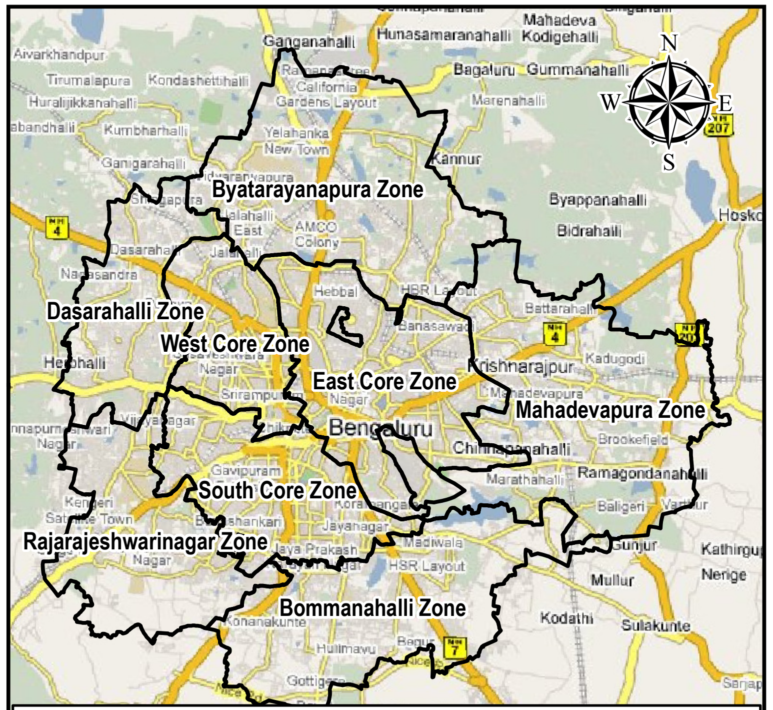
Sl. No.	Zone	Count
1	East	1
2	West	0
3	South	1
4	Bommanahalli	4
5	Dasarahalli	1
6	Yelahanka	3
7	Mahadevapura	3
8	Rajarajeshwarinagara	1
	Total	**14**

Table 5.32 Details of Localised Sewage Treatment Plants Proposed Under Storm Water Drain Master Plan Project in BBMP Area

Sl. No.	STP Location	Lakes Covered	Lake Area (Hectares)	STP capacity provided (MLD)
1.	Doddabettahalli	a) Chikkabettahalli 1	1.60	12.50
		b) Chikkabettahalli 2	0.58	
		c) Doddabettahalli	2.05	
		d) Veerasagar	8.72	
		e) Attur	28.76	
		f) Puttanahalli	12.72	
		g) Yelahanka	115.35	
2.	Dodda Bommasandra	a) Tindlu	6.57	10.00
		b) Dodda Bommasandra	43.11	
		c) Hebbal	54.18	
		d) Nagavara	19.56	
3.	Rachenahalli	a) Amruthahalli Kere	8.499	7.50
		b) Rachenahalli Kere	44.505	
		c) Hennuru 1	9.800	
		d) Hennuru 2	7.405	
		e) Tanisandra	2.284	
		f) Byrathikhane 1	8.606	
		g) Byrathikhane 2	5.236	
4.	Ulsoor	a) Ulsoor	40.22	3.00
5.	Benniganahalli	a) Beninganahalli	10.88	7.50
		b) Kaggadasapura	16.59	
		c) Doddanekundi	43.14	
		d) Doddanekkundi 2	18.70	
6.	Ramamurthynagara	a) Ramamurthynagara	3.19	1.00
		b) Gangadhra	9.61	
7.	Whitefield	a) Whitefield	2.37	3.00
		b) Hoodi 1	11.31	
		c) Kodigehalli	23.21	
8.	Parappana Agrahara	a) Parappana Agrahara	6.35	5.00
		b) Kudlu	14.25	
		c) Haraluru	9.08	
		d) Haraluru 2	0.52	
		e) Kasavanahalli	10.57	
		f) Kalkondanahalli	12.83	
		g) Kaikondanahalli	13.70	
		h) Kaikondanahalli 2	0.77	
9.	Dodda Begur	a) Dodda Begur	44.65	7.50
		b) Agara	39.40	
10.	Hullimavu	a) Hullimavu	43.48	7.5 New + 4.0 Exist
		b) Madivala	95.27	
11.	Krishna Nagara	a) Krishna Nagar	6.86	3.00
		b) Chunchagatta	5.11	
		c) Puttennahalli	27.59	
12.	Hosakerehalli	a) Hosakerehalli	20.20	2.00
13.	Kempambudhi	a) Kempambudhi	16.04	2.00
14.	Shivapura	a) Shivapura	6.55	5.00
		b) Nelagadirenahalli	19.16	
		c) Gangondanahalli	20.94	
		d) Lakkanahalli	4.18	
		e) Machahalli	9.92	



STP Group	Name	Area (ha)
1	Veerasagara Kere	8.719
	Attur Kere	28.759
	Chikkabettahalli Kere 1	1.600
	Chikkabettahalli Kere 2	0.579
	Doddabettahalli Kere	2.045
	Puttanahalli Kere	12.719
	Yelahanka Kere	115.350
1 Total		**169.771**
2	Doddabommasandra Kere	43.111
	Hebbal Kere	54.178
	Nagavara Kere	19.558
	Tindlu Kere	6.570
2 Total		**123.417**
3	Hennuru Kere 1	9.800
	Hennuru Kere 2	7.405
	Byrathikhane 1	8.606
	Byrathikhane 2	5.236
	Amruthahalli Kere	8.499
	Rachanahalli Kere	44.505
	Tanisandra Kere	2.284
3 Total		**86.335**
4	Ulsoor Kere	40.216
4 Total		**40.216**
5	Kaggadasapura Kere	16.586
	Benniganahalli Kere	10.878
	Doddanekkundi Kere 2	18.695
	Doddanekundi Kere	43.137
5 Total		**89.296**
6	Gangadhra Kere	9.607
	Ramamurthynagara Kere	3.189
6 Total		12.796
7	Hoodi Kere 1	11.311
	Kodigehalli Kere	23.209
	Whitefield Kere	2.371
7 Total		**36.891**
8	Kudlu Kere	14.247
	Parappana Agrahara Kere	6.353
	Haraluru Kere	9.075
	Haraluru Kere 2	0.517
	Kaikondanahalli Kere	13.702
	Kaikondanahalli Kere 2	0.771
	Kalkondanahalli Kere	12.828
	Kasavanahalli Kere	10.571
8 Total		**68.064**
9	Agara Kere	39.400
	Dodda Begur Kere	44.652
9 Total		**84.052**
10	Hullimavu Kere	43.475
	Madivala Kere	95.274
10 Total		**138.749**
11	Chunchagatta Kere	5.114
	Krishna Nagar Kere	6.860
	Puttennahalli Kere	27.590
11 Total		**39.564**
12	Hosakerehalli Kere	20.197
12 Total		**20.197**
13	Kempambudhi Kere	16.038
13 Total		**16.038**
14	Gangondanahalli Kere	20.936
	Lakkanahalli Kere	4.175
	Machahalli Kere	9.917
	Nelagadirenahalli	19.162
	Shivapura Kere	6.552
14 Total		**60.742**
Grand Total		**986.128**



Key Map

Legend

- STP - BBMP SWD Master Plan
- Primary SWD
- Secondary SWD
- Watershed Cluster

Water Bodies

- Not in STP Group

STP Group

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

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ISO 9001 DNV REGISTERED

OWNER
Bruhat Bengaluru Mahanagara Palike

DATE
August 2010

CONTRACTOR

DRAWN
MNS (SDE)

PROJECT
Preparation of Master Plan for Remodeling of Storm Water Drains in Eight Zones of Bruhat Bengaluru Mahanagara Palike

PREPARED
MNS (SDE)

CHECKED
RSP (APC)

TITLE
Map Showing Locations of Proposed Decentralized STPs under Maser Plan

APPROVED
YDM (CC)

No.SWD-MP-TP-01 | REV R0 | JOB No. 10331/E

SCALE
AS SPECIFIED

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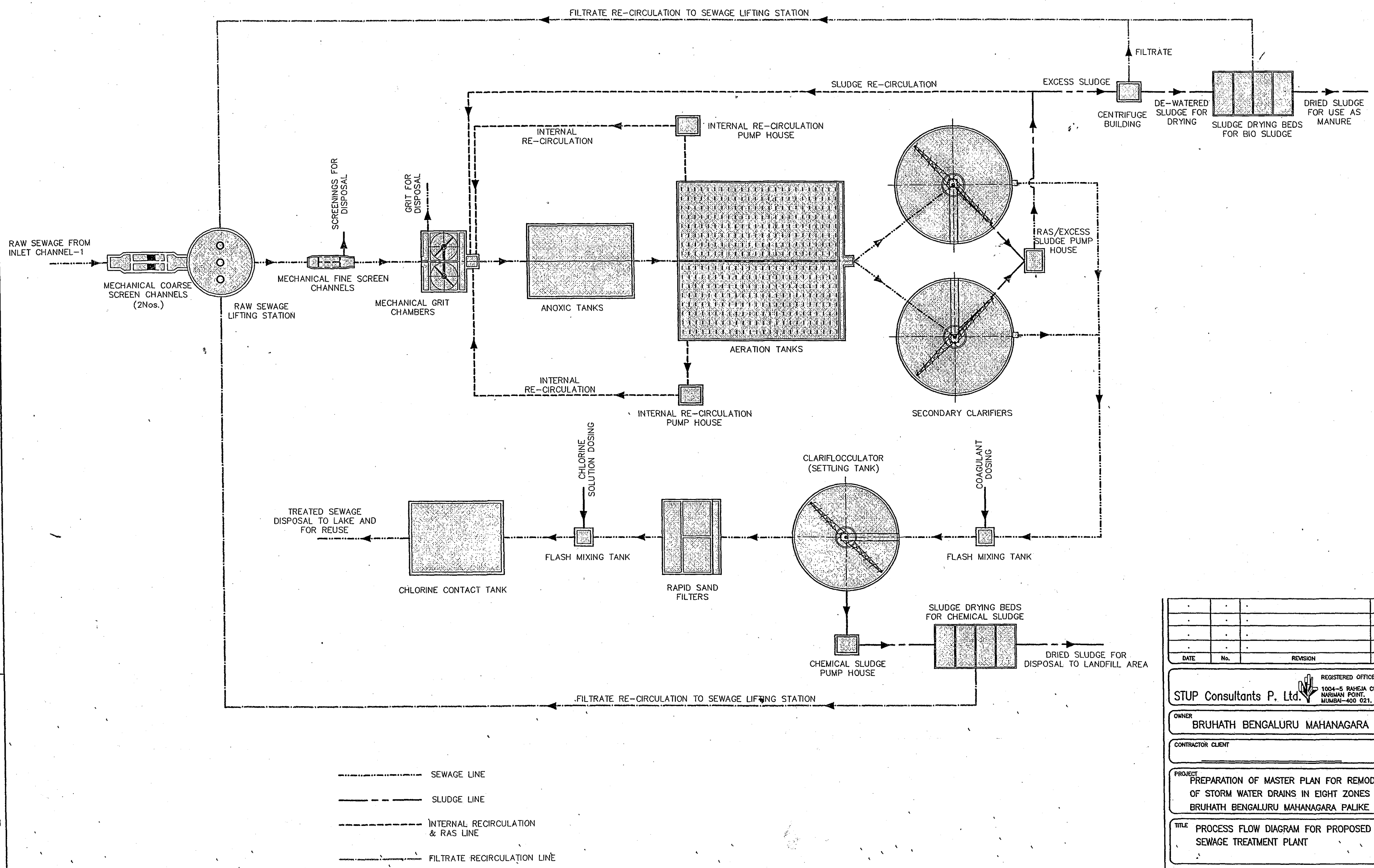
A3 Size



DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

REGISTERED OFFICE : 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI-400 021.

OFFICE OF ORIGIN : A-1 TOWER, 5th & 6th FLOOR, "GOLDEN ENCLAVE" HAL AIRPORT ROAD, BENGALURU-560 017.

OWNER: BRUHATH BENGALURU MAHANAGARA PALIKE

DATE: SEP 2010

CONTRACTOR CLIENT

DRAWN: MGM

PROJECT: PREPARATION OF MASTER PLAN FOR REMODELING OF STORM WATER DRAINS IN EIGHT ZONES OF BRUHATH BENGALURU MAHANAGARA PALIKE

PREPARED: RSP

CHECKED: RDS

TITLE: PROCESS FLOW DIAGRAM FOR PROPOSED SEWAGE TREATMENT PLANT

APPROVED: YDM

DRG.NO.: | REV. R0 | JOB NO.10331/E | SCALE

221

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A2

5.15 Source Control

Research into “source control” technology has resulted into methods of storm water management technology comprising flood control and runoff quantity minimization, storm water pollution containment and harvesting and use of storm water.

According to published information, the “first call” of any comprehensive Water Sensitive Urban Design application and its most basic element is that involving the storage and harvesting of roof runoff. Yet the “sizing” of such storages to achieve significant conservation of mains water involves quite a complex interaction between hydrology (daily rainfall records), urban infrastructure (roof area) and domestic or industrial behaviour in the way water is used. As one proceeds further along the (storm water) ‘source control’ path considering such elements as on-site retention and detention, pollution control installations, swales and wetlands, the interactions faced by the designer become progressively more complex. This is a direct consequence of the greater (design) dependence of these elements on soil properties, geological characteristics including salinisation potential, regulatory constraints, biological treatment processes, sediment chemistry and water quality criteria required for safe discharge to receiving waters.

Application of Source Control by way of detention, retention and/or infiltration may be in areas like car park, new area development, household lots, ponding and parking lot, porous pavements, for parking lot etc.

Past 30 years rainfall pattern has been studied which shows that the intensity of rainfall generally during the first half an hour of the storm is high as can be seen from intensity vs duration graph. If this storm water is stored in a detention pond, will considerably reduce the flood flow. The constricted drains in Bengaluru will hydraulically be sufficient to meet the intensity of rainfall beyond the initial peak.

Therefore a holding tank with percolation arrangement as shown in the **Fig. 5.15** needs to be enforced for all properties of size equivalent to half an hour of rainfall with an intensity of 65mm/hr for entire property with 80% of runoff.

E.g. for a site of 40 ft x 60 ft (12.2m x 18.3 m) the size of holding cum recharge tank will be as follows,

Area = 12.2 x 18.3 = 223.26 sq.m
Intensity I = 65 mm / hr = 0.065 m/hour
Runoff co-efficient C = 0.8
Duration = ½ hour

Capacity = 223.26 x 0.065 x 0.8 x ½
= 5.8 cum or say 5000 lt.

Further the excess runoff from these holding ponds at property level, is taken through the tertiary drain network into the lakes or detention ponds, the flood discharge will come down considerably.

The effect of source runoff control will be considerable on sizing the drains as the peak runoff gets flattened as the duration of rainfall increases which is shown in **Fig. 5.16.**

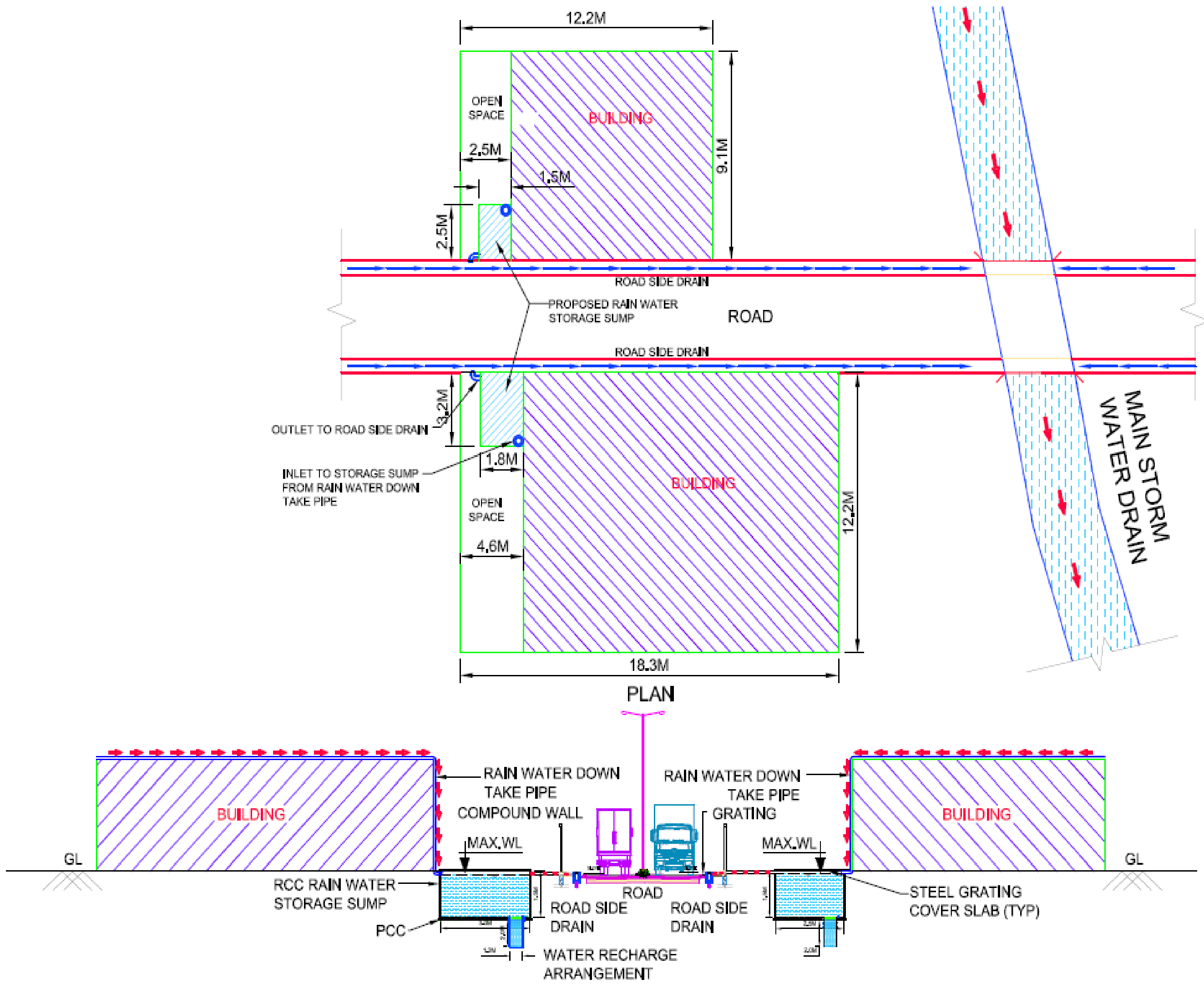

Fig. 5.15 Typical Arrangement Details for Construction of Rain Water Collection Pit for Individual Residential Buildings

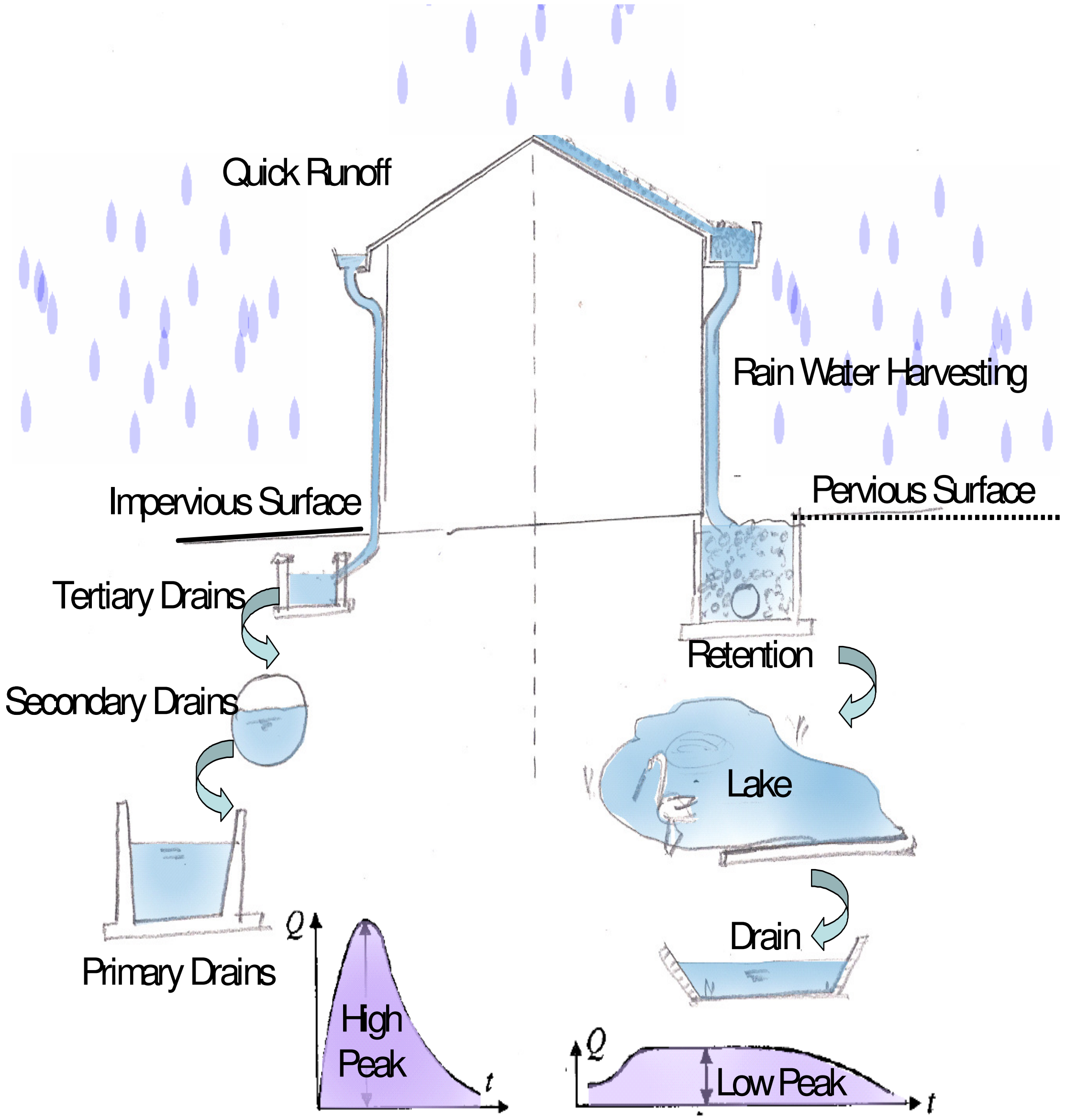

Fig. 5.16 Source Control

5.16 Catchment Control Measures

Catchment control measures include Regulation of floodplain, Land use and zoning plans, Land acquisition, Safety code of practice, Construction sites regulation, Land erosion control and Source control measures.

Maintaining a specified drainage corridor along the drain alignment free from encroachments and improper use is essential to prevent inundation of the area.

Land use management employs two principal options: zoning control and development/building control. Zoning control includes designating, by the responsible authority, the type of activity that can be undertaken within the flood-prone area. Most of the physical, social and economic problems associated with flooding, soil erosion and water pollution storm water are attributable to inappropriate urbanisation of the floodplain, unwise land use within the city, insufficient attention to drainage in urban planning, ineffective updating of existing storm water control facilities and lack of enforcement of zoning ordinances. On the basis of an objective assessment of hazard, economic, social, and environmental factors, the responsible authority should impose appropriate conditions to ensure that the future development is compatible with the prevailing flood situation preventing development from constricting drainage ways which may be institutionally accompanied by legal measures that enforce zoning, density and pace of development may guide development away from hazard areas.

The concept of flooding and pollution source control introduces the measures that mimic the natural ways of attenuating and purifying runoff before it arrives at the problem area. The further upstream a control measure, the closer it is to the nature's way of a spatially distributed control system. Source control measures do not eliminate the conventional structural techniques. Of the many source control measures that are possible detention of roof drainage and allowing a slower release or as is practiced house soakaways (Rain Water Harvesting) are successful.

5.17 Lake Control

All the existing lakes in the city shall be protected, developed and used for controlling floods. To achieve the objectives and the develop the water bodies as holding ponds the following needs to be done;

1 The sewage flow to lakes needs to be stopped.
2 The lake shall be cleared of all weeds.
3 Lake shall be desilted and bed lowered
4 Lake/ tank sluice shall be restored to working condition.
5 From outlet of regulatory gate, connecting drain/channel needs to be constructed upto the main drain.

On restoration of lakes as stated above, flood control management shall be done by adopting following procedure during rainy days as follows.

1 Based on data received from Meteorological department / data centre, the water level in the lakes needs to be lowered by operating the regulatory gate and maintain the level for the duration specified to receive additional inflow discharge.
2 The water level in the waterbody to be lowered/maintained minimum / equivalent to half hour storage so which intern can perform as holding ponds till peak rainfall intensity subsides.
3 This water level lowering activity needs to be carried out prior to the rainy day
4 All operating gadgets shall be kept in handy and in working condition by maintain periodically.
5 The above needs to be done strictly with qualified / trained supervisor where low lying areas situated on the down stream reach and also drain sizes having inadequate carrying capacities.
6 The water level to be maintained in the water body can be calculated by obtaining accurate field data and correlating the same with the past experience of the surrounding community people.

5.18 NON STRUCTURAL MEASURES

Non-structural flood control measures tend to address prevention of consequences of flooding rather than remedying. A number of generally accepted concepts include

1 Storm water management in urban environments is an integrated, multi-sectorial, process for storm water drainage and pollution control
2 traditional site-specific planning needs to be replaced with watershed oriented planning
3 regionalisation has to be based on hydrologic principles rather than on administrative ones
4 storm water in cities is a resource to be managed, and proper linkage to the land use planning process has to be established
5 the four cornerstones of a comprehensive management process are: fact finding

(through contemporary data acquisition, database updating and exchange), master planning (preventive or remedial), an unified action policy effected by the authorities (through guidance documents, codes of practice and adequate legislative support), and changing public attitude (by raising awareness, building capacity and setting up involvement in planning, decision-making and implementation)

5.19 MANAGEMENT

5.19.1 Zonal Rain Gauge Stations

Computation of surface runoff is made from historical rainfall data following statistical procedures. Rainfall data are taken from recording of rainfall at gauge stations. For the whole city of Bengaluru there is only two stations and the coverage is of the order of 800 sq. Km. Reliance on such a situation tends to sub optimal design of drainage systems. In order to improve the optimisation, historical records of rainfall measured at multiple locations are required. Therefore it is suggested to have number of Rain gauge Stations at least one in each zone.

It is also proposed to setup the rain gauging stations in each zone as per the guidelines and specifications set forth by Meteorological Department.

Multi location measurement of rainfall and recording the data will facilitate correlation of flood occurrences with the rainfall data collected as well as to characterise the study area in terms of rainfall pattern and to develop reference database based on which flood forecasting and advance warning. Also as the development takes place and flood insurance system is operational as is the case in the western countries, local data will become a necessity.

A catalogue of commercially available rain gauge system is enclosed in **Annexure 4.**

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Raingauge Stations & Data Centres Proposed under Master Plan Project in BBMP Area

Sl. No.	Zone	Count
1	East	1
2	West	1
3	South	1
4	Bommanahalli	1
5	Dasarahalli	1
6	Yelahanka	1
7	Mahadevapura	1
8	Rajarajeshwarinagara	1
	Total	**8**

Automated Rain Gauging Station, Current Meter, Data Logger

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5.19.2 Drainage corridor Delineation and Preservation

Storm drains are invariably encroached upon or abused by dumping solid waste or illicit discharge of sewage. In order to prevent these, a corridor on either side is proposed to be developed. Within the corridor service roads as appropriate for facilitating maintenance of drains are to be provided. In the designs made here such an approach is adopted considering the drain width required to cater for a 2 year return period flood discharge and providing 7.5 m service road on either side and buffer for construction of walls on either side.

No development should be permitted in this corridor and encroachments shall be made severely punishable.

The proposals for development of service corridor along side SWD has been discussed in length at various levels in several forms at BBMP central office coordination meeting on 27th April 2010, BWSSB central office coordination meeting on 24th May 2010 and at Vidhana Soudha, on 11th June 2010,. Wherein, it was suggested and agreed by all stake holders and public representatives to take up this proposal on priority in stages by working out a suitable compensation package for land losers.

During the discussion BWSSB mentioned that tenders have been already invited and work awarded for laying trunk sewer pipeline works in the peripheral areas and planned to complete the task before March 2012. Considering the fact the task of procuring the land required for development of drainage corridor is taken up in three stages;

Stage 1: Procurement of land at locations where drain widening & service corridor is proposed and at locations were shifting of sewer pipeline away from SWD is necessary.

Stage 2: Procurement of land at locations where drain widening is proposed and at locations due to drain widening shifting of sewer pipeline is necessary.

Stage 3: Procurement of land at locations where drain widening & service corridor is proposed to increase the carrying for routing maintenance of drainage system.

The following methodology has been adopted in formulating the proposals and which is at very macro level.

As discussed in the previous chapters, hydraulic analysis has been carried out for the entire study area and required drain cross section has been determined for each individual drains. Using satellite images storm water drain and service corridor has been identified and base maps for individual zones are generated. Further, the revenue survey maps have been procured from land records departments for the entire zone, on identification of raja kaluves in the revenue survey maps required revenue survey details like Village Name, Hobli, Hissa No., names of the land owner etc have been obtained from **"Bhumi"** website which is officially launched by state land records departments.

All Revenue survey data pertaining to storm water drain project for the entire catchment area has been captured in tabular form approved by BBMP. Two separate formats have been circulated by BBMP for carrying out the task;

Section 1: Revenue data at locations where storm water drains alignment are in present location

Section 2: Revenue data at locations where storm water drains alignment is modified from its original location.

Revenue Survey details, Statements & Maps required to progress further in procurement of land for drain widening and formation of service corridor is enclosed with this report as **Volume - IV.**

The details furnished in the proposals shall be verified and established at site by department/licensed revenue surveyor and verified with legal documents for its accuracy and authenticity.

Details of SWD & Service Corridor alongside SWD in BBMP Area

Name of Zone		East Core Zone						
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
Nagawara Kere Water shed Region								
H100	0	475	475	3.0	6.0	0	475	22.20
	475	550	75	4.0	6.0	475	550	22.20
	550	950	400	4.5	6.0	550	950	22.20
	950	1000	50	3.5	6.0	950	1000	22.20
	1000	1200	200	3.5	6.0	1000	1200	22.20
	1200	1400	200	4.5	6.0	1200	1400	22.20
	1400	1525	125	4.5	6.0	1400	1525	22.20
	1525	1700	175	4.5	7.0	1525	1700	23.20
	1700	2000	300	5.5	8.0	1700	2000	24.20
	2000	2125	125	6.0	8.0	2000	2125	24.20
	2125	2175	50	6.0	6.0	2125	2175	22.20
	2175	2275	100	6.0	8.0	2175	2275	24.20
	2275	2675	400	6.0	8.0	2275	2675	24.20
	2675	2875	200	6.0	13.0	2675	2875	29.20
	2875	3000	125	6.0	14.0	2875	3000	30.20
	3000	3325	325	8.0	16.0	3000	3325	32.20
	3325	3600	275	8.0	16.0	3325	3600	32.20
	3600	3800	200	11.0	18.0	3600	3800	34.20
	3800	4100	300	12.0	20.0	3800	4100	36.20
	4100	4125	25	11.0	20.0	4100	4125	36.20
	4125	4500	375	6.5	22.0	4125	4500	38.20
	4500	5600	1100	10.0	24.0	4500	5600	40.20
Kacharakanahalli Kere Water shed Region								
H300	0	850	850	3.0	3.0	0	850	19.20

Name of Zone		East Core Zone						
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	850	900	50	3.0	5.0	850	900	21.20
	900	1250	350	3.0	5.0	900	1250	21.20
	1250	1400	150	2.5	5.0	1250	1400	21.20
	1400	1550	150	2.5	5.0	1400	1550	21.20
	1550	1750	200	3.0	5.0	1550	1750	21.20
	1750	1800	50	3.0	6.0	1750	1800	22.20
	1800	1850	50	3.0	6.0	1800	1850	22.20
	1850	1950	100	4.0	7.0	1850	1950	23.20
	1950	2000	50	10.5	10.5	1950	2000	26.70
	2000	3000	1000	10.5	10.5	2000	3000	26.70
	3000	4000	1000	12.0	12.0	3000	4000	28.20
	4000	5000	1000	14.5	14.5	4000	5000	30.70
	5000	5200	200	18.0	18.0	5000	5200	34.20
	5200	6000	800	16.5	22.0	5200	6000	38.20
	6000	7500	1500	10.5	24.0	6000	7500	40.20
Hennur Bande Water shed Region								
H400	0	1000	1000	3.0	3.0	0	1000	19.20
	1000	2000	1000	4.0	4.0	1000	2000	20.20
	2000	2300	300	4.0	4.0	2000	2300	20.20
	2300	2800	500	4.0	8.0	2300	2800	24.20
	2800	3000	200	5.0	8.0	2800	3000	24.20
	3000	5000	2000	5.0	10.0	3000	5000	26.20
Millers tank Water shed Region								
C100	0	275	275	2.5	2.5	0	275	18.70
	275	350	75	2.5	4.5	275	350	20.70

Name of Zone			East Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	350	400	50	2.5	5.0	350	400	21.20
	400	625	225	3.0	6.0	400	625	22.20
	625	1800	1175	5.0	6.0	625	1800	22.20
	1800	2000	200	4.5	7.5	1800	2000	23.70
	2000	2610	610	7.5	7.5	2000	2610	23.70
	2610	2725	115	7.0	10.5	2610	2725	26.70
	2725	3075	350	9.5	11.0	2725	3075	27.20
	3075	3150	75	6.0	12.0	3075	3150	28.20
	3150	4000	850	14.0	14.0	3150	4000	30.20
Ulsoor Kere Water shed Region								
C100	4000	4925	925	14.0	14.0	4000	4925	30.20
	4925	5000	75	11.0	15.0	4925	5000	31.20
	5000	5050	50	11.5	15.0	5000	5050	31.20
	5050	5650	600	17.5	17.5	5050	5650	33.70
	5650	6000	350	17.0	20.0	5650	6000	36.20
	6000	6725	725	14.5	24.0	6000	6725	40.20
	6725	6750	25	15.0	24.0	6725	6750	40.20
	6750	7000	250	13.0	24.0	6750	7000	40.20
	7000	7550	550	14.0	26.0	7000	7550	42.20
	7550	7625	75	21.0	26.0	7550	7625	42.20
	7625	7700	75	20.0	26.0	7625	7700	42.20
	7700	8075	375	22.0	26.0	7700	8075	42.20
	8075	8600	525	16.0	28.0	8075	8600	44.20
	8600	9000	400	17.0	28.0	8600	9000	44.20
	9000	10000	1000	18.0	30.0	9000	10000	46.20
	10000	12000	2000	20.0	35.0	10000	12000	51.20

Name of Zone			East Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
Bharathinagara Kere Water shed Region								
C200	0	270	270	4.0	4.0	0	270	20.20
	270	320	50	4.5	6.0	270	320	22.20
	320	445	125	4.5	6.0	320	445	22.20
	445	465	20	4.0	6.5	445	465	22.70
	465	1050	585	4.8	8.0	465	1050	24.20
	1050	1200	150	4.8	8.0	1050	1200	24.20
	1200	1500	300	4.8	8.0	1200	1500	24.20
	1500	1875	375	5.0	9.0	1500	1875	25.20
	1875	1975	100	8.0	10.0	1875	1975	26.20
	1975	2075	100	7.8	10.0	1975	2075	26.20
	2075	2175	100	8.0	11.0	2075	2175	27.20
	2175	4050	1875	10.4	12.0	2175	4050	28.20
	4050	4100	50	11.0	14.0	4050	4100	30.20
Lalbagh Kere Water shed Region								
K100	0	500	500	2.0	2.0	0	500	18.20
	500	1000	500	1.6	4.0	500	1000	20.20
	1000	1500	500	2.5	6.5	1000	1500	22.70
	1500	1800	300	5.5	8.0	1500	1800	24.20
	1800	2000	200	4.5	8.0	1800	2000	24.20
	2000	2275	275	5.5	10.0	2000	2275	26.20
	2275	3275	1000	9.5	10.0	2275	3275	26.20
	3275	3475	200	8.5	12.5	3275	3475	28.70
	3475	5200	1725	15.0	15.0	3475	5200	31.20
	5200	6000	800	14.0	22.5	5200	6000	38.70
	6000	6575	575	12.0	22.5	6000	6575	38.70

Name of Zone						East Core Zone		
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	6575	6600	25	20.0	24.0	6575	6600	40.20
	6600	6900	300	12.0	24.0	6600	6900	40.20
	6900	7000	100	15.0	16.0	6900	7000	32.20
	7000	7200	200	7.5	16.0	7000	7200	32.20
	7200	7850	650	8.0	16.0	7200	7850	32.20
	7850	8200	350	12.0	18.0	7850	8200	34.20
	8200	8400	200	7.5	18.0	8200	8400	34.20
	8400	8425	25	10.0	18.0	8400	8425	34.20
	8425	8500	75	10.5	18.0	8425	8500	34.20
	8500	8700	200	9.5	18.0	8500	8700	34.20
	8700	8725	25	10.5	18.0	8700	8725	34.20
	8725	8825	100	11.5	18.0	8725	8825	34.20
	8825	9000	175	10.0	18.0	8825	9000	34.20
	9000	9600	600	11.0	18.0	9000	9600	34.20
	9600	9650	50	11.0	18.0	9600	9650	34.20
	9650	10000	350	13.0	20.0	9650	10000	36.20
	10000	12000	2000	14.0	24.0	10000	12000	40.20

Total Length = 46,200 m

Name of Zone			South Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
Byrasandra Kere Water shed Region								
K200	0	2050	2050	4.0	4.0	0	2050	20.20
	2050	2340	290	6.5	6.5	2050	2340	22.70
	2340	2400	60	4.5	7.5	2340	2400	23.70
	2400	2700	300	6.5	8.0	2400	2700	24.20
	2700	2900	200	7.5	10.5	2700	2900	26.70
	2900	3000	100	5.0	10.5	2900	3000	26.70
	3000	3300	300	6.0	10.5	3000	3300	26.70
	3300	3450	150	6.0	10.5	3300	3450	26.70
	3450	3550	100	5.0	10.5	3450	3550	26.70
	3550	3625	75	7.0	10.5	3550	3625	26.70
	3625	3750	125	7.0	10.5	3625	3750	26.70
	3750	4000	250	7.0	10.5	3750	4000	26.70
	4000	4150	150	8.0	10.5	4000	4150	26.70
	4150	7000	2850	8.5	22.0	4150	7000	38.20
	7000	7825	825	20.0	30.0	7000	7825	46.20
Kempambudhi Kere Water shed Region								
V100	6225	6300	75	22.0	22.0	6225	6300	38.20
	6300	6400	100	21.0	21.0	6300	6400	37.20
	6400	6600	200	12.0	16.0	6400	6600	32.20
	6600	7250	650	20.0	20.0	6600	7250	36.20
	7250	7450	200	15.0	20.0	7250	7450	36.20
	7450	7750	300	18.0	20.0	7450	7750	36.20
	7750	8000	250	15.0	20.0	7750	8000	36.20
	8000	8400	400	23.0	23.0	8000	8400	39.20
	8400	8800	400	24.0	32.0	8400	8800	48.20

Name of Zone			South Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	8800	9000	200	24.0	32.0	8800	9000	48.20
	9000	10000	1000	24.0	32.0	9000	10000	48.20
	10000	10500	500	24.0	32.0	10000	10500	48.20
	10500	11000	500	24.0	34.0	10500	11000	50.20
	11000	12000	1000	30.0	36.0	11000	12000	52.20
	12000	13000	1000	30.0	40.0	12000	13000	56.20
	13000	14000	1000	30.0	45.0	13000	14000	61.20
Nayandanahalli Kere Water shed Region								
V200	7000	8000	1000	15.0	24.0	7000	8000	40.20
	8000	8650	650	20.0	24.0	8000	8650	40.20
	8650	9200	550	20.0	24.0	8650	9200	40.20
	9200	10000	800	22.0	26.0	9200	10000	42.20
	10000	10050	50	22.0	26.0	10000	10050	42.20
	10050	10200	150	32.0	26.0	10050	10200	42.20
	10200	10300	100	32.0	26.0	10200	10300	42.20
	10300	10850	550	32.0	26.0	10300	10850	42.20
	10850	11000	150	22.0	28.0	10850	11000	44.20
	11000	11500	500	25.0	28.0	11000	11500	44.20
	11500	12000	500	25.0	28.0	11500	12000	44.20
	12000	13300	1300	26.0	30.0	12000	13300	46.20
Yediyur Kere Water shed Region								
V300	0	300	300	2.5	2.5	0	300	18.70
	300	500	200	2.5	2.5	300	500	18.70
	500	1400	900	5.0	5.0	500	1400	21.20
	1400	1500	100	5.0	6.5	1400	1500	22.70
	1500	1575	75	7.5	7.5	1500	1575	23.70

Name of Zone			South Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	1575	1950	375	7.5	8.0	1575	1950	24.20
	1950	2850	900	10.0	10.0	1950	2850	26.20
	2850	3000	150	5.0	10.0	2850	3000	26.20
	3000	3150	150	10.0	10.0	3000	3150	26.20
	3150	3325	175	10.0	10.5	3150	3325	26.70
	3325	3450	125	5.5	10.5	3325	3450	26.70
	3450	3650	200	10.0	12.0	3450	3650	28.20
	3650	4000	350	12.0	18.0	3650	4000	34.20
	4000	5000	1000	14.0	24.0	4000	5000	40.20

Total Length = 26,900 m

Name of Zone	West Core Zone							
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
Mattikere Kere Water shed Region								
H200	0	425	425	2.5	2.5	0	425	18.70
	425	550	125	2.5	3.0	425	550	19.20
	550	1000	450	2.5	4.0	550	1000	20.20
	1000	1700	700	2.5	4.0	1000	1700	20.20
	1700	1900	200	3.0	4.5	1700	1900	20.70
	1900	2000	100	2.8	4.0	1900	2000	20.20
	2000	2475	475	2.8	6.0	2000	2475	22.20
	2475	2800	325	5.0	7.5	2475	2800	23.70
	2800	2925	125	7.5	7.5	2800	2925	23.70
	2925	2950	25	7.0	7.5	2925	2950	23.70
	2950	3625	675	7.5	7.5	2950	3625	23.70
	3625	3775	150	8.0	14.0	3625	3775	30.20
	3775	3800	25	6.0	14.0	3775	3800	30.20
	3800	3950	150	5.5	14.0	3800	3950	30.20
	3950	4000	50	6.0	14.0	3950	4000	30.20
	4000	4225	225	6.0	15.0	4000	4225	31.20
	4225	4250	25	6.0	15.0	4225	4250	31.20
	4250	4450	200	6.5	15.0	4250	4450	31.20
	4450	4550	100	6.5	15.0	4450	4550	31.20
	4550	4825	275	11.5	16.5	4550	4825	32.70
	4825	4950	125	11.5	16.5	4825	4950	32.70
	4950	5025	75	11.5	18.0	4950	5025	34.20
	5025	5075	50	11.5	18.0	5025	5075	34.20
	5075	5175	100	5.5	18.0	5075	5175	34.20

Name of Zone	West Core Zone							
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	5175	5600	425	5.5	10.0	5175	5600	26.20
	5600	5750	150	5.0	10.0	5600	5750	26.20
	5750	6000	250	6.0	10.0	5750	6000	26.20
	6000	6075	75	4.0	10.0	6000	6075	26.20
	6075	6350	275	6.5	12.0	6075	6350	28.20
	6350	7000	650	10.0	22.0	6350	7000	38.20
	7000	7750	750	10.0	22.0	7000	7750	38.20
	7750	7800	50	9.0	24.0	7750	7800	40.20
	7800	8000	200	10.0	24.0	7800	8000	40.20
	8000	9000	1000	10.0	24.0	8000	9000	40.20
Sankey Kere Water shed Region								
V100	0	2000	2000	6.5.	6.5	0	2000	22.70
	2000	2100	100	11.0	11.0	2000	2100	27.20
	2100	2300	200	11.0	11.0	2100	2300	27.20
	2300	2500	200	10.0	14.0	2300	2500	30.20
	2500	3800	1300	13.0	16.0	2500	3800	32.20
	3800	3900	100	12.0	18.0	3800	3900	34.20
	3900	5150	1250	18.0	18.0	3900	5150	34.20
	5150	5600	450	12.0	18.0	5150	5600	34.20
	5600	6225	625	20.0	20.0	5600	6225	36.20
Nandini Layout Water shed Region								
V200	0	225	225	3.5	3.5	0	225	19.70
	225	325	100	4.0	4.5	225	325	20.70
	325	1900	1575	4.5	4.5	325	1900	20.70
	1900	2000	100	4.7	6.5	1900	2000	22.70
	2000	2175	175	7.5	8.0	2000	2175	24.20

Name of Zone			West Core Zone					
Drain ID	Drain Widening					Service Corridor		
	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
	From	To				From	To	
	2175	2200	25	7.0	8.0	2175	2200	24.20
	2200	2325	125	7.5	8.0	2200	2325	24.20
	2325	2700	375	7.5	8.0	2325	2700	24.20
	2700	3000	300	7.5	8.0	2700	3000	24.20
	3000	3300	300	8.0	10.0	3000	3300	26.20
	3300	3500	200	8.0	10.0	3300	3500	26.20
	3500	3900	400	10.0	18.0	3500	3900	34.20
	3900	4000	100	12.0	18.0	3900	4000	34.20
	4000	4200	200	10.0	20.0	4000	4200	36.20
	4200	4300	100	10.0	20.0	4200	4300	36.20
	4300	4500	200	14.0	20.0	4300	4500	36.20
	4500	4800	300	12.5	20.0	4500	4800	36.20
	4800	5000	200	20.0	22.0	4800	5000	38.20
Laggere Kere water shed region								
V200	5000	5250	250	18.0	22.0	5000	5250	38.20
	5250	5350	100	14.0	22.0	5250	5350	38.20
	5350	6000	650	16.0	22.0	5350	6000	38.20
	6000	6800	800	17.0	22.0	6000	6800	38.20
	6800	7000	200	12.0	24.0	6800	7000	40.20

Total Length = 22,225 m

Name of Zone				Bommanahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Thalaghattapura Kere Watershed Region									
BH811	Pri.	0	300	300	3.0	3.0	0	300	19.2
BH812	Sec.	0	270	270	2.5	2.5			
BH813	Pri.	0	1065	1065	4.0	5.0	0	1065	21.2
BH813A	Sec.	0	575	575	4.0	4.0	0	575	10.7
BH814	Pri.	0	500	500	3.0	5.0	0	500	21.2
	Pri.	500	1000	500	7.5	7.5	500	1000	23.7
	Pri.	1000	2450	1450	4.0	7.5	1000	2450	23.7
BH814A	Sec.	0	600	600	3.5	3.5	0	600	15.7
	Sec.	600	910	310	2.5	3.5			
BH841	Pri.	0	1550	1550	1.5	3.0	0	1550	19.2
	Pri.	1550	1720	170	2.5	4.0	1550	1720	20.2
BH842	Sec.	0	840	840	2.5	2.5	0	200	14.7
BH843	Pri.	0	1135	1135	4.0	5.0	0	1135	21.2
BH851	Pri.	0	100	100	3.5	5.0	0	100	21.2
	Pri.	100	600	500	2.5	5.0	100	600	21.2
	Pri.	600	1200	600	2.0	6.0	600	1200	22.2
	Pri.	1200	1700	500	3.0	6.0	1200	1700	22.2
	Pri.	1700	1950	250	5.0	6.0	1700	1950	22.2
	Pri.	1950	2260	310	5.0	6.0	1950	2260	22.2
BH851A	Sec.	0	640	640	2.0	2.0			
BH851B	Sec.	0	495	495	1.5	1.5			
BH861	Pri.	0	1000	1000	5.5	8.0	0	1000	24.2
	Pri.	1000	2000	1000	6.0	10.0	1000	2000	26.2
	Pri.	2000	3000	1000	11.0	12.0	2000	3000	28.2
	Pri.	3000	3800	800	14.0	14.0	3000	3800	30.2
BH861A	Sec.	0	1005	1005	2.5	2.5			
BH861B	Sec.	0	475	475	4.0	4.0	500	1000	16.2

Name of Zone				Bommanahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
BH861C	Sec.	0	235	235	2.0	2.0	0	150	8.7
BH871	Sec.	0	650	650	2.5	3.5	0	650	15.70
BH872	Sec.	0	500	500	2.0	2.0			
	Sec.	500	900	400	2.5	3.0			
	Sec.	900	1475	575	3.0	3.0	450	1200	15.2
	Sec.	1475	1800	325	4.0	4.0	1200	1400	16.2
BH872A	Sec.	0	520	520	1.5	1.5			
BH873	Pri.	0	500	500	8.0	10.0	0	500	26.2
	Pri.	500	1000	500	10.0	12.5	500	1000	28.7
	Pri.	1000	1545	545	12.0	14.0	1000	1545	30.2
Hulimavu Kere Watershed Region									
BH522	Pri.	0	530	530	4.0	5.0	0	425	21.2
BH523	Pri.	0	725	725	4.5	5.0	0	725	21.2
BH524	Pri.	0	1500	1500	3.0	6.0	0	1500	22.2
	Pri.	1500	1950	450	7.0	7.5	1500	1950	23.7
BH525	Pri.	0	1035	1035	3.0	5.0	0	400	21.2
BH532	Pri.	0	1075	1075	3.5	5.0	0	1075	21.2
BH527	Sec.	0	300	300	2.0	2.5	0	300	9.2
	Sec.	300	750	450	2.0	2.0			
Ibaluru Kere Watershed Region									
BH599	Pri.	0	800	800	4.5	5.0	0	0	21.2
BH599A	Sec.	0	1150	1150	7.0	7.0	0	1150	19.2
Shanboganahalli Kere Watershed Region									
BH911	Pri.	0	500	500	2.0	3.0	0	500	19.2
	Pri.	500	1000	500	3.0	5.0	500	1000	21.2
	Pri.	1000	1500	500	5.0	6.0	1000	1500	22.2
	Pri.	1500	2000	500	8.0	8.0	1500	2000	24.2
	Pri.	2000	2500	500	5.0	10.0	2000	2500	26.2
	Pri.	2500	2700	200	6.0	12.0	2500	2700	28.2

