Bruhath Bengaluru Mahanagara Palike

Narashima Raja Square

Bengaluru

Remodeling of Primary & Secondary Storm Water Drains in Bengaluru Under JNNURM Scheme

Vrishabhavathi Main Valley

Feasibility & Detailed Project Report

Volume – I

December 2006

STUP Consultants P. Limited

Remodelling of Primary and Secondary Storm Water Drains

In Bangalore City

VOLUME I

FEASIBILITY & DETAILED PROJECT REPORT

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EXECUTIVE SUMMARY

INTRODUCTION :

The total area of Bangalore city is approximately about 225 Sq.km. and the topography is divided by four major valleys namely Vrishabhavathy, Koramangala, Challaghatta and Hebbal valley with total length of primary and secondary drains is more than 260 Km. Challaghatta main valley originates from palace ground in Jayamahal and join Bellandur lake. Hebbal main valley starts from Matadahalli and joins Nagavara Lake. Koramangala main valley originates from Subhashnagara and joins Bellandur lake and Vrishabhavathy main valley originates from Sankey tank and joins Vrishabhavathi valley near Mysore road.

Due to rapid urbanization, the rate of growth of population in Bangalore has been explosive during the last two decades. Bangalore being a chosen 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 infrastructure. The large scale construction of office premises, Commercial establishments, residential accommodations to meet the demands of the rising population has resulted in :

i) Increased pavement area & rapid change in landuse pattern

ii) Developments of land inside the buffer storage areas and tanks

iii) Encroachments into the storm water drains

iv) Uncontrolled discharge of sewage & effluents inside the storm water drain

v) Constructions activities noticed inside the channel to facilitate for other utilities/service lines.

Bangalore Mahanagara Palike, agency responsible for the maintenance of the city's infrastructure with an endeavor to improve the storm drainage system has taken up the project of remodeling the entire storm water drains and to improve the efficiency of the storm water drainage system in the city, invited tenders and entrusted the work to M/s. STUP Consultants P. Limited.

The scope of work includes:

I) Preparation of:

a) Feasibility Report
b) Detailed Project Report
c) Construction Supervision for four valleys :

i.Vrishabhavathi Valley
ii.Koramangala Valley
iii.Challaghatta Valley
iv.Hebbal Valley

II) Detailed scope of services includes;

- Detailed topographical and geo-technical survey
- Assessment of quantity and quality of drainage discharge
- Analysis of the existing system
- Prevention of sewerage entering drains (to the possible extent)
- Hydraulic and structural designs and drawings
- Preparation of Cost estimation and Bill of Quantities
- Technical specifications
- Bid documents
- Slicing and Packing (Phasing for Implementation)
- Assistance for inviting tenders and evaluating Bids
- Construction Supervision and Quality assurance
- Training for BMP staff

While Remodeling proposals on the entire Storm water drain system is in progress, the report on Vrishabhavathi main valley (V100) remodeling is being submitted as a first part in 2 Volumes namely :

VOLUME I	Project Report
VOLUME II	Drain Alignment Plan, Longitudinal Section, Cross Section & General Arrangement Drawings for Vrishabhavathi Main Valley.

WORK METHODOLOGY:

To asses the existing condition of the drain a detailed topographical survey has been carried out using total station equipments in which the alignment of the drain, length of the drain, adjoining buildings, culverts / bridges, cross section of the drain, land marks etc. are identified.

Condition survey of the drain and bridges were also carried out in which the bed condition of the drain, drain walls, silt level in the drains, obstructions, sewage entry points to the drain, pipe crossings, manholes etc., were also identified and listed in the formats. The condition of bridges and culverts have also been assessed. Various low lying areas are identified during reconnaissance survey which are prone to flooding even for small intensity of rainfall and the bottle neck locations and reason causing flooding were identified.

It is an established fact that the high intensity, high volume rainfall follows laws of probability which can be established for a place like Bangalore where rainfall data for over 25 – 30 years is available. These mathematical laws generally called as “extreme value distributions” enable one to correlate the intensity of rainfall and the chances (probability) of that rainfall taking place within a given time frame (1 hour, 12

hours, 24 hours, etc.) when such precipitation takes place, the amount of water that will flow from various parts of the catchment area to the drains can be calculated based on knowledge of the type and characteristics of terrain (in terms of its absorption and runoff) type of drains, sectional areas of drains and their slopes, etc.

This method, (Called Rational Method) being logical and incorporating various actual physical characteristics is considered to be a realistic method for predicting the maximum expected floods. However, to evaluate and fix various physical parameters of catchment areas (i.e. properties) and to fit rainfall data is a difficult task. Even when carried out, it needs to be "confirmed" by observation of actual water discharge against the calculated discharge., A set of catchment parameters need to be consistently chosen and adjusted in prediction model whose predictions shall match with the actual observations of flood. This stage is termed as the "Calibration of the System".

The rational method is universally accepted method for design of a "Greenfield" project (i.e new towns, new development areas, etc.). However, this method is not adequate on its own for studying the existing systems which have been developed over a period of time without having any systematic design philosophy behind its design.

Therefore, as a first step in improving the existing system it is necessary to take following steps :

a) Repair and rehabilitation of damaged portion of existing drains.
b) Cleaning and clearing of waterway by removal of debris, artificial constrictions, blockages, etc.
c) Making the entire storm drain network system internally consistent over its full length.

Once the above is achieved, the probabilistic predictions of discharge, velocity and capacity can be compared with those of actually observed floods. This will enable one to establish correct mathematical model which is then used for optimizing the design for other portions of drainage channels (i.e. primary, secondary and tertiary drains) and make the whole system internally consistent and cost effective.

At present, the mathematic model for rainfall in Bangalore has been established based on rainfall data of part several years. Also, the parameters of catchment have been evaluated and the first order prediction model is prepared.

This model has been used to make first predictions of the expected flood. This is found to yield higher flood levels than those actually observed and will need second stage corrections. This can be effectively done after completing three stages of repair/rehabilitation mentioned above. Meanwhile, these first order results, have been used as a guideline in preparing proposals of widening / additional capacity of drains at local portions in such a way as to make the system internally consistent.

DESIGN PHILOSOPHY:

The data required for adequacy analysis of drain like rainfall data, topography and land use from the available satellite image are collected. The detailed technical and hydraulic analysis have been carried out to assess the hydraulic capacity of the storm drain and cross drains. Various statistical analysis were studied for rainfall and the method which is best suited to the site condition, i.e. CPHEEO method has been selected and analysed.

Further inorder to achieve the objectives of the project and to assess the cost of the project, the findings and the proposals found necessity and feasible are classified into Carrying capacity improvement works & Rehabilitation works.

RECOMMENDATIONS:

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

1. Provision of gratings for closed drains for allowing surface water to enter the drain and also with openings at regular intervals for routine maintenance of the system.

2.Closing of all side openings made to the drain walls for draining out surface water into the main drain, i.e., where the drain wall top is higher than the ground level/road level and construct side drains leading off storm water to the down stream end.

3.Provision of rehabilitation works like cavity filling, restoration of eroded stones plastering & pointing to inside surface of existing stone masonry drain walls.

4.Provision of C.C. drain bed to improve the flow.

5.Provision of bed and wall for drain wherever the drain is in natural condition to improve the hydraulics.

6.Removal and reconstruction of drain wall wherever the drain wall is in dilapidated conditions.

7.Construction of embankment, providing stone revetment, bed protection, and service road formation where sufficient land is available.

8.The improvement shall be taken up from the down stream of all the valleys. If remodeling is commenced from upstream side, situation at the downstream end would further get aggravated.

9.Increase the drain wall height to increase the carrying capacity of the drain wherever required. Provide parallel drain adjacent to the raised drain wall to dispose the surface water to down stream of drain.

10.All obstructions like inadequate vent way bridges/culverts, utility lines, manholes, etc. shall be removed and rebuilt wherever required.

11.Removal of silt, debris & vegetation growth noticed inside the storm drains.

12.Formation of service roads where ever possible/required for routine maintenance of storm drains.

13. Lowering of Rocky out crop near Shastrinagara near Sriramapura to improve the flow conditions in Malleshwaram & Sheshadripura surrounding area.

14. Regradation of primary drain bed near Sheshadripura.

15. Reconstruction of existing multiple span culverts near Prakashanagara with single span culverts/bridges.

16. Lowering of drain bed near Gubbana layout, Mariappanapalya, Cholarapalya, Telecom layout. Further, lowering of rocky out crop noticed near Jagajeevanramnagara railway line.

17. Widening of existing railway bridge near Jagajeevanramnagara.

18. Regrading of existing secondary & tertiary drain bed levels to new bed level of primary drain.

19. Remodeling of inadequate vent way/structurally unsound condition culverts near Sheshadripura, Mariappanapalya, Prakashnagara, Ramachandrapura, Guddahalli, Bhuvaneshwarinagara, Jaibharathnagara, Ranganatha colony, Good shed road, Timber yard layout, Ragavendranagara etc.

20. Removal of debris, silt & vegetation growth noticed inside the drain.

21. Desilting of covered reaches of drains.

22. Construction of RCC box drains near Guddahalli, Rajajinagara industrial area

23. Widening of drain, formation of embankment with imported earth and stone revetment to be provided near Kavika layout, Pantharpalya, Rajarajeshwarinagara, Venkateshnagara near Mysore road etc.

24. Lowering of rocky out crops near Bapujinagara & Timber yard layout. Further removal of buildings constructed in the water way near Bapujinagara to increase the capacity of primary storm drain.

25. Widening of drain, formation of embankment with imported earth and stone revetment to be provided near Timber yard layout, Ragavendranagara.

26. Formation of service road.

27. Removal of debris, silt & vegetation growth noticed inside the drain near Rajarajeshwarinagara main road.

28. Set-up a vigilance squad to prevent debris dumping, encroaching of drain, local obstruction, such as, pipe crossing, construction inside the drain, any construction other than required for storm water in drainage.

29. Encourage rain water harvesting in institutions, public parks, open grounds.

30. Lowering of manholes and relocating service lines.

ENVIRONMENTAL AND SOCIAL IMPACTS

Storm drains carrying sewage and solid wastes are causing environmental hazards such as :

1. Pollution of ground water source.
2. Odour problem
3. Mosquito menace
4. Unhygienic conditions are causing serious health hazards

The inadequate size of the drains, which is causing flooding problems to low lying areas such as Malleshwaram, Sudhindranagara, Seshadripura, Prakashnagara, Sriramapura, Ramachandrapura, Okalipura, Gopalapura, Gubbana layout, Cholarapalya, Sidharthanagara, Ranganatha colony, Binny mill tank area, Kempapura Agrahara, Manjunathanagara, Guddahalli, Shamannanagara, Telecom layout, Padarayanpura, Jagajeevanaramnagara, Saneguruvanahalli, Shivanahalli, Rajajinagar industrial area, Bapujinagara, Brindavananagara, Samerapura near Kempegowdanagara, Timber yard layout, Ragavendranagara, Kalidasa layout, Markandeshwaranagara, Venkateshpura etc, causing threatening the life and

properties of the people residing in these region. inconvenience to vehicular & pedestrian movement

Therefore, to minimize flooding, comprehensive proposals for both immediate and long term are prepared for entire Vrishabhavathi Main Valley (V100).

Cost Estimation:

For implementation of the various strategic actions, recommendations and proposals a detailed cost estimation has been prepared, and financial projection is as shown below;

Sl.No.	Description	Amount (Rs. In Lakhs)
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	8,397.05
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	554.96
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	447.60
4	Construction of Detention Ponds / Retarding Basins	60.00
5	Construction of Wells with pumping arrangement in low lying areas	100.00
6	Procurement of desilting machine	0.00
7	Miscellaneous and rounding off	0.002
8	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	143.00
	TOTAL	**9,703.01**
9	Annual Operation & Maintenance Cost (1.0 % of Item 1 to 7)	191.20

For effective functioning of any system, requires regular maintenance. The operation and maintenance requirement have been identified and costing is indicated.

CHAPTER – 1

INTRODUCTION AND BACKGROUND

1.1 GENERAL:

Bangalore, the capital of Karnataka, is one of the fastest growing cities in India with a current estimated population of 6.0 million people, spread over an area of about 225 Sq.km. and is situated at an altitude of about 894 m. above MSL.

Bangalore was once well known for its open parkland environment with significant number of large traditional tanks with a good network of waterways and thick vegetative cover. Rapid increase in population, industrialization and migration of people from rural Karnataka and rest of the country in a relatively short span of time has put more pressure on the utilities and services, which are already loaded beyond their capacities. Storm water drains are one of the most affected services in the city. The problem is aggravated by uncontrolled urbanisation, infringement by other utilities, encroachments and indiscriminate dumping of solid wastes and over flowing of sewers in drain. Other secondary problems includes sedimentation, vegetation growth and sewage outlets into the drains, etc. Due to the above, there is reduction in carrying capacity of the drains causing localized flooding to the settlements adjacent to the drains and tanks, in low lying areas. Many tank beds have been converted into residential layouts causing disappearance of water body which otherwise would have acted as detention ponds / holding tanks. The damage caused by the floods, are very serious in terms of life and property. 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.

1.2 PROJECT BACKGROUND:

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

During recent monsoon, Bangalore city experienced unusually high intensity rainfall, which resulted in substantial damage to both life and property.

Bangalore Mahanagara Palike (BMP), the agency responsible for maintenance of the city's infrastructure with an endeavour to obviate the problems faced by the city, therefore took up the project including preliminary investigations, detailed survey, system analysis and proposals for improvements and capacity augmentations of the existing drainage system in Bangalore.

Bangalore Mahanagara Palike invited proposals from competent consultants based on the approach document prepared by BMP and entrusted the work to M/s. STUP Consultants Private Limited, Bangalore 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 Bangalore City.

Further, the outputs 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 BMP.

Bangalore city topography is marked by the presence of Four Primary valleys, viz.,

1.Vrishabhavathi Valley

2.Koramangala Valley

3.Challaghatta Valley

4.Hebbal Valley

Based on the survey conducted, the length of the primary drains in the four major valleys are as shown in the table below:

Sl. No.	Name of the Valley	Primary Drain Length (m.)
1.	Vrishabhavathi Valley	32,150
2.	Koramangala Valley	19,625
3.	Challaghatta Valley	16,150
4.	Hebbal Valley	25,800
	Total length of drains	**93,725**

This volume of the report forms the detailed project report for Vrishabhavathi Main Valley (V100).

1.3 OBJECTIVES OF THE PROJECT:

The objectives, defined in broad terms are:

- To study the main reasons for failure of the existing storm water drains to dispose the storm water without flooding the low lying areas of the city.

- To study the carrying capacity of the existing primary and secondary storm drains.

- To suggest modifications to the primary and secondary storm drains in respect of improvement, in flow characteristics and capacity.

- To study the feasibility of segregating sewage from storm water to the extent practicable.

- To provide rehabilitation to culvert / bridges constructed across storm water drains.

- To reconstruct the culverts/bridges, that are causing hindrances to free flow of water in the drains.

1.4 REPORT OBJECTIVES:

This report provides, details of existing storm water drainage system in Vrishabhavathi Main Valley, wherein it also provides a strategic framework to ensure better management of drainage assets in Bangalore which also has significant implications in:

- Future management of storm drainage system in Vrishabhavathi Main Valley.

- Strategies to be followed for implementation of improvement measures.

- Resources generation to achieve the stated objectives and targets.

For the report purpose, the studies made are:

- Identifying the low lying area and reasons for flooding
- Assessment of existing condition of drainage system
- 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.

Further, for the preparation of this report, supplementary sources are considered at a macro level and also the results of those studies and investigations are integrated into this report.

This project report has the following structure:

VOLUME I	Project Report
VOLUME II	Drain Alignment Plan, Longitudinal Section, Cross Section & General Arrangement Drawings for Vrishabhavathi Main Valley.

1.5 SCOPE OF ASSIGNMENT:

A Brief scope of assignment to be rendered by the Consultants as defined in the TOR is given below:

- Detailed topographical and geo-technical survey
- Assessment of quantity of runoff
- Adequacy analysis of existing drains
- Hydraulic and structural designs and drawings
- Cost estimation and Bill of Quantities
- Technical specifications.
- Bid Documents
- Slicing and Packaging (Phasing for Implementation)
- Assistance in Inviting and evaluating Bids
- Project Supervision

1.6 PHASES OF THE PROGRAMME

The consultancy services which is to be carried out in three (3) phases are as given below:

Phase 1: Technical, Economical and Environmental Feasibility Study of the Project of Remodeling of the Storm Water Drain System.

Phase 2: Detailed engineering design, preparation of tender documents, cost estimates for the remodeling work, Preparation of Bid document and assist BMP to entrust the work to experienced, competent and successful agency.

Phase 3: Supervision of the construction works.

1.7 PREAMBLE TO INCEPTION REPORT:

Reference are made in this section to the earlier inception report. Wherein the inception report clearly narrates the identification of different valleys, conditions of existing storm drains, new drains (i.e., not considered in TOR), low lying areas in different drainage zones, etc. in this report. The details from previous data, recommendations made during past initiatives, current approach, methodology, design procedures and work plans adopted for preparation of feasibility report are indicated in this report.

CHAPTER - 2

ASSESSMENT OF EXISTING STORM WATER DRAINAGE SYSTEM

2.1 INTRODUCTION:

Bangalore city is at an altitude of 894 m. above MSL and has the general advantage of natural valleys offering good drainage for storm water. However, misuse of these valleys result in flooding. The two main factors responsible for flooding in Bangalore are:

- A general neglect of the basic functions of the major drains which has allowed numerous channel restrictions to occur and caused a general down grading of the channel capacities, without provision for floods larger than design and;

- The apparent acceptance of a design standard for main drains in the core area that is extremely low by accepted standards for a large city with rolling topography.

The study concerned with tertiary drains and their level of services offered is outside the current scope.

The area covered for the study is basically the area administered by Bangalore Mahanagara Palike. A locality plan showing the extent of study area has been included as Figure 2.1.

2.2 DESCRIPTION OF CATCHMENTS:

Bangalore is situated on the divide between the Cauvery Basin and the Ponnaiyar Basin, and also with nearly 40% of the projected future population living within the Cauvery Basin. There are four major valleys and five minor valleys. Three of the four major valleys namely, Vrishabhavathy (V-Valley), Koramangala (K-Valley) and Challaghatta (C-Valley), run generally from North to South direction dividing the greater part of the metropolitan area into three separate and distinct drainage zones.

A fourth major valley, referred to as the Hebbal series (H-valley), forms the drainage zone to the North of the ridge and runs in Northeast direction.

Five minor valleys, the Kathriguppe and the Tavarekere lie to the South, the

77°26'19"E 77°27'19"E 77°28'19"E 77°29'19"E 77°30'19"E 77°31'19"E 77°32'19"E 77°33'19"E 77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E 77°42'19"E 77°43'19"E 77°44'19"E 77°45'19"E 77°46'19"E 77°47'19"E 77°48'19"E 77°49'19"E 77°50'19"E 77°51'19"E 77°52'19"E 77°53'19"E 77°54'19"E

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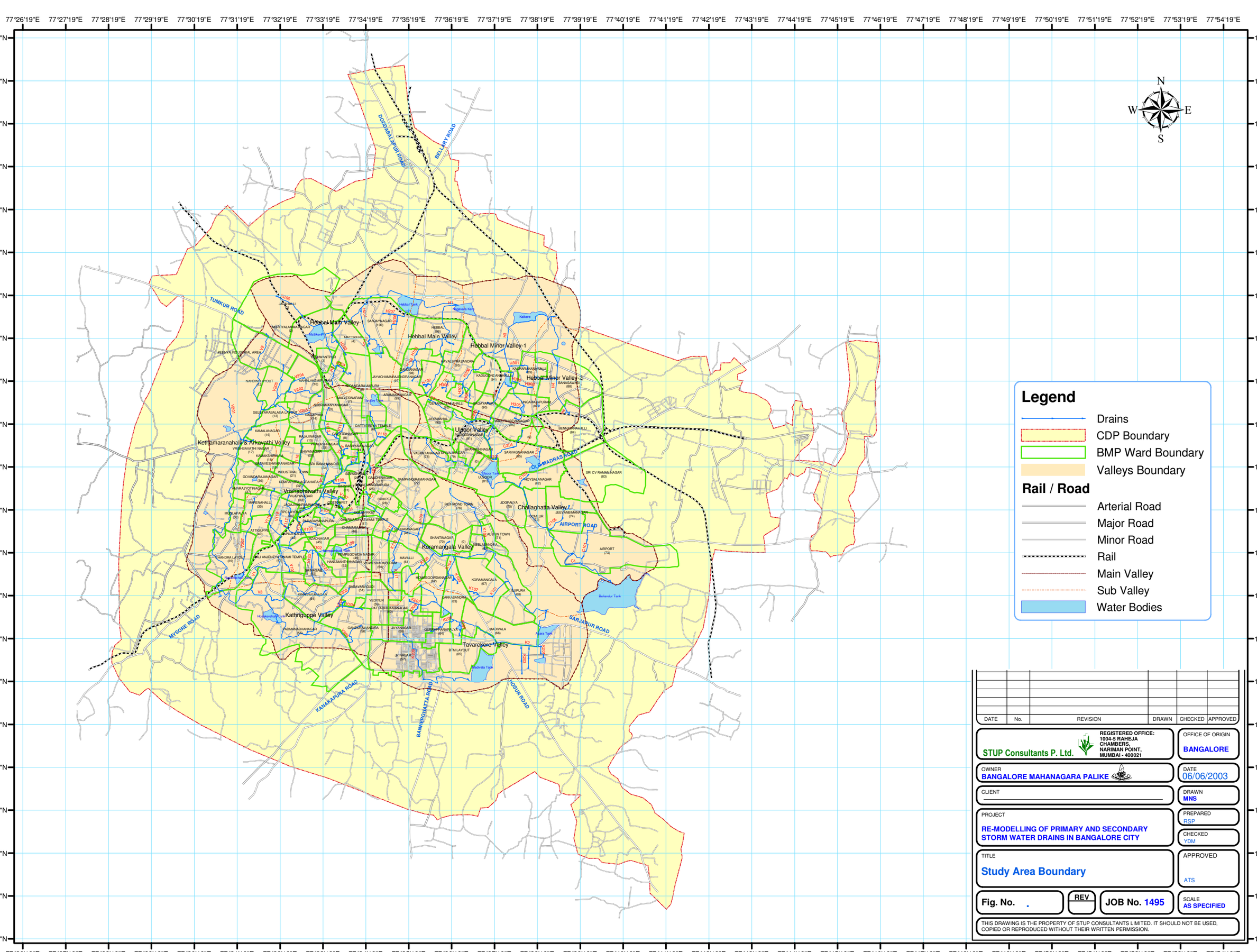


DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

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

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: 06/06/2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED: RSP

CHECKED: YDM

TITLE: Study Area Boundary

APPROVED: ATS

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

Kethamaranahalli and Arkavathi lie to the North-West, Hebbal minor valleys 1 & 2 lie to the North-East. All these valleys lie outside the tributary areas of the major valleys and drain independently. The catchment boundaries of major and minor valleys are shown in Figure 2.2.

Details of these catchments are given in Table 2.1.

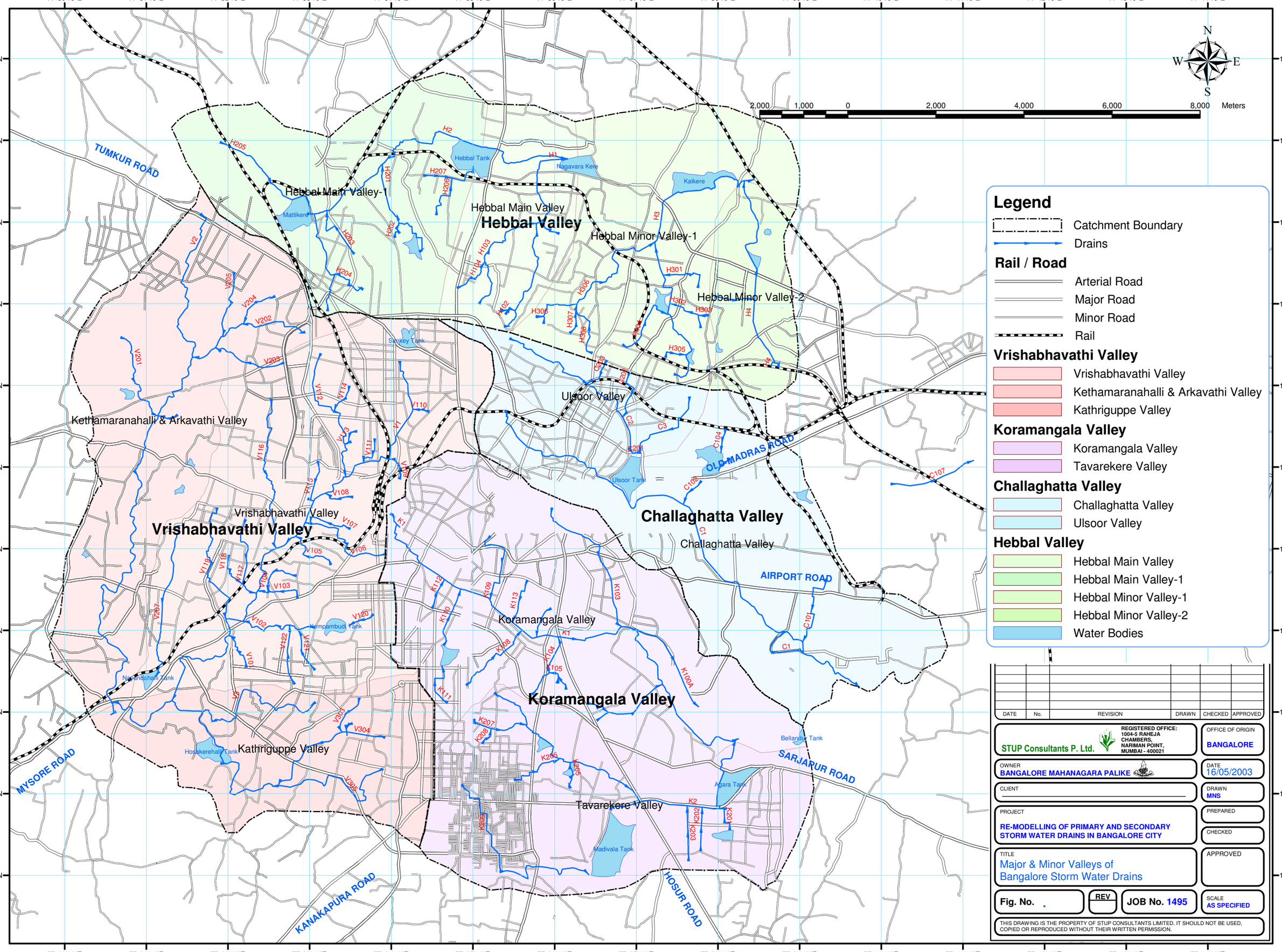
TABLE 2.1 SUMMARY OF STORM WATER DRAINAGE CATCHMENT

Valley Names	Major & Minor Valleys	Drop (m.)	Pri. Drain Origin Point	Pri. Drain Terminal Point	Catchment Area (Ha.)	Total Length of Primary Drain (m.)	Municipalities in catchment
Vrishabhavathi Valley	Vrishabhavathi Main Valley	120	Sankey tank	Kenchanahalli Near Mysore Road	3,625	14,000	BMP, Kengeri & Patanagere
	Kethamaranahalli & Arkavathi Valley		Near Peenya Indl. area	Kenchanahalli Near Mysore Road	3,351	13,300	
	Kathariguppe Valley		Near Srinivasnagara	Rajarajeshwari nagara	1,653	4,850	
Koramangala Valley	Koramangala Main Valley	20	Near Majestic Area	Bellandur lake	3,548	12,000	BMP, Bommana halli & Mahadeve pura
	Tavarekere Valley		Near NIMHANS Hospital	Bellandur lake	2,690	7,625	
Challaghatta Valley	Challaghatta Main Valley	30	Near Vasanthnagara	Bellandur lake	3,168	12,000	BMP, Krishnaraja pura
	Ulsoor Valley		Near Jayamahal Extn.	Ulsoor lake	710	4,150	
Hebbal Valley	Hebbal Main Valley	30	Near Matadahalli	Nagavara lake	836	4,425	BMP, Dasarahalli & Bayatarayanapura
	a) Hebbal Main Valley – I		Near Mysore lamps works	Hebbal lake	2,590	9,000	
	b) Hebbal Minor Valley – I		Near Jaibharathnagara	Kalkere lake	1,529	7,375	
	c) Hebbal Minor Valley – II		Near Chikka Banasawadi	Kalkere lake	754	5,000	

Note: Catchment areas indicated in the table is inclusive of CMC / TMC areas coming within respective catchment boundaries.

2.3 DESCRIPTION OF VRISHABHAVATHI MAIN VALLEY:

2.3.1 Vrishabhavathi Main Valley (V1):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13°2'7"N
13°1'7"N
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2,000 1,000 0 2,000 4,000 6,000 8,000 Meters
TUMKUR ROAD
Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
Ulsoor Valley
Ulsoor Tank
OLD MADRAS ROAD
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Vrishabhavathi Valley
Challaghatta Valley
Challaghatta Valley
AIRPORT ROAD
Kempambudi Tank
Koramangala Valley
Koramangala Valley
Nayandahalli Tank
Kathriguppe Valley
Hosakerehalli Tank
Bellandur Tank
SARJAPUR ROAD
Agara Tank
Tavarekere Valley
Madivala Tank
MYSORE ROAD
KANAKAPURA ROAD
HOSUR ROAD
Legend
Catchment Boundary
Drains
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Vrishabhavathi Valley
Vrishabhavathi Valley
Kethamaranahalli & Arkavathi Valley
Kathriguppe Valley
Koramangala Valley
Koramangala Valley
Tavarekere Valley
Challaghatta Valley
Challaghatta Valley
Ulsoor Valley
Hebbal Valley
Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Water Bodies
DATE
No.
REVISION
DRAWN
CHECKED
APPROVED
REGISTERED OFFICE:
1004-5 RAHEJA CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021
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OFFICE OF ORIGIN
BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
DATE
16/05/2003
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
CHECKED
TITLE
Major & Minor Valleys of
Bangalore Storm Water Drains
APPROVED
Fig. No. .
REV
JOB No. 1495
SCALE
AS SPECIFIED
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The catchment area of Vrishabhavathi valley is the largest of all the valleys comprises of one main valley and two minor valley catchments, viz. Kethmaranahalli & Arkavathi valley and Kathriguppe valley.

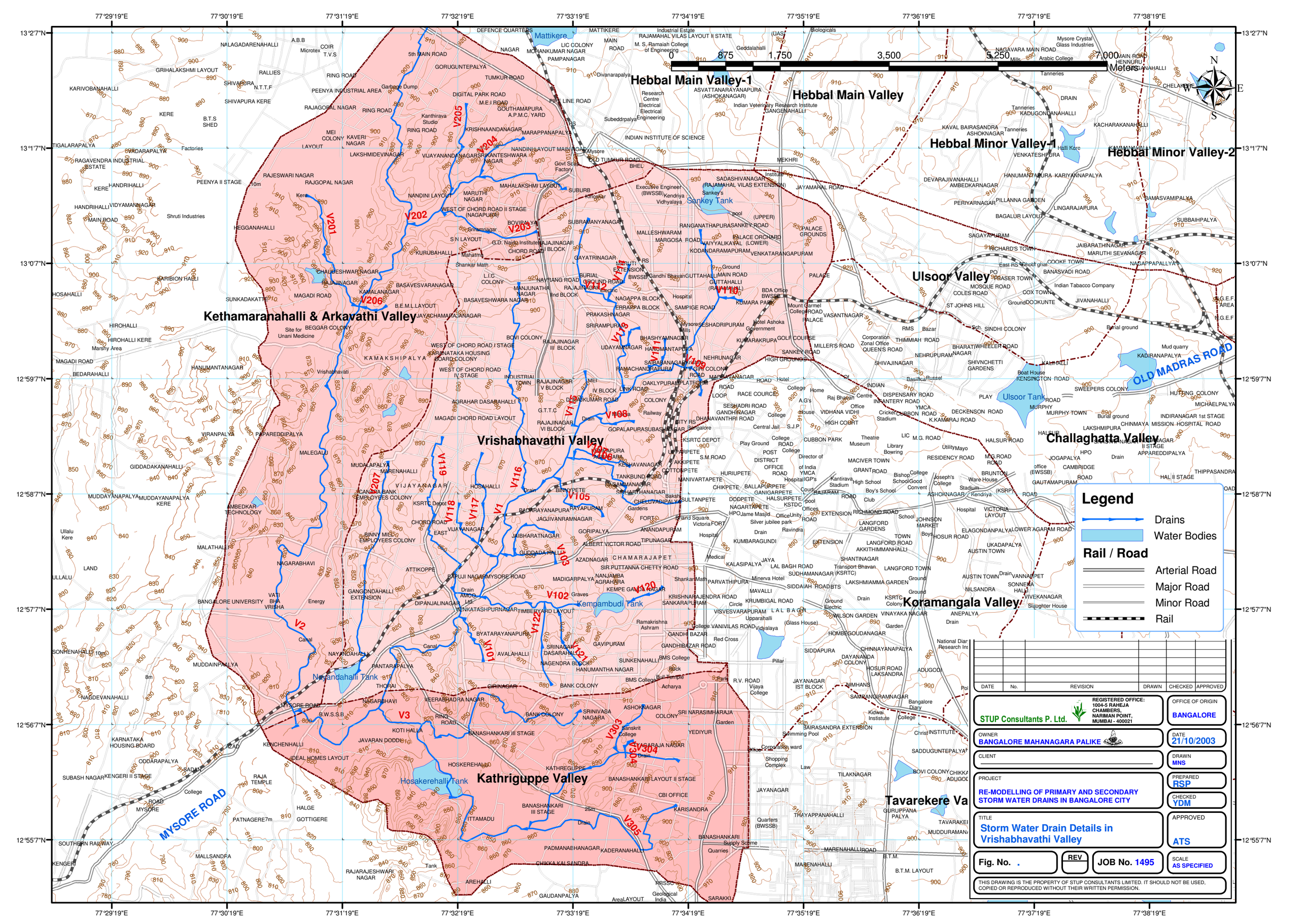
Vrishabhavathi main valley primary storm drain (V100) starts from Sankey tank and runs through Gayatri park extn., Ranganathapura, Vaialikaval, Swimming pool extn., Sheshadripura, Srirampura, Okalipura, Gopalapura, Manjunathanagara, Padarayanapura, Kempapura Agrahara, Guddadahalli, Bapujinagara, Gali Anjaneya temple, Pantharpalya, Rajarajeshwarinagara, Kenchanahalli, Kengeri on Mysore Road and finally joins Byramangala tank which is situated near Bidadi at about 40 km. from Bangalore.