Name of Zone				Bommanahalli Zone					
		Drain Widening					Service Corridor		
Drain ID	TYPE	Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
BH912	Sec.	0	425	425	5.0	5.0	0	425	17.2
BH921	Sec.	0	950	950	8.0	8.0	0	950	20.2
BH922	Sec.	0	1010	1010	8.0	8.0	0	1010	20.2
BH923	Sec.	0	625	625	8.0	8.0			
BH931	Sec.	0	1000	1000	6.0	6.0	0	1000	18.2
	Sec.	1000	2065	1065	6.0	6.0	1000	2065	18.2
BH932	Pri.	0	550	550	6.0	7.5	0	550	23.7
BH933	Pri.	0	775	775	10.0	12.5	0	775	28.7
Madivala Kere Watershed Region									
BH541	Pri.	0	400	400	4.0	4.0	0	400	20.2
	Pri.	400	905	505	4.0	6.0	400	905	22.2
BH542	Sec.	0	545	545	6.0	6.0	0	545	18.2
BH543	Sec.	0	700	700	3.0	3.0			
	Sec.	700	900	200	5.0	5.5			
	Sec.	900	1050	150	5.5	5.5	900	1050	12.2
BH544	Pri.	0	1370	1370	2.0	5.0	0	1370	21.2
BH547	Pri.	0	200	200	2.5	6.0	0	200	22.2
BH549	Pri.	0	230	230	2.0	7.5	0	230	23.7
BH551	Pri.	0	500	500	3.0	4.0	0	500	20.2
BH552A	Pri.	0	1135	1135	1.5	4.0	0	1135	20.2
BH553	Pri.	0	515	515	1.5	5.0	0	515	21.2
BH554	Pri.	0	1150	1150	7.0	8.0	0	1150	24.2
	Pri.	1150	1425	275	6.0	8.0	1150	1425	24.2
	Pri.	1425	1730	305	5.0	8.5	1425	1735	24.7
BH552	Sec.	0	975	975	2.0	2.0			
Puttenahalli Kere Watershed Region									
BH511	Sec.	0	350	350	2.0	2.0			
	Sec.	350	650	300	2.0	2.0			
	Sec.	650	700	50	3.0	3.0			

Name of Zone				Bommanahalli Zone					
		Drain Widening					Service Corridor		
Drain ID	TYPE	Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
BH512	Pri.	0	500	500	1.5	3.0	0	500	19.2
	Pri.	500	1000	500	1.5	4.0	500	1000	20.2
	Pri.	1000	1125	125	1.5	5.0	1000	1125	21.2
	Pri.	1125	1800	675	2.0	5.0	1125	1800	21.2
BH512B	Pri.	0	520	520	3.0	5.0	0	520	21.2
BH514	Sec.	0	735	735	1.0	2.0	0	735	18.2
BH515	Sec.	0	1165	1165	4.0	4.5	0	950	20.7
BH516	Pri.	0	810	810	4.5	5.0	0	810	21.2
Dodda Begur Kere Watershed Region									
BH561	Pri.	0	1000	1000	7.0	10.0	0	1000	26.2
	Pri.	1000	1280	280	8.0	10.0	1000	1280	26.2
BH562	Pri.	0	760	760	5.0	7.5	0	760	23.7
BH563	Pri.	0	895	895	9.0	12.5	0	895	28.7
BH563A	Sec.	0	1000	1000	5.0	5.0	0	1000	17.2
	Sec.	1000	2045	1045	7.0	7.0	1000	2045	19.2
BH563B	Sec.	0	920	920	4.0	4.0	0	920	16.2
BH564	Pri.	0	435	435	2.5	4.0	0	435	20.2
BH565	Pri.	0	730	730	3.0	4.5	0	730	20.7
BH566	Pri.	0	270	270	2.0	5.0	0	270	21.2
BH567	Sec.	0	1090	1090	4.0	4.5	0	200	16.7
BH568	Pri.	0	1000	1000	4.5	7.5	0	1000	23.7
	Pri.	1000	1355	355	5.0	7.5	1000	1200	23.7
BH569	Pri.	0	500	500	5.0	5.0	0	500	21.2
	Pri.	500	750	250	2.0	6.0	500	750	22.2
	Pri.	750	925	175	3.5	6.0	750	925	22.2
	Pri.	925	1000	75	5.0	7.5	925	1000	23.7
	Pri.	1000	1100	100	6.0	10.0	1000	1100	26.2
Kaikonadanahalli Kere Watershed Region									
(K203)	Pri.	0	1230	1230	5.0	12.5	0	1230	28.7

Name of Zone				Bommanahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
(K209)	Pri.	2900	4150	1250	9.0	12.0	2900	4150	28.2
(K210)	Pri.	1500	1550	50	3.0	10.0	1500	1550	26.2
BH517A	Sec.	0	665	665	2.0	2.0			
BH517B	Sec.	0	300	300	2.0	2.0	0	150	8.7
BH517C	Sec.	0	180	180	1.5	2.0			
BH613	Sec.	0	545	545	9.0	9.0	0	600	21.2
BH614	Pri.	0	500	500	2.0	3.0	0	500	19.2
	Pri.	500	700	200	3.0	4.0	500	700	20.2
	Pri.	700	775	75	4.0	4.0	700	775	20.2
	Pri.	775	1125	350	3.5	5.0	775	1125	21.2
BH614A	Sec.	0	300	300	2.0	2.0			
	Sec.	300	475	175	2.5	2.5			
	Sec.	475	510	35	2.0	2.5			
BH615	Sec.	0	815	815	7.0	7.0	0	815	19.2
BH621	Pri.	0	1000	1000	9.0	10.0	0	1000	26.2
BH622	Sec.	0	175	175	2.0	2.5			
	Sec.	175	375	200	3.0	3.0			
	Sec.	375	825	450	3.0	3.5	400	825	15.7
BH623	Pri.	0	300	300	9.0	10.0	0	300	26.2
BH624	Pri.	0	150	150	6.0	6.0	0	150	22.2
	Pri.	150	660	510	2.5	7.0	150	660	23.2
BH624A	Sec.	0	125	125	3.0	3.0			
	Sec.	125	175	50	3.0	3.0			
	Sec.	175	450	275	3.0	3.0	350	450	15.2
BH624B	Sec.	0	365	365	1.0	1.0			
BH625	Pri.	0	600	600	9.0	10.0	0	600	26.2
BH625A	Sec.	0	475	475	2.0	2.0			
BH627	Pri.	0	550	550	3.0	10.0	0	550	26.2
BH628	Pri.	0	800	800	10.0	10.0	0	800	26.2

Name of Zone				Bommanahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Chikka Begur Kere Watershed Region									
BH571	Pri.	0	275	275	8.0	12.5	0	275	28.7
	Pri.	275	525	250	4.5	12.5	275	525	28.7
BH572	Pri.	0	150	150	5.0	12.5	0	150	28.7
	Pri.	150	375	225	2.0	12.5	150	375	28.7
	Pri.	375	1240	865	6.0	12.5	375	1240	28.7
BH572A	Pri.	0	500	500	4.5	5.0	0	500	21.2
	Pri.	500	900	400	3.0	5.0	500	900	21.2
	Pri.	900	1050	150	3.0	6.0	900	1050	22.2
BH573	Sec.	0	500	500	2.0	2.0			
	Sec.	500	850	350	3.5	4.0	650	950	10.7
BH574	Pri.	0	760	760	5.0	12.5	0	760	28.7
BH576	Sec.	0	845	845	3.5	4.0			
BH577	Pri.	0	500	500	5.0	12.5	0	500	28.7
BH578	Sec.	0	1010	1010	3.0	3.0	0	250	9.7
BH579	Pri.	0	685	685	6.0	12.5	0	685	28.7
BH581	Pri.	0	650	650	2.0	3.0	0	650	19.2
	Pri.	650	1000	350	5.0	6.0	650	1000	22.2
BH582	Sec.	0	450	450	3.5	3.5			
BH583	Pri.	0	1125	1125	4.0	4.0	0	1125	20.2
BH584	Pri.	0	600	600	2.0	3.0	0	600	19.2
	Pri.	600	825	225	3.5	5.0	600	825	21.2
BH593	Sec.	0	275	275	1.0	1.5			
	Sec.	275	350	75	1.5	2.0			
BH593A	Sec.	0	525	525	3.0	3.5	150	425	10.2
BH594	Pri.	0	545	545	3.0	4.0	0	545	20.2
BH595	Pri.	0	970	970	4.5	5.0	0	970	21.2
BH597	Pri.	0	2120	2120	4.0	5.0	0	2120	21.2
BH597A	Sec.	0	200	200	2.5	2.5	0	200	14.7

Name of Zone		Bommanahalli Zone							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Bellanduru Kere Water Shed Region									
BH631	Sec.	0	445	445	2.5	3.0	0	445	15.2
BH632	Pri.	0	1075	1075	4.0	5.0	0	1075	21.2
BH633	Pri.	0	725	725	6.0	6.0	0	725	22.2
	Pri.	725	1860	1135	1.3	7.5	725	1860	23.7
BH634	Pri.	0	775	775	2.5	5.0	0	775	21.2
	Pri.	775	1155	380	4.0	8.0	775	1020	24.2
BH636	Pri.	0	1000	1000	6.0	8.0	0	1000	24.2
	Pri.	1000	1525	525	6.0	10.0	1000	1525	26.2
BH641	Sec.	0	275	275	3.0	3.5	0	275	15.7
BH642	Sec.	0	805	805	4.0	4.0	0	805	16.2
BH643	Pri.	0	245	245	2.0	5.0	0	245	21.2
BH644	Sec.	0	560	560	3.0	3.0	0	560	15.2
BH645	Pri.	0	600	600	8.0	10.0	0	600	26.2
BH646	Sec.	0	515	515	3.0	3.0	0	515	15.2
BH647	Pri.	0	175	175	8.0	8.0	0	175	24.2
BH648	Pri.	0	950	950	5.0	6.0	0	950	22.2

Total Length = 104,025 m

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
Yelahanka Kere Water Shed Region										
BP122A	Sec.	0	225	225	2.0	3.0	0	900	15.2	
	Sec.	225	600	375	4.5	5.0				
	Sec.	600	900	300	7.5	8.0				
BP122	Pri.	0	150	150	3.0	3.0	0	150	19.20	
	Pri.	150	500	350	3.0	3.0	150	500	19.20	
	Pri.	500	750	250	3.0	3.5	500	750	19.70	
	Pri.	750	1050	300	3.0	5.0	750	1050	21.20	
BP123	Sec.	0	250	250	4.5	5.0	0	550	17.2	
	Sec.	250	500	250	6.0	6.0				
	Sec.	500	725	225	3.0	7.5				
BP123A	Sec.	0	200	200	5.0	5.0	0	800	17.2	
	Sec.	200	500	300	6.0	6.0				
	Sec.	500	800	300	6.0	7.5				
BP124	Pri.	0	1060	1060	5.0	7.5	0	1060	23.70	
BP125	Pri.	0	125	125	16.0	16.0	0	125	32.20	
	Pri.	125	1075	950	8.0	8.0	125	1075	24.20	
	Pri.	1075	1250	175	4.0	14.0	1075	1250	30.20	
	Pri.	1250	1550	300	13.0	17.5	1250	1550	33.70	
	Pri.	1550	2500	950	14.0	20.0	1550	2500	36.20	
BP131	Pri.	0	250	250	2.5	4.5	0	250	20.70	
	Pri.	250	500	250	3.5	5.0	250	500	21.20	
	Pri.	500	700	200	4.5	6.0	500	700	22.20	
BP132	Pri.	0	250	250	2.5	7.0	0	250	23.20	
	Pri.	250	500	250	2.5	7.5	250	500	23.70	
	Pri.	500	830	330	2.0	10.0	500	830	26.20	
BP133	Pri.	0	250	250	1.5	4.0	0	250	20.20	

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
		250	500	250	2.0	5.0	250	500	21.20	
		500	750	250	3.0	6.0	500	750	22.20	
		750	1150	400	3.0	7.5	750	1150	23.70	
BP134	Pri.	0	250	250	2.5	7.5	0	250	23.70	
	Pri.	250	500	250	1.5	8.5	250	500	24.70	
	Pri.	500	750	250	1.5	10.0	500	750	26.20	
	Pri.	750	825	75	3.0	12.0	750	825	28.20	
BP135	Pri.	0	250	250	4.5	12.5	0	250	28.70	
	Pri.	250	500	250	8.0	14.0	250	500	30.20	
	Pri.	500	850	350	1.6	16.0	500	850	32.20	
BP136	Pri.	0	1300	1300	8.0	15.0	0	1300	31.20	
BP137	Sec.	0	250	250	1.0	1.5				
	Sec.	250	450	200	1.5	2.5	250	400	14.7	
	Sec.	450	925	475	1.5	3.0				
	Sec.	925	1150	225	1.5	5.0				
	Sec.	1150	1450	300	2.0	7.0	1200	1500	19.2	
BP138	Sec.	0	350	350	1.5	1.5				
	Sec.	350	600	250	2.5	3.0				
	Sec.	600	875	275	2.5	4.0				
BP141	Pri.	0	1325	1325	4.0	7.5	0	1325	23.70	
Allalasandra Kere Water Shed Region										
BP161 (BY13)	Pri.	0	800	800	4.0	4.0	0	800	20.20	
	Pri.	800	1000	200	3.5	6.5	800	1000	22.70	
	Pri.	1000	1100	100	4.0	7.5	1000	1100	23.70	
BP161A	Sec.	0	485	485	2.5	2.5				
BP162	Sec.	0	525	525	1.5	1.5				

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Sec.	525	625	100	2.0	2.0				
	Sec.	625	1600	975	2.0	2.0				
	Sec.	1600	1800	200	3.5	6.0	1000	1800	12.1	
BP162A	Sec.	0	1300	1300	3.0	3.0				
	Sec.	1300	1410	110	3.0	5.0				
BP162B	Sec.	0	460	460	1.2	2.5				
BP163 (BY12)	Pri.	0	250	250	4.5	4.5	0	250	20.70	
	Pri.	250	600	350	2.5	5.0	250	600	21.20	
	Pri.	600	900	300	3.5	7.5	600	900	23.70	
	Pri.	900	1000	100	8.0	8.0	900	1000	24.20	
	Pri.	1000	1500	500	9.0	9.0	1000	1500	25.20	
	Pri.	1500	1800	300	5.5	9.0	1500	1800	25.20	
	Pri.	1800	2000	200	4.5	10.0	1800	2000	26.20	
	Pri.	2000	2610	610	5.0	12.0	2000	2610	28.20	
Jakkuru Kere Water Shed Region										
BP159A	Sec.	0	505	505	2.5	4.0	150	525	16.2	
BP159B	Sec.	0	400	400	2.0	3.0	0	400	9.1	
	Sec.	400	900	500	2.5	4.0	400	900	16.2	
BP142 (BY09)	Pri.	0	425	425	16.0	16.0	0	425	32.20	
	Pri.	475	650	175	6.5	16.0	475	650	32.20	
	Pri.	650	1000	350	28.0	28.0	650	1000	44.20	
	Pri.	1000	2525	1525	20.0	35.0	1000	2525	51.20	
BP142A	Pri.	0	1085	1085	6.0	10.0	0	1085	26.20	
BP151	Pri.	0	250	250	2.0	2.0	0	250	18.20	
	Pri.	250	425	175	3.0	4.0	250	425	20.20	

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Pri.	425	875	450	4.0	5.0	425	875	21.20	
BP151A	Sec.	0	625	625	1.2	2.5				
BP152	Pri.	0	340	340	2.5	2.5	0	340	18.70	
BP160	Sec.	0	440	440	4.5	6.0	0	440	12.1	
BP154	Pri.	0	935	935	2.0	3.0	0	935	19.20	
BP155	Sec.	0	1245	1245	4.5	5.0	300	450	11.1	
BP155A	Sec.	0	295	295	3.0	5.0	0	300	11.1	
BP156	Pri.	0	1000	1000	3.0	7.0	0	1000	23.20	
	Pri.	1000	1375	375	5.0	8.5	1000	1375	24.70	
	Pri.	1375	2225	850	6.0	10.0	1375	2225	26.20	
BP157	Pri.	0	150	150	1.0	3.0	0	150	19.20	
	Pri.	150	500	350	2.0	5.0	150	500	21.20	
	Pri.	500	725	225	2.0	7.5	500	725	23.70	
BP158	Pri.	0	200	200	2.0	5.0	0	200	21.20	
	Pri.	200	550	350	2.0	7.0	200	550	23.20	
	Pri.	550	900	350	3.0	7.5	550	900	23.70	
	Pri.	900	1300	400	5.0	10.0	900	1300	26.20	
BP158A	Sec.	0	335	335	2.0	3.0	150	350	15.2	
BP158B	Sec.	0	535	535	2.5	3.0	0	550	15.2	
BP171B	Sec.	0	575	575	2.0	4.0	0	500	10.1	
	Sec.	575	875	300	3.0	6.0	500	900	18.2	
BP171E	Sec.	0	750	750	1.0	2.0				
Rachenahalli Kere Water Shed Region										
BP171 (BY10)	Pri.	0	500	500	15.0	18.0	0	500	34.20	
BP171A	Pri.	0	400	400	17.0	20.0	0	400	36.20	
	Pri.	0	400	400	17.0	20.0	0	400	36.20	

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Pri.	400	1100	700	17.0	20.0	400	1100	36.20	
	Pri.	1100	1500	400	11.0	20.0	1100	1500	36.20	
	Pri.	1500	1800	300	8.0	22.0	1500	1800	38.20	
BP171C	Sec.	0	250	250	2.5	3.0				
	Sec.	250	500	250	3.0	4.0	250	500	16.2	
	Sec.	500	800	300	4.0	6.0				
	Sec.	800	1325	525	4.0	7.5	800	1325	19.7	
BP171D	Sec.	0	550	550	1.8	4.0	175	550	10.1	
BP172	Sec.	0	100	100	2.5	3.0				
	Sec.	100	250	150	2.5	3.0				
	Sec.	250	350	100	4.0	5.0				
	Sec.	350	775	425	5.0	6.5				
	Sec.	775	1100	325	4.5	7.5	650	1200	13.6	
	Sec.	1100	1300	200	2.5					Parallel Box (3 x 2)
BP172A	Sec.	0	265	265	3.0	3.0	0	265	9.1	
BP174	Sec.	0	250	250	4.0	5.0	0	500	17.2	
	Sec.	250	500	250	2.5	5.0				
	Sec.	500	650	150	2.5	5.0	500	650	11.1	
	Sec.	650	1000	350	2.5	5.0	650	1170	11.1	
	Sec.	1000	1170	170	5.0	6.0				
BP176	Pri.	0	250	250	5.0	6.0	0	250	22.20	
	Pri.	250	1250	1000	6.0	7.5	250	1250	23.70	
	Pri.	1300	1675	375	7.0	8.0	1300	1675	24.20	
BP176A	Sec.	0	200	200	5.0	6.0	0	200	12.1	
BP176B	Sec.	0	1120	1120			750	1037	8.1	
BP177	Pri.	0	50	50	5.5	6.0	0	50	22.20	

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Pri.	50	150	100	3.5	6.0	50	150	22.20	
	Pri.	150	300	150	2.0	6.0	150	300	22.20	Parallel Box (3 x 2)
	Pri.	300	1000	700	3.0	8.0	550	1000	24.20	
	Pri.	1000	1125	125	5.5	10.0				
BP177A	Sec.	0	1510	1510	0.5	2.0				
BP177B	Sec.	0	850	850	1.5	4.0	550	850	10.1	
BP177C	Sec.	0	1020	1020	1.5	4.0	500	900	15.6	
BP177D	Sec.	0	135	135	1.0	2.0	25	135	8.1	
BP178	Sec.	0	200	200	1.5	1.5				
	Sec.	200	400	200	1.5					Parallel Box (2 x 2)
	Sec.	400	600	200	4.0	6.0				
Doddabommasandra Kere Water Shed Region										
BP010	Pri.	0	475	475	3.5	3.5	0	475	19.70	
	Pri.	475	600	125	3.5	6.0	475	600	22.20	
BP010A	Sec.	0	975	975	1.5	3.0				
BP012	Pri.	0	600	600	1.5	3.0	0	600	19.20	Parallel Box (3 x 2m)
BP013	Pri.	0	375	375	5.0	5.0	0	375	21.20	
	Pri.	375	1050	675	3.5	6.0	375	1050	22.20	
BP014	Pri.	0	300	300	2.0	4.0	0	300	20.20	
	Pri.	300	575	275	2.0	5.0	300	575	21.20	
	Pri.	575	1900	1325	7.0	7.0	575	1900	23.20	
BP015 (BY08)	Pri.	0	1005	1005	3.0	7.0	0	1005	23.20	
BP016 (BY07)	Pri.	0	600	600	2.5	2.5	0	600	18.70	
	Pri.	600	875	275	2.5	3.0	600	875	19.20	
	Pri.	875	1050	175	3.0	3.0	875	1050	19.20	
BP016A	Sec.	0	100	100	2.0	2.0				

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Sec.	100	700	600	2.0	2.0				
	Sec.	700	800	100	2.0	4.0				
BP016B	Sec.	0	150	150	1.0	2.5				
	Sec.	150	500	350	2.0	2.0				New box (2 x 1.5m)
	Sec.	500	700	200	2.0	2.0				
	Sec.	700	775	75	2.0	3.0				
	Sec.	775	1200	425	2.0	3.0				
BP017	Pri.	0	900	900	5.0	5.0	0	900	21.20	
	Pri.	900	1200	300	4.0	5.0	900	1200	21.20	
	Pri.	1200	2000	800	3.0	5.0	1200	2000	21.20	
BP020 (BY01)	Pri.	0	765	765	3.0	7.0	0	765	23.20	
BP022 (BY04)	Pri.	0	400	400	3.0	6.0	0	400	22.20	
	Pri.	400	460	60	3.0	6.0	400	460	22.20	
BP025 (BY02A)	Pri.	0	380	380	3.0	3.0	0	380	19.20	
BP025 (BY02)	Pri.	0	650	650	3.0	6.0	0	650	22.20	
BP026 (BY03)	Pri.	0	400	400	1.5	4.0	0	400	20.20	
	Pri.	400	600	200	3.5	4.0	400	600	20.20	
	Pri.	600	900	300	3.5	4.0	600	900	20.20	
	Pri.	900	1445	545	6.0	6.0	900	1445	22.20	
BP026A	Sec.	0	250	250	1.0	2.0				
	Sec.	250	500	250	1.0	3.5	300	500	9.6	
BP026B	Sec.	0	200	200	1.0	2.0				
	Sec.	200	315	115	1.5	3.5				
Gedalahalli Kere Water Shed Region										
BP181	Pri.	0	100	100	15.0	15.0	0	100	31.20	

Name of Zone	Yelahanka Zone									
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Pri.	100	250	150	13.5	15.0	100	250	31.20	
	Pri.	250	600	350	11.5	16.0	250	600	32.20	
BP181A (BY11)	Pri.	0	600	600	14.5	16.0	0	600	32.20	
	Pri.	600	1000	400	13.5	28.0	600	1000	44.20	
	Pri.	1000	1200	200	11.5	30.0	1000	1200	46.20	
	Pri.	1200	1310	110	10.5	32.0	1200	1310	48.20	
BP183 (BY06)	Pri.	0	200	200	19.0	24.0	0	200	40.20	
	Pri.	200	800	600	11.0	24.0	200	800	40.20	
	Pri.	800	1075	275	11.0	24.0	800	1075	40.20	
	Pri.	1075	2000	925	10.0	32.0	1075	2000	48.20	
	Pri.	2000	3000	1000	12.0	34.0	2000	3000	50.20	
	Pri.	3000	4100	1100	25.0	36.0	3000	4100	52.20	
BP184	Pri.	0	450	450	2.0	3.0	0	450	19.20	Box Drain (3 x 2m)
	Pri.	450	950	500	3.5	3.5	450	950	19.70	
	Pri.	950	1500	550	3.5	4.0	950	1500	20.20	
	Pri.	1500	1875	375	3.5	4.0	1500	1875	20.20	
BP184A	Sec.	0	200	200	1.0	1.6				
	Sec.	200	425	225	2.0	3.5				
BP184B	Sec.	0	450	450	1.0	2.0				
Kacharakanahalli Kere (H300) Watershed Region										
BP183A	Sec.	0	245	245	1.0	2.0				
BP183B	Sec.	0	500	500	1.5	1.5				
	Sec.	500	680	180	1.5	3.5	500	750	9.6	
Kalkere Water Shed Region										
BP186	Sec.	0	100	100	2.0					Parallel Box (4 x 2m)

Name of Zone	**Yelahanka Zone**									
Drain ID	**TYPE**	**Drain Widening**					**Service Corridor**			**Remarks**
		Chainage		**Length (m.)**	**Ex. Avg. Width (m.)**	**Prop Avg. Width (m.)**	**Total Length (m.)**		**Total Width Required incl. SR (m.)**	
		From	**To**				**From**	**To**		
	Sec.	100	160	60	2.0	5.0				
MD196 (KR13)	Pri.	0	4695	4695	40.0	50.0	0	4695	66.20	
BP191	Pri.	0	1000	1000	5.5	8.0	0	1000	24.20	
	Pri.	1000	2000	1000	6.0	8.0	1000	2000	24.20	
	Pri.	2000	2500	500	4.0	8.0	2000	2500	24.20	
	Pri.	2500	3000	500	4.0	10.0	2500	3000	26.20	
	Pri.	3000	3500	500	3.5	12.5	3000	3500	28.70	
	Pri.	3500	3750	250	8.0	15.0	3500	3750	31.20	
	Pri.	3750	4000	250	10.0	18.0	3750	4000	34.20	
BP192	Sec.	0	600	600	6.0	8.0	0	600	20.2	
BP193	Sec.	0	400	400	4.0	5.0	0	400	17.2	
BP194	Sec.	0	750	750	4.0	5.0	0	500	11.1	
	Sec.	750	900	150	4.0	5.0	700	1250	11.1	
	Sec.	900	1000	100	5.0	7.5				
	Sec.	1000	1250	250	6.0	8.0				
BP195	Sec.	0	500	500	8.0	8.0	0	1400	20.2	
	Sec.	500	1000	500	8.0	10.0				
	Sec.	1000	1295	295	8.0	12.0				
Bellahalli (Kannuru) Kere Water Shed Region										
BP211	Pri.	0	500	500	6.0	6.0	0	500	22.20	
	Pri.	500	860	360	4.5	8.0	500	860	24.20	
BP213	Pri.	0	400	400	6.5	8.0	0	400	24.20	
	Pri.	400	710	310	2.5	10.0	400	710	26.20	
BP213A	Sec.	0	400	400	3.0	4.0				
	Sec.	400	600	200	2.0	5.0				

Name of Zone	**Yelahanka Zone**									
Drain ID	**TYPE**	**Drain Widening**					**Service Corridor**			**Remarks**
		Chainage		**Length (m.)**	**Ex. Avg. Width (m.)**	**Prop Avg. Width (m.)**	**Total Length (m.)**		**Total Width Required incl. SR (m.)**	
		From	**To**				**From**	**To**		
	Sec.	600	745	145	2.0	6.0				
BP213B	Sec.	0	681	681			0	700	12.2	
Shingapura Kere Water Shed Region										
BP110	Sec.	0	225	225	4.5	6.0	0	225	12.1	
BP111	Pri.	0	155	155	1.6	4.0	0	155	20.20	
BP111A	Sec.	0	450	450	2.0	2.0	450	800	14.2	
		450	777	327	3.0	4.0				
BP112	Sec.	0	350	350	3.5	4.0				
	Sec.	350	500	150	6.0	7.5	350	500	13.6	
	Sec.	500	700	200	8.0	8.0				
BP113	Pri.	0	100	100	4.5	5.0	0	100	21.20	
	Pri.	100	280	180	1.5	6.0	100	280	22.20	
BP114	Pri.	0	250	250	2.1	4.0	0	250	20.20	
	Pri.	250	500	250	3.0	6.0	250	500	22.20	
	Pri.	500	1000	500	2.5	7.5	500	1000	23.70	
	Pri.	1000	1675	675	2.0	8.0	1000	1675	24.20	
	Pri.	1675	1795	120	1.5	8.0	1675	1795	24.20	Parallel Box (3 x 2)
BP114A	Sec.	0	380	380	2.0					Parallel Box (3 x 2)
BP114B	Sec.	0	230	230	1.5					Parallel Box (3 x 2)
BP114C	Sec.	0	400	400	1.0					Parallel Box (2 x 1.5)

Total Length =100,656 m

Name of Zone				Dasarahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Laggere Kere Watershed Region									
DH112	Sec.	0	350	350	2.0	2.0			
	Sec.	350	575	225	2.5	2.5			
DH113	Sec.	0	1905	1905	4.0	4.0	1200	1905	16.2
DH114	Sec.	0	345	345	3.5	3.5			
DH121	Sec.	0	780	780	3.5	3.5			
DH122	Sec.	0	660	660	4.5	4.5			
DH141A	Sec.	0	440	440	4.0	4.0	325	445	16.2
DH141B	Sec.	0	1045	1045	4.0	4.0			
DH141C	Sec.	0	1260	1260	5.5	5.5			
DH141D	Sec.	0	175	175	4.0	4.0			
Herehalli Kere Watershed Region									
DH367	Sec.	0	1000	1000	3.5	3.5			
DH367	Sec.	1000	1250	250	4.0	4.5			
DH367	Sec.	1250	2660	1410	5.0	5.0	1250	2660	17.2
DH368	Sec.	0	420	420	3.0	3.0			
DH369	Sec.	0	500	500	1.0	1.5	0	500	**12.20**
DH369	Sec.	500	1000	500	3.5	3.5	500	1000	**15.20**
DH369	Sec.	1000	2115	1115	5.5	5.5	1000	2115	**17.70**
DH370	Sec.	0	650	650	2.0	2.0			
DH370	Sec.	650	1545	895	5.0	5.0	650	1000	11.7
DH612	Sec.	0	910	910	4.0	4.0			
DH612A	Sec.	0	440	440	2.0	2.0			
DH612B	Sec.	0	400	400	4.0	4.0			

Name of Zone				Dasarahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Kammagoundanahalli Kere Watershed Region									
DH131	Pri.	0	400	400	1.5	2.5	0	400	18.70
	Pri.	400	1100	700	2.5	2.5	400	1100	18.70
	Pri.	1100	2015	915	4.0	6.0	1100	2015	22.20
DH134	Sec.	0	416	416	2.0	2.5			
DH135	Pri.	0	1000	1000	6.0	7.5	0	1000	23.70
	Pri.	1000	2530	1530	5.0	8.0	1000	2530	24.20
DH136	Sec.	0	720	720	6.0	6.0			
DH141	Pri.	0	1250	1250	6.0	6.0	0	1250	22.20
DH142	Pri.	0	575	575	6.5	6.5	0	575	22.70
DH142A	Sec.	0	400	400	2.5	3.0	0	400	15.2
DH143	Pri.	0	1575	1575	4.0	7.5	0	1575	23.70
DH143A	Pri.	0	985	985	3.0	6.5	0	985	22.70
Abbigere Kere Watershed Region									
DH124	Pri.	0	1000	1000	5.5	6.0	0	1000	22.20
	Pri.	1000	1800	800	7.0	7.5	1000	1800	23.70
	Pri.	1800	2175	375	3.0	10.0	1800	2175	26.20
DH125	Sec.	0	500	500	6.5	7.0	0	760	19.2
Anchepalya Kere Watershed Region									
DH211	Pri.	0	950	950	3.0	4.0	0	950	20.20
	Pri.	950	1000	50	4.5	6.0	950	1000	22.20
	Pri.	1000	2200	1200	6.0	8.0	1000	2200	24.20

Name of Zone				Dasarahalli Zone						
Drain ID	TYPE	Drain Widening					Service Corridor			
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
DH211A	Sec.	0	800	800	4.0	4.0	125	300	10.7
DH211B	Sec.	0	400	400	1.5	2.0			
DH211B	Sec.	400	600	200	2.0	2.5			
DH212	Sec.	0	1275	1275	2.5	3.0			
DH213	Pri.	0	600	600	7.0	8.0	0	600	24.20
	Pri.	600	800	200	7.0	8.0	600	800	24.20
	Pri.	800	1300	500	6.0	8.0	800	1300	24.20
	Pri.	1300	1775	475	8.0	10.0	1300	1775	26.20
DH217B	Sec.	0	485	485	3.0	3.0	0	485	15.2
DH218	Pri.	0	1000	1000	9.0	10.0	0	1000	26.20
	Pri.	1000	1500	500	9.0	10.0	1000	1500	26.20
	Pri.	1500	2000	500	7.5	12.0	1500	2000	28.20
	Pri.	2000	2400	400	6.5	14.0	2000	2400	30.20
DH221	Pri.	0	1000	1000	4.5	5.0	0	1000	21.20
	Pri.	1000	2625	1625	7.0	8.0	1000	2625	24.20
DH214	Sec.	0	500	500	2.0	2.0			
	Sec.	500	600	100	2.5	3.0			
	Sec.	600	1450	850	5.0	5.0	850	1350	17.2
DH216	Sec.	0	450	450	4.0	4.0			
	Sec.	450	1350	900	4.0	4.0	1150	1350	16.2
DH217A	Sec.	0	300	300	5.0	5.0			
	Sec.	300	1285	985	5.0	5.0	800	1285	11.7
DH222	Sec.	0	835	835	3.5	3.5			

Name of Zone				Dasarahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
DH224	Sec.	0	700	700	5.0	5.0	125	400	17.2
	Sec.	700	1580	880	5.0	5.0	700	1580	17.2
DH225	Sec.	0	510	510	9.0	9.0	0	510	21.2
DH231	Sec.	0	850	850	3.0	3.0	300	450	9.7
DH232	Pri.	0	1325	1325	5.5	8.0	0	1325	24.20
DH233	Pri.	0	100	100	4.5	5.0	0	100	21.20
DH233	Pri.	100	1305	1205	4.0	6.0	100	1305	22.20
DH233A	Sec.	0	400	400	2.0	3.0			
DH235	Sec.	0	500	500	1.0	2.0			
DH235	Sec.	500	1375	875	2.5	3.5	1000	1375	10.2
DH236	Sec.	0	520	520	4.0	5.0	0	520	17.2
Gangondanahalli Kere Watershed Region									
DH311	Pri.	0	500	500	2.5	4.0	0	500	20.20
	Pri.	500	950	450	4.5	5.0	500	950	21.20
	Pri.	950	1130	180	4.5	6.5	950	1130	22.70
DH311A	Sec.	0	440	440	2.0	2.0	150	300	14.2
DH312	Pri.	0	700	700	6.0	7.5	0	700	23.70
DH312A	Sec.	0	300	300	2.0	2.0			
DH312B	Sec.	0	175	175	1.5	2.0			
	Sec.	175	235	60	2.0	2.0			
DH313	Sec.	0	485	485	2.0	2.0	0	250	8.7
DH313A	Sec.	0	725	725	5.5	5.5	0	725	17.70
DH314	Sec.	0	1105	1105	4.5	4.5			

Name of Zone				Dasarahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
DH314A	Sec.	0	300	300	2.0	2.0			
	Sec.	300	525	225	3.0	3.0			
	Sec.	525	750	225	3.0	3.0	525	750	9.7
DH315	Pri.	0	850	850	3.0	3.0	0	850	19.20
	Pri.	850	1000	150	3.5	5.0	850	1000	21.20
	Pri.	1000	1140	140	4.0	6.0	1000	1140	22.20
DH321	Pri.	0	1300	1300	1.0	5.0	0	1300	21.20
	Pri.	1300	1600	300	1.0	7.5	1300	1600	23.70
	Pri.	1600	2300	700	1.0	10.0	1600	2300	26.20
DH321A	Sec.	0	380	380	2.0	2.0			
DH321B	Sec.	0	455	455	2.0	2.0			
DH321C	Sec.	0	570	570	3.5	3.5	0	570	15.7
DH331	Pri.	0	1000	1000	3.0	3.0	0	1000	19.20
DH331	Pri.	1000	1500	500	5.0	5.0	1000	1500	21.20
	Pri.	1500	2000	500	5.0	6.0	1500	2000	22.20
	Pri.	2000	2200	200	6.0	7.5	2000	2200	23.70
DH332	Sec.	0	975	975	3.0	3.5	700	975	15.7
DH333	Pri.	0	1000	1000	11.0	12.5	0	1000	28.70
	Pri.	1000	1200	200	13.0	14.0	1000	1200	30.20
Kachohalli Kere Watershed Region									
DH352	Pri.	0	800	800	8.0	8.0	0	800	24.20
DH353	Pri.	0	1100	1100	6.0	8.0	0	1100	24.20
	Pri.	1100	1800	700	7.0	10.0	1100	1800	26.20
	Pri.	1800	2225	425	6.0	12.0	1800	2225	28.20

Name of Zone				Dasarahalli Zone					
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
DH361	Pri.	0	1000	1000	5.0	6.0	0	1000	22.20
	Pri.	1000	1500	500	6.5	7.5	1000	1500	23.70
	Pri.	1500	2100	600	6.5	8.0	1500	2100	24.20
DH351	Sec.	0	685	685	4.0	4.0			
DH362	Sec.	0	400	400	2.5	2.5	0	400	16.20

Total Length = 75,061 m

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Hormavu Agara Kere Water Shed Region									
MD241	Sec.	0	1175	1175	6.0	6.0	0	1175	18.2
MD242	Sec.	0	1175	1175	6.0	6.0	400	1175	18.2
MD243	Pri.	0	725	725	6.0	6.0	0	725	22.2
	Pri.	725	1245	520	6.0	6.0	725	1245	22.2
MD245	Pri.	0	540	540	4.0	5.0	0	540	21.2
MD246	Sec.	0	425	425	5.0	5.0			
MD247	Pri.	0	1750	1750	6.0	7.5	0	1750	23.7
MD251	Sec.	0	600	600	5.0	5.0	0	250	11.7
	Sec.	600	1025	425	2.0	5.0	250	450	11.7
MD251A	Sec.	0	325	325	2.0	2.5			
MD252	Sec.	0	860	860	1.5	3.0			
MD253	Pri.	0	700	700	3.0	5.0	0	700	21.2
	Pri.	700	1350	650	5.5	7.0	700	1350	23.2
MD254	Pri.	0	1350	1350	5.5	6.0	0	1350	22.2
Seigehalli Kere Water Shed Region									
MD261	Pri.	0	480	480	2.5	4.0	0	480	20.2
MD261A	Sec.	0	475	475	2.5	2.5			
MD261B	Sec.	0	240	240	1.5	1.5			
MD262 (KR06)	Pri.	0	1040	1040	5.0	6.0	0	1040	22.2
MD264	Sec.	0	0	0	4.0	4.0			
MD264	Sec.	1150	1415	265	4.0	4.0			
MD265	Sec.	0	800	800	3.0	3.0			
MD266 (KR07)	Pri.	0	1200	1200	5.0	7.5	0	1200	23.7
MD267	Sec.	0	400	400	2.0	3.0			
	Sec.	400	655	255	5.0	5.0	400	655	11.7
MD269	Pri.	0	200	200	7.0	7.5	0	200	23.7
	Pri.	200	400	200	9.0	10.0	200	400	26.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD271 (KR10)	Pri.	0	1080	1080	3.0	5.0	0	1080	21.2
MD272 (KR12)	Pri.	0	400	400	3.0	3.0	0	400	19.2
	Pri.	400	1325	925	2.0	5.0	400	1325	21.2
	Pri.	1325	1915	590	3.5	6.0	1325	1915	22.2
MD272A	Sec.	0	895	895	1.0	2.0			
MD273 (KR09)	Pri.	0	1000	1000	6.5	7.5	0	1000	23.7
	Pri.	1000	1200	200	7.0	10.0	1000	1200	26.2
MD273B	Pri.	0	615	615	1.5	3.0	0	615	19.2
MD274	Pri.	0	125	125	12.0	14.0	0	125	30.2
MD275	Sec.	0	750	750	6.0	6.0	0	750	18.2
MD276	Pri.	0	760	760	6.0	14.0	0	760	30.2
MD277	Sec.	0	1350	1350	10.0	10.0	0	1350	22.2
MD278	Sec.	0	950	950	6.0	6.0	0	950	12.7
	Sec.	1150	1180	30	3.0	6.0	1150	1180	12.7
MD279	Sec.	0	165	165	6.0	6.0			
B.Narayanapura Kere Water Shed Region									
MD321	Pri.	0	225	225	1.0	3.0	0	225	19.2
	Pri.	225	500	275	1.0	5.0	225	500	21.2
MD321A	Sec.	0	300	300	2.5	3.0	225	500	9.7
MD322	Sec.	0	450	450	1.5	2.0	300	450	8.7
MD322A	Pri.	0	200	200	6.0	6.0	0	200	22.2
MD323	Pri.	0	500	500	2.0	3.0	0	500	19.2
	Pri.	500	700	200	2.5	4.0	500	700	20.2
MD323A	Sec.	0	900	900	5.0	5.0	0	950	11.7
MD324	Pri.	0	1125	1125	7.0	8.0	0	1125	24.2
MD325	Pri.	0	625	625	5.0	6.0	0	625	22.2
MD325A	Pri.	0	150	150	2.0	3.0	0	150	19.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
	Pri.	150	350	200	2.0	4.0	150	350	20.2
	Pri.	350	970	620	5.0	5.0	350	970	21.2
MD329A	Pri.	0	100	100	1.0	2.0			18.2
	Pri.	100	500	400	1.0	2.0	100	500	18.2
	Pri.	500	1350	850	1.0	2.0			18.2
Kaggadasapura Kere Water Shed Region									
MD310	Pri.	0	755	755	2.5	3.0	0	755	19.2
MD310A	Sec.	0	250	250	2.0	3.0			
MD311	Sec.	0	200	200	3.0	4.0			
MD312	Pri.	0	725	725	3.5	8.0	0	725	24.2
	Pri.	725	1550	825	7.0	10.0	725	1550	26.2
MD312B	Sec.	0	50	50	1.5	2.0			
	Sec.	50	175	125	1.3	2.0			
	Sec.	175	295	120	1.3	2.0			
MD312C	Sec.	0	175	175	1.3	2.0			
MD313	Pri.	0	1455	1455	8.5	10.0	0	1455	26.2
Kodigehalli Kere Water Shed Region									
MD281	Pri.	0	250	250	1.0	2.0	0	250	18.2
	Pri.	250	425	175	1.0	3.0	250	425	19.2
	Pri.	425	500	75	1.0	3.0	425	500	19.2
MD282	Pri.	0	850	850	2.5	6.0	0	850	22.2
MD283	Pri.	0	725	725	2.0	3.0	0	725	19.2
MD284	Pri.	0	200	200	4.0	6.0	0	200	22.2
	Pri.	200	400	200	3.5	6.0	200	400	22.2
	Pri.	400	1225	825	5.0	7.5	400	1225	23.7
MD284A	Sec.	0	500	500	1.5	2.0			
	Sec.	500	1195	695	4.0	4.0	500	1195	10.7

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD286	Sec.	0	975	975	5.5	5.5	400	600	12.2
MD287	Pri.	0	1000	1000	11.0	12.5	0	1000	28.7
	Pri.	1000	2000	1000	5.0	14.0	1000	2000	30.2
	Pri.	2000	2525	525	4.0	15.0	2000	2525	31.2
MD288	Pri.	0	500	500	6.0	7.5	0	500	23.7
	Pri.	500	1000	500	6.0	10.0	500	1000	26.2
	Pri.	1000	1350	350	8.0	12.0	1000	1350	28.2
	Pri.	1350	1500	150	4.0	15.0	1350	1500	31.2
MD292	Sec.	0	1500	1500	4.0	4.0			
	Sec.	1500	1750	250	7.0	8.0	650	1750	20.20
MD292B	Sec.	0	1350	1350	6.0	6.0	0	1350	**12.20**
MD294	Sec.	0	1500	1500	6.0	6.0	0	1500	18.2
	Sec.	1500	1900	400	7.0	7.0			
MD295	Sec.	0	300	300	3.0	3.0			
	Sec.	300	750	450	7.0	7.0	300	550	
	Sec.	750	1075	325	5.0	7.0			
MD296	Pri.	0	200	200	4.0	6.0	0	200	22.2
	Pri.	200	900	700	7.0	7.5	200	900	23.7
Channapanahalli KereWater Shed Region									
MD362	Pri.	0	200	200	2.5	3.0	0	200	19.2
	Pri.	200	340	140	1.5	4.0	200	340	20.2
MD362A	Sec.	0	700	700	4.0	4.0	350	700	16.2
MD363	Pri.	0	350	350	5.0	5.0	0	350	21.2
	Pri.	350	550	200	2.0	6.0	350	550	22.2
MD364	Sec.	0	430	430	1.5	2.0			
MD365	Pri.	0	300	300	2.5	6.0	0	300	22.2
	Pri.	300	1000	700	3.0	6.0	300	1000	22.2
	Pri.	1000	1070	70	4.0	7.5	1000	1070	23.7

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD368	Sec.	0	125	125	6.0	6.0	0	125	12.7
MD369	Pri.	0	1100	1100	7.0	8.0	0	1100	24.2
Vibuthipura Kere Shed Region									
MD331 (KR01)	Pri.	0	175	175	2.5	3.0	0	175	19.2
	Pri.	175	895	720	2.5	4.0	175	895	20.2
MD332 (KR02)	Pri.	0	690	690	1.5	2.5	0	690	18.7
	Pri.	690	1415	725	2.0	2.5			18.7
MD332A	Pri.	0	250	250	2.5	8.0	0	250	24.2
	Pri.	250	450	200	2.5	8.0	250	450	24.2
MD332A (KR03)	Pri.	0	250	250	2.5	6.0	0	250	22.2
	Pri.	250	450	200	2.5	7.0	250	450	23.2
MD334	Pri.	0	600	600	5.0	10.0	0	600	26.2
MD335	Sec.	0	445	445	3.0	3.0			
MD349	Pri.	0	1000	1000	12.5	12.5	0	1000	28.7
	Pri.	1000	2000	1000	14.0	14.0	1000	2000	30.2
	Pri.	2000	2500	500	11.0	16.0	2000	2500	32.2
	Pri.	2500	2700	200	20.0	20.0	2500	2700	36.2
	Pri.	2700	3600	900	27.0	45.0	2700	3600	61.2
	Pri.	3600	4725	1125	23.0	50.0	3600	4725	66.2
Kundalahalli Kere Water Shed Region									
MD371	Pri.	0	275	275	2.0	3.0	0	275	19.2
	Pri.	275	400	125	2.0	4.0	275	400	20.2
MD372	Sec.	0	150	150	3.5	4.5			
	Sec.	150	225	75	3.5	4.5			
MD373	Pri.	0	175	175	1.5	4.0	0	175	20.2
	Pri.	175	275	100	1.5	4.0	175	275	20.2
	Pri.	275	525	250	1.5	4.0	275	525	20.2
	Pri.	525	780	255	1.5	5.0	525	780	21.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD374	Sec.	0	510	510	2.0	2.5			
MD375	Pri.	0	365	365	4.5	6.0	0	365	22.2
MD377	Sec.	0	660	660	2.0	3.5	0	660	15.7
MD378	Pri.	0	655	655	6.0	6.0	0	655	22.2
MD379	Pri.	0	725	725	4.5	8.0	0	725	24.2
Kadabeesanahalli Kere Shed Region									
MD349A	Pri.	0	1550	1550	7.5	10.0	0	1550	26.2
MD352	Pri.	0	250	250	24.0	56.0	0	250	72.2
MD353	Pri.	0	750	750	4.0	10.0	0	750	26.2
MD354	Pri.	0	750	750	2.5	8.5	0	750	24.7
MD355	Pri.	0	850	850	3.0	14.0	0	850	30.2
MD357	Sec.	0	195	195	4.0	4.0	0	200	16.2
MD358	Pri.	0	650	650	4.0	5.0	0	650	21.2
MD359	Pri.	0	200	200	13.0	16.0	0	200	32.2
MD361	Sec.	0	1350	1350	8.0	8.0	0	1350	20.2
MD365A	Sec.	0	300	300	2.5	2.5			
	Sec.	300	1040	740	4.0	4.0	600	1040	16.2
MD368A	Pri.	0	400	400	30.0	60.0	0	400	76.2
MD369A	Pri.	0	1290	1290	30.0	65.0	0	1290	81.2
Chikka Bellandur Kere Water Shed Region									
MD381	Pri.	0	275	275	1.5	7.0	0	275	23.2
MD382	Pri.	0	1800	1800	4.5	7.5	0	1800	23.7
	Pri.	1800	2500	700	6.0	8.5	1800	2500	24.7
	Pri.	2500	3000	500	5.0	10.0	2500	3000	26.2
	Pri.	3000	3400	400	6.0	12.0	3000	3400	28.2
MD383	Sec.	0	215	215	8.0	9.5	0	225	21.7