Vrishabhavathi main valley comprises of about twenty two secondary storm drains, covering the entire Vrishabhavathi main valley. The details of these drains are as mentioned in Table 2.2 and are shown in Figure 2.3.

TABLE 2.2 DETAILS OF VRISHABHAVATHI MAIN VALLEY STORM DRAINS

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Vrishabhavathi Main Valley (V1):						
1	V100	Vrishabhavathi	Pri.	Sankey Reservoir	Kenchanahalli	14,000
2	V101	Byatarayanapura	Sec.	Avalahalli	Deepanjalinagara	910
3	V102	Timber Yard Layout	Sec.	Timber Yard Layout	Bapujinagara	1,875
4	V103	Guddadahalli	Sec.	Guddadahalli	Shammananagara	1,050
5	V104	Jai Bharathnagara	Sec.	Jagajivanramnagara	Jai Bharathnagara	1,020
6	V105	Binnypet	Sec.	Ranganatha Colony	Cholurpalya	1,325
7	V106	Bakshi Garden	Sec.	Sulthanpet	K.P. Agrahara	2,445
8	V107	K.P. Agrahara	Sec.	Keshavanagara	K.P. Agrahara	1,075
9	V108	Gopalpura	Sec.	Subashnagara	Minerva Mill	980
10	V109	Platform Road	Sec.	Dhanavantri Road	V.V.Giri Colony	200
11	V110	Sheshadaripura	Sec.	Kumara Park	Palace Guttahalli	380
12	V111	Hanumanthapura	Sec.	Gowthamnagar	Saibabanagara	580
13	V112	Prakashnagara	Sec.	Gayathainagara	Ramachandrapura	3,420
14	V113	Dayanandanagara	Sec.	Bashyamnagara	Lakshminarayanpura	470
15	V114	Subrahmanyanagara	Sec.	Gayatrinagara	Srirampura	700
16	V115	M.E.I. Polytechnic	Sec.	M.E.I. Polytechnic	Magadi Road	940
17	V116	Agrahara Dasarahalli	Sec.	Manjunathanagara	Padarayanapura	3,775
18	V117	Hosahalli	Sec.	Magadi Chord Road Layout	Shammana Layout	1,585
19	V118	Vijayanagara	Sec.	Hosahalli Extension	R.P.C. Layout	1,250
20	V119	R.P.C. Layout	Sec.	Govindaraj Layout	Kavika Layout	3,140
21	V120	Kempe Gowdanagara	Sec.	Vinayaka Extension	Ragavendra Colony	800
22	V121	Srinagara	Sec.	Hanumanthanagara	Vittalnagara	1,425
23	V122	Muneshwara Block	Sec.	Nagendra Block	Timber Yard Layout	1,600
					Total Length of Primary Drains	**14,000**
					Total Length of Secondary Drains	**30,945**

The total length of primary and secondary drain mentioned in the TOR for all the four valleys was 179.3 kms. But during reconnaissance survey, it was observed that the length of primary and secondary drains in all the valleys were exceeding and which


Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Kathriguppe Valley
Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Ulsoor Valley
Koramangala Valley
Challaghatta Valley
Tavarekere Va
Mattikere
Sankey Tank
Kempambudi Tank
Nayandahalli Tank
Hosakerehalli Tank
Ulsoor Tank
V201
V202
V203
V204
V205
V206
V207
V208
V209
V210
V211
V212
V213
V214
V215
V216
V217
V218
V219
V220
V1
V2
V3
V101
V102
V103
V104
V105
V106
V107
V108
V109
V110
V111
V112
V113
V114
V115
V116
V117
V118
V119
V120
V121
V122
V301
V302
V303
V304
V305
OLD MADRAS ROAD
MYSORE ROAD
0
875
1,750
3,500
5,250
7,000
Meters
N
S
E
W
Legend
Drains
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
DATE
No.
REVISION
DRAWN
CHECKED
APPROVED
STUP Consultants P. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
OFFICE OF ORIGIN
BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
DATE
21/10/2003
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
RSP
CHECKED
YDM
TITLE
Storm Water Drain Details in Vrishabhavathi Valley
APPROVED
ATS
Fig. No. .
REV
JOB No. 1495
SCALE
AS SPECIFIED
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require approval from BMP.

2.4 RECONNAISSANCE SURVEY:

Reconnaissance survey was carried out in the entire Vrishabhavathi main valley. The critical locations which cause obstruction to smooth flow of water have been identified and photographed.

Reconnaissance survey was carried out with a view to :

- Descriptize the contributory areas of different drains
- 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 requirement for widening
- Status of land use pattern / type and intensity of development adjoining the drain (i.e., residential, commercial, industrial or vacant land etc.)
- and other issues which have bearing on the drains.

2.5 REPORT ON FIELD SURVEY OF DRAINS IN VRISHABHAVATHI MAIN VALLEY:

2.5.1 METHODOLOGY

Having identified the drains, the chainage were marked along the drain after measuring the length of the drain starting from `0' chainage at the upper starting point and the chainage increasing towards the down stream direction.

Entire topographic survey was done based on local coordinate system using total station equipment and traversing it all along the drain. Every point is surveyed for its planimetry and height. For heights inside the drain, this was necessary since conventional levelling was not feasible as the drain bottom is at a very low level and also at some places compared to the sides of the drain. By resorting to Total station equipment's, the names of the roads, localities and important land marks were picked up at site and incorporated along with others details.

The heights were given to points with the help of Total stations based on T.B.Ms established all along the drains on permanent objects such as culverts. Before that, the existing GTS B.Ms established by Survey of India were checked for stability and after ensuring the stability of these B.Ms the levelling was done to establish T.B.Ms all along the drain.

•Methodology adopted in representing the drains in the drawing:

Plan showing details of drains, land marks, bench marks, encroachments,, locations where sewage entering into storm water drain, condition of retaining walls, location of bridges and cross drainages and utility crossing are identified in the drawing to a scale of 1:1000 and longitudinal section details of drains in 1:1000 / 1:100 are proposed in the same drawing.

As per TOR, each primary and secondary drains in all the valleys are to be identified w.r.t to their respective predominant locality names and correspondingly numbering has been made.

For ease of identification, sub drains in all the valleys have been identified from down stream end, accordingly, numbers have been assigned for each secondary drains in the respective valleys and the same are to be read as follows.

Eg. : 1) V100 = V1 represents Vrishabhavathi main valley primary storm drain.

2)V101 = V1 represents Vrishabhavathi main valley primary storm drain & 01 indicates first secondary drain in Vrishabhavathi main valley .

•Elevation drawings of culverts / bridges:

The vent way measurements were collected at site along with width of piers / columns

and also heights at various levels of the culverts along with information regarding the type and material of piers / columns, slabs over culverts and parapet wall. These culverts were serially numbered and each culvert has an identical number both in strip map and its elevation drawing. The sectional drawings also show the pipes, manholes, etc. that come immediately at that location.

•Longitudinal Section:

Showing heights at bed level at every 25 m. apart on a horizontal scale of 1:1000 and on vertical scale of 1:100 has been made for every drain.

•Cross-section:

Cross section at every 25 m. interval has been made showing drain depths, 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 indicate whether the walls / buildings that rests on the drain at that particular section.

•Other Items:

Locations where public have the tendency of dumping garbage in the drain, sewer outlets are noted at sites and also utility lines inside and across the drain etc., are indicated separately in the condition survey formats.

2.6 DETAILS OF EXISTING STORM DRAINS IN VRISHABHAVATHI MAIN VALLEY:

2.6.1 OBSERVATIONS DURING SITE INVESTIGATIONS OF VRISHABHAVATHI MAIN VALLEY STORM DRAIN (V100):

During reconnaissance survey of storm drains in Vrishabhavathi main valley certain issues which were significantly contributing for the flooding problems in low lying areas of the catchment were noted and are as discussed below;

- Width of the secondary drains is drastically reduced at down stream end, when compared to upstream end.
  Eg.: near Sheshadripura, Prakashnagara, Padarayanapura etc.

- Width of the primary drain is reduced at the secondary drain joining locations.
  Eg.: near Kempapura Agrahara, Padarayanapura, Bapujinagara.

- Primary drain bed level and secondary drain bed is almost same at many places.
  Eg.: near Cholurpalya, Telecom layout.

- Floor level of residential buildings are much below the drain bed level at many places.
  Eg.: near Gopalpura, Ranganathapura, Goripalya, Kempapura Agrahara, Padarayanapura, Bapujinagara.

- Rocky out crops noticed at several places, down stream of low lying areas is causing accumulation of garbage, siltation, and intern causing heading up of water in the upstream reaches.
  Eg.: Shastrinagara near Krishna floor mills, Srirampura, Kempapura Agrahara, Padarayanapura, Bapujinagara, Timber yard layout.

- Inadequate culverts constructed by railway authority.
  Eg.: near Jagajeevanramnagara, Vijayanagara, R.P.C. layout.

- Typical design of culvert with multiple spans adopted for construction of culverts at closer interval.
  Eg.: near Prakashnagara.
- Service lines laid exactly at the bed level of main drain and secondary drains at many places.
  Eg.: near Kavika layout, Bapujinagara.

- Dumping of debris and disposal of rejected solid waste materials from recycling units, situated adjacent to primary storm drain.
  Eg.: near Jagajeevanramnagara, Mysore Road.

- Construction of inadequate vent size culverts (i.e., reduced vertical cleareance / width) by the authority.
  Eg.: Pipeline road Timber Yard Layout.

- Covered reaches of drains, giving less scope for providing improvement works.
  Eg.: Cholurpalya, Kempapura Agrahara, Padarayanapura.

Further, detailed assessment of existing condition of storm drains in Vrishabhavathi main valley is discussed in the subsequent section. For ease of assessment the main valley primary drain is divided into 14 segments. The details of each segment is as mentioned below :

Segment - 1 (Chainage 0 m to 1,000.00 m.)

(From Gayatri Park Extension, 15th Cross Road upto Sangeetha Apartment near Geethanjali Theater).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Ranganathapura near Sankey reservoir, Malleshwaram, Vaiyyalikaval and Guttahalli area forms the part of contributory areas for this section.

•Initial reach (about 150 m.) of storm drain is covered with RCC/BS slab.

•This reach of storm drain is an open drain.

•The width of drainage channel varies from 3.0 m to 7.0 m & depth varies from 1.2 to 2.0 m.

•S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

•Rehabilitation works to be provided to the existing walls at some places.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel.

•Stone slab bed is provided in the initial reach of drain and further drain bed is in natural condition.

•Residential buildings have been constructed up to the edge of the drain.

•Large quantity of sewage flow is observed inside the drain.

•Large number of sewer outlets from residential buildings are connected directly to storm drain.

•Summer flow drain is noticed near Malleshwaram 10th Cross Road.

•Large number of utility lines have been laid across storm drain with interment supports.

Segment - 2 (Chainage 1,000.00 m to 2,000.00 m.)

(From Sangeetha Apartment near Geethanjali Theater upto Platform Road near Rajiv Gandhi Circle)

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Kumarapark, Sheshadaripura, Muslim colony, Railway colony, Shastrinagara and Platform Road area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•number of cross drains have been constructed across SWD in this reach.

•S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

•Rehabilitation works to be provided to the existing walls at some places.

- The width of drainage channel varies from 7.0 m to 12.0 m & depth varies from 1.7 to 2.5 m.

- Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

- Drain bed is in natural condition.

- Large number of sewer outlets from residential buildings have been connected directly to storm drain.

- Secondary drain V110 from Kumara park area joins the main drain near Sheshadripura.

- Secondary drain bed level and main drain bed level is almost same.

- Floor level of residential buildings are much below the HFL level of drain at many places near Guttahalli & Pipeline road.

- Dense residential buildings have been constructed on either side of the drain.

- Large number of manholes have been constructed inside the channel.

- Large quantity of silt, garbage and vegetation growth is noticed inside the drain.

- Tertiary drain bed level and secondary drain bed level is almost same.

- Bed level of primary drain is having moderate slope in this reach.

- Large quantity of sewage flow is noticed inside the storm drain.
- Parapet walls of cross drains near Sheshadripura requires rehabilitation.

Segment - 3 (Chainage 2,000.00 m to 3,000.00 m.)

(From Platform Road near Rajiv Gandhi Circle upto Kalappa Block near Srirampura).

As per the preliminary investigations made by the consultants, it was noticed that

localities surrounding Srirampura, Lakshminarayanapura and Hanumanthapura area forms the part of contributory areas for this section.

•This reach of drain is open drain.

•Drain reach near Jakarayanakere & Lakshman Rao Nagara is in natural condition.

•Rocky out crop noticed near Tumkur railway line (behind Krishna floor mill) is obstructing free flow of water and also causing stagnation and heading up of water in the upstream reaches.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The width of drainage channel varies from 11.0 m to 15.0 m & depth varies from 2.4 to 3.0 m.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

•Rehabilitation works to be provided to the existing walls at some places.

•Drain bed is in natural condition.
•Drain bed level of primary drain is having moderate slope in this reach.

•Large number of sewer outlets from residential buildings have been connected directly to storm drain.

•Secondary drain V109 & V111 from Platform Road & Hanumanthapura joins the main

drain near Shastrinagara & Lakshman Rao Nagara.

•Dense residential buildings have been constructed on either side of the drain.

•Large number of manholes have been constructed inside the channel.

•Large quantity of vegetation growth & sewage flow is noticed inside the storm drain.

Segment - 4 (Chainage 3,000.00 m to 4,000.00 m.)

(From Kalappa Block near Srirampura upto Gubbanna Industrial Area near Gopalpura).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Ramachandrapura, Saibabanagara and Minerva mills area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Larger diameter sewer pipeline and manholes are notice inside the storm drain.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Kalappa block & Hanumanthapura

•The width of drainage channel varies from 13.0 m to 20.0 m & depth varies from 2.2 m. To 3.0 m.

•Sewage stagnation is noticed at many places.

•Secondary drains from Prakashnagara V113 joins the main drain near Sujatha theater & also another secondary drain from Minerva Mills V108 joins the main drain near

Gubbana industrial area.

•Service road is available on right hand side near Ramachandrapura.

•Large quantity of silt accumulation is noticed near Gubbana industrial area.

•Existing inadequate vent size culvert near Sujatha theater is being reconstructed with increased vent size and also large quantity of construction debris dump is noticed inside the drain at the construction site.

Segment - 5 (Chainage 4,000.00 m to 5,000.00 m.)

(From Gubbanna Industrial Area near Gopalpura upto Manjunathanagara near Magadi Main Road).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Gopalapura, Shankarappa garden, Gubbana industrial area and Magadi road area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Sewer pipeline replacement & manhole construction work inside the storm drain is under progress.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•Sewerage system and Solid waste management system is inadequate in the adjoining areas.

•Secondary storm drains from M.E.I. Polytechnic V115 joins the main drain near Gopalpura & also another secondary drain from Bakshi Garden V106 joins the main drain near Manjunathnagara.

•The width of drainage channel varies from 16.0 m to 22.0 m & depth varies from 2.4 m. To 3.0 m.

•Ground level is below the drain bed level near Gopalpura.

•Drain bed is in natural condition.

•Service road do not exist in this reach.

•Residential buildings & industrial establishments have been constructed upto the edge of the drain.

Segment - 6 (Chainage 5,000.00 m to 6,000.00 m.)

(From Manjunathanagara near Magadi Main Road upto Telecom Layout near Padarayanapura).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Cholurpalya, Bhuvaneshwarinagara, Cheluvappa garden, Mariyappanapalya, Manjunathanagara, Telecom layout, Vidhyarayananagara and Kempapura Agrahara area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Secondary drains V116 from Agrahara Dasarahalli (Saneguruvanahalli), V106 from Bakshi garden, V107 from Ranganatha Colony, & Kempa Pura Agrahara joins the main drain near Cholurpalya.

•Residential establishments are noticed on either side of the drain.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•Sewerage system and Solid waste management system is inadequate in the adjoining areas.

- The width of drainage channel varies from 13.0 m to 25.0 m & depth varies from 2.5 m. to 3.0 m.

- Ground level is below the drain bed level near Mariappanpalya.

- Sewage stagnation is noticed at many places.

- Large quantity of silt accumulation is noticed inside the drain.

- Service road do not exist in this reach.

- Residential buildings have been constructed upto the edge of the drain.

- Larger diameter BWSSB sewer pipeline has been laid all along the reach.

Segment - 7 (Chainage 6,000.00 m to 7,000.00 m.)

(From Telecom Layout near Padarayanapura upto 5th Cross Road Shammana Garden Pipeline Road near Jagajeevanramnagara).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Padarayanapura, Vinayakanagara, Shammana garden, Arifnagara and Guddahalli area forms the part of contributory areas for this section.

- This reach of storm drain is an open drain.

- Rocky out crop noticed near Mysore railway line is obstructing free flow of water.

- RCC drain walls have been constructed on either side near Jagajeevanramnagara pipeline road.

- The existing Railway bridge near Ramesh babu circle level crossing is having very inadequate vent way.

- Drain bed is in natural condition.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•Sewerage system and Solid waste management system is inadequate in the adjoining areas.

•The width of drainage channel varies from 18.0 m to 24.0 m & depth varies from 2.6 m. to 3.5 m.

•Existing masonry drain wall is in moderate condition.

•Service road do not exist in this reach.

Segment - 8 (Chainage 7,000.00 m to 8,000.00 m.)

(From 5th Cross Road Shammana Garden Pipeline Road near Jagajeevanramnagara upto Bapujinagara Main Road Bridge near Gali Anjaneya Temple).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Bapujinagara, Gali Anjaneya temple area and New Guddadahalli area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Rocky out crops noticed at many places in this reach is obstructing free flow of water.

•Drain width is drastically reduced at many places due to construction of buildings over rocky out crops.

•Dense builtup residential establishments are noticed on either side of the drain.

•The existing BWSSB sewer pipeline laid across the storm drain near Gali Anjaneya temple is causing accumulation of garbage intern causing heading up of water.

- Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

- Large quantity of sewage flow is noticed inside the drain.

- Sewerage system and solid waste management system is inadequate in the adjoining areas.

- The width of drainage channel varies from 16.0 m to 22.0 m & depth varies from 3.0 m. to 4.0 m.

- Secondary drains V115 from Vijayanagara, V117 from Chord Road layout, V103 from Jagajeevan Rama Nagara and V104 from Guddadahalli areas joins the main drain near Bapujinagara.

- Ground level is below the drain bed level at many places near Bapujinagara.

- Drain bed is in natural condition.

- Sewage stagnation is noticed at many places.

- Debris and garbage dumps are noticed on either side of the drain.

- Service road do not exist in this reach.

Segment - 9 (Chainage 8,000.00 m to 9,000.00 m.)

(From Bapujinagara Main Road Bridge near Gali Anjaneya Temple upto Mysore Road Bridge near Chord Road Junction).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Deepanjalinagara, Kavika layout, Venkateshpura and Mysore Road area forms the part of contributory areas for this section.

- This reach of storm drain is an open drain.

- Drain reach near Kavika layout is in natural condition.

- Residential establishments is noticed on one side and open space on the other side of the drain.

- Large quantity of debris is being dumped behind the residential buildings.

- Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

- Large quantity of sewage flow is noticed inside the drain.

- Sewerage system and Solid waste management system is inadequate in the adjoining areas.

- The width of drainage channel varies from 20.0 m to 40.0 m & depth varies from 3.0 m. to 4.2 m.

- Secondary drains V119 from RPC layout, V120 from Bull temple road, V121 from Srinagara and V102 from Timber yard layout joins the main drain near Gali Anjaneya Temple.

- Sewage stagnation is noticed at many places.

- Siltation and vegetation growth is noticed inside the drain.
- Drain bed is in natural condition.

- Service road do not exist in this reach.

Segment - 10 (Chainage 9,000.00 m to 10,000.00 m.)

(From Mysore Road Bridge near Chord Road Junction upto B.W.S.S.B. Pipeline Bridge behind Kwality Biscuits Factory near Mysore Road).

As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Pantharpalya and Mysore Road area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Residential establishments and few open spaces are noticed on either side of the drain.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•Sewerage system and Solid waste management system is inadequate in the adjoining areas.

•The width of drainage channel varies from 25.0 m to 35.0 m & depth varies from 2.0 m. to 2.8 m.

•Masonry wall has been constructed for a shorter length in this reach and is in good condition.

•Sewage stagnation is noticed at many places.

•Siltation and vegetation growth is noticed inside the drain.

•Drain bed is in natural condition.

•Service road do not exist in this reach.

Segment - 11 (Chainage 10,000.00 m to 11,000.00 m.)

(From B.W.S.S.B. Pipeline Bridge behind Kwality Biscuits Factory near Mysore Road upto Pantharpalya).

As per the preliminary investigations made by the consultants, it was noticed that Nayanandahalli, BWSSB Vrishabhavathi valley treatment plant area and its surrounding area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Large quantity of debris is being dumped near Mysore Road - Ring Road Junction.

•Drain reach is in natural condition.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 20.0 m to 40.0 m & depth varies from 2.2. m. to 4.5 m.

•Siltation and vegetation growth is noticed inside the drain.

•The width of the drainage channel is reduced at many places.

•Drain bed is in natural condition and also at few places, weathered rock formation is noticed.

•Service road do not exist in this reach.

Segment - 12 (Chainage 11,000.00 m to 12,000.00 m.)

(From Pantharpalya upto Vrishabhavathi valley sewage treatment plant.

As per the preliminary investigations made by the consultants, it was noticed that Rajarajeshwarinagara and its adjoining area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Drain reach is in natural condition.

•Open spaces are noticed on either side of the drain.

•Drain width is drastically reduced in this reach.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 18.0 m to 40.0 m & depth varies from 2.2 m. To 4.0 m.

•Siltation and vegetation growth is noticed inside the drain.

•Drain bed is in natural condition and also at few places, weathered rock formation is noticed.

Segment - 13 (Chainage 12,000.00 m to 13,000.00 m.)

(From Vrishabhavathi valley sewage treatment plant upto Rajarejeshwarinagara Main Road).

•This reach of storm drain is an open drain.

•Drain reach is in natural condition.

•Open spaces are noticed on either side of the drain.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 16.0 m to 30.0 m & depth varies from 2.2 m.

To 5.0 m.

•Sever Siltation and dense vegetation growth is noticed inside the drain.

•Debris and garbage dumps are noticed on either side of the drain.

•Drain bed is in natural condition.

Segment - 14 (Chainage 13,000.00 m to 14,000.00 m.)

(From Rajarejeshwarinagara Main Road upto Mysore Road - Janabharathi Junction).

As per the preliminary investigations made by the consultants, it was noticed that Rajarajeshwarinagara & Kenchanahalli and its surrounding area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Drain reach is in natural condition.

•Open spaces are noticed on either side of the drain.

•Drain width is drastically reduced at many places in this reach.

•Vrishabhavathi minor valleys Primary drains V200 & V300 joins the Vrishabhavathi main valley primary drain near Mysore road.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 20.0 m to 50.0 m & depth varies from 2.4 m. To 5.0 m.

•Sever Siltation and dense vegetation growth is noticed inside the drain.

•Debris and garbage dumps are noticed on either side of the drain.

•Drain bed is in natural condition.

2.6.2 OBSERVATIONS DURING SITE INVESTIGATIONS OF VRISHABHAVATHI MAIN VALLEY SECONDARY STORM DRAINS:

2.6.2.1 Byatarayanapura secondary storm drain (V101):

(Writers Colony near Avalahalli upto Deepanjalinagara near Mysore Road).

As per the preliminary investigations made by the consultants, it was noticed that Girinagara writers colony, Avalahalli, Ganapathinagara, Byatrayanapura and its surrounding area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain except in the initial reaches which is covered by BS slabs.

•Residential buildings are noticed on either side of the drain.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 2.0 m to 5.5 m & depth varies from 1.6 m. To 2.5 m.

•Large quantity of debris and garbage dumps are noticed on either side of the drain near Girinagar Main Road, Bayatarayanapura.

•Drain bed is in natural condition.

•Existing masonry drain walls are in moderate condition and requires minor rehabilitation

works at few places.

•Sewer pipeline and manholes are noticed inside the drain.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

2.6.2.2 Timber Yard Layout secondary storm drain (V102):

(Brindavannagara near Timber Yard Layout upto Gali Anjaneya Temple near Bapujinagara).

As per the preliminary investigations made by the consultants, it was noticed that Gavipura Guttahalli, Gavipura, Kalidasa layout, Brindavannagara, Adarashanagara, Vittalnagara, Bhaktha Markandeya layout, Karithimmanahalli, Venkateshpura Timber yard layout and its surrounding area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain.

•Alignment of drain is altered at many places.

•Large quantity of sewage flow is noticed inside the drain near Indoor Stadium.

•Culvert constructed behind Indoor stadium is inadequate and obstructing free flow of water.

•Drain reach is in natural condition near Ragavendranagara, Vittalnagara & Kalidasa layout.

•Densely built residential buildings and few open spaces are noticed on either side of the drain.

•Drain width is drastically reduced at many places in this reach.

•Large number of sewer outlets from residential buildings are directly connected to storm water drains.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places

inside the channel.

•Raw sewage is being directly discharged into the drains from the adjoining slum areas.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 4.0 m to 12.0 m & depth varies from 1.4 m. To 2.4 m.

•Sever Siltation and dense vegetation growth is noticed inside the drain.

•Debris and garbage dumps are noticed on either side of the drain.

•Drain bed is in natural condition.

•Rocky outcrops is noticed in the drain bed near Mysore Road Bus Station is causing accumulation of silt.

•Secondary drains V120 from Bull Temple Road, V121 from Srinagara and V122 from Muneshwara block joins this secondary drain near Timber yard layout.

•Existing ground level is much below the drain bed level at many places.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•Existing culvert near Kariyamanapalya & Pipeline road near Kasturibainagara is inadequate and it needs to be reconstructed.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

2.6.2.3 Guddadahalli secondary storm drain (V103):

(Guddahalli upto Shammananagar).

As per the preliminary investigations made by the consultants, it was noticed that Goripalya, Jagajeevanramnagara, Guddadahalli and its surrounding area forms the part of contributory areas for this section.

- This reach of storm drain is an open drain.
- Densely built residential buildings are noticed on either side of the drain.
- Drain width is reduced at many places in this reach.
- Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel.
- Large quantity of sewage flow is noticed inside the drain.
- The width of drainage channel varies from 3.0 m to 6.0 m & depth varies from 1.4 m. To 2.8 m.
- Debris and garbage dumps are noticed on either side of the drain.
- Drain bed is in natural condition.
- Large quantity of vegetation growth is noticed inside the drain.
- Large number of sewer outlets from residential buildings are directly connected to storm water drain.
- Secondary drains V104 from Jagajeevana Rama Nagara joins this secondary drain near New Guddadahalli.
- Existing ground level is much below the drain bed level at many places.

- Sewerage system and solid waste management system is very inadequate in the adjoining areas.

- The existing drain wall is in moderate condition.

- Minor rehabilitation works needs to be provided to the existing drain wall.

- Existing culvert near Janatha Colony Main Road is inadequate and it needs to be reconstructed.

2.6.2.4 Jaibharathnagar secondary storm drain (V104):

(Goripalya near Jagajivanramnagara upto Jaibharathnagara).

As per the preliminary investigations made by the consultants, it was noticed that Devaraja urs nagara, Vinayakanagara and its surrounding area forms the part of contributory areas for this section.

- This reach of storm drain is an open drain except in the initial reaches which is covered by BS slabs.

- Alignment of drain is altered at many places.

- Large quantity of sewage flow is noticed inside the drain.

- Densely built residential buildings are noticed on either side of the drain.
- Drain width is drastically reduced at many places in this reach.

- Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel.

- The width of drainage channel varies from 2.0 m to 3.5 m & depth varies from 1.2 m. To 1.8 m.

- Debris and garbage dumps are noticed on either side of the drain near Guddahalli.

•Drain bed is in natural condition.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing culvert near Nehru Road is inadequate and requires to be reconstructed

2.6.2.5 Binnypet secondary storm drain (V105):

(Ranganatha Colony near Cheluvadipalya upto Cholurpalya).

As per the preliminary investigations made by the consultants, it was noticed that Binnypete, Ranganatha Colony, Rayapura, Cleluvappa Garden and its surrounding area forms the part of contributory areas for this section.

•This reach of storm drain is an open drain further from Mysore railway line it is covered by RCC slab.

•Alignment of drain is altered at many places.
•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•Dumping of debris, solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•The width of drainage channel varies from 1.4 m to 3.5 m & depth varies from 1.2 m. To 1.8 m.

•Drain bed is in natural condition near Ranganatha Colony.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing culvert near R.R. Nagar is inadequate and requires to be reconstructed

•Existing ground level is much below the drain bed level.

2.6.2.6 Bakshi Garden secondary storm drain (V106):

(Sulthanpet upto Manjunathanagara near Kempapura Agrahara).

As per the preliminary investigations made by the consultants, it was noticed that Ranasinghpete, Bakashi Garden, Anjanappa Garden, Cottonpete, Nagamma nagara, Mariappanapalya and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain is covered by BS Slabs further from L & T Casting yard drain reach is open except at few reaches in the middle near Bhuvaneshwarinagara.

•Secondary drain V107 from Kempa Pura Agrahara joins this secondary drain near Mariappanapalya.

•Drain wall near L & T casting yard is not in good condition.

•Alignment of drain is altered at many places.

•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 3.0 m to 7.0 m & depth varies from 1.4 m. To 2.4 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing culvert near R.R. Nagar is inadequate and requires to be reconstructed

•Existing ground level is much below the drain bed level.

•Secondary drain bed level and main drain bed level is almost same.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

2.6.2.7 Kempapura Agrahara secondary storm drain (V107):

(Keshavanagara near Binny Mill upto Mariappanapalya near Kempapura Agrahara).

As per the preliminary investigations made by the consultants, it was noticed that Binnyston Garden, Keshavanagara, Kempapura Agrahara and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain is covered by BS Slabs further drain reach is open except at few reaches in the middle. .

•Large quantity of sewage flow & garbage dumps is noticed inside the drain near Kempapura Agrahara.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 1.4 m to 2.6 m & depth varies from 1.0 m. To 1.6 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing culvert near Bhuvaneshawarinagara is inadequate and requires to be reconstructed.

•Existing ground level is much below the drain bed level.

2.6.2.8 Gopalapura secondary storm drain (V108):

(Subashnagara upto Minerva Mill).

As per the preliminary investigations made by the consultants, it was noticed that Subashnagara, Gopalpura and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain inside Minerva mill is in natural condition.

•Large quantity of debris and vegetation growth is noticed in side the drain near Minerva

mill.

•Large quantity of sewage from the adjoining Minerva mill quarters is being directly discharged into the storm drain.

•Dry stone revetment has been provided to drain wall & drain bed for a shorter length inside Minerva Mill.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 1.6 m to 2.4 m & depth varies from 1.8 m. To 2.4 m.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing ground level is much below the drain bed level near Gopala pura.

2.6.2.9 Platform Road secondary storm drain (V109):

(Dhanavanthri Road upto V.V. Giri Colony).

As per the preliminary investigations made by the consultants, it was noticed that Platform road, Dhanavanthri road, V.V. Giri Colony, Shastrinagara and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain is covered by BS Slabs further from Shastrinagara drain reach is open.

•Sewer pipeline and manhole are noticed inside the drain.

•Large quantity of sewage flow is noticed inside the drain.

•Rocky out crop noticed in the drain bed near Shastrinagara is obstructing free flow of water.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 4.0 m to 6.0 m & depth varies from 2.2 m. To 2.8 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

2.6.2.10 Sheshadaripura secondary storm drain (V110):

(Kumara Park Area upto Guttahalli).

As per the preliminary investigations made by the consultants, it was noticed that Kumara park area, Annayappa block, Sripura, Palace Guttahalli, Nehru nagara, Sheshadaripura and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain is covered by BS Slabs further from Nagappa street, the drain reach is open.

•Alignment of drain is altered at many places.

•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 1.8 m to 2.8 m & depth varies from 1.6 m. To 2.4 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing culvert near Nagappa street is inadequate and requires to be reconstructed

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Large number of service lines are crossing the drain near Nagappa street.

•Main drain bed level and secondary drain bed level is almost same.
•Width of drain is drastically reduced when compared to upstream drain width.

2.6.2.11 Hanumanthapura secondary storm drain (V111):

(Gowthamnagar upto Saibabanagar).

As per the preliminary investigations made by the consultants, it was noticed that Swatantrapalya, Hanumanthapura, Gowthamnagar, Saibabhanagar, Srirampura and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is covered by BS slab in the initial reaches near Sriramapura &

further by RCC Slab near Kalappa block.

•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 2.0 m to 3.5 m & depth varies from 1.2 m. To 1.8 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing culvert near Kalappa block is total blocked due to dumping of garbage by adjoining small scale industries.

•Main drain bed level and secondary drain bed level is almost same.

•Adjoining ground level and drain bed level is almost same.

•Large number of sewer outlets from residential buildings are directly connected to storm water drains.

2.6.2.12 Prakashnagara secondary storm drain (V112):

(Gayatrinagara upto Ramachandrapura).

As per the preliminary investigations made by the consultants, it was noticed that Gayatrinagara, Mariappanapalya, Prakashnagara, Errappa block, Kallappa block, Udayamnagara, Ramachandrapura and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain upto Varalakshmi nursing home is covered by BS/RCC Slabs further drain reach is open.

- Secondary drains V113 from Dayanandanagara and V114 from Maruthi Extension joins this secondary drain near Prakashnagara.

- Large number of culverts with multiple spans have been constructed in this reach and are obstructing free flow of water.

- Alignment of drain is altered at many places.

- Large quantity of sewage flow is noticed inside the drain.

- Densely built residential buildings which are abutting to the drain walls are noticed on either side of the drain.

- The width of drainage channel varies from 3.0 m to 8.0 m & depth varies from 1.6 m. To 3.0 m.

- Sewerage system and solid waste management system is very inadequate in the adjoining areas.

- Large number of sewer outlets from residential buildings are directly connected to storm water drain.

- The existing drain wall is collapsed at few places and also is in moderate condition at few places.
- Rehabilitation works needs to be provided to the existing drain wall.

- Existing culverts near Maha Kavi Kuvempu Road, Mariappanapalya, 9th main road, 12th main road, 4th cross road, 5th main road Prakashanagara, 4th cross road Ramachandrapura, 2nd cross road Ramachandrapura is inadequate and requires to be reconstructed

- Existing ground level is much below the drain bed level.

- Drain width is reduced at many places when compared with upstream drain width.

•Large quantity of silt accumulation is noticed all along the drain near Ramachandrapura.

2.6.2.13 Dayanandanagara secondary storm drain (V113):

(Bashyamnagara upto Lakshminarayanpura).

As per the preliminary investigations made by the consultants, it was noticed that Bashyamnagara, Dayanandanagara, Lakshminarayanpura, and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is an open drain.

•Alignment of drain is altered at many places.

•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 2.4 m to 4.0 m & depth varies from 1.8 m. To 2.4 m.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is damaged near Lakshminarayanapura and in other places it is moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

2.6.2.14 Subramanyanagara secondary storm drain (V114):

(Maruthi Extn. upto Srirampura).

As per the preliminary investigations made by the consultants, it was noticed that Maruthi Extn., Rammohanpura, Subramanyanagara and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is an open drain except the initial reaches is covered by RCC slab.

•Large quantity of sewage flow is noticed inside the drain.

•Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 3.0 m to 6.0 m & depth varies from 2.4 m. To 3.0 m.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Secondary drain bed level and Prakashnagar secondary drain bed level is almost same.

•Sewer pipeline and large number of manholes are noticed inside the drain.

2.6.2.15 M.E.I. Polytechnic secondary storm drain (V115):

(M.E.I. Polytechnic upto Magadi Road).

As per the preliminary investigations made by the consultants, it was noticed that Rajajinagara 3rd, 4th, 5th, 6th block, Gubbana Industrial area and its surrounding area forms the part of contributory areas for this section.

•Initial reach of drain is covered by BS / RCC Slabs further drain reach is open.

•Large quantity of sewage flow is noticed inside the drain.

•Dense builtup residential buildings & Industrial establishments are noticed on either side of the drain.

•Large number of sewer outlets from residential buildings are directly connected to storm water drain.

•BS slab laid drain bed is damaged in the initial reaches.

•Main drain bed level and secondary drain bed level is almost same.

•Large quantity of construction debris dump is noticed inside the drain near M.E.I. Polytechnic.

•The width of drainage channel varies from 5.0 m to 8.0 m & depth varies from 2.2 m. To 2.8 m.

•Sewerage system and solid waste management system is very inadequate in the adjoining areas.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Existing ground level is much below the drain bed level.

2.6.2.16 Agrahara Dasarahalli secondary storm drain (V116):

(Manjunathanagara upto Padarayanapura).

As per the preliminary investigations made by the consultants, it was noticed that Basaveshwaranagara, Sharada layout, Saneguruvanahalli, Bovi colony, Shivanahalli, West of Chord Road layout, Agrahara Dasarahalli, Oddarahalli, Vidyaranyanagara, Cholurpalya and its surrounding area forms the part of contributory areas for this section.

- This reach of drain is an open drain except the initial reaches is covered by RCC slab near Basaveshwaranagara, Manjunathanagara, Judges Colony.

- Alignment of drain is altered at many places.

- Width of drain near Rajajinagara industrial area is drastically reduced.

- Tertiary drain bed level and secondary drain bed level are almost same.

- Large number of sewer outlets from residential buildings are directly connected to storm water drain.

- Structural arrangement near Rajajinagar Industrial area secondary drain & tertiary drain joining location is very inappropriate.

- Large quantity of sewage flow is noticed inside the drain.

- Dense builtup residential buildings and industrial establishments are noticed on either side of the drain.

- The width of drainage channel varies from 3.0 m to 12.0 m & depth varies from 1.4 m. To 3.2 m.

- Sewerage system and solid waste management system is very inadequate in the adjoining areas.

- The existing drain wall is in moderate condition.

- Minor rehabilitation works needs to be provided to the existing drain wall.

- Existing ground level is much below the drain bed level at many places.

- Main drain bed level and secondary drain bed level is almost same.

2.6.2.17 Hosahalli secondary storm drain (V117):

(Magadi Chord Road Layout upto Shammana Layout).

As per the preliminary investigations made by the consultants, it was noticed that Hosahalli Extension, Vijayanagara, R.P.C. Layout, Shammana Layout and its surrounding area forms the part of contributory areas for this section.

- This reach of drain is almost covered by RCC slabs and also it is open except at few stretches in the middle. .

- Densely built residential buildings are noticed on either side of the drain.

- The width of drainage channel varies from 3.0 m to 6.0 m & depth varies from 1.0 m. To 2.0 m.

- Minor rehabilitation works needs to be provided to the existing drain wall.

- Structural arrangement near Vijayanagar swimming pool, secondary drain & tertiary drain joining location is very inappropriate.

2.6.2.18 Vijayanagara secondary storm drain (V118):

(Hosahalli Extn. upto R.P.C. Layout).

As per the preliminary investigations made by the consultants, it was noticed that Hosahalli extn., Vijayanagara, RPC layout and its surrounding area forms the part of contributory areas for this section.

- This reach of drain is almost covered by RCC slab and also it is open at few reaches in the middle. .

- Secondary drain V117 from Hosahalli joins this secondary drain near Shammananagara.

- Densely built residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 2.2 m to 6.0 m & depth varies from 1.4 m. To 2.2 m.

•Rocky out crop noticed near Shammananagara needs to be lowered.

•Sewer pipeline and large number of manholes are noticed inside the drain.

2.6.2.19 R.P.C. Layout secondary storm drain (V119):

(Govindaraj Layout upto Kavika Layout).

As per the preliminary investigations made by the consultants, it was noticed that Thimmanahalli, Govindarajnagara, Saraswathinagara, B.H.E.L. township, R.P.C. layout, Kavika layout and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is almost covered by RCC slabs and also it is open at few reaches in the middle. .

•Large quantity of sewage flow is noticed inside the drain.

•Existing BS slab laid drain bed is damaged at many places.

•The width of drainage channel varies from 2.4 m to 4.0 m & depth varies from 1.8 m. To 3.0 m.

•Sewer pipeline and manholes are noticed inside the drain at many places.

•Sewer pipe line is exactly laid over the drain bed and it is totally obstructing flow of water near Kavika layout.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

2.6.2.20 Kempegowda Nagara secondary storm drain (V120):

(Vinayaka Extn. upto Ragavendra Colony).

As per the preliminary investigations made by the consultants, it was noticed that Vinayaka Extn., Chamarajapete, Ragavendra Colony, Kempegowda nagara and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is covered by BS slabs and it is open only near Kempambudhi tank.

•The width of drainage channel varies from 3.0 m to 8.0 m & depth varies from 1.6 m. To 2.2 m.

•Drain bed is completely damaged near Kembambudhi tank.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Service road exist by the side of the drain for full length on right side.

2.6.2.21 Srinagara secondary storm drain (V121):

(Hanumanthanagara upto Vittalnagara).

As per the preliminary investigations made by the consultants, it was noticed that Srinagara, Banashankari 1st Stage, Kalidasa layout, Harishta nagara and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is open drain except initial reaches which is covered by RCC slabs near Hanumanthanagara.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 5.0 m to 10.0 m & depth varies from 2.2 m. To 3.2 m.

•Large number of sewer outlets from residential buildings are directly connected to storm

water drain.

•Summer flow drain exists near Srinagara bus stand.

•Existing BS slab laid drain bed is damaged at many places near Srinagara.

•Large quantity of construction debris dump is noticed near Kalidasa housing cooperative society near Srinagara.

•Drain reach is in natural condition near Ragavendranagara (Kasturi bai nagara).

•Sewer pipeline and manholes are noticed inside the drain at many places.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

2.6.2.22 Muneshwara Block secondary storm drain (V122):

(Nagendra Block upto Timber Yard Layout).

As per the preliminary investigations made by the consultants, it was noticed that Bank Colony, Nagendra Block, Muneshwara Block, Telecom Colony, Timber yard layout, Ragavendra nagara and its surrounding area forms the part of contributory areas for this section.

•This reach of drain is covered by RCC slabs in the initial reaches.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel varies from 2.8 m to 4.0 m & depth varies from 1.2 m. To 2.0 m.

•Large number of sewer outlets from residential buildings are directly connected to storm

water drain.

•Sewer pipeline and manholes are noticed inside the drain at many places.

•Drain reach is in natural condition near Ragavendranagara.

•The existing drain wall is in moderate condition.

•Minor rehabilitation works needs to be provided to the existing drain wall.

•Large number of sewer outlets from residential buildings are directly connected to storm water drains.

2.7 Condition Survey of Cross Drains :

During reconnaissance survey, the existing cross drains constructed across both primary and secondary drains has been assessed for its structural and hydrological conditions. The details of these existing cross drains like type of structure, type of slab, abutment/piers, service lines near the structure, condition of parapet wall etc., have been collected and enclosed in Volume II of this report.

2.8 OBSERVATIONS DURING SITE INVESTIGATION OF LOW LYING AREAS IN VRISHABHAVATHI MAIN VALLEY:

During reconnaissance survey of Vrishabhavathi main valley, a detailed assessment of site condition, reason for flooding and possible mitigative measures to overcome the flooding problems in low lying areas have been identified and the same is discussed in the subsequent sections.

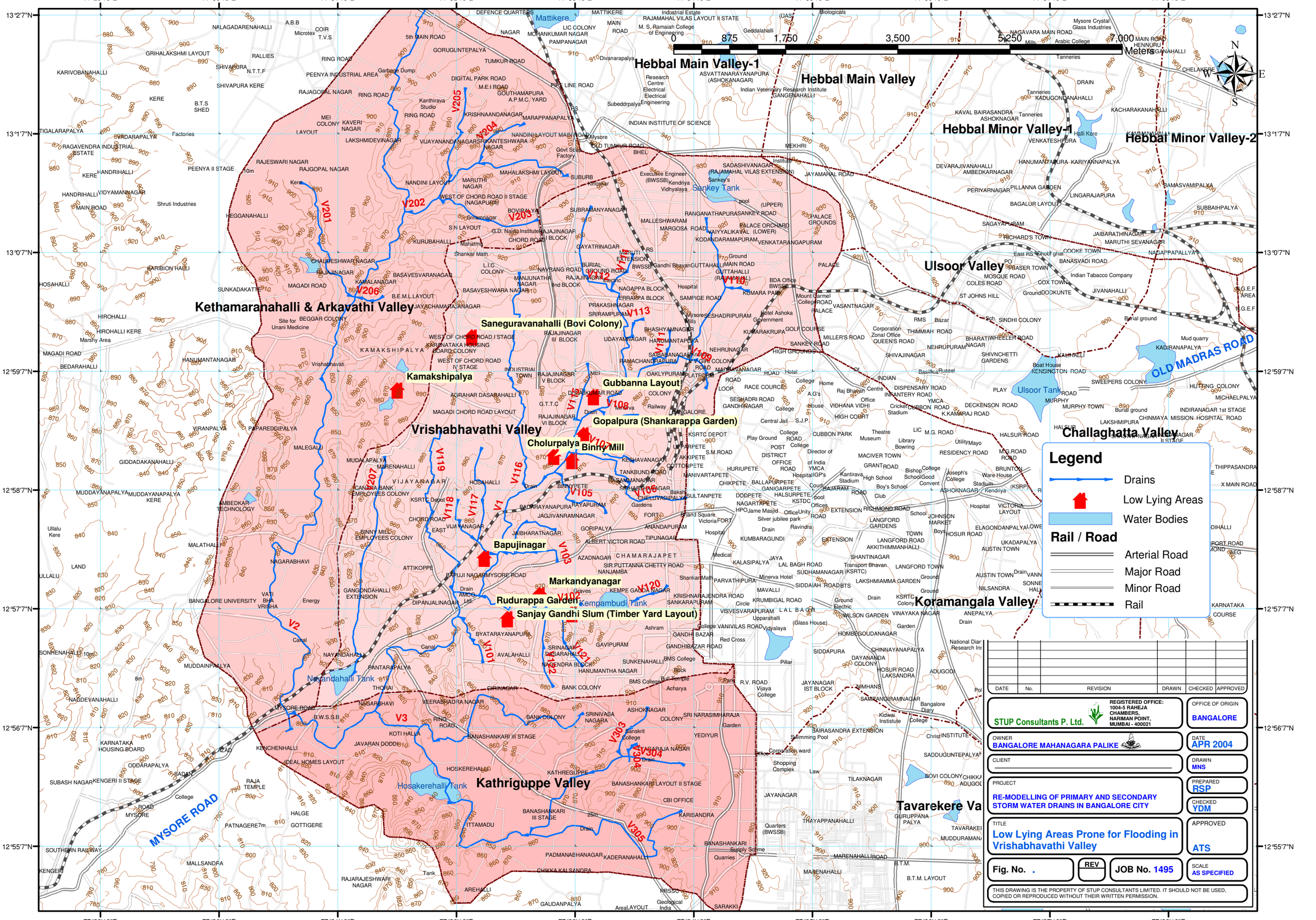
The list of critical low lying areas identified in Vrishabhavathi main valley is as mentioned in Table 2.3 and same is depicted in Figure 2.4.

TABLE 2.3 List of Critical Low Lying Areas in Vrishabhavathi Main Valley

Sl.No.	Location	Valley	BMP Zonal Division
1.	Gubbana Layout	Vrishabhavathi Main Valley Primary Storm Drain	West
2.	Gopalapura (Shankarappa Garden)	Vrishabhavathi Main Valley Primary Storm Drain	West
3.	Cholarapalya	Vrishabhavathi Main Valley Primary Storm Drain	South
4.	Binny Mill Tank Area	Vrishabhavathi Main Valley Primary Storm Drain	South
5.	Bapujinagara	Vrishabhavathi Main Valley Primary Storm Drain	South
6.	Saneguruvanahalli (Bovi Colony)	Vrishabhavathi Main Valley Secondary Storm Drain	West
7.	Markandayanagara	Vrishabhavathi Main Valley Secondary Storm Drain	South
8.	Timber Yard Layout (Sanjay Gandhi Slum)	Vrishabhavathi Main Valley Secondary Storm Drain	South
9.	Rudrappa Garden	Vrishabhavathi Main Valley Secondary Storm Drain	South

2.8.1 Gubbana Layout:

Gubbana Layout is situated very close to Vrishabhavathi main valley primary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.


77°29'19"E
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77°38'19"E
13°2'7"N
13°1'7"N
13°0'7"N
12°59'7"N
12°58'7"N
12°57'7"N
12°56'7"N
12°55'7"N
0
875
1,750
3,500
5,250
7,000
Meters
N
S
E
W
Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Ulsoor Valley
Kethamaranahalli & Arkavathi Valley
Saneguravanahalli (Bovi Colony)
Kamakshipalya
Gubbanna Layout
Gopalpura (Shankarappa Garden)
Vrishabhavathi Valley
Cholurpalya
Binny Mill
Bapujinagar
Markandyanagar
Rudurappa Garden
Sanjay Gandhi Slum (Timber Yard Layout)
Kathriguppe Valley
Challaghatta Valley
Koramangala Valley
Tavarekere Valley
Sankey Tank
Kempambudi Tank
Nayandahalli Tank
Hosakerehalli Tank
Ulsoor Tank
OLD MADRAS ROAD
MYSORE ROAD
V1
V2
V3
V101
V102
V103
V104
V105
V106
V107
V108
V109
V110
V111
V112
V113
V114
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Legend
Drains
Low Lying Areas
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
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No.
REVISION
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APPROVED
STUP Consultants P. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
OFFICE OF ORIGIN
BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
DATE
APR 2004
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PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
RSP
CHECKED
YDM
TITLE
Low Lying Areas Prone for Flooding in Vrishabhavathi Valley
APPROVED
ATS
Fig. No. .
REV
JOB No. 1495
SCALE
AS SPECIFIED
THIS DRAWING IS THE PROPERTY OF STUP CONSULTANTS LIMITED. IT SHOULD NOT BE USED, COPIED OR REPRODUCED WITHOUT THEIR WRITTEN PERMISSION.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered in this region.

- The existing tertiary drain bed level and primary drain bed level is almost same.

- Due to drastic reduction in width of primary drain in the down stream reach, heading up of water and spreading is experienced.

- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

- Large quantity of sewage flow is noticed inside the existing storm drain.

- Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.
- Large quantity of surplus excavated earth generated during laying of sewer pipeline & construction of manhole has resulted in causing sever siltation in the drain and intern reducing the carrying capacity of drain.

2.8.2 Gopala Pura:

Gopala pura is situated very close to Vrishabhavathi main valley primary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered in this region.

- The existing tertiary drain bed level and primary drain bed level is almost same.

- Due to drastic reduction in width of primary drain in the down stream reach, heading up of

water is experienced.

•Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

•Large quantity of sewage flow is noticed inside the existing storm drain.

•Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

•Large quantity of surplus excavated earth generated during laying of sewer pipeline & construction of manhole has resulted in causing sever siltation in the drain and intern reducing the carrying capacity of drain.

2.8.3 Cholurpalya:

Cholurpalya is situated very close to Vrishabhavathi main valley primary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

•Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered in this region.

•The existing secondary drain bed level and primary drain bed level is almost same.

•Due to drastic reduction in width of primary drain in the down stream reach, heading up of water is experienced.

•Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

•Large quantity of sewage flow is noticed inside the existing storm drain.

•Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

•Large quantity of surplus excavated earth generated during laying of sewer pipeline & construction of manhole has resulted in causing sever siltation in the drain and intern reducing the carrying capacity of drain.

2.8.4 Binney Mill Tank Area:

This area is situated very close to Vrishabhavathi main valley Secondary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

•Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered in this region.

•Due to change in land use pattern.

•Due to covering of secondary drain in the down stream reach, the width is reduced and intern heading up of water is experienced.

•Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

•Large quantity of sewage flow is noticed inside the existing storm drain.

•Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

2.8.5 Bapujinagara:

Bapujinagara is situated very close to Vrishabhavathi main valley primary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary storm drain has been altered in this region.

- The existing tertiary drain bed level and primary drain bed level is almost same.

- Due to drastic reduction in width of primary drain in the down stream reach, heading up of water is experienced.

- Rocky out crops noticed at many places and also due to construction of buildings over these rocks the width is drastically reduced at many places.

- Due to sewer pipe line laid across storm drain near Gali Anjaneya temple,

- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

- Large quantity of sewage flow is noticed inside the existing storm drain.

- Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

2.8.6 Saneguruvanahalli:

Saneguruvanahalli is situated very close to Vrishabhavathi main valley Secondary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered in this region.

- Width of secondary drain is drastically reduced at the down stream reach near Rajajinagara ind. area.

- The existing tertiary drain bed level and primary drain bed level is almost same.

- Due to drastic reduction in width of primary drain in the down stream reach, heading up of water is experienced.

- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

- Large quantity of sewage flow is noticed inside the existing storm drain.

- Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

2.8.7 Markandeya Layout, Rudrappa Garden & Timber yard layout:

Markandeya Layout, Rudrappa Garden & Timber yard layout is situated very close to Vrishabhavathi main valley secondary storm drain. Localised flooding problem is being experienced by the residents of these regions due to the following reasons mentioned below.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered in this region.

- Drain reach is in natural condition at few places.

- The existing tertiary drain bed level and primary drain bed level is almost same.

- Due to drastic reduction in width of primary drain in the down stream reach, heading up of water is experienced.

- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

- Large quantity of sewage flow is noticed inside the existing storm drain.

- Large quantity of debris, garbage dump and vegetation growth is noticed at many places inside the existing SWD.

- Rocky out crop noticed near K.S.R.T.C. bus stop near Mysore road is causing heading up of water.

2.9 Existing Operation and Maintenance Practice

During the recent years BMP has undertaken reconstruction of drain walls and cross drains at some strategic locations to overcome the present flooding situations and also during the last two years BMP has undertaken a large scale program of desilting of storm water drains and solid waste management.

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

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

CHAPTER 3

STORM WATER DRAINAGE SYSTEM DESIGN AND ANALYSIS

3.1 INTRODUCTION:

Application of concepts and methodologies of drainage design requires establishment of design parameters of the system considered for the design. Such parameters specifies the system performance with regard to various inputs. While the design concepts and methodologies are fairly general, design parameters are site specific. Depending on the design objectives and the availability of supporting data, different design parameters may apply to each region, location and project. Various parameters that are considered and analysed are discussed here under:

3.2 DESIGN CRITERIA:

These include planning horizon, design period, catchment physical parameters, process parameters and meteorological parameters.

3.2.1 PLANNING HORIZON:

Ideally planning of storm drainage works may be implemented in two levels – planning for short term and the long term. Planning for short term considers the proposed development plans for immediate mitigative measure. Information pertaining to development plan includes population trends, comprehensive land use and zoning plan, location of future roads, airports, and industrial area which may affect the drainage design as well as jurisdictional division and financial arrangement. The long term planning process reflects the ultimate development anticipated over a period of time which may be as long as 25 to 50 years. But, these may not be feasible for well developed cities, to accommodate higher size drains in already developed layouts. Therefore, one best alternative approach is to backfit the drain capacity with respect to the prevailing site conditions and arrive at the suitable return period, which is acceptable to the implementing agency.

3.2.2 DESIGN PERIOD:

Planning horizon reflects the envisaged land use projected for a certain number of years, the design period of drainage system indicates the expected levels of protection against such phenomena as flooding, health hazard or deterioration in the quality of receiving waters. Besides the desired level of protection, the design period depends on construction cost and damage (losses) resulting from system failures. The planning horizon may be linked to the longest design life of structures under design. Thus, while there is only one planning horizon for a drainage area, the design period may differ for the individual system components.

The TOR specifies that the acceptable design standards commensurate with the anticipated runoff volume in the next 20 years be determined in Phase-I. Thus, it is considered that the adequacy of the existing primary and secondary storm drains be studied, for the anticipated runoff rate over the next 20 years.

But, after consecutive discussions with BMP and also based on prevailing site conditions, it was decided by BMP and agreed, that inorder to incur minimum construction cost, minimum land acquisition and to avoid large scale distraction of properties adjoining to drains, it was decided to consider five year return period for drains.

3.2.3 PHYSICAL PARAMETERS OF CATCHMENT:

Base maps showing the project area, topographical details like contour, water courses, tanks, wooded areas, rocky outcrops, marshes, etc., details of existing and proposed land uses, existing and proposed drains for establishing the study area drainage boundaries, general drainage pattern in these areas, surface slopes and total catchment area are developed. The catchment area is divided into pervious and impervious areas. In addition, the existing drainage channels in the catchment need to be characterized in terms of the cross sections, slopes, lengths, and linkages. The extent of development of the catchment has significant bearing on the runoff calculations.

3.2.4 PROCESS PARAMETERS:

These include infiltration rates, depression storage, roughness of transport elements and runoff coefficient. Generally, these parameters will be considered together as a lumped aggregate parameter.

3.2.5 METEOROLOGICAL DATA:

Important input for runoff computation is rainfall data. Rainfall data processing may be carried out by many approaches. Some of the methods are as listed and explained here under,

1. CPHEEO MANUAL
2. CALIFORNIA METHOD OF RANKING
3. GUMBEL'S DISTRIBUTION METHOD
4. LOG – PEARSON TYPE III DISTRIBUTION

3.2.5.1 RAIN FALL ANALYSIS USING CPHEEO METHOD:

The rainfall data, for the period of past 25 years (i.e., from 1976 to 2001) has been collected from IMD. And analysis for calculating the frequency of storms for the stated intensities and duration has been computed and the same is tabulated.

From the tabulated values, storm occurrences for the different years has been computed and time intensity values for these frequencies has been obtained by interpolating the values for storms occurring once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years.

Using log-log sheet, a graph has been plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years respectively. From the best fit line, values of 'a' & 'n' are obtained. Further the same is substituted in the equation below.

$$i = \frac{a}{t^n}$$

Where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' and 'n', different values of " i " for a various values of " t " are calculated and tabulated. A curve is plotted using an ordinary graph paper.

Another graph of runoff coefficients (c) v/s duration time (t) is plotted as per the values given in Horner's table (Table 3.3, Pg. No. 45 of CPHEEO Manuel).

3.2.5.2 RAIN FALL ANALYSIS USING RANKING METHOD:

The rainfall data for a period of 25 years is collected from Indian Meteorological Department (IMD). From the rainfall data, intensity of highest rainfall is considered in that particular duration and year which is arranged in descending order and the rank is assigned with a rank one to the highest value, a rank of two to the next highest value and so on. Whenever a particular value occurs more then once, all the values should have the same rank as they are equal. Further, recurrence interval or frequency corresponding to each rank can be calculated using a formula

$$N = T \times m$$

Where 'm' is the number of times, given rain is equalled or exceeded and is known as the ranking of the storm or ranking number

Extracting rainfall of various duration for desired frequency, further calculation of rainfall intensity in mm/hour has been done.

Using log-log sheet, graphs have been plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years respectively. From the best fit curve, values of 'a' &'n' are obtained. Further, the same are substituted in the equation below.

$$i = \frac{a}{t^n}$$

Where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' & 'n' different values of 'i' for a various values of 't' are calculated and tabulated. A curve is plotted using an ordinary graph paper.

3.2.5.3 RAIN FALL ANALYSIS USING GUMBEL'S DISTRIBUTION METHOD:

The rainfall data for a period of 25 years is collected from IMD and the highest rainfall intensity in that particular duration and year is considered and it is arranged in a sequential order. For each duration, the mean and standard deviation are calculated. Subsequently, the amount of rainfall for various duration and return period is calculated using the below equation.

$$X T = X + K Sx$$

Where, X is the mean.

Sx is the standard deviation of the sample of extreme rainfall.

X_T is the rainfall amount which is equalled or exceeded on an average once in 'T' years.

K is the frequency factor which can be expressed in terms of the return period 'T' and the number of years of record 'N',

The value of 'K' can be obtained from standard table.

By substituting the values of 'X', 'Sx' and 'K'. The value of 'K' can be obtained from standard table (from S.K Garg, Table 10.6) for N = 25 and return periods varying from 1 to 20 years.

Amount of rainfall obtained will be tabulated and further the same is converted into rainfall intensities and tabulated.

Using log-log sheet, a graph is plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years. From the best fit curve, values of 'a' & 'n' are obtained. Further the same is substituted in the equation below.

$$i = \frac{a}{t^n}$$

where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' & 'n', different values of 'i' for various values of 't' are calculated and tabulated, a graph is plotted on an ordinary graph sheet.

Values obtained from the above three methods are compared with other design parameters which is suitable for the present site conditions and that method is adopted for computing storm water runoff.

3.2.6 STRUCTURAL DESIGN PARAMETERS :

Parameters and standards considered for design of sub structures, super structures and cross drainage works are as follows;

1.The structures are categorized as per Table-5B of IRC : 21-2000. Since the materials used are RCC, PCC and Stone masonry and in case of bridges total length is generally less than 60 m. In case the total length of the bridge is more than 60 m. or any innovative design approach is adopted the same is categorized as per Table - 5A of IRC : 21-2000.

2.For design purposes the condition of exposure is considered as SEVERE. Since the structures are in contact with untreated sewage and drainage effluent.

3.The following materials are proposed to be used in the structures.

i.Minimum Grades of Concretes used are as below

- M15 - In levelling course below RCC, PCC & Stone masonry foundations, pile caps, approach slabs and in footpath fillings.
- M20 - In PCC structural elements like retaining walls & abutments
- M25 - In kerbs, hand rail, and posts, approach slab, retaining walls, piers, pile caps and abutments.

- M35 - In crash barriers, super structures, box culverts & piles etc.
- Maximum water cement ratio shall be 0.45.

ii. Grade of steel to be used is Fe 415.

iii. Course rubble stone masonry for bridge works such as abutments.

iv. Random rubble stone masonry for retaining structures other than bridge abutments.

v. CM 1:3 for stone masonry.

vi. PVC pipes for weep holes in retaining walls and provision for service lines in superstructure.

vii. Elastomeric bearings for beam and slab type superstructure.

viii. Compression seal expansion joint for joints along longitudinal direction in carriage way portion of superstructure.

ix. PVC water bar type expansion joint for superstructures with beam and slab arrangement.

x. Premoulded bitumen filling joint for solid slab type superstructures covering full depth.

xi. Premoulded bitumen filling joint for retaining walls.

xii. Asphalted concrete wearing coat over mastic asphalt.

xiii. Back filling behind abutments, returns and retaining walls shall be with granular materials with soil as per Appendix-6 of IRC : 78-2000.

xiv. GI drainage spouts as per drawings.

4. Minimum dimensional requirements:

i. Levelling course - 100 mm. thick below RCC / PCC foundations.
- 300 mm. thick below stone masonry foundations on soil base.
- 150 mm. thick below stone masonry foundations on rock base
- 150 mm. thick below approach slabs.

ii. Walls - 200 mm. thick for RCC / PCC walls.
- 500 mm. thick for stone masonry walls.

iii. Wearing coat on deck slabs shall be 50 mm. thick asphalted concrete in two layers of 25 mm. each over 6 mm. thick mastic asphalt. Thickness of asphalted concrete shall be varied suitably to achieve the slopes for camber or super elevation.

iv.Normal camber considered is 2.5 %.

v.Weep holes with PVC pipes (100 mm. dia. in RCC and 150 mm. dia. in stone masonry) shall be used in retaining structures including abutments and retaining walls. The spacing of weep holes shall be 1.0 m. in either direction in staggered way, with lowest at about 150 mm. above the low water level or ground level which ever is higher. (MOST Spec. : 2706).

5.Loading :

Density of PCC	=	2.2 t/m^3
RCC	=	2.4 t/m^3
Stone masonry	=	2.2 t/m^3
Back filling	=	2.0 t/m^3

i.Load due to wearing coat = 0.2 t/m^2

ii.Load due to crash barrier = 0.8 t/m On each side.

iii.Load due to hand rail and kerb = 0.95 t/m On each side.

iv.Load due to services in footpath = 0.1 t/m On each side.

v.Foot path live load = 0.5 t/m^2 On each side.

vi.Vehicle live loads are as per clause 207.4, Table-2 of IRC:6-2000 for different carriage ways.

vii.Load due to water current as per clause 213 of IRC : 6 -2000.

viii.Live load surcharge is 1.2 m height of back fill.

ix.Buoyancy force as per clause 216 of IRC : 6-2000.

x.One span dislodged condition is not considered in the case of slab bridges not provided with bearings. (As per clause 221.1 of IRC:6-2000.)

xi.Seismic forces are not considered as the structures are located in Seismic Zone-1. (As per clause 222.1 of IRC : 6-2000.)

6.Miscellaneous details :

i.Bridges or culverts with out footpath are provided with crash barrier / Hand rail.

ii. Bridges or culverts with footpath are provided with hand rails as per SD/202 of MOST STD drawing with or with out crash barrier at the edge of carriage way.

iii. Drainage spouts in the superstructure of the bridge or culverts are as per SD/205 of MOST STD drawing.

3.3 CATCHMENT ANALYSIS:

To study the hydrological conditions and drainage characteristics of Vrishabhavathi main valley catchment area, the following analysis procedure has been adopted

- Identification of ridge line and demarcation of catchment boundary.
- Demarcation of primary and secondary valleys.
- Demarcation of entire catchment into micro/sub catchments.
- Identification of flow regions within micro catchments.
- Codification of flow regions.
- Characterisation of the entire catchment in terms of landuse categories.
- Identification of open and closed reach of drains.
- Assignment of the degree of imperviousness to rainfall for the above categories.
- Computation of weighted average imperviousness for each of the flow region.

The ridge lines of Vrishabhavathi main valley catchment area are demarcated based on the available 10 m. interval elevation contour information in the survey of India 1:20,000 scale topo map for Bangalore city. On which the valley lines and the local ridge lines are identified to demarcate the sub catchments and flow regions. These details prepared on 1:20000 scale map are digitized to generate a vector layer in Arcview GIS as line coverage, as well as polygons coverage. After the transformation of the coverage with reference to the map used for digitization, various attribute details on length of arcs and area of polygons are analyzed to obtain the length both primary and secondary drains and area of catchment, sub catchment and micro catchment and the same is also indicated in Figure 3.1.