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD385	Pri.	0	250	250	4.0	4.0	0	250	20.2
	Pri.	250	1000	750	2.5	5.0	250	1000	21.2
MD387	Pri.	0	1000	1000	6.5	6.5	0	1000	22.7
MD388	Pri.	0	400	400	7.0	7.5	0	400	23.7
	Pri.	400	750	350	5.0	10.0	400	750	26.2
Valepura Kere Water Shed Region									
MD429	Pri.	0	555	555	14.0	30.0	0	555	46.2
MD434	Sec.	0	100	100	2.5	2.5	0	1330	14.7
	Sec.	100	1330	1230	7.0	7.0			
MD436A	Pri.	0	1115	1115	3.5	5.0	0	1115	21.2
MD437	Sec.	0	895	895	6.0	6.0			
MD438	Pri.	0	550	550	6.0	7.5	0	550	23.7
MD441	Pri.	0	1100	1100	11.5	70.0	0	1100	86.2
MD441B	Sec.	0	795	795	2.0	5.5	0	795	17.7
MD442	Sec.	0	595	595	1.5	2.0			
MD443	Sec.	0	925	925	5.5	5.5			
MD451	Sec.	0	600	600	6.0	6.0	400	1500	18.2
	Sec.	600	1470	870	7.0	7.0			
MD452	Sec.	0	500	500	3.5	3.5	0	500	15.7
MD453	Pri.	0	300	300	7.0	7.0	0	300	23.2
	Pri.	300	600	300	5.0	7.0	300	600	23.2
	Pri.	600	970	370	7.0	7.5	600	970	23.7
MD454	Sec.	0	125	125	3.5	4.0	0	125	16.2
MD455	Pri.	0	700	700	15.0	75.0	0	700	91.2
MD456	Sec.	0	1265	1265	3.0	3.0	0	1265	15.2
MD457	Pri.	0	900	900	18.0	80.0	0	900	96.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
Varthur Kere Water Shed Region									
MD389	Pri.	0	400	400	2.0	4.0	0	400	20.2
	Pri.	400	600	200	5.0	5.0	400	600	21.2
	Pri.	600	900	300	7.0	7.5	600	900	23.7
MD391	Sec.	0	565	565	7.0	7.0	0	565	19.2
MD392	Sec.	0	440	440	7.0	7.0	0	440	19.2
MD393	Pri.	0	500	500	8.0	8.0	0	500	24.2
MD394	Sec.	0	500	500	6.0	7.0	0	500	19.2
MD395	Sec.	0	235	235	7.0	7.0	0	235	19.2
MD396	Sec.	0	940	940	7.0	7.0	0	940	19.2
MD397	Pri.	0	500	500	7.0	8.0	0	500	24.2
MD398	Sec.	0	1000	1000	7.0	7.0	0	1900	19.2
	Sec.	1000	1795	795	7.5	7.5			
MD398A	Sec.	0	170	170	4.0	4.0	0	170	10.7
MD399	Pri.	0	525	525	8.0	8.0	0	525	24.2
MD425A	Sec.	0	430	430	2.5	3.0	0	430	15.2
MD427B	Pri.	0	300	300	2.0	3.0	0	300	19.2
MD427C	Pri.	0	225	225	45.0	45.0	0	225	61.2
	Pri.	225	350	125	30.0	50.0	225	350	66.2
	Pri.	350	600	250	28.0	50.0	350	600	66.2
MD429A	Pri.	0	600	600	17.0	50.0	0	600	66.2
MD429B	Sec.	0	395	395	5.0	5.0	0	395	17.2
MD433	Pri.	0	750	750	2.0	3.0	0	750	19.2
Sheelavantana Kere Water Shed Region									
MD411	Sec.	0	505	505	4.5	5.0	0	505	17.2
MD412	Sec.	0	300	300	1.0	2.5			
	Sec.	300	400	100	2.0	2.5	300	400	9.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD413	Pri.	0	375	375	4.0	4.0	0	375	20.2
	Pri.	375	600	225	6.0	6.0	375	600	22.2
MD414	Sec.	0	200	200	5.5	5.5	0	200	12.2
	Sec.	200	795	595	4.5	6.0	500	795	12.7
MD415	Sec.	0	600	600	4.0	5.0	0	300	11.7
	Sec.	600	1090	490	3.0	4.5			
MD416	Sec.	0	460	460	2.5	2.5	250	460	9.2
MD417	Pri.	0	250	250	8.0	8.0	0	250	24.2
	Pri.	250	415	165	6.0	8.0	250	415	24.2
MD418	Sec.	0	190	190	2.5	2.5	0	190	14.7
MD419	Pri.	0	720	720	2.5	8.0	0	720	24.2
MD422	Pri.	0	845	845	4.5	8.0	0	845	24.2
MD423	Sec.	0	285	285	3.5	3.5	0	285	10.2
MD425	Sec.	0	550	550	4.5	5.0	0	550	11.7
MD427	Pri.	0	400	400	20.0	40.0	0	400	56.2
MD427A	Sec.	0	440	440	2.0	3.5	0	440	15.7
MD428	Pri.	0	475	475	9.0	10.0	0	475	26.2
MD431	Pri.	0	2550	2550	4.0	7.5	0	2550	23.7
MD432	Pri.	0	600	600	15.0	60.0	0	600	76.2
MD435	Pri.	0	500	500	7.0	8.0	0	500	24.2
MD436	Pri.	0	1100	1100	13.5	65.0	0	1100	81.2
Bellanduru Kere Water Shed Region									
MD342	Pri.	0	185	185	9.0	10.0	0	185	26.2
MD343	Sec.	0	540	540	4.0	4.0	0	350	10.7
MD344	Pri.	0	125	125	5.0	10.0	0	125	26.2
MD346	Pri.	0	450	450	25.0	25.0	0	450	41.2
MD346	Pri.	450	1300	850	15.0	30.0	450	1300	46.2
MD346	Pri.	1300	2550	1250	18.0	35.0	1300	2550	51.2

Name of Zone		Mahadevapura							
Drain ID	TYPE	Drain Widening					Service Corridor		
		Chainage		Length	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)
		From	To				From	To	
MD346A	Pri.	0	1000	1000	30.0	30.0	0	1000	46.2
MD346A	Pri.	1000	2000	1000	35.0	45.0	1000	2000	61.2
MD348	Sec.	0	650	650	4.5	4.5	0	650	16.7

Total Length = 131,315 m

Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
Konnasandra Kere Water Shed Region										
RN181	Pri.	0	400	400	21.0	45.0	0	400	61.20	
	Pri.	400	1150	750	16.2	48.0	400	1150	64.20	
	Pri.	1150	1830	680	19.5	54.0	1150	1830	70.20	
	Pri.	1830	3140	1310	27.0	54.0	1830	3140	70.20	
	Pri.	3140	4550	1410	16.5	56.0	3140	4550	72.20	
	Pri.	4550	5830	1280	15.5	56.0	4550	5830	72.20	
	Pri.	5830	6160	330	18.0	58.0	5830	6160	74.20	
	Pri.	6160	6785	625	18.0	58.0	6160	6785	74.20	
	Pri.	6785	9475	2690	21.5	60.0	6785	9475	76.20	
	Pri.	9475	11260	1785	17.5	60.0	9475	11260	76.20	
RN582	Sec.	0	600	600	3.0	3.5				
	Sec.	600	750	150	4.0	6.0	600	750	12.10	
RN582A	Sec.	0	200	200	4.0	6.0	0	625	12.10	
	Sec.	200	450	250	6.0	7.5				
	Sec.	450	625	175	3.5	8.0				
RN583	Pri.	0	1050	1050	2.5	5.0	0	1050	21.20	
RN584	Sec.	0	650	650	4.0	6.0	0	650	18.20	
RN585	Pri.	0	225	225	4.5	6.0	0	225	22.20	
RN591	Pri.	0	325	325	2.0	2.0	0	325	18.20	
	Pri.	325	650	325	3.0	5.0	325	650	21.20	
	Pri.	650	950	300	3.0	5.0	650	950	21.20	
	Pri.	950	1738	788	3.5	7.5	950	1738	23.70	
RN592	Pri.	0	1000	1000	3.0	7.5	0	1000	23.70	
RN593	Pri.	0	350	350	3.0	6.0	0	350	22.20	

Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Pri.	350	600	250	4.0	8.0	350	600	24.20	
	Pri.	600	1100	500	6.5	10.0	600	1100	26.20	
Hosahalli Kere Water Shed Region										
RN311	Pri.	0	400	400	5.0	6.0	0	400	22.20	
	Pri.	400	800	400	3.0	6.0	400	800	22.20	
	Pri.	800	1000	200	3.5	6.0	800	1000	22.20	
	Pri.	1000	1500	500	5.0	6.0	1000	1500	22.20	
	Pri.	1500	1750	250	5.0	6.0	1500	1750	22.20	
	Pri.	1750	2470	720	5.0	6.0	1750	2470	22.20	
RN311A	Sec.	0	475	475	1.5	2.0				
	Sec.	475	650	175	1.5	3.0				
	Sec.	650	825	175	2.5					Parallel drain (3 x2m)
RN311B	Sec.	0	250	250	1.5	1.5				
	Sec.	250	500	250	1.5					Parallel drain (3 x2m)
	Sec.	500	835	335	3.5	5.0	500	850	11.10	
RN312A	Sec.	0	905	905	1.6	2.0	0	905		
RN312	Pri.	0	700	700	4.0	6.0	0	700	22.20	
	Pri.	700	950	250	4.0	7.5	700	950	23.70	
	Pri.	950	1335	385	6.0	10.0	950	1335	26.20	
RN411	Sec.	0	300	300	3.5	4.0	0	300	10.10	
RN412	Sec.	0	475	475	4.0	5.0	0	475	16.60	
RN421A	Sec.	0	300	300	4.0	4.0	0	300	10.10	
RN572 (RNR04)	Pri.	0	1500	1500	12.0	14.5	0	1500	30.70	

Name of Zone		Rajarajeshwari Nagara Zone								
		Drain Widening					Service Corridor			
Drain ID	TYPE	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	Remarks
		From	To				From	To		
	Pri.	1500	2430	930	16.0	18.0	1500	2430	34.20	
Muddayanapalya Kere Water Shed Region										
RN151	Sec.	0	400	400	3.5	4.0				
	Sec.	400	650	250	3.3	4.0				
	Sec.	650	1000	350	4.0	5.0				
	Sec.	1000	1250	250	3.6	6.0				
	Sec.	1250	1300	50	3.5	7.5				
RN151A	Sec.	0	200	200	5.0	6.0	0	200	18.20	
RN169	Sec.	0	650	650	2.7	3.0				
	Sec.	650	740	90	2.5	4.0				
RN170	Sec.	0	350	350	3.0	3.0	150	450	15.20	
	Sec.	350	450	100	4.0	6.0				
RN171 (RNR05)	Pri.	0	1020	1020	3.5	3.5	0	1020	19.70	
RN171A (RNR05)	Sec.	0	150	150	3.5	3.5				
	Sec.	150	375	225	3.5	4.0				
	Sec.	375	695	320	4.5	4.5				
RN171B	Sec.	0	150	150	4.0	4.0				
RN172	Sec.	0	300	300	4.0	4.0				
	Sec.	300	900	600	4.0	4.0				
RN511	Sec.	0	1100	1100	3.0	4.0	0	1675	16.20	
	Sec.	1100	1375	275	2.5					Parallel drain (3 x2m)
	Sec.	1375	1675	300	3.5	5.0				
RN512	Sec.	0	710	710	2.0	2.0				

Name of Zone		Rajarajeshwari Nagara Zone								
		Drain Widening					Service Corridor			
Drain ID	TYPE	Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	Remarks
		From	To				From	To		
RN513	Sec.	0	250	250	2.0	2.0				
RN514 (RNR01)	Pri.	0	1600	1600	4.5	5.0	0	1600	21.20	
	Pri.	1600	2000	400	5.0	6.0	1600	2000	22.20	
	Pri.	2000	2515	515	3.5	7.5	2000	2515	23.70	
RN514A	Sec.	0	510	510	2.0	2.0				
RN516	Sec.	0	125	125	1.0	1.5				
	Sec.	125	550	425	2.0	2.0				
RN521	Pri.	0	1000	1000	3.0	5.0	0	1000	21.20	
	Pri.	1000	1500	500	3.5	6.0	1000	1500	22.20	
	Pri.	1500	1820	320	3.5	7.5	1500	1820	23.70	
RN521A	Pri.	0	585	585	3.0	6.0	0	585	22.20	
RN521B	Sec.	0	350	350	1.5	2.0	0	565	14.20	
	Sec.	350	565	215	2.0	3.0				
RN522	Sec.	0	700	700	2.0	2.0				
	Sec.	700	1035	335	2.5	4.0				
RN541 (RNR06)	Sec.	0	550	550	3.5	3.5				
	Sec.	550	700	150	4.0					Parallel drain (2 x2m)
	Sec.	700	1400	700	7.0	7.5				
	Sec.	1400	1550	150	6.0	8.0				
	Sec.	1550	2010	460	7.0	10.0				
RN551	Sec.	0	650	650	6.0	6.0	0	700	18.20	
	Sec.	650	1100	450	4.5	8.0				
	Sec.	1100	1720	620	5.0	8.0				

Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage From	Chainage To	Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.) From	Total Length (m.) To	Total Width Required incl. SR (m.)	
RN551A	Sec.	0	205	205	4.0	5.0	0	305	17.20	
RN551B	Sec.	0	200	200	1.5	2.0				
	Sec.	200	300	100	3.0	3.0	200	300	15.20	
	Sec.	300	425	125	4.0	4.0				
RN552	Sec.	0	1000	1000	5.0	5.0	0	1000	17.20	
RN553	Sec.	0	500	500	5.0	5.0				
	Sec.	500	800	300	5.0	7.5	500	1000	13.60	
	Sec.	800	1000	200	5.0	10.0				
RN531	Pri.	0	500	500	6.0	6.0	0	500	22.20	
	Pri.	500	1000	500	8.0	8.0	500	1000	24.20	
	Pri.	1000	1500	500	9.0	10.0	1000	1500	26.20	
	Pri.	1500	1610	110	11.0	12.0	1500	1610	28.20	
RN554	Pri.	0	200	200	6.0	8.0	0	200	24.20	
	Pri.	200	1000	800	7.0	10.0	200	1000	26.20	
	Pri.	1000	1500	500	10.0	12.0	1000	1500	28.20	
	Pri.	1500	3687	2187	11.0	12.0	1500	3687	28.20	
RN555	Sec.	0	425	425	2.5	3.0				
	Sec.	425	920	495	3.0	4.0	400	920	16.20	
RN562 (RNR03)	Pri.	0	1690	1690	4.0	5.0	0	1690	21.20	
RN562A (RNR03)	Sec.	0	325	325	3.0	3.0	0	200	9.10	
	Sec.	325	550	225	2.0					Parallel drain (2 x2m)
Subramanyapura Kere Water Shed Region										
RN211 (RNR11)	Pri.	0	500	500	2.0	3.0	0	500	19.20	

Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage From	Chainage To	Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.) From	Total Length (m.) To	Total Width Required incl. SR (m.)	
	Pri.	500	700	200	6.0	10.0	500	700	26.20	
	Pri.	700	1000	300	3.0	5.0	700	1000	21.20	
	Pri.	1000	2000	1000	3.5	5.0	1000	2000	21.20	
	Pri.	2000	3200	1200	5.0	6.0	2000	3200	22.20	
RN212	Sec.	0	975	975	2.0	2.0				
	Sec.	975	1140	165	1.6					Parallel drain (2 x2m)
RN213	Sec.	0	300	300	1.6	2.0				
	Sec.	300	500	200	1.6	3.0				
	Sec.	500	610	110	1.6	5.0				
RN214	Sec.	0	350	350	1.6	2.0				
	Sec.	350	550	200	3.0	4.0				
	Sec.	550	825	275	2.5	4.0				Parallel drain (4 x2m)
	Sec.	825	960	135	3.5	6.0				
RN215	Pri.	0	510	510	2.0	3.0	0	510	19.20	
RN216	Sec.	0	500	500	1.5	1.5	500	600	7.60	
RN216A	Sec.	0	100	100	1.5	2.0				
	Sec.	150	350	200	2.0	2.0				
	Sec.	350	450	100	2.5	3.0	350	450	9.10	
RN217 (RNR10)	Sec.	0	900	900	3.5	6.0				
RN221	Sec.	0	400	400	3.5	3.5				
RN222	Sec.	0	550	550	1.6	3.0	0	250	9.10	
	Sec.	550	850	300	2.0	3.0				

Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
RN223	Pri.	0	1000	1000	4.0	8.0	0	1000	24.20	
	Pri.	1000	2000	1000	4.0	10.0	1000	2000	26.20	
	Pri.	2000	3000	1000	5.0	14.0	2000	3000	30.20	
	Pri.	3000	4000	1000	12.0	16.0	3000	4000	32.20	
	Pri.	4000	5000	1000	10.0	18.0	4000	5000	34.20	
	Pri.	5000	5200	200	10.0	18.0	5000	5200	34.20	
	Pri.	5200	6000	800	10.0	20.0	5200	6000	36.20	
	Pri.	6000	7000	1000	10.0	20.0	6000	7000	36.20	
	Pri.	7000	8000	1000	12.5	20.0	7000	8000	36.20	
	Pri.	8000	9000	1000	12.0	20.0	8000	9000	36.20	
	Pri.	9000	10000	1000	14.0	24.0	9000	10000	40.20	
RN224	Sec.	0	200	200	2.5	2.5	0	450	9.20	
	Sec.	200	325	125	2.5	2.5				
	Sec.	325	525	200	2.5	3.0				
RN226	Sec.	0	300	300	1.5	1.5				
RN226	Sec.	300	325	25	1.5	1.5				
RN231	Sec.	0	500	500	1.5	3.0	0	500	9.10	
	Sec.	500	600	100	4.0	5.0	500	825	17.20	
	Sec.	600	750	150	7.0	8.0				
	Sec.	750	825	75	8.0	10.0				
RN232	Sec.	0	440	440	4.0	6.0	0	450	12.10	
RN232A	Sec.	0	345	345	3.5	6.0	0	450	18.20	
RN241	Sec.	0	700	700	3.0	4.0				
	Sec.	700	805	105	4.0	6.0				
RN242	Sec.	0	300	300	2.0	5.0	0	1175	11.10	

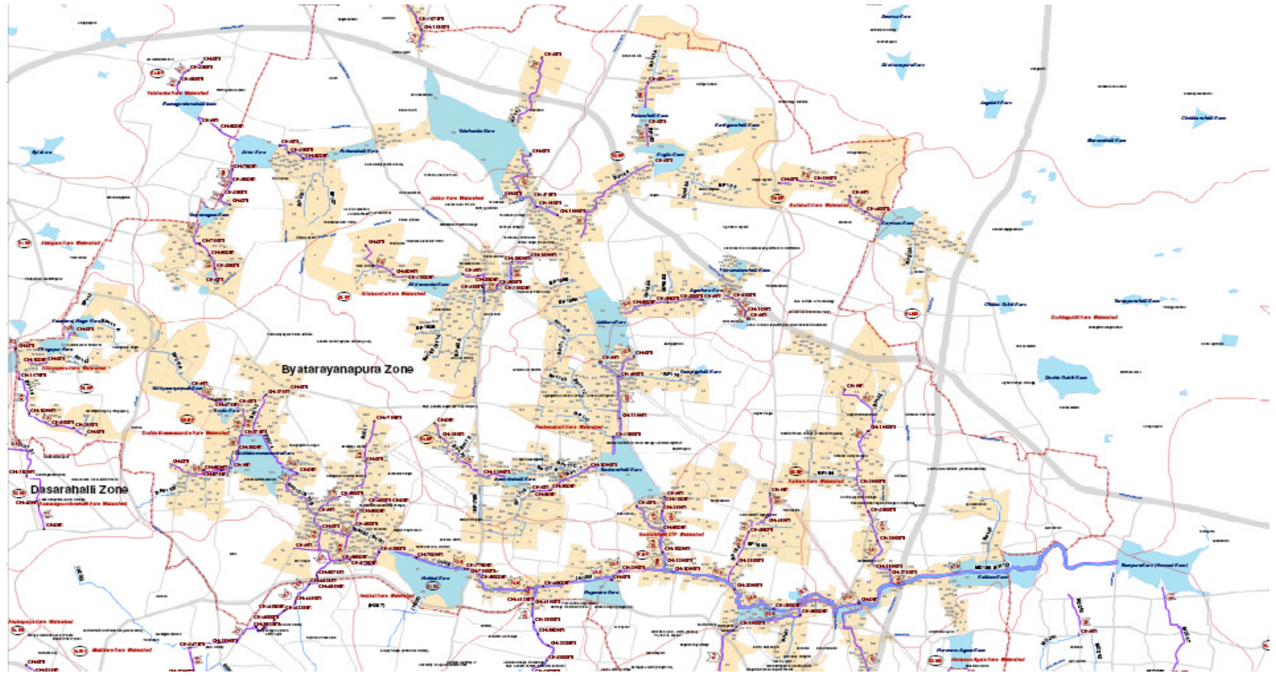
Name of Zone		Rajarajeshwari Nagara Zone								
Drain ID	TYPE	Drain Widening					Service Corridor			Remarks
		Chainage		Length (m.)	Ex. Avg. Width (m.)	Prop Avg. Width (m.)	Total Length (m.)		Total Width Required incl. SR (m.)	
		From	To				From	To		
	Sec.	300	800	500	2.0	6.0				
	Sec.	800	1175	375	3.0	7.5				
RN243	Sec.	0	300	300	2.6	3.0				
	Sec.	300	440	140	3.0	5.0				
RN252	Sec.	0	500	500	2.0	4.0				
	Sec.	500	700	200	3.0	6.0				
	Sec.	700	1225	525	2.5	7.0				
	Sec.	1225	1475	250	3.5	8.0				
RN252A	Sec.	0	450	450	1.8	2.0				
	Sec.	450	590	140	2.0	4.0				
RN252B	Sec.	0	305	305	2.0	8.0	0	325	20.20	
RN253	Sec.	0	340	340	2.0	8.0				
RN254	Sec.	0	380	380	5.0	10.0	0	400	22.20	
Halagevadarahalli Kere Water Shed Region										
RN183	Sec.	0	450	450	2.0	3.0				
	Sec.	450	775	325	4.0	6.0	450	775	18.20	
RN184	Sec.	0	600	600	3.0	3.0				
	Sec.	600	750	150	11.0	12.0				
RN191 (RNR12)	Pri.	0	850	850	2.5	2.5	0	850	18.70	
	Pri.	850	1520	670	2.5	3.5	850	1520	19.70	
RN192	Pri.	0	100	100	3.0	3.0	0	100	19.20	
	Pri.	100	1400	1300	3.0	3.0	100	1400	19.20	
RN193 (RNR09)	Pri.	0	600	600	3.5	4.0	0	600	20.20	
	Pri.	600	900	300	2.5	6.0	600	900	22.20	

Name of Zone		**Rajarajeshwari Nagara Zone**								
Drain ID	**TYPE**	**Drain Widening**					**Service Corridor**			**Remarks**
		Chainage		**Length (m.)**	**Ex. Avg. Width (m.)**	**Prop Avg. Width (m.)**	**Total Length (m.)**		**Total Width Required incl. SR (m.)**	
		From	**To**				**From**	**To**		
RN194 (RNR08)	Pri.	0	750	750	3.5	6.5	0	750	22.70	
RN195 (RNR07)	Pri.	0	510	510	6.5	10.0	0	510	26.20	
Thalaghattapura Kere Water Shed Region (Bommanahalli Zone)										
RN711	Sec.	0	500	500	2.0	4.0				
	Sec.	500	1000	500	2.0	5.0				
	Sec.	1000	1325	325	4.0	6.0				
RN711A	Sec.	0	300	300	2.0	4.0				
RN712	Sec.	0	300	300	2.0	3.0				
	Sec.	300	500	200	2.5	5.0				
	Sec.	500	1025	525	4.5	6.0				
Kammayanapalya Kere Water Shed Region										
RN731	Sec.	0	1150	1150	3.5	4.0	0	825	16.20	
	Sec.	1150	1350	200	3.5	7.5				

Total Length = 98,890

Note : Service Road Formation Proposal for Core Area SWD shall be finalised in consultaion with BWSSB

Identification of SWD and demarcation of drainage corridor using Satellite Images



Demarcation of drainage corridor & Revenue Survey Details using GIS on SWD Base Map

Identification of SWD and demarcation of drainage corridor on CDP & RS Maps

Identification of Properties affected using GIS data base

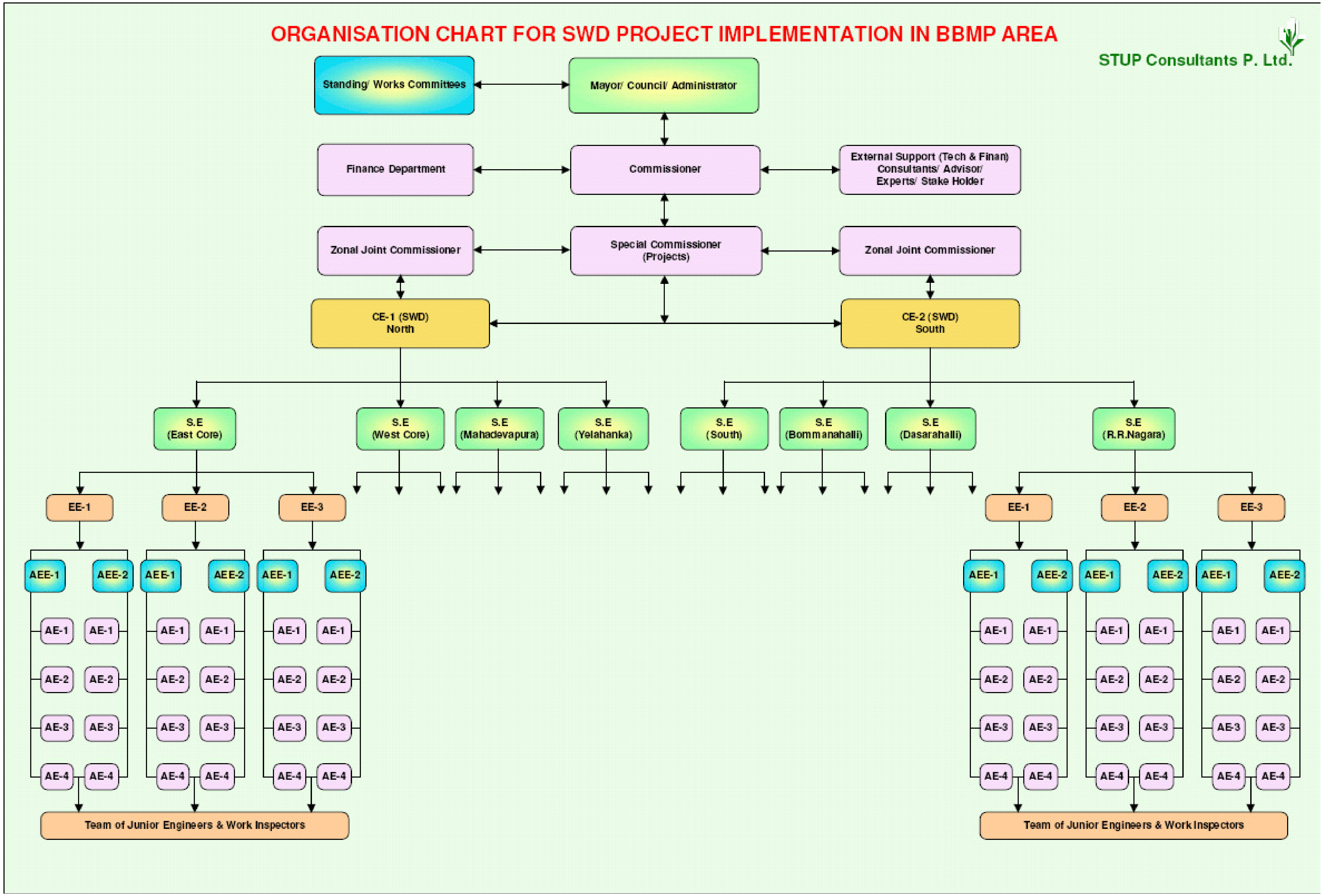
5.19.3 Institutional Framework

The institutional arrangements with respect to responsibilities and control of urban waters are typically fragmented in cites all around the world. One institution is responsible for municipal wastewater collection and treatment, another for land drainage and flood control, and yet another for the drainage of highways and urban traffic arteries. This fragmentation and overlapping of authority results in a dilution of powers, brings potential conflicting interests and prevents the application of integral watershed management.

The overall co-ordination of flood management activities should be entrusted to one leading organisation that assumes responsibility for legal, administrative and financial matters. The organisation should also have the necessary technical and institutional expertise for the setting of standards, provision of technical advice and to ensure that the optimum mixture of both structural and non-structural measures is applied.

With increasing urbanisation altering the land use pattern with the consequent increased runoff and the investments made to ensure comfort to public, organisational expansion is required. A larger organisation to address storm drainage management is essential. Suggested organisation for the purpose is shown in **Fig. 5.17.**

Fig. 5.17. Organization Chart



5.20 Operation & Management

It is impossible to overstate the importance of effective maintenance in the overall storm water management effort. Without maintenance, drainage facilities will deteriorate, and their design capacities will be reduced by accumulations of sediments, weeds and debris. Not only will they fail to function as intended, but they will become hazards and blight on the City's landscape. Inadequate maintenance, as with any facility, transforms a productive resource into a multi-faceted liability.

Following general guidelines may be considered for the operation and maintenance:

Inspection and Cleaning of Drainage Facilities

1 Periodically inspect and clean drainage facilities as needed. Maintain appropriate records. This information should be used to determine problem areas that may need to be checked more often.

2 Remove trash and debris as needed from open channels and properly dispose of these materials (at an approved landfill or recycling facility). It should be noted that major debris removal may require other regulatory permits prior to completing the work.

3 Conduct annual visual inspections during the dry season to determine if there are problem inlets where sediment/trash or other pollutants accumulate.

4 Eliminate any discharges that may occur while maintaining and cleaning any municipal drainage facilities.

5 Train crews in proper maintenance activities, including record keeping and disposal.

6 Provide energy dissipaters (e.g. riprap) below culvert outfalls to minimize potential for erosion.

The above mentioned activities may be outsourced which should include additionally periodic desilting and maintenance of desilt chambers, detention ponds, retention basins, lakes with the installed floor regulators.

Waste Management

1. Store wastes collected from cleaning activities of the drainage facilities in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
2. Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device to remove the sand and debris prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not permitted, water should be pumped or vacuumed to a tank and properly disposed of.
3. Provide for laboratory analysis of at least one randomly collected sediment (less the debris) sample per year from the storm drain.

Sediment Control from Catchment

- An effective permit and control procedure is to be developed to prevent construction materials like sand and building debris getting into the drainage system
- There should be a stipulation that the materials should be stored with proper dyke like arrangement.
- Prior permission should be obtained for storing the building materials.

Controlling Illicit Connections and Discharges

Report prohibited discharges such as dumping, paint spills, abandoned oil containers, etc. observed during the course of normal daily activities so they can be investigated, contained, and cleaned up.

Conduct field investigations to detect and eliminate existing illicit connections and improper disposal of pollutants into the storm drain (i.e. identify problem areas where discharges or illegal connections may occur and follow up stream to determine the source(s)

Controlling Illegal Dumping

Illegally dumped wastes can cause storm water and receiving water quality problems as well as clog the storm drain system itself. Non-hazardous solid wastes may include garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes discarded home and industrial appliances, manure, vegetable or animal solid and semi-solid wastes and other discarded solid or semi-solid waste provided that such wastes do not contain wastes which must be managed as hazardous wastes, or wastes which contain soluble pollutants in concentration which exceed applicable water quality objectives or could cause degradation of waters of the state**.**

Field Investigation

Report prohibited discharges such as dumpings observed during the course of normal daily activities so they can be investigated, contained and cleaned up.

Conduct field investigations to detect and eliminate improper disposal of pollutants into the storm drain (i.e. identify problem areas where discharges or illegal connections may occur and follow up stream to determine the source(s)).

Post “No Dumping” signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.

Training/Education/Outreach

Annually train municipal employees to recognize and report illegal dumping.
Educate the public with public education materials such as a hotline.

5.21 Disaster Management

Natural disaster impact on development may be direct physical destruction of infrastructure, loss of cash, loss of crops and animal stock, destruction of social infrastructure, and the resulting shortage of materials and equipment, shortage of labor, and depletion of development projects.

The contemporary approach assumes that disaster management must be shared by all sectors and activities that have any connection with development and change at all levels of policy making. In this approach, vulnerability is reduced by integrating measures for survival, rehabilitation and reconstruction within development planning.

Prerequisites for development planning for disaster reduction are as follows:

1 acceptance that disasters can happen
2 perceptions of causes, incidence and effects of environmental hazards
3 integration of perceptions in a development policy, meaning preparation of development guidelines for disaster reduction
4 evaluation of all development proposals against development guidelines

Development planning determines where people and structures are located, what material and methods are used in construction, how topography is altered, what emergency systems are provided, what resource reserves are maintained, what communication and transportation systems are available.

The planning process may be represented as a cycle to emphasise the need for continual development, as opposed to a non-recurring linear process.

5.22 Risk Assessment

Risk assessment is a diagnostic process of balancing known risks against available resources. The process starts with vulnerability analysis and hazard mapping. Hazard mapping reveals the areas that are particularly susceptible to floods.

Information is needed both in spatial and temporal terms and include location, frequency of occurrence, duration and severity. When this information becomes available it is possible to develop contours which indicate the severity of risk.

Vulnerability assessment determines the vulnerability of elements at risk-persons or property exposure to the hazards which has been mapped. This analysis is site-specific.

Designing levels of acceptable risk is essentially a political process. Political leaders determine priorities and such decisions are always difficult, concerning what is essential, acceptable, affordable or politically expedient. Defining levels of acceptable risk should be based on both the quantitative analysis, such as cost of flood damage evaluation, and on qualitative multi-attribute analysis.

Based on such an analysis there should be a rule stipulating development above HFL in vulnerable locations.

Besides the following are also recommended

1 Constitute disaster management team with training.
2 Based on the intensity of rainfall recorded provide alarm to tackle flood in critical area.
3 Low lying area flood warning alarm connected to rescue dept.
4 Team for managing the lake water level which may be out sourced.
5 Prepare escape route map for each critical area in consultation with locals
6 Display Dos and Don’t chart prominently in critical area
7 Train local volunteers to manage flood in case of emergency.
8 Educate children in school.

5.23 Legislation

Legislation that needs to be enacted in order to provide legal basis for implementation of storm water directives and programs should include:

1 provisions for storm water pollution control
2 provisions for temporary storage of excess runoff
3 provisions for disconnection of roof drains from sanitary sewers – provisions for floodplain
4 zoning and regulation
5 provisions for flood-proofing of buildings
6 provisions for development of a compatible and coordinated storm water drainage system.
7 provisions for implementing the source control

The extent to which the basin-wide management approach can be applied will depend largely on the nature of the ownership of land (government or private) and the authority that can be imposed by the drainage agency over development.

5.24 INFORMATION,-EDUCATION-AND COMMUNICATION

A social survey carried out among the residents in the study zones revealed that about 93% of those surveyed reported flooding of there are thrice in five years. Detailed report on the social survey is given in **Annexure - 4.**

The sustainability of the assets created and their effective performance depends on the social interaction as much as the integrity of the engineered systems. A programme of information generation and sharing, educating the residents of an area about the impacts of flooding and a constant interaction with communication is essential.

Awareness program as a tool is to be designed to address issues and propagate messages relevant to segmented consumers in respect of maintaining the environment to defined standards. The messages would include the types of technology, sources (availability), behaviour pattern, ways to prevent dumping of waste, significance of clean environment with respect to health and safety and impact (social & economic) of not adhering to recommended rules and procedures.

Communication in the form of scientific intervention is critical to educate the economically weaker sections of the society, policy makers from health department, local bodies in charge of maintaining the environment around the storm water drains, lakes and other water bodies. They need to be aware of the systems governing safe environment, clean air and lakes with fresh water allowing fish to thrive. Unclean environment and the resultant odour and mosquito infestation affect their livelihood and also their health. The awareness in respect of impact of letting out wastewater without treatment on the environment and personal health are equally important. The communication program should aim at creating awareness on the ill-effects of having unclean storm water drain and water bodies and living in the midst of polluted environment caused by letting out un-treated wastewater and solid waste into the open. It has been established through studies that more than 60% of the diseases caused are water borne and by effectively controlling sections of the society to seek and resort to safe disposal of both solid and liquid waste substantial savings would be made in the outlays currently made by the health department to address the public-health concerns. Orientation of the society through communication is an effective tool to achieve the desired results concerning behaviour of citizens. They would emulate what is told if they are convinced of the impact in their lives. Practical demonstrations with test reports and certificates from authorized agencies entwined with communications program for spreading the message would achieve the desired result. Messages propagated in the local lingua and through personalities accepted by the community would have a significant impact in terms of acceptability and remembrance.

5.24.1 Public education and outreach on storm water impacts.

1 Implementation of a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water run

2 Educational materials should be available to assist the BBMP in preparing a public education program. The public education program should inform individuals and households about the steps they can take to reduce storm water pollution, such as ensuring the proper use and disposal of landscape and garden chemicals including fertilizers and pesticides, protecting and restoring riparian vegetation, and properly disposing of used motor oil or household hazardous wastes.

3 The public education program should be tailored, using a mix of locally appropriate strategies, to target specific audiences and communities. Examples of strategies include distributing brochures or fact sheets, sponsoring speaking engagements before community

groups, providing public service announcements, implementing educational programs targeted at school age children, and conducting community-based projects such as storm drain stencilling, and watershed and beach cleanups. In addition, the EPA recommends that some of the materials or outreach programs be directed toward targeted groups of commercial, industrial, and institutional entities likely to have significant storm water impacts. For example, providing information to garages on the impact of oil discharges.

5.24.2 Public involvement / Participation

1 Compliance with statutory local public notice requirements when implementing a public involvement/ participation program.

2 Formation of local storm water management panel

3 The public should be included in developing, implementing, and reviewing the BBMP's storm water management program and that the public participation process should make efforts to reach out and engage all economic and ethnic groups. Opportunities for member of the public to participate in program development and implementation include serving as citizen representatives on a local storm water management panel, attending public hearings, working as citizen volunteers to educate other individuals about the program, assisting in program coordination with other pre-existing programs, or participating in volunteer monitoring efforts.

5.25 Resettlement and Rehabilitation

In urban and semi urban areas since land value being low the land adjacent to water ways are more susceptible for development of slum areas and construction of buildings/ encroachment. Whereas it is a common phenomenon in all developed cities as the development of the city's growth progress and demand for change in landuse also increase which intern demands for additional land to increase the carrying capacity of drains to cater for increased discharge and also to provide relief for flood affected people in low lying areas.

Since the land requirement is huge and the land prices are high, resettlement of project affected people is a big challenging task especially in drainage projects. The issue of resettlement depends on various issues like willingness of the people to move/resettle, enforcement measures, compensation packages offered etc.,

The resettlement issue requires involvement of NGOs at various stages during the coarse of the project to motivate the people to understand the importance of the project requirements, strict enforcement measures, willingness of the government, attractive compensation packages, effective and timely completion of programmes etc.

The task of procurement of land for implementing the project proposals shall be taken up with stake holders in coordinated manner. As a preferred options depending upon specific requirements BBMP shall try combination of below mentioned alternatives.

1) Promotion of TDR scheme along with monitory benefits (as per guidance value)
2) Pay for land compensation as per prevailing market rate.
3) Alternative land with all infrastructure facilities in developed layout.
4) Combination of above options.

The above mentioned alternatives has been discussed with all stakeholders and public representatives in length on 11th June 2010 during coordination meeting at Vidhana Soudha and the discussion on the issue is pending for want of approval on the land acquisition proposals.

CHAPTER - 6

COST ESTIMATION

6.0 INTRODUCTION:

All development projects shall aim to make the best use of available financial, physical and institutional resources for implementation in an optimal manner

This is especially true for an infrastructure project like storm drainage for which the available resources for implementation of project are usually limited in relation to the total need. It is therefore very much important to minimize the cost at which services are provided while ensuring that agreed minimum standards are achieved. In the meantime, it is also important to ensure that cost, both capital cost and recurrent cost are affordable to the organization and also as well as agreeable to all the beneficiaries.

6.1 COSTS:

The costs considered in the current project are divided into capital cost and the recurrent cost.

Capital costs are the costs incurred at the beginning of the project between its inception and its completion on the ground. Further the capital cost include,

- The cost of planning and designing the work,
- Construction costs,
- Supervision costs, and
- Overheads.

Recurrent costs are the cost incurred after execution of the project for the routine maintenance and operations of the system.

6.1.1 CAPITAL COST:

Various proposals assessed herein are costed following the standard practice. Baseline cost estimates has been prepared for all the structural measures proposed are as per 2010-11 KPWD, Schedule of Rates for Bengaluru Circle, NH & Water resources dept. and consultants data bank. Unit costs considered for assessing the cost of the proposals are given in **Annexure 6.**

Estimates are prepared for improving the carrying capacity of the system, rehabilitating the existing system, remodeling of inadequate vent size / structurally unsound culverts/bridges, rehabilitation of existing culverts/bridges, formation of service roads where ever possible for routine maintenance of drains and laying service lines, providing chain link fencing to prevent dumping garbage / debris into SWD other allied works to minimizing the flooding problems in low lying areas like construction of diversion drains, development of existing water bodies as retention ponds, providing improvement works to inlet/outlet weir, construction of detention ponds, retention basins, utility shifting service lines were causing obstruction to flow of water, development of flood plains, etc.. In addition improvement of environmental sanitation conditions in the water shed catchment areas, Sewage treatment plants (STPs), Intermittent sewage pump stations (ISPS) have been proposed in all the zones.

Budgetary provision has been included in the costing for temporary shifting of utilities, strengthening of diversion roads, traffic diversion, providing improvement works like green belt development along side of storm drains etc.,

Rehabilitation work includes drain wall reconstruction, cavity filling, restoration of eroded stones, providing pointing, drain wall lining, coping concrete, providing haunch etc. and where as carrying capacity improvement work includes drain desilting, widening and providing bank protective works, deepening and bed regradation to the required profile, RCC box drain construction, fencing, wall raising, construction of water recharging structures and providing drain bed protection etc.

As discussed during project review meeting on 17th June 2010 at BBMP Central Office, chaired by Special Commissioner, BBMP and members present Chief Engineer (SWD), all Executive Engineers (SWD). A lead distance of 15 Kms. has been considered for conveyance of silt in the estimates.

Considering site constraints for desilting and conveyance in built up areas, separate rates have been worked for removal of silt from storm water drains. Whereas drains having width upto 5.0 m. is considered to be done by manual means and beyond 5.0 m. it is considered to be done by mechanical means.

It is proposed to use TMT steel and ready mix concrete of required proportion (design mix) as specified in the detailed structural drawings for all structural works.

For ease of assessment, carrying capacity improvement works and rehabilitation works have been identified and assessed separately for each zone and each water shed cluster wise and included in the report.

The component wise broad summary of estimated cost for remodeling of SWDs in Eight Zones of BBMP Area is given **Table – 6.1** below.

Table - 6.1 TOTAL ESTIMATED COST FOR SWD MASTER PLAN PROJECT

(As per 2010 – 11 Price Level)

Sl. No.	Name of the Zone	Amount (Rs. Crores)
1	East	654.22
2	West	
3	South	
4	Bommanahalli	665.14
5	Yelahanka	655.26
6	Dasarahalli	508.99
7	Mahadevapura	914.91
8	Rajrarajeshwarinagara	759.73
	Total Estimated Cost of Master Plan =	4,158.25

The component wise broad details of estimated cost for each zone are given **Table – 6.2 to 6.7** below.

TABLE - 6.2 ESTIMATED COST FOR CORE AREA OF BBMP

Sl. No.	Name of Water Shed / Items of Work	Unit	Core Area (W + E+ S) Quantity	Core Area (W + E+ S) Amount (Rs. Crores)
1.0	Carrying Capacity Improvement Works:			
1.1	Desilting and deepening	Rmt	227,380	62.09
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	1,850	6.92
	b. RCC independent walls	Rmt	22,890	134.16
	c. RCC "U" shaped walls	Rmt	7,785	63.97
	d. CRS / SSM masonry walls	Rmt	3,850	7.84
	e. RCC box drain	Rmt	5,017	119.06
1.3	Bed protection	Rmt	1,800	4.99
	Sub Total =			399.02
2.0	Rehabilitation / Strengthening Works:			
	CRS / SSM wall reconstruction	Rmt	2,755	4.54
	CRS / SSM wall restoration			
	Sub Total =			4.54
3.0	Culverts / Bridges:			
3.1	Utility support structures / bridges	Nos	0	0.00
3.2	Proposed for remodelling	Nos	59	32.82
3.3	Proposed for rehabilitation	Nos	0	0.00
3.4	Railway Culverts	Nos		
	Sub Total =			32.82
4.0	Allied Drain Works:			
4.1	Fixing boundary stones along the drains	Nos	15,159	0.29
4.2	Development of drains in low lying areas	LOT	58	87.00
4.3	Service road formation	Rmt	17,000	9.50
4.4	Fencing	Rmt	14,790	8.10
4.5	Detention ponds	Nos	33	5.09
4.6	Retarding basins	Nos	14	1.70
4.7	Development of existing water bodies as holding ponds	Nos	7	14.00
4.8	Silt traps	Nos	0	0.00
4.9	Desilting ramps	Nos	0	0.00
4.10	Inlet / out weir strengthening	Nos	15	5.48
4.11	Setting up of rain gauge stations	Nos	8	0.20
4.12	Shifting of sewers from SWD's	LOT	4	11.31
4.13	Procurement of desilting machines	Nos	4	4.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	4	0.40
	Sub Total =			147.06
5.0	Decentralized Sewage Treatment Plants:			
	Construction of decentralized STP's near lakes	Nos	2	12.50
	Sub Total =			12.50
Total for Str. Works =				604.36
6.0	Other Non Structural Works:			
6.1	Consultancy for preparation of DPR and project management services @ 1% of project cost	LS		6.04
6.2	Rehabilitation and resettlement @ 2%	LS		12.09
6.3	Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%*	LS		8.42
6.4	Development of green belt adjacent to SWD's @ 0.25%	LS		1.51
6.5	Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)	LS		30.22
Total for Non Str. Works =				49.86
Total Cost for Master Plan =				654.22
*Note : Shifting of other services @ 2% considered only for drains				

TABLE - 6.3 ESTIMATED COST FOR BOMMANAHALLI ZONE OF BBMP

Sl. No.	Name of Water Shed / Items of Work	Unit	Bommanahalli Quantity	Amount (Rs. Crores)
1.0	Carrying Capacity Improvement Works:			
1.1	Desilting and deepening	Rmt	101,005	8.09
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	10,900	35.89
	b. RCC independent walls	Rmt	1,250	7.17
	c. RCC "U" shaped walls	Rmt	32,305	205.89
	d. CRS / SSM masonry walls	Rmt	25,225	61.20
	e. RCC box drain	Rmt	15,535	93.70
1.3	Bed protection	Rmt	11,685	5.17
	Sub Total =			417.11
2.0	Rehabilitation / Strengthening Works:			
	CRS / SSM wall reconstruction	Rmt	13,105	2.20
	CRS / SSM wall restoration			
	Sub Total =			2.20
3.0	Culverts / Bridges:			
3.1	Utility support structures / bridges	Nos	4	1.02
3.2	Proposed for remodelling	Nos	68	12.49
3.3	Proposed for rehabilitation	Nos	141	1.97
3.4	Railway Culverts	Nos		
	Sub Total =			15.48
4.0	Allied Drain Works:			
4.1	Fixing boundary stones along the drains	Nos	6,626	0.20
4.2	Development of drains in low lying areas	LOT	24	36.00
4.3	Service road formation	Rmt	80,695	39.91
4.4	Fencing	Rmt	400	0.28
4.5	Detention ponds	Nos	10	1.62
4.6	Retarding basins	Nos	10	1.37
4.7	Development of existing water bodies as holding ponds	Nos	7	14.00
4.8	Silt traps	Nos	28	2.60
4.9	Desilting ramps	Nos	5	1.00
4.10	Inlet / out weir strengthening	Nos	26	9.49
4.11	Setting up of rain gauge stations	Nos	11	0.55
4.12	Shifting of sewers from SWD's	LOT	11	4.30
4.13	Procurement of desilting machines	Nos	4	4.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	11	1.10
	Sub Total =			116.42
5.0	Decentralized Sewage Treatment Plants:			
	Construction of decentralized STP's near lakes	Nos	4	54.00
	Sub Total =			54.00
	Total for Str. Works =			614.45
6.0	Other Non Structural Works:			
6.1	Consultancy for preparation of DPR and project management services @ 1% of project cost	LS		6.14
6.2	Rehabilitation and resettlement @ 2%	LS		12.29
6.3	Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%*	LS		9.24
6.4	Development of green belt adjacent to SWD's @ 0.25%	LS		1.54
6.5	Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)	LS		30.72
	Total for Non Str. Works =			50.69
	Total Cost for Master Plan =			665.14

*Note : Shifting of other services @ 2% considered only for drains

TABLE - 6.4 ESTIMATED COST FOR YELAHANKA ZONE OF BBMP

Sl. No.	Name of Water Shed / Items of Work	Unit	Yelahanka Zone Quantity	Amount (Rs. Crores)
1.0	***Carrying Capacity Improvement Works:***			
1.1	Desilting and deepening	Rmt	98,786	10.63
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	14,070	32.99
	b. RCC independent walls	Rmt	10,910	60.30
	c. RCC "U" shaped walls	Rmt	28,860	123.87
	d. CRS / SSM masonry walls	Rmt	23,380	54.92
	e. RCC box drain	Rmt	7,630	37.57
1.3	Bed protection	Rmt	38,140	15.39
	Sub Total =			335.66
2.0	***Rehabilitation / Strengthening Works:***			
	CRS / SSM wall reconstruction	Rmt	24,190	0.30
	CRS / SSM wall restoration	Rmt		1.59
	Sub Total =			1.88
3.0	***Culverts / Bridges:***			
3.1	Utility support structures / bridges	Nos	4	0.97
3.2	Proposed for remodelling	Nos	229	61.77
3.3	Proposed for rehabilitation	Nos	13	0.16
3.4	Railway Culverts	Nos	2	2.15
	Sub Total =			65.05
4.0	***Allied Drain Works:***			
4.1	Fixing boundary stones along the drains	Nos	0	
4.2	Development of drains in low lying areas	LOT	15	24.63
4.3	Service road formation	Rmt	74,500	27.12
4.4	Fencing	Rmt	33,425	20.58
4.5	Detention ponds	Nos	16	2.71
4.6	Retarding basins	Nos	6	0.81
4.7	Development of existing water bodies as holding ponds	Nos	9	17.02
4.8	Silt traps	Nos	242	0.27
4.9	Desilting ramps	Nos	5	0.93
4.10	Inlet / out weir strengthening	Nos	15	6.63
4.11	Setting up of rain gauge stations	Nos	1	0.05
4.12	Shifting of sewers from SWD's	LOT	18,365	15.38
4.13	Procurement of desilting machines	Nos	4	4.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	9	0.90
	Sub Total =			121.02
5.0	***Decentralized Sewage Treatment Plants:***			
	Construction of decentralized STP's near lakes	Nos	3	74.00
	Sub Total =			74.00
Total for Str. Works =				605.32
6.0	***Other Non Structural Works:***			
6.1	**Consultancy for preparation of DPR and project management services @ 1% of project cost**	**LS**		6.05
6.2	**Rehabilitation and resettlement @ 2%**	**LS**		12.11
6.3	**Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%***	**LS**		7.71
6.4	**Development of green belt adjacent to SWD's @ 0.25%**	**LS**		1.51
6.5	**Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)**	**LS**		30.27
Total for Non Str. Works =				49.94
Total Cost for Master Plan =				655.26

***Note : Shifting of other services @ 2% considered only for drains**

TABLE - 6.5 ESTIMATED COST FOR DASARAHALLI ZONE OF BBMP

Sl. No.	Name of Water Shed / Items of Work	Unit	Dasarahalli Zone Quantity	Amount (Rs. Crores)
1.0	***Carrying Capacity Improvement Works:***			
1.1	Desilting and deepening	Rmt	79,110	6.40
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	3,735	10.02
	b. RCC independent walls	Rmt	10,005	64.78
	c. RCC "U" shaped walls	Rmt	36,940	209.11
	d. CRS / SSM masonry walls	Rmt	9,775	20.33
	e. RCC box drain	Rmt	300	1.58
1.3	Bed protection	Rmt	19,110	10.47
	Sub Total =			322.69
2.0	***Rehabilitation / Strengthening Works:***			
	CRS / SSM wall reconstruction	Rmt	13,485	2.12
	CRS / SSM wall restoration			0.00
	Sub Total =			2.12
3.0	***Culverts / Bridges:***			
3.1	Utility support structures / bridges	Nos	4	1.02
3.2	Proposed for remodelling	Nos	133	27.48
3.3	Proposed for rehabilitation	Nos	69	1.54
3.4	Railway Culverts	Nos		
	Sub Total =			30.04
4.0	***Allied Drain Works:***			
4.1	Fixing boundary stones along the drains	Nos	5,521	0.17
4.2	Development of drains in low lying areas	LOT	17	25.50
4.3	Service road formation	Rmt	57,160	26.12
4.4	Fencing	Rmt	13,660	8.42
4.5	Detention ponds	Nos	22	3.67
4.6	Retarding basins	Nos	18	2.50
4.7	Development of existing water bodies as holding ponds	Nos	6	12.00
4.8	Silt traps	Nos	18	1.49
4.9	Desilting ramps	Nos	6	1.20
4.10	Inlet / out weir strengthening	Nos	8	2.92
4.11	Setting up of rain gauge stations	Nos	8	0.40
4.12	Shifting of sewers from SWD's	LOT	8	6.45
4.13	Procurement of desilting machines	Nos	4	4.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	8	0.80
	Sub Total =			95.64
5.0	***Decentralized Sewage Treatment Plants:***			
	Construction of decentralized STP's near lakes	Nos	1	12.50
	Sub Total =			12.50
Total for Str. Works =				470.20
6.0	***Other Non Structural Works:***			0.00
6.1	**Consultancy for preparation of DPR and project management services @ 1% of project cost**	**LS**		4.70
6.2	**Rehabilitation and resettlement @ 2%**	**LS**		9.40
6.3	**Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%***	**LS**		7.22
6.4	**Development of green belt adjacent to SWD's @ 0.25%**	**LS**		1.18
6.5	**Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)**	**LS**		23.51
Total for Non Str. Works =				38.79
Total Cost for Master Plan =				508.99
***Note : Shifting of other services @ 2% considered only for drains**				

TABLE - 6.6 ESTIMATED COST FOR MAHADEVAPURA ZONE OF BBMP

Sl. No.	Name of Water Shed / Items of Work	Unit	Mahadevpura Zone Quantity	Amount (Rs. Crores)
1.0	***Carrying Capacity Improvement Works:***			
1.1	Desilting and deepening	Rmt	131,770	15.53
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	41,980	150.98
	b. RCC independent walls	Rmt	7,340	49.52
	c. RCC "U" shaped walls	Rmt	35,335	217.34
	d. CRS / SSM masonry walls	Rmt	30,415	60.34
	e. RCC box drain	Rmt	11,880	98.42
1.3	Bed protection	Rmt	2,700	1.28
	Sub Total =			593.42
2.0	***Rehabilitation / Strengthening Works:***			
	CRS / SSM wall reconstruction	Rmt	5,400	0.94
	CRS / SSM wall restoration			0.00
	Sub Total =			0.94
3.0	***Culverts / Bridges:***			
3.1	Utility support structures / bridges	Nos	6	1.53
3.2	Proposed for remodelling	Nos	167	38.15
3.3	Proposed for rehabilitation	Nos	81	1.22
3.4	Railway Culverts	Nos	6	5.01
	Sub Total =			45.91
4.0	***Allied Drain Works:***			
4.1	Fixing boundary stones along the drains	Nos	8,629	0.26
4.2	Development of drains in low lying areas	LOT	23	34.50
4.3	Service road formation	Rmt	118,900	59.21
4.4	Fencing	Rmt	3,550	2.46
4.5	Detention ponds	Nos	10	1.70
4.6	Retarding basins	Nos	5	0.75
4.7	Development of existing water bodies as holding ponds	Nos	15	30.00
4.8	Silt traps	Nos	48	5.98
4.9	Desilting ramps	Nos	5	1.00
4.10	Inlet / out weir strengthening	Nos	16	5.84
4.11	Setting up of rain gauge stations	Nos	14	0.70
4.12	Shifting of sewers from SWD's	LOT	14	15.87
4.13	Procurement of desilting machines	Nos	5	5.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	14	1.40
	Sub Total =			164.67
5.0	***Decentralized Sewage Treatment Plants:***			
	Construction of decentralized STP's near lakes	Nos	3	27.00
	Sub Total =			27.00
Total for Str. Works =				845.19
6.0	***Other Non Structural Works:***			
6.1	**Consultancy for preparation of DPR and project management services @ 1% of project cost**	**LS**		8.45
6.2	**Rehabilitation and resettlement @ 2%**	**LS**		16.90
6.3	**Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%***	**LS**		13.24
6.4	**Development of green belt adjacent to SWD's @ 0.25%**	**LS**		2.11
6.5	**Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)**	**LS**		42.26
Total for Non Str. Works =				69.73
Total Cost for Master Plan =				914.91
***Note : Shifting of other services @ 2% considered only for drains**				

TABLE - 6.7 ESTIMATED COST FOR RAJARAJESHWARINAGAR ZONE OF BBMP

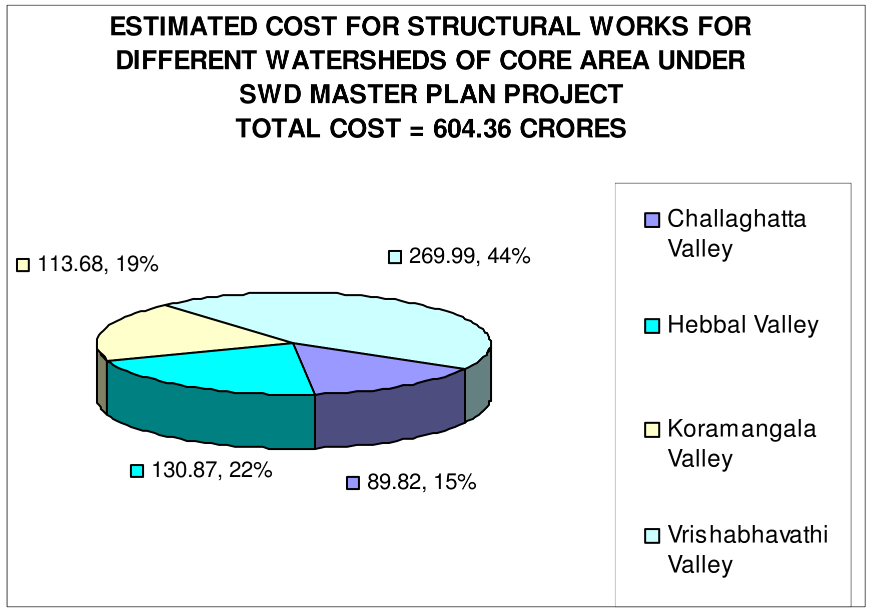
Sl. No.	Name of Water Shed / Items of Work	Unit	Rajarajeshwarinagar Quantity	Amount (Rs. Crores)
1.0	***Carrying Capacity Improvement Works:***			
1.1	Desilting and deepening	Rmt	98,920	18.54
1.2	Drain Widening			
	a. Earthen bund formation	Rmt	550	1.79
	b. RCC independent walls	Rmt	26,725	243.69
	c. RCC "U" shaped walls	Rmt	30,350	151.43
	d. CRS / SSM masonry walls	Rmt	10,750	25.49
	e. RCC box drain	Rmt	5,360	18.93
1.3	Bed protection	Rmt	53,785	41.46
	Sub Total =			501.34
2.0	***Rehabilitation / Strengthening Works:***			
	CRS / SSM wall reconstruction	Rmt	24,935	2.80
	CRS / SSM wall restoration			0.00
	Sub Total =			2.80
3.0	***Culverts / Bridges:***			
3.1	Utility support structures / bridges	Nos	5	1.21
3.2	Proposed for remodelling	Nos	230	71.74
3.3	Proposed for rehabilitation	Nos	103	2.33
3.4	Railway Culverts	Nos	2	1.51
	Sub Total =			76.79
4.0	***Allied Drain Works:***			
4.1	Fixing boundary stones along the drains	Nos	8,460	0.25
4.2	Development of drains in low lying areas	LOT	10	17.06
4.3	Service road formation	Rmt	67,610	25.60
4.4	Fencing	Rmt	35,715	21.80
4.5	Detention ponds	Nos	10	1.64
4.6	Retarding basins	Nos	10	1.32
4.7	Development of existing water bodies as holding ponds	Nos	6	9.38
4.8	Silt traps	Nos	12	1.34
4.9	Desilting ramps	Nos	5	0.93
4.10	Inlet / out weir strengthening	Nos	14	5.46
4.11	Setting up of rain gauge stations	Nos	6	0.30
4.12	Shifting of sewers from SWD's	LOT	6	16.15
4.13	Procurement of desilting machines	Nos	3	3.00
4.14	Procurement of vehicles for BBMP vigilance squad	Nos	6	0.60
	Sub Total =			104.83
5.0	***Decentralized Sewage Treatment Plants:***			
	Construction of decentralized STP's near lakes	Nos	1	5.00
	Sub Total =			5.00
Total for Str. Works =				701.82
6.0	***Other Non Structural Works:***			
6.1	**Consultancy for preparation of DPR and project management services @ 1% of project cost**	**LS**		7.02
6.2	**Rehabilitation and resettlement @ 2%**	**LS**		14.04
6.3	**Shifting of other services i.e. water supply, electricity, telephone, fiber optic @ 2%***	**LS**		11.06
6.4	**Development of green belt adjacent to SWD's @ 0.25%**	**LS**		1.75
6.5	**Work Charge Establishment and Administrative Charges @ 5% (3% + 2%)**	**LS**		35.09
Total for Non Str. Works =				57.90
Total Cost for Master Plan =				759.73

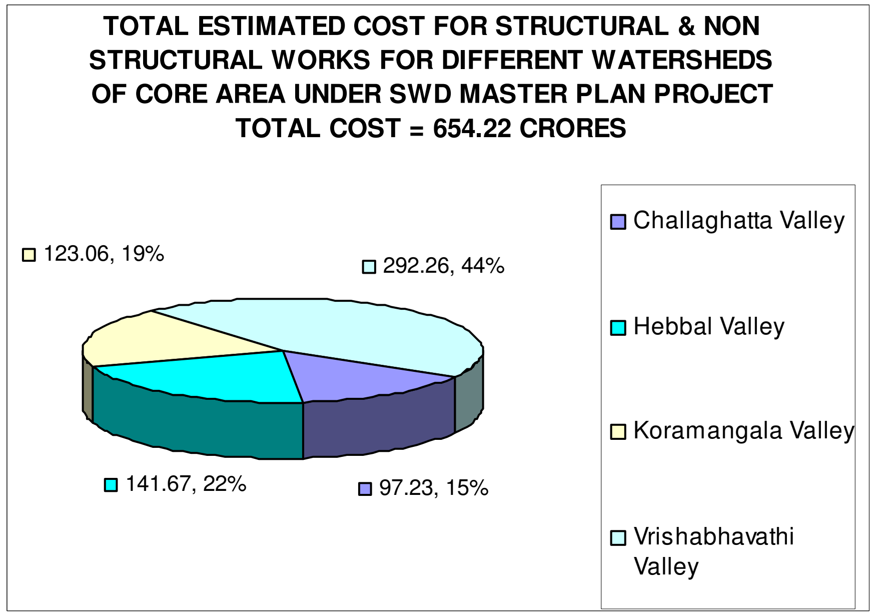
***Note : Shifting of other services @ 2% considered only for drains**

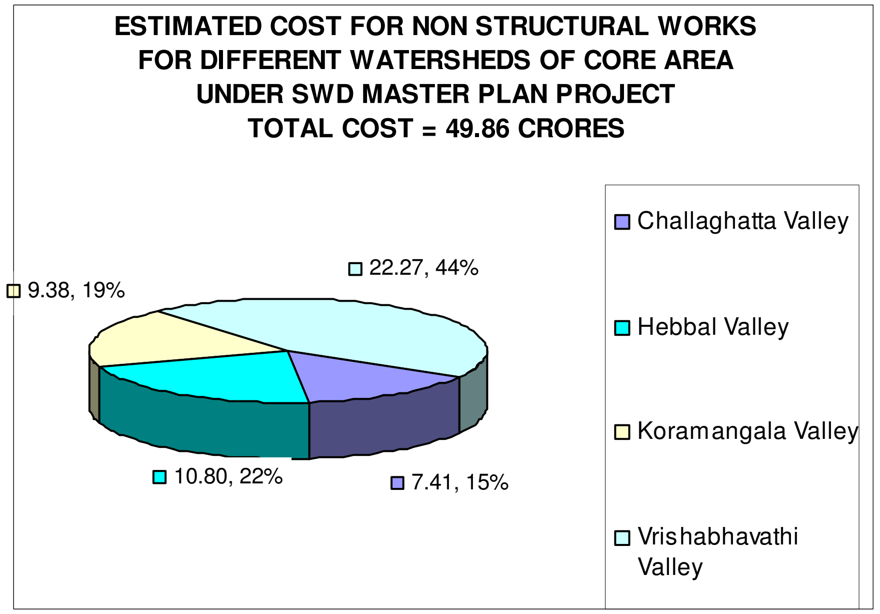
Pictorial representation of the costs comprising structural and non structural measures along with functional distribution of works are given in **Figures - 6.1 to 6.7** as given below.

FIGURE - 6.1

PICTORIAL REPRESENTATION OF COSTS FOR CORE AREA







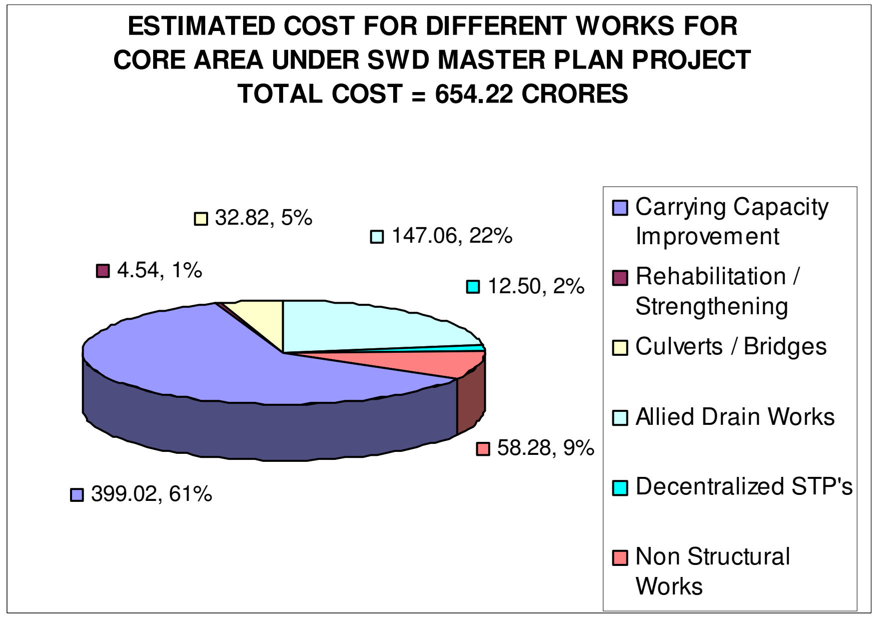
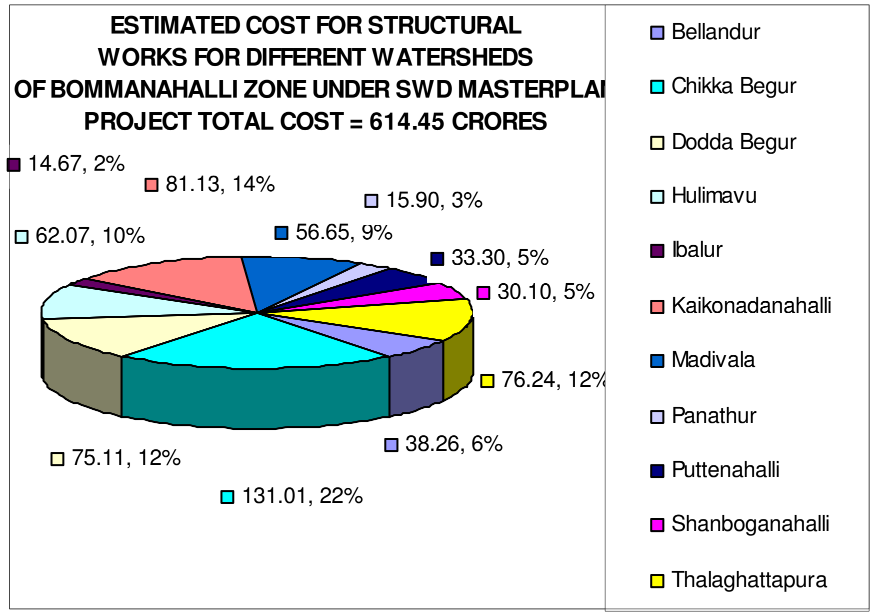
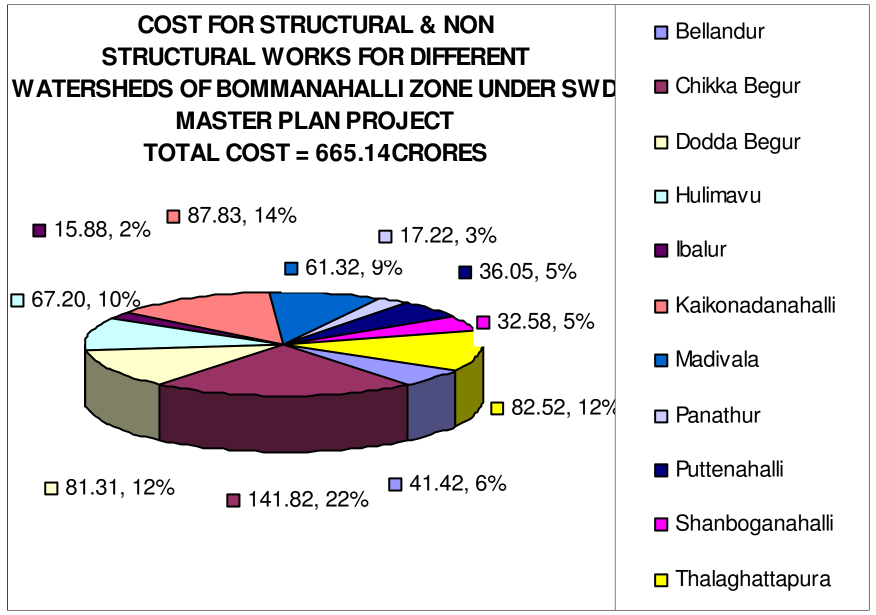
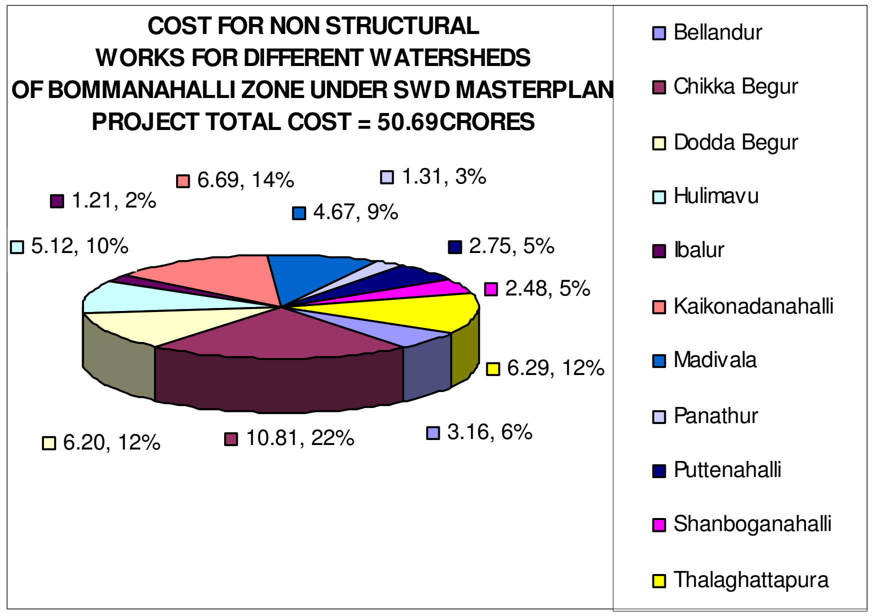


FIGURE - 6.2

PICTORIAL REPRESENTATION OF COSTS FOR BOMMANAHALLI ZONE







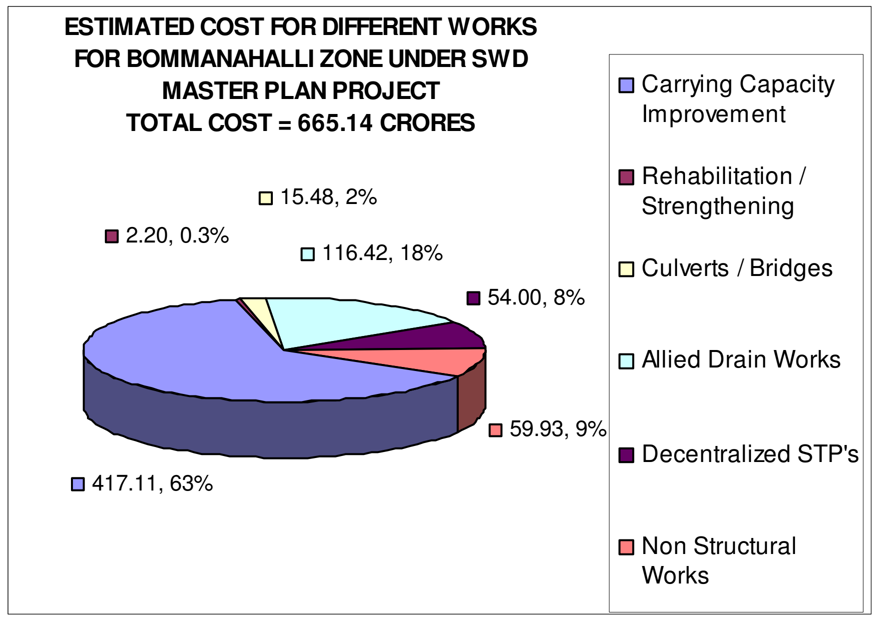
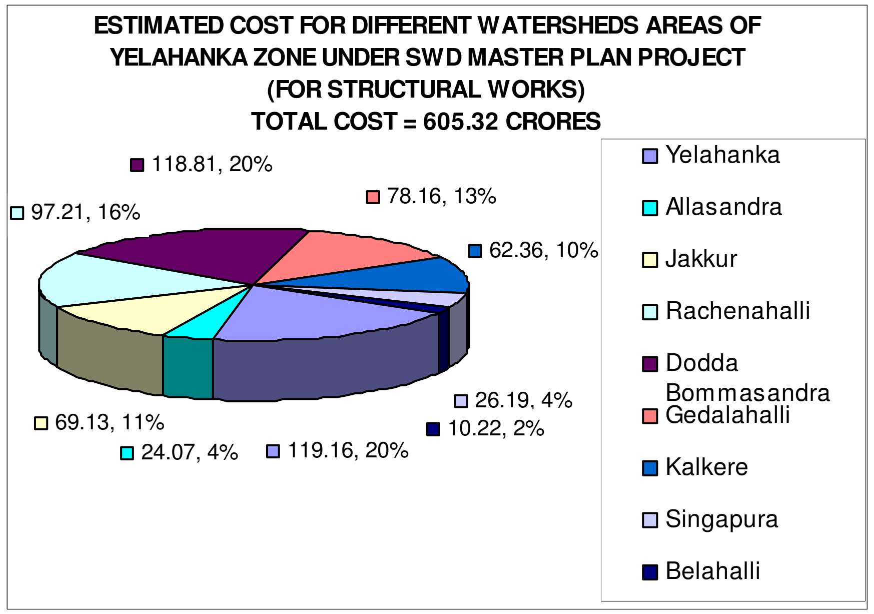
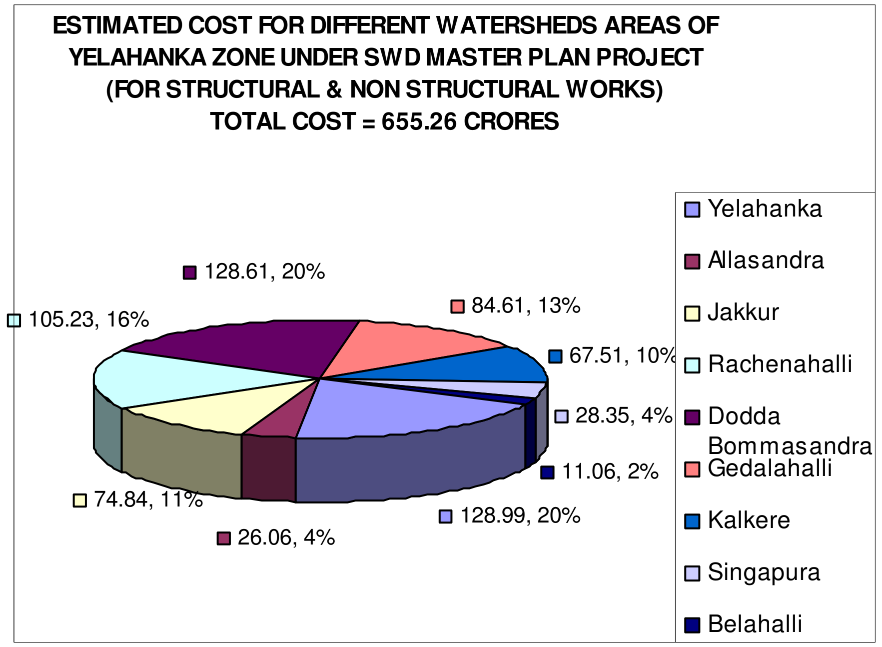
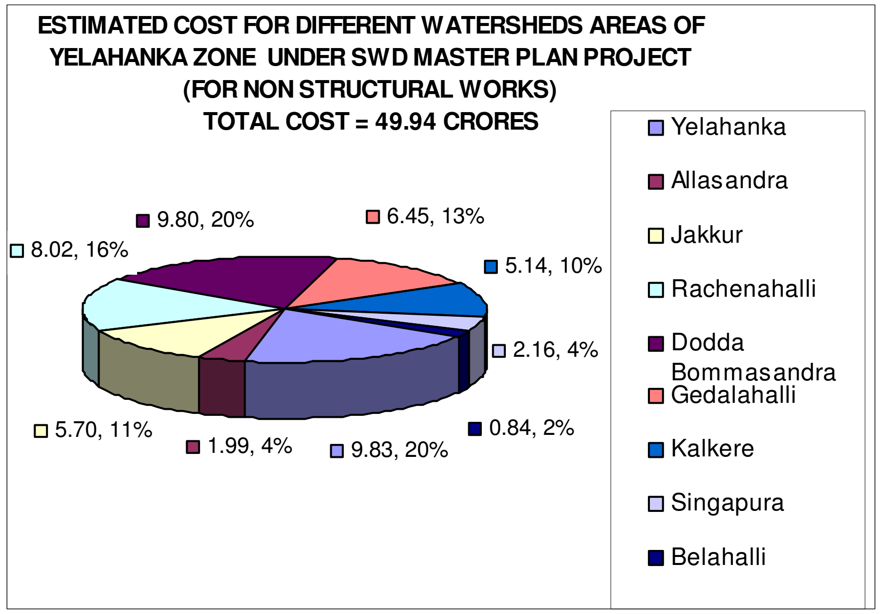


FIGURE - 6.3

PICTORIAL REPRESENTATION OF COSTS FOR YELAHANKA ZONE







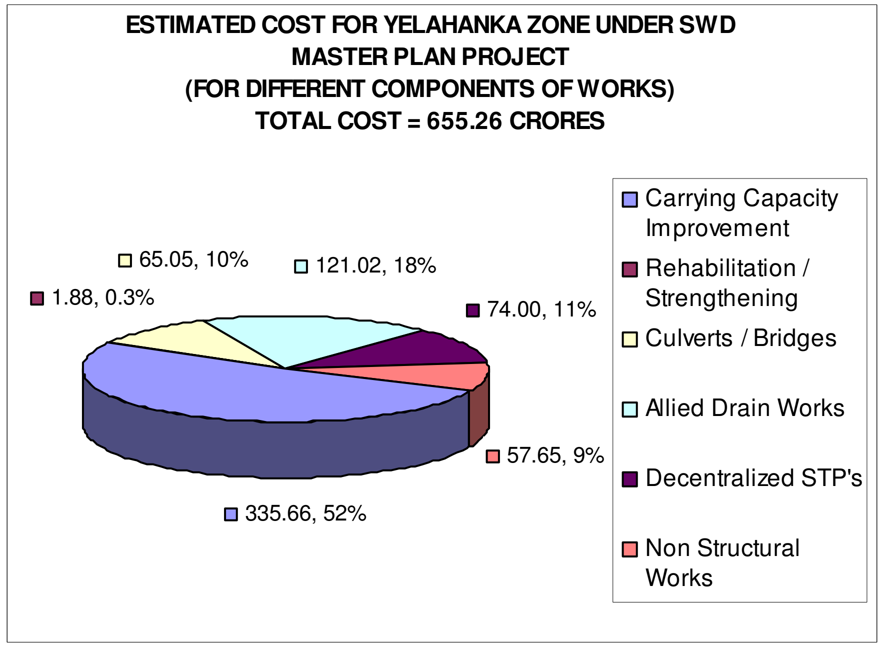
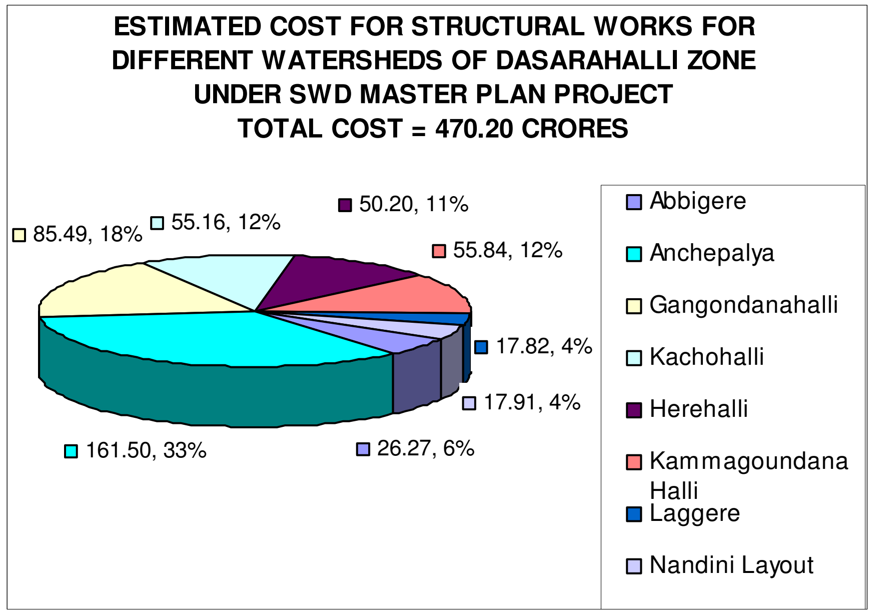
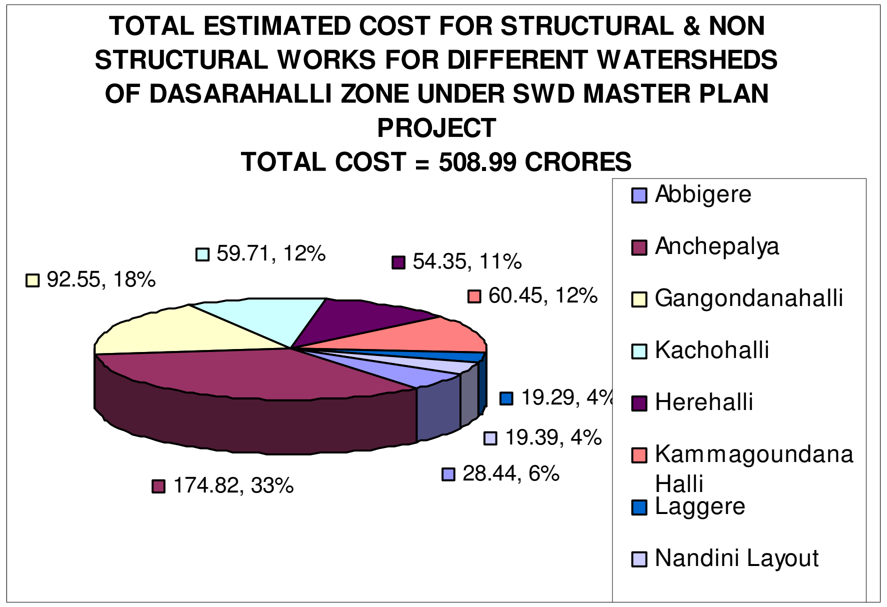
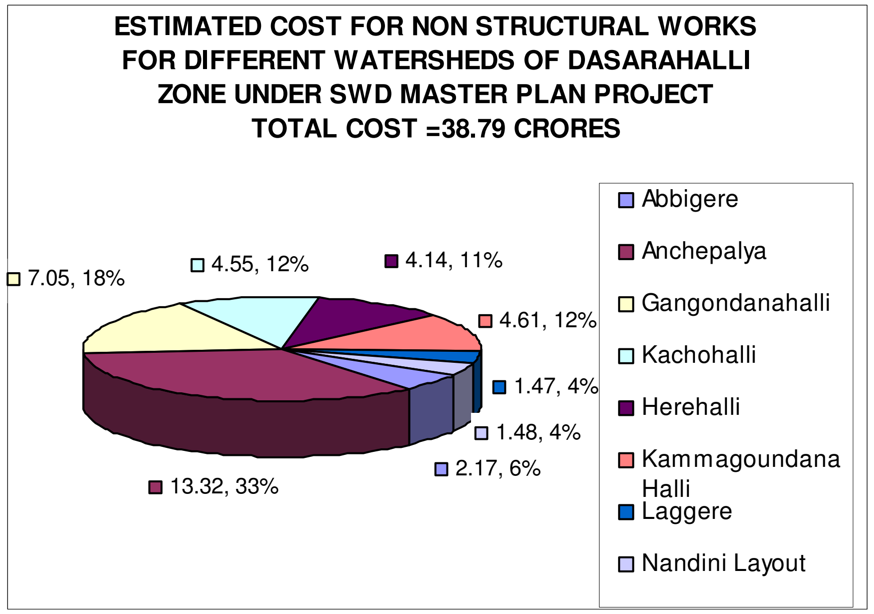


FIGURE - 6.4

PICTORIAL REPRESENTATION OF COSTS FOR DASARAHALLI ZONE







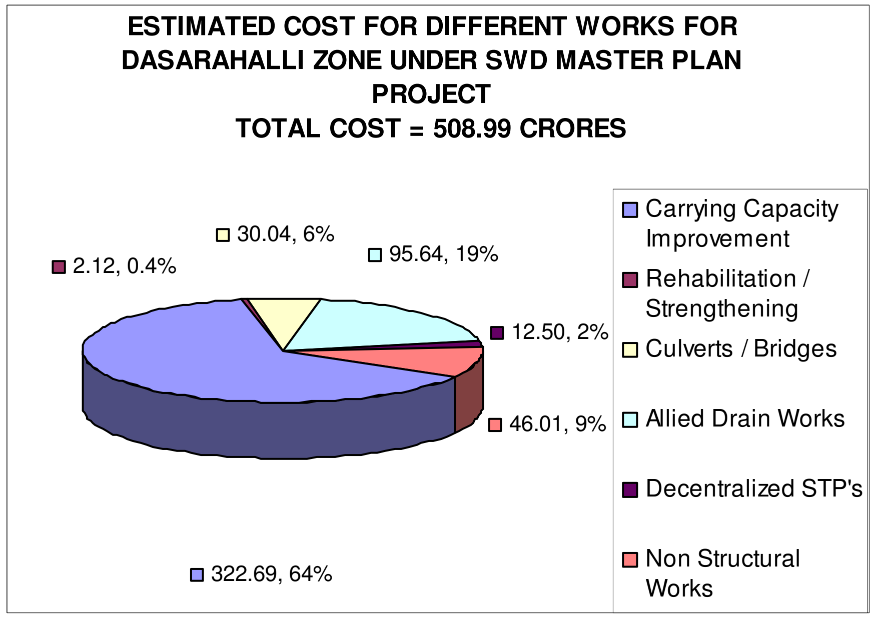
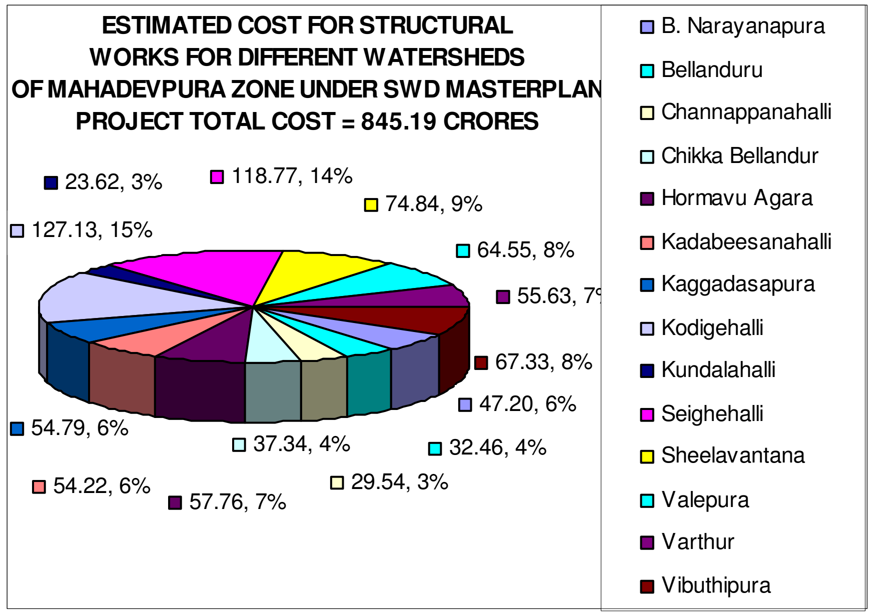
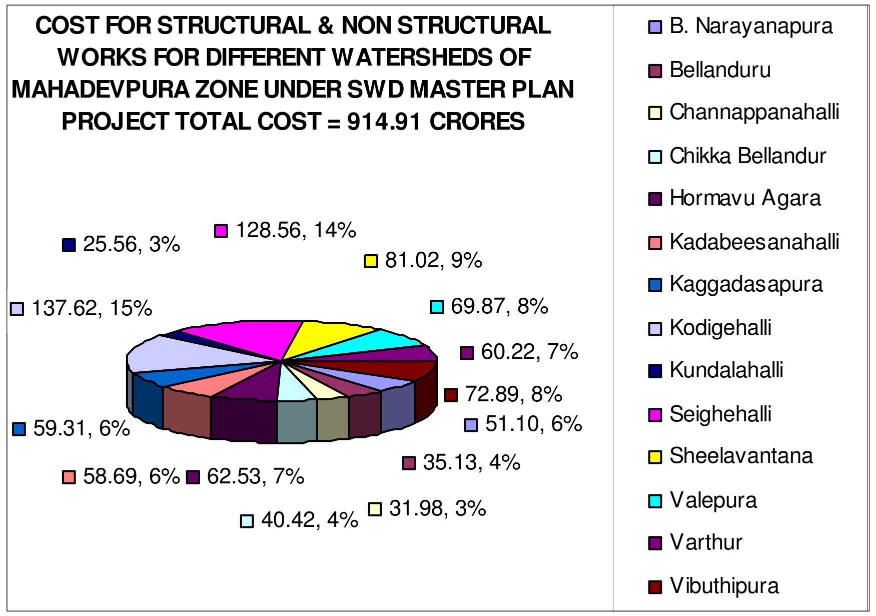
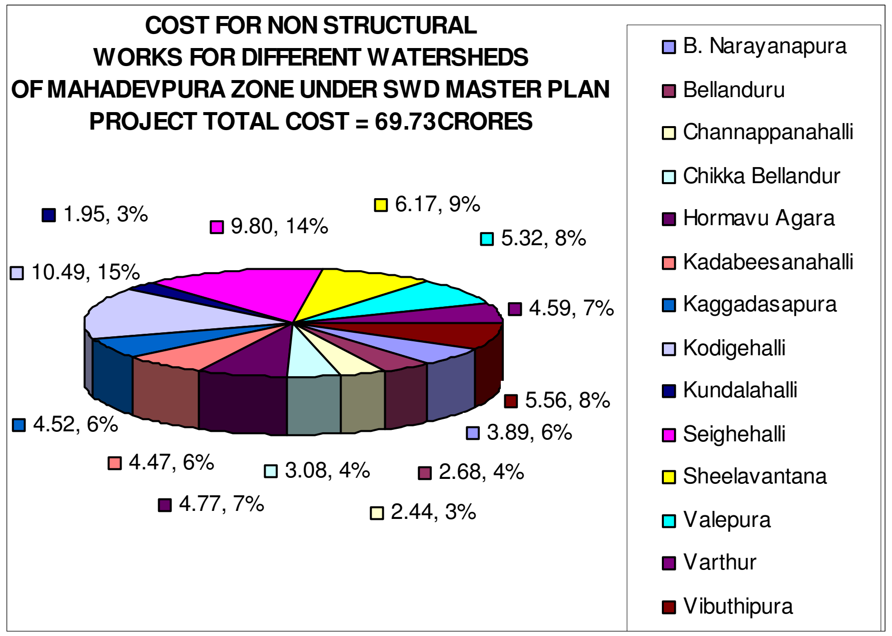


FIGURE - 6.5

PICTORIAL REPRESENTATION OF COSTS FOR MAHADEVAPURA ZONE







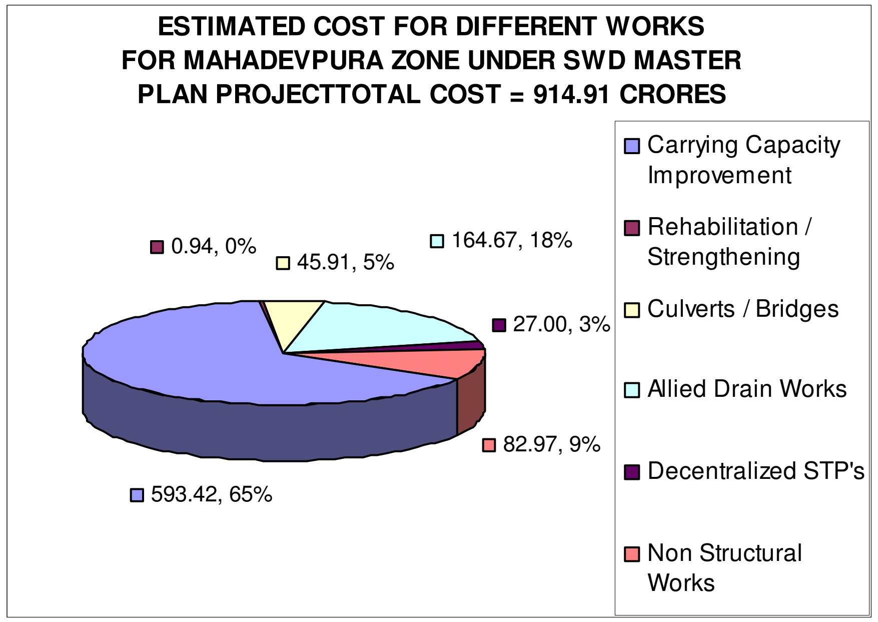
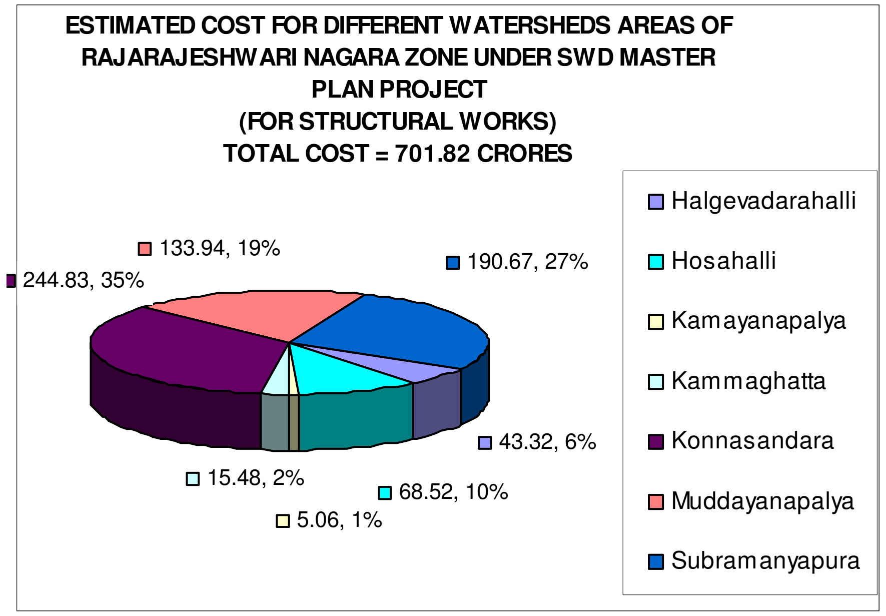
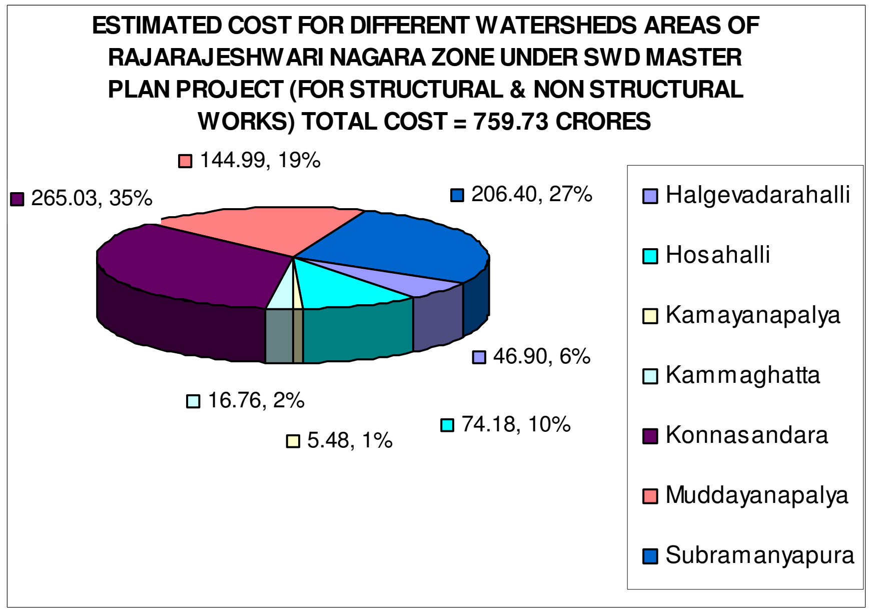
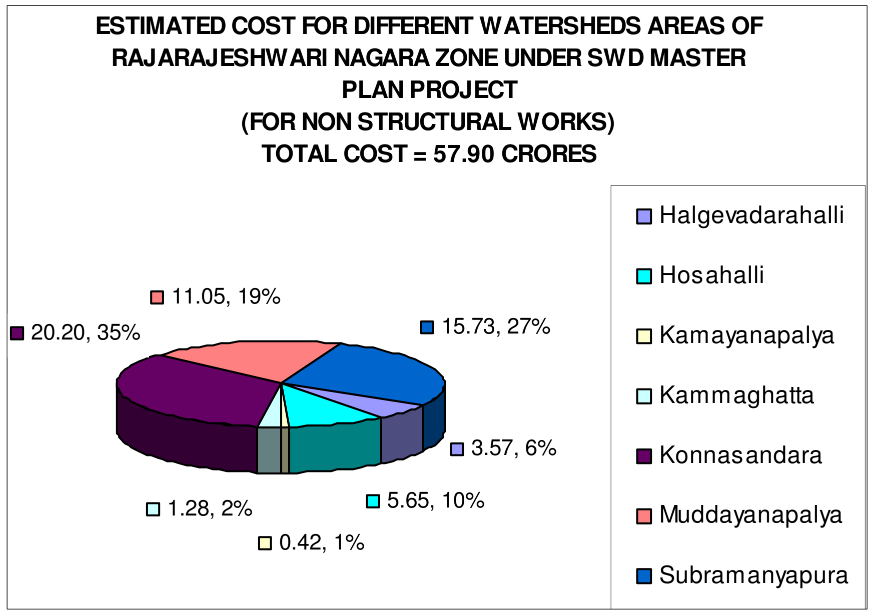