Further, to calculate the inlet time and time of concentration the sub/micro catchments are segmented into different flow regions based on terrain slope and other aspect derived from contour information. The area details of the micro catchments codes, flow regions, land use characteristics in Vrishabhavathi main valley are provided in

Table – 3.1 & Table – 3.2.

Table 3.1 VRISHABHAVATHI MAIN VALLEY (V100) MICRO CATCHMENT CODE

Sl. No.	Micro Catchment Code	Area (Ha.)
1	A1	595.76
2	A10	224.76
3	A11	171.44
4	A12	242.4
5	A13	71.54
6	A15	111.79
7	A18	80.75
8	A19	80.53
9	A2	450.95
10	A20	66.44
11	A21	107.14
12	A22	66.02
13	A23	80.69
14	A3	56.31
15	A4	108.55
16	A5	94.41
17	A6	191.41
18	A7	113.96
19	A8	28.03
20	A9	463.98
21	B3	61.69
22	C2	80.83
23	C4	49.68
24	C5	25.83
	TOTAL	**3624.89**

Table 3.2 VRISHABHAVATHI MAIN VALLEY (V100) FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1.	A1(a)	163.84

2.	A1(b)	124.98
3.	A1(c)	215.5
4.	A1(d)	91.44
5.	A10(a)	39.88
6.	A10(b)	26.24
7.	A10(c)	85.47
8.	A10(d)	73.17
9.	A11(a)	48.04
10.	A11(b)	25.51
11.	A11(c)	57.91
12.	A11(d)	39.99
13.	A12(a)	125.59
14.	A12(b)	116.81
15.	A13	71.54
16.	A15	111.79
17.	A18(a)	47.3
18.	A18(b)	33.45
19.	A19(a)	36.92
20	A19(b)	43.61
21	A2(a)	130.39
22	A2(b)	103.82
23	A2(c)	52.91
24	A2(d)	49.64
25	A2(e)	114.19
26	A20	66.44
27	A21	107.14
28	A22(a)	33.33
29	A22(b)	32.69
30	A23	80.69
31	A3	56.31
32	A4(a)	49.79
33	A4(b)	58.76
34	A5(a)	51.18
Sl.No.	**Flow Region Code**	**Area (ha.)**
35	A5(b)	43.23
36	A6(a)	51.03
37	A6(b)	70.67

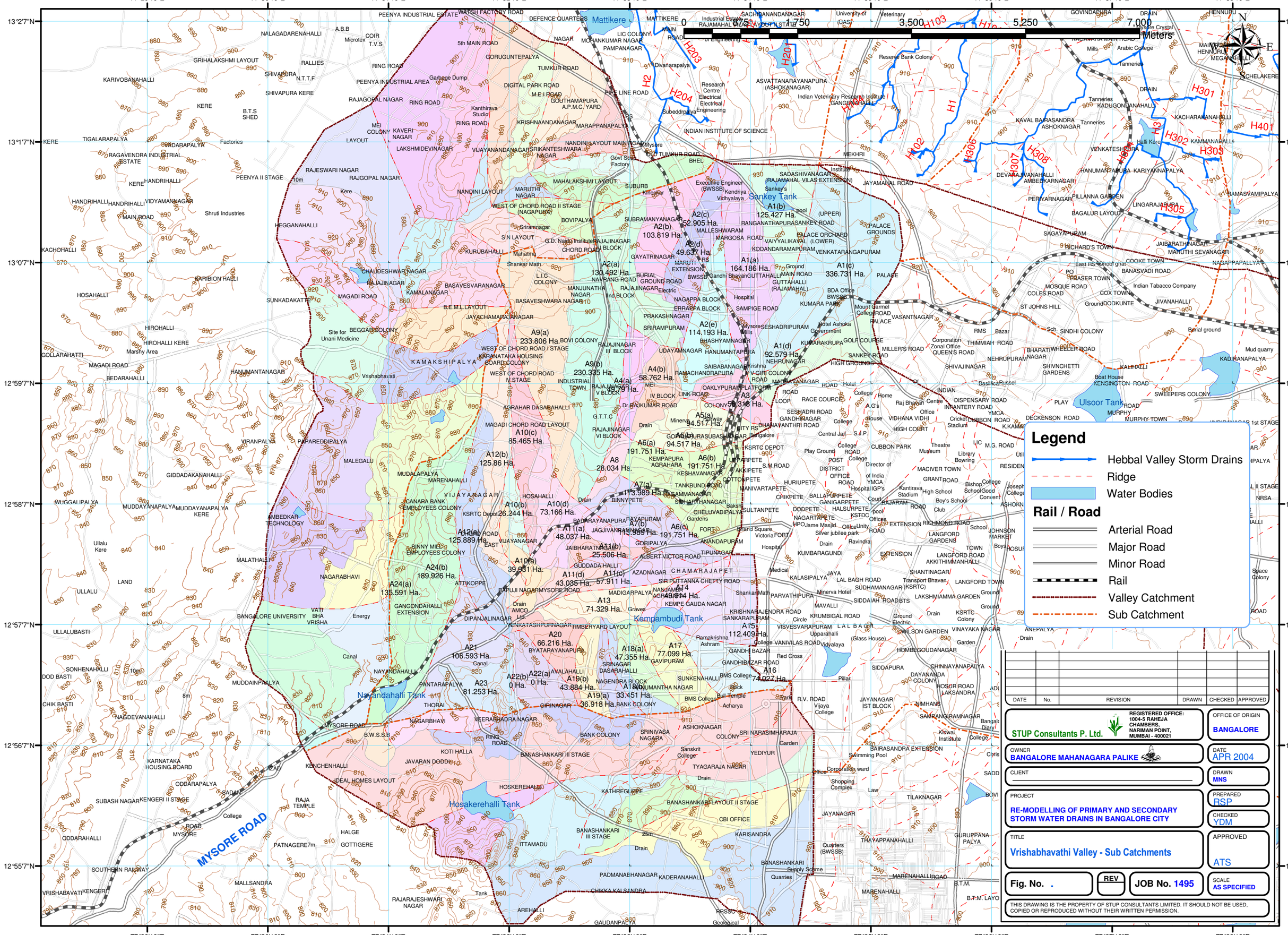
38	A6(c)	69.71
39	A7(a)	56.93
40	A7(b)	57.03
41	A8	28.04
42	A9(a)	233.72
43	A9(b)	230.26
44	B3	61.69
45	C2	80.83
46	C4(a)	19.79
47	C4(b)	29.89
48	C5	25.83
	TOTAL	**3624.89**

Using digital image processing technique and also by visual interpretation, satellite image is used to analyze the catchments and categorise the same for various landuse categories as listed below and further at strategic locations the processed results are cross verified at site and accordingly range of percent imperviousness is assigned for each category.

1. Highly / Dense built up area with sparse vegetal cover
2. Dense built up area with medium / thick vegetal cover
3. Built up area with more open space as well as fairly dense vegetal cover
4. Open space with no vegetal cover / Open space with scrubs and other vegetation
5. Parks
6. Water bodies

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 is shown in Table - 3.3.

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 plans for the entire Vrishabhavathi main valley is generated by incorporating the drainage lines, ridge lines, flow region boundaries and the landuse


77°29'19"E
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77°37'19"E
77°38'19"E
13°2'7"N
13°1'7"N
13°0'7"N
12°59'7"N
12°58'7"N
12°57'7"N
12°56'7"N
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1,750
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E
S
Mattikere
Sankey Tank
Kempambudi Tank
Nayandahalli Tank
Hosakerehalli Tank
Ulsoor Tank
MYSORE ROAD
Legend
Hebbal Valley Storm Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Valley Catchment
Sub Catchment
DATE
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APPROVED
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
STUP Consultants P. Ltd.
OFFICE OF ORIGIN
BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
DATE
APR 2004
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
RSP
CHECKED
YDM
TITLE
Vrishabhavathi Valley - Sub Catchments
APPROVED
ATS
Fig. No. .
REV
JOB No. 1495
SCALE
AS SPECIFIED
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and land cover categories and the same is indicated in Figure 3.2.

The weighted average percent imperviousness (IW) for each flow region is computed and is given by

$$IW = \frac{I_1 A_1 + I_2 A_2 + I_3 A_3 + I_4 A_4 \ldots\ldots}{A_1 + A_2 + A_3 + A_4 \ldots\ldots}.$$

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 3.3 VRISHABHAVATHI MAIN VALLEY (V100)
LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	2579.45	75 – 90
2.	Dense built up area with medium / thick vegetal cover	316.04	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	351.08	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	289.79	10 – 25
5	Parks	47.4	05 – 20
6	Water Bodies	41.13	--
	Total	**3624.89**	

3.4 DESIGN PROCEDURE:

3.4.1 GENERAL:

Having understood the site conditions and terms of reference it is proposed to adopt the approach philosophy of which revolves around 4 cardinal points viz.:

77°29'19"E 77°30'19"E 77°31'19"E 77°32'19"E 77°33'19"E 77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E

13°2'7"N 13°1'7"N 13°0'7"N 12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N

0 875 1,750 3,500 5,250 7,000 Meters

Legend

- Drains
- Ridge
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Valley Catchment
- Sub Catchment

LandUse

- Dense Builtup Area
- Medium Builtup Area
- Open Space with Vegitation
- Open Space No Vegitation
- Parks / Vegitation
- Water Bodies
- Industrial Areas

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

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OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: APR 2004

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED: RSP

CHECKED: YDM

TITLE: Vrishabhavathi Valley - Land Use Map

APPROVED: ATS

Fig. No. .

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JOB No. 1495

SCALE: AS SPECIFIED

1. Understanding the project requirements and the accomplishment of the overall objective of the project.

2. Appreciation of the various factors that help or hinder the overall objective of the project both from the review of available documents and a field visit to support the overall objective.

3. Ensuring ways and means of assuring quality of the contract deliverables taking into considerations the factors – efficiency of function, economy of implementation, ease of construction and recognising the link of designs-operations interactions.

4. Ensuring quality assurance in the materials and methods of execution including modern methods of construction for early completion of the works.

And also review of available data through site appreciation leads us to formulate the method of working to ensure:

•High degree of professional standards in designing the components.
•Clear detailing that will facilitate working and
•Quality assurance in the contract deliverables.
•Quality assurance in execution of contract.

In order to accomplish these objectives, following issues need to be addressed, as applicable for each of the three stages of the project Viz. Feasibility report, Detailed Project Report and Construction Supervision.

3.4.2 STORM WATER RUNOFF:

The storm water run off is the balance of rain water precipitation on the ground which flows in drains after a part of storm water getting infiltration into the soil, retention in surface depressions and evaporated. The rate of storm water run off to be used for design of storm sewers is complex to evaluate accurately. The rate of precipitation which causes the runoff is highly variable from place to place even within a smaller region of the city. The rainfall recording stations from which the intensity of

precipitation and duration of rain fall is obtained for the design of storm water drains in many instances are remotely located from the area where the storm water drain has to be designed. The geological formation of the sub-surface will also be varying and estimations of these losses are complex. Numerous empirical runoff formulae had been used for estimation of storm water runoff. Some of the methods adopted are:

1.1.Rational method (Lloyd-Davis method evolved in the United Kingdom).

1.2.Hydrographs (Over-land Flow) method.

1.3.Inlet Method.

1.4.Unit Hydrograph method.

Out of the above methods, the rational method is widely used throughout the World. More than 90% of the Engineering offices through out the United States have confirmed in a questionnaire in the year 1956 with the rational method of design has given satisfactory results for urban drainage areas. The Ministry of Urban Development, Government of India, New Delhi, Central Public Health and Environmental Engineering Organization, has also recommended the estimation of storm water runoff by rational method.

3.4.2.1. RATIONAL METHOD:

The entire precipitation over the drainage district does not reach the storm water drains. The characteristics of the drainage district such as imperviousness, topography including depressions and water pockets, shape of the drainage basin and duration of the precipitation determine the function of the precipitation, which will reach the drain. This fraction known as the coefficient of runoff needs to be determined for each drainage district. The runoff reaching the drain is given by the expression,

$$Q = 10\ C\ i\ A$$

Where, 'Q' is the runoff in m^3/hr;

'C' is the coefficient of runoff;

'i' is the intensity of rainfall in mm/hr. and

'A' is the area of drainage district in hectares.

3.4.3. STORM FREQUENCY:

Urban storm drains 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 drain depends on the importance of area to be drained. Commercial and industrial areas have to be subjected to less frequent flooding. Manual on Sewerage and Sewage Treatment by the Ministry of Urban Development recommend the following:

- Residential area and Peripheral areas Twice a year
- Central and high priced areas Once a year
- Commercial and high period areas Once in two years.

3.4.4 INTENSITY OF PRECIPITATION:

The intensity of rainfall decreases with duration. Analysis of the observed data on intensity duration of rainfall of past records over a. period of years in the area is necessary to arrive at a fair estimate of intensity - duration for given frequencies. The longer record available, the more dependable is the forecast. In Indian conditions, intensity of rainfall adopted in design is usually in the range of 12 mm./hr. to 20 mm./hr. Rainfall data over a period of 25 years is collected and considered.

Frequency of storms of intensities 10 mm./hr to 120 mm./hr. for duration of 5 min. to 120 min. are tabulated, and the number of storms that had occurred for the stated intensities and duration for the desired frequency of storms (once in a year and once in two years) are considered.

The relationship between intensity and duration of storm may be expressed by a suitable, mathematical formula, several forms of which are available. The following two equations are commonly used.

$$\text{i)} \quad i = \frac{a}{t^n} \qquad \text{------}$$

$$\text{ii)} \quad i = \frac{a}{t + b} \qquad \text{------}$$

Where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

The available data on 'i' and 't' are plotted and the values of the intensity (i) can be determined for any given time of consideration, (t_c).

3.4.5. TIME OF CONCENTRATION:

It is the time required for the rain water to flow over the ground surface from the farthest point of the drainage basin to reach the nodal point i.e., under consideration.

Time of concentration (t_c) is equal to inlet time (t) plus the time of flow in the drain (t). The inlet time is dependent on the distance of the farthest point in the drainage basin to the inlet of the drain, the shape, characteristics and topography of the basin may generally vary. The time of flow is determined by the length of SWD and the velocity of flow in the SWD. It is to be computed for each length of SWD to be designed.

3.4.6. COEFFICIENT OF RUNOFF:

The portion of rainfall which finds its way to the drain is dependent on the imperviousness and the shape of tributary area, apart from the duration of storm.

1) 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 may 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.

3.4.7. TRIBUTARY AREA:

For each length of storm sewer, the drainage area should be indicated clearly on the map and measured. The boundaries of each tributary are dependent on topography,

land use, nature of development and shape of the drainage basins. The incremental area may be indicated separately on the compilation sheet and the total area computed.

3.4.8. DURATION OF STORM:

The concept of design storm is developed to account for the time varying rainfall input as against the constant intensity design rainfalls. The assumption made in this concept is that the return period of the calculated runoff event is identical to the design storm.

For selected return period, the design storm is characterized by the duration, total amount of rainfall, the maximum rainfall intensity of a certain short duration, the timing of peak intensity and temporal storm rainfall distribution.

Continuously long light rain saturates the soil and produces higher coefficient than that of heavy rainfall for shorter duration. But intermittent rains in the same area causes lesser saturation in the latter case. Runoff from an area is significantly influenced by the saturation of the surface near the point of concentration, rather than the flow from the distant area. The runoff coefficient of a larger area has to be adjusted by dividing the area into zones of concentration and by suitably decreasing the coefficient with the distance of the zones.

3.4.9. COMPUTATION OF RUNOFF COEFFICIENTS:

The weighted average runoff coefficients for rectangular areas of length four times the width as well as for sector shaped areas with varying percentages of impervious surface, for different times of concentration are given in Table 3.4. Although these are applicable to particular shape of areas, they also apply in a general way to the areas which are usually encountered in practice. Errors due to difference in shape of drainage are within the limits of accuracy of the rational method and of the assumption on which it is based.

TABLE – 3.4 Table of CPHEEO Manual - Runoff Coefficient

Duration t, minutes	10	20	30	45	60	75	90	100	120	135	150	185

Weighted average coefficients												
1. Sector concentrating in stated time												
a) Impervious	.525	.588	.642	.700	.740	.711	.795	.813	.828	.840	.850	.865
b)60% impervious	.365	.427	.477	.531	.569	.598	.622	.641	.656	670	.682	.701
c)40% Impervious	.285	.346	.395	.446	.482	.512	.535	.554	.571	.585	.597	.618
d) Pervious	.125	.185	.230	.312	.312	.330	.362	.382	.399	.414	.429	.454
2. Rectangle (length = 4 x width) Concentrating in stated time												
a) Impervious	.550	.648	.711	.768	.808	.837	.856	.869	.879	.887	.892	.903
b)50% Impervious	.350	.442	.499	.551	.590	.618	.639	.657	.671	.683	.694	.713
c)30% Impervious	.269	.360	.414	.464	.502	.530	.552	.572	.588	.601	.614	.636
d) Pervious	.149	.236	.287	.334	.371	.398	.422	.445	.463	.479	.49	.522

3.5. HYDRAULICS OF STORM DRAIN:

Flow capacity of open channels is calculated for each stretch of drain, of different bed slope using Manning's formula.

$$V = [(l/n)] \times [R^{2/3} S^{1/2}]$$

The Mannings co-efficient 'n' for various drain surfaces are Masonry with;

a.Neat cement plaster	0.013
b.Sand and cement plaster	0.015
c.Concrete, steel troweled	0.014
d.Concrete, wood troweled	0.015

e.Brick in good condition	0.017	
f.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	

3.5.1 RATIONAL METHOD:

The Rational method is based on the following assumptions :

1)The peak rate of runoff at any point is a direct function of the average rainfall intensity during the time of concentration to that point.

2)The frequency of the peak discharge is the same as the frequency of the average rainfall intensity. The time of concentration is the time required for the runoff to become established and flow from the most remote part of the drainage area to the point under design.

The later assumption applies to the part most remote in time, not necessarily in distance. In the rational method, average intensities have no time sequence relation to the actual rainfall pattern during the storm. The intensity duration curve used in this method is not a time sequence curve of precipitation.

The determination of values for the coefficient of runoff is difficult because this factor must represent many variables, including infiltration, ground slope, ground cover, surface and depression storage, antecedent precipitation and soil moisture, shape of drainage area, overland flow velocity, etc.

AREA:

The area of tributary to any point under consideration in a storm-sewer system must be determined.

Boundaries of the drainage area may be established by field surveys or from suitable maps or aerial photographs.

The complete drainage area is subdivided into sub-catchments and further into micro catchments for each tributary upto the point of inlet. This requires a preliminary layout of the system and tentative location of inlet point. Rearrangement of the system layout or of inlet location often is indicated as the design process proceeds. This requires reorganisation of component parts of the main drainage area to conform to the system layout and inlet scheme finally adopted.

3.5.2RAINFALL:

(a) Rainfall intensity factor, Determination of rainfall intensity, 'i' for storm-sewer design involves consideration of the following factor:

1. Average frequency of occurrence
2. Intensity - duration characteristic of rainfall for selected average frequency of occurrence.
3. Time of concentration.

b) Rainfall frequency: The average frequency of rainfall occurrence used for design determines the degree of protection afforded by a given storm drain system. This protection should be consistent with the amount of damage prevented. But in practice, cost-benefit studies usually are not conducted for the ordinary urban storm drainage project. Judgement supported by records of performance in other similar areas is usually basis of selected frequency.

The range of rainfall frequency used in engineering practices is as follows:

1)For storm drains in residential areas, 2 to 15 years with 5 year most commonly reported.

2)For storm drains in commercial and high value areas, 10 to 50 years, depending on economic justifications.

3)For flood protection works, 50 years or more

In the analysis of point rainfall intensity-duration data, there are two approaches, the annual duration and partial-duration series. In the annual duration series, for each duration selected, the heaviest rainfall that occurred in each year is listed, with no tabulation of lesser intensities during the same calendar year, even though some of them might be greater than rainfall intensities that occurred in other years of record. The first of these methods gives the probability of occurrence that the maximum rainfall in anyone year for a specified duration will equal or exceed in given intensity. In the other treatment of the data, partial duration series, all rainfall intensities above a practical minimum for each duration for the entire period of record are included. The second method gives the frequency or the number of occurrences in a given period of time that a rainfall of given intensity and duration will be equal or exceeded.

Sherman has injected the concept of "extended duration" which has been used widely and is recommended for developing rainfall intensity frequency data. In this method, if the total precipitation in a storm is sufficient to show significant average rates for periods longer than the actual duration of the rainfall, such storms are included in the data compilations as multiple events as though they had continued for the longer times. For example, a rainfall amount for an actual 50 min storm would be listed not only as a 50-min storm with its corresponding intensity, but also as a 60-min or 90-min, or longer duration storm with a corresponding lesser intensity.

Table - Empirical Factors for Converting Annual-Duration Series to Partial-Duration Series

Return Period (Years)	Multiplier
2	1.14
5	1.04
10	1.01

Time of Concentration - An estimate of the time of concentration to the point under consideration is made so that the average rainfall rate may be determined. For urban

storm sewer the time of concentration consists of the inlet time plus the time of flow in the sewer from the most remote inlet to the point under consideration.

Time of flow in the sewer may be estimated closely from the hydraulic properties of the conduit. Inlet time is the overland flow time for runoff to reach established surface drainage channels such as street gutters and ditches and travel through them to the point of inlet.

Inlet time will vary with surface slope, nature of surplus cover, and length of path of surface flow, as well with the variables influenced by antecedent rainfall intensity and duration such as infiltration capacity.

3.5.3 RUNOFF COEFFICIENTS:

General Considerations.- The runoff coefficient, 'C' is the variable in rational method, which is least susceptible to precise determination. Its use in the formula implies a fixed ratio for any given drainage area, whereas, in reality, the coefficient accounts for abstractions or losses between rainfall and runoff which may vary for a given drainage area as influenced by differing climatological and seasonal conditions.

These losses, together. with their order of magnitude as observed by various investigators include:

1) Interception by vegetation. This is not usually significant in urban drainage but may range from 0.01 to 0.5 in. (0.03 to 0.13 cm.) in forest areas, depending on type of cover.

2) Infiltration into permeable soils. The ability of a soil to absorb water and percolate it to deeper groundwater is affected by certain events before and during a given storm, such as compaction of the surface, in-washing of finer sediments, and swelling of clays or colloidal soils. The Hydrology Handbook gives the following range of value of infiltration capacity. !f various types of bare soils after 1 hr. of continuous rainfall.

Soil Group	Infiltration (In./hr.)

High (sandy, open structured)	0.50 to 1.00
Intermediate (loam)	0.10 to 0.50
Low (clay, dense structured)	0.01 to 0.10

Note: In. x 2.54 = cm.

The hand book also notes the profound influence of ground cover showing that bare-soil infiltration capacity can be increased from 3 to 7.5 times with good permanent forest or grass cover, ranging down. to little or no increase with poor row crops. Antecedent precipitation also affects soil infiltration capacity, but few quantitative data are available to evaluate this factor.

Retention in Surface Depressions.- The excess rainfall fills depressions essentially present in all surfaces. Retention in forest litter may be as much as 0.3 in. (0.08 cm.): in good pasture, 0.2 in. (0.05 cm.): and in smooth cultivated land, 0.05 to 0.10 in. (0.13 to 0:3 cm.). In urban areas of moderate grade, recent gauging shows retention to be about 0.05 in. (0.13 cm.) for impervious surfaces. Retention has been assumed to be 0.10 in. (0.3 cm) for surfaces such as lawns and normal urban pervious surfaces.

Evaporation and Transpiration - These are of little significance for the short rainfall duration encountered in urban storm drainage design.

Average Coefficients.- The use of average coefficients for various surface types, which are assumed not to vary through the duration of the storm is common.

The range of coefficient, classified with respect to the general character of the tributary area reported in use is :

Description of Area	**Runoff coefficients**
Business	
Down Town	0.70 to 0.95
Neighbourhood	0.50 to 0.70
Residential	
Single Family	0.30 to 0.50
Multi-Units, detached	0.40 to 0.60
Multi-Units, attached	0.60 to 0.75

Description of Area	Runoff coefficients
Residential (Suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yards	0.20 to 0.35
Unimproved lands	0.10 to 0.30

It often is desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. This procedure often is applied to typical "sample" blocks as a guide to selection of reasonable values of the coefficient for an entire area. Coefficients with respect to surface type currently in use are:

Character of Surface	Runoff Coefficients
Pavement	
Asphaltic and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil	
Flat, 2 percent	0.05 to 0.10
Average, 2 to 7 percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average, 2 to 7 percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

The coefficient in these two tabulations are applicable for storms of 5 to 10 years frequencies. Less frequent, higher intensity storms will require the use of higher coefficients because infiltration and other losses have a proportionally smaller effect

on runoff. The coefficient based on the assumption that the designs storm does not occur when the ground surface is frozen.

3.6. APPLICATION OF RATIONAL METHOD:

After the items discussed in the proceeding sections have been determined or estimated, a tentative arrangement of the proposed system including the location of inlets is made to permit division of the whole drainage area into sub districts tributary to sections of the storm sewer system.

Coefficients are selected or estimated which are appropriate for the land use and development expected at the end of the period of design.

Rainfall frequency consistent with degree of protection desired is selected and intensity-duration curves for the locality are developed from available rainfall records or from such other data as may be available (6).

Many designers find it convenient to reduce the rainfall – intensity relationship to a family of curves of runoff for rainfall intensities of selected frequencies. Such curves indicate the product of the runoff coefficient and average rain intensity (18). Other designers suggest weighing the size of the areas to reflect the variation imperviousness of individual sub areas from the average imperviousness of the project area. The weighted area size then is applied to the runoff curve developed for the average degree of imperviousness.

3.7 PROCESSING OF RAINFALL DATA:

Estimation of storm run-off depends on many factors and is difficult to evaluate accurately. It however demands a study of rainfall data for the past few years with regard to intensity and duration of each spell etc. Indian Meteorological Department, (IMD) Bangalore was contacted to furnish the rainfall data and they made available rainfall data i.e. intensity and duration at 15 minutes intervals for the years 1976 to 2001 (25 years) and it was possible to carry out the analysis of the frequency of storms of stated intensities and durations. In general there are two approaches in the analysis of rainfall intensity - duration data viz., (1) Annual - duration. series and (2) Partial - duration series. In partial - duration series, all rainfall intensities above a practical

minimum for each duration for the entire period of record are included and hence this series is adopted for the analysis with the concept of "extended duration" as recommended by American Society of Civil Engineers manual. Due to practical limitations IMD have not been able to give the amount of spells less than 15 minutes for longer duration of rainfalls i.e. for 5 and 10 minutes durations, having higher intensities. As this is an essential data, corresponding higher intensity rainfall for lesser duration of 5 and 10 minutes was computed, from the available heaviest rainfall. in 15 minutes. The occurrence values thus arrived at are plotted on a graph paper against the time duration for various intensities of rainfall viz. 15 mm/hr to 240 mm/hr., are plotted on graphs, and the line of best fit is drawn for each curve of Occurrence vs. Duration. From these lines of best fit marked in the graphs of each intensities, the frequency of storms for different stated duration are finally derived.

Table – 3.5 gives the analysis of the frequency of storms of stated intensities and duration during the past 25 years.

Table 3.5

Table 3.6 Time intensity values of storms

Intensity (i) mm/hr.	Duration (t) in minutes				
	One year storm (i.e. 25 times)	Two year storm (i.e. 12.5 times)	Five year storm (i.e. 5 times)	Ten year storm (i.e. 2.5 times)	Twenty year storm (i.e.1.25 times)
15	123.75	202.50	-	-	-
20	101.25	155.63	202.50	-	-
25	65.63	106.88	165.00	217.50	236.25
30	51.00	77.50	120.00	187.50	206.25
35	39.38	69.38	112.50	157.50	176.25
40	30.00	57.50	97.50	127.50	146.25
50	23.75	55.86	75.00	108.75	118.13
60	-	34.39	67.50	92.50	98.75
70	-	16.00	30.00	48.75	58.13
80	-	-	24.00	37.50	51.63
90	-	-	18.75	28.00	41.25
100	-	-	-	18.75	28.13
120	-	-	-	-	-

The time intensity values for these frequencies are obtained by interpolation and given in Table 3.6, for storm occurring once a year, once in 2 year, once in 5 year, once in 10 year & once in 20 years.

A graph (Fig. 3.3 to 3.7) is plotted using the values of 'i' and 't' from Table-3.6 for once a year, once in two years and once in five years storms on a log-log paper. As per central Public Health and Environmental Engineering organisation (CPHEEO) manual guidelines, once a year frequency of storm is considered for central and comparatively high priced areas, for commercial areas once in two years frequency of storm is to be considered. In addition once in five years, ten year and twenty year frequency is also considered for checking, the adequacy of culverts and the adequacy of drain reach near flood prone areas.

The generalised formula adopted for intensity and duration is :

$$i = \frac{a}{t^n} \quad \text{------}$$

Where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

From the line of best fit marked in the graph (Fig. 3.3 to 3.7) the values of 'a' and 'n' are found out for one, two, five, ten and twenty year storms. From the plotted best fit line, values of 'a' and 'n' are obtained:

(i) a = 414.25 and n = 0.673 for storm once a year.
(ii) a = 511.91 and n = 0.6399 for storm once in two years,
(iii) a = 570.75 and n = 0.5987 for storm once in five years.
(iv) a = 568.72 and n = 0.5476 for storm once in ten years.
(v) a = 976.47 and n = 0.6442 for storm once in twenty years.

Now using the above equation and substituting, the values of 'a' and 'n' , different values of 'i' for various values of 't' are calculated and tabulated in Table 3.7.

TABLE – 3.7

Duration "t" in minutes	**Intensity (i) = a / t^n (mm/hour)**				
	One year storm	Two year storm	Five year storm	Ten year storm	Twenty year storm
	(i.e. 25 times)	(i.e. 12.5 times)	(i.e. 5 times)	(i.e. 2.5 times)	(i.e. 1.25 times)
	a = 414.25	a = 511.91	a = 570.75	a = 568.72	a = 976.47
	n = 0.673	n = 0.6399	n = 0.5989	n = 0.5474	n = 0.6442
5	140.23	182.78	217.69	235.66	346.24
10	87.96	117.30	143.73	161.25	221.54
15	66.95	90.49	112.74	129.15	170.62
20	55.17	75.28	94.90	110.34	141.75
25	47.47	65.26	83.03	97.65	122.77
30	41.99	58.07	74.44	88.37	109.17
45	31.96	44.80	58.39	70.78	84.07
60	26.34	37.27	49.15	60.47	69.85
75	22.66	32.31	43.00	53.52	60.50
90	20.05	28.75	38.55	48.43	53.79
105	18.07	26.05	35.15	44.51	48.71
120	16.52	23.92	32.45	41.38	44.69
135	15.26	22.18	30.24	38.79	41.43
150	14.22	20.74	28.39	36.62	38.71
165	13.33	19.51	26.82	34.76	36.40
180	12.57	18.45	25.45	33.14	34.42
195	11.91	17.53	24.26	31.72	32.69
210	11.33	16.72	23.21	30.46	31.17
225	10.82	16.00	22.27	29.33	29.81
240	10.36	15.35	21.43	28.31	28.60

A curve is plotted on an ordinary graph paper (Fig 3.8) and from this graph or from log-log paper (Fig. 3.3 to 3.7), value of intensity of storm for any given duration can be worked out for return period of one, two, five, ten and twenty years. .

Another graph (Fig.3.9), run-off coefficient 'c' vs duration time 't' is plotted as per : values given in Homer's table (Table 3.3, Pg. No. 45 of CPHEEO Manuel).

3.8 COMPUTATION OF STORM WATER RUN-OFF:

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 (t_c) and for weighted imperviousness. Refer Graph (Fig. 3.9).

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) till 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 8.0 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 4.5 m/sec and 3.5 m/sec respectively. Keeping this velocities in view, a velocity of flow 1.2 m/sec to 2.0 m/sec for terrain and maximum of 5.1 m/sec in drain was chosen to estimate the time of flow (considering cleaned drain with moderate siltation / vegetation).

To arrive at a realistic time of concentration, surface flow velocity of rainwater is taken as 2 m/sec as stated above and the time of flow from the farthest point of the contributory area is worked out, The inlet time varying from 5 to 20 minutes depending on various factors**.** The time thus derived are used to compute design run-off of each segment.

The weighted imperviousness of the drainage area segment-wise, was worked out as stated in earlier section. Due to non-availability of 0.5 m. or 1.0 m. contour map, the entire tributary area has been divided into various segments with respect to the ridge line and flow patterns, using the area map developed from the satellite image.

The identification of roadside drains / feeder drains leading to primary or secondary drains and adequacy check of such drains is not under the scope of work. However, multiple number of small drains existing in reality by the side of roads in each segment of catchment area (to be drained into main valley) is assumed to be replaced by centrally placed storm drain.

Intensity of rainfall (i) is arrived from the Graphs (Fig. 3.3 to 3.7 or 3.8) with respect to time of concentration (t_c).

Area of each drainage segment for the entire watershed area has been arrived from the micro catchment area map enclosed in Section 3.3 of this chapter.

Quantity of storm water run-off, worked out segment-wise are furnished for Vrishabhavathi Main Valley in Table 4.1 and is enclosed in the section 4.2 of Chapter - 4 in this report.

CHAPTER - 4

REVIEW OF ASSESSMENT AND RECOMMENDATIONS ON EXISTING STORM WATER DRAINAGE SYSTEM

4.1 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 groupings of approach and methodologies in achieving the objective and proper functionality of the system for different applications are needed.

To identify and prioritise 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 BMP shall progressively improve towards achieving this long-term objective.