FIGURE - 6.6

PICTORIAL REPRESENTATION OF COSTS FOR RAJARAJESHWARINAGAR ZONE







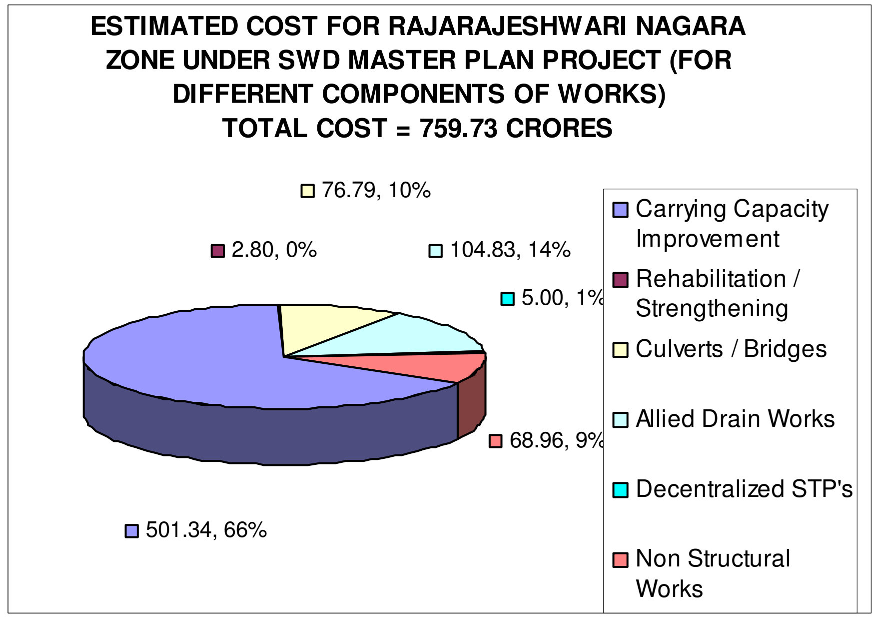
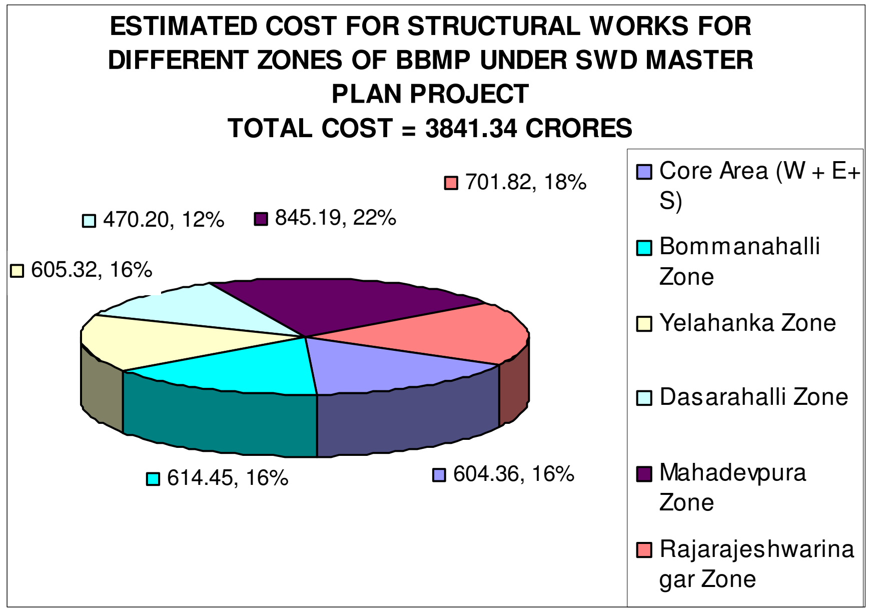
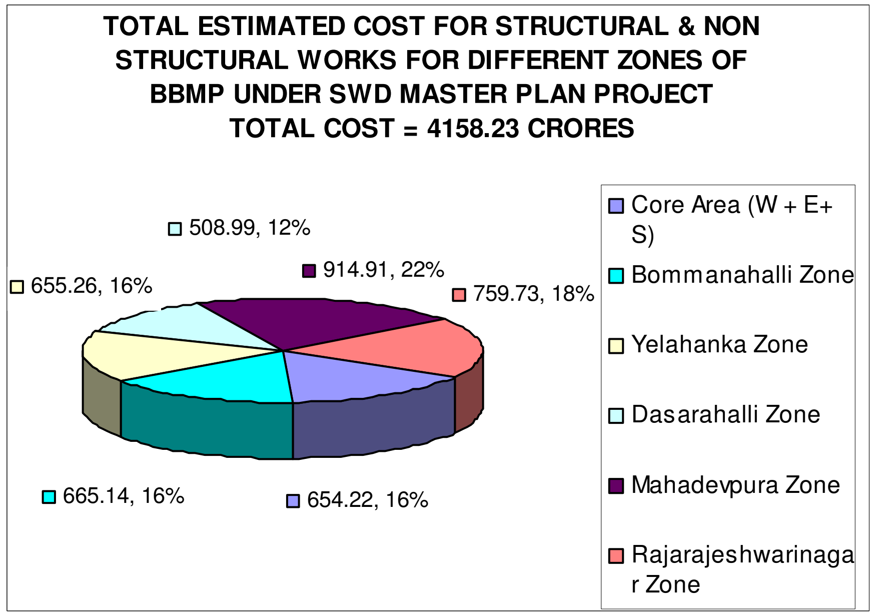
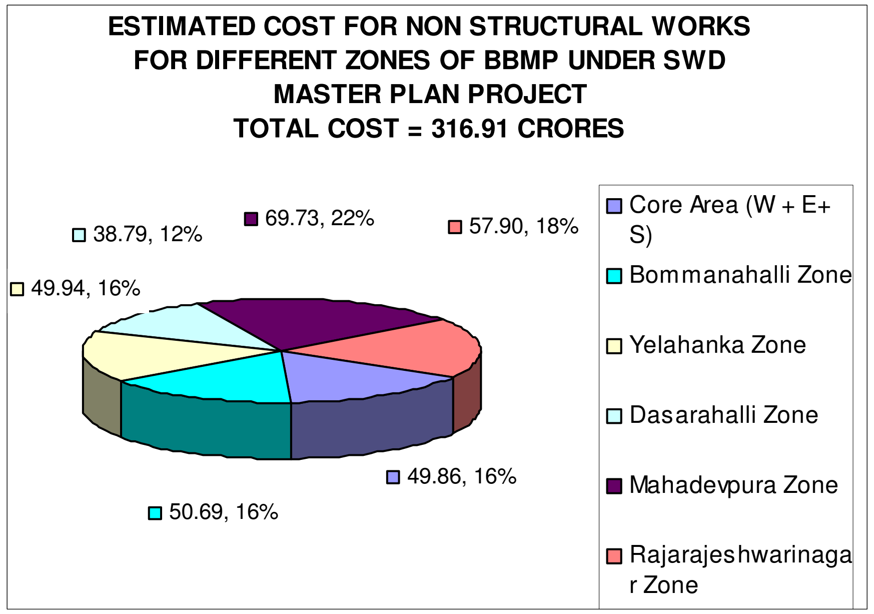


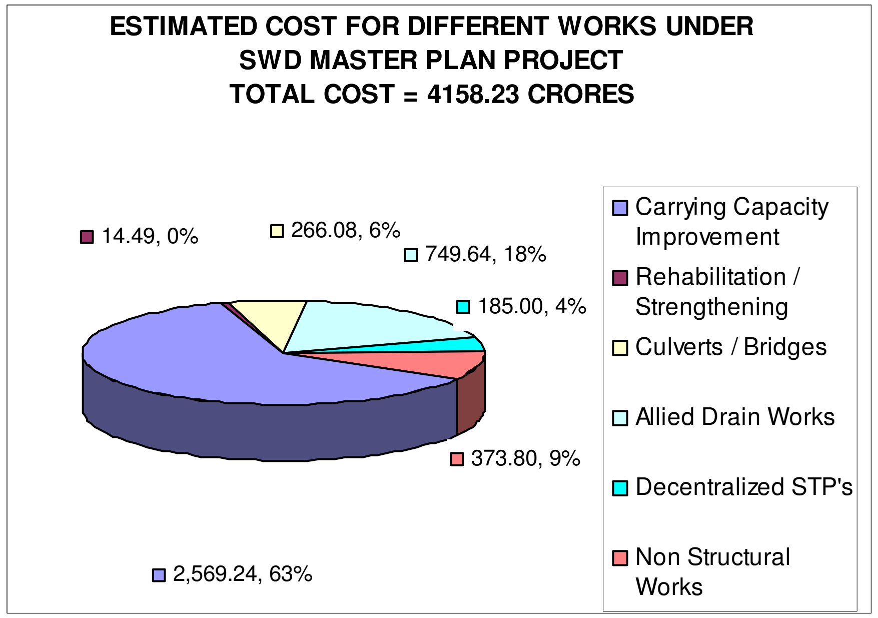
FIGURE - 6.7

PICTORIAL REPRESENTATION OF COSTS FOR MASTER PLAN









Apart from the cost incurred for remodeling of storm drains, some of the costs which are not considered in the estimate and which are envisaged to be a large amount are,

- Land Acquisition
- Rehabilitation cost for distracted property owners
- Removal of structures & Disposal of debris
- Permanent shifting of service lines by various agencies
- Sewerage system improvement works
- Restoration of roads and cross drainages after completion of the works
- Cost incurred for asset management
- Maintenance of drains, etc

The cost of acquiring land for the preservation of the integrity of the identified drainage corridor with service roads and fencing, not being considered in the cost of the project, BBMP's particular attention is required on top priority for a policy decision on this aspect for the options like compensation or Transfer of Development Rights or Rehabilitation and Resettlement of Project affected Persons.

The zone wise approximate land requirement for drain widening, service road formation etc. is given in **Table - 6.8.**

Table 6.8

DETAILS OF ADDITIONAL LAND REQUIREMENT

Sl .No.	Name of the Zone	Total Area (in Sq.m.)
1	East	1,245,143
2	West	778,250
3	South	773,152
4	Bommanahalli	1,814,652
5	Yelahanka	1,642,813
6	Dasarahalli	821,007
7	Mahadevapura	2,356,615
8	Rajrarajeshwarinagara	1,606,981
	Total	**11,038,612**

6.1.1.1 East Core Zone

Detailed costing of individual component of the proposals making up Table 6.2 are given in **Part 3, Appendix 1,** which need to be apportioned to the individual zone in the core area corresponding to East Core Zone. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as given below:

Table -I Cost Abstract

Table -2 Summary of Cost - Cluster

Table – 3 Summary of Cost for Drains and Culverts Modification

Table – 4 Drain wise cross section details and cost

Table – 5 Culvert wise cross section details and cost

Table – 6 Summary of cost of Detention Pond

Table – 7 Summary of cost of Retention Basin

Table – 8 Cost of Low lying Area Drain Improvement Cost

Table – 9 Cost of Development of existing water bodies as holding ponds

Table – 10 Cost of Localized Sewage Treatment Plant

Table – 11 Operation and Maintenance Cost for the Zone

6.1.1.2 West Core Zone

Detailed costing of individual component of the proposals making up Table 6.2 are given in **Part 3, Appendix 2,** which need to be apportioned to the individual zone in the core area corresponding to West Core Zone. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.3 South Core Zone

Detailed costing of individual component of the proposals making up Table 6.2 are given in **Part 3, Appendix 3,** which need to be apportioned to the individual zone in the core area corresponding to South Core Zone. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.4 Bommanahalli Zone

Detailed costing of individual component of the proposals making up Table 6.3 are given in **Part 3, Appendix 4**. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.5 Yelahanka Zone

Detailed costing of individual component of the proposals making up Table 6.4 are given in **Part 3, Appendix 5**. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.6 Dasarahalli Zone

Detailed costing of individual component of the proposals making up Table 6.5 are given in **Part 3, Appendix 6**. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.7 Mahadevapura Zone

Detailed costing of individual component of the proposals making up Table 6.6 are given in **Part 3, Appendix 7**. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.1.1.8 Raja RajeshwariNagara Zone

Detailed costing of individual component of the proposals making up Table 6.7 are given in **Part 3, Appendix 8**. Details given cover drains and culverts which are consolidated watershed clusterwise and abstracted to zone as Tables 1 to 11 cited above.

6.2 RECURRENT COST:

For maintaining the existing drains in good condition and to have maximum hydraulic carrying capacity, the drainage system has to be maintained in good condition. The general maintenance envisaged are given in the **Table 6.9.**

- Removal of weeds
- Removal of silt
- Removal of debris and garbage
- Repair of civil structures
- Public awareness campaigns
- Maintenance of desilting equipment's
- Manpower requirement for maintenance of the system.

For effective functioning of any system, requires regular maintenance. The operation and maintenance requirement have been identified and costing is indicated.

Table 6.9 Indicates abstract of cost for annual operation and maintenance of the drains.

Table 6.9 Abstract of Cost for Operation and Maintenance of Storm Water Drains & its Allied works

Sl No	Description	East	West	South	Rajarajeshwarinagara	Dasarahalli	Yelahanka	Mahadevapura	Bommanahalli	Total Amount (Rs. In Lakhs)
1	Establishment Charges	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	560.00
2	Cost for purchase of Plants, Machineries & their maintenance	5.03	1.32	2.17	3.55	3.70	8.95	9.82	9.63	44.17
3	Drain desilting works	177.53	107.78	142.71	180.16	144.67	167.74	255.38	187.00	1362.96
4	Maintenance of other allied structure	5.03	1.32	2.17	3.55	3.70	8.95	9.82	9.63	44.17
5	Staff Training, Community Awareness etc	2.52	0.66	1.09	1.78	1.85	4.48	4.91	4.81	22.08
6	Holding pond operator cost	1.44	0.00	0.36	1.08	1.80	3.24	2.88	1.80	12.60
7	STP O & M Cost for 37.5 MLD	300.00	0.00	50.00	150.00	200.00	700.00	700.00	750.00	2850.00
	Total	**561.54**	**181.08**	**268.49**	**410.11**	**425.72**	**963.35**	**1052.81**	**1032.87**	**4895.98**

CHAPTER - 7

IMPLEMENTATION PROGRAMME

7.0 INTRODUCTION:

This chapter provides a strategic framework to ensure that the storm water drains project initiative taken up by BBMP is managed in a reliable, affordable, sustainable and environmentally friendly manner, and which is most essential for success of any project.

But from the existing management practices followed by the stakeholders and also with the prevailing site conditions, it appears that, along with the resources required to achieve the recommended targets, strategies and actions, they need to reframe the work approach by adoption of best storm drain management practices, improvised construction and construction supervision techniques, strengthened organizational setup, major legislative changes, coordination with other stakeholders, public awareness campaigns including their participation to minimize the adverse implications on storm drain functionality and storm drain management practice in the city.

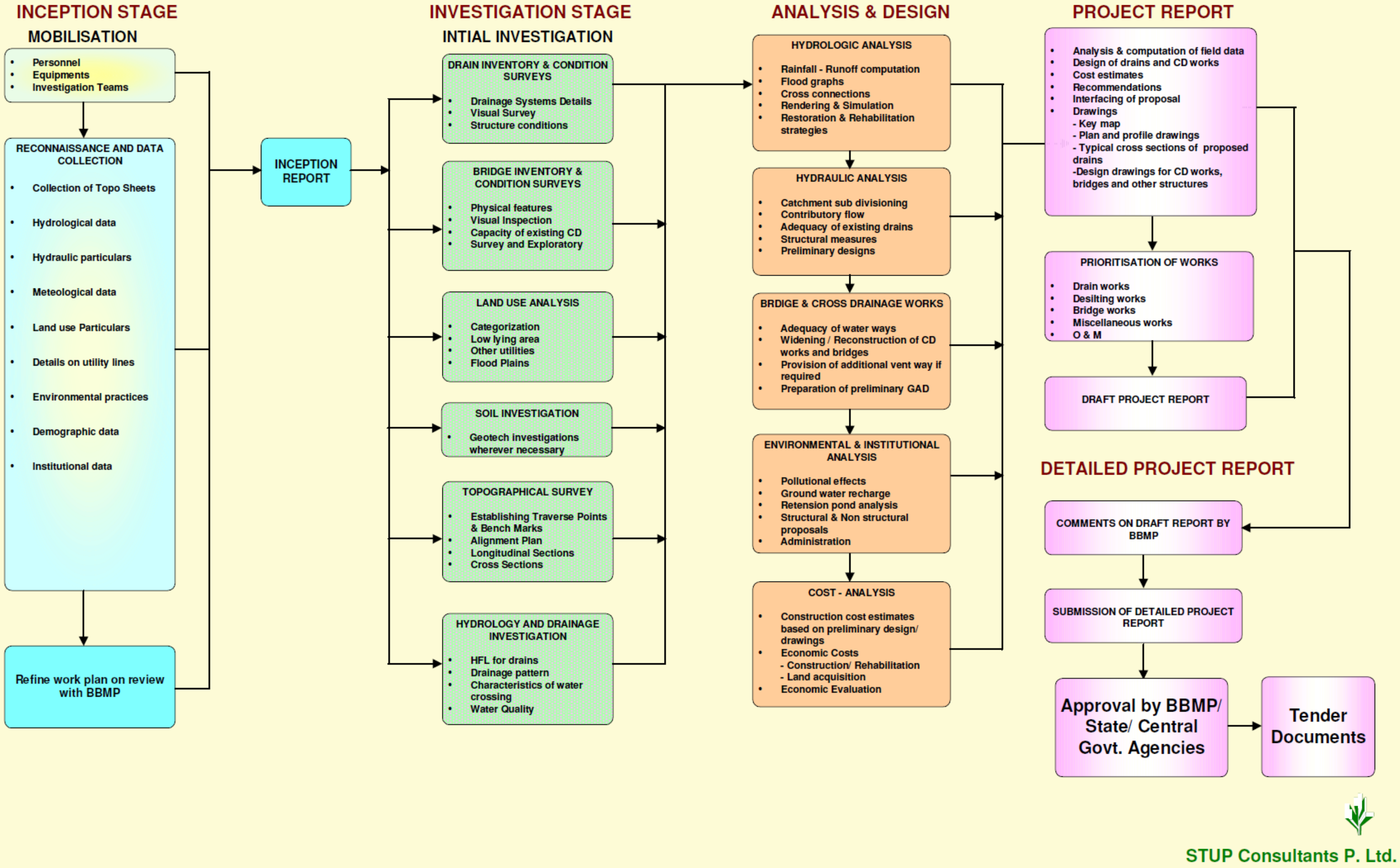
In order to achieve the overall objectives of the project, it is very much essential to have a proper implementation programme that could ensure better control over the project cost and resources mobilized etc. BBMP proposes to have a separate project implementation unit within BBMP for SWD Projects (other than members from stake holders dept.), headed by a senior officer from the Engineering wing, Revenue, consortia of Technical consultants, Financial advisors, Project management consultants, co ordination committee members (other stake holders dept. members), PRO's & NGO's.

7.1 STAGES OF THE PROJECT:

The proposed project is suggested to be implemented over a 10 year period considering the cost of the project. It is suggested that the implementation be over three phases of 3 year each. The first year is considered for forming a Project Facilitation Unit together with the implementation of programmes in the highly critical and vulnerable areas as identified hereunder. The first year may be utilized to consolidate various detailed engineering proposals as developed for the individual zones with detailed Project Reports framed in accordance with the proposed masterplan.

The outline methodology depicting the activities involved in the preparation of DPR is shown in **Fig. 7.1.**

Fig. 7.1 : DETAILED PROJECT REPORT - PROCESS
(As per Master Plan Recommendations)



7.2 PRIORITIZATION OF WORKS:

The structural and non structural proposals envisaged in the master plan project is prioritized based on severity of the problems in the catchment area, effective functionality of the system etc.

The proposals envisaged in the master plan project are prioritized into three categories and some of these proposals are parallel activities also interrelated and on completion of priority- I works subsequent priority works can be taken up;

The works proposed to be taken up under different priorities are as follows viz;

Priority – I:

- Setting up of project implementation unit
- Verification of land records and demarcation of required water ways along with service corridors.
- Discussion with other stake holders and fixing responsibilities and targets for taking up the respective works.
- Setting up of coordination committee, comprising of members from each department and the committee headed by Commissioner, BBMP.
- Setting up of rain gauging stations, flow measuring and data collection centers.
- Setting up of control rooms grievances addressal cell
- Desilting and drain bed regradation / profile modification of entire length of drains
- Remodelling of culverts/bridges
- Removal of encroachments
- Providing drain improvement works in low lying areas
- Restoration of existing walls
- Reconstruction of dilapidated walls
- Development of water bodies as flood retention basins
- Procurement of additional land required for drain remodeling and setting up of STPs etc
- Removal of obstacles and shifting service lines that are obstructing flow

Priority – II:

- Create public awareness
- Drain widening and bank protective works
- Setting up of Sewage Treatment Plants
- Development of flood plains

Priority – III:

- Providing bed protection works
- Rehabilitation of existing culverts/bridges
- Providing fencing
- Formation of service roads for routine maintenance and laying service lines
- Construction of detention ponds, retention basins, silt traps etc.

7.3 IMPLEMENTATION PROGRAMME:

It is proposed that BBMP shall set up a separate Project Implementation Unit (PIU) for implementation of proposals whose responsibilities would include ensuring the deployment of adequate staff, finalization of proposals, tendering, preparation of work programme and approval, procurement of land, removal of encroachments, identification of work fronts, obtaining approvals / clearances from other departments, for smoother implementation of proposals, conducting coordination meetings, addressing issues / grievances in consultation with the competent authority, ensure adoption of good construction practices, project monitoring and reporting the project progress to the project monitoring/funding agencies and complete the project as per schedule.

Whereas, the technical specifications, construction methodologies and Tender conditions which needs to be adopted during implementation are reflected in the bid document issued by BBMP. During implementation the contracting agency / firm authorized shall strictly adhere to the environmental regulations set forth by the authorities. The PIU shall keep the citizens and their representatives informed about the scheduled of the project underway in a periodic manner.

Having several round of discussions with senior officials of BBMP, stake holders and beneficiaries of the project. A brief work programme with a broader perspective has been formulated keeping in view the availability of the resources, minimum distraction to the adjoining properties, to cause less inconvenience to the public, considering the environmental aspects, financial capabilities etc., for smooth and successful implementation of the project.

The works proposed for remodeling of storm drains in BBMP Area, shall be taken up in a phased manner simultaneously in all the packages. Since, some of the critical issues which requires coordination from other agencies in several instances, community participation, removal of encroachments, acquisition of land from both government & public, shifting of utilities, traffic diversion at several places etc., are envisaged in each of the drains.

Programme for implementation of all the works envisaged in the master plan project initiative in the master plan project initiative is prepared zone and appended in the report as **Fig. 7.2 to 7.8**

FIGURE-7.1

WORK PROGRAMME BAR CHART FOR CORE AREA OF BBMP (EAST + WEST + SOUTH)

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year 1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	6208.70	310.43	1862.61	620.87	620.87	931.30	558.78	372.52	465.65	279.39
1.2	Widening										
	a. Earthen bund	691.53	0.00	69.15	34.58	34.58	138.31	82.98	55.32	138.31	82.98
	b. RCC independent walls	13416.10	670.81	2683.22	1609.93	1073.29	2012.42	1207.45	804.97	1677.01	1006.21
	c. RCC "U" shaped walls	6397.16	319.86	1279.43	767.66	511.77	959.57	575.74	383.83	799.65	479.79
	d. CRS / SSM masonry walls	784.25	39.21	156.85	94.11	62.74	117.64	70.58	47.05	98.03	58.82
	e. RCC box drain	11905.67	595.28	2381.13	1428.68	952.45	1785.85	1071.51	714.34	1488.21	892.93
1.3	Bed protection	498.96	24.95	29.94	49.90	19.96	74.84	124.74	49.90	37.42	62.37
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM Wall Reconstruction	453.63	45.36	113.41	68.04	45.36	68.04	40.83	27.22	22.68	13.61
	CRS / SSM Wall Restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	Remodeling	3282.00	492.30	984.60	410.25	246.15	393.84	164.10	98.46	295.38	123.07
3.3	Rehabilitation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.4	Railway Culverts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.0	**Allied Works:**										
4.1	Boundary stones	28.78	11.51	10.36	3.45	3.45	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	8700.00	1305.00	3132.00	1305.00	783.00	783.00	326.25	195.75	522.00	217.50
4.3	Service roads	949.62	0.00	37.98	56.98	94.96	56.98	85.47	142.44	94.96	142.44
4.4	Fencing	809.60	0.00	32.38	48.58	80.96	48.58	72.86	121.44	80.96	121.44
4.5	Detention ponds	508.96	0.00	40.72	30.54	30.54	101.79	76.34	76.34	61.08	45.81
4.6	Retarding basins	170.18	8.51	34.04	20.42	13.61	25.53	15.32	10.21	21.27	12.76
4.7	Development of water bodies	1400.00	140.00	126.00	210.00	84.00	168.00	280.00	112.00	84.00	140.00
4.8	Silt traps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.9	Desilting ramps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.10	Inlet / out weirs	547.50	27.38	164.25	54.75	54.75	82.13	49.28	32.85	41.06	24.64
4.11	Rain gauge stations	20.00	8.00	7.20	2.40	2.40	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	1131.00	56.55	339.30	113.10	113.10	169.65	101.79	67.86	84.83	50.90
4.13	Desilting equipments	400.00	100.00	120.00	40.00	40.00	50.00	30.00	20.00	0.00	0.00
4.14	Vehicles for vigilance squad	40.00	4.00	12.00	4.00	4.00	5.00	3.00	2.00	3.00	1.80
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	1250.00	125.00	93.75	225.00	56.25	125.00	300.00	75.00	62.50	150.00
6.0	**Non Structural Works:**										
6.1	DPR and PMC	604.36	604.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	1208.72	483.49	435.14	145.05	145.05	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	842.30	42.12	252.69	84.23	84.23	126.35	75.81	50.54	63.17	37.90
6.4	Development of green belt	151.09	0.00	6.04	9.07	15.11	9.07	13.60	22.66	15.11	22.66
6.5	WCE + Admin.	3021.80	302.18	226.63	317.29	362.62	226.63	317.29	362.62	226.63	317.29
	Total of SWD =	**65421.90**	**5716.29**	**14630.83**	**7753.86**	**5535.20**	**8459.51**	**5643.72**	**3845.32**	**6382.91**	**4284.31**

FIGURE-7.2

WORK PROGRAMME BAR CHART FOR BOMMANAHALLI ZONE

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year								
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	809.05	40.45	242.71	80.90	80.90	121.36	72.81	48.54	60.68	36.41
1.2	Widening										
	a. Earthen bund	3589.12	0.00	358.91	179.46	179.46	717.82	430.69	287.13	717.82	430.69
	b. RCC independent walls	716.63	35.83	143.33	86.00	57.33	107.49	64.50	43.00	89.58	53.75
	c. RCC "U" shaped walls	20589.45	1029.47	4117.89	2470.73	1647.16	3088.42	1853.05	1235.37	2573.68	1544.21
	d. CRS / SSM masonry walls	6119.67	305.98	1223.93	734.36	489.57	917.95	550.77	367.18	764.96	458.98
	e. RCC box drain	9370.32	468.52	1874.06	1124.44	749.63	1405.55	843.33	562.22	1171.29	702.77
1.3	Bed protection	516.55	25.83	30.99	51.65	20.66	77.48	129.14	51.65	38.74	64.57
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM Wall Reconstruction	220.16	22.02	55.04	33.02	22.02	33.02	19.81	13.21	11.01	6.60
	CRS / SSM Wall Restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	102.00	15.30	30.60	12.75	7.65	12.24	5.10	3.06	9.18	3.83
3.2	Remodeling	1248.97	187.35	374.69	156.12	93.67	149.88	62.45	37.47	112.41	46.84
3.3	Rehabilitation	196.58	29.49	58.97	24.57	14.74	23.59	9.83	5.90	17.69	7.37
3.4	Railway Culverts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.0	**Allied Works:**										
4.1	Boundary stones	19.88	7.95	7.16	2.39	2.39	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	3600.00	540.00	1296.00	540.00	324.00	324.00	135.00	81.00	216.00	90.00
4.3	Service roads	3990.52	0.00	159.62	239.43	399.05	239.43	359.15	598.58	399.05	598.58
4.4	Fencing	27.72	0.00	1.11	1.66	2.77	1.66	2.49	4.16	2.77	4.16
4.5	Detention ponds	161.84	0.00	12.95	9.71	9.71	32.37	24.28	24.28	19.42	14.57
4.6	Retarding basins	137.48	6.87	27.50	16.50	11.00	20.62	12.37	8.25	17.19	10.31
4.7	Development of water bodies	1400.00	140.00	126.00	210.00	84.00	168.00	280.00	112.00	84.00	140.00
4.8	Silt traps	260.25	13.01	78.08	26.03	26.03	39.04	23.42	15.62	19.52	11.71
4.9	Desilting ramps	100.00	0.00	4.00	6.00	10.00	6.00	9.00	15.00	10.00	15.00
4.10	Inlet / out weirs	949.00	47.45	284.70	94.90	94.90	142.35	85.41	56.94	71.18	42.71
4.11	Rain gauge stations	55.00	22.00	19.80	6.60	6.60	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	430.35	21.52	129.11	43.04	43.04	64.55	38.73	25.82	32.28	19.37
4.13	Desilting equipments	400.00	100.00	120.00	40.00	40.00	50.00	30.00	20.00	0.00	0.00
4.14	Vehicles for vigilance squad	110.00	11.00	33.00	11.00	11.00	13.75	8.25	5.50	8.25	4.95
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	5400.00	540.00	405.00	972.00	243.00	540.00	1296.00	324.00	270.00	648.00
6.0	**Non Structural Works:**										
6.1	DPR and PMC	614.45	614.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	1228.89	491.56	442.40	147.47	147.47	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	924.19	46.21	277.26	92.42	92.42	138.63	83.18	55.45	69.31	41.59
6.4	Development of green belt	153.61	0.00	6.14	9.22	15.36	9.22	13.83	23.04	15.36	23.04
6.5	WCE + Admin.	3072.24	307.22	230.42	322.58	368.67	230.42	322.58	368.67	230.42	322.58
	Total of SWD =	**66513.91**	**5069.48**	**12171.37**	**7744.95**	**5294.18**	**8674.84**	**6765.18**	**4393.03**	**7031.78**	**5342.57**

FIGURE NO. 7.3 WORK PROGRAMME FOR REMODELLING OF STORM WATER DRAINS IN YELAHANKA ZONE

Sl. No,	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year									
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year
1.0	**Improvement to Carrying Capacity:**											
1.1	Desilting & deepening	1062.55	53.13	318.76	106.25	106.25	159.38	95.63	63.75	79.69	47.81	31.88
1.2	Widening											
	a. Earthen bund	3298.68	0.00	329.87	164.93	164.93	659.74	395.84	263.89	659.74	395.84	263.89
	b. RCC independent walls	6029.89	301.49	1205.98	723.59	482.39	904.48	542.69	361.79	753.74	452.24	301.49
	c. RCC "U" shaped walls	12387.18	619.36	2477.44	1486.46	990.97	1858.08	1114.85	743.23	1548.40	929.04	619.36
	d. CRS / SSM masonry walls	5491.62	274.58	1098.32	658.99	439.33	823.74	494.25	329.50	686.45	411.87	274.58
	e. RCC box drain	3756.98	187.85	751.40	450.84	300.56	563.55	338.13	225.42	469.62	281.77	187.85
1.3	Bed protection	1538.78	76.94	92.33	153.88	61.55	230.82	384.70	153.88	115.41	192.35	76.94
2.0	**Rehabilitation and Strengthening:**											
	CRS / SSM Wall Reconstruction & Raising	29.73	2.97	7.43	4.46	2.97	4.46	2.68	1.78	1.49	0.89	0.59
	CRS / SSM Wall Restoration	158.64	15.86	39.66	23.80	15.86	23.80	14.28	9.52	7.93	4.76	3.17
3.0	**Culverts and Bridges:**											
3.1	Utility supports & bridges	97.00	14.55	29.10	12.13	7.28	11.64	4.85	2.91	8.73	3.64	2.18
3.2	Remodeling	6176.52	926.48	1852.96	772.07	463.24	741.18	308.83	185.30	555.89	231.62	138.97
3.3	Rehabilitation	16.24	2.44	4.87	2.03	1.22	1.95	0.81	0.49	1.46	0.61	0.37
3.4	Railway Culverts	214.80	32.22	64.44	26.85	16.11	25.78	10.74	6.44	19.33	8.05	4.83
4.0	**Allied Works:**											
4.1	Boundary stones	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	2462.67	369.40	886.56	369.40	221.64	221.64	92.35	55.41	147.76	61.57	36.94
4.3	Service roads	2711.93	0.00	108.48	162.72	271.19	162.72	244.07	406.79	271.19	406.79	677.98
4.4	Fencing	2057.95	0.00	82.32	123.48	205.79	123.48	185.22	308.69	205.79	308.69	514.49
4.5	Detention ponds	271.16	0.00	21.69	16.27	16.27	54.23	40.67	40.67	32.54	24.40	24.40
4.6	Retarding basins	81.46	4.07	16.29	9.78	6.52	12.22	7.33	4.89	10.18	6.11	4.07
4.7	Development of water bodies	1701.82	170.18	153.16	255.27	102.11	204.22	340.36	136.15	102.11	170.18	68.07
4.8	Silt traps	26.62	1.33	7.99	2.66	2.66	3.99	2.40	1.60	2.00	1.20	0.80
4.9	Desilting ramps	92.50	0.00	3.70	5.55	9.25	5.55	8.33	13.88	9.25	13.88	23.13
4.10	Inlet / out weirs	663.17	33.16	198.95	66.32	66.32	99.48	59.69	39.79	49.74	29.84	19.90
4.11	Rain gauge stations	5.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	1537.95	76.90	461.39	153.80	153.80	230.69	138.42	92.28	115.35	69.21	46.14
4.13	Desilting equipments	400.00	100.00	120.00	40.00	40.00	50.00	30.00	20.00	0.00	0.00	0.00
4.14	Vehicles for vigilance squad	90.00	9.00	27.00	9.00	9.00	11.25	6.75	4.50	6.75	4.05	2.70
5.0	**Sewage Treatment Plants:**											
	Decentralized STP's	7400.00	740.00	555.00	1332.00	333.00	740.00	1776.00	444.00	370.00	888.00	222.00
6.0	**Non Structural Works:**											
6.1	DPR and PMC	605.32	605.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	1210.64	484.25	435.83	145.28	145.28	0.00	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	771.01	38.55	231.30	77.10	77.10	115.65	69.39	46.26	57.83	34.70	23.13
6.4	Development of green belt	151.33	0.00	6.05	9.08	15.13	9.08	13.62	22.70	15.13	22.70	37.83
6.5	WCE + Admin.	3026.59	302.66	226.99	317.79	363.19	226.99	317.79	363.19	226.99	317.79	363.19
	Total of SWD =	**65525.72**	**5447.70**	**11815.26**	**7681.76**	**5090.92**	**8279.78**	**7040.64**	**4348.69**	**6530.49**	**5319.61**	**3970.88**

FIGURE-7.4

WORK PROGRAMME BAR CHART FOR DASARAHALLI ZONE

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year 1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	639.84	31.99	191.95	63.98	63.98	95.98	57.59	38.39	47.99	28.79
1.2	Widening										
	a. Earthen bund	1002.42	0.00	100.24	50.12	50.12	200.48	120.29	80.19	200.48	120.29
	b. RCC independent walls	6477.95	323.90	1295.59	777.35	518.24	971.69	583.02	388.68	809.74	485.85
	c. RCC "U" shaped walls	20910.57	1045.53	4182.11	2509.27	1672.85	3136.59	1881.95	1254.63	2613.82	1568.29
	d. CRS / SSM masonry walls	2033.04	101.65	406.61	243.96	162.64	304.96	182.97	121.98	254.13	152.48
	e. RCC box drain	158.13	7.91	31.63	18.98	12.65	23.72	14.23	9.49	19.77	11.86
1.3	Bed protection	1046.61	52.33	62.80	104.66	41.86	156.99	261.65	104.66	78.50	130.83
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM wall reconstruction	212.48	21.25	53.12	31.87	21.25	31.87	19.12	12.75	10.62	6.37
	CRS / SSM wall restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	102.00	15.30	30.60	12.75	7.65	12.24	5.10	3.06	9.18	3.83
3.2	Remodeling	2748.09	412.21	824.43	343.51	206.11	329.77	137.40	82.44	247.33	103.05
3.3	Rehabilitation	153.59	23.04	46.08	19.20	11.52	18.43	7.68	4.61	13.82	5.76
3.4	Railway Culverts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.0	**Allied Works:**										
4.1	Boundary stones	16.56	6.62	5.96	1.99	1.99	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	2550.00	382.50	918.00	382.50	229.50	229.50	95.63	57.38	153.00	63.75
4.3	Service roads	2611.74	0.00	104.47	156.70	261.17	156.70	235.06	391.76	261.17	391.76
4.4	Fencing	842.34	0.00	33.69	50.54	84.23	50.54	75.81	126.35	84.23	126.35
4.5	Detention ponds	366.76	0.00	29.34	22.01	22.01	73.35	55.01	55.01	44.01	33.01
4.6	Retarding basins	250.34	12.52	50.07	30.04	20.03	37.55	22.53	15.02	31.29	18.78
4.7	Development of water bodies	1200.00	120.00	108.00	180.00	72.00	144.00	240.00	96.00	72.00	120.00
4.8	Silt traps	148.75	7.44	44.63	14.88	14.88	22.31	13.39	8.93	11.16	6.69
4.9	Desilting ramps	120.00	0.00	4.80	7.20	12.00	7.20	10.80	18.00	12.00	18.00
4.10	Inlet / out weirs	292.00	14.60	87.60	29.20	29.20	43.80	26.28	17.52	21.90	13.14
4.11	Rain gauge stations	40.00	16.00	14.40	4.80	4.80	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	645.16	32.26	193.55	64.52	64.52	96.77	58.06	38.71	48.39	29.03
4.13	Desilting equipments	400.00	100.00	120.00	40.00	40.00	50.00	30.00	20.00	0.00	0.00
4.14	Vehicles for vigilance squad	80.00	8.00	24.00	8.00	8.00	10.00	6.00	4.00	6.00	3.60
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	1250.00	125.00	93.75	225.00	56.25	125.00	300.00	75.00	62.50	150.00
6.0	**Non Structural Works:**										
6.1	DPR and PMC	470.20	470.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	940.40	376.16	338.54	112.85	112.85	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	721.68	36.08	216.50	72.17	72.17	108.25	64.95	43.30	54.13	32.48
6.4	Development of green belt	117.55	0.00	4.70	7.05	11.76	7.05	10.58	17.63	11.76	17.63
6.5	WCE + Admin.	2351.00	235.10	176.33	246.86	282.12	176.33	246.86	282.12	176.33	246.86
	Total of SWD =	**50899.22**	**3977.59**	**9793.49**	**5831.96**	**4168.33**	**6621.08**	**4761.96**	**3367.62**	**5355.25**	**3888.48**

FIGURE-7.5

WORK PROGRAMME BAR CHART FOR MAHADEVPURA ZONE

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year 1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	1553.33	77.67	466.00	155.33	155.33	233.00	139.80	93.20	116.50	69.90
1.2	Widening										
	a. Earthen bund	15098.16	0.00	1509.82	754.91	754.91	3019.63	1811.78	1207.85	3019.63	1811.78
	b. RCC independent walls	4951.84	247.59	990.37	594.22	396.15	742.78	445.67	297.11	618.98	371.39
	c. RCC "U" shaped walls	21733.85	1086.69	4346.77	2608.06	1738.71	3260.08	1956.05	1304.03	2716.73	1630.04
	d. CRS / SSM masonry walls	6034.20	301.71	1206.84	724.10	482.74	905.13	543.08	362.05	754.28	452.57
	e. RCC box drain	9842.47	492.12	1968.49	1181.10	787.40	1476.37	885.82	590.55	1230.31	738.19
1.3	Bed protection	128.27	6.41	7.70	12.83	5.13	19.24	32.07	12.83	9.62	16.03
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM Wall Reconstruction	94.11	9.41	23.53	14.12	9.41	14.12	8.47	5.65	4.71	2.82
	CRS / SSM Wall Restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	153.00	22.95	45.90	19.13	11.48	18.36	7.65	4.59	13.77	5.74
3.2	Remodeling	3815.38	572.31	1144.61	476.92	286.15	457.85	190.77	114.46	343.38	143.08
3.3	Rehabilitation	121.75	18.26	36.52	15.22	9.13	14.61	6.09	3.65	10.96	4.57
3.4	Railway Culverts	501.24	75.19	150.37	62.65	37.59	60.15	25.06	15.04	45.11	18.80
4.0	**Allied Works:**										
4.1	Boundary stones	25.89	10.35	9.32	3.11	3.11	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	3450.00	517.50	1242.00	517.50	310.50	310.50	129.38	77.63	207.00	86.25
4.3	Service roads	5920.52	0.00	236.82	355.23	592.05	355.23	532.85	888.08	592.05	888.08
4.4	Fencing	246.02	0.00	9.84	14.76	24.60	14.76	22.14	36.90	24.60	36.90
4.5	Detention ponds	170.00	0.00	13.60	10.20	10.20	34.00	25.50	25.50	20.40	15.30
4.6	Retarding basins	75.20	3.76	15.04	9.02	6.02	11.28	6.77	4.51	9.40	5.64
4.7	Development of water bodies	3000.00	300.00	270.00	450.00	180.00	360.00	600.00	240.00	180.00	300.00
4.8	Silt traps	598.00	29.90	179.40	59.80	59.80	89.70	53.82	35.88	44.85	26.91
4.9	Desilting ramps	100.00	0.00	4.00	6.00	10.00	6.00	9.00	15.00	10.00	15.00
4.10	Inlet / out weirs	584.00	29.20	175.20	58.40	58.40	87.60	52.56	35.04	43.80	26.28
4.11	Rain gauge stations	70.00	28.00	25.20	8.40	8.40	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	1587.28	79.36	476.18	158.73	158.73	238.09	142.86	95.24	119.05	71.43
4.13	Desilting equipments	500.00	125.00	150.00	50.00	50.00	62.50	37.50	25.00	0.00	0.00
4.14	Vehicles for vigilance squad	140.00	14.00	42.00	14.00	14.00	17.50	10.50	7.00	10.50	6.30
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	2700.00	270.00	202.50	486.00	121.50	270.00	648.00	162.00	135.00	324.00
6.0	**Non Structural Works:**										
6.1	DPR and PMC	845.19	845.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	1690.37	676.15	608.53	202.84	202.84	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	1324.02	66.20	397.20	132.40	132.40	198.60	119.16	79.44	99.30	59.58
6.4	Development of green belt	211.30	0.00	8.45	12.68	21.13	12.68	19.02	31.69	21.13	31.69
6.5	WCE + Admin.	4225.93	422.59	316.94	443.72	507.11	316.94	443.72	507.11	316.94	443.72
	Total of SWD =	**91491.29**	**6327.52**	**16279.16**	**9611.38**	**7144.91**	**12606.69**	**8905.06**	**6277.03**	**10718.00**	**7601.97**

FIGURE NO. 7.6 WORK PROGRAMME FOR REMODELLING OF STORM WATER DRAINS IN RAJARAJESHWARI NAGARA ZONE

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Project Implementation Year								
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	1854.23	92.71	556.27	185.42	185.42	278.13	166.88	111.25	139.07	83.44
1.2	Widening										
	a. Earthen bund	178.59	0.00	17.86	8.93	8.93	35.72	21.43	14.29	35.72	21.43
	b. RCC independent walls	24369.43	1218.47	4873.89	2924.33	1949.55	3655.41	2193.25	1462.17	3046.18	1827.71
	c. RCC "U" shaped walls	15143.48	757.17	3028.70	1817.22	1211.48	2271.52	1362.91	908.61	1892.94	1135.76
	d. CRS / SSM masonry walls	2549.47	127.47	509.89	305.94	203.96	382.42	229.45	152.97	318.68	191.21
	e. RCC box drain	1893.41	94.67	378.68	227.21	151.47	284.01	170.41	113.60	236.68	142.01
1.3	Bed protection	4145.70	207.28	248.74	414.57	165.83	621.85	1036.42	414.57	310.93	518.21
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM Wall Reconstruction & Raising	280.00	28.00	70.00	42.00	28.00	42.00	25.20	16.80	14.00	8.40
	CRS / SSM Wall Restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	121.25	18.19	36.38	15.16	9.09	14.55	6.06	3.64	10.91	4.55
3.2	Remodeling	7173.77	1076.07	2152.13	896.72	538.03	860.85	358.69	215.21	645.64	269.02
3.3	Rehabilitation	233.46	35.02	70.04	29.18	17.51	28.02	11.67	7.00	21.01	8.75
3.4	Railway Culverts	150.63	22.59	45.19	18.83	11.30	18.08	7.53	4.52	13.56	5.65
4.0	**Allied Works:**										
4.1	Boundary stones	25.38	10.15	9.14	3.05	3.05	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	1706.19	255.93	614.23	255.93	153.56	153.56	63.98	38.39	102.37	42.65
4.3	Service roads	2560.03	0.00	102.40	153.60	256.00	153.60	230.40	384.00	256.00	384.00
4.4	Fencing	2180.19	0.00	87.21	130.81	218.02	130.81	196.22	327.03	218.02	327.03
4.5	Detention ponds	164.28	0.00	13.14	9.86	9.86	32.86	24.64	24.64	19.71	14.79
4.6	Retarding basins	131.52	6.58	26.30	15.78	10.52	19.73	11.84	7.89	16.44	9.86
4.7	Development of water bodies	937.94	93.79	84.41	140.69	56.28	112.55	187.59	75.04	56.28	93.79
4.8	Silt traps	134.25	6.71	40.28	13.43	13.43	20.14	12.08	8.06	10.07	6.04
4.9	Desilting ramps	92.50	0.00	3.70	5.55	9.25	5.55	8.33	13.88	9.25	13.88
4.10	Inlet / out weirs	546.14	27.31	163.84	54.61	54.61	81.92	49.15	32.77	40.96	24.58
4.11	Rain gauge stations	30.00	12.00	10.80	3.60	3.60	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	1614.88	80.74	484.46	161.49	161.49	242.23	145.34	96.89	121.12	72.67
4.13	Desilting equipments	300.00	75.00	90.00	30.00	30.00	37.50	22.50	15.00	0.00	0.00
4.14	Vehicles for vigilance squad	60.00	6.00	18.00	6.00	6.00	7.50	4.50	3.00	4.50	2.70
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	500.00	50.00	37.50	90.00	22.50	50.00	120.00	30.00	25.00	60.00
6.0	**Non Structural Works:**										
6.1	DPR and PMC	701.82	701.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	1403.65	561.46	505.31	168.44	168.44	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	1105.78	55.29	331.73	110.58	110.58	165.87	99.52	66.35	82.93	49.76
6.4	Development of green belt	175.46	0.00	7.02	10.53	17.55	10.53	15.79	26.32	17.55	26.32
6.5	WCE + Admin.	3509.12	350.91	263.18	368.46	421.09	263.18	368.46	421.09	263.18	368.46
	Total of SWD =	**75972.55**	**5971.35**	**14880.43**	**8617.90**	**6206.39**	**9980.09**	**7150.25**	**4994.97**	**7928.69**	**5712.66**

FIGURE-7.7

WORK PROGRAMME BAR CHART FOR TOTAL STORM WATER DRAIN REMODELLING MASTER PLAN PROJECT

Sl. No.	Project Component	Estimated Cost (Rs. Crores)	Project Implementation Year								
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year
1.0	**Improvement to Carrying Capacity:**										
1.1	Desilting & deepening	121.28	6.06	36.38	12.13	12.13	18.19	10.91	7.28	9.10	5.46
1.2	Widening										
	a. Earthen bund	238.59	0.00	23.86	11.93	11.93	47.72	28.63	19.09	47.72	28.63
	b. RCC independent walls	559.62	27.98	111.92	67.15	44.77	83.94	50.37	33.58	69.95	41.97
	c. RCC "U" shaped walls	971.62	48.58	194.32	116.59	77.73	145.74	87.45	58.30	121.45	72.87
	d. CRS / SSM masonry walls	230.12	11.51	46.02	27.61	18.41	34.52	20.71	13.81	28.77	17.26
	e. RCC box drain	369.27	18.46	73.85	44.31	29.54	55.39	33.23	22.16	46.16	27.70
1.3	Bed protection	78.75	3.94	4.72	7.87	3.15	11.81	19.69	7.87	5.91	9.84
2.0	**Rehabilitation and Strengthening:**										
	CRS / SSM Wall Reconstruction	12.90	1.29	3.23	1.94	1.29	1.94	1.16	0.77	0.65	0.39
	CRS / SSM Wall Restoration	1.59	0.16	0.40	0.24	0.16	0.24	0.14	0.10	0.08	0.05
3.0	**Culverts and Bridges:**										
3.1	Utility supports & bridges	5.75	0.86	1.73	0.72	0.43	0.69	0.29	0.17	0.52	0.22
3.2	Remodeling	244.45	36.67	73.33	30.56	18.33	29.33	12.22	7.33	22.00	9.17
3.3	Rehabilitation	7.22	1.08	2.16	0.90	0.54	0.87	0.36	0.22	0.65	0.27
3.4	Railway Culverts	8.67	1.30	2.60	1.08	0.65	1.04	0.43	0.26	0.78	0.32
4.0	**Allied Works:**										
4.1	Boundary stones	1.16	0.47	0.42	0.14	0.14	0.00	0.00	0.00	0.00	0.00
4.2	Drains in low lying areas	224.69	33.70	80.89	33.70	20.22	20.22	8.43	5.06	13.48	5.62
4.3	Service roads	187.44	0.00	7.50	11.25	18.74	11.25	16.87	28.12	18.74	28.12
4.4	Fencing	61.64	0.00	2.47	3.70	6.16	3.70	5.55	9.25	6.16	9.25
4.5	Detention ponds	16.43	0.00	1.31	0.99	0.99	3.29	2.46	2.46	1.97	1.48
4.6	Retarding basins	8.46	0.42	1.69	1.02	0.68	1.27	0.76	0.51	1.06	0.63
4.7	Development of water bodies	96.40	9.64	8.68	14.46	5.78	11.57	19.28	7.71	5.78	9.64
4.8	Silt traps	11.68	0.58	3.50	1.17	1.17	1.75	1.05	0.70	0.88	0.53
4.9	Desilting ramps	5.05	0.00	0.20	0.30	0.51	0.30	0.45	0.76	0.51	0.76
4.10	Inlet / out weirs	35.82	1.79	10.75	3.58	3.58	5.37	3.22	2.15	2.69	1.61
4.11	Rain gauge stations	2.20	0.88	0.79	0.26	0.26	0.00	0.00	0.00	0.00	0.00
4.12	Shifting of sewers	69.47	3.47	20.84	6.95	6.95	10.42	6.25	4.17	5.21	3.13
4.13	Desilting equipments	24.00	6.00	7.20	2.40	2.40	3.00	1.80	1.20	0.00	0.00
4.14	Vehicles for vigilance squad	5.20	0.52	1.56	0.52	0.52	0.65	0.39	0.26	0.39	0.23
5.0	**Sewage Treatment Plants:**										
	Decentralized STP's	185.00	18.50	13.88	33.30	8.33	18.50	44.40	11.10	9.25	22.20
6.0	**Non Structural Works:**										
6.1	DPR and PMC	38.41	38.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	Rehabilitation and resettlement	76.83	30.73	27.66	9.22	9.22	0.00	0.00	0.00	0.00	0.00
6.3	Shifting of other services	56.89	2.84	17.07	5.69	5.69	8.53	5.12	3.41	4.27	2.56
6.4	Development of green belt	9.60	0.00	0.38	0.58	0.96	0.58	0.86	1.44	0.96	1.44
6.5	WCE + Admin.	192.07	19.21	14.41	20.17	23.05	14.41	20.17	23.05	14.41	20.17
	Total of SWD =	**4158.25**	**325.07**	**795.72**	**472.42**	**334.41**	**546.22**	**402.67**	**272.27**	**439.47**	**321.50**

7.4 FACTORS FOR CONSIDERATION DURING IMPLEMENTATION

The following may be considered while preparing the work programme and particular attention may be given to the examination of the feasibility of taking up the works concurrently.

- Before inviting the tenders it is suggested to invite expression of interest / tenders to evaluate the financial and technical capabilities of the contracting agencies. The tender forms shall be issued only to the agencies which satisfies all the requirements of the qualifying criteria.
- The implementing agency shall preferably not award more than one package to one contracting agency. However, considering the past experiences and performance track record the criteria shall be reconsidered.
- Before commencement of implementation activity, all relevant project reports, drawings, meeting proceedings, shall be read in conjunction with tender clauses. Ambiguity shall be cleared necessary approvals shall be obtained.
- All components of the work need to be studied for site suitability and work programme evolved jointly by BBMP and the contracting agency.
- Before commencement of any work, detailed work plan has to be prepared for all the packages and get approved by BBMP.
- Additional land required from drain remodeling and formation of service corridors shall be procured and demarcated at site.
- Land records to be verified, encroachment of water way if any shall be cleared before awarding the contracts / commencement of works.
- All work fronts should be clear from all encumbrances, necessary permission/approvals for shifting service lines near/inside SWD, traffic diversion etc. shall be obtained.
- All necessary precautionary and safety measures as per the tender clauses should be ensured at site by the implementing agency and the contracting agency before starting any work at site.
- All ongoing works taken up by implementing agency and stake holders shall be dovetailed with the present comprehensive project proposals.
- All the works considered under remodeling project shall start simultaneously from down stream end of respective packages.
- Vegetation growth noticed inside the drain at various locations, shall be removed in all the packages.
- Strengthening of inlet and outlet weir of the tank shall be taken up simultaneously at all the tanks existing in the catchment area.
- Rocky out crops noticed all along the drains at various locations which are obstructing free flow of water & also causing accumulation of silt, garbage etc. needs to be removed/lowered and the work shall be taken up simultaneously in all the packages.
- Shifting of service lines which are noticed all along the drain at various locations, shall be taken up simultaneously in coordination with various agencies in all the packages.
- Stoppage of sewage and other undesirable liquid wastes entry into storm drains which are noticed along the drains shall be taken up simultaneously in all the packages before taking up bed protection works.
- Desilting of drains, removal of debris/solid wastes etc., which are noticed along the drains, shall be taken up simultaneously in all the packages.
- Widening of storm drains at the critical reaches, which are identified at various locations under the project, shall be taken up simultaneously in all the packages.
- Construction of retention basins which are identified at various locations under the project, shall be taken up simultaneously in all the packages.
- Culvert/bridges considered for remodeling under the project, at various locations shall be taken up simultaneously in all the packages.

- Construction of new drains considered for minimizing the flooding problems in low lying areas which are spread over at various locations shall be taken up simultaneously in all the packages.
- Reaches of existing drain walls proposed for reconstruction/restoration under the project at various locations along the drains, shall be taken up simultaneously in all the packages.
- Providing rehabilitation works to existing drain walls and other structures considered under the project at various locations, shall be taken up simultaneously in all the packages.
- Construction of new drain wall / stone revetment in the reaches identified at various locations under the project shall be taken up simultaneously in all the packages.
- Providing pointing and skin reinforcement to the existing SSM masonry drain walls shall be taken up simultaneously in all the packages.
- Construction of water recharging structures and development of land along side of the drain shall be taken up simultaneously in all the packages.
- Providing bed protection to the entire length of storm drains shall be taken up simultaneously in all the packages.
- Providing fencing and parapet wall construction to storm drains shall be taken up simultaneously in all the packages.
- Restoration of roads, cross drains and other infrastructure facilities, after completion of the works at various locations, shall be taken up simultaneously in all the packages.
- Providing improvements works at along side of the storm drains, shall be taken up simultaneously in all the packages.
- Periodic maintenance of storm drainage system shall be taken up for the entire length of the drains in all the packages.
- Providing chain link fence at vulnerable locations to prevent dumping of garbage / solid waste materials into SWD.
- Providing rehabilitation work to existing culverts/bridges
- Setting up of emergency squad to provide relief measure at vulnerable locations

7.5 FINANCIAL AND OPERATING PLAN

The storm water drain projects when implemented would not generate additional revenue for the principal implementing agency viz. BBMP. Thus, it is a social infrastructure project attempting to restore the eco-system and relieve the citizens and residents of hardships that they are currently exposed by way of polluted drains, flooding and potential danger of public health hazards. These characteristics of the project lend itself for grants, aid and soft loans. Not withstanding the above social aspects, BBMP needs to provide appropriate support to the project by means of initial seed amount and through budget provision to support the operation and maintenance of the SWDs once constructed.

However, BBMP is examining the possibility of levying a one time collection charges from property owners in the city and extend the same principle to the extended areas towards partial recovery of capital cost that is estimated for the remodeling of the storm water drains. It is under consideration to recover at the maximum ______% of the capital cost through such cess. The recovery would be made over a period of five years from the property owners. This scheme is subject to willingness and affordability criteria of the residents and the approval of the BBMP council and the State Government.

The revenue accrual on account of the proposed cess is summarized below – a total collection of Rs __________ Crores from the years 2010-11 till 2020-21.

Storm Water Drain Cess	0.00	0.00	0.00	0.00	0.00

Table 7.2 Estimated Capital Costs

(Cost in Rs Crores)

Name of Zone	Capital Cost	Years			
		Gestation (1 Year-5%)	Stage I (50%)	Stage II (30%)	Stage III (15%)
Core Area	654.22	32.71	327.11	196.27	98.13
Bommanahalli	665.14	33.26	332.57	199.54	99.77
Yelahanka	655.26	32.76	327.63	196.58	98.29
Dasarahalli	508.99	25.45	254.50	152.70	76.35
Mahadevapura	914.91	45.75	457.46	274.47	137.24
Rajarajeshwarinagara	759.73	37.99	379.87	227.92	113.96
Total	**4,158.25**	**207.91**	**2,079.13**	**1,247.48**	**623.74**

Table 7.3 Funding pattern for Remodeling of Storm Water Drains in BBMP Area

(Rs. in Crores)

Funding Pattern	Total	Gestation (1 Year)	Stage - I	Stage - II	Stage - III
GOI Grant 35 %	1,455.39	72.77	727.69	436.62	218.31
GOK Grant 15 %	623.74	31.19	311.87	187.12	93.56
BBMP financing 50 %	2,079.13	103.96	1,039.56	623.74	311.87
Total	**4,158.25**	**207.91**	**2,079.13**	**1,247.48**	**623.74**

The funding pattern is based on the guidelines set forth for JnNURM Projects.

The fund flow statement for BBMP for the next _____ years has been developed taking into consideration the financing of major infrastructure projects under JnNURM stream and non-JnNURM stream. These projections are under review by SBI Caps who are carrying out a due diligence exercise as well as the evaluation of viability for seeking external funding (viability gap after grant funding). The viability gap is proposed to be funded by direct loans as well as tax free municipal bonds that is under active consideration of both the State and the Central governments.

The basic assumptions in the financial projections are:

The property tax collection would move from Rs _____ crores in the year 2010-11 to Rs _____ Crores in the year 2020-21; this is being achieved with reforms in the property tax collection mechanism aided by GIS system for all the wards of BBMP. The collection efficiency is estimated to go up to ____% by the year 2020-21 (the efficiency currently is ____%).

The revenue accretion from the State Government is estimated to move up from Rs ____ Crores in the year 2011-12 to Rs _____ Crores in the year 2020-21. This is based on the devolution criteria and guidelines provided by the Urban Development Department of the Government of Karnataka

Levy of storm water drain cess as a one time fee to be collected from all property owners – **10%** cess on property tax paid – this would result in revenue accretion of Rs _____ crores over a period of 5 years

The total capital expenditure programme envisaged by BBMP under JnNURM is approximately Rs ______ crores including the basic services to urban poor component. Out of this BBMP needs to mobilize Rs ______ crores. It is assumed that BBMP would arrange for term loans to the extent of Rs _____ crores and the balance Rs _____ crores would be obtained through issuing a series of tax free municipal bonds.

Government of Karnataka would provide guarantees for the issue of municipal bonds to the extent of viability gap identified by the financial advisor. The cost of the municipal bonds is taken as ____% per annum and the bonds would be redeemed after ____ years period

The interest rate for future loans is assumed as _____ % per annum

The projections show a deficit in the terminal years when the bonds get redeemed; BBMP proposes to identify additional sources of revenue from the year 2010-11 to improve its financial position in order to fund capital expenditure as well as honor financial commitments

The projections based on the assumptions are as follows:

BBMP to furnish the details for Table 7.4 in the format enclosed for development of the financial operating model.

However, project phasing and investment plan is depicted in **Table 7.2 to 7.8 and Figure 7.9 to 7.15.**

Table 7.4 Projected Funds Flow Statement for BBMP

(Rs. In Crores)

REVENUE	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2021-22**
REVENUE RECEIPTS											
Tax Revenues											
Property Tax											
Advertisement Taxes											
Surcharge on Stamp Duty											
Non Tax Revenues											
Grants											
SFC Grants											
Other Grants:											
Grants towards electricity											
Incentivisation											
Twelfth Finance Commission											
Service Charges											
Infrastructure Cess / User charges											
SWM Cess											
Service chgs on Tax exempt Props											
Fees & Fines											
Building License Fees											
Compounding Fees											
Development Charges											
Ground Rent											
Road Cutting Charges											
Khata Transfer & Extract fees											
Hotel / Power License Fees											
Fee for Quality Control											
Others											
Receipts from Corporation Properties											
Rent from Shops /Leased											
Others											
Total Revenue Receipts											

REVENUE	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2021-22
Capital Grants											
MOU Grants											
JNNURM Funds											
Long Term Loans											
Loans from Financial Institutions for JNNURM matching grants											
Bonds for JNNURM matching grants											
Loans from Financial Institutions others											
Others											
Improvement Charges											
Bldg Deviation Regularization											
Sale of Properties											

Total Capital Receipts											
Other Receipts											
Cesses collected on Property Tax											
Storm Water Drain Cess											
Deposits, Statutory Deductions etc											
Total other receipts											
TOTAL RECEIPTS											

EXPENDITURE	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2021-22
Administrative Expenses											
Salaries											
Pay of Officers											
Pay of Establishment											
Allowances											
Pension / Gratuity											
Advertisement & Publicity											
Printing & Stationery											
Telephone Charges											
Electricity Charges											
Water Charges											
Council related Expenditure											
Office Infrastructure											
Vehicles - M & R Cost											
Other Expenses											
Welfare Activities											
18% Allocation											
Backward Classes & Minority Welfare											
Women Welfare											
General											
Educational Promotion Activities											
18% allocation											
General											
Sports Activities											
Health & Sanitation											
Cleaning of Garbage											
Decentralised Composting											
Street Dog Management											
Tipping Fees											
Others											

EXPENDITURE	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2021-22
Financial Expenses											
Interest on Loans											
Interest on Municipal Bonds											
Total Revenue Expenditure											
CAPITAL EXPENDITURE											
Public Works											
Solid Waste Management											
Engineering - Zonal											
Multi Purpose Engg Divisions											
Projects											
Infrastructure											
Comprehensive Development Plan											
Storm Water Drain Network											
Challaghatta Valley											
Hebbal Valley											
Koramangala Valley											
Vrishabhavathi valley											
Sub-total for four valleys											
Extension work into CMC areas											
Environment Management											
Tanks											
Parks											
Incinerator, Crematorium and Abattoirs											
Tree Plantation and Nurseries											
Urban Renewal											
Decongestion											
Development of CBD											
Road Network											
Arterial and Sub arterial roads											
* Includes IT/BT, Flood damaged roads											
Grade Separators											
Pedestrian subways											
Foot Over Bridges											
Foot Path improvements											
Internal Core Ring Road											
Road Widening											

Waste Management											
Scientific Land fill stations at Mandur, Mavallipura, Manavarthekaval and near Ramanagara											
Transfer stations											
Basic Services to Urban Poor											
Traffic Engineering Cell											
Electrical Engg											
Horticulture											
Repayment of Long Term Liabilities											
Repayment of Loans to Fin Instns											
Repayment of Municipal Bonds											
Total Capital Expenditure											
Other Payments											
Repayment of Cesses - Current											
Repayment of Cesses - Arrears											
Repayment of Statutory Deductions / Deposits											
TOTAL PAYMENTS											
Net Surplus / Deficit											

TABLE - 7.5

PROJECT PHASING AND BUDGETARY ALLOCATION FOR MASTER PLAN PROJECT - ALL ZONES OF BBMP

Sl. No.	Project Component	Estimated Cost (Rs. Crores)	Gestation (1 Year) %	Gestation (1 Year) Amount	Stage - 1 (3 Years) %	Stage - 1 (3 Years) Amount	Stage - 2 (3 Years) %	Stage - 2 (3 Years) Amount	Stage - 3 (3 Years) %	Stage - 3 (3 Years) Amount
1.0	**Improvement to Carrying Capacity:**									
1.1	Desilting & deepening	121.28	5%	6.06	50%	60.64	30%	36.38	15%	18.19
1.2	Widening									
	a. Earthen bund	238.59	0%	0.00	20%	47.72	40%	95.43	40%	95.43
	b. RCC independent walls	559.62	5%	27.98	40%	223.85	30%	167.89	25%	139.90
	c. RCC "U" shaped walls	971.62	5%	48.58	40%	388.65	30%	291.49	25%	242.90
	d. CRS / SSM masonry walls	230.12	5%	11.51	40%	92.05	30%	69.04	25%	57.53
	e. RCC box drain	369.27	5%	18.46	40%	147.71	30%	110.78	25%	92.32
1.3	Bed protection	78.75	5%	3.94	20%	15.75	50%	39.37	25%	19.69
	Sub Total	**2569.24**		**116.53**		**976.36**		**810.38**		**665.97**
2.0	**Rehabilitation and Strengthening:**									
	CRS / SSM Wall Reconstruction	12.90	10%	1.29	50%	6.45	30%	3.87	10%	1.29
	CRS / SSM Wall Restoration	1.59	10%	0.16	50%	0.79	30%	0.48	10%	0.16
	Sub Total	**14.49**		**1.45**		**7.24**		**4.35**		**1.45**
3.0	**Culverts and Bridges:**									
3.1	Utility supports & bridges	5.75	15%	0.86	50%	2.88	20%	1.15	15%	0.86
3.2	Remodeling	244.45	15%	36.67	50%	122.22	20%	48.89	15%	36.67
3.3	Rehabilitation	7.22	15%	1.08	50%	3.61	20%	1.44	15%	1.08
3.4	Railway Culverts	8.67	15%	1.30	50%	4.33	20%	1.73	15%	1.30
	Sub Total	**266.08**		**39.91**		**133.04**		**53.22**		**39.91**
4.0	**Allied Works:**									
4.1	Boundary stones	1.16	40%	0.47	60%	0.70	0%	0.00	0%	0.00
4.2	Drains in low lying areas	224.69	15%	33.70	60%	134.81	15%	33.70	10%	22.47
4.3	Service roads	187.44	0%	0.00	20%	37.49	30%	56.23	50%	93.72
4.4	Fencing	61.64	0%	0.00	20%	12.33	30%	18.49	50%	30.82
4.5	Detention ponds	16.43	0%	0.00	20%	3.29	50%	8.22	30%	4.93
4.6	Retarding basins	8.46	5%	0.42	40%	3.38	30%	2.54	25%	2.12
4.7	Development of water bodies	96.40	10%	9.64	30%	28.92	40%	38.56	20%	19.28
4.8	Silt traps	11.68	5%	0.58	50%	5.84	30%	3.50	15%	1.75
4.9	Desilting ramps	5.05	0%	0.00	20%	1.01	30%	1.52	50%	2.53
4.10	Inlet / out weirs	35.82	5%	1.79	50%	17.91	30%	10.75	15%	5.37
4.11	Rain gauge stations	2.20	40%	0.88	60%	1.32	0%	0.00	0%	0.00
4.12	Shifting of sewers	69.47	5%	3.47	50%	34.73	30%	20.84	15%	10.42
4.13	Desilting equipments	24.00	25%	6.00	50%	12.00	25%	6.00	0%	0.00
4.14	Vehicles for vigilance squad	5.20	10%	0.52	50%	2.60	25%	1.30	15%	0.78
	Sub Total	**749.64**		**57.48**		**296.33**		**201.64**		**194.18**
5.0	**Sewage Treatment Plants:**									
	Decentralized STP's	185.00	10%	18.50	30%	55.50	40%	74.00	20%	37.00
	Sub Total	**185.00**		**18.50**		**55.50**		**74.00**		**37.00**
	Total Structural =	**3784.45**		**233.87**		**1468.47**		**1143.59**		**938.51**
6.0	**Non Structural Works:**									
6.1	DPR and PMC	38.41	100%	38.41	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	76.83	40%	30.73	60%	46.10	0%	0.00	0%	0.00
6.3	Shifting of other services	56.89	5%	2.84	50%	28.44	30%	17.07	15%	8.53
6.4	Development of green belt	9.60	0%	0.00	20%	1.92	30%	2.88	50%	4.80
6.5	WCE + Admin.	192.07	10%	19.21	30%	57.62	30%	57.62	30%	57.62
	Total Non Structural =	**373.80**		**91.20**		**134.08**		**77.57**		**70.96**
	Total of SWD =	**4158.25**		**325.07**		**1602.55**		**1221.15**		**1009.47**

Sl. No.	Project Component	Stage - 1 1st Year %	Stage - 1 1st Year Amount	Stage - 1 2nd Year %	Stage - 1 2nd Year Amount	Stage - 1 3rd Year %	Stage - 1 3rd Year Amount	Stage - 2 1st Year %	Stage - 2 1st Year Amount	Stage - 2 2nd Year %	Stage - 2 2nd Year Amount	Stage - 2 3rd Year %	Stage - 2 3rd Year Amount	Stage - 3 1st Year %	Stage - 3 1st Year Amount	Stage - 3 2nd Year %	Stage - 3 2nd Year Amount	Stage - 3 3rd Year %	Stage - 3 3rd Year Amount
1.0	**Improvement to Carrying Capacity:**																		
1.1	Desilting & deepening	60%	36.38	20%	12.13	20%	12.13	50%	18.19	30%	10.91	20%	7.28	50%	9.10	30%	5.46	20%	3.64
1.2	Widening																		
	a. Earthen bund	50%	23.86	25%	11.93	25%	11.93	50%	47.72	30%	28.63	20%	19.09	50%	47.72	30%	28.63	20%	19.09
	b. RCC independent walls	50%	111.92	30%	67.15	20%	44.77	50%	83.94	30%	50.37	20%	33.58	50%	69.95	30%	41.97	20%	27.98
	c. RCC "U" shaped walls	50%	194.32	30%	116.59	20%	77.73	50%	145.74	30%	87.45	20%	58.30	50%	121.45	30%	72.87	20%	48.58
	d. CRS / SSM masonry walls	50%	46.02	30%	27.61	20%	18.41	50%	34.52	30%	20.71	20%	13.81	50%	28.77	30%	17.26	20%	11.51
	e. RCC box drain	50%	73.85	30%	44.31	20%	29.54	50%	55.39	30%	33.23	20%	22.16	50%	46.16	30%	27.70	20%	18.46
1.3	Bed protection	30%	4.72	50%	7.87	20%	3.15	30%	11.81	50%	19.69	20%	7.87	30%	5.91	50%	9.84	20%	3.94
	Sub Total		**491.09**		**287.61**		**197.66**		**397.31**		**250.99**		**162.08**		**329.05**		**203.73**		**133.19**
2.0	**Rehabilitation and Strengthening:**																		
	CRS / SSM Wall Reconstruction	50%	3.23	30%	1.94	20%	1.29	50%	1.94	30%	1.16	20%	0.77	50%	0.65	30%	0.39	20%	0.26
	CRS / SSM Wall Restoration	50%	0.40	30%	0.24	20%	0.16	50%	0.24	30%	0.14	20%	0.10	50%	0.08	30%	0.05	20%	0.03
	Sub Total		**3.62**		**2.17**		**1.45**		**2.17**		**1.30**		**0.87**		**0.72**		**0.43**		**0.29**
3.0	**Culverts and Bridges:**																		
3.1	Utility supports & bridges	60%	1.73	25%	0.72	15%	0.43	60%	0.69	25%	0.29	15%	0.17	60%	0.52	25%	0.22	15%	0.13
3.2	Remodeling	60%	73.33	25%	30.56	15%	18.33	60%	29.33	25%	12.22	15%	7.33	60%	22.00	25%	9.17	15%	5.50
3.3	Rehabilitation	60%	2.16	25%	0.90	15%	0.54	60%	0.87	25%	0.36	15%	0.22	60%	0.65	25%	0.27	15%	0.16
3.4	Railway Culverts	60%	2.60	25%	1.08	15%	0.65	60%	1.04	25%	0.43	15%	0.26	60%	0.78	25%	0.32	15%	0.19
	Sub Total		**79.82**		**33.26**		**19.96**		**31.93**		**13.30**		**7.98**		**23.95**		**9.98**		**5.99**
4.0	**Allied Works:**																		
4.1	Boundary stones	60%	0.42	20%	0.14	20%	0.14	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	60%	80.89	25%	33.70	15%	20.22	60%	20.22	25%	8.43	15%	5.06	60%	13.48	25%	5.62	15%	3.37
4.3	Service roads	20%	7.50	30%	11.25	50%	18.74	20%	11.25	30%	16.87	50%	28.12	20%	18.74	30%	28.12	50%	46.86
4.4	Fencing	20%	2.47	30%	3.70	50%	6.16	20%	3.70	30%	5.55	50%	9.25	20%	6.16	30%	9.25	50%	15.41
4.5	Detention ponds	40%	1.31	30%	0.99	30%	0.99	40%	3.29	30%	2.46	30%	2.46	40%	1.97	30%	1.48	30%	1.48
4.6	Retarding basins	50%	1.69	30%	1.02	20%	0.68	50%	1.27	30%	0.76	20%	0.51	50%	1.06	30%	0.63	20%	0.42
4.7	Development of water bodies	30%	8.68	50%	14.46	20%	5.78	30%	11.57	50%	19.28	20%	7.71	30%	5.78	50%	9.64	20%	3.86
4.8	Silt traps	60%	3.50	20%	1.17	20%	1.17	50%	1.75	30%	1.05	20%	0.70	50%	0.88	30%	0.53	20%	0.35
4.9	Desilting ramps	20%	0.20	30%	0.30	50%	0.51	20%	0.30	30%	0.45	50%	0.76	20%	0.51	30%	0.76	50%	1.26
4.10	Inlet / out weirs	60%	10.75	20%	3.58	20%	3.58	50%	5.37	30%	3.22	20%	2.15	50%	2.69	30%	1.61	20%	1.07
4.11	Rain gauge stations	60%	0.79	20%	0.26	20%	0.26	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	60%	20.84	20%	6.95	20%	6.95	50%	10.42	30%	6.25	20%	4.17	50%	5.21	30%	3.13	20%	2.08
4.13	Desilting equipments	60%	7.20	20%	2.40	20%	2.40	50%	3.00	30%	1.80	20%	1.20	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	60%	1.56	20%	0.52	20%	0.52	50%	0.65	30%	0.39	20%	0.26	50%	0.39	30%	0.23	20%	0.16
	Sub Total		**147.80**		**80.43**		**68.10**		**72.79**		**66.52**		**62.34**		**56.87**		**60.99**		**76.33**
5.0	**Sewage Treatment Plants:**																		
	Decentralized STP's	25%	13.88	60%	33.30	15%	8.33	25%	18.50	60%	44.40	15%	11.10	25%	9.25	60%	22.20	15%	5.55
	Sub Total		**13.88**		**33.30**		**8.33**		**18.50**		**44.40**		**11.10**		**9.25**		**22.20**		**5.55**
	Total Structural =		**736.21**		**436.77**		**295.49**		**522.71**		**376.52**		**244.36**		**419.84**		**297.33**		**221.35**
6.0	**Non Structural Works:**																		
6.1	DPR and PMC	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	60%	27.66	20%	9.22	20%	9.22	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	60%	17.07	20%	5.69	20%	5.69	50%	8.53	30%	5.12	20%	3.41	50%	4.27	30%	2.56	20%	1.71
6.4	Development of green belt	20%	0.38	30%	0.58	50%	0.96	20%	0.58	30%	0.86	50%	1.44	20%	0.96	30%	1.44	50%	2.40
6.5	WCE + Admin.	25%	14.41	35%	20.17	40%	23.05	25%	14.41	35%	20.17	40%	23.05	25%	14.41	35%	20.17	40%	23.05
	Total Non Structural =		**59.51**		**35.65**		**38.92**		**23.51**		**26.15**		**27.90**		**19.63**		**24.17**		**27.16**
	Total of SWD =		**795.72**		**472.42**		**334.41**		**546.22**		**402.67**		**272.27**		**439.47**		**321.50**		**248.50**

TABLE - 7.6

PROJECT PHASING AND BUDGETARY ALLOCATION FOR MASTER PLAN PROJECT - CORE AREA OF BBMP (WEST ZONE, SOUTH ZONE & EAST ZONE)

Sl. No.	Project Component	Estimated Cost	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)		Stage - 1						Stage - 2						Stage - 3					
											1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
		(Rs. Lakhs)	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																											
1.1	Desilting & deepening	6208.70	5%	310.43	50%	3104.35	30%	1862.61	15%	931.30	60%	1862.61	20%	620.87	20%	620.87	50%	931.30	30%	558.78	20%	372.52	50%	465.65	30%	279.39	20%	186.26
1.2	Widening																											
	a. Earthen bund	691.53	0%	0.00	20%	138.31	40%	276.61	40%	276.61	50%	69.15	25%	34.58	25%	34.58	50%	138.31	30%	82.98	20%	55.32	50%	138.31	30%	82.98	20%	55.32
	b. RCC independent walls	13416.10	5%	670.81	40%	5366.44	30%	4024.83	25%	3354.03	50%	2683.22	30%	1609.93	20%	1073.29	50%	2012.42	30%	1207.45	20%	804.97	50%	1677.01	30%	1006.21	20%	670.81
	c. RCC "U" shaped walls	6397.16	5%	319.86	40%	2558.86	30%	1919.15	25%	1599.29	50%	1279.43	30%	767.66	20%	511.77	50%	959.57	30%	575.74	20%	383.83	50%	799.65	30%	479.79	20%	319.86
	d. CRS / SSM masonry walls	784.25	5%	39.21	40%	313.70	30%	235.27	25%	196.06	50%	156.85	30%	94.11	20%	62.74	50%	117.64	30%	70.58	20%	47.05	50%	98.03	30%	58.82	20%	39.21
	e. RCC box drain	11905.67	5%	595.28	40%	4762.27	30%	3571.70	25%	2976.42	50%	2381.13	30%	1428.68	20%	952.45	50%	1785.85	30%	1071.51	20%	714.34	50%	1488.21	30%	892.93	20%	595.28
1.3	Bed protection	498.96	5%	24.95	20%	99.79	50%	249.48	25%	124.74	30%	29.94	50%	49.90	20%	19.96	30%	74.84	50%	124.74	20%	49.90	30%	37.42	50%	62.37	20%	24.95
	Sub Total	**39902.37**		**1960.54**		**16343.72**		**12139.66**		**9458.45**		**8462.34**		**4605.72**		**3275.66**		**6019.93**		**3691.79**		**2427.93**		**4704.28**		**2862.48**		**1891.69**
2.0	**Rehabilitation and Strengthening:**																											
	CRS / SSM Wall Reconstruction	453.63	10%	45.36	50%	226.82	30%	136.09	10%	45.36	50%	113.41	30%	68.04	20%	45.36	50%	68.04	30%	40.83	20%	27.22	50%	22.68	30%	13.61	20%	9.07
	CRS / SSM Wall Restoration	0.00	10%	0.00	50%	0.00	30%	0.00	10%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
	Sub Total	**453.63**		**45.36**		**226.82**		**136.09**		**45.36**		**113.41**		**68.04**		**45.36**		**68.04**		**40.83**		**27.22**		**22.68**		**13.61**		**9.07**
3.0	**Culverts and Bridges:**																											
3.1	Utility supports & bridges	0.00	15%	0.00	50%	0.00	20%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00
3.2	Remodeling	3282.00	15%	492.30	50%	1641.00	20%	656.40	15%	492.30	60%	984.60	25%	410.25	15%	246.15	60%	393.84	25%	164.10	15%	98.46	60%	295.38	25%	123.07	15%	73.84
3.3	Rehabilitation	0.00	15%	0.00	50%	0.00	20%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00
3.4	Railway Cuvlerts	0.00	15%	0.00	50%	0.00	20%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00
	Sub Total	**3282.00**		**492.30**		**1641.00**		**656.40**		**492.30**		**984.60**		**410.25**		**246.15**		**393.84**		**164.10**		**98.46**		**295.38**		**123.07**		**73.84**
4.0	**Allied Works:**																											
4.1	Boundary stones	28.78	40%	11.51	60%	17.27	0%	0.00	0%	0.00	60%	10.36	20%	3.45	20%	3.45	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	8700.00	15%	1305.00	60%	5220.00	15%	1305.00	10%	870.00	60%	3132.00	25%	1305.00	15%	783.00	60%	783.00	25%	326.25	15%	195.75	60%	522.00	25%	217.50	15%	130.50
4.3	Service roads	949.62	0%	0.00	20%	189.92	30%	284.89	50%	474.81	20%	37.98	30%	56.98	50%	94.96	20%	56.98	30%	85.47	50%	142.44	20%	94.96	30%	142.44	50%	237.41
4.4	Fencing	809.60	0%	0.00	20%	161.92	30%	242.88	50%	404.80	20%	32.38	30%	48.58	50%	80.96	20%	48.58	30%	72.86	50%	121.44	20%	80.96	30%	121.44	50%	202.40
4.5	Detention ponds	508.96	0%	0.00	20%	101.79	50%	254.48	30%	152.69	40%	40.72	30%	30.54	30%	30.54	40%	101.79	30%	76.34	30%	76.34	40%	61.08	30%	45.81	30%	45.81
4.6	Retarding basins	170.18	5%	8.51	40%	68.07	30%	51.05	25%	42.55	50%	34.04	30%	20.42	20%	13.61	50%	25.53	30%	15.32	20%	10.21	50%	21.27	30%	12.76	20%	8.51
4.7	Development of water bodies	1400.00	10%	140.00	30%	420.00	40%	560.00	20%	280.00	30%	126.00	50%	210.00	20%	84.00	30%	168.00	50%	280.00	20%	112.00	30%	84.00	50%	140.00	20%	56.00
4.8	Silt traps	0.00	5%	0.00	50%	0.00	30%	0.00	15%	0.00	60%	0.00	20%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.9	Desilting ramps	0.00	0%	0.00	20%	0.00	30%	0.00	50%	0.00	20%	0.00	30%	0.00	50%	0.00	20%	0.00	30%	0.00	50%	0.00	20%	0.00	30%	0.00	50%	0.00
4.10	Inlet / out weirs	547.50	5%	27.38	50%	273.75	30%	164.25	15%	82.13	60%	164.25	20%	54.75	20%	54.75	50%	82.13	30%	49.28	20%	32.85	50%	41.06	30%	24.64	20%	16.43
4.11	Rain gauge stations	20.00	40%	8.00	60%	12.00	0%	0.00	0%	0.00	60%	7.20	20%	2.40	20%	2.40	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	1131.00	5%	56.55	50%	565.50	30%	339.30	15%	169.65	60%	339.30	20%	113.10	20%	113.10	50%	169.65	30%	101.79	20%	67.86	50%	84.83	30%	50.90	20%	33.93
4.13	Desilting equipments	400.00	25%	100.00	50%	200.00	25%	100.00	0%	0.00	60%	120.00	20%	40.00	20%	40.00	50%	50.00	30%	30.00	20%	20.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	40.00	10%	4.00	50%	20.00	25%	10.00	15%	6.00	60%	12.00	20%	4.00	20%	4.00	50%	5.00	30%	3.00	20%	2.00	50%	3.00	30%	1.80	20%	1.20
	Sub Total	**14705.64**		**1660.95**		**7250.22**		**3311.85**		**2482.62**		**4056.23**		**1889.22**		**1304.78**		**1490.65**		**1040.30**		**780.90**		**993.16**		**757.28**		**732.17**
5.0	**Sewage Treatment Plants:**																											
	Decentralized STP's	1250.00	10%	125.00	30%	375.00	40%	500.00	20%	250.00	25%	93.75	60%	225.00	15%	56.25	25%	125.00	60%	300.00	15%	75.00	25%	62.50	60%	150.00	15%	37.50
	Sub Total	**1250.00**		**125.00**		**375.00**		**500.00**		**250.00**		**93.75**		**225.00**		**56.25**		**125.00**		**300.00**		**75.00**		**62.50**		**150.00**		**37.50**
	Total Structural =	**59593.63**		**4284.15**		**25836.76**		**16743.99**		**12728.73**		**13710.32**		**7198.23**		**4928.20**		**8097.46**		**5237.02**		**3409.51**		**6078.00**		**3906.45**		**2744.28**
6.0	**Non Structural Works:**																											
6.1	DPR and PMC	604.36	100%	604.36	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	1208.72	40%	483.49	60%	725.23	0%	0.00	0%	0.00	60%	435.14	20%	145.05	20%	145.05	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	842.30	5%	42.12	50%	421.15	30%	252.69	15%	126.35	60%	252.69	20%	84.23	20%	84.23	50%	126.35	30%	75.81	20%	50.54	50%	63.17	30%	37.90	20%	25.27
6.4	Development of green belt	151.09	0%	0.00	20%	30.22	30%	45.33	50%	75.54	20%	6.04	30%	9.07	50%	15.11	20%	9.07	30%	13.60	50%	22.66	20%	15.11	30%	22.66	50%	37.77
6.5	WCE + Admin.	3021.80	10%	302.18	30%	906.54	30%	906.54	30%	906.54	25%	226.63	35%	317.29	40%	362.62	25%	226.63	35%	317.29	40%	362.62	25%	226.63	35%	317.29	40%	362.62
	Total Non Structural =	**5828.27**		**1432.14**		**2083.14**		**1204.56**		**1108.43**		**920.51**		**555.63**		**607.00**		**362.05**		**406.69**		**435.82**		**304.92**		**377.86**		**425.66**
	Total of SWD =	**65421.90**		**5716.29**		**27919.90**		**17948.55**		**13837.16**		**14630.83**		**7753.86**		**5535.20**		**8459.51**		**5643.72**		**3845.32**		**6382.91**		**4284.31**		**3169.94**

TABLE - 7.7

PROJECT PHASING AND BUDGETARY ALLOCATION FOR MASTER PLAN PROJECT - BOMMANAHALLI ZONE OF BBMP

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)	
			%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**									
1.1	Desilting & deepening	809.05	5%	40.45	50%	404.52	30%	242.71	15%	121.36
1.2	Widening									
	a. Earthen bund	3589.12	0%	0.00	20%	717.82	40%	1435.65	40%	1435.65
	b. RCC independent walls	716.63	5%	35.83	40%	286.65	30%	214.99	25%	179.16
	c. RCC "U" shaped walls	20589.45	5%	1029.47	40%	8235.78	30%	6176.84	25%	5147.36
	d. CRS / SSM masonry walls	6119.67	5%	305.98	40%	2447.87	30%	1835.90	25%	1529.92
	e. RCC box drain	9370.32	5%	468.52	40%	3748.13	30%	2811.09	25%	2342.58
1.3	Bed protection	516.55	5%	25.83	20%	103.31	50%	258.27	25%	129.14
	Sub Total	**41710.78**		**1906.08**		**15944.08**		**12975.46**		**10885.16**
2.0	**Rehabilitation and Strengthening:**									
	CRS / SSM Wall Reconstruction	220.16	10%	22.02	50%	110.08	30%	66.05	10%	22.02
	CRS / SSM Wall Restoration	0.00	10%	0.00	50%	0.00	30%	0.00	10%	0.00
	Sub Total	**220.16**		**22.02**		**110.08**		**66.05**		**22.02**
3.0	**Culverts and Bridges:**									
3.1	Utility supports & bridges	102.00	15%	15.30	50%	51.00	20%	20.40	15%	15.30
3.2	Remodeling	1248.97	15%	187.35	50%	624.49	20%	249.79	15%	187.35
3.3	Rehabilitation	196.58	15%	29.49	50%	98.29	20%	39.32	15%	29.49
3.4	Railway Culverts	0.00	15%	0.00	50%	0.00	20%	0.00	15%	0.00
	Sub Total	**1547.55**		**232.13**		**773.77**		**309.51**		**232.13**
4.0	**Allied Works:**									
4.1	Boundary stones	19.88	40%	7.95	60%	11.93	0%	0.00	0%	0.00
4.2	Drains in low lying areas	3600.00	15%	540.00	60%	2160.00	15%	540.00	10%	360.00
4.3	Service roads	3990.52	0%	0.00	20%	798.10	30%	1197.16	50%	1995.26
4.4	Fencing	27.72	0%	0.00	20%	5.54	30%	8.32	50%	13.86
4.5	Detention ponds	161.84	0%	0.00	20%	32.37	50%	80.92	30%	48.55
4.6	Retarding basins	137.48	5%	6.87	40%	54.99	30%	41.24	25%	34.37
4.7	Development of water bodies	1400.00	10%	140.00	30%	420.00	40%	560.00	20%	280.00
4.8	Silt traps	260.25	5%	13.01	50%	130.13	30%	78.08	15%	39.04
4.9	Desilting ramps	100.00	0%	0.00	20%	20.00	30%	30.00	50%	50.00
4.10	Inlet / out weirs	949.00	5%	47.45	50%	474.50	30%	284.70	15%	142.35
4.11	Rain gauge stations	55.00	40%	22.00	60%	33.00	0%	0.00	0%	0.00
4.12	Shifting of sewers	430.35	5%	21.52	50%	215.18	30%	129.11	15%	64.55
4.13	Desilting equipments	400.00	25%	100.00	50%	200.00	25%	100.00	0%	0.00
4.14	Vehicles for vigilance squad	110.00	10%	11.00	50%	55.00	25%	27.50	15%	16.50
	Sub Total	**11642.04**		**909.81**		**4610.74**		**3077.02**		**3044.48**
5.0	**Sewage Treatment Plants:**									
	Decentralized STP's	5400.00	10%	540.00	30%	1620.00	40%	2160.00	20%	1080.00
	Sub Total	**5400.00**		**540.00**		**1620.00**		**2160.00**		**1080.00**
	Total Structural =	**60520.53**		**3610.04**		**23058.68**		**18588.03**		**15263.79**
6.0	**Non Structural Works:**									
6.1	DPR and PMC	614.45	100%	614.45	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	1228.89	40%	491.56	60%	737.34	0%	0.00	0%	0.00
6.3	Shifting of other services	924.19	5%	46.21	50%	462.09	30%	277.26	15%	138.63
6.4	Development of green belt	153.61	0%	0.00	20%	30.72	30%	46.08	50%	76.81
6.5	WCE + Admin.	3072.24	10%	307.22	30%	921.67	30%	921.67	30%	921.67
	Total Non Structural =	**5993.38**		**1459.44**		**2151.82**		**1245.01**		**1137.11**
	Total of SWD =	**66513.91**		**5069.48**		**25210.50**		**19833.04**		**16400.90**

Sl. No.	Project Component	Stage - 1						Stage - 2						Stage - 3					
		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
		%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																		
1.1	Desilting & deepening	60%	242.71	20%	80.90	20%	80.90	50%	121.36	30%	72.81	20%	48.54	50%	60.68	30%	36.41	20%	24.27
1.2	Widening																		
	a. Earthen bund	50%	358.91	25%	179.46	25%	179.46	50%	717.82	30%	430.69	20%	287.13	50%	717.82	30%	430.69	20%	287.13
	b. RCC independent walls	50%	143.33	30%	86.00	20%	57.33	50%	107.49	30%	64.50	20%	43.00	50%	89.58	30%	53.75	20%	35.83
	c. RCC "U" shaped walls	50%	4117.89	30%	2470.73	20%	1647.16	50%	3088.42	30%	1853.05	20%	1235.37	50%	2573.68	30%	1544.21	20%	1029.47
	d. CRS / SSM masonry walls	50%	1223.93	30%	734.36	20%	489.57	50%	917.95	30%	550.77	20%	367.18	50%	764.96	30%	458.98	20%	305.98
	e. RCC box drain	50%	1874.06	30%	1124.44	20%	749.63	50%	1405.55	30%	843.33	20%	562.22	50%	1171.29	30%	702.77	20%	468.52
1.3	Bed protection	30%	30.99	50%	51.65	20%	20.66	30%	77.48	50%	129.14	20%	51.65	30%	38.74	50%	64.57	20%	25.83
	Sub Total		**7991.83**		**4727.54**		**3224.71**		**6436.07**		**3944.29**		**2595.09**		**5416.75**		**3291.37**		**2177.03**
2.0	**Rehabilitation and Strengthening:**																		
	CRS / SSM Wall Reconstruction	50%	55.04	30%	33.02	20%	22.02	50%	33.02	30%	19.81	20%	13.21	50%	11.01	30%	6.60	20%	4.40
	CRS / SSM Wall Restoration	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
	Sub Total		**55.04**		**33.02**		**22.02**		**33.02**		**19.81**		**13.21**		**11.01**		**6.60**		**4.40**
3.0	**Culverts and Bridges:**																		
3.1	Utility supports & bridges	60%	30.60	25%	12.75	15%	7.65	60%	12.24	25%	5.10	15%	3.06	60%	9.18	25%	3.83	15%	2.30
3.2	Remodeling	60%	374.69	25%	156.12	15%	93.67	60%	149.88	25%	62.45	15%	37.47	60%	112.41	25%	46.84	15%	28.10
3.3	Rehabilitation	60%	58.97	25%	24.57	15%	14.74	60%	23.59	25%	9.83	15%	5.90	60%	17.69	25%	7.37	15%	4.42
3.4	Railway Culverts	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00
	Sub Total		**464.26**		**193.44**		**116.07**		**185.71**		**77.38**		**46.43**		**139.28**		**58.03**		**34.82**
4.0	**Allied Works:**																		
4.1	Boundary stones	60%	7.16	20%	2.39	20%	2.39	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	60%	1296.00	25%	540.00	15%	324.00	60%	324.00	25%	135.00	15%	81.00	60%	216.00	25%	90.00	15%	54.00
4.3	Service roads	20%	159.62	30%	239.43	50%	399.05	20%	239.43	30%	359.15	50%	598.58	20%	399.05	30%	598.58	50%	997.63
4.4	Fencing	20%	1.11	30%	1.66	50%	2.77	20%	1.66	30%	2.49	50%	4.16	20%	2.77	30%	4.16	50%	6.93
4.5	Detention ponds	40%	12.95	30%	9.71	30%	9.71	40%	32.37	30%	24.28	30%	24.28	40%	19.42	30%	14.57	30%	14.57
4.6	Retarding basins	50%	27.50	30%	16.50	20%	11.00	50%	20.62	30%	12.37	20%	8.25	50%	17.19	30%	10.31	20%	6.87
4.7	Development of water bodies	30%	126.00	50%	210.00	20%	84.00	30%	168.00	50%	280.00	20%	112.00	30%	84.00	50%	140.00	20%	56.00
4.8	Silt traps	60%	78.08	20%	26.03	20%	26.03	50%	39.04	30%	23.42	20%	15.62	50%	19.52	30%	11.71	20%	7.81
4.9	Desilting ramps	20%	4.00	30%	6.00	50%	10.00	20%	6.00	30%	9.00	50%	15.00	20%	10.00	30%	15.00	50%	25.00
4.10	Inlet / out weirs	60%	284.70	20%	94.90	20%	94.90	50%	142.35	30%	85.41	20%	56.94	50%	71.18	30%	42.71	20%	28.47
4.11	Rain gauge stations	60%	19.80	20%	6.60	20%	6.60	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	60%	129.11	20%	43.04	20%	43.04	50%	64.55	30%	38.73	20%	25.82	50%	32.28	30%	19.37	20%	12.91
4.13	Desilting equipments	60%	120.00	20%	40.00	20%	40.00	50%	50.00	30%	30.00	20%	20.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	60%	33.00	20%	11.00	20%	11.00	50%	13.75	30%	8.25	20%	5.50	50%	8.25	30%	4.95	20%	3.30
	Sub Total		**2299.01**		**1247.25**		**1064.48**		**1101.77**		**1008.10**		**967.14**		**879.65**		**951.34**		**1213.49**
5.0	**Sewage Treatment Plants:**																		
	Decentralized STP's	25%	405.00	60%	972.00	15%	243.00	25%	540.00	60%	1296.00	15%	324.00	25%	270.00	60%	648.00	15%	162.00
	Sub Total		**405.00**		**972.00**		**243.00**		**540.00**		**1296.00**		**324.00**		**270.00**		**648.00**		**162.00**
	Total Structural =		**11215.15**		**7173.26**		**4670.27**		**8296.58**		**6345.59**		**3945.86**		**6716.69**		**4955.36**		**3591.74**
6.0	**Non Structural Works:**																		
6.1	DPR and PMC	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	60%	442.40	20%	147.47	20%	147.47	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	60%	277.26	20%	92.42	20%	92.42	50%	138.63	30%	83.18	20%	55.45	50%	69.31	30%	41.59	20%	27.73
6.4	Development of green belt	20%	6.14	30%	9.22	50%	15.36	20%	9.22	30%	13.83	50%	23.04	20%	15.36	30%	23.04	50%	38.40
6.5	WCE + Admin.	25%	230.42	35%	322.58	40%	368.67	25%	230.42	35%	322.58	40%	368.67	25%	230.42	35%	322.58	40%	368.67
	Total Non Structural =		**956.22**		**571.69**		**623.92**		**378.26**		**419.59**		**447.16**		**315.09**		**387.22**		**434.80**
	Total of SWD =		**12171.37**		**7744.95**		**5294.18**		**8674.84**		**6765.18**		**4393.03**		**7031.78**		**5342.57**		**4026.54**