Further, Improvements to the existing storm drainage system, which is serving the core area is considered to be on priority for five key reasons:

- To rectify current localised flooding problems in the critical low lying areas.
- To cope with additional areas being included into the BMP administered area.
- To improve and extend the security of services in vulnerable areas of the current BMP administered area.
- 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.

4.2 REPORT ON ADEQUACY ANALYSIS OF EXISTING SYSTEM:

An assessment of the existing system for its adequacy has been made using computer modelling. 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

➢**Storm Water Drains:**

The total catchment area of the Vrishabhavathi Main Valley is 3625 Ha. The localities which contribute and the existing condition of these drains is detailed in Section 2.3 & Section 2.6 of Chapter 2.

Cross section data of the existing drains at every 25 m. apart was collected and computer models & spread sheets were developed to analyse for their carrying capacity. The analysis has been done for different year return periods. The calculations and results of these analysis for storm drains is enclosed in Table 4.1 (For existing hydraulic flow conditions) & Table 4.2 (For improved hydraulic flow conditions)

These tables show the discharge (Q) in the existing drain at that particular chainage. The procedure adopted to work out the required data are furnished below.

1.Drain bed levels on either side of the existing drain differ marginally and hence the average of these levels are considered for computation.

2.Drain wall top levels of the existing drain also differ and hence the lower wall level / lowest ground level heights are considered for the depth of the drain.
3.Free board of 100 mm. Is considered for analysis.

4.Coefficient of roughness (n) considered as 0.035 – 0.050 for unclean conditions and 0.025 for clean conditions respectively for the analysis of existing drains and 0.02 – 0.025 for remodelled drain.

5.Design runoff (Q required) are worked out for respective chainages based on the runoff calculated segment wise.

From the analysis and the assessment carried out, following outcomes are highlighted for the existing hydraulic flow conditions (unclean condition) of primary & secondary storm drain.

➔Vrishabhavathi Main Valley Primary Storm Drain (V100) :

✔Near Ranganathapura, Malleshwaram, Kodandaramapura, Sudhindranagara the existing storm drain is having an sloping topography, more paved, less time of concentration, sufficient drain depth and width, good slope is available, silted, bed is in lined with BS slabs and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period hydraulic requirements.

✔Near Seshadripura & Guttahalli area the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, sufficient drain depth and width, moderate bed slope is available, silted, bed is in natural condition, number of obstructions and also drain is in natural condition in few places. The drain capacity is adequate to cater for ten year return period hydraulic requirements.

✔Near Srirampura, Okalipura & Ramachandrapura the existing storm drain is having a larger and dense built up catchment area with very undulating topography, less time of concentration, drain width is less, shallow depth, moderate bed slope is available, severely silted, bed is in natural condition, max. obstructions. The drain capacity in this stretch is adequate to cater for twenty year return period hydraulic requirements.

✔Near Gopalapura, Shankarappa garden & Magadi road the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, insufficient drain depth and width, gentle slope is available, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity in this reach is adequate to cater for five year return period hydraulic requirements.

✔Near K.P. Agrahara, Manjunathanagara, Cholarapalya & Bhuvaneshawarinagara the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, insufficient drain depth and width, gentle bed slope is available, severely silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity in this reach is adequate to cater for two year return period hydraulic requirements.

✔Near Padarayanapura, Arifnagara & Shammananagara the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, sufficient drain depth and width, good slope is available, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity in this reach is adequate to cater for five year return period hydraulic requirements.

✔Near Bapujinagara, Guddahalli & Kavika layout the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, insufficient drain depth and width, moderate slope is available, severely silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity in this reach is adequate to cater for two year return period hydraulic requirements.

✔Near Mysore Road, Bayatarayanapura & Venkateshpura the existing storm drain is having a larger catchment area with very undulating topography, more paved, less time of concentration, insufficient drain depth and width, gentle slope is available, severely silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity in this reach is adequate to cater for five year return period hydraulic requirements.

✔Near Pantharpalya, Rajarajeshwarinagara, Mysore Road the existing storm drain is having a larger catchment area with very undulating topography, less paved, more time of concentration, sufficient drain depth and width, good slope is available, severely silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity in this reach is very inadequate.

✔Near Rajarajeshwarinagara, Kenchanahalli, Janabharathi campus, Mysore Road the

existing storm drain is having a larger catchment area with very undulating topography, less paved, more time of concentration, sufficient drain depth and width, good slope is available, severely silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity in this reach is adequate to cater for one year return period hydraulic requirements.

•Byatarayanapura Secondary Storm Drain (V101):

✔Near Girinagara writers colony, Avalahalli & Ganapathinagara the existing storm drain is having a moderate catchment area with sloping topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope is available, silted, bed is in natural condition and also drain walls are in good condition. Drain capacity is adequate to cater for twenty year return period hydraulic requirements.

•Timber Yard Layout Secondary Storm Drain (V102):

✔Near Brindavanagara, Ragavendranagara, Timber yard layout & Kalidasa layout the existing storm drain is having a larger catchment area with moderate flat topography, more paved, less time of concentration, sufficient drain depth and width, moderate bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year return period.

➢**Guddadahalli Secondary Storm Drain (V103):**

✔Near Jagajeevanaramanagara the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, more obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period hydraulic requirements.

➢**Jaibharathnagara Secondary Storm Drain (V104):**

✔Near Guddahalli, Vinayakanagara Goripalya the existing storm drain is having a moderate catchment area with sloping topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope is available, silted, max. obstructions, bed is in natural condition and also drain is in natural condition. Drain capacity is adequate to cater for twenty year return period hydraulic requirements.

➢**Binnypet Secondary Storm Drain (V105):**

✔Near Ranganatha colony, Binnypete & K.P. Agrahara the existing storm drain is having a moderate catchment area with sloping & undulating topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Bakshi Garden Secondary Storm Drain (V106):**

✔Near Sulthanpete, Bakshi garden, Sidharthanagara, Cottonpete & Mariappanapalya the existing storm drain is having a larger catchment area with moderate flat topography, more paved, less time of concentration, sufficient drain depth and width, moderate bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Kempapura Agrahara Secondary Storm Drain (V107):**

✔Near Keshavanagara, K.P. Agrahara the existing storm drain is having a larger moderate catchment area with flatter topography, more paved, less time of concentration, sufficient drain depth and width, moderate bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year return period.

➢**Gopalapura Secondary Storm Drain (V108):**

✔Near Gopalapura the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Platform Road Secondary Storm Drain (V109):**

✔Near Shastrinagara, V.V. Giri Colony the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Sheshadaripura Secondary Storm Drain (V110):**

✔Near Seshadripura & Guttahalli the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Hanumanthapura Secondary Storm Drain (V111):**

✔Near Hanumanthapura the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Prakashnagara Secondary Storm Drain (V112):**

✔Near Gayatrinagara, Mariappanpalya Prakashnagara, Ramchandrapura the existing storm drain is having a larger catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, moderate bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Dayanandanagara Secondary Storm Drain (V113):**

✔Near Gopalapura the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year return period.

➢**Subramanyanagara Secondary Storm Drain (V114):**

✔Near Sriramapura, Nagappa block the existing storm drain is having a smaller catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**M.E.I. Polytechnic Secondary Storm Drain (V115):**

✔Near Rajajinagara 4^{th} & 6^{th} block the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Agrahara Dasarahalli Secondary Storm Drain (V116):**

✔Near Saneguravanahalli, Manjunathanagara, Shivanahalli & Rajajinagara Industrial area the existing storm drain is having a larger catchment area with less undulation topography, more paved, less time of concentration, insufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. In the Initial reaches drain capacity is adequate to cater for one year return period & near Rajajingara industrial area it is adequate to cater for five year return period.

➢**Hosahalli Secondary Storm Drain (V117):**

✔Near W.O.C. Road layout, Hosahalli Extn & Vijayanagara the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, less. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Vijayanagara Secondary Storm Drain (V118):**

✔Near R.P.C. layout & Shamannanagara the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**R.P.C. Layout Secondary Storm Drain (V119):**

✔Near Govindarajnagara & R.P.C. layout the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Kempegowda Nagara Secondary Storm Drain (V120):**

✔Near National college, Bull temple road & Kempegowdanagara the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Srinagara Secondary Storm Drain (V121):**

✔Near Srinagara the existing storm drain is having a smaller catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Muneshwara Block Secondary Storm Drain (V122):**

✔Near Hanumanthanagara, Muneshwara block & Nagendra block the existing storm drain is having a larger catchment area with undulation topography, more paved, less time of concentration, sufficient drain depth and width, good bed slope, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period.

➢**Cross Drains:**

Existing culverts based on their structural conditions, no. of vents, no. of utilities laid across SWD at the culvert location which in turn causing obstruction for free flow of water were identified during reconnaissance survey and further analysed for their carrying capacity.

Table 4.3 (For existing hydraulic flow conditions) & Table 4.4 (For improved hydraulic

flow conditions) shows the results of adequacy analysis of existing inadequate culverts/bridges along with all other data required to derive the same. The procedure adopted to workout the required data are furnished below:

1.Adequacy check is carried out under clean condition only, since the drains on either side of the culvert are presumed to be free of silt and vegetation to achieve optimum carrying capacity.

2.Dimensions shown in the table is the existing dimensions and the vent way considered is actually collected from site, and accordingly vent way sizes has been worked out.

3.Bed levels at culvert location could not be measured due to flow of water. The bed slope in the direction of flow is assumed as 1 in 500 (0.002), which may produce a reasonable velocity of flow through the vent way to prevent deposition of silt and scouring action.

4.Free board is considered as 0.1 m for analysis.

5.The percentage area reduction at the vent way of the culvert with reference to the upstream side drain area are worked out for reference and guidance.

6.Coefficient of roughness(n) is considered as 0.02.

7.Design runoff are worked out based on the runoff calculated for the drain segment both upstream and down stream side (near the culvert locations) for the length of about 100 m.

The remarks column of these tables, indicate the existing culvert which are inadequate to carry the design runoff and such culverts are found to be very few. The culverts which are considered to be inadequate were jointly site inspected with BMP officials and various options were explored to increase the carrying capacity before deciding for remodelling.

The existing culvert in Vrishabhavathi Main Valley which are considered to be inadequate are listed in Table – 4.5

The inspection details of these existing culverts/bridges is enclosed in Volume 2 - Condition Survey.

Based on the assessment, 18 culverts which were structurally in moderate condition and inadequate to satisfy hydraulic requirements has been shortlisted and considered for reconstruction.

The detailed designs, estimates and relevant general arrangement drawings required for remodeling of these culverts / bridges is enclosed in Volume III & Volume IV.

The list of culverts / bridges proposed for reconstruction is as listed below and the same is depicted in Figure 4.1.

TABLE 4.5 Existing Culvert / Bridges Considered for Remodeling

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Vrishabhavathi Main Valley Primary Storm Drain (V100) :				
1	V - C17	2050	Venkataranga Iyengar Mn Rd, Sheshadaripura	Ex. Culvert/Bridge considered for remodelling Pro. Addl. Single Span, Box Culvert, each 5 m wide, 4.4 m
Timberyard Secondary Storm Drain (V102) :				
1	V13/C7	230	2nd Main Road, Kariyamnapalya.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span - Box culvert, 8 m wide, 2 m ht.
2	V13/C6	380	Pipeline Road, Utharayappa Garden, Kashturibai Nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span - Box culvert, 7 m wide, 2 m ht.
Guddadahalli Secondary Storm Drain (V103) :				
1	V3/C6A	170	Janatha Colony Mn. Rd.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 3.5 m Wide, 1.5 m ht.
JaiBharathnagara Secondary Storm Drain (V104) :				
1	V10A/C10	550	9th Cross Guddadahalli Nehru Road, Mysore Road.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 5 m wide, 1.75 m ht.
Binnypet Secondary Storm Drain (V105) :				
1	V5/C11	150	1st Main 3rd Cross Road, R.R.Nagara, Ranganatha Colony.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 5 m wide, 1.75 m ht.
Bakshi Garden Secondary Storm Drain (V106) :				
1	V - 6/C23	220	Goods shed road, Velmuruga nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 6 m wide, 2.1 m ht.
Kempapura Agrahara Secondary Storm Drain (V107) :				
1	V - 7/C13A	385	Bhuvaneswari nagara, Magadi Road.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 3.5 m wide, 1.5 m ht.
Sheshadaripura Secondary Storm Drain (V110) :				
1	V1/C5	35	Nagappa Street, Sheshadaripura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 6 m wide, 1.7 m ht.
Prakash Nagara Secondary Storm Drain (V112) :				

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
1	VS1/C7	920	M.K.K.Road, 2nd Stage, Rajajinagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.1m ht.
2	VS1/C9	1,150	Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.2m ht.
3	VS1/C10	1,385	9th Main Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2m ht.
4	VS1/C11	1,440	12th Main Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2m ht.
5	VS1/C13	1,575	4th Cross Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 8 m wide, 2.1m ht.
6	VS1/C14	1,610	5th Main Road, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 8 m wide, 2m ht.
7	VS1/C25	2,980	4th Cross Road, Ramachandrapura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.3m ht.
8	VS1/C26	3,140	4th Main, 2nd Cross Road, Ramachandrapura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.5m ht.
Muneshwara Block Secondary Storm Drain (V122) :				
1	SN-S1-C8	1,225	15th Main Road, Kalidasa Layout, Raghavendra nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 3.5 m wide,1.6 m ht.

4.2 STRATEGIC ACTIONS AND RECOMMENDATIONS:

➢Vrishabhavathi Main Valley Primary Storm Drain (V100):

•The existing covered drain near Malleshwaram swimming pool extension needs to be opened at regular interval and desilted. Further steel gratings needs to be provided at regular intervals.

•Large quantity of garbage and debris being dumped near Datteraya temple street needs to be cleared and further dumping needs to be prevented.

•Existing BS slab covered drain bed noticed near Malleshwaram needs to be reset true to line and missing slabs to be made good with new slabs.

•The existing drain walls near Mallehawaram area needs to be strengthened at few places and drain bed protection to be provided.

•Existing culvert near Venkataranga Iyengar Main Road needs to be reconstructed.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

77°29'19"E 77°30'19"E 77°31'19"E 77°32'19"E 77°33'19"E 77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E

13°2'7"N 13°1'7"N 13°0'7"N 12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N

0 875 1,750 3,500 5,250 7,000 Meters

N W E S

Hebbal Main Valley-1

Hebbal Main Valley

Hebbal Minor Valley-1

Hebbal Minor Valley-2

Kethamaranahalli & Arkavathi Valley

Vrishabhavathi Valley

Kathriguppe Valley

Ulsoor Valley

Koramangala Valley

Tavarekere Valley

Sankey Tank

Nayandahalli Tank

Kempambudi Tank

Hosakerehalli Tank

Ulsoor Tank

Mattikere

Malagala Main Road, Panchasheelanagar

Vinosantho, Mudalapalya

Magadi Main Road, Malagalu

Manivilas Garden Kamalanagar

Annapurnaswari nagar, Laggere

Laggere Main Road, Kurubarhalli

1st Cross Lavakushanagar

4th A Cross Lavakushanagar

Premnagar

Cross Road, JC nagar

1st Main Road JC nagar

Nandhini Layout

Mosque Road, Lakshmidevi nagar

Shankarnagar Main Road

APMC Yard Yeshwanthpur

M.K.K Road Rajajinagar

Mariyappapalya Prakshnagar

5th Main Mariyappapalya

12th Main road Mariyappapalya, Prakashnagar

Nagappa Street, Sheshadripuram

4th Cross Mariyappapalya

Venkataranga Iyengar Mn. Road Sheshadripuram

4th Cross Ramchandrapura

44th Main, 2nd Cross Ramchandrapura

1st Main 3rd Road, Hanganatha Colony

Goodsshed road Velmuruganagar

Bhuvaneswarinagar, Magadi Road

9th Cross, Guddadahalli Nehru road

Janata colony Main road

2nd Mn Road Kariyamnaplya

Pipeline Road Kasturibainagar

15th main road, Raghavendanagar

OLD MADRAS ROAD

MYSORE ROAD

Legend

- Culvert Locations
- Drains
- Ridge
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Main Valley
- Sub Valley

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

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

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: APR 2004

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED: RSP

CHECKED: YDM

TITLE: Vrishabhavathi Valley (V200) Culverts Considered for Re-Modelling

APPROVED: ATS

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

- Drain needs to be desilted and drain bed to be lowered near Rajiv Gandhi Circle.

- Rehabilitation works to the existing drain walls & drain bed protection needs to be provided near Sirur park.

- Drain to be desilted & Vegetation growth noticed near Jakkarayanakere needs to be cleared and new walls to be provided on both sides.

- Rocky out crop noticed near Tumkur railway line needs to be lowered and drain bed upstream of this location needs to be regraded to avoid accumulation of silt and to minimise flooding problems in Malleshwaram & Guttahalli surrounding areas.

- Drain reach is in natural condition for a short length near Railway track, wherein embankment needs to be made up with imported earth and stone revetment needs to be provided.

- Sewer Pipeline laying & manhole construction work should be immediately stopped and alternate arrangement needs to be made.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved near Okalipura, Hanumanthpura, Sri ramapura & Ramachandrapura.

- Drain reach is in natural condition near Minerva mill treatment plant wherein drain to be widened and new wall to be constructed.

- Large quantity of silt and surplus excavated earth generated during sewer pipeline laying needs to be removed immediately near Gubbana layout.

- After desilting, drain bed near Gubbana layout needs to be lowered.

- Existing secondary & tertiary drain network bed level needs to be regraded to suit with new drain bed level near Manjunathanagara, Kempapura Agrahara & Mariappanapalya. .

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Gopalapura, Manjunathanagara, Kempapura Agrahara & Mariappanapalya.

- After drain desilting drain bed protection needs to be provided for full length and width near Manjunathanagara, Kempapura Agrahara & Mariappanapalya. .

- Existing masonry drain walls needs to be strengthened at few places near Manjunathanagara, Kempapura Agrahara & Mariappanapalya. .

- After desilting, drain bed near Manjunathanagara & Cholurapalya needs to be lowered.

- After drain desilting drain bed protection needs to be provided for full length and width.

- Existing drain needs to be widened on right side near Manjunathanagara.
- Alternative arrangements needs to be made to relocate BWSSB sewer pipeline and manholes.

- Existing Secondary & tertiary drain network bed level needs to be regraded to suit with new drain bed level.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Arifnagara & Shamanna garden.

- Large quantity of silt and surplus excavated earth generated during sewer pipeline laying needs to be removed immediately.

- Construction of residential buildings over drain walls needs to be prevented.

- Construction of residential buildings in the water way and also below flood plain needs to be prevented near Cholarapalya.

- Rocky out crop noticed near Telecom layout needs to be lowered.

- Existing Mysore railway line bridge near Jagajeevanramnagara needs to be widened. But budgetary amount provision for reconstruction of the bridge is considered in the estimate. Where as furnishing of detailed design and drawings for the bridge do not come in the purview of the present scope of the study.

- Drain reach near Shammana garden needs to be desilted and further drain bed needs to be lowered.

- Existing secondary and tertiary drain network bed level needs to be regraded to suit with new drain bed level near Guddahalli & Bapujinagara.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

- After drain desilting drain bed protection needs to be provided for full length and width.

- Rocky out crops noticed near Bapujinagara needs to be lowered.

- Buildings constructed over the rocky out crops needs to be relocated and drain to be widened near Bapujinagara.

- Rehabilitation works needs to be provided to the existing drain walls.

- Sewerpipe line laid across storm drain near Gali Anjaneya temple needs to be relocated/lowered.

- Drain reach behind Kavika factory needs to be widened, deepened Further, embankment to be made up with imported earth and stone revetment and bed protection needs to be provided.

- Dumping of debris inside storm drain needs to be prevented immediately near Venkateshpura & Bayatarayanapura.

- Sewerage system to be extended to the entire slum area to prevent entry of sewage into storm drains near Kavika layout.

- Alignment of drain needs to be slightly altered, widened and embankment to be made up with imported earth and stone revetment to be provided on both sides.

- Large quantity of vegetation growth noticed inside the drain needs to be cleared immediately near Mysore Road.

- Drain reach behind Kawality biscuit factory needs to be widened, stone revetment and bed protection needs to be provided.

- Large quantity of silt accumulated near Mysore Road - Ring Road Junction needs to be cleared immediately.

- Stone revetment and bed protection needs to be provided.

- Service road to be formed.

- Dumping of debris and garbage needs to be prevented immediately near Pantharpalya.

- Caution board needs to be installed to create awareness among public about storm water drains and its importance.

- Dense vegetation growth noticed behind BWSSB sewage treatment plant needs to be cleared and drain bed to be lowered.

- Alignment of drain needs to be slightly altered, widened and embankment to be made up with imported earth and stone revetment to be provided on both sides.

- Bed protection needs to be provided and service road needs to be formed.

- Drain reach near Rajarajeshwarinagara needs to be desilted, widened, embankment needs to be made up with imported earth and stone revetment and drain bed needs to be provided for full length and width.

- Service road to be formed.

- Construction of residential buildings inside water way area needs to be prevented.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region near Kenchanahalli.

- Sewer Pipeline laying & manhole construction work should be immediately stopped and alternate arrangement needs to be made.

- Drain reach is in natural condition near BWSSB pipeline bridge. Drain to be widened & embankment needs to be formed with imported earth and stone revetment to be provided on both sides and service road to be formed on either side of the drain.

- Alignment of drain needs to be slightly altered embankment to be made up with imported earth and stone revetment to be provided on both sides and service road to be formed on both sides near Mysore Road.

•Dense vegetation growth noticed near New BWSSB sewage treatment plant area needs to be cleared immediately.

➢**Vrishabhavathi Main Valley Secondary Storm Drain:**

➢ **Byatarayanapura Secondary Storm Drain (V101):**

•Existing covered drain near Avalhalli needs to be opened at regular interval and desilt further steel grating needs to be provided t regular interval.

•Vegetation growth noticed near Bayatarayanapura needs to be cleared immediately.

•Large quantity of silt noticed inside the drain near Bayatarayanapura needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Sewer Pipeline laying & manhole construction work should be immediately stopped and alternate arrangement needs to be made.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

➢**Timber Yard Layout Secondary Storm Drain (V102):**

•Large quantity of silt, debris & vegetation growth noticed inside the drain near Dhobi ghat main road & indoor stadium needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Kalidasa layout &

Vittalnagara.

•Drain reach is in natural condition near Vittalanagara, embankment to be made up with imported earth and stone revetment needs to be provided. Further service road to be formed.

•Alignment of the drain to be altered.

•All openings made to the drain wall needs to be closed.

•Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Rocky out crop noticed near K.S.R.T.C. new bus stand needs to be lowered to avoid siltation and heading up of water in the upstream reaches.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

➢**Guddadahalli Secondary Storm Drain (V103):**

•Large quantity of silt, debris & vegetation growth noticed inside the drain near Janatha Colony needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Janatha Colony, Vinayakanagara and Guddahalli.

- Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Existing masonry walls needs minor rehabilitation at few places.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

➢ **Jaibharathnagara Secondary Storm Drain (V104):**

- Existing BS slab covered drain needs to be opened at regular interval desilt and steel grating need to be provided at regular interval.

- Large quantity of silt & garbage noticed inside the drain near Padarayanapura, D.G. Nagara & Guddahalli needs to be cleared immediately.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Padarayanapura, D.G. Nagara & Guddahalli

- Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

- Authorities should have strict vigil and prevent construction of building structures over

the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

➢**Binnypet Secondary Storm Drain (V105):**

•Existing BS slab covered drain in the initial reach needs to be opened at regular interval desilt and steel grating need to be provided at regular interval.

•Large quantity of silt & garbage noticed inside the drain near Ranganatha Colony, V.S. Garden, Goripalya, Jajajeevanaramanagara needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Ranganatha Colony, V.S. Garden, Goripalya, Jajajeevanaramanagara.

•Manholes noticed inside the drain needs to be lowered near Ranganatha Colony.

•All openings made to the drain wall needs to be closed.

•Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

•Existing BS slab covered drain near V.S. Garden needs to be opened at regular interval desilt and steel grating need to be provided at regular interval and also reset the cover slabs true to line.

•Authorities should have strict vigil and prevent construction of building structures over

the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•RCC slab covered drain near Gangappa garden & Bhuvaneshwarinagara needs to opened at regular interval and desilt.

➢**Bakshi Garden Secondary Storm Drain (V106):**

•Existing BS slab covered drain in the initial reach near Sulthanpete, Cottonpete & Bakshi garden needs to be opened at regular interval desilt and steel grating need to be provided at regular interval.

•Large quantity of silt & garbage noticed inside the drain near Sidharthanagara, Jaibhimanagara needs to be cleared immediately.

•Drain wall near L & T casting yard to be reconstructed.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Bakshi garden, Velumurganagara, Sidharthanagara, Jaibhimanagara.

•Sewerage system to be extended to the slum areas situated adjoining to storm drain to prevent entry of sewage.

•Drain bed needs to be regraded to match with new drain bed level near APMC yard and Markandeyanagara.

•Existing tertiary drain bed level needs to be regraded to match with the new drain bed

level.

- Existing RCC slab covered drain near Mariappanapalya & Kempapura Agrahara needs to be opened at regular interval desilt and steel grating need to be provided at regular interval.

- All openings made to the drain wall needs to be closed.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Existing masonry walls needs minor rehabilitation at few places.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Secondary drain bed level near Bhuvaneshwarinagara needs to be regraded to suit with the new drain bed level.

➢ **Kempapura Agrahara Secondary Storm Drain (V107):**

- Existing BS slab covered drain in the initial reach near K.P. Agrahara needs to be opened at regular interval desilt.

- Large quantity of silt & garbage noticed inside the drain near K.P. Agrahara & Bhuvaneshwarinagar needs to be cleared immediately.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near K.P. Agrahara & Bhuvaneshwarinagara.

- All openings made to the drain wall needs to be closed.

- Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Existing masonry walls needs minor rehabilitation at few places.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- New RCC box drain needs to be constructed near Bhuvaneshwarinagara

- Drain bed needs to be provided for full length and width.

➢ **Gopalapura Secondary Storm Drain (V108):**

- Large quantity of silt & vegetation growth noticed inside the drain near Minerva mill needs to be cleared immediately.

- Sewerage system to be extended to the adjoining Minerva mill quarters area to prevent entry of sewage into storm drain.

- Existing tertiary drain bed level needs to be regraded to match with the new drain bed level near Gopalapura.

- All openings made to the drain wall needs to be closed.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

➢**Platform Road Secondary Storm Drain (V109):**

•Large quantity of silt & garbage noticed inside the drain near Shastrinagara needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near V.V. Giri Colony & Shastrinagara.

•Rocky out crop noticed near Shastrinagara needs to be lowered.

•Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

➢**Sheshadaripura Secondary Storm Drain (V110):**

•Large quantity of silt & garbage noticed inside the drain near Sheshadripura link Road needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Guttahalli.

•Existing tertiary drain bed level needs to be regraded to match with the new drain bed level.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

➢**Hanumanthapura Secondary Storm Drain (V111):**

•Existing BS slab covered drain needs to be opened at regular interval and desit near Sriramapura.

•Large quantity of silt & garbage noticed inside the drain near Sriramapura & Kalappa block needs to be cleared immediately.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Sriramapura & Kalappa block

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Existing masonry walls needs minor rehabilitation at few places.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Drain bed needs to be provided for full length and width.

➢ **Prakashnagara Secondary Storm Drain (V112):**

- Existing BS / RCC slab covered drain needs to be opened at regular interval and desit near Rajajinagara, Mariappanapalya & Varalakshmi nursing home adjoining area.

- Large quantity of silt & garbage dumps noticed inside the drain near Mariappanpalya & Maha Kavi Kuvempu Road needs to be cleared immediately.

- Rocky out crop noticed near Maha Kavi Kuvempu Road needs to be lowered to avoid heading up of water in the upstream reaches.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Mariappanapalya,

Prakashnagara, Sriramapura & Ramachandrapura.

•Existing culverts with multiple spans needs to reconstructed with single span culverts.

•All openings made to the drain wall needs to be closed.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Existing masonry walls needs minor rehabilitation at few places.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

•Large quantity of construction debris noticed inside the drain near Sujatha theater needs to be cleared immediately.

➢ **Dayanandanagara Secondary Storm Drain (V113):**

•Existing BS / RCC slab covered drain needs to be opened at regular interval and desit near Lakshminarayapura.

•Large quantity of silt & garbage dumps noticed inside the drain near Lakshminarayanapura & Dayanandanagara needs to be cleared immediately.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Lakshminarayanapura & Dayanandanagara.

•Secondary drain bed level to be regraded to match with new drain bed level of Prakashnagara secondary drain.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Existing masonry walls needs minor rehabilitation at few places near Dayanandanagara.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Drain bed needs to be provided for full length and width.

➢ **Subramanyanagara Secondary Storm Drain (V114):**

- Existing RCC slab covered drain needs to be opened at regular interval and desit near Maruthi Extn. & Gayatrinagara.

- Large quantity of silt & garbage dumps noticed inside the drain near Gayatrinagara needs to be cleared immediately.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Lakshminarayanapura Nagappa block & Sriramapura

- All openings made to the drain wall needs to be closed.

•Secondary drain bed level to be regraded to match with new drain bed level of Prakashnagara secondary drain.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

•Large number of manholes noticed inside the drain needs to be lowered.

➢**M.E.I. Polytechnic Secondary Storm Drain (V115):**

•Existing RCC slab covered drain needs to be opened at regular interval and desit near M.E.I Polytechnic.

•Large quantity of silt & garbage dumps noticed inside the drain near Gubbana layout & Rajajinagara needs to be cleared immediately.

•Large quantity of debris dump noticed inside the drain near Polytechnic college premises needs to be cleared immediately.

•BS slab laid drain bed needs to be set true to line and missing slabs needs to be

made good with new slabs.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Gubbana layout & Rajajinagara

•All openings made to the drain wall needs to be closed.

•Secondary drain bed level to be regraded to match with new drain bed level of Primary drain.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width.

➢ **Agrahara Dasarahalli Secondary Storm Drain (V116):**

•Existing RCC slab covered drain needs to be opened at regular interval and desit and steel grating needs to be provided at regular intervals near Basaveshwaranagara, Indiranagara, Manjunathanagara & A.D. Halli.

•Large quantity of silt & garbage dumps noticed inside the drain near Shivanahalli & Judges Colony needs to be cleared immediately.

•Existing SSM walls needs to be dismantled and drain to be widened near Rajajinagara industrial area and new wall to be constructed.

- BS slab laid drain bed needs to be set true to line and missing slabs needs to be made good with new slabs.

- All openings made to the drain wall needs to be closed.

- Existing tertiary drain bed level needs to be regraded to match with new drain bed level.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Shivanahalli & Rajajinagara Industrial area.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Drain bed needs to be provided for full length and width.

- Large quantity of silt and garbage dump noticed inside the drain near Cholarpalya needs to be removed immediately.

- Secondary drain bed level needs to be regraded to match with the new drain bed level.

- Disposal of liquid industrial waste from small scale industries needs to be prevented.

➢ **Hosahalli Secondary Storm Drain (V117):**

- Existing RCC slab covered drain needs to be opened at regular interval and desit and steel grating needs to be provided at regular intervals near R.P. C. Layout

- Large quantity of silt & garbage dumps noticed inside the drain near Vijayanagara Swimming pool needs to be cleared immediately.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Drain bed needs to be provided for full length and width near Vijayanagara Swimming pool.

- Manhole noticed near railway track needs to be lowered.

➢ **Vijayanagara Secondary Storm Drain (V118):**

- Existing RCC slab covered drain needs to be opened at regular interval and desit and steel grating needs to be provided at regular intervals near Vijayanagara & R.P. C. Layout.
- Large quantity of silt & garbage dumps noticed inside the drain near Shamannanagara needs to be cleared immediately.

- Rocky out crop noticed inside the drain near Shammananagara needs to be lowered

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Drain bed needs to be provided for full length and width near Vijayanagara Swimming pool.

•Manhole noticed near railway track needs to be lowered.

➢**R.P.C. Layout Secondary Storm Drain (V119):**

•Existing BS / RCC slab covered drain needs to be opened at regular interval and desit and steel grating needs to be provided at regular intervals near Binny Layout

•Large quantity of silt & garbage dumps noticed inside the drain near Vijayanagara & Maruthinagara needs to be cleared immediately.

•Existing BS slab laid drain bed needs to relaid true to line and missing slabs needs to be made good with new slabs near Maruthinagara & Subbana garden.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Existing RCC slab covered drain needs to be opened at regular interval and desit near R.P.C. Layout

•Manhole noticed near railway track needs to be lowered.

•Minor rehabilitation works needs to be provided to the existing masonry walls.

•Sewer pipeline laid across storm drain near Kavika layout needs to be lowered immediately to prevent heading up of water in the up stream reaches..

➢**Kempegowda Nagara Secondary Storm Drain (V120):**

•Existing BS slab covered drain needs to be opened at regular interval and desit near Kempegowdanagara.

•All openings made to the drain wall needs to be closed.

•Authorities should have strict vigil and prevent construction of building structures over the drain walls.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•Minor rehabilitation works needs to be provided to the existing masonry walls.

➢**Srinagara Secondary Storm Drain (V121):**

•Existing BS slab covered drain needs to be opened at regular interval and desit near Hanumanthanagara.

•Large quantity of silt & garbage dumps noticed inside the drain near Srinagara, Weavers colony, Ragavendranagara & Kasturibainagara needs to be cleared immediately.

•Existing BS slab laid drain bed needs to relaid true to line and missing slabs needs to be made good with new slabs near Srinagara bus stand.

•All openings made to the drain wall needs to be closed.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

- Sewerage system and solid waste management system in this area needs to be improved.

- Minor rehabilitation works needs to be provided to the existing masonry walls.