TABLE 7.8 PROJECT PHASING AND BUDGETARY ALLOCATION FOR REMODELLING OF STORM WATER DRAINS IN YELAHANKA ZONE

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)		Stage - 1						Stage - 2						Stage - 3					
											1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
			%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																											
1.1	Desilting & deepening	1062.55	5%	53.13	50%	531.27	30%	318.76	15%	159.38	60%	318.76	20%	106.25	20%	106.25	50%	159.38	30%	95.63	20%	63.75	50%	79.69	30%	47.81	20%	31.88
1.2	Widening																											
	a. Earthen bund	3298.68	0%	0.00	20%	659.74	40%	1319.47	40%	1319.47	50%	329.87	25%	164.93	25%	164.93	50%	659.74	30%	395.84	20%	263.89	50%	659.74	30%	395.84	20%	263.89
	b. RCC independent walls	6029.89	5%	301.49	40%	2411.96	30%	1808.97	25%	1507.47	50%	1205.98	30%	723.59	20%	482.39	50%	904.48	30%	542.69	20%	361.79	50%	753.74	30%	452.24	20%	301.49
	c. RCC "U" shaped walls	12387.18	5%	619.36	40%	4954.87	30%	3716.15	25%	3096.79	50%	2477.44	30%	1486.46	20%	990.97	50%	1858.08	30%	1114.85	20%	743.23	50%	1548.40	30%	929.04	20%	619.36
	d. CRS / SSM masonry walls	5491.62	5%	274.58	40%	2196.65	30%	1647.49	25%	1372.90	50%	1098.32	30%	658.99	20%	439.33	50%	823.74	30%	494.25	20%	329.50	50%	686.45	30%	411.87	20%	274.58
	e. RCC box drain	3756.98	5%	187.85	40%	1502.79	30%	1127.09	25%	939.25	50%	751.40	30%	450.84	20%	300.56	50%	563.55	30%	338.13	20%	225.42	50%	469.62	30%	281.77	20%	187.85
1.3	Bed protection	1538.78	5%	76.94	20%	307.76	50%	769.39	25%	384.70	30%	92.33	50%	153.88	20%	61.55	30%	230.82	50%	384.70	20%	153.88	30%	115.41	50%	192.35	20%	76.94
	Sub Total	**33565.68**		**1513.35**		**12565.03**		**10707.33**		**8779.97**		**6274.09**		**3744.95**		**2545.99**		**5199.79**		**3366.08**		**2141.47**		**4313.04**		**2710.93**		**1755.99**
2.0	**Rehabilitation and Strengthening:**																											
	CRS / SSM Wall Reconstruction & Raising	29.73	10%	2.97	50%	14.87	30%	8.92	10%	2.97	50%	7.43	30%	4.46	20%	2.97	50%	4.46	30%	2.68	20%	1.78	50%	1.49	30%	0.89	20%	0.59
	CRS / SSM Wall Restoration	158.64	10%	15.86	50%	79.32	30%	47.59	10%	15.86	50%	39.66	30%	23.80	20%	15.86	50%	23.80	30%	14.28	20%	9.52	50%	7.93	30%	4.76	20%	3.17
	Sub Total	**188.37**		**18.84**		**94.19**		**56.51**		**18.84**		**47.09**		**28.26**		**18.84**		**28.26**		**16.95**		**11.30**		**9.42**		**5.65**		**3.77**
3.0	**Culverts and Bridges:**																											
3.1	Utility supports & bridges	97.00	15%	14.55	50%	48.50	20%	19.40	15%	14.55	60%	29.10	25%	12.13	15%	7.28	60%	11.64	25%	4.85	15%	2.91	60%	8.73	25%	3.64	15%	2.18
3.2	Remodeling	6176.52	15%	926.48	50%	3088.26	20%	1235.30	15%	926.48	60%	1852.96	25%	772.07	15%	463.24	60%	741.18	25%	308.83	15%	185.30	60%	555.89	25%	231.62	15%	138.97
3.3	Rehabilitation	16.24	15%	2.44	50%	8.12	20%	3.25	15%	2.44	60%	4.87	25%	2.03	15%	1.22	60%	1.95	25%	0.81	15%	0.49	60%	1.46	25%	0.61	15%	0.37
3.4	Railway Culverts	214.80	15%	32.22	50%	107.40	20%	42.96	15%	32.22	60%	64.44	25%	26.85	15%	16.11	60%	25.78	25%	10.74	15%	6.44	60%	19.33	25%	8.05	15%	4.83
	Sub Total	**6504.56**		**975.68**		**3252.28**		**1300.91**		**975.68**		**1951.37**		**813.07**		**487.84**		**780.55**		**325.23**		**195.14**		**585.41**		**243.92**		**146.35**
4.0	**Allied Works:**																											
4.1	Boundary stones	0.00	40%	0.00	60%	0.00	0%	0.00	0%	0.00	60%	0.00	20%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	2462.67	15%	369.40	60%	1477.60	15%	369.40	10%	246.27	60%	886.56	25%	369.40	15%	221.64	60%	221.64	25%	92.35	15%	55.41	60%	147.76	25%	61.57	15%	36.94
4.3	Service roads	2711.93	0%	0.00	20%	542.39	30%	813.58	50%	1355.96	20%	108.48	30%	162.72	50%	271.19	20%	162.72	30%	244.07	50%	406.79	20%	271.19	30%	406.79	50%	677.98
4.4	Fencing	2057.95	0%	0.00	20%	411.59	30%	617.38	50%	1028.97	20%	82.32	30%	123.48	50%	205.79	20%	123.48	30%	185.22	50%	308.69	20%	205.79	30%	308.69	50%	514.49
4.5	Detention ponds	271.16	0%	0.00	20%	54.23	50%	135.58	30%	81.35	40%	21.69	30%	16.27	30%	16.27	40%	54.23	30%	40.67	30%	40.67	40%	32.54	30%	24.40	30%	24.40
4.6	Retarding basins	81.46	5%	4.07	40%	32.58	30%	24.44	25%	20.37	50%	16.29	30%	9.78	20%	6.52	50%	12.22	30%	7.33	20%	4.89	50%	10.18	30%	6.11	20%	4.07
4.7	Development of water bodies	1701.82	10%	170.18	30%	510.55	40%	680.73	20%	340.36	30%	153.16	50%	255.27	20%	102.11	30%	204.22	50%	340.36	20%	136.15	30%	102.11	50%	170.18	20%	68.07
4.8	Silt traps	26.62	5%	1.33	50%	13.31	30%	7.99	15%	3.99	60%	7.99	20%	2.66	20%	2.66	50%	3.99	30%	2.40	20%	1.60	50%	2.00	30%	1.20	20%	0.80
4.9	Desilting ramps	92.50	0%	0.00	20%	18.50	30%	27.75	50%	46.25	20%	3.70	30%	5.55	50%	9.25	20%	5.55	30%	8.33	50%	13.88	20%	9.25	30%	13.88	50%	23.13
4.10	Inlet / out weirs	663.17	5%	33.16	50%	331.59	30%	198.95	15%	99.48	60%	198.95	20%	66.32	20%	66.32	50%	99.48	30%	59.69	20%	39.79	50%	49.74	30%	29.84	20%	19.90
4.11	Rain gauge stations	5.00	100%	5.00	0%	0.00	0%	0.00	0%	0.00	60%	0.00	20%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	1537.95	5%	76.90	50%	768.98	30%	461.39	15%	230.69	60%	461.39	20%	153.80	20%	153.80	50%	230.69	30%	138.42	20%	92.28	50%	115.35	30%	69.21	20%	46.14
4.13	Desilting equipments	400.00	25%	100.00	50%	200.00	25%	100.00	0%	0.00	60%	120.00	20%	40.00	20%	40.00	50%	50.00	30%	30.00	20%	20.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	90.00	10%	9.00	50%	45.00	25%	22.50	15%	13.50	60%	27.00	20%	9.00	20%	9.00	50%	11.25	30%	6.75	20%	4.50	50%	6.75	30%	4.05	20%	2.70
	Sub Total	**12102.23**		**769.04**		**4406.31**		**3459.68**		**3467.19**		**2087.53**		**1214.24**		**1104.55**		**1179.46**		**1155.58**		**1124.64**		**952.66**		**1095.92**		**1418.62**
5.0	**Sewage Treatment Plants:**																											
	Decentralized STP's	7400.00	10%	740.00	30%	2220.00	40%	2960.00	20%	1480.00	25%	555.00	60%	1332.00	15%	333.00	25%	740.00	60%	1776.00	15%	444.00	25%	370.00	60%	888.00	15%	222.00
	Sub Total	**7400.00**		**740.00**		**2220.00**		**2960.00**		**1480.00**		**555.00**		**1332.00**		**333.00**		**740.00**		**1776.00**		**444.00**		**370.00**		**888.00**		**222.00**
	Total Structural =	**59760.84**		**4016.91**		**22537.81**		**18484.43**		**14721.68**		**10915.08**		**7132.51**		**4490.22**		**7928.05**		**6639.84**		**3916.54**		**6230.53**		**4944.42**		**3546.73**
6.0	**Non Structural Works:**																											
6.1	DPR and PMC	605.32	100%	605.32	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	1210.64	40%	484.25	60%	726.38	0%	0.00	0%	0.00	60%	435.83	20%	145.28	20%	145.28	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	771.01	5%	38.55	50%	385.51	30%	231.30	15%	115.65	60%	231.30	20%	77.10	20%	77.10	50%	115.65	30%	69.39	20%	46.26	50%	57.83	30%	34.70	20%	23.13
6.4	Development of green belt	151.33	0%	0.00	20%	30.27	30%	45.40	50%	75.66	20%	6.05	30%	9.08	50%	15.13	20%	9.08	30%	13.62	50%	22.70	20%	15.13	30%	22.70	50%	37.83
6.5	WCE + Admin.	3026.59	10%	302.66	30%	907.98	30%	907.98	30%	907.98	25%	226.99	35%	317.79	40%	363.19	25%	226.99	35%	317.79	40%	363.19	25%	226.99	35%	317.79	40%	363.19
	Total Non Structural =	**5764.89**		**1430.78**		**2050.13**		**1184.68**		**1099.29**		**900.18**		**549.25**		**600.70**		**351.73**		**400.80**		**432.15**		**299.95**		**375.19**		**424.15**
	Total of SWD =	**65525.72**		**5447.70**		**24587.94**		**19669.11**		**15820.97**		**11815.26**		**7681.76**		**5090.92**		**8279.78**		**7040.64**		**4348.69**		**6530.49**		**5319.61**		**3970.88**

TABLE - 7.9

PROJECT PHASING AND BUDGETARY ALLOCATION FOR MASTER PLAN PROJECT - DASARAHALLI ZONE OF BBMP

Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)		Stage - 1						Stage - 2						Stage - 3					
											1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
			%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																											
1.1	Desilting & deepening	639.84	5%	31.99	50%	319.92	30%	191.95	15%	95.98	60%	191.95	20%	63.98	20%	63.98	50%	95.98	30%	57.59	20%	38.39	50%	47.99	30%	28.79	20%	19.20
1.2	Widening																											
	a. Earthen bund	1002.42	0%	0.00	20%	200.48	40%	400.97	40%	400.97	50%	100.24	25%	50.12	25%	50.12	50%	200.48	30%	120.29	20%	80.19	50%	200.48	30%	120.29	20%	80.19
	b. RCC independent walls	6477.95	5%	323.90	40%	2591.18	30%	1943.39	25%	1619.49	50%	1295.59	30%	777.35	20%	518.24	50%	971.69	30%	583.02	20%	388.68	50%	809.74	30%	485.85	20%	323.90
	c. RCC "U" shaped walls	20910.57	5%	1045.53	40%	8364.23	30%	6273.17	25%	5227.64	50%	4182.11	30%	2509.27	20%	1672.85	50%	3136.59	30%	1881.95	20%	1254.63	50%	2613.82	30%	1568.29	20%	1045.53
	d. CRS / SSM masonry walls	2033.04	5%	101.65	40%	813.22	30%	609.91	25%	508.26	50%	406.61	30%	243.96	20%	162.64	50%	304.96	30%	182.97	20%	121.98	50%	254.13	30%	152.48	20%	101.65
	e. RCC box drain	158.13	5%	7.91	40%	63.25	30%	47.44	25%	39.53	50%	31.63	30%	18.98	20%	12.65	50%	23.72	30%	14.23	20%	9.49	50%	19.77	30%	11.86	20%	7.91
1.3	Bed protection	1046.61	5%	52.33	20%	209.32	50%	523.30	25%	261.65	30%	62.80	50%	104.66	20%	41.86	30%	156.99	50%	261.65	20%	104.66	30%	78.50	50%	130.83	20%	52.33
	Sub Total	**32268.57**		**1563.31**		**12561.60**		**9990.13**		**8153.52**		**6270.93**		**3768.33**		**2522.35**		**4890.41**		**3101.70**		**1998.03**		**4024.43**		**2498.39**		**1630.70**
2.0	**Rehabilitation and Strengthening:**																											
	CRS / SSM Wall Reconstruction	212.48	10%	21.25	50%	106.24	30%	63.74	10%	21.25	50%	53.12	30%	31.87	20%	21.25	50%	31.87	30%	19.12	20%	12.75	50%	10.62	30%	6.37	20%	4.25
	CRS / SSM Wall Restoration	0.00	10%	0.00	50%	0.00	30%	0.00	10%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
	Sub Total	**212.48**		**21.25**		**106.24**		**63.74**		**21.25**		**53.12**		**31.87**		**21.25**		**31.87**		**19.12**		**12.75**		**10.62**		**6.37**		**4.25**
3.0	**Culverts and Bridges:**																											
3.1	Utility supports & bridges	102.00	15%	15.30	50%	51.00	20%	20.40	15%	15.30	60%	30.60	25%	12.75	15%	7.65	60%	12.24	25%	5.10	15%	3.06	60%	9.18	25%	3.83	15%	2.30
3.2	Remodeling	2748.09	15%	412.21	50%	1374.05	20%	549.62	15%	412.21	60%	824.43	25%	343.51	15%	206.11	60%	329.77	25%	137.40	15%	82.44	60%	247.33	25%	103.05	15%	61.83
3.3	Rehabilitation	153.59	15%	23.04	50%	76.80	20%	30.72	15%	23.04	60%	46.08	25%	19.20	15%	11.52	60%	18.43	25%	7.68	15%	4.61	60%	13.82	25%	5.76	15%	3.46
3.4	Railway Culverts	0.00	15%	0.00	50%	0.00	20%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00	60%	0.00	25%	0.00	15%	0.00
	Sub Total	**3003.68**		**450.55**		**1501.84**		**600.74**		**450.55**		**901.10**		**375.46**		**225.28**		**360.44**		**150.18**		**90.11**		**270.33**		**112.64**		**67.58**
4.0	**Allied Works:**																											
4.1	Boundary stones	16.56	40%	6.62	60%	9.94	0%	0.00	0%	0.00	60%	5.96	20%	1.99	20%	1.99	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	2550.00	15%	382.50	60%	1530.00	15%	382.50	10%	255.00	60%	918.00	25%	382.50	15%	229.50	60%	229.50	25%	95.63	15%	57.38	60%	153.00	25%	63.75	15%	38.25
4.3	Service roads	2611.74	0%	0.00	20%	522.35	30%	783.52	50%	1305.87	20%	104.47	30%	156.70	50%	261.17	20%	156.70	30%	235.06	50%	391.76	20%	261.17	30%	391.76	50%	652.94
4.4	Fencing	842.34	0%	0.00	20%	168.47	30%	252.70	50%	421.17	20%	33.69	30%	50.54	50%	84.23	20%	50.54	30%	75.81	50%	126.35	20%	84.23	30%	126.35	50%	210.59
4.5	Detention ponds	366.76	0%	0.00	20%	73.35	50%	183.38	30%	110.03	40%	29.34	30%	22.01	30%	22.01	40%	73.35	30%	55.01	30%	55.01	40%	44.01	30%	33.01	30%	33.01
4.6	Retarding basins	250.34	5%	12.52	40%	100.14	30%	75.10	25%	62.59	50%	50.07	30%	30.04	20%	20.03	50%	37.55	30%	22.53	20%	15.02	50%	31.29	30%	18.78	20%	12.52
4.7	Development of water bodies	1200.00	10%	120.00	30%	360.00	40%	480.00	20%	240.00	30%	108.00	50%	180.00	20%	72.00	30%	144.00	50%	240.00	20%	96.00	30%	72.00	50%	120.00	20%	48.00
4.8	Silt traps	148.75	5%	7.44	50%	74.38	30%	44.63	15%	22.31	60%	44.63	20%	14.88	20%	14.88	50%	22.31	30%	13.39	20%	8.93	50%	11.16	30%	6.69	20%	4.46
4.9	Desilting ramps	120.00	0%	0.00	20%	24.00	30%	36.00	50%	60.00	20%	4.80	30%	7.20	50%	12.00	20%	7.20	30%	10.80	50%	18.00	20%	12.00	30%	18.00	50%	30.00
4.10	Inlet / out weirs	292.00	5%	14.60	50%	146.00	30%	87.60	15%	43.80	60%	87.60	20%	29.20	20%	29.20	50%	43.80	30%	26.28	20%	17.52	50%	21.90	30%	13.14	20%	8.76
4.11	Rain gauge stations	40.00	40%	16.00	60%	24.00	0%	0.00	0%	0.00	60%	14.40	20%	4.80	20%	4.80	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	645.16	5%	32.26	50%	322.58	30%	193.55	15%	96.77	60%	193.55	20%	64.52	20%	64.52	50%	96.77	30%	58.06	20%	38.71	50%	48.39	30%	29.03	20%	19.35
4.13	Desilting equipments	400.00	25%	100.00	50%	200.00	25%	100.00	0%	0.00	60%	120.00	20%	40.00	20%	40.00	50%	50.00	30%	30.00	20%	20.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	80.00	10%	8.00	50%	40.00	25%	20.00	15%	12.00	60%	24.00	20%	8.00	20%	8.00	50%	10.00	30%	6.00	20%	4.00	50%	6.00	30%	3.60	20%	2.40
	Sub Total	**9563.66**		**699.94**		**3595.20**		**2638.98**		**2629.54**		**1738.51**		**992.37**		**864.32**		**921.73**		**868.57**		**848.68**		**745.16**		**824.11**		**1060.27**
5.0	**Sewage Treatment Plants:**																											
	Decentralized STP's	1250.00	10%	125.00	30%	375.00	40%	500.00	20%	250.00	25%	93.75	60%	225.00	15%	56.25	25%	125.00	60%	300.00	15%	75.00	25%	62.50	60%	150.00	15%	37.50
	Sub Total	**1250.00**		**125.00**		**375.00**		**500.00**		**250.00**		**93.75**		**225.00**		**56.25**		**125.00**		**300.00**		**75.00**		**62.50**		**150.00**		**37.50**
	Total Structural =	**46298.38**		**2860.04**		**18139.88**		**13793.59**		**11504.86**		**9057.41**		**5393.03**		**3689.44**		**6329.45**		**4439.58**		**3024.56**		**5113.04**		**3591.51**		**2800.31**
6.0	**Non Structural Works:**																											
6.1	DPR and PMC	470.20	100%	470.20	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	940.40	40%	376.16	60%	564.24	0%	0.00	0%	0.00	60%	338.54	20%	112.85	20%	112.85	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	721.68	5%	36.08	50%	360.84	30%	216.50	15%	108.25	60%	216.50	20%	72.17	20%	72.17	50%	108.25	30%	64.95	20%	43.30	50%	54.13	30%	32.48	20%	21.65
6.4	Development of green belt	117.55	0%	0.00	20%	23.51	30%	35.27	50%	58.78	20%	4.70	30%	7.05	50%	11.76	20%	7.05	30%	10.58	50%	17.63	20%	11.76	30%	17.63	50%	29.39
6.5	WCE + Admin.	2351.00	10%	235.10	30%	705.30	30%	705.30	30%	705.30	25%	176.33	35%	246.86	40%	282.12	25%	176.33	35%	246.86	40%	282.12	25%	176.33	35%	246.86	40%	282.12
	Total Non Structural =	**4600.83**		**1117.55**		**1653.89**		**957.07**		**872.33**		**736.07**		**438.92**		**478.89**		**291.63**		**322.39**		**343.05**		**242.21**		**296.96**		**333.16**
	Total of SWD =	**50899.22**		**3977.59**		**19793.77**		**14750.66**		**12377.19**		**9793.49**		**5831.96**		**4168.33**		**6621.08**		**4761.96**		**3367.62**		**5355.25**		**3888.48**		**3133.47**

TABLE - 7.10

PROJECT PHASING AND BUDGETARY ALLOCATION FOR MASTER PLAN PROJECT - MAHADEVPURA ZONE OF BBMP

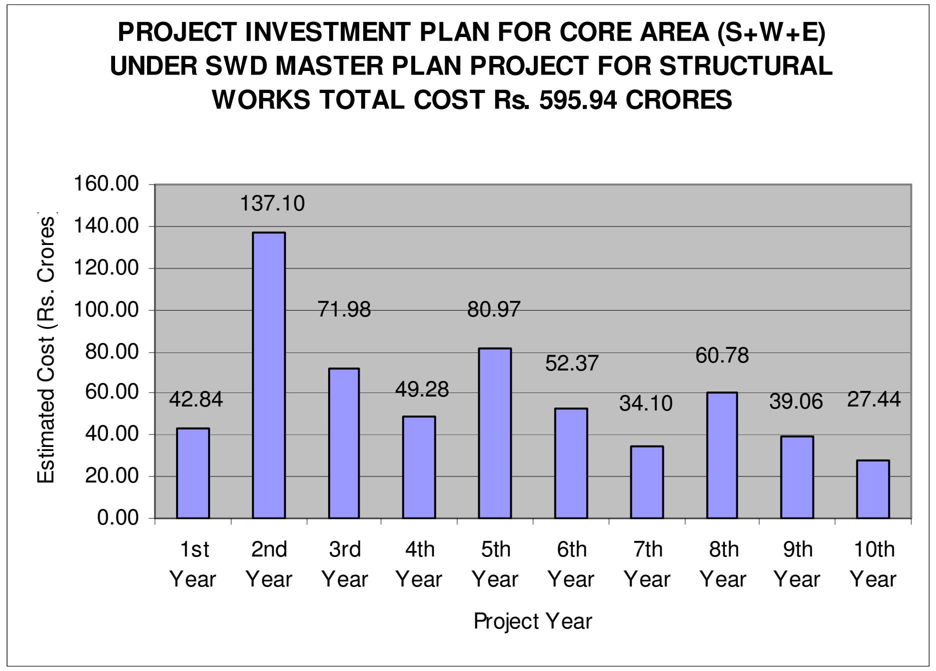
Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)		Stage - 1						Stage - 2						Stage - 3					
											1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
			%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																											
1.1	Desilting & deepening	1553.33	5%	77.67	50%	776.66	30%	466.00	15%	233.00	60%	466.00	20%	155.33	20%	155.33	50%	233.00	30%	139.80	20%	93.20	50%	116.50	30%	69.90	20%	46.60
1.2	Widening																											
	a. Earthen bund	15098.16	0%	0.00	20%	3019.63	40%	6039.26	40%	6039.26	50%	1509.82	25%	754.91	25%	754.91	50%	3019.63	30%	1811.78	20%	1207.85	50%	3019.63	30%	1811.78	20%	1207.85
	b. RCC independent walls	4951.84	5%	247.59	40%	1980.74	30%	1485.55	25%	1237.96	50%	990.37	30%	594.22	20%	396.15	50%	742.78	30%	445.67	20%	297.11	50%	618.98	30%	371.39	20%	247.59
	c. RCC "U" shaped walls	21733.85	5%	1086.69	40%	8693.54	30%	6520.15	25%	5433.46	50%	4346.77	30%	2608.06	20%	1738.71	50%	3260.08	30%	1956.05	20%	1304.03	50%	2716.73	30%	1630.04	20%	1086.69
	d. CRS / SSM masonry walls	6034.20	5%	301.71	40%	2413.68	30%	1810.26	25%	1508.55	50%	1206.84	30%	724.10	20%	482.74	50%	905.13	30%	543.08	20%	362.05	50%	754.28	30%	452.57	20%	301.71
	e. RCC box drain	9842.47	5%	492.12	40%	3936.99	30%	2952.74	25%	2460.62	50%	1968.49	30%	1181.10	20%	787.40	50%	1476.37	30%	885.82	20%	590.55	50%	1230.31	30%	738.19	20%	492.12
1.3	Bed protection	128.27	5%	6.41	20%	25.65	50%	64.13	25%	32.07	30%	7.70	50%	12.83	20%	5.13	30%	19.24	50%	32.07	20%	12.83	30%	9.62	50%	16.03	20%	6.41
	Sub Total	**59342.12**		**2212.20**		**20846.89**		**19338.11**		**16944.92**		**10495.98**		**6030.55**		**4320.36**		**9656.23**		**5814.26**		**3867.62**		**8466.05**		**5089.89**		**3388.98**
2.0	**Rehabilitation and Strengthening:**																											
	CRS / SSM Wall Reconstruction	94.11	10%	9.41	50%	47.06	30%	28.23	10%	9.41	50%	23.53	30%	14.12	20%	9.41	50%	14.12	30%	8.47	20%	5.65	50%	4.71	30%	2.82	20%	1.88
	CRS / SSM Wall Restoration	0.00	10%	0.00	50%	0.00	30%	0.00	10%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
	Sub Total	**94.11**		**9.41**		**47.06**		**28.23**		**9.41**		**23.53**		**14.12**		**9.41**		**14.12**		**8.47**		**5.65**		**4.71**		**2.82**		**1.88**
3.0	**Culverts and Bridges:**																											
3.1	Utility supports & bridges	153.00	15%	22.95	50%	76.50	20%	30.60	15%	22.95	60%	45.90	25%	19.13	15%	11.48	60%	18.36	25%	7.65	15%	4.59	60%	13.77	25%	5.74	15%	3.44
3.2	Remodeling	3815.38	15%	572.31	50%	1907.69	20%	763.08	15%	572.31	60%	1144.61	25%	476.92	15%	286.15	60%	457.85	25%	190.77	15%	114.46	60%	343.38	25%	143.08	15%	85.85
3.3	Rehabilitation	121.75	15%	18.26	50%	60.87	20%	24.35	15%	18.26	60%	36.52	25%	15.22	15%	9.13	60%	14.61	25%	6.09	15%	3.65	60%	10.96	25%	4.57	15%	2.74
3.4	Railway Culverts	501.24	15%	75.19	50%	250.62	20%	100.25	15%	75.19	60%	150.37	25%	62.65	15%	37.59	60%	60.15	25%	25.06	15%	15.04	60%	45.11	25%	18.80	15%	11.28
	Sub Total	**4591.36**		**688.70**		**2295.68**		**918.27**		**688.70**		**1377.41**		**573.92**		**344.35**		**550.96**		**229.57**		**137.74**		**413.22**		**172.18**		**103.31**
4.0	**Allied Works:**																											
4.1	Boundary stones	25.89	40%	10.35	60%	15.53	0%	0.00	0%	0.00	60%	9.32	20%	3.11	20%	3.11	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	3450.00	15%	517.50	60%	2070.00	15%	517.50	10%	345.00	60%	1242.00	25%	517.50	15%	310.50	60%	310.50	25%	129.38	15%	77.63	60%	207.00	25%	86.25	15%	51.75
4.3	Service roads	5920.52	0%	0.00	20%	1184.10	30%	1776.16	50%	2960.26	20%	236.82	30%	355.23	50%	592.05	20%	355.23	30%	532.85	50%	888.08	20%	592.05	30%	888.08	50%	1480.13
4.4	Fencing	246.02	0%	0.00	20%	49.20	30%	73.80	50%	123.01	20%	9.84	30%	14.76	50%	24.60	20%	14.76	30%	22.14	50%	36.90	20%	24.60	30%	36.90	50%	61.50
4.5	Detention ponds	170.00	0%	0.00	20%	34.00	50%	85.00	30%	51.00	40%	13.60	30%	10.20	30%	10.20	40%	34.00	30%	25.50	30%	25.50	40%	20.40	30%	15.30	30%	15.30
4.6	Retarding basins	75.20	5%	3.76	40%	30.08	30%	22.56	25%	18.80	50%	15.04	30%	9.02	20%	6.02	50%	11.28	30%	6.77	20%	4.51	50%	9.40	30%	5.64	20%	3.76
4.7	Development of water bodies	3000.00	10%	300.00	30%	900.00	40%	1200.00	20%	600.00	30%	270.00	50%	450.00	20%	180.00	30%	360.00	50%	600.00	20%	240.00	30%	180.00	50%	300.00	20%	120.00
4.8	Silt traps	598.00	5%	29.90	50%	299.00	30%	179.40	15%	89.70	60%	179.40	20%	59.80	20%	59.80	50%	89.70	30%	53.82	20%	35.88	50%	44.85	30%	26.91	20%	17.94
4.9	Desilting ramps	100.00	0%	0.00	20%	20.00	30%	30.00	50%	50.00	20%	4.00	30%	6.00	50%	10.00	20%	6.00	30%	9.00	50%	15.00	20%	10.00	30%	15.00	50%	25.00
4.10	Inlet / out weirs	584.00	5%	29.20	50%	292.00	30%	175.20	15%	87.60	60%	175.20	20%	58.40	20%	58.40	50%	87.60	30%	52.56	20%	35.04	50%	43.80	30%	26.28	20%	17.52
4.11	Rain gauge stations	70.00	40%	28.00	60%	42.00	0%	0.00	0%	0.00	60%	25.20	20%	8.40	20%	8.40	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	1587.28	5%	79.36	50%	793.64	30%	476.18	15%	238.09	60%	476.18	20%	158.73	20%	158.73	50%	238.09	30%	142.86	20%	95.24	50%	119.05	30%	71.43	20%	47.62
4.13	Desilting equipments	500.00	25%	125.00	50%	250.00	25%	125.00	0%	0.00	60%	150.00	20%	50.00	20%	50.00	50%	62.50	30%	37.50	20%	25.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	140.00	10%	14.00	50%	70.00	25%	35.00	15%	21.00	60%	42.00	20%	14.00	20%	14.00	50%	17.50	30%	10.50	20%	7.00	50%	10.50	30%	6.30	20%	4.20
	Sub Total	**16466.91**		**1137.08**		**6049.56**		**4695.81**		**4584.46**		**2848.61**		**1715.15**		**1485.80**		**1587.16**		**1622.87**		**1485.77**		**1261.65**		**1478.09**		**1844.72**
5.0	**Sewage Treatment Plants:**																											
	Decentralized STP's	2700.00	10%	270.00	30%	810.00	40%	1080.00	20%	540.00	25%	202.50	60%	486.00	15%	121.50	25%	270.00	60%	648.00	15%	162.00	25%	135.00	60%	324.00	15%	81.00
	Sub Total	**2700.00**		**270.00**		**810.00**		**1080.00**		**540.00**		**202.50**		**486.00**		**121.50**		**270.00**		**648.00**		**162.00**		**135.00**		**324.00**		**81.00**
	Total Structural =	**83194.50**		**4317.39**		**30049.19**		**26060.42**		**22767.50**		**14948.02**		**8819.74**		**6281.43**		**12078.47**		**8323.16**		**5658.78**		**10280.62**		**7066.98**		**5419.89**
6.0	**Non Structural Works:**																											
6.1	DPR and PMC	845.19	100%	845.19	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	1690.37	40%	676.15	60%	1014.22	0%	0.00	0%	0.00	60%	608.53	20%	202.84	20%	202.84	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	1324.02	5%	66.20	50%	662.01	30%	397.20	15%	198.60	60%	397.20	20%	132.40	20%	132.40	50%	198.60	30%	119.16	20%	79.44	50%	99.30	30%	59.58	20%	39.72
6.4	Development of green belt	211.30	0%	0.00	20%	42.26	30%	63.39	50%	105.65	20%	8.45	30%	12.68	50%	21.13	20%	12.68	30%	19.02	50%	31.69	20%	21.13	30%	31.69	50%	52.82
6.5	WCE + Admin.	4225.93	10%	422.59	30%	1267.78	30%	1267.78	30%	1267.78	25%	316.94	35%	443.72	40%	507.11	25%	316.94	35%	443.72	40%	507.11	25%	316.94	35%	443.72	40%	507.11
	Total Non Structural =	**8296.79**		**2010.13**		**2986.27**		**1728.37**		**1572.03**		**1331.13**		**791.65**		**863.49**		**528.22**		**581.90**		**618.25**		**437.38**		**535.00**		**599.66**
	Total of SWD =	**91491.29**		**6327.52**		**33035.46**		**27788.79**		**24339.53**		**16279.16**		**9611.38**		**7144.91**		**12606.69**		**8905.06**		**6277.03**		**10718.00**		**7601.97**		**6019.55**

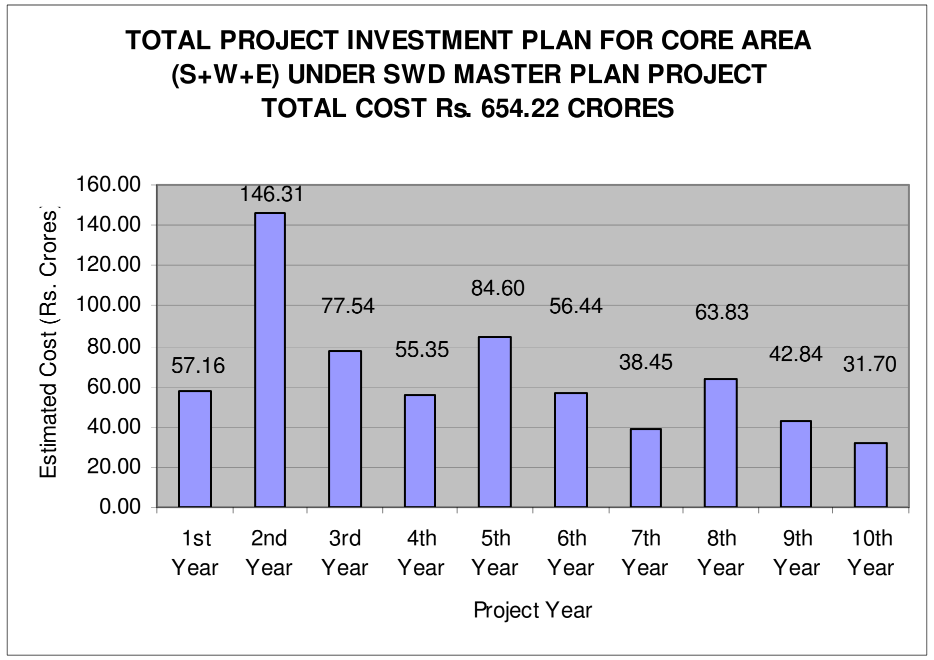
TABLE 7.11 PROJECT PHASING AND BUDGETARY ALLOCATION FOR REMODELLING OF STORM WATER DRAINS IN RAJARAJESHWARI NAGAR ZONE

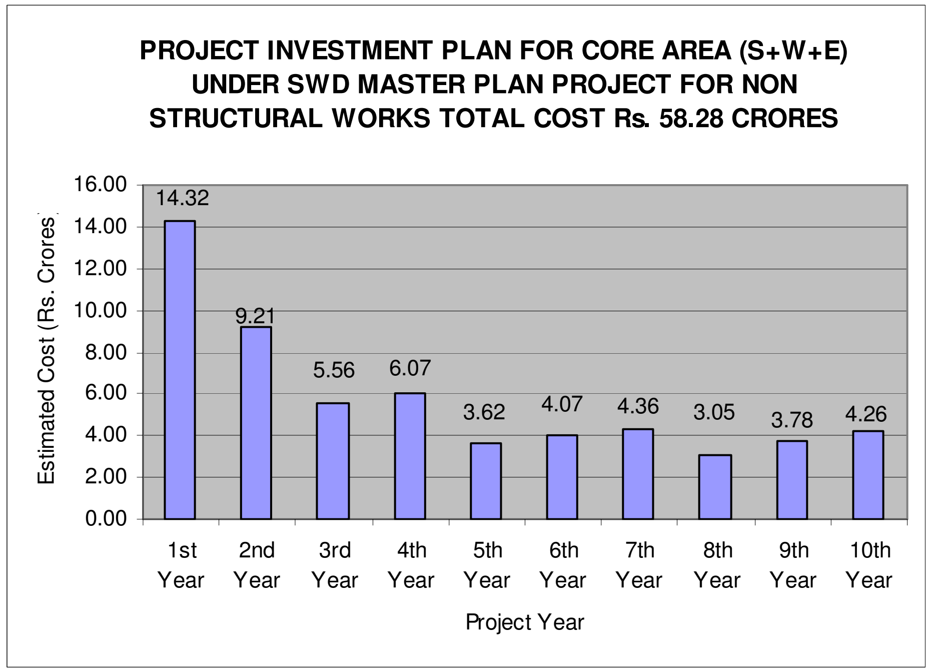
Sl. No.	Project Component	Estimated Cost (Rs. Lakhs)	Gestation (1 Year)		Stage - 1 (3 Years)		Stage - 2 (3 Years)		Stage - 3 (3 Years)		Stage - 1						Stage - 2						Stage - 3					
											1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year		1st Year		2nd Year		3rd Year	
			%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1.0	**Improvement to Carrying Capacity:**																											
1.1	Desilting & deepening	1854.23	5%	92.71	50%	927.12	30%	556.27	15%	278.13	60%	556.27	20%	185.42	20%	185.42	50%	278.13	30%	166.88	20%	111.25	50%	139.07	30%	83.44	20%	55.63
1.2	Widening																											
	a. Earthen bund	178.59	0%	0.00	20%	35.72	40%	71.44	40%	71.44	50%	17.86	25%	8.93	25%	8.93	50%	35.72	30%	21.43	20%	14.29	50%	35.72	30%	21.43	20%	14.29
	b. RCC independent walls	24369.43	5%	1218.47	40%	9747.77	30%	7310.83	25%	6092.36	50%	4873.89	30%	2924.33	20%	1949.55	50%	3655.41	30%	2193.25	20%	1462.17	50%	3046.18	30%	1827.71	20%	1218.47
	c. RCC "U" shaped walls	15143.48	5%	757.17	40%	6057.39	30%	4543.05	25%	3785.87	50%	3028.70	30%	1817.22	20%	1211.48	50%	2271.52	30%	1362.91	20%	908.61	50%	1892.94	30%	1135.76	20%	757.17
	d. CRS / SSM masonry walls	2549.47	5%	127.47	40%	1019.79	30%	764.84	25%	637.37	50%	509.89	30%	305.94	20%	203.96	50%	382.42	30%	229.45	20%	152.97	50%	318.68	30%	191.21	20%	127.47
	e. RCC box drain	1893.41	5%	94.67	40%	757.36	30%	568.02	25%	473.35	50%	378.68	30%	227.21	20%	151.47	50%	284.01	30%	170.41	20%	113.60	50%	236.68	30%	142.01	20%	94.67
1.3	Bed protection	4145.70	5%	207.28	20%	829.14	50%	2072.85	25%	1036.42	30%	248.74	50%	414.57	20%	165.83	30%	621.85	50%	1036.42	20%	414.57	30%	310.93	50%	518.21	20%	207.28
	Sub Total	**50134.30**		**2497.79**		**19374.28**		**15887.29**		**12374.94**		**9614.03**		**5883.62**		**3876.64**		**7529.07**		**5180.76**		**3177.46**		**5980.18**		**3919.77**		**2474.99**
2.0	**Rehabilitation and Strengthening:**																											
2.1	CRS / SSM Wall Reconstruction & Raising	280.00	10%	28.00	50%	140.00	30%	84.00	10%	28.00	50%	70.00	30%	42.00	20%	28.00	50%	42.00	30%	25.20	20%	16.80	50%	14.00	30%	8.40	20%	5.60
2.2	CRS / SSM Wall Restoration	0.00	10%	0.00	50%	0.00	30%	0.00	10%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
	Sub Total	**280.00**		**28.00**		**140.00**		**84.00**		**28.00**		**70.00**		**42.00**		**28.00**		**42.00**		**25.20**		**16.80**		**14.00**		**8.40**		**5.60**
3.0	**Culverts and Bridges:**																											
3.1	Utility supports & bridges	121.25	15%	18.19	50%	60.63	20%	24.25	15%	18.19	60%	36.38	25%	15.16	15%	9.09	60%	14.55	25%	6.06	15%	3.64	60%	10.91	25%	4.55	15%	2.73
3.2	Remodeling	7173.77	15%	1076.07	50%	3586.89	20%	1434.75	15%	1076.07	60%	2152.13	25%	896.72	15%	538.03	60%	860.85	25%	358.69	15%	215.21	60%	645.64	25%	269.02	15%	161.41
3.3	Rehabilitation	233.46	15%	35.02	50%	116.73	20%	46.69	15%	35.02	60%	70.04	25%	29.18	15%	17.51	60%	28.02	25%	11.67	15%	7.00	60%	21.01	25%	8.75	15%	5.25
3.4	Railway Culverts	150.63	15%	22.59	50%	75.31	20%	30.13	15%	22.59	60%	45.19	25%	18.83	15%	11.30	60%	18.08	25%	7.53	15%	4.52	60%	13.56	25%	5.65	15%	3.39
	Sub Total	**7679.11**		**1151.87**		**3839.56**		**1535.82**		**1151.87**		**2303.73**		**959.89**		**575.93**		**921.49**		**383.96**		**230.37**		**691.12**		**287.97**		**172.78**
4.0	**Allied Works:**																											
4.1	Boundary stones	25.38	40%	10.15	60%	15.23	0%	0.00	0%	0.00	60%	9.14	20%	3.05	20%	3.05	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.2	Drains in low lying areas	1706.19	15%	255.93	60%	1023.71	15%	255.93	10%	170.62	60%	614.23	25%	255.93	15%	153.56	60%	153.56	25%	63.98	15%	38.39	60%	102.37	25%	42.65	15%	25.59
4.3	Service roads	2560.03	0%	0.00	20%	512.01	30%	768.01	50%	1280.02	20%	102.40	30%	153.60	50%	256.00	20%	153.60	30%	230.40	50%	384.00	20%	256.00	30%	384.00	50%	640.01
4.4	Fencing	2180.19	0%	0.00	20%	436.04	30%	654.06	50%	1090.10	20%	87.21	30%	130.81	50%	218.02	20%	130.81	30%	196.22	50%	327.03	20%	218.02	30%	327.03	50%	545.05
4.5	Detention ponds	164.28	0%	0.00	20%	32.86	50%	82.14	30%	49.28	40%	13.14	30%	9.86	30%	9.86	40%	32.86	30%	24.64	30%	24.64	40%	19.71	30%	14.79	30%	14.79
4.6	Retarding basins	131.52	5%	6.58	40%	52.61	30%	39.46	25%	32.88	50%	26.30	30%	15.78	20%	10.52	50%	19.73	30%	11.84	20%	7.89	50%	16.44	30%	9.86	20%	6.58
4.7	Development of water bodies	937.94	10%	93.79	30%	281.38	40%	375.18	20%	187.59	30%	84.41	50%	140.69	20%	56.28	30%	112.55	50%	187.59	20%	75.04	30%	56.28	50%	93.79	20%	37.52
4.8	Silt traps	134.25	5%	6.71	50%	67.13	30%	40.28	15%	20.14	60%	40.28	20%	13.43	20%	13.43	50%	20.14	30%	12.08	20%	8.06	50%	10.07	30%	6.04	20%	4.03
4.9	Desilting ramps	92.50	0%	0.00	20%	18.50	30%	27.75	50%	46.25	20%	3.70	30%	5.55	50%	9.25	20%	5.55	30%	8.33	50%	13.88	20%	9.25	30%	13.88	50%	23.13
4.10	Inlet / out weirs	546.14	5%	27.31	50%	273.07	30%	163.84	15%	81.92	60%	163.84	20%	54.61	20%	54.61	50%	81.92	30%	49.15	20%	32.77	50%	40.96	30%	24.58	20%	16.38
4.11	Rain gauge stations	30.00	40%	12.00	60%	18.00	0%	0.00	0%	0.00	60%	10.80	20%	3.60	20%	3.60	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
4.12	Shifting of sewers	1614.88	5%	80.74	50%	807.44	30%	484.46	15%	242.23	60%	484.46	20%	161.49	20%	161.49	50%	242.23	30%	145.34	20%	96.89	50%	121.12	30%	72.67	20%	48.45
4.13	Desilting equipments	300.00	25%	75.00	50%	150.00	25%	75.00	0%	0.00	60%	90.00	20%	30.00	20%	30.00	50%	37.50	30%	22.50	20%	15.00	50%	0.00	30%	0.00	20%	0.00
4.14	Vehicles for vigilance squad	60.00	10%	6.00	50%	30.00	25%	15.00	15%	9.00	60%	18.00	20%	6.00	20%	6.00	50%	7.50	30%	4.50	20%	3.00	50%	4.50	30%	2.70	20%	1.80
	Sub Total	**10483.31**		**574.21**		**3717.97**		**2981.10**		**3210.02**		**1747.92**		**984.39**		**985.66**		**997.95**		**956.57**		**1026.58**		**854.72**		**991.99**		**1363.31**
5.0	**Sewage Treatment Plants:**																											
	Decentralized STP's	500.00	10%	50.00	30%	150.00	40%	200.00	20%	100.00	25%	37.50	60%	90.00	15%	22.50	25%	50.00	60%	120.00	15%	30.00	25%	25.00	60%	60.00	15%	15.00
	Sub Total	**500.00**		**50.00**		**150.00**		**200.00**		**100.00**		**37.50**		**90.00**		**22.50**		**50.00**		**120.00**		**30.00**		**25.00**		**60.00**		**15.00**
	Total Structural =	**69076.72**		**4301.87**		**27221.81**		**20688.21**		**16864.83**		**13773.18**		**7959.90**		**5488.73**		**9540.52**		**6666.48**		**4481.21**		**7565.02**		**5268.13**		**4031.68**
6.0	**Non Structural Works:**																											
6.1	DPR and PMC	701.82	100%	701.82	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00
6.2	Rehabilitation and resettlement	1403.65	40%	561.46	60%	842.19	0%	0.00	0%	0.00	60%	505.31	20%	168.44	20%	168.44	50%	0.00	30%	0.00	20%	0.00	50%	0.00	30%	0.00	20%	0.00
6.3	Shifting of other services	1105.78	5%	55.29	50%	552.89	30%	331.73	15%	165.87	60%	331.73	20%	110.58	20%	110.58	50%	165.87	30%	99.52	20%	66.35	50%	82.93	30%	49.76	20%	33.17
6.4	Development of green belt	175.46	0%	0.00	20%	35.09	30%	52.64	50%	87.73	20%	7.02	30%	10.53	50%	17.55	20%	10.53	30%	15.79	50%	26.32	20%	17.55	30%	26.32	50%	43.86
6.5	WCE + Admin.	3509.12	10%	350.91	30%	1052.74	30%	1052.74	30%	1052.74	25%	263.18	35%	368.46	40%	421.09	25%	263.18	35%	368.46	40%	421.09	25%	263.18	35%	368.46	40%	421.09
	Total Non Structural =	**6895.83**		**1669.49**		**2482.91**		**1437.11**		**1306.33**		**1107.25**		**658.00**		**717.66**		**439.58**		**483.77**		**513.76**		**363.66**		**444.54**		**498.13**
	Total of SWD =	**75972.55**		**5971.35**		**29704.72**		**22125.32**		**18171.16**		**14880.43**		**8617.90**		**6206.39**		**9980.09**		**7150.25**		**4994.97**		**7928.69**		**5712.66**		**4529.81**

FIGURE - 7.9

PROJECT PHASING AND INVESTMENT PLAN FOR CORE AREA







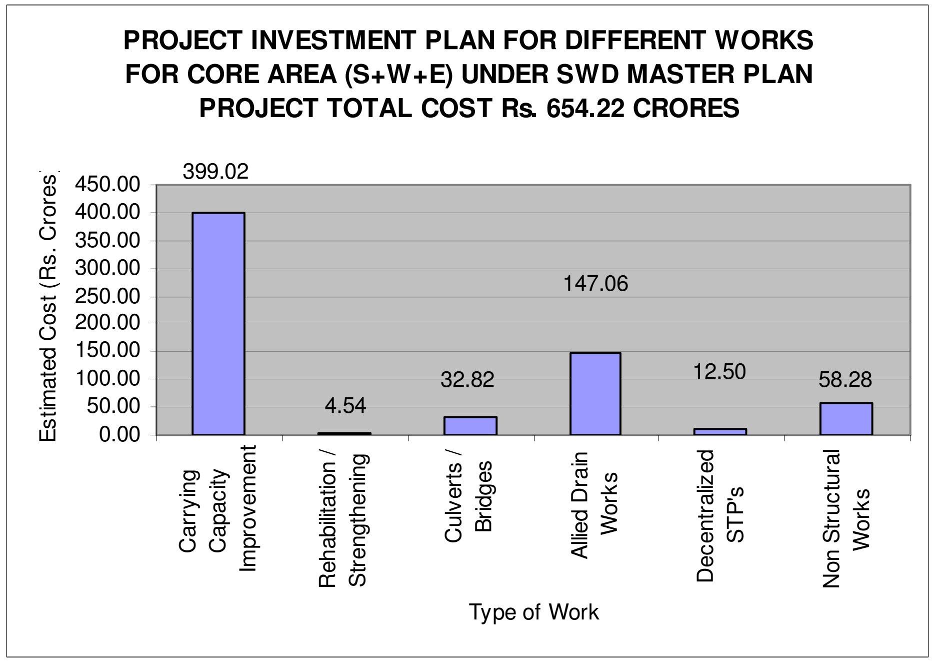
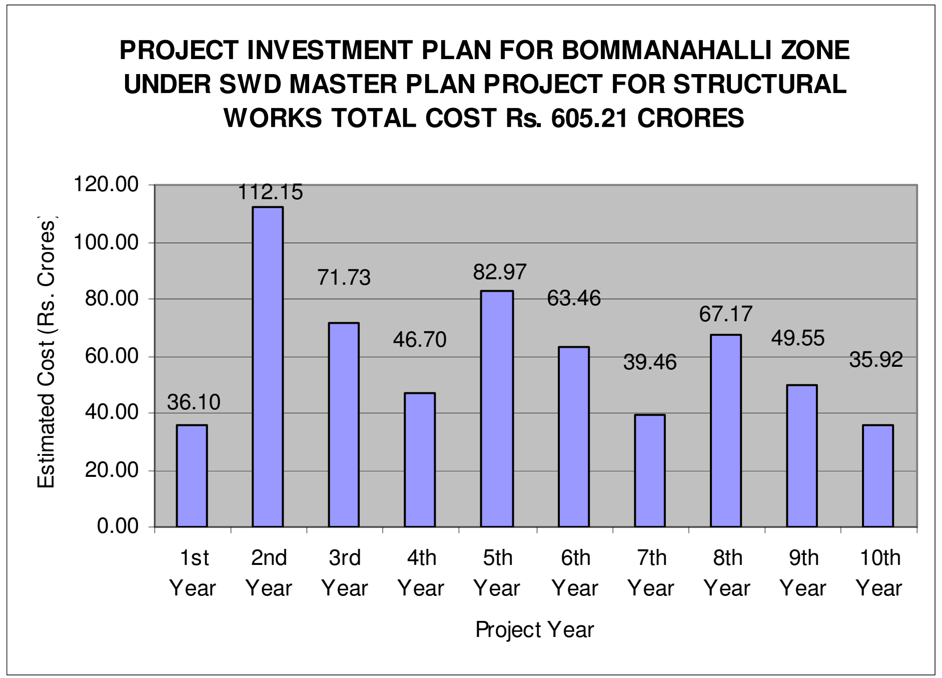
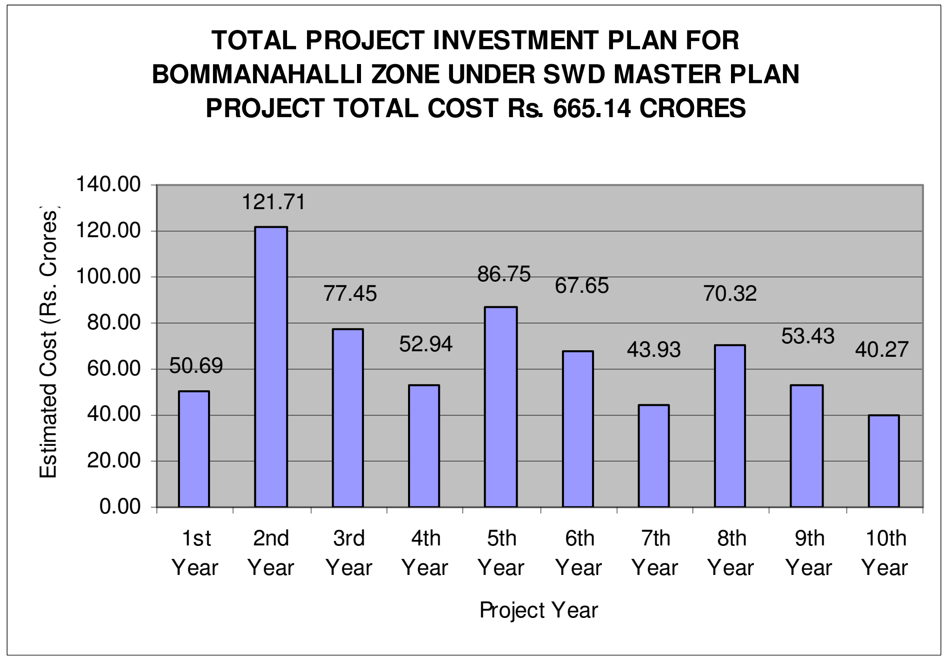
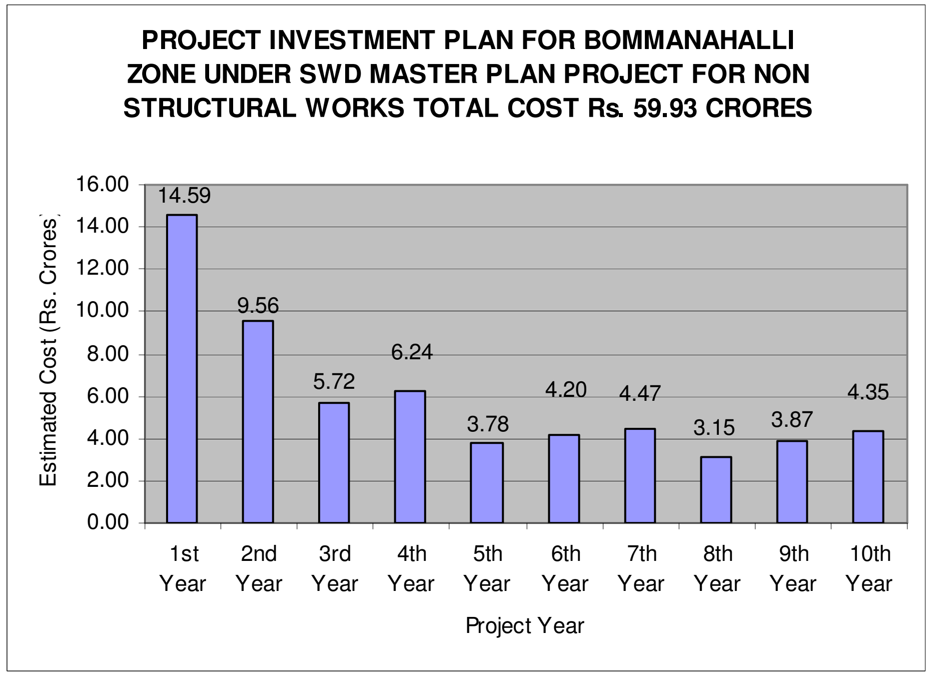