- Drain reach is in natural condition near Kalidasa housing society & Kasturibainagara new walls to be constructed.

➢ **Muneshwara Block Secondary Storm Drain (V122):**

- Existing BS slab covered drain needs to be opened at regular interval and desit near Nagendra Block.

- Large quantity of silt, garbage dumps & vegetation growth noticed inside the drain near Muneshwara block & Ragavendranagara needs to be cleared immediately.

- Authorities should have strict vigil and prevent construction of building structures over the drain walls.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.
- Sewerage system and solid waste management system in this area needs to be improved.

- Minor rehabilitation works needs to be provided to the existing masonry walls.

- Drain reach is in natural condition near Ragavendranagara, new walls to be constructed.

•All openings made to the drain wall needs to be closed.

4.3 MITIGATIVE MEASURES FOR LOW LYING AREAS:

4.3.1 Gopalapura & Gubbana Layout:

Mitigative Measures

•Large quantity of silt & garbage noticed inside the drain near Gopalapura needs to be cleared immediately.

•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.

•Dumping of debris & garbage needs to be stopped immediately.

•Desilting of existing secondary & tertiary drains needs to be attended immediately.

•Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

•Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

•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.

4.3.2 Cholarapalya & Kempapura Agrahara:

Mitigative Measures

- Large quantity of silt & garbage noticed inside the drain near Cholarapalya & K.P.Agrahara needs to be cleared immediately.

- 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.

- Rocky out crop noticed near Telecom layout needs to be lowered.

- Railway culvert near Jagajeevanarama nagara needs to be widened.

- Alternative arrangement needs to be made to locate BWSSB sewer pipe line.

- Dumping of debris & garbage needs to be stopped immediately.

- Desilting of existing secondary & tertiary drains needs to be attended immediately.

- Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

- Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management
- Sewerage system and solid waste management system in this area needs to be improved.

- 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.

4.3.3 Sidharthanagara (Binny Mill Tank Area):

Mitigative Measures

- Large quantity of silt & garbage noticed inside the drain near Sidharthanagara, Markandeshwaranagara, Ranganatha Colony & K.P. Agrahara needs to be cleared immediately.

- Primary, Secondary 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.

- Dumping of debris & garbage near Mariappananapalya needs to be stopped immediately.

- Desilting of existing secondary & tertiary drains needs to be attended immediately.

- Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

- Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.
- 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.

4.3.3 Bapujinagara:

Mitigative Measures

- Large quantity of silt & garbage noticed inside the drain near Bapujinagara needs to be cleared immediately.

- Rocky outcrops noticed near Bapujinagara needs to be lowered.

- Buildings constructed over the rocky out crops needs to be relocated and drain needs to be widened.

- 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.

- Alternative arrangement needs to be made to locate BWSSB sewer pipe line noticed near Gali Anjaneya Temple.

- Dumping of debris & garbage near Kavika layout needs to be stopped immediately.

- Desilting of existing secondary & tertiary drains needs to be attended immediately.

- Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

- Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.

- 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.

4.3.4 Saneguruvanahalli:

Mitigative Measures

- Drain width is drastically reduced near Rajajinagara Industrial area, which needs to be widened to avoid spreading of water in the upstream reaches.

- Large quantity of silt, debris, garbage dumps & vegetation growth noticed inside the drain near Shivanahalli, Manjunathanagara, Basaveshwaranagara, Rajajinagara Industrial area needs to be cleared immediately.

- Structural arrangements near existing tertiary drain joining secondary drain needs to be modified.

- Drain reach near Gangama Thimaiah Kalayan Mantapa & Rajajinagara industrial area needs to be widened to avoid heading up of water in the upstream reaches.

- RCC box drain needs to be constructed near Rajajinagara industrial area to increase the capacity of drain.

- Secondary drain bed level near Cholarapalya needs to be regarded to suit the new drain bed level of primary drain.

- Dumping of debris & garbage needs to be stopped immediately.

- Desilting of existing secondary & tertiary drains needs to be attended immediately.

- Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

- Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.

- 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.

4.3.5 Rudrappa Garden, Timber Yard Layout (Sanjay Gandhi Slum) & Markandayanagara:

Mitigative Measures

- Large quantity of silt, garbage & Vegetation growth noticed inside the drain near Brindavanagara, Sanjay Gandhi Slum & Timber Yard Layout needs to be cleared immediately.

- Rocky outcrops noticed near K.S.R.T.C. new bus stand needs to be lowered.

- Drain alignment needs to be modified at few locations.

- Secondary 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.

- Dumping of debris & garbage near Ragavendranagara needs to be stopped immediately.

- Drain width needs to be increased near Kalidasa layout

- Desilting of existing secondary & tertiary drains needs to be attended immediately.

- Drain bed is in natural condition CC bed lining to be provided to prevent vegetation growth & to improve hydraulic characteristics.

- Construction of residential buildings very close to water way & also below HFL level needs to be avoided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.

- 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.

4.4 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

To improve the section of the drain and to minimize the flooding problems in low lying areas, various drain improvement methods suggested are :-

1.Increase the carrying capacity of existing tertiary drains.

2.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.

3.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.

4.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.

5.Encourage rain water harvesting in institutions, public parks, open grounds, etc.,

CHAPTER - 5

ENVIRONMENTAL AND SOCIAL IMPACT

5.1 INTRODUCTION:

This chapter provides a strategic framework to ensure that existing storm drainage system in Bangalore is managed in a reliable, affordable, sustainable and environmentally friendly manner, 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 also needs to adopt best storm drain management practices, improvised construction and construction supervision techniques, strengthened organisational setup, major legislative changes, coordination with other stakeholders, public awareness campaigns including their participation to minimise the adverse implications on storm drain functionality and storm drain management practice in the city.

5.2 ENVIRONMENTAL CONDITIONS:

Open parks, major waterways and water bodies that exists in a city like Bangalore can be a significant amenity for flood protection. But in recent times, due to lack of planning and rapid changes in the landuse, these amenities have been largely ignored to a great extent by various stakeholders, service providers and the public in general. In the recent history, there has been no comprehension for the development of primary and secondary storm water drainage system in the city by the stake holders beyond the level of tertiary drains. As a consequence, the primary and secondary drainage systems in the core (BMP) administered area have developed on an adhoc basis and now they have reached a saturation level and not in a position to provide security to the low lying areas during most needed situations.

Further, there are many evidence that in areas outside the BMP administered region, the development authorities do not enforce and adopt even rudimentary

practices for planning, construction and maintenance of primary and secondary drains and also they lack of resources and technical expertise to adopt best storm drain management practices.

Significantly, what is seen over a period of time is that, number of lakes that were existing in BMP, BDA & BMRDA area have been filled up and converted into residential layouts and recreational areas. These lake areas otherwise would have acted as buffer zones for flood protection. The tank beds, and its adjoining areas being the lowest point in the valley 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 inorder to avert such expensive recurring problems & expenditures. At this juncture, 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 intern reduce the runoff and flooding problems in some of the adjoining low lying areas to a certain extent.

As mentioned earlier in the Chapter 2 of this report, storm drains in Vrishabhavathi main valley flows through dense residential, commercial and few open areas of the city. Due to encroachments and also due to inappropriate planning by the landuse planners, the natural coarse of the drain is altered at many places in the initial reaches.

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 intern 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 Vrishabhavathi main valley, under ground sewerage system has been provided, 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 out lets 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 intern distracting the visual aesthetic amenity of waterway, causing odour problem, making place favorable for mosquito breading, causing substantial inconvenience to the surrounding locality resident, pedestrians and vehicular movement.

Since the topography of the terrain is undulating & sloping towards the drain and also due to improper solid waste collection and conveyance arrangement in the valley, all the solid waste generated and the greasy liquid waste from industries & service stations, find their way into the storm drain, 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 and intern pose substantial damage to both life and property.

The more extensive tertiary drains that exists are the key elements of the urban drainage system, but due to deficiencies in designs and maintenance practice, the existing tertiary drains 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, 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 aggregate the already aggravated situation.

The end result is environmentally most polluting, flooding and nuisance value being high. Vrishabhavathi main valley is one such valley around the city, which suffers from all the above problems.

5.2.1 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 to be significant due to various reasons, even though the responsibility for both drainage and solid waste management in the core area lies with BMP and outer periphery areas with CMC/TMC.

As observed during reconnaissance survey, disposal of bio degradable and non degradable material into the drains were of a common practice all along the drain and intern factors that were influenced to affect the functionality of the system were also noted and few factors that were noted are as explained in brief here under,

The disposals of house hold garbage, street sweepings and construction debris into drains near Malleshwaram Swimming Pool Extn., Sheshadripura, Hanumanthapura, Okalipura, Sri Ram Pura, Ramachandrapura, Prakashnagara, Rajajinagara, Ranganatha Colony, Manjunathanagara, Kempapura Agrahara, Guddadahalli, Padarayanapura, Shammananagara, Bapujinagar, Kavika layout, Goripalya, Timber yard layout, Ragavendranagara, Bayatarayanapura, Deepanjalinagara and along side Mysore Road is affecting free flow of water, reducing the aesthetic appearance, reducing 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.

5.2.2 Conflicts between Sewers and Drains:

At present there are some trunk sewers laid within drainage channels. Problems that arise from sewers in drainage channels are numerous and include:

- capacity reduction of drains due to manholes;
- restrictions on channel augmentation options;

- ready opportunities to relieve excess sewage into channels;
- need for parallel programming and close coordination, where rehabilitation of either service is proposed;
- difficult access for sewer maintenance;
- lack of access to sewers under lined inverts and cross drainage culverts
- 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 Vrishabhavathi main valley and therefore urgent efforts are required to cleanse the entire system.

5.2.3 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 emphasised, 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:

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

- local area inundation and water stagnation in residential areas, caused by "local" drainage deficiencies and run-off from adjacent local catchments as in Datteraya temple adjoining areas in Malleshwaram, Sheshadripura, Gubbana layout, Nagappa block near Prakashnagar, Ramachandrapura, Kalappa block near Okalipura, Gopalpura, Saneguruvanahalli, Vidhyaranyanagara near West of chord road, Cholurpalya, Mariappanapalya near Kempapura Agrahara, Ranganatha Colony near Binnypete, Shammananagar near Padarayanapura,

Guddahalli, Bapujinagara, Brindavannagara, Ragavendranagara, Timber yard layout and Venkateshpura near Bayatarayanapura

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

•Having high solid waste and sewage concentrations, the flood waters which inundate dwellings and their curtilages create particularly very objectionable conditions in Bangalore.

•The frequency and duration of flooding is relatively high in some of the locations, occurring usually during the south west monsoon period. Whilst 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 favorable for mosquitoes breeding and intern leads to unsanitary conditions. Even the water quality in some of the borewells that are dug adjacent to storm drains are polluted.

•Out of the 360 officially recognized slums in Bangalore, only 30 percent have underground sewerage services. Hence, the major portion of the wastewater generated from such slums will be discharged via the storm water system causing very unhygienic conditions.

5.3 ENVIRONMENTAL MANAGEMENT PLAN:

The proposed activities arising from this chapter 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.

Recommendations:

- Prepare a comprehensive management plan which is acceptable and affordable by stake holders 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.

- Ground water quality analysis to be carried out periodically and the analysed results should be compared with past records and accordingly action to be framed.

- Large scale green belt development activity to be taken up and encouraged all along the channel and also in open lands 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 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 catchment 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.

- Service station / garages should not be allowed to dispose the greasy effluent into the drain.

- 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 slums and other residential areas.

- Silt traps and silt barriers must be constructed along the drain at strategic locations to reduce silt load at downstream of the valley.

- Municipal authorities should encourage public and private sector enterprises for usage of recycled water and adopt rain water harvesting techniques in open lands etc.

- Create awareness among the public, regarding importance of the system functionality.

- Detention ponds for recharging ground water and to minimise fine silt transportation should be constructed along the strategic vantage locations in the valley. Few locations where such ponds could be created/constructed apart from existing parks maintained by BMP are as listed below and the same is depicted in ***Figure 5.1.***

Table 5.1 List of Locations For Construction of Detention Ponds

In Vrishabhavathi Main Valley (V100):

1.Bangalore Palace Ground.
2.National T.B. Institute, Bellary Road.
3.Jakkarayana kere Area.
4.Agrahara Dasarahalli tank Area, near Gangamma Thimiah Kalyan Mantap.
5.Minerva Mill Area.
6.Binny Mill Area.
7.Open land at Kempapura Agrahara, near Cheluvappa Garden
8.Open land behind new K.S.R.T.C. Bus stand, Mysore Road.
9.Shammana Park, Bull Temple Road.
10.Open land near Timber yard layout.

5.4 SOCIAL IMPACTS:

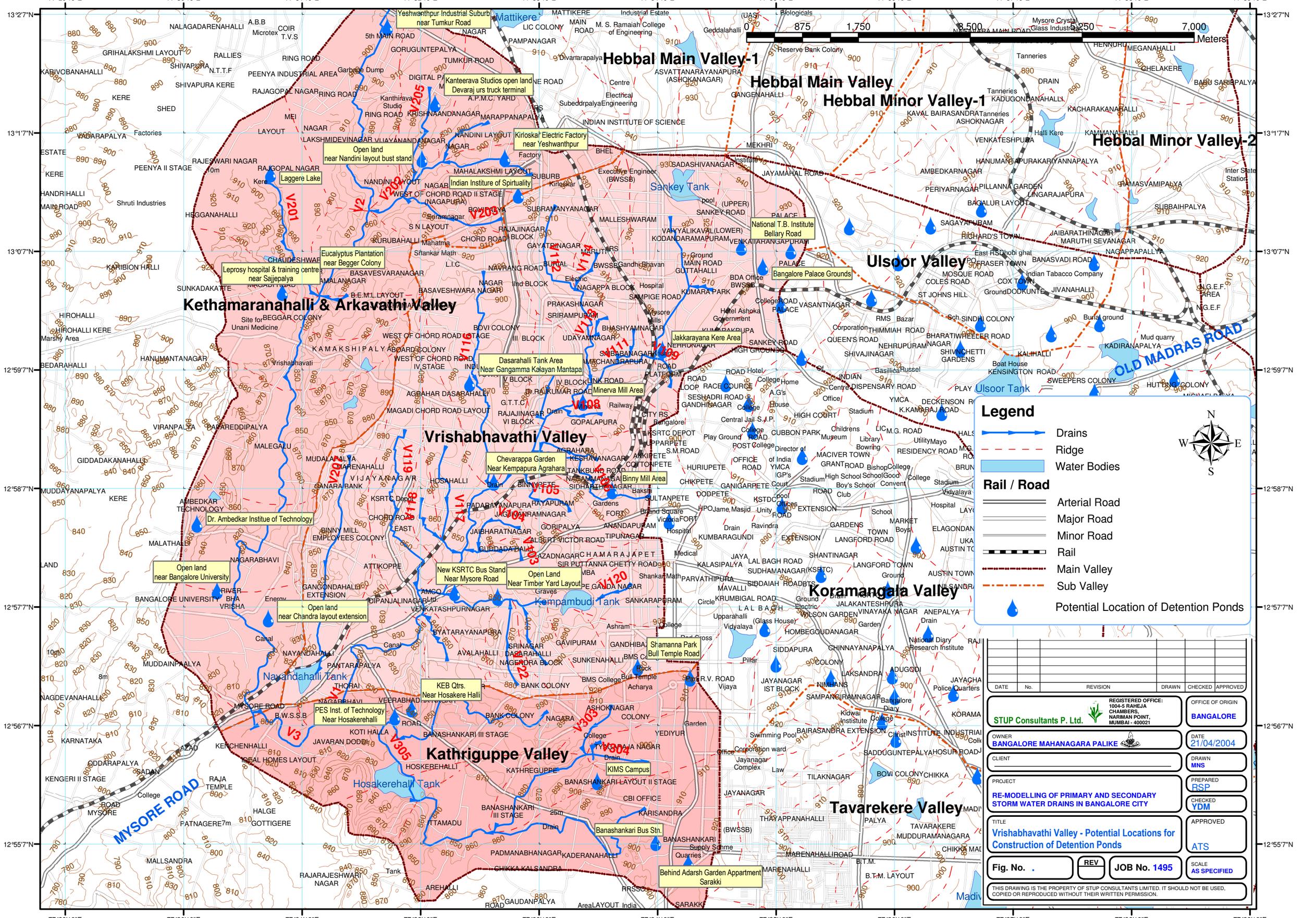
Baseline data together with data on social and environmental impact of flooding has been collected during reconnaissance survey to ascertain the level of service offered by the existing drainage system at various locations in the BMP, BDA and BMA administered areas.

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

•7% of the household in B.M.P. 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 central part of the city.

•Of the house holds that had experienced flooding, 72% reported such occurrences in the last one year, 15% had experienced flooding in the year 1999, 7% during the period 1995 to 1998, while 2% reported that they had experienced flooding prior to 1995.


Yeshwanthpur Industrial Suburb near Tumkur Road
Kanteerava Studios open land Devaraj urs truck terminal
Kirloskar Electric Factory near Yeshwanthpur
Open land near Nandini layout bust stand
Laggere Lake
Indian Institure of Spirtuality
Eucalyptus Plantation near Begger Colony
Leprosy hospital & training centre near Sajjepalya
Dasarahalli Tank Area Near Gangamma Kalayan Mantapa
Minerva Mill Area
Chevarappa Garden Near Kempapura Agrahara
Binny Mill Area
Dr. Ambedkar Institue of Technology
Open land near Bangalore University
New KSRTC Bus Stand Near Mysore Road
Open Land Near Timber Yard Layout
Open land near Chandra layout extension
KEB Qtrs. Near Hosakere Halli
PES Inst. of Technology Near Hosakerehalli
Shamanna Park Bull Temple Road
National T.B. Institute Bellary Road
Bangalore Palace Grounds
Jakkarayana Kere Area
KIMS Campus
Banashankari Bus Stn.
Behind Adarsh Garden Appartment Sarakki
Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Ulsoor Valley
Koramangala Valley
Kathriguppe Valley
Vrishabhavathi Valley
Tavarekere Valley
Kethamaranahalli & Arkavathi Valley
Sankey Tank
Ulsoor Tank
Nayandahalli Tank
Kempambudi Tank
Hosakerehalli Tank
OLD MADRAS ROAD
MYSORE ROAD
Legend
Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Main Valley
Sub Valley
Potential Location of Detention Ponds
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STUP Consultants P. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021
OFFICE OF ORIGIN BANGALORE
OWNER BANGALORE MAHANAGARA PALIKE
DATE 21/04/2004
CLIENT
DRAWN MNS
PROJECT RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED RSP
CHECKED YDM
TITLE Vrishabhavathi Valley - Potential Locations for Construction of Detention Ponds
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JOB No. 1495
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THIS DRAWING IS THE PROPERTY OF STUP CONSULTANTS LIMITED. IT SHOULD NOT BE USED, COPIED OR REPRODUCED WITHOUT THEIR WRITTEN PERMISSION.

- Of the households that had experienced flooding, a majority said that the effects had lasted for one to three days, while 3 % said they had extended beyond a week.

- Two thirds of the households ascribed the reasons for flooding to blockages in the sewerage system, 12% to ingress of rain water into the house, while 11% said that it had been caused by a blocked drains or gutter.

- 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.

- Few households from the conurbation and green belt areas reported that their houses had been flooded in the recent past, suggesting the high density of houses and lack of planned development have contributed to the problem of improper drainage in the corporation area.

- Out of 360 officially recognized slum in Bangalore, only 30% have underground sewerage services. Hence, in the majority of slums wastewater must be discharged via. the storm water system, during flooding instances due to water stagnation, it provides a breeding ground for mosquitoes and leads to generally unsanitary conditions and health hazards.

Details on the areas affected, the frequency of flooding, 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. But, during reconnaissance survey such information's were collected from public as first hand information and were considered during the evaluation of analysis results to improve the existing situation.

CHAPTER - 6

COST ESTIMATION

6.1 INTRODUCTION:

All development projects shall aim to make the best use of available financial, physical and institutional resources.

This is especially true for upgrading work for which the available resources are usually limited in relation to the total need. It is therefore very much important to minimise the cost at which services are provided while ensuring that agreed minimum standards are achieved. In the mean while, 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.

6.2 COSTS:

The costs considered when appraising remodeling proposals, fall into two basic categories, capital costs and recurrent costs.

Capital cost 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 its routine maintenance and operations.

6.3 COST ESTIMATE:

Cost estimates has been worked out for the techno-economical proposals suggested in this feasibility report, considering the current schedule of rates and also as per the lead statement furnished by BMP.

The works envisaged in Vrishabhavathi Main Valley primary and secondary storm drains is as listed below in the Table 6.1 & Table 6.2.

TABLE 6.1 Details of Primary and Secondary Storm Drains of Vrishabhavathi Main Valley (V100) considered for Remodeling

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Vrishabhavathi Main Valley (V1):						
1	V100	Vrishabhavathi	Pri.	Sankey Reservoir	Kenchanahalli	14,000
2	V101	Byatarayanapura	Sec.	Avalahalli	Deepanjalinagara	910
3	V102	Timber Yard Layout	Sec.	Timber Yard Layout	Bapujinagara	1,875
4	V103	Guddadahalli	Sec.	Guddadahalli	Shammananagara	1,050
5	V104	Jai Bharathnagara	Sec.	Jagajivanramnagara	Jai Bharathnagara	1,020
6	V105	Binnypet	Sec.	Ranganatha Colony	Cholurpalya	1,325
7	V106	Bakshi Garden	Sec.	Sulthanpet	K.P. Agrahara	2,445
8	V107	K.P. Agrahara	Sec.	Keshavanagara	K.P. Agrahara	1,075
9	V108	Gopalpura	Sec.	Subashnagara	Minerva Mill	980
10	V109	Platform Road	Sec.	Dhanavantri Road	V.V.Giri Colony	200
11	V110	Sheshadaripura	Sec.	Kumara Park	Palace Guttahalli	380
12	V111	Hanumanthapura	Sec.	Gowthamnagar	Saibabanagara	580
13	V112	Prakashnagara	Sec.	Gayathainagara	Ramachandrapura	3,420
14	V113	Dayanandanagara	Sec.	Bashyamnagara	Lakshminarayanpura	470
15	V114	Subrahmanyanagara	Sec.	Gayatrinagara	Srirampura	700
16	V115	M.E.I. Polytechnic	Sec.	M.E.I. Polytechnic	Magadi Road	940
17	V116	Agrahara Dasarahalli	Sec.	Manjunathanagara	Padarayanapura	3,775
18	V117	Hosahalli	Sec.	Magadi Chord Road Layout	Shammana Layout	1,585
19	V118	Vijayanagara	Sec.	Hosahalli Extension	R.P.C. Layout	1,250
20	V119	R.P.C. Layout	Sec.	Govindaraj Layout	Kavika Layout	3,140
21	V120	Kempe Gowdanagara	Sec.	Vinayaka Extension	Ragavendra Colony	800
22	V121	Srinagara	Sec.	Hanumanthanagara	Vittalnagara	1,425
23	V122	Muneshwara Block	Sec.	Nagendra Block	Timber Yard Layout	1,600
				Total Length of Primary Drains		**14,000**
				Total Length of Secondary Drains		**30,945**

TABLE – 6.2 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Vrishabhavathi Main Valley (V100) Considered for Remodeling

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Vrishabhavathi Main Valley Primary Storm Drain (V100) :				
1	V - C17	2050	Venkataranga Iyengar Mn Rd, Sheshadaripura	Ex. Culvert/Bridge considered for remodelling Pro. Addl. Single Span, Box Culvert, each 5 m wide, 4.4 m
Timberyard Secondary Storm Drain (V102) :				
1	V13/C7	230	2nd Main Road, Kariyamnapalya.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span - Box culvert, 8 m wide, 2 m ht.
2	V13/C6	380	Pipeline Road, Utharayappa Garden, Kashturibai Nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span - Box culvert, 7 m wide, 2 m ht.
Guddadahalli Secondary Storm Drain (V103) :				
1	V3/C6A	170	Janatha Colony Mn. Rd.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 3.5 m Wide, 1.5 m ht.
JaiBharathnagara Secondary Storm Drain (V104) :				
1	V10A/C10	550	9th Cross Guddadahalli Nehru Road, Mysore Road.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 5 m wide, 1.75 m ht.
Binnypet Secondary Storm Drain (V105) :				
1	V5/C11	150	1st Main 3rd Cross Road, R.R.Nagara, Ranganatha Colony.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 5 m wide, 1.75 m ht.
Bakshi Garden Secondary Storm Drain (V106) :				
1	V - 6/C23	220	Goods shed road, Velmuruga nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 6 m wide, 2.1 m ht.
Kempapura Agrahara Secondary Storm Drain (V107) :				
1	V - 7/C13A	385	Bhuvaneswari nagara, Magadi Road.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 3.5 m wide, 1.5 m ht.
Sheshadaripura Secondary Storm Drain (V110) :				
1	V1/C5	35	Nagappa Street, Sheshadaripura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 6 m wide, 1.7 m ht.
Prakash Nagara Secondary Storm Drain (V112) :				
1	VS1/C7	920	M.K.K.Road, 2nd Stage, Rajajinagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.1m ht.
2	VS1/C9	1,150	Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.2m ht.
3	VS1/C10	1,385	9th Main Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2m ht.
4	VS1/C11	1,440	12th Main Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2m ht.
5	VS1/C13	1,575	4th Cross Road, Mariyappa Palya, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 8 m wide, 2.1m ht.
6	VS1/C14	1,610	5th Main Road, Prakash Nagara	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box culvert, 8 m wide, 2m ht.
7	VS1/C25	2,980	4th Cross Road, Ramachandrapura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.3m ht.
8	VS1/C26	3,140	4th Main, 2nd Cross Road, Ramachandrapura	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Slab Bridge, 10 m wide, 2.5m ht.
Muneshwara Block Secondary Storm Drain (V122) :				

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
1	SN-S1-C8	1,225	15th Main Road, Kalidasa Layout, Raghavendra nagara.	Ex. Culvert/Bridge considered for remodelling Pro. Single Span, Box Culvert, 3.5 m wide,1.6 m ht.

Detailed cost estimate has been worked out for improving the carrying capacity of the existing system, rehabilitating the existing system and remodeling of inadequate vent way / structurally unsound bridges/culverts, formation of service roads where ever possible for maintenance of drains and other allied works to minimizing the flooding problems in low lying areas.

Wherein, rehabilitation work includes drain wall reconstruction, cavity filling, restoration of eroded stones, providing pointing, drain wall lining etc. and where as carrying capacity improvement work includes desilting, widening, deepening, plastering, wall raising, construction of water recharging structures and providing drain bed protection, utility shifting etc.

For ease of assessment, carrying capacity improvement works and rehabilitation works have been identified and assessed for every kilometer length and accordingly cost estimates have been worked out and given in Volume IV of this report.

Further for better understanding work summary statements and strip plans for every kilometer length, have been prepared and enclosed in this chapter.

For assessment of cost, detailed hydraulic design, structural designs, quantity estimation and cost estimation as per current schedule of rates of KPWD, NH, MI, Market rates / Consultants data bank have been carried out

A lumpsum amount provision for temporary shifting of utilities, traffic diversion, providing improvement works like green belt development along side of storm drains and service road formation etc., are made in the estimate.

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,

•Procurement of land / acquisition cost
•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.

Table 6.3 & 6.4 indicates carrying capacity improvement works & rehabilitation works for Primary storm drain in Vrishabhavathi Main Valley.

Table 6.5 & 6.6 indicates carrying capacity improvement works & rehabilitation works for Secondary storm drains in Vrishabhavathi Main Valley.

Table 6.7 Indicates abstract of cost for remodelling of existing culverts / bridges and also construction of new bridges in the entire Vrishabhavathi Main Valley (V100)

TABLE 6. 7 Abstract of Cost for Remodeling of Culvert / Bridges in Vrishabhavathi Main Valley (V100)

Sl. No.	Culvert No.	Chainage (m.)	Location	Amount (Rs. in Lakhs)
Vrishabhavathi Main Valley Primary Storm Drain (V100) :				
1	V - C17	2050	Venkataranga Iyengar Mn Rd, Sheshadaripura	10.00

Sl. No.	Culvert No.	Chainage (m.)	Location	Amount (Rs. in Lakhs)
Timberyard Secondary Storm Drain (V102) :				
1	V13/C7	230	2nd Main Road, Kariyamnapalya.	18.70
2	V13/C6	380	Pipeline Road, Utharayappa Garden, Kashturibai Nagara.	20.86
Guddadahalli Secondary Storm Drain (V103) :				
1	V3/C6A	170	Janatha Colony Mn. Rd.	8.75
JaiBharathnagar Secondary Storm Drain (V104) :				
1	V10A/C10	550	9th Cross Guddadahalli Nehru Road, Mysore Road.	16.90
Binnypet Secondary Storm Drain (V105) :				
1	V5/C11	150	1st Main 3rd Cross Road, R.R.Nagara, Ranganatha Colony.	13.50
Bakshi Garden Secondary Storm Drain (V106) :				
1	V6/C23	220	Goods shed road, Velmuruga nagara.	21.99
Kempapura Agrahara Secondary Storm Drain (V107) :				
1	V7/C13A	385	Bhuvaneswari nagara, Magadi Road.	8.80
Sheshadaripura Secondary Storm Drain (V110) :				
1	V1/C5	35	Nagappa Street, Sheshadaripura	14.68
Prakash Nagar Secondary Storm Drain (V112) :				
1	VS1/C7	920	M.K.K.Road, 2nd Stage, Rajajinagara	31.74
2	VS1/C9	1150	Mariyappa Palya, Prakash Nagara	36.65
3	VS1/C10	1385	9th Main Road, Mariyappa Palya, Prakash Nagara	35.99
4	VS1/C11	1440	12th Main Road, Mariyappa Palya, Prakash Nagara	35.94
5	VS1/C13	1575	4th Cross Road, Mariyappa Palya, Prakash Nagara	18.25
6	VS1/C14	1610	5th Main Road, Prakash Nagara	21.60
7	VS1/C25	2980	4th Cross Road, Ramachandrapura	36.31
8	VS1/C26	3140	4th Main, 2nd Cross Road, Ramachandrapura	36.35
Muneshwara Block Secondary Storm Drain (V122) :				
1	SN-S1-C8	1225	15th Main Road, Kalidasa Layout, Raghavendra nagara.	10.59
Total Cost				**397.60**

6.4 Work Programme for Vrishabhavathi Main Valley:

The works proposed for remodeling of storm drains in Vrishabhavathi Main Valley, 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, acquisition of land from both government & public,

shifting of utilities, traffic diversion at several places etc., are envisaged in all the packages.

After having several discussion with senior officials of BMP and other stake holders and beneficiaries of the project. 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 etc., also for smooth and successful implementation of the project, which is as narrated below,

✓**Brief Work Programme for Remodeling of Storm Water Drains in the entire Vrishabhavathi Main Valley:**

•Before commencement of any work, detailed work plan has to be prepared for all the packages and get approved by BMP.

•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.

•Rocky out crops noticed all along the entire length of drains at various locations which are obstructing free flow of water & also causing accumulation of silt, garbage etc. needs to be removed/lowering work shall be taken up simultaneously in all the packages.

•Shifting of service lines which are noticed all along the entire length of 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 over the entire length, shall be taken up simultaneously in all the packages.

- Desilting of drains, removal of debris/solid wastes etc., which are noticed over the entire length of storm drain, 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.

- Culvert/bridges considered for remodeling under the project, at various locations shall be takenup simultaneously in all the packages.

- Construction of new drains considered for minimising 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 in the entire length of drain, 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 location under the project shall be taken up simultaneously in all the packages.

- Providing pointing and skin reinforcement to the entire length of existing SSM storm 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.

- 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.

6.6 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:

1.Removal of weeds
2.Removal of silt
3.Removal of debris and garbage
4.Repair of civil structures
5.Public awareness campaigns
6.Maintenance of desilting equipment's
7.Manpower requirement for maintenance of the system.

Table 6.8 Indicates abstract of cost for annual operation and maintenance of the drainage system in the entire Vrishabhavathi Main Valley.

TABLE 6.8 Abstract of Cost for Operation & Maintenance of Primary & Secondary Storm Drains in Vrishabhavathi Main Valley (V100)

Sl. No.	Description	Amount (Rs. In Lakhs)	Remarks
1	**Operation & Maintenance**		(Cost considered is per annum)
	a) Manpower Cost	18.88	
	b) Equipment Cost	16.19	
	c) Establishment Cost	5.40	
	d) Desilting Works	161.85	(min. 300 mm. every year)
	e) Staff Training & Community Education	8.09	
	Total Operation & Maintenance Cost	**210.41**	

Abstract of Cost

for Remodeling of Primary and Secondary

Storm Water Drains, Culverts/Bridges & its appurtenant works

in Vrishabhavathi Main Valley (V100)

Sl.No.	Description	Amount (Rs. In Lakhs)
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	8,397.05
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	55.96
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	447.60
4	Construction of Detention Ponds / Retarding Basins	60.00
5	Construction of Wells with pumping arrangement in low lying areas	100.00
6	Procurement of desilting machine	0.00
7	Miscellaneous and rounding off	0.002
8	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	143.00
	✓TOTAL	**9,703.01**
9	Annual Operation & Maintenance Cost (1.0 % of Item 1 to 7)	191.20

Table Showing Adequacy Analysis Results for Vrishabhavathi Valley (V1) - Existing Hydraulic Flow Conditions

(Unclean Condition)

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	V100	Sankey Reservoir	N. Subbaih Road 2 nd Cross Road	0	500	108.94	Pri.	3.2	8.23	11.18	14.02	16.19	21.07	1.8	2.57	3.5	4.38	5.06	6.59	3.5	1.43	1.94	2.43	2.81	3.66	AD	AD	AD	AD	IA
2	V100	N. Subbaih Road 2 nd Cross Road	Shree Ragavandra Jyothrisyalayam	500	1180	200.35	Pri.	2.5	14.71	20.06	25.26	29.34	37.78	2	5.89	8.02	10.11	11.74	15.11	5.6	2.94	4.01	5.05	5.87	7.56	AD	AD	AD	IA	IA
3	V100	Shree Ragavandra Jyothrisyalayam	Subedah Chitram Road near Malleswaram	1180	2000	401.15	Pri.	2.5	28.85	39.44	49.85	58.15	74.26	2.3	11.54	15.78	19.94	23.26	29.7	10.25	5.02	6.86	8.67	10.11	12.91	AD	AD	AD	AD	IA
4	V100	Subedah Chitram Road near Malleswaram	Lakshmi Rao Nagar, Okalipuram	2000	2480	485.09	Pri.	3.2	34.17	46.81	59.3	69.38	88.11	2.54	10.68	14.63	18.53	21.68	27.53	11.3	4.2	5.76	7.3	8.54	10.84	AD	AD	AD	AD	AD
5	V100	Lakshmi Rao Nagar, Okalipuram	Okalipuram	2480	3140	622.22	Pri.	2.8	43.64	59.78	75.71	88.56	112.51	2.5	15.59	21.35	27.04	31.63	40.18	13	6.23	8.54	10.82	12.65	16.07	AD	AD	AD	AD	IA
6	V100	Okalipuram	Near Water Effluent Treatment Plant	3140	3700	706.99	Pri.	3	49.45	67.78	85.92	100.61	127.55	2.36	16.48	22.59	28.64	33.54	42.52	13.5	6.98	9.57	12.14	14.21	18.02	AD	AD	AD	IA	IA
7	V100	Near Water Effluent Treatment Plant	Near Magadi road area, Gopalapura	3700	4250	1205.38	Pri.	3.4	76.25	104.53	132.55	155.27	196.72	2.7	22.43	30.74	38.98	45.67	57.86	17.5	8.31	11.39	14.44	16.91	21.43	AD	AD	AD	AD	IA
8	V100	Near Magadi road area, Gopalapura	Shankrappa Garden, Magadi Road	4250	4575	1293.08	Pri.	2.8	82.47	113.06	143.38	167.98	212.77	2.7	29.45	40.38	51.21	59.99	75.99	17.1	10.91	14.96	18.97	22.22	28.14	AD	AD	IA	IA	IA
9	V100	Shankrappa Garden, Magadi Road	Bhuvaneswari Nagar	4575	5170	1368.97	Pri.	2.6	83.54	114.56	145.35	170.38	215.59	2.4	32.13	44.06	55.9	65.53	82.92	20	13.39	18.36	23.29	27.3	34.55	AD	AD	IA	IA	IA
10	V100	Bhuvaneswari Nagar	Near Cholur Palaya Road	5170	5550	1585.97	Pri.	2.6	98.77	135.49	171.95	201.65	254.96	2.7	37.99	52.11	66.14	77.56	98.06	14	14.07	19.3	24.49	28.73	36.32	IA	IA	IA	IA	IA
11	V100	Near Cholur Palaya Road	Padarayanpura	5550	6080	1688.63	Pri.	2.6	106	145.42	184.56	216.46	273.64	2.8	40.77	55.93	70.98	83.25	105.25	23	14.56	19.97	25.35	29.73	37.59	AD	AD	IA	IA	IA
12	V100	Padarayanpura	Arif Nagar	6080	7000	2203.08	Pri.	3.4	139.66	191.92	244.11	287.07	361.08	3.2	41.08	56.45	71.8	84.43	106.2	22	12.84	17.64	22.44	26.38	33.19	AD	AD	IA	IA	IA
13	V100	Arif Nagar	Shamanna Nagar 1 st Main Road	7000	7300	2212.81	Sec.	3.6	140.12	192.58	244.98	288.14	362.3	3.7	38.92	53.49	68.05	80.04	100.64	20	10.52	14.46	18.39	21.63	27.2	AD	AD	AD	IA	IA
14	V100	Shamanna Nagar 1 st Main Road	Bapuji Nagar Bridge Road	7300	8000	2546.34	Sec.	3.4	165.29	227	288.48	338.91	427.1	3.2	48.62	66.76	84.85	99.68	125.62	19	15.19	20.86	26.52	31.15	39.26	AD	IA	IA	IA	IA
15	V100	Bapuji Nagar Bridge Road	Kavika Layout	8000	8500	2944.69	Pri.	3.3	166.97	229.39	291.67	342.88	431.58	3.42	50.6	69.51	88.39	103.9	130.78	23	14.79	20.33	25.84	30.38	38.24	AD	AD	IA	IA	IA
16	V100	Kavika Layout	Near Mysore Road	8500	8900	3207.95	Pri.	3	185.24	254.53	323.67	380.57	478.86	3.2	61.75	84.84	107.89	126.86	159.62	35	19.3	26.51	33.72	39.64	49.88	AD	AD	AD	IA	IA

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
17	V100	Near Mysore Road		8900	10000	3371.3	Pri.	3.4	189.25	260.28	331.38	390.24	489.62	2.3	55.66	76.55	97.46	114.78	144.01	30	24.2	33.28	42.38	49.9	62.61	AD	IA	IA	IA	IA
18	V100	0		10000	11000	3461.66	Pri.	3.4	192.84	265.43	338.32	398.99	499.27	2.64	56.72	78.07	99.51	117.35	146.84	28	21.48	29.57	37.69	44.45	55.62	AD	IA	IA	IA	IA
19	V101	Avalahalli	Deepanjalinagar	0	900	65.88	Pri.	4.1	5.35	7.28	9.14	10.58	13.71	2.2	1.3	1.78	2.23	2.58	3.34	4.6	0.59	0.81	1.01	1.17	1.52	AD	AD	AD	AD	AD
20	V102	Timber Yard Layout	Near Utharayappa Garden	0	350	14.52	Pri.	4.5	1.41	1.9	2.36	2.69	3.58	2.3	0.31	0.42	0.52	0.6	0.79	10	0.14	0.18	0.23	0.26	0.35	AD	AD	AD	AD	AD
21	V102	Near Utharayappa Garden	Sanjay Nagar	350	800	105.65	Pri.	3	8.81	12	15.1	17.52	22.61	1.42	2.94	4	5.03	5.84	7.54	4.5	2.07	2.82	3.55	4.11	5.31	AD	AD	AD	AD	IA
22	V102	Sanjay Nagar	Bapujinagar	800	1860	250.04	Pri.	4.1	19.41	26.54	33.54	39.12	49.96	2.2	4.73	6.47	8.18	9.54	12.18	11	2.15	2.94	3.72	4.34	5.54	AD	AD	AD	AD	AD
23	V103	Vinayaka Nagar	New Guddada Halli	0	800	67.69	Pri.	4.5	5.73	7.78	9.75	11.25	14.66	1.6	1.27	1.73	2.17	2.5	3.26	3.9	0.8	1.08	1.35	1.56	2.04	AD	AD	AD	AD	AD
24	V103	New Guddada Halli	JaiBharathnagar	800	1050	120.26	Pri.	4.5	9.7	13.2	16.59	19.21	24.86	2.5	2.15	2.93	3.69	4.27	5.52	5.5	0.86	1.17	1.47	1.71	2.21	AD	AD	AD	AD	AD
25	V104	Jagajivanramnagar	JaiBharathnagar	0	1020	38.56	Pri.	4.1	2.96	4.04	5.1	5.93	7.62	1.7	0.72	0.99	1.24	1.45	1.86	2.8	0.43	0.58	0.73	0.85	1.09	AD	AD	AD	AD	AD
26	V105	R.R. Nagar, Ranganatha Colony	Jagajeevanram nagar	0	500	33.93	Pri.	3.7	2.73	3.7	4.64	5.35	6.97	1.6	0.74	1	1.25	1.45	1.88	2.9	0.46	0.63	0.78	0.9	1.18	AD	AD	AD	AD	AD
27	V105	Jagajeevanram nagar	Binnypet	500	1320	77.52	Pri.	4.2	6	8.18	10.31	11.98	15.41	2.2	1.43	1.95	2.45	2.85	3.67	3.3	0.65	0.89	1.12	1.3	1.67	AD	AD	AD	AD	AD
28	V106	Bakshi Garden	Nethaji Nagar	0	1000	66.32	Pri.	3.5	4.9	6.7	8.47	9.87	12.62	2	1.4	1.91	2.42	2.82	3.6	4.6	0.7	0.96	1.21	1.41	1.8	AD	AD	AD	AD	AD
29	V106	Nethaji Nagar	Bhuvaneswari Nagar	1000	2000	114.24	Pri.	4	8.27	11.33	14.37	16.83	21.32	2	2.07	2.83	3.59	4.21	5.33	3.5	1.03	1.42	1.8	2.1	2.67	AD	AD	AD	AD	AD
30	V106	Bhuvaneswari Nagar		2000	2325	127.92	Pri.	3.2	9.16	12.57	15.95	18.71	23.65	1.7	2.86	3.93	4.99	5.85	7.39	3.9	1.68	2.31	2.93	3.44	4.35	AD	AD	AD	AD	IA
31	V106	0	K.P. Agrahara	2325	2444	188.6	Pri.	3.2	13.75	18.84	23.87	27.94	35.46	1.8	4.3	5.89	7.46	8.73	11.08	4.9	2.39	3.27	4.14	4.85	6.16	AD	AD	AD	AD	IA
32	V107	Keshavanagar	K.P. Agrahara	0	1070	54.86	Pri.	2.7	4.19	5.71	7.2	8.38	10.76	1.4	1.55	2.12	2.67	3.1	3.98	2.3	1.11	1.51	1.91	2.22	2.85	AD	AD	AD	AD	IA
33	V108	Subashnagar	Minerva Mill	0	660	53.92	Pri.	2.8	4.4	5.98	7.51	8.69	11.27	2.1	1.57	2.14	2.68	3.11	4.03	2	0.75	1.02	1.28	1.48	1.92	AD	AD	AD	AD	AD
34	V109	Dhanavantri Road	V.V.Giri Colony	0	180	91.44	Pri.	3.5	6.78	9.22	11.57	13.38	17.37	2.5	1.94	2.63	3.31	3.82	4.96	2	0.77	1.05	1.32	1.53	1.98	AD	AD	AD	AD	AD
35	V110	Kumara Park	Palace Guttahalli	0	380	61.79	Pri.	2.5	4.32	5.89	7.41	8.61	11.08	2	1.73	2.35	2.97	3.44	4.43	2.5	0.86	1.18	1.48	1.72	2.22	AD	AD	AD	AD	AD
36	V111	Hanumanthapura	Ramachandrapura	0	580	37.84	Pri.	3.4	3.26	4.44	5.59	6.49	8.37	1.5	0.96	1.31	1.64	1.91	2.46	2	0.64	0.87	1.1	1.27	1.64	AD	AD	AD	AD	AD

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
37	V112	Subrmananayanagar	Near Rajajinagar Kalyana Mandapam	0	1000	151.96	Pri.	3.85	12.31	16.81	21.2	24.66	31.65	1.8	3.2	4.37	5.51	6.41	8.22	4	1.78	2.43	3.06	3.56	4.57	AD	AD	AD	AD	IA
38	V112	Near Rajajinagar Kalyana Mandapam	Lakshminarayana puram	1000	1640	232.05	Pri.	3.4	18.3	25.03	31.64	36.91	47.12	2.2	5.38	7.36	9.31	10.86	13.86	6.6	2.45	3.35	4.23	4.93	6.3	AD	AD	AD	AD	AD
39	V112	Lakshminarayanapuram	Udayam Nagar	1640	2580	398.42	Pri.	4.5	30.61	41.9	53.01	61.92	78.86	2.67	6.8	9.31	11.78	13.76	17.53	6.3	2.55	3.49	4.41	5.15	6.56	AD	AD	AD	AD	IA
40	V112	Udayam Nagar	Sujatha Theater	2580	3417	457	Pri.	3.8	35	47.91	60.64	70.87	90.18	2.6	9.21	12.61	15.96	18.65	23.73	8.5	3.54	4.85	6.14	7.17	9.13	AD	AD	AD	AD	IA
41	V113	Maruthi Extn.	Dayanandanagar	0	470	25.82	Pri.	4.5	2.29	3.1	3.87	4.45	5.84	2.2	0.51	0.69	0.86	0.99	1.3	3.6	0.23	0.31	0.39	0.45	0.59	AD	AD	AD	AD	AD
42	V114	Gayathri Nagar	Prakashnagar	0	700	69.98	Pri.	4.5	5.66	7.71	9.68	11.21	14.52	2.8	1.26	1.71	2.15	2.49	3.23	4.5	0.45	0.61	0.77	0.89	1.15	AD	AD	AD	AD	AD
43	V115	M.E.I. Polytechnic	Magadi Road	0	940	56.26	Pri.	2.5	4.47	6.1	7.67	8.89	11.48	2.4	1.79	2.44	3.07	3.56	4.59	6.7	0.75	1.02	1.28	1.48	1.91	AD	AD	AD	AD	AD
44	V116	Near Modi Hospital Road, Manjunathanagar	Shivana Halli	0	1000	130.99	Pri.	1.8	9.33	12.78	16.18	18.92	24.06	1.6	5.18	7.1	8.99	10.51	13.36	3.3	3.24	4.44	5.62	6.57	8.35	AD	IA	IA	IA	IA
45	V116	Shivana Halli	Dasara Halli	1000	2000	265.34	Pri.	3.7	18.87	25.91	32.9	38.61	48.74	2.4	5.1	7	8.89	10.44	13.17	3.6	2.13	2.92	3.71	4.35	5.49	AD	AD	IA	IA	IA
46	V116	Dasara Halli	Near Rajaji Nagar Ind. Town, Mysore Road	2000	3000	400.56	Pri.	4.1	27.5	37.87	48.29	56.95	71.23	2.2	6.71	9.24	11.78	13.89	17.37	6.3	3.05	4.2	5.35	6.31	7.9	AD	AD	AD	IA	IA
47	V116	Near Rajaji Nagar Ind. Town, Mysore Road	Padarayanapura	3000	3770	464.12	Pri.	4.1	31.38	43.28	55.27	65.33	81.38	2.51	7.65	10.56	13.48	15.93	19.85	10.42	3.05	4.21	5.37	6.35	7.91	AD	AD	AD	AD	AD
48	V117	Hosahalli 80 ft. Road	Near Office of the Executive Engg. Water Supply & Sewage Division	0	1000	87.79	Pri.	4.1	6.9	9.42	11.87	13.8	17.74	1.3	1.68	2.3	2.9	3.37	4.33	3.65	1.3	1.77	2.23	2.59	3.33	AD	AD	AD	AD	AD
49	V117	Near Office of the Executive Engg. Water Supply & Sewage Division	R.P.C. Layout	1000	1584	120.92	Pri.	3.8	9.31	12.71	16.05	18.7	23.94	1.8	2.45	3.35	4.22	4.92	6.3	4.5	1.36	1.86	2.35	2.73	3.5	AD	AD	AD	AD	AD
50	V118	Magadi Cd Road Layout	Vijayanagar 2 nd Stage	0	850	32.36	Pri.	3.8	2.55	3.47	4.37	5.07	6.54	1.7	0.67	0.91	1.15	1.33	1.72	3	0.39	0.54	0.68	0.78	1.01	AD	AD	AD	AD	AD
51	V118	Vijayanagar 2 nd Stage	R.P.C. Layout	850	1245	188.16	Pri.	4.5	14.34	19.6	24.77	28.89	36.91	2	3.19	4.36	5.51	6.42	8.2	5	1.59	2.18	2.75	3.21	4.1	AD	AD	AD	AD	AD
52	V119	Vijayanagar East	Siddeshwara nagar	0	1000	68.07	Pri.	3.3	5.45	7.42	9.33	10.81	13.98	2	1.65	2.25	2.83	3.28	4.24	3	0.83	1.12	1.41	1.64	2.12	AD	AD	AD	AD	AD

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
53	V119	Siddeshwara nagar	R.P.C. Layout , Vijayanagar 2 nd Stage	1000	2000	147.71	Pri.	3.9	11.13	15.22	19.23	22.42	28.66	2	2.86	3.9	4.93	5.75	7.35	3.5	1.43	1.95	2.47	2.87	3.67	AD	AD	AD	AD	IA
54	V119	R.P.C. Layout , Vijayanagar 2 nd Stage	R.P.C. Layout	2000	3132	236.62	Pri.	4.3	17.07	23.41	29.7	34.82	44.05	2.4	3.97	5.44	6.91	8.1	10.24	3.5	1.65	2.27	2.88	3.37	4.27	AD	AD	AD	AD	IA
55	V120	Chamarajapet	Kempambudhi Tank	0	800	111.79	Pri.	3.3	8.47	11.56	14.58	16.97	21.77	1.9	2.57	3.5	4.42	5.14	6.6	7.2	1.35	1.84	2.33	2.71	3.47	AD	AD	AD	AD	AD
56	V121	Hnumanthangar	Kalidas Layout	0	1000	52.69	Pri.	4.2	4.43	6.03	7.58	8.78	11.36	2.4	1.05	1.44	1.8	2.09	2.7	6.3	0.44	0.6	0.75	0.87	1.13	AD	AD	AD	AD	AD
57	V121	Kalidas Layout	Rudrappa Garden	1000	1425	71.29	Pri.	4.5	5.94	8.1	10.19	11.83	15.26	2.5	1.32	1.8	2.27	2.63	3.39	8.8	0.53	0.72	0.91	1.05	1.36	AD	AD	AD	AD	AD
58	V122	Bank Colony	Ragavendra Nagar	0	1000	44.75	Pri.	4.2	3.65	4.96	6.23	7.21	9.35	1.8	0.87	1.18	1.48	1.72	2.23	3.2	0.48	0.66	0.82	0.95	1.24	AD	AD	AD	AD	AD
59	V122	Ragavendra Nagar	Sanjaya Gandhi Slum	1000	1600	73.85	Pri.	3.5	5.95	8.12	10.22	11.88	15.29	1.6	1.7	2.32	2.92	3.39	4.37	3.4	1.06	1.45	1.83	2.12	2.73	AD	AD	AD	AD	AD

Landuse Analysis for Vrishabhavathi Valley (V1) – Existing Hydraulic Flow Conditions