FIGURE - 7.10

PROJECT PHASING AND INVESTMENT PLAN FOR BOMMANAHALLI







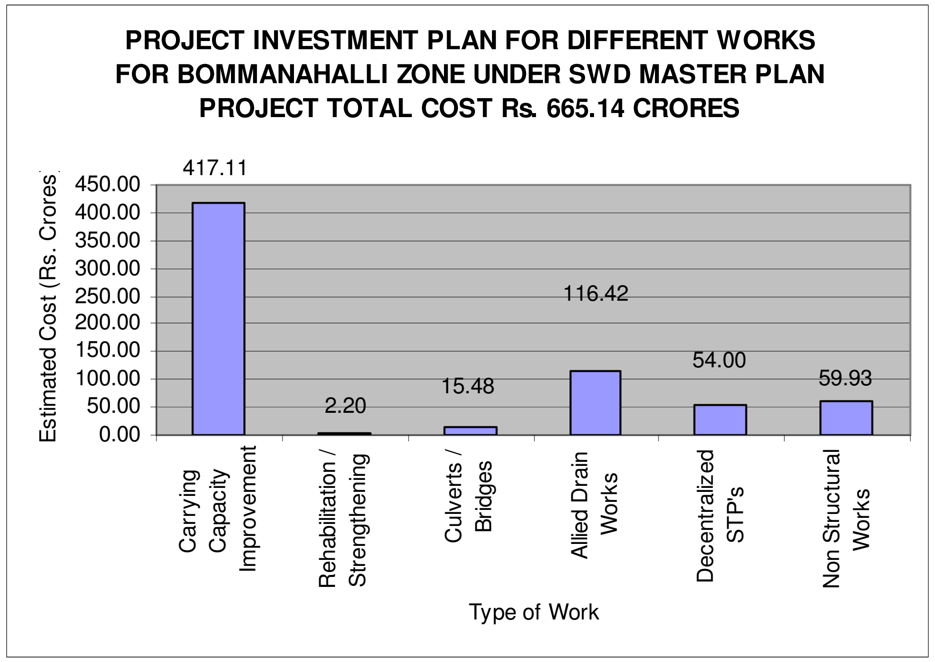
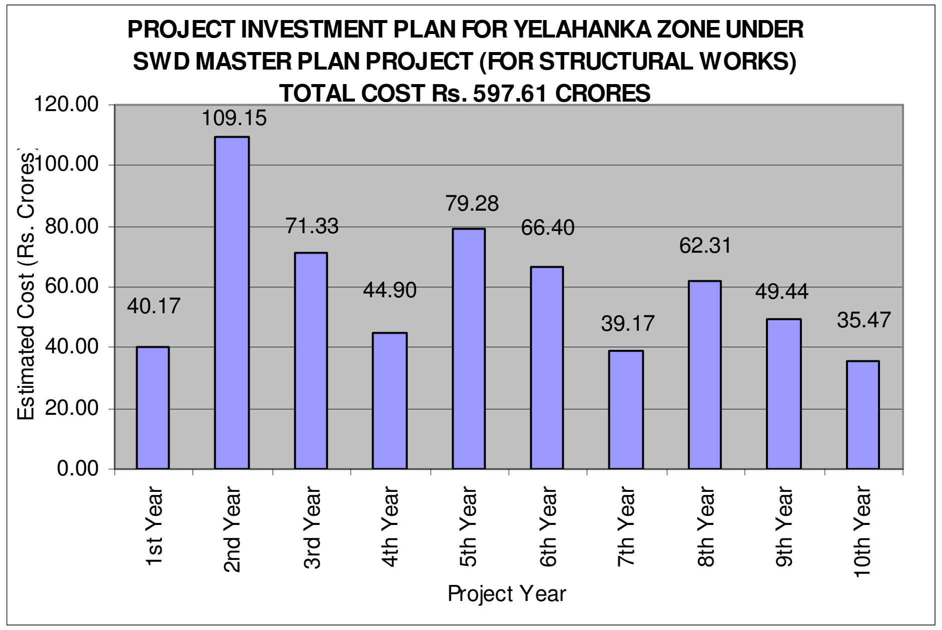
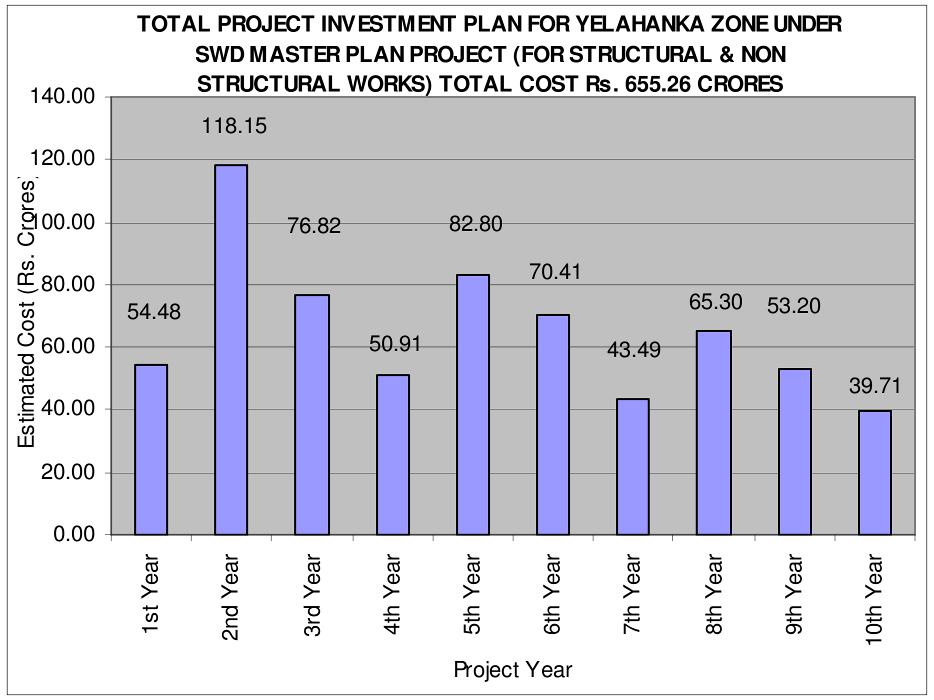
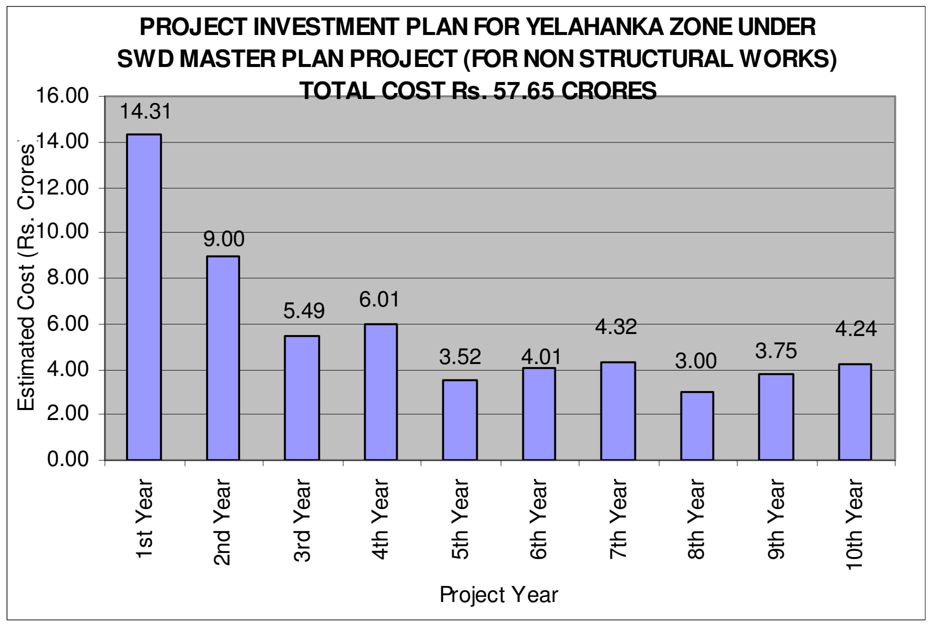


FIGURE - 7.11

PROJECT PHASING AND INVESTMENT PLAN FOR YELAHANKA







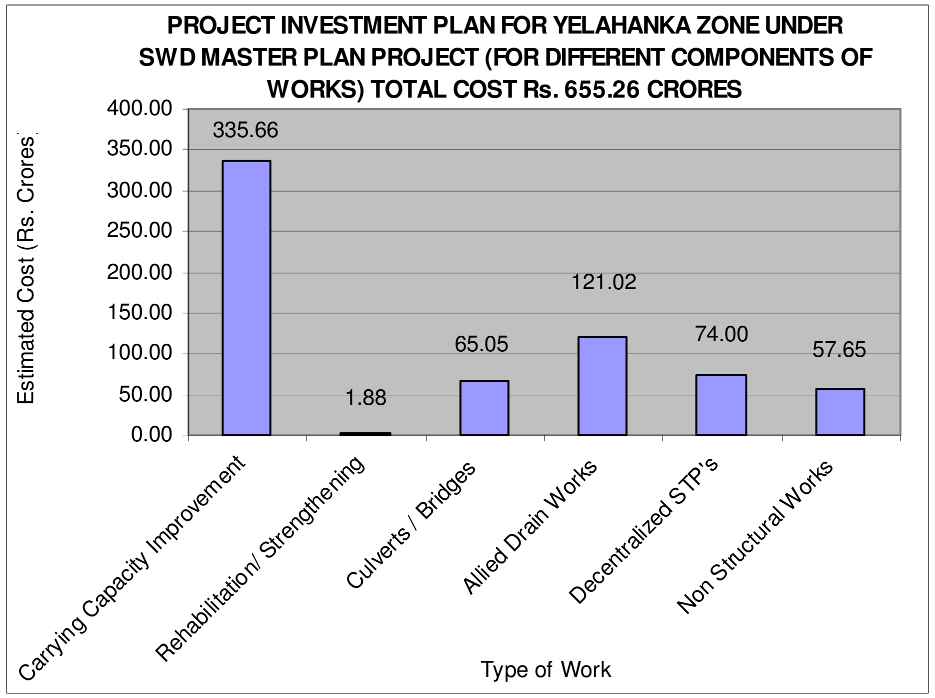
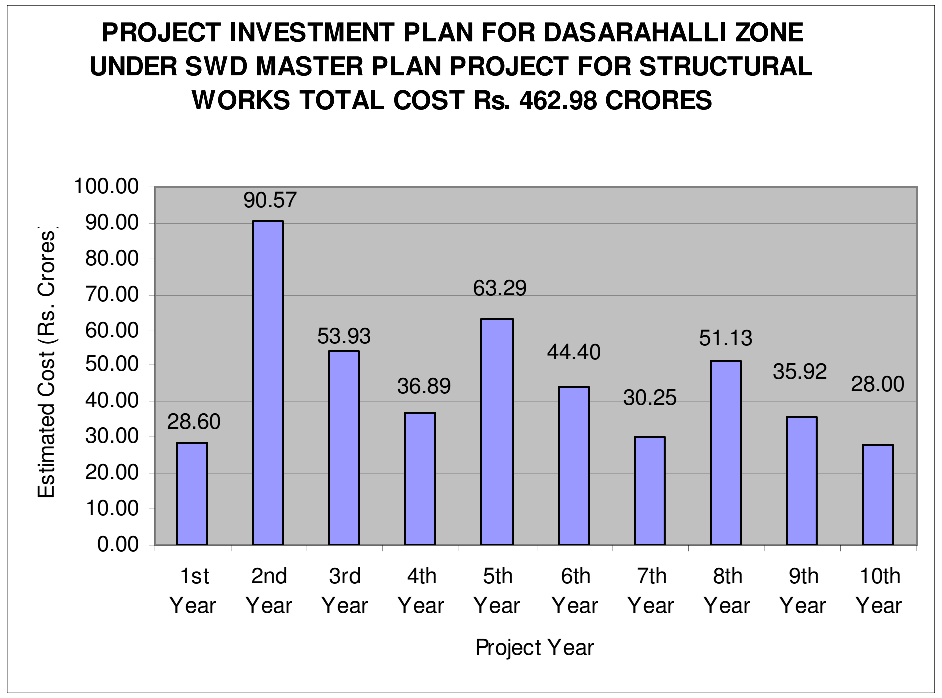
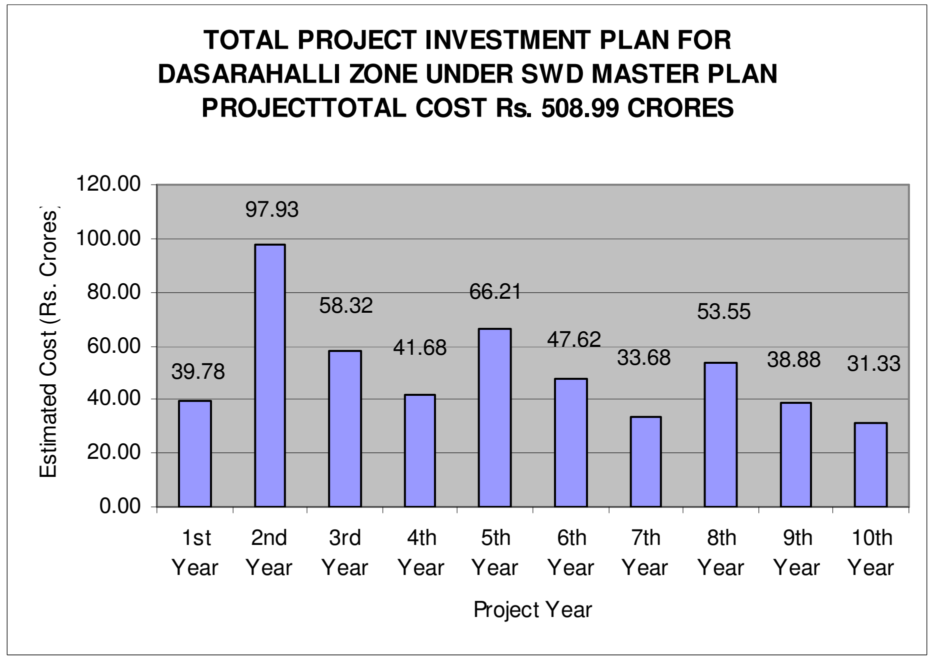
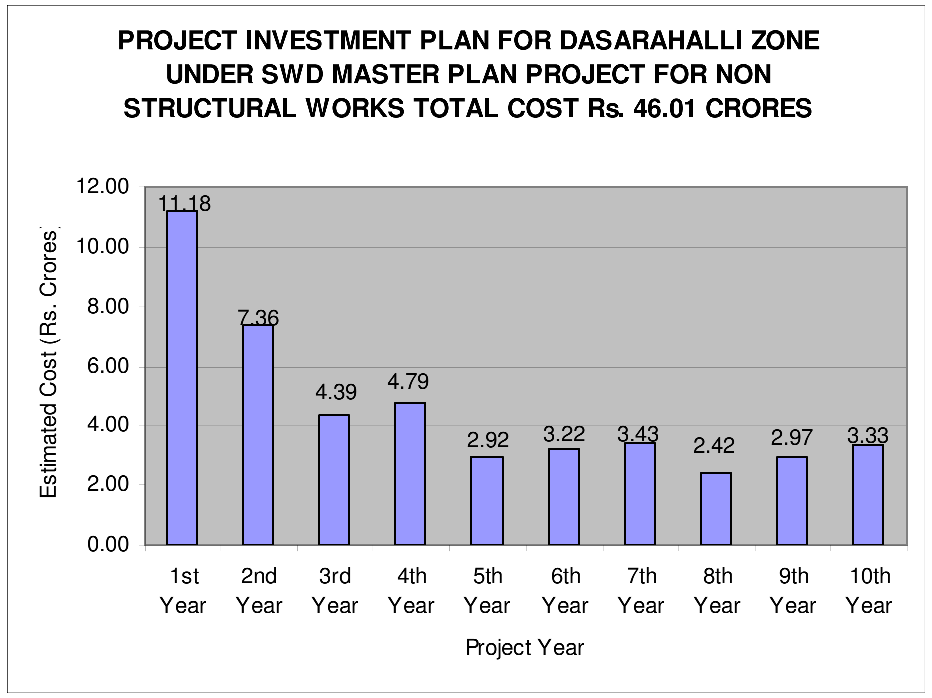


FIGURE - 7.12

PROJECT PHASING AND INVESTMENT PLAN FOR DASARAHALLI







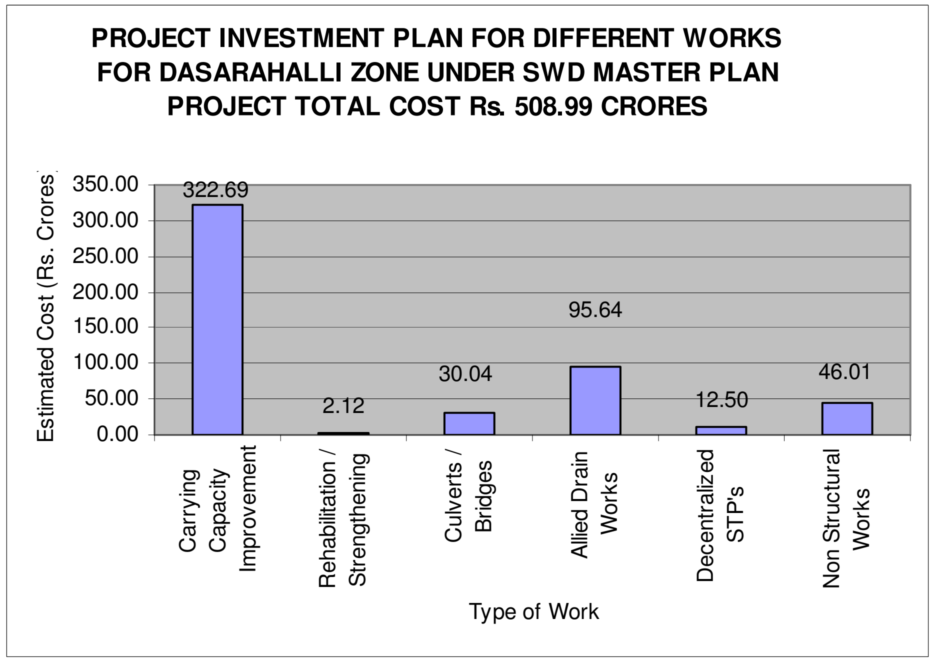
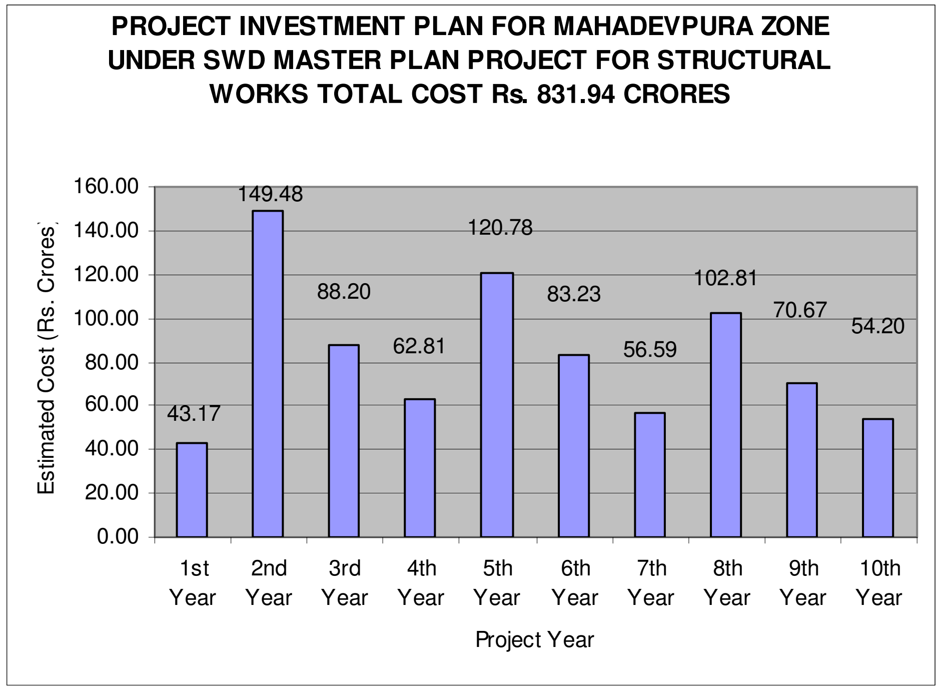
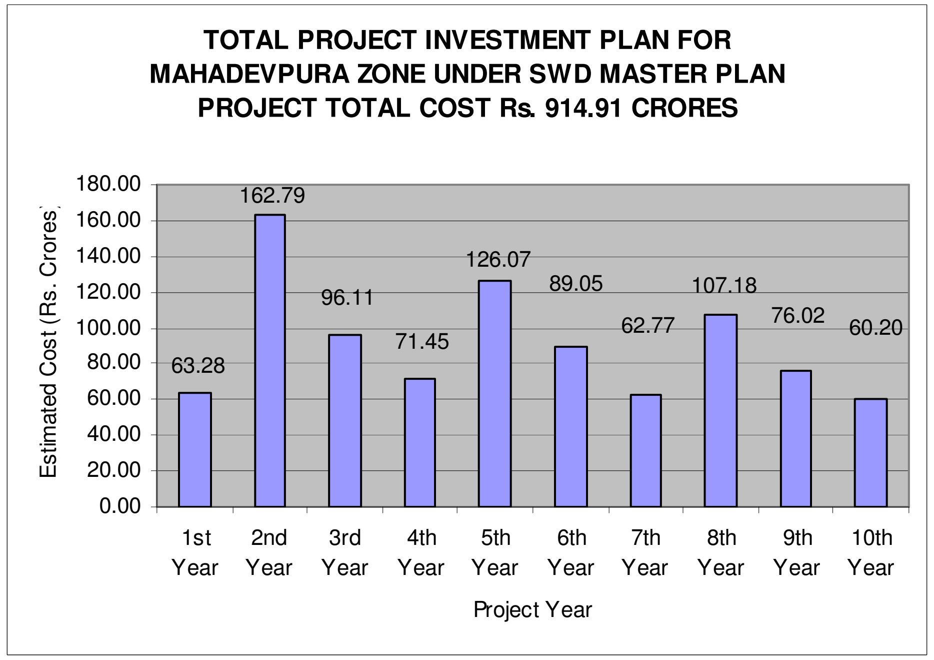
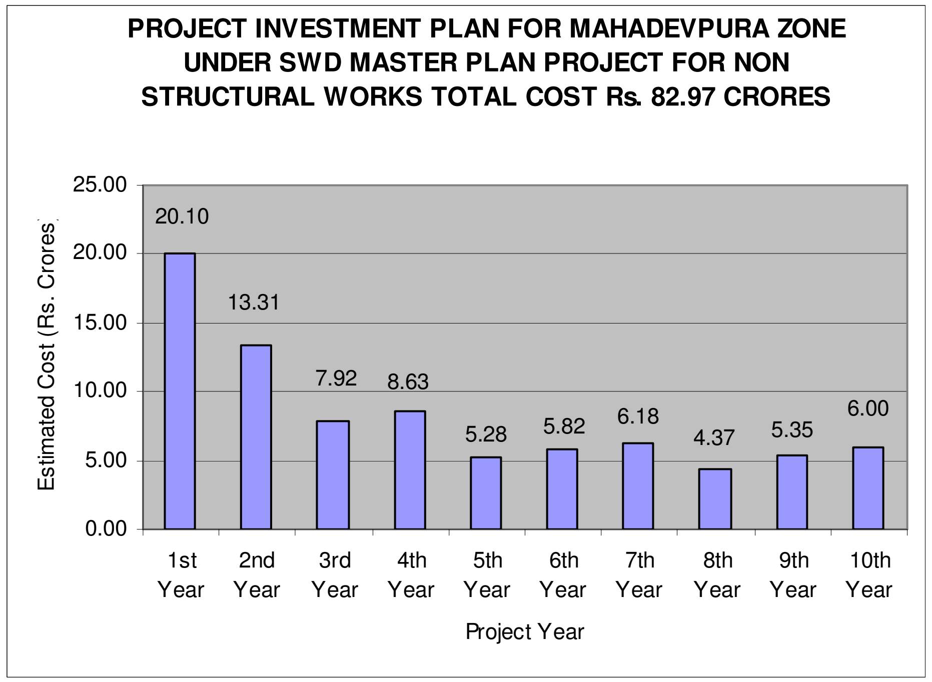


FIGURE - 7.13

PROJECT PHASING AND INVESTMENT PLAN FOR MAHADEVPURA







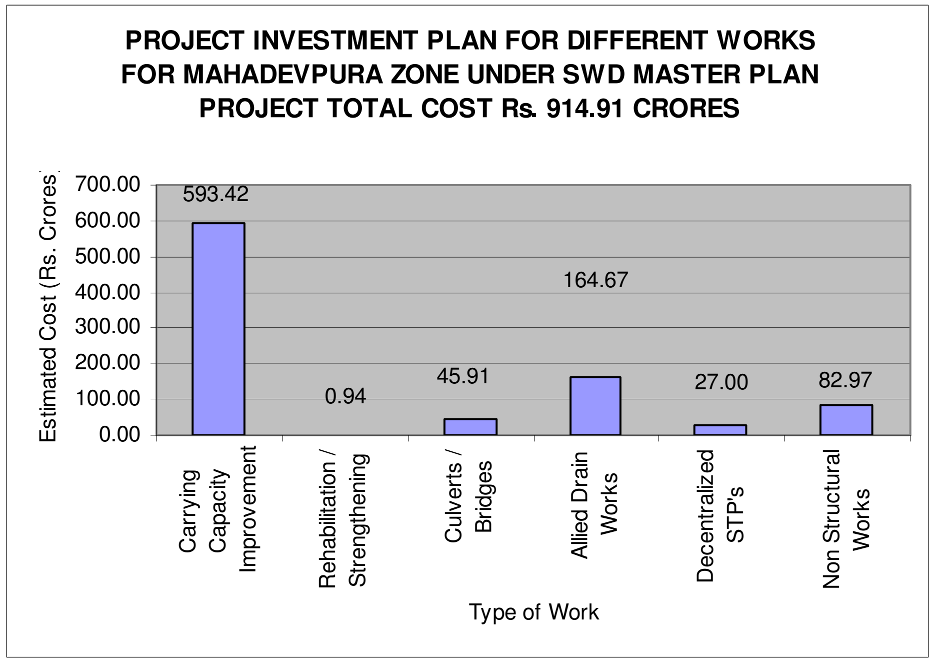
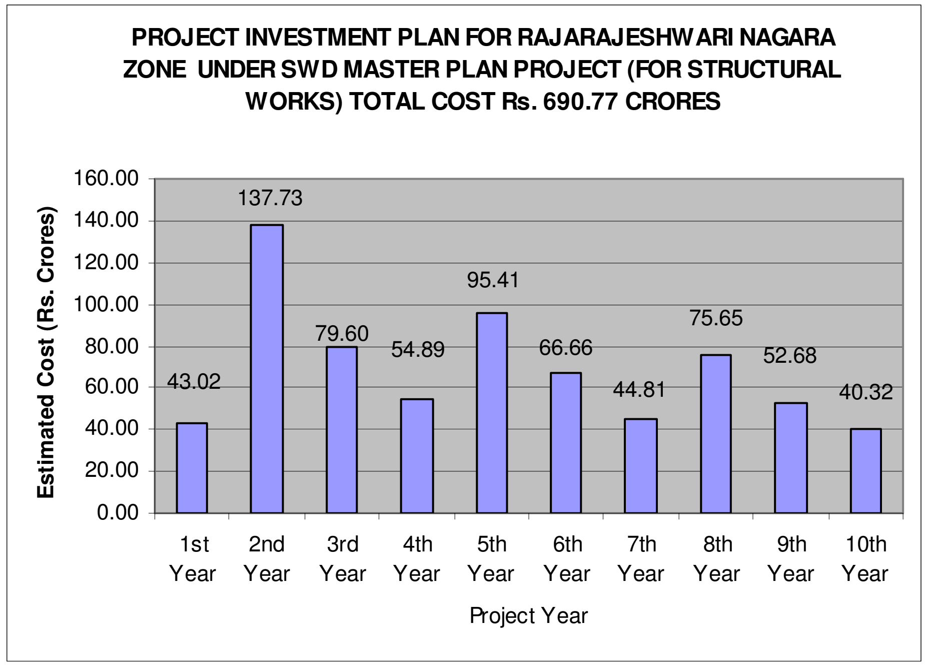
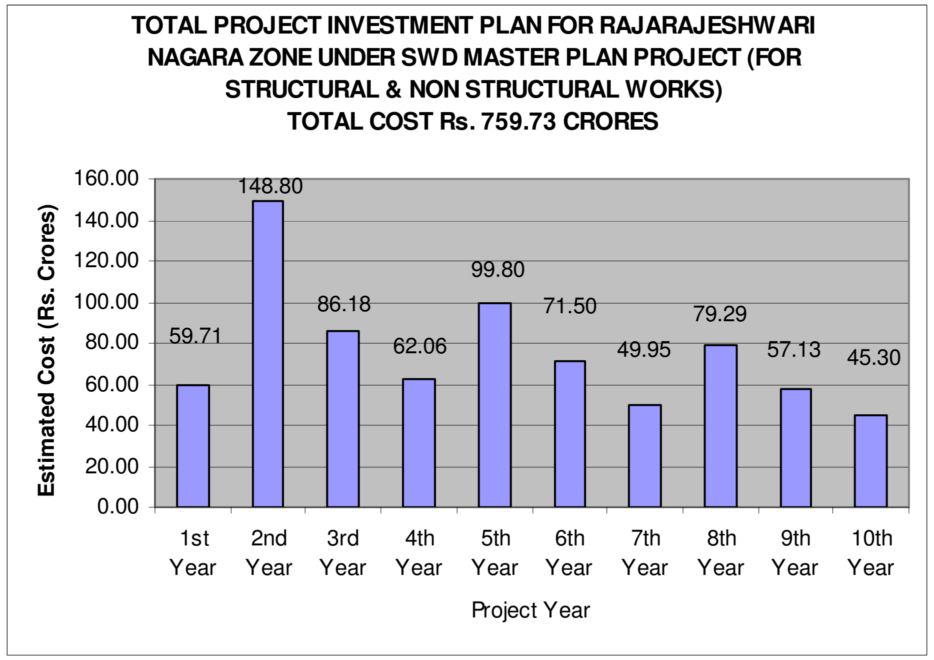
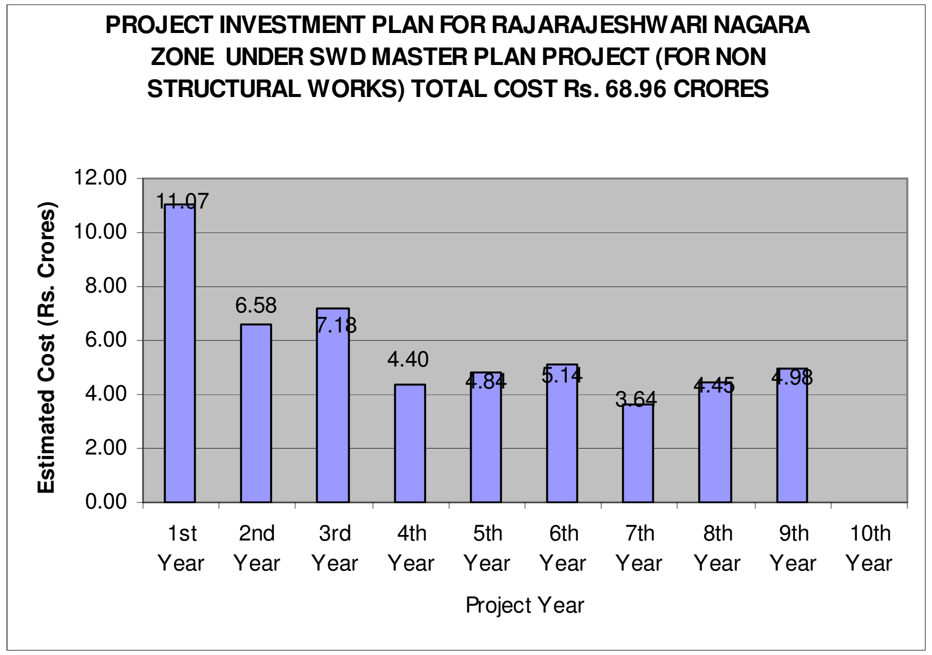


FIGURE - 7.14

PROJECT PHASING AND INVESTMENT PLAN FOR RAJARAJESHWARINAGARA







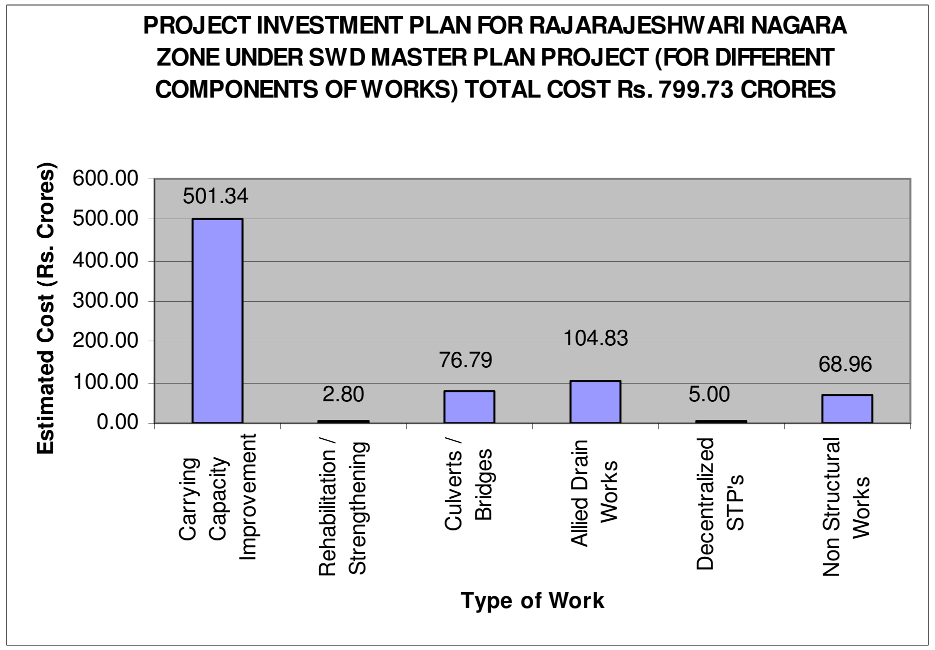
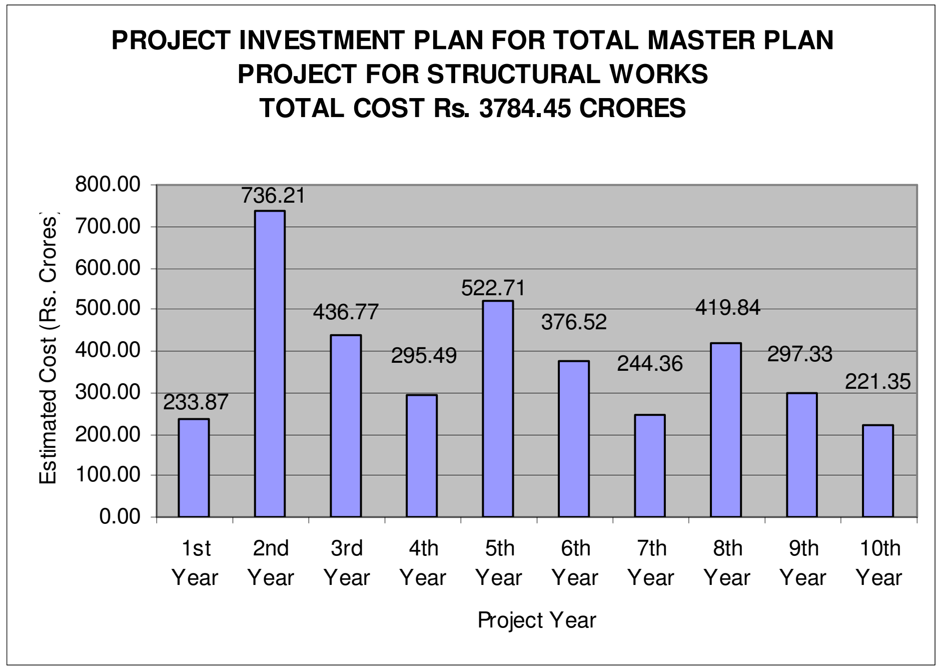
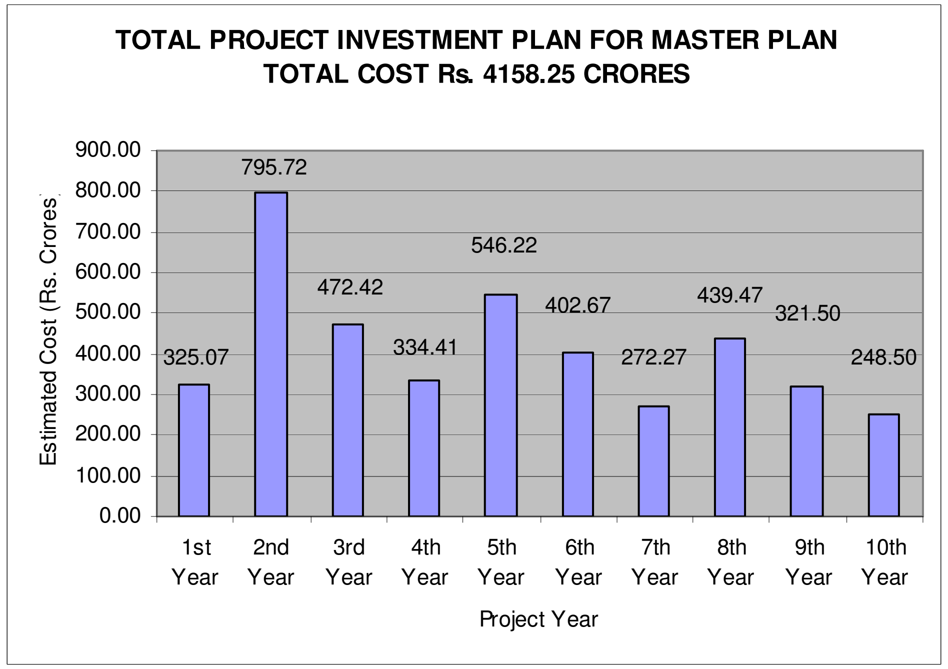
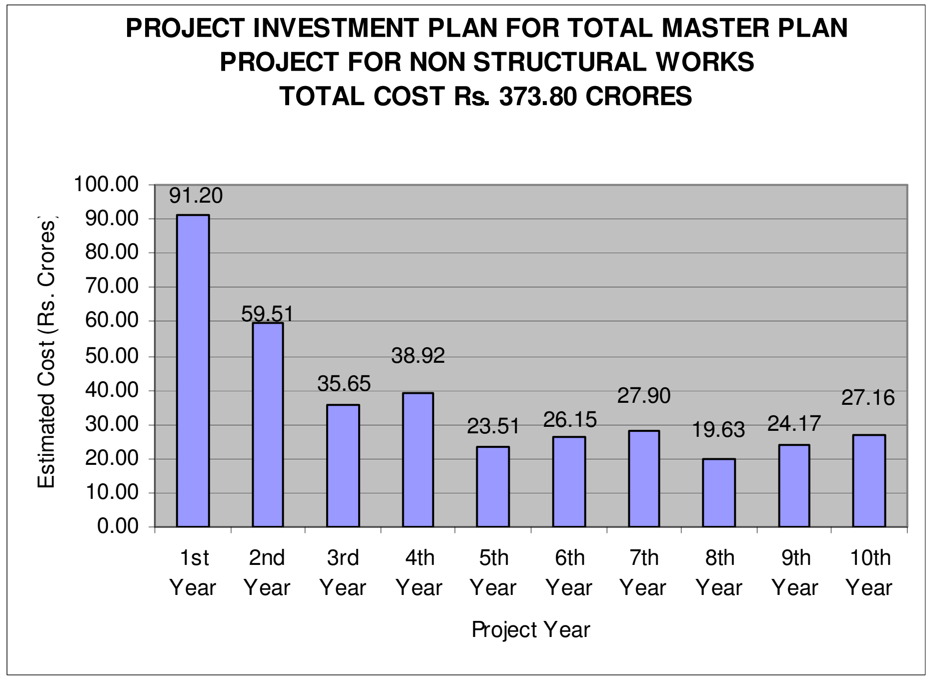


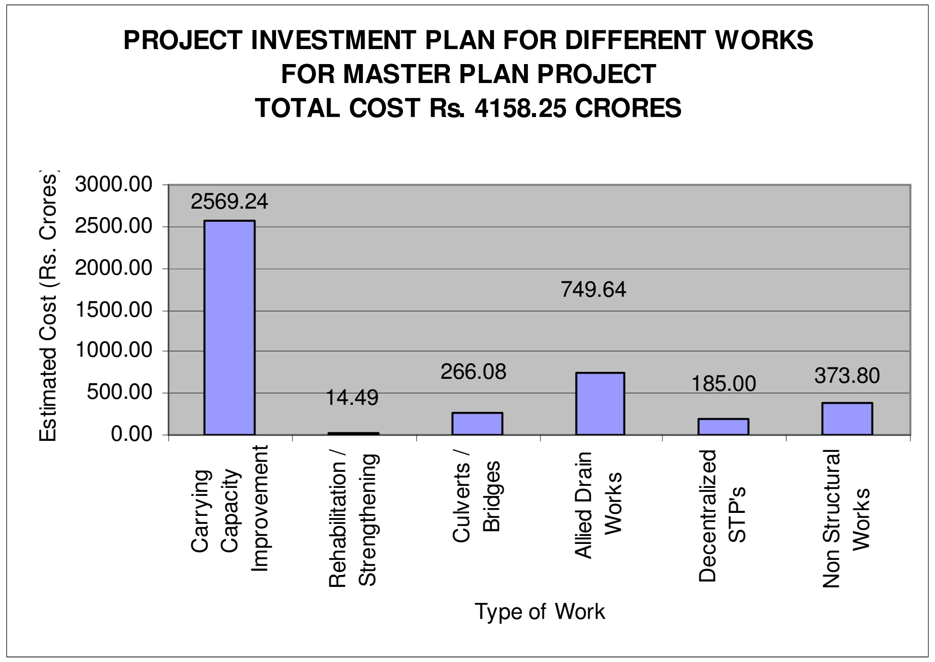
FIGURE - 7.14

PROJECT PHASING AND INVESTMENT PLAN FOR MASTER PLAN PROJECT









7.8 BENEFIT FROM IMPLEMENTATION:

The implementation of the project is expected to result in number of benefits;

1. Provision of a properly designed drainage system for a reasonably acceptable return period would ensure reduction in flood incidences.

2. Provision and properly maintained drainage system with controls on sewage connections and solid waste dumping will enhance the Environmental quality in the form of reduced pollution of water bodies, ground water and aesthetic appearance of cities environs.

3. Provision and proper maintenance of facilities like detention ponds and retention basins will not only attenuate the peak run-offs but also provide recharge of ground water which will improve ground water table.

4. Provision and proper maintenance of localized sewage treatment plants and using the treated sewage will reduce the stress on fresh water sources.

5. Availability of treated sewage will enable more greenery and fresh water lake gets developed assists reduction in climate change.

6. Apart from the environmental benefits there would be economic opportunities in the implementation and maintenance with the private sector operating the systems.

CHAPTER – 8
ENVIRONMENTAL MANAGEMENT AND RISK ASSESSMENT

8.0 INTRODUCTION:

Flood events in recent years resulting in life losses, huge damages, demand urgent reactions. The emergency is also stressed by the fact that we face the threat of climate change. In order to overcome such threats preparedness plans shall be in place.

The Environment Management and Risk Management Plans are part of best practices documents and are living documents which needs continuous input and improvement based on applications and experiences. These documents aims to describes measures and best practices to prevent, protect mitigate the adverse impact flood impacts on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment. These documents are strategic rather than technical.

The plan prepared should be based on an integrated approach covering all relevant aspects of water management, physical planning, land use agriculture, transport, and urban development, nature conservations at all levels in the development of management plans, decision makers at all levels (local, regional, and national) as well as stakeholders and civil society should be involved.

8.1 ENVIRONMENTAL MANAGEMENT PLAN:

The proposed activities narrated in this section are strategic in nature, and as such, the detailed investigations required have not been performed. Consequently, the environmental assessment of the proposed activities addresses generic environmental impacts and mitigation measures only.

- Prepare a comprehensive management plan, which is acceptable and affordable by stakeholders and the community.
- Prepare a risk assessment plan and risk management plan.
- Prepare a construction and maintenance schedule to ensure effective functionality of the system.
- Implement an effective, improvised solid waste collection and conveyance system.
- Disused earth and silt removed from storm water drains and receiving water bodies (initial layers) shall be disposed off at designated dumping sites in a scientific manner to avoid causing any type of nuisance to the surrounding area and community.
- Ground water quality analysis to be carried out periodically and the analyzed results should be compared with past records and accordingly action to be framed.
- Large-scale green belt development activity shall be taken up and encouraged all along the channel and also in open lands to minimize the sediment transport and to improve the aesthetic value of the city environs.
- Prepare a strategic plan for development of land in low-lying areas.
- Municipal authorities should be more vigilant on the SWM contractors responsible for disposal of solid wastes generated from the market yards, small scale industries, slums and densely populated areas.
- There should be stringent penalty on commercial establishments, industries, hospitals lying in the catchments area that are disposing off their liquid/solid waste in the valley in an inappropriate manner.
- There should be a ban on the construction of public toilets on the banks of the waterway or otherwise the toilets should be sewered without any scope for leakage of sewage.
- Service station / garages should not be allowed to dispose the greasy effluent into the drains.

- There should be a strict vigil on slaughter houses, industries, which are discharging their liquid waste directly into drains and they should be instructed to dispose of their waste in a secured manner.
- Horticulture gardens and nurseries situated along the banks of the valleys should be cordoned off from the valley and should dispose the vegetative waste separately outside as a landfill and not to discard in the drain.
- There should be no sewer outlet connection into the drain from slum areas and other residential areas.
- Silt traps and silt barriers must be constructed along the drains at strategic locations to reduce silt load at downstream of the catchment area / drain.
- Municipal authorities should encourage public and private sector enterprises for usage of recycled water and adopt rain water harvesting techniques in open lands.
- Fencing provided at strategic vulnerable locations to avoid dumping of garbage into SWD and install mechanically operated trash barriers and conveyance arrangement system to arrest and remove all floating materials from SWD.
- Create awareness among the public, public representative regarding importance of the system functionality.
- Detention ponds should be constructed along the strategic vantage locations in the catchment area for recharging of the ground water and to minimize transportation of fine silt. Few locations where such ponds could be created/constructed apart from existing parks maintained by BBMP / BDA.

8.2 RISK ASSESSMENT:

Internal risks come mainly from three sources: the project, the organizations involved, and the relationships among partners. Most projects suffer at least temporarily, from a deficient project structure: many are launched even though objectives are not clear, a business case had not been completed, and milestones were only vaguely defined, if defined at all. On the organizational side, lack of project control mechanisms is the factor that most impede many projects. Finally, risks associated with the relationships among partners has been the major source of concern present in all projects, lack of definition of role and responsibility as the most important problem for project implementation.

The risks associated with the storm water drain projects fall into three categories:

- Multiple stakeholder coordination risk during execution of work
- Project risk
- Acquisition of land and removal of encroachments while widening the drains

Continuing discharge of sewerage into the drains – BWSSB is expected to draw up plans for connecting the households that now discharge the sewerage direct to the drains. Coordination and integration of BWSSBs plans with that of BBMP alone will ensure the drains carrying the storm water of acceptable quality

Encroachment of waterways, Indiscriminate dumping of solid waste and debris into the drains is another aspect exposed to risk. BBMP has earmarked areas in each of the wards in the city where encroachment has taken place and construction debris could be dumped. The exercise has begun and once implemented would greatly reduce the extent of encroachment and amount of debris being dumped into the storm water drains. This combined with proper education and awareness programmes would help prevent encroachment and debris getting into the drains.

8.3 RISK MANAGEMENT:

Risk	Stakeholders	Severity of risk	Solution
Acquisition of land	BBMP, BWSSB, BDA, Government of Karnataka	Medium	A combination of enforcement and rehabilitation measures is required to notify the affected people and provide alternate arrangements for living
Removal of encroachments	BBMP, BDA, Government of Karnataka	Medium	Legislation followed by proper enforcement; affected people to be considered for housing under basic services to urban poor plan

Internal risks associated with storm water drain projects in the study area of Bengaluru with suggested measures to address the risks.

Risks associated with the project itself	***Characteristics of clients/users of the service:*** resistance to change, lack of involvement, inadequate education level, difficulties in communicating, unrealistic expectations. (to overcome BBMP is seeking citizen participation through ward committees and others) ***Scope of the project:*** universality or specificity of the service, number of partners involved, number of clients, size of budget. (contract documentation being revamped to define the role and responsibility very clearly) ***Complexity of the project:*** especially organizational and technological complexity. (consultant would evaluate various assumptions made in the design and detailed engineering) ***Definition and structure of the project:*** unclear objectives, ill-defined specifications and functional requirements, changes in the scope or the reach of the project, difficulties in integrating data or processes. (flexibility to accommodate changes from contractors)
Organizational risks	***Lack of resources:*** uncertainty of funding, inadequate resources, lack of expertise in complex resource management. ***Project team competencies:*** lack of experience, expertise, stability, and communication skills. (it is proposed to establish a PMU with requisite skills and experience) ***Management strategy:*** inadequate or inappropriate organizational support and control, absence of a champion, lack of leadership, unavailability of tested management tools and processes. (inter-institutional committee proposed to deal with policy level decisions) ***Technological know-how:*** absence of an adequate technological infrastructure and of in-house technological competencies. (Competencies being upgraded).
Relationship risks	***Form of collaboration:*** inadequate or inappropriate type of agreement, misunderstandings regarding the content of the agreement; inappropriate selection of partners. (all contractual frameworks to define the role, responsibility and liability of various parties clearly) ***Collaborative process:*** problems occurring with coordination, communications, inertia, dependency, mistrust, lack of consensus or involvement. (change management proposed)