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	0	500	A1(a)	52.92	35.93	16.99	57.34	12.57	0.01	1.2	3.2	2.6	2.08	17.26	0.450	60.93	82.73	103.67	119.62	155.89	4.03	5.47	6.86	7.91	10.31											
			A1(b)	56.02	40.19	15.83	59.46	12.26	0.01	1.2	3.2	2.6	2.78	17.64	0.450	60.02	81.57	102.30	118.18	153.68	4.2	5.71	7.16	8.28	10.76											
			Total	**108.94**							3.2										**8.23**	**11.18**	**14.02**	**16.19**	**21.07**	3.5	1.8	**2.6**	**3.5**	**4.4**	**5.1**	**6.6**	**1.4**	**1.9**	**2.4**	**2.8**	**3.7**
V100	500	1180	A1(a)	41.68	37.51	4.17	69.5	10.8	0.02	1.5	2.5	7.87	3.33	22	0.500	51.74	70.82	89.63	104.73	133.31	3	4.1	5.19	6.06	7.72											
			A1(b)	49.73	44.76	4.97	69.5	10.8	0.01	1.2	2.5	7.87	4.17	22.83	0.500	50.46	69.16	87.66	102.62	130.16	3.49	4.78	6.05	7.09	8.99											
			Total	**91.41**							2.5										**6.48**	**8.88**	**11.24**	**13.15**	**16.71**											
			Total	**200.35**							2.5										**14.71**	**20.06**	**25.26**	**29.34**	**37.78**	5.6	2	**5.9**	**8.0**	**10.1**	**11.7**	**15.1**	**2.9**	**4.0**	**5.1**	**5.9**	**7.6**
V110	0	380	A1(c)	61.79	41.35	20.44	56.81	12.65	0.02	1.5	2.5	2.53	4.44	19.62	0.450	55.87	76.20	95.98	111.49	143.50	4.32	5.89	7.41	8.61	11.08											
			Total	**61.79**							2.5										**4.32**	**5.89**	**7.41**	**8.61**	**11.08**	2.5	2	**1.7**	**2.4**	**3.0**	**3.4**	**4.4**	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**
V100	1180	2000	A1(c)	102.98	92.68	10.3	69.5	10.8	0.02	1.5	2.5	10	3.33	24.13	0.550	48.61	66.75	84.80	99.55	125.60	7.65	10.5	13.34	15.66	19.76											
			A1(a)	36.03	22.21	13.82	53.9	13.07	0.02	1.5	2.5	10	5.56	28.62	0.500	43.34	59.85	76.56	90.67	112.52	2.17	2.99	3.83	4.54	5.63											
			Total	**139.01**							2.5										**9.82**	**13.5**	**17.17**	**20.2**	**25.39**											
			Total	**401.15**							2.5										**28.85**	**39.44**	**49.85**	**58.15**	**74.26**	10.25	2.3	**11.5**	**15.8**	**19.9**	**23.3**	**29.7**	**5.0**	**6.9**	**8.7**	**10.1**	**12.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	2000	2480	A1(c)	50.73	41.62	9.11	65.12	11.44	0.02	1.5	3.2	12.92	5.56	29.91	0.550	42.08	58.19	74.57	88.52	109.38	3.26	4.51	5.78	6.86	8.48											
			A1(a)	33.21	26.75	6.46	64.3	11.56	0.01	1.2	3.2	12.92	6.94	31.42	0.550	40.71	56.38	72.41	86.17	105.97	2.07	2.86	3.67	4.37	5.38											
			Total	**83.94**							3.2										**5.33**	**7.37**	**9.45**	**11.23**	**13.85**											
			Total	**485.09**							3.2										**34.17**	**46.81**	**59.3**	**69.38**	**88.11**	11.3	2.54	**10.7**	**14.6**	**18.5**	**21.7**	**27.5**	**4.2**	**5.8**	**7.3**	**8.5**	**10.8**
V109	0	180	A1(d)	91.44	61.06	30.38	56.73	12.66	0.02	1.5	3.5	0.86	4.44	17.96	0.450	59.31	80.64	101.22	117.03	151.93	6.78	9.22	11.57	13.38	17.37											
			Total	**91.44**							3.5										**6.78**	**9.22**	**11.57**	**13.38**	**17.37**	2	2.5	**1.9**	**2.6**	**3.3**	**3.8**	**5.0**	**0.8**	**1.1**	**1.3**	**1.5**	**2.0**
V100	2480	3140	A2(e)	20.8	18.72	2.08	69.5	10.8	0.01	1.2	2.8	18.69	5.56	35.05	0.600	37.82	52.57	67.82	81.16	98.76	1.31	1.82	2.35	2.81	3.42											
			A3	24.89	19.91	4.98	64	11.6	0.01	1.2	2.8	18.69	6.94	37.24	0.550	36.31	50.58	65.40	78.52	94.98	1.38	1.92	2.49	2.99	3.61											
			Total	**45.69**							2.8										**2.69**	**3.75**	**4.84**	**5.8**	**7.04**											
			Total	**622.22**							2.8										**43.64**	**59.78**	**75.71**	**88.56**	**112.51**	13	2.5	**15.6**	**21.3**	**27.0**	**31.6**	**40.2**	**6.2**	**8.5**	**10.8**	**12.7**	**16.1**
V111	0	580	A2(e)	37.84	33.25	4.59	68.33	10.97	0.02	1.5	3.4	2.84	5.56	19.37	0.550	56.37	76.84	96.74	112.29	144.71	3.26	4.44	5.59	6.49	8.37											
			Total	**37.84**							3.4										**3.26**	**4.44**	**5.59**	**6.49**	**8.37**											
			Total	**37.84**							3.4										**3.26**	**4.44**	**5.59**	**6.49**	**8.37**	2	1.5	**1.0**	**1.3**	**1.6**	**1.9**	**2.5**	**0.6**	**0.9**	**1.1**	**1.3**	**1.6**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	3140	3700	A2(e)	15.5	13.49	2.01	67.87	11.04	0.02	1.5	3	20.56	7.78	39.37	0.600	34.97	48.80	63.26	76.16	91.63	0.9	1.26	1.63	1.97	2.37											
			A3	31.43	13.57	17.86	43.75	14.55	0.02	1.5	3	20.56	5.56	40.66	0.550	34.22	47.81	62.05	74.83	89.75	1.64	2.3	2.98	3.59	4.31											
			Total	**46.93**							3										**2.55**	**3.56**	**4.61**	**5.56**	**6.68**											
			Total	**706.99**							3										**49.45**	**67.78**	**85.92**	**100.61**	**127.55**	13.5	2.36	**16.5**	**22.6**	**28.6**	**33.5**	**42.5**	**7.0**	**9.6**	**12.1**	**14.2**	**18.0**
V112	0	1000	B3	61.69	54.29	7.4	68.4	10.96	0.02	1.5	3.85	4.33	4.44	19.73	0.550	55.67	75.93	95.67	111.15	142.99	5.25	7.16	9.02	10.48	13.48											
			A2(a)	38.08	32.15	5.93	66.44	11.25	0.02	1.5	3.85	4.33	4.44	20.02	0.550	55.13	75.23	94.84	110.28	141.67	3.21	4.38	5.52	6.42	8.24											
			A2(b)	52.19	29.85	22.34	51.46	13.42	0.02	1.5	3.85	4.33	3.33	21.09	0.500	53.24	72.77	91.94	107.19	137.00	3.86	5.27	6.66	7.77	9.93											
			Total	**151.96**							3.85										**12.31**	**16.81**	**21.2**	**24.66**	**31.65**											
			Total	**151.96**							3.85										**12.31**	**16.81**	**21.2**	**24.66**	**31.65**	4	1.8	**3.2**	**4.4**	**5.5**	**6.4**	**8.2**	**1.8**	**2.4**	**3.1**	**3.6**	**4.6**
V112	1000	1640	A2(a)	28.46	25.62	2.84	69.51	10.8	0.01	1.2	3.4	8.04	4.17	23	0.550	50.21	68.83	87.27	102.20	129.53	2.18	2.99	3.79	4.44	5.63											
			A2(b)	51.63	46.46	5.17	69.49	10.8	0.02	1.5	3.4	8.04	5.56	24.4	0.550	48.26	66.29	84.25	98.97	124.72	3.81	5.23	6.65	7.81	9.84											
			Total	**80.09**							3.4										**5.99**	**8.22**	**10.44**	**12.25**	**15.47**											
			Total	**232.05**							3.4										**18.3**	**25.03**	**31.64**	**36.91**	**47.12**	6.6	2.2	**5.4**	**7.4**	**9.3**	**10.9**	**13.9**	**2.4**	**3.3**	**4.2**	**4.9**	**6.3**
V114	0	700	A2(c)	52.89	41.14	11.75	62.78	11.78	0.02	1.5	4.5	2.59	3.89	18.26	0.500	58.65	79.80	100.22	115.98	150.32	4.31	5.86	7.36	8.52	11.04											
			A2(d)	17.09	12.82	4.27	61.26	12	0.02	1.5	4.5	2.59	4.44	19.04	0.500	57.03	77.70	97.75	113.36	146.34	1.35	1.84	2.32	2.69	3.47											
			Total	**69.98**							4.5										**5.66**	**7.71**	**9.68**	**11.21**	**14.52**											
			Total	**69.98**							4.5										**5.66**	**7.71**	**9.68**	**11.21**	**14.52**	4.5	2.8	**1.3**	**1.7**	**2.2**	**2.5**	**3.2**	**0.4**	**0.6**	**0.8**	**0.9**	**1.2**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V112	1640	2580	A2(a)	63.85	45.47	18.38	59.17	12.3	0.02	1.5	4.5	9.56	4.44	26.3	0.550	45.88	63.17	80.54	94.97	118.82	4.48	6.16	7.86	9.26	11.59											
			A2(d)	32.54	25.28	7.26	62.73	11.78	0.01	1.2	4.5	9.56	6.94	28.28	0.550	43.69	60.30	77.11	91.27	113.39	2.17	3	3.83	4.54	5.64											
			Total	**96.39**							4.5										**6.65**	**9.16**	**11.69**	**13.8**	**17.23**											
			Total	**398.42**							4.5										**30.61**	**41.9**	**53.01**	**61.92**	**78.86**	6.3	2.67	**6.8**	**9.3**	**11.8**	**13.8**	**17.5**	**2.5**	**3.5**	**4.4**	**5.2**	**6.6**
V113	0	470	A2(e)	25.82	22.41	3.41	67.74	11.06	0.02	1.5	4.5	1.74	3.33	16.13	0.500	63.75	86.38	107.94	124.12	162.81	2.29	3.1	3.87	4.45	5.84											
			Total	**25.82**							4.5										**2.29**	**3.1**	**3.87**	**4.45**	**5.84**											
			Total	**25.82**							4.5										**2.29**	**3.1**	**3.87**	**4.45**	**5.84**	3.6	2.2	**0.5**	**0.7**	**0.9**	**1.0**	**1.3**	**0.2**	**0.3**	**0.4**	**0.4**	**0.6**
V112	2580	3417	A2(e)	15.13	13.46	1.67	68.93	10.88	0.02	1.5	3.8	17.05	5.56	33.49	0.600	39.00	54.13	69.69	83.21	101.70	0.98	1.36	1.76	2.1	2.56											
			A4(b)	17.63	15.87	1.76	69.51	10.8	0.01	1.2	3.8	17.05	6.94	34.79	0.600	38.01	52.82	68.12	81.49	99.23	1.12	1.55	2	2.39	2.92											
			Total	**32.76**							3.8										**2.1**	**2.92**	**3.76**	**4.49**	**5.48**											
			Total	**457**							3.8										**35**	**47.91**	**60.64**	**70.87**	**90.18**	8.5	2.6	**9.2**	**12.6**	**16.0**	**18.6**	**23.7**	**3.5**	**4.8**	**6.1**	**7.2**	**9.1**
V100	3700	4250	A4(b)	15.88	13.51	2.37	66.79	11.19	0.02	1.5	3.4	25.74	4.44	41.37	0.600	33.82	47.28	61.40	74.11	88.75	0.9	1.25	1.63	1.96	2.35											
			A5(a)	25.51	20.41	5.1	64	11.6	0.02	1.5	3.4	25.74	5.56	42.89	0.600	33.01	46.20	60.09	72.67	86.71	1.4	1.96	2.55	3.09	3.69											
			Total	**41.39**							3.4										**2.3**	**3.22**	**4.18**	**5.05**	**6.04**											
			Total	**1205.38**							3.4										**76.25**	**104.53**	**132.55**	**155.27**	**196.72**	17.5	2.7	**22.4**	**30.7**	**39.0**	**45.7**	**57.9**	**8.3**	**11.4**	**14.4**	**16.9**	**21.4**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V108	0	660	A5(a)	25.69	21.88	3.81	66.84	11.19	0.03	1.5	2.8	3.93	2.22	17.34	0.500	60.73	82.48	103.38	119.31	155.42	2.17	2.94	3.69	4.26	5.55											
			A5(b)	28.23	21.76	6.47	62.39	11.83	0.02	1.5	2.8	3.93	3.33	19.1	0.500	56.91	77.54	97.57	113.17	146.04	2.23	3.04	3.83	4.44	5.73											
			Total	**53.92**							2.8										**4.4**	**5.98**	**7.51**	**8.69**	**11.27**											
			Total	**53.92**							2.8										**4.4**	**5.98**	**7.51**	**8.69**	**11.27**	2	2.1	**1.6**	**2.1**	**2.7**	**3.1**	**4.0**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
V100	4250	4575	A4(b)	18.78	16.9	1.88	69.49	10.8	0.02	1.5	2.8	27.23	5.56	43.59	0.600	32.66	45.73	59.51	72.03	85.82	1.02	1.43	1.86	2.25	2.69											
			A5(b)	15	12.75	2.25	66.75	11.2	0.02	1.5	2.8	27.23	6.67	45.1	0.600	31.92	44.74	58.31	70.70	83.95	0.8	1.12	1.46	1.77	2.1											
			Total	**33.78**							2.8										**1.82**	**2.55**	**3.32**	**4.02**	**4.78**											
			Total	**1293.08**							2.8										**82.47**	**113.06**	**143.38**	**167.98**	**212.77**	17.1	2.7	**29.5**	**40.4**	**51.2**	**60.0**	**76.0**	**10.9**	**15.0**	**19.0**	**22.2**	**28.1**
V115	0	940	A4(a)	49.79	44.81	4.98	69.5	10.8	0.04	1.5	2.5	6.27	1.67	18.73	0.500	57.65	78.50	98.69	114.36	147.86	3.99	5.43	6.82	7.91	10.22											
			A4(b)	6.47	5.78	0.69	69.13	10.85	0.02	1.5	2.5	6.27	3.33	20.45	0.500	54.34	74.21	93.63	108.99	139.72	0.49	0.67	0.84	0.98	1.26											
			Total	**56.26**							2.5										**4.47**	**6.1**	**7.67**	**8.89**	**11.48**											
			Total	**56.26**							2.5										**4.47**	**6.1**	**7.67**	**8.89**	**11.48**	6.7	2.4	**1.8**	**2.4**	**3.1**	**3.6**	**4.6**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
V100	4575	5170	A6(a)	8.42	7.58	0.84	69.51	10.8	0.02	1.5	2.6	33.14	4.44	48.38	0.650	30.44	42.77	55.91	68.03	80.24	0.46	0.65	0.85	1.03	1.22											
			A8	11.21	10.09	1.12	69.5	10.8	0.02	1.5	2.6	33.14	5.56	49.5	0.650	29.98	42.15	55.15	67.19	79.07	0.61	0.85	1.12	1.36	1.6											
			Total	**19.63**							2.6										**1.07**	**1.5**	**1.97**	**2.39**	**2.82**											
			Total	**1368.97**							2.6										**83.54**	**114.56**	**145.35**	**170.38**	**215.59**	20	2.4	**32.1**	**44.1**	**55.9**	**65.5**	**82.9**	**13.4**	**18.4**	**23.3**	**27.3**	**34.6**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V106	0	1000	A6(b)	28.54	19.98	8.56	58.5	12.4	0.01	1.2	3.5	4.76	2.78	19.94	0.500	55.28	75.42	95.07	110.52	142.03	2.19	2.99	3.77	4.38	5.63											
			A6(c)	37.78	26.33	11.45	58.33	12.42	0.01	1.2	3.5	4.76	4.86	22.05	0.500	51.66	70.73	89.52	104.60	133.13	2.71	3.71	4.7	5.49	6.99											
			Total	**66.32**							3.5										**4.9**	**6.7**	**8.47**	**9.87**	**12.62**											
			Total	**66.32**							3.5										**4.9**	**6.7**	**8.47**	**9.87**	**12.62**	4.6	2	**1.4**	**1.9**	**2.4**	**2.8**	**3.6**	**0.7**	**1.0**	**1.2**	**1.4**	**1.8**
V106	1000	2000	A6(b)	24.15	21.74	2.41	69.51	10.8	0.01	1.2	4.0	8.33	5.56	24.69	0.550	47.88	65.79	83.66	98.32	123.77	1.77	2.43	3.09	3.63	4.57											
			A6(c)	23.77	21.39	2.38	69.49	10.8	0.02	1.5	4.0	8.33	8.89	28.02	0.550	43.96	60.66	77.54	91.73	114.07	1.6	2.2	2.82	3.33	4.14											
			Total	**47.92**							4.0										**3.36**	**4.63**	**5.9**	**6.96**	**8.71**											
			Total	**114.24**							4.0										**8.27**	**11.33**	**14.37**	**16.83**	**21.32**	3.5	2	**2.1**	**2.8**	**3.6**	**4.2**	**5.3**	**1.0**	**1.4**	**1.8**	**2.1**	**2.7**
V106	2000	2325	A6(b)	5.75	5.18	0.57	69.55	10.79	0.01	1.2	3.2	12.11	5.56	28.46	0.550	43.51	60.07	76.83	90.96	112.94	0.38	0.53	0.67	0.8	0.99											
			A6(c)	7.93	7.13	0.8	69.45	10.81	0.02	1.5	3.2	12.11	6.67	29.58	0.550	42.39	58.60	75.07	89.05	110.16	0.51	0.71	0.91	1.08	1.33											
			Total	**13.68**							3.2										**0.9**	**1.24**	**1.58**	**1.88**	**2.33**											
			Total	**127.92**							3.2										**9.16**	**12.57**	**15.95**	**18.71**	**23.65**	3.9	1.7	**2.9**	**3.9**	**5.0**	**5.8**	**7.4**	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**
V107	0	1070	A6(a)	42.63	30.62	12.01	59.51	12.25	0.04	1.5	2.7	6.6	1.11	19.97	0.500	55.22	75.35	94.98	110.43	141.89	3.27	4.46	5.62	6.54	8.4											
			A6(b)	12.23	8.56	3.67	58.5	12.4	0.02	1.5	2.7	6.6	1.67	20.67	0.500	53.95	73.70	93.04	108.36	138.77	0.92	1.25	1.58	1.84	2.36											
			Total	**54.86**							2.7										**4.19**	**5.71**	**7.2**	**8.38**	**10.76**											
			Total	**54.86**							2.7										**4.19**	**5.71**	**7.2**	**8.38**	**10.76**	2.3	1.4	**1.6**	**2.1**	**2.7**	**3.1**	**4.0**	**1.1**	**1.5**	**1.9**	**2.2**	**2.8**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V106	2325	2444	A6(a)	3.1	2.79	0.31	69.5	10.8	0.01	1.2	3.2	12.73	6.94	30.47	0.600	41.55	57.50	73.74	87.62	108.07	0.21	0.3	0.38	0.45	0.56												
			A6(c)	2.72	2.44	0.28	69.34	10.82	0.01	1.2	3.2	12.73	6.94	30.5	0.600	41.53	57.47	73.71	87.58	108.02	0.19	0.26	0.33	0.4	0.49												
			Total	**5.82**							3.2										**0.4**	**0.56**	**0.72**	**0.85**	**1.05**												
			Total	**188.6**							3.2										**13.75**	**18.84**	**23.87**	**27.94**	**35.46**	4.9	1.8	**4.3**	**5.9**	**7.5**	**8.7**	**11.1**	**2.4**	**3.3**	**4.1**	**4.8**	**6.2**
V100	5170	5550	A7(a)	19.73	17.76	1.97	69.51	10.8	0.01	1.2	2.6	35.58	5.56	51.93	0.650	29.03	40.88	53.59	65.44	76.66	1.03	1.46	1.91	2.33	2.73												
			A8	8.67	7.78	0.89	69.35	10.82	0.01	1.2	2.6	35.58	6.94	53.34	0.650	28.51	40.18	52.74	64.49	75.35	0.45	0.63	0.83	1.01	1.18												
			Total	**28.4**							2.6										**1.48**	**2.09**	**2.73**	**3.34**	**3.91**												
			Total	**1585.97**							2.6										**98.77**	**135.49**	**171.95**	**201.65**	**254.96**	14	2.7	**38.0**	**52.1**	**66.1**	**77.6**	**98.1**	**14.1**	**19.3**	**24.5**	**28.7**	**36.3**
V105	0	500	A7(a)	17.21	12.04	5.17	58.48	12.4	0.02	1.5	3.7	2.25	2.78	17.43	0.450	60.51	82.19	103.03	118.95	154.87	1.3	1.77	2.22	2.56	3.33												
			A7(b)	16.72	14.71	2.01	68.39	10.96	0.02	1.5	3.7	2.25	3.89	17.1	0.500	61.29	83.21	104.22	120.20	156.79	1.42	1.93	2.42	2.79	3.64												
			Total	**33.93**							3.7										**2.73**	**3.7**	**4.64**	**5.35**	**6.97**												
			Total	**33.93**							3.7										**2.73**	**3.7**	**4.64**	**5.35**	**6.97**	2.9	1.6	**0.7**	**1.0**	**1.3**	**1.4**	**1.9**	**0.5**	**0.6**	**0.8**	**0.9**	**1.2**
V105	500	1320	A7(a)	20	18	2	69.5	10.8	0.02	1.5	4.2	5.24	4.44	20.48	0.500	54.29	74.14	93.55	108.90	139.59	1.51	2.06	2.6	3.03	3.88												
			A7(b)	23.59	20.6	2.99	68.03	11.01	0.01	1.2	4.2	5.24	7.64	23.89	0.550	48.95	67.18	85.31	100.10	126.42	1.76	2.42	3.07	3.61	4.56												
			Total	**43.59**							4.2										**3.27**	**4.48**	**5.67**	**6.63**	**8.43**												
			Total	**77.52**							4.2										**6**	**8.18**	**10.31**	**11.98**	**15.41**	3.3	2.2	**1.4**	**1.9**	**2.5**	**2.9**	**3.7**	**0.6**	**0.9**	**1.1**	**1.3**	**1.7**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	5550	6080	A7(b)	16.72	15.04	1.68	69.47	10.8	0.01	1.2	2.6	38.97	6.94	56.72	0.650	27.35	38.63	50.83	62.36	72.43	0.83	1.17	1.53	1.88	2.19											
			A8	8.42	7.56	0.86	69.38	10.82	0.01	1.2	2.6	38.97	8.33	58.12	0.650	26.91	38.03	50.09	61.53	71.29	0.41	0.58	0.76	0.94	1.08											
			Total	**25.14**							2.6										**1.23**	**1.74**	**2.3**	**2.82**	**3.27**											
			Total	**1688.63**							2.6										**106**	**145.42**	**184.56**	**216.46**	**273.64**	23	2.8	**40.8**	**55.9**	**71.0**	**83.3**	**105.2**	**14.6**	**20.0**	**25.4**	**29.7**	**37.6**
V116	0	1000	A9(a)	79.17	69.66	9.51	68.39	10.96	0.02	1.5	1.8	9.26	1.11	21.33	0.500	52.82	72.24	91.31	106.51	135.99	5.81	7.94	10.04	11.71	14.95											
			A9(b)	51.82	32.73	19.09	54.74	12.95	0.03	1.5	1.8	9.26	1.67	23.87	0.500	48.97	67.22	85.35	100.15	126.48	3.52	4.84	6.14	7.21	9.1											
			Total	**130.99**							1.8										**9.33**	**12.78**	**16.18**	**18.92**	**24.06**											
			Total	**130.99**							1.8										**9.33**	**12.78**	**16.18**	**18.92**	**24.06**	3.3	1.6	**5.2**	**7.1**	**9.0**	**10.5**	**13.4**	**3.2**	**4.4**	**5.6**	**6.6**	**8.4**
V116	1000	2000	A9(a)	63.6	55.16	8.44	67.7	11.06	0.02	1.5	3.7	9.01	4.44	24.52	0.550	48.10	66.08	84.01	98.70	124.33	4.67	6.42	8.16	9.59	12.08											
			A9(b)	70.75	60.84	9.91	67.3	11.12	0.01	1.2	3.7	9.01	6.94	27.07	0.550	44.99	62.02	79.16	93.48	116.63	4.86	6.7	8.56	10.1	12.61											
			Total	**134.35**							3.7										**9.54**	**13.12**	**16.72**	**19.69**	**24.69**											
			Total	**265.34**							3.7										**18.87**	**25.91**	**32.9**	**38.61**	**48.74**	3.6	2.4	**5.1**	**7.0**	**8.9**	**10.4**	**13.2**	**2.1**	**2.9**	**3.7**	**4.3**	**5.5**
V116	2000	3000	A9(a)	66.04	57.45	8.59	67.85	11.04	0.01	1.2	4.1	12.2	8.33	31.57	0.550	40.58	56.21	72.20	85.94	105.64	4.09	5.67	7.28	8.67	10.66											
			A9(b)	69.18	59.49	9.69	67.3	11.12	0.01	1.2	4.1	12.2	9.72	33.04	0.600	39.35	54.60	70.26	83.83	102.59	4.54	6.3	8.1	9.67	11.83											
			Total	**135.22**							4.1										**8.63**	**11.97**	**15.39**	**18.34**	**22.49**											
			Total	**400.56**							4.1										**27.5**	**37.87**	**48.29**	**56.95**	**71.23**	6.3	2.2	**6.7**	**9.2**	**11.8**	**13.9**	**17.4**	**3.0**	**4.2**	**5.4**	**6.3**	**7.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V116	3000	3770	A9(a)	24.93	20.02	4.91	64.17	11.58	0.02	1.5	4.1	15.33	8.89	35.79	0.600	37.29	51.87	66.97	80.24	97.44	1.55	2.16	2.78	3.33	4.05											
			A9(b)	38.63	27.43	11.2	59.05	12.32	0.01	1.2	4.1	15.33	9.72	37.37	0.600	36.22	50.46	65.27	78.36	94.77	2.33	3.25	4.2	5.05	6.1											
			Total	**63.56**							4.1										**3.88**	**5.4**	**6.98**	**8.38**	**10.15**											
			Total	**464.12**							4.1										**31.38**	**43.28**	**55.27**	**65.33**	**81.38**	10.42	2.51	**7.7**	**10.6**	**13.5**	**15.9**	**19.8**	**3.0**	**4.2**	**5.4**	**6.3**	**7.9**
V100	6080	7000	A11(a)	27.46	24.71	2.75	69.49	10.8	0.01	1.2	3.4	41.67	11.11	63.58	0.650	25.33	35.91	47.47	58.58	67.29	1.26	1.78	2.35	2.9	3.34											
			A10(d)	22.87	18.46	4.41	64.39	11.54	0.01	1.2	3.4	41.67	12.5	65.71	0.650	24.77	35.16	46.54	57.53	65.88	1.02	1.45	1.92	2.38	2.72											
			Total	**50.33**							3.4										**2.28**	**3.23**	**4.28**	**5.28**	**6.06**											
			Total	**2203.08**							3.4										**139.66**	**191.92**	**244.11**	**287.07**	**361.08**	22	3.2	**41.1**	**56.4**	**71.8**	**84.4**	**106.2**	**12.8**	**17.6**	**22.4**	**26.4**	**33.2**
V100	7000	7300	A11(a)	4.5	3.8	0.7	66.44	11.24	0.01	1.2	3.6	43.06	12.5	66.8	0.700	24.50	34.80	46.09	57.02	65.18	0.21	0.3	0.4	0.5	0.57											
			A10(d)	5.23	4.68	0.55	69.22	10.84	0.01	1.2	3.6	43.06	13.89	67.79	0.700	24.26	34.47	45.69	56.56	64.57	0.25	0.35	0.46	0.58	0.66											
			Total	**9.73**							3.6										**0.46**	**0.66**	**0.87**	**1.07**	**1.23**											
			Total	**2212.81**							3.6										**140.12**	**192.58**	**244.98**	**288.14**	**362.3**	20	3.7	**38.9**	**53.5**	**68.0**	**80.0**	**100.6**	**10.5**	**14.5**	**18.4**	**21.6**	**27.2**
V103	0	800	A11(c)	57.91	52.12	5.79	69.5	10.8	0.02	1.5	4.5	2.96	3.33	17.1	0.500	61.31	83.23	104.25	120.23	156.83	4.93	6.69	8.38	9.67	12.61											
			A11(d)	9.78	8.49	1.29	67.75	11.06	0.01	1.2	4.5	2.96	4.17	18.18	0.500	58.81	80.00	100.46	116.23	150.71	0.8	1.09	1.36	1.58	2.05											
			Total	**67.69**							4.5										**5.73**	**7.78**	**9.75**	**11.25**	**14.66**											
			Total	**67.69**							4.5										**5.73**	**7.78**	**9.75**	**11.25**	**14.66**	3.9	1.6	**1.3**	**1.7**	**2.2**	**2.5**	**3.3**	**0.8**	**1.1**	**1.4**	**1.6**	**2.0**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V104	0	1020	A11(b)	25.51	22.89	2.62	69.35	10.82	0.03	1.5	4.1	4.15	4.44	19.41	0.500	56.28	76.73	96.61	112.15	144.50	1.99	2.72	3.42	3.97	5.12											
			A11(a)	13.05	11.09	1.96	66.74	11.2	0.02	1.5	4.1	4.15	5.56	20.9	0.500	53.55	73.18	92.42	107.70	137.78	0.97	1.33	1.68	1.95	2.5											
			Total	**38.56**							4.1										**2.96**	**4.04**	**5.1**	**5.93**	**7.62**											
			Total	**38.56**							4.1										**2.96**	**4.04**	**5.1**	**5.93**	**7.62**	2.8	1.7	**0.7**	**1.0**	**1.2**	**1.4**	**1.9**	**0.4**	**0.6**	**0.7**	**0.9**	**1.1**
V103	800	1050	A11(a)	3.03	2.73	0.3	69.55	10.79	0.02	1.5	4.5	4.7	5.56	21.05	0.500	53.30	72.85	92.03	107.28	137.15	0.22	0.31	0.39	0.45	0.58											
			A11(d)	10.98	9.88	1.1	69.49	10.8	0.01	1.2	4.5	4.7	6.94	22.45	0.500	51.04	69.91	88.55	103.57	131.59	0.78	1.07	1.35	1.58	2.01											
			Total	**14.01**							4.5										**1**	**1.37**	**1.74**	**2.03**	**2.58**											
			Total	**120.26**							4.5										**9.7**	**13.2**	**16.59**	**19.21**	**24.86**	5.5	2.5	**2.2**	**2.9**	**3.7**	**4.3**	**5.5**	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**
V118	0	850	A10(a)	6.12	5.39	0.73	68.44	10.95	0.02	1.5	3.8	3.73	3.33	18.02	0.500	59.18	80.48	101.03	116.83	151.62	0.5	0.68	0.86	0.99	1.29											
			A10(b)	26.24	23.62	2.62	69.51	10.8	0.02	1.5	3.8	3.73	5	19.53	0.500	56.06	76.44	96.27	111.79	143.96	2.04	2.79	3.51	4.07	5.25											
			Total	**32.36**							3.8										**2.55**	**3.47**	**4.37**	**5.07**	**6.54**											
			Total	**32.36**							3.8										**2.55**	**3.47**	**4.37**	**5.07**	**6.54**	3	1.7	**0.7**	**0.9**	**1.1**	**1.3**	**1.7**	**0.4**	**0.5**	**0.7**	**0.8**	**1.0**
V117	0	1000	A10(c)	65.21	55.43	9.78	66.75	11.2	0.02	1.5	4.1	4.07	4.44	19.71	0.500	55.71	75.99	95.73	111.22	143.10	5.05	6.88	8.67	10.07	12.96											
			A10(d)	22.58	19.42	3.16	67.3	11.12	0.02	1.5	4.1	4.07	5.56	20.74	0.550	53.83	73.55	92.86	108.16	138.47	1.86	2.54	3.2	3.73	4.78											
			Total	**87.79**							4.1										**6.9**	**9.42**	**11.87**	**13.8**	**17.74**											
			Total	**87.79**							4.1										**6.9**	**9.42**	**11.87**	**13.8**	**17.74**	3.65	1.3	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**	**1.3**	**1.8**	**2.2**	**2.6**	**3.3**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V117	1000	1584	A10(c)	20.26	17.22	3.04	66.75	11.2	0.01	1.2	3.8	6.95	4.17	22.31	0.500	51.25	70.18	88.87	103.92	132.10	1.44	1.97	2.5	2.92	3.72											
			A10(d)	12.87	10.58	2.29	65.21	11.42	0.01	1.2	3.8	6.95	5.56	23.93	0.550	48.90	67.12	85.24	100.02	126.30	0.96	1.32	1.68	1.97	2.48											
			Total	**33.13**							3.8										**2.4**	**3.29**	**4.18**	**4.89**	**6.2**											
			Total	**120.92**							3.8										**9.31**	**12.71**	**16.05**	**18.7**	**23.94**	4.5	1.8	**2.4**	**3.3**	**4.2**	**4.9**	**6.3**	**1.4**	**1.9**	**2.3**	**2.7**	**3.5**
V118	850	1245	A10(a)	19.88	17.89	1.99	69.49	10.8	0.01	1.2	4.5	7.33	6.94	25.07	0.550	47.38	65.14	82.88	97.49	122.54	1.44	1.98	2.52	2.96	3.72											
			A10(d)	15	13.5	1.5	69.5	10.8	0.01	1.2	4.5	7.33	8.33	26.46	0.550	45.69	62.93	80.25	94.66	118.36	1.05	1.44	1.84	2.17	2.71											
			Total	**34.88**							4.5										**2.49**	**3.42**	**4.36**	**5.13**	**6.43**											
			Total	**188.16**							4.5										**14.34**	**19.6**	**24.77**	**28.89**	**36.91**	5	2	**3.2**	**4.4**	**5.5**	**6.4**	**8.2**	**1.6**	**2.2**	**2.8**	**3.2**	**4.1**
V100	7300	8000	A10(a)	5.88	5.06	0.82	67.33	11.12	0.01	1.2	3.4	49.02	11.11	71.25	0.700	23.46	33.39	44.34	55.04	62.53	0.27	0.38	0.51	0.63	0.71											
			A11(d)	19.23	17.31	1.92	69.51	10.8	0.01	1.2	3.4	49.02	12.5	72.32	0.700	23.23	33.07	43.95	54.59	61.93	0.87	1.24	1.64	2.04	2.32											
			Total	**25.11**							3.4										**1.14**	**1.62**	**2.15**	**2.67**	**3.03**											
			Total	**2546.34**							3.4										**165.29**	**227**	**288.48**	**338.91**	**427.1**	19	3.2	**48.6**	**66.8**	**84.8**	**99.7**	**125.6**	**15.2**	**20.9**	**26.5**	**31.1**	**39.3**
V120	0	800	A15	111.79	81.87	29.92	60.28	12.14	0.01	1.2	3.3	4.04	4.17	20.35	0.500	54.53	74.45	93.92	109.30	140.19	8.47	11.56	14.58	16.97	21.77											
			Total	**111.79**							3.3										**8.47**	**11.56**	**14.58**	**16.97**	**21.77**											
			Total	**111.79**							3.3										**8.47**	**11.56**	**14.58**	**16.97**	**21.77**	7.2	1.9	**2.6**	**3.5**	**4.4**	**5.1**	**6.6**	**1.4**	**1.8**	**2.3**	**2.7**	**3.5**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V102	0	350	A13	5.06	4.04	1.02	63.91	11.61	0.02	1.5	4.5	1.3	1.11	14.02	0.500	70.06	94.49	117.40	134.02	178.21	0.49	0.66	0.83	0.94	1.25												
			A18(a)	9.46	8.51	0.95	69.48	10.8	0.01	1.2	4.5	1.3	2.08	14.18	0.500	69.52	93.79	116.59	133.17	176.88	0.91	1.23	1.53	1.75	2.32												
			Total	**14.52**							4.5										**1.41**	**1.9**	**2.36**	**2.69**	**3.58**												
			Total	**14.52**							4.5										**1.41**	**1.9**	**2.36**	**2.69**	**3.58**	10	2.3	**0.3**	**0.4**	**0.5**	**0.6**	**0.8**	**0.1**	**0.2**	**0.2**	**0.3**	**0.3**
V121	0	1000	A18(a)	28.38	25.54	2.84	69.5	10.8	0.03	1.5	4.2	3.97	3.33	18.1	0.500	58.99	80.24	100.74	116.52	151.16	2.33	3.16	3.97	4.59	5.96												
			A18(b)	24.31	21.84	2.47	69.41	10.81	0.02	1.5	4.2	3.97	4.44	19.23	0.550	56.65	77.20	97.17	112.75	145.41	2.1	2.87	3.61	4.19	5.4												
			Total	**52.69**							4.2										**4.43**	**6.03**	**7.58**	**8.78**	**11.36**												
			Total	**52.69**							4.2										**4.43**	**6.03**	**7.58**	**8.78**	**11.36**	6.3	2.4	**1.1**	**1.4**	**1.8**	**2.1**	**2.7**	**0.4**	**0.6**	**0.8**	**0.9**	**1.1**
V121	1000	1425	A18(a)	9.46	8.51	0.95	69.48	10.8	0.02	1.5	4.5	5.28	4.44	20.53	0.550	54.21	74.04	93.44	108.78	139.40	0.78	1.07	1.35	1.57	2.01												
			A18(b)	9.14	8.23	0.91	69.52	10.8	0.02	1.5	4.5	5.28	5.56	21.63	0.550	52.33	71.60	90.55	105.70	134.78	0.73	1	1.26	1.48	1.88												
			Total	**18.6**							4.5										**1.51**	**2.07**	**2.61**	**3.05**	**3.9**												
			Total	**71.29**							4.5										**5.94**	**8.1**	**10.19**	**11.83**	**15.26**	8.8	2.5	**1.3**	**1.8**	**2.3**	**2.6**	**3.4**	**0.5**	**0.7**	**0.9**	**1.1**	**1.4**
V102	350	800	A13	13.18	11.86	1.32	69.49	10.8	0.01	1.2	3	10.42	2.78	24	0.550	48.80	67.00	85.09	99.87	126.06	0.98	1.35	1.71	2.01	2.54												
			A19(a)	6.66	5.99	0.67	69.47	10.8	0.01	1.2	3	10.42	4.17	25.39	0.550	46.98	64.62	82.26	96.83	121.56	0.48	0.66	0.84	0.99	1.24												
			Total	**19.84**							3										**1.46**	**2.01**	**2.55**	**3**	**3.78**												
			Total	**105.65**							3										**8.81**	**12**	**15.1**	**17.52**	**22.61**	4.5	1.42	**2.9**	**4.0**	**5.0**	**5.8**	**7.5**	**2.1**	**2.8**	**3.5**	**4.1**	**5.3**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V122	0	1000	A19(a)	18.59	15.12	3.47	64.73	11.49	0.02	1.5	4.2	3.97	2.22	17.68	0.500	59.93	81.45	102.16	118.03	153.45	1.55	2.1	2.64	3.05	3.96											
			A19(b)	26.16	23.55	2.61	69.51	10.8	0.02	1.5	4.2	3.97	3.89	18.66	0.500	57.81	78.71	98.94	114.62	148.25	2.1	2.86	3.59	4.16	5.39											
			Total	**44.75**							4.2										**3.65**	**4.96**	**6.23**	**7.21**	**9.35**											
			Total	**44.75**							4.2										**3.65**	**4.96**	**6.23**	**7.21**	**9.35**	3.2	1.8	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**	**0.5**	**0.7**	**0.8**	**1.0**	**1.2**
V122	1000	1600	A19(a)	11.66	10.49	1.17	69.48	10.8	0.02	1.5	3.5	7.62	2.22	20.64	0.550	54.00	73.77	93.11	108.44	138.89	0.96	1.31	1.66	1.93	2.47											
			A19(b)	17.44	15.69	1.75	69.48	10.8	0.02	1.5	3.5	7.62	4.44	22.87	0.550	50.41	69.09	87.58	102.54	130.04	1.34	1.84	2.33	2.73	3.46											
			Total	**29.1**							3.5										**2.31**	**3.16**	**3.99**	**4.66**	**5.94**											
			Total	**73.85**							3.5										**5.95**	**8.12**	**10.22**	**11.88**	**15.29**	3.4	1.6	**1.7**	**2.3**	**2.9**	**3.4**	**4.4**	**1.1**	**1.4**	**1.8**	**2.1**	**2.7**
V102	800	1860	A13	53.32	46.92	6.4	68.4	10.96	0.01	1.2	4.1	11.93	5.56	28.45	0.550	43.52	60.08	76.85	90.98	112.97	3.55	4.89	6.26	7.41	9.2											
			A20	17.22	11.31	5.91	56.12	12.75	0.02	1.5	4.1	11.93	5.56	30.23	0.550	41.77	57.79	74.10	88.00	108.63	1.1	1.52	1.95	2.32	2.86											
			Total	**70.54**							4.1										**4.64**	**6.41**	**8.21**	**9.73**	**12.06**											
			Total	**250.04**							4.1										**19.41**	**26.54**	**33.54**	**39.12**	**49.96**	11	2.2	**4.7**	**6.5**	**8.2**	**9.5**	**12.2**	**2.2**	**2.9**	**3.7**	**4.3**	**5.5**
V100	8000	8500	A10(a)	7.98	7.18	0.8	69.49	10.8	0.02	1.5	3.3	55.56	8.89	75.25	0.700	22.61	32.24	42.92	53.42	60.37	0.35	0.5	0.67	0.83	0.94											
			A20	28.54	24.26	4.28	66.75	11.2	0.02	1.5	3.3	55.56	10	76.76	0.750	22.31	31.84	42.41	52.84	59.60	1.33	1.89	2.52	3.14	3.54											
			Total	**36.52**							3.3										**1.68**	**2.39**	**3.19**	**3.97**	**4.48**											
			Total	**2944.69**							3.3										**166.97**	**229.39**	**291.67**	**342.88**	**431.58**	23	3.42	**50.6**	**69.5**	**88.4**	**103.9**	**130.8**	**14.8**	**20.3**	**25.8**	**30.4**	**38.2**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V119	0	1000	A12(a)	21.34	19.2	2.14	69.48	10.8	0.03	1.5	3.3	5.05	1.67	17.52	0.500	60.31	81.93	102.73	118.63	154.38	1.79	2.43	3.04	3.52	4.58												
			A12(b)	46.73	41.12	5.61	68.4	10.96	0.02	1.5	3.3	5.05	3.33	19.34	0.500	56.42	76.90	96.81	112.37	144.83	3.66	4.99	6.28	7.29	9.4												
			Total	**68.07**							3.3										**5.45**	**7.42**	**9.33**	**10.81**	**13.98**												
			Total	**68.07**							3.3										**5.45**	**7.42**	**9.33**	**10.81**	**13.98**	3	2	**1.7**	**2.2**	**2.8**	**3.3**	**4.2**	**0.8**	**1.1**	**1.4**	**1.6**	**2.1**
V119	1000	2000	A12(a)	44.6	36.13	8.47	64.55	11.52	0.03	1.5	3.9	8.55	3.33	23.4	0.500	49.63	68.08	86.38	101.25	128.12	3.07	4.22	5.35	6.27	7.94												
			A12(b)	35.04	30.54	4.5	67.94	11.03	0.02	1.5	3.9	8.55	4.44	24.02	0.550	48.77	66.95	85.04	99.81	125.98	2.61	3.58	4.55	5.34	6.74												
			Total	**79.64**							3.9										**5.69**	**7.8**	**9.9**	**11.62**	**14.68**												
			Total	**147.71**							3.9										**11.13**	**15.22**	**19.23**	**22.42**	**28.66**	3.5	2	**2.9**	**3.9**	**4.9**	**5.7**	**7.3**	**1.4**	**2.0**	**2.5**	**2.9**	**3.7**
V119	2000	3132	A12(a)	53.87	48.22	5.65	69.23	10.84	0.02	1.5	4.3	12.14	4.44	27.42	0.550	44.61	61.51	78.55	92.83	115.67	3.67	5.06	6.46	7.64	9.52												
			A12(b)	35.04	30.84	4.2	68.41	10.96	0.02	1.5	4.3	12.14	6.67	29.77	0.550	42.21	58.37	74.79	88.75	109.72	2.26	3.12	4	4.75	5.87												
			Total	**88.91**							4.3										**5.93**	**8.19**	**10.47**	**12.39**	**15.39**												
			Total	**236.62**							4.3										**17.07**	**23.41**	**29.7**	**34.82**	**44.05**	3.5	2.4	**4.0**	**5.4**	**6.9**	**8.1**	**10.2**	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**
V100	8500	8900	A12(a)	5.96	5.36	0.6	69.46	10.81	0.01	1.2	3	63.33	4.17	78.31	0.750	22.02	31.43	41.90	52.27	58.84	0.27	0.39	0.52	0.65	0.73												
			A20	20.68	17.37	3.31	66.2	11.28	0.01	1.2	3	63.33	5.56	80.17	0.750	21.67	30.96	41.32	51.60	57.96	0.93	1.33	1.78	2.22	2.5												
			Total	**26.64**							3										**1.21**	**1.72**	**2.3**	**2.87**	**3.23**												
			Total	**3207.95**							3										**185.24**	**254.53**	**323.67**	**380.57**	**478.86**	35	3.2	**61.7**	**84.8**	**107.9**	**126.9**	**159.6**	**19.3**	**26.5**	**33.7**	**39.6**	**49.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V101	0	900	A22(a)	33.33	28.87	4.46	67.64	11.07	0.02	1.5	4.1	3.66	2.78	17.51	0.500	60.34	81.97	102.78	118.68	154.45	2.79	3.79	4.76	5.49	7.15											
			A22(b)	32.55	23.28	9.27	59.34	12.28	0.02	1.5	4.1	3.66	3.33	19.27	0.500	56.56	77.09	97.03	112.60	145.19	2.56	3.49	4.39	5.09	6.56											
			Total	**65.88**							4.1										**5.35**	**7.28**	**9.14**	**10.58**	**13.71**											
			Total	**65.88**							4.1										**5.35**	**7.28**	**9.14**	**10.58**	**13.71**	4.6	2.2	**1.3**	**1.8**	**2.2**	**2.6**	**3.3**	**0.6**	**0.8**	**1.0**	**1.2**	**1.5**
V100	8900	10000	A21	64.28	54.58	9.7	66.7	11.21	0.01	1.2	3.4	68.63	8.33	88.17	0.750	20.33	29.13	39.03	48.98	54.51	2.72	3.9	5.23	6.56	7.3											
			A23	33.19	12.66	20.53	40.98	14.95	0.01	1.2	3.4	68.63	6.94	90.52	0.700	19.97	28.65	38.42	48.28	53.59	1.29	1.85	2.48	3.12	3.46											
			Total	**97.47**							3.4										**4.01**	**5.75**	**7.71**	**9.68**	**10.76**											
			Total	**3371.3**							3.4										**189.25**	**260.28**	**331.38**	**390.24**	**489.62**	30	2.3	**55.7**	**76.6**	**97.5**	**114.8**	**144.0**	**24.2**	**33.3**	**42.4**	**49.9**	**62.6**
V100	10000	11000	A21	42.86	36.57	6.29	66.93	11.17	0.01	1.2	3.4	73.53	9.72	94.43	0.750	19.41	27.88	37.46	47.18	52.16	1.73	2.49	3.34	4.21	4.66											
			A23	47.5	18.99	28.51	41.99	14.8	0.01	1.2	3.4	73.53	11.11	99.44	0.750	18.75	26.97	36.32	45.86	50.45	1.86	2.67	3.59	4.54	4.99											
			Total	**90.36**							3.4										**3.59**	**5.16**	**6.94**	**8.75**	**9.65**											
			Total	**3461.66**							3.4										**192.84**	**265.43**	**338.32**	**398.99**	**499.27**	28	2.64	**56.7**	**78.1**	**99.5**	**117.4**	**146.8**	**21.5**	**29.6**	**37.7**	**44.5**	**55.6**
V100	11000	11500	C4(a)	7.89	6.9	0.99	68.1	11	0.01	1.2	3.2	80.73	11.11	102.84	0.750	18.33	26.40	35.59	45.02	49.36	0.3	0.43	0.59	0.74	0.81											
			C4(b)	29.89	11.95	17.94	41.99	14.8	0.01	1.2	3.2	80.73	9.72	105.25	0.750	18.04	26.01	35.10	44.46	48.63	1.12	1.62	2.19	2.77	3.03											
			Total	**37.78**							3.2										**1.42**	**2.05**	**2.77**	**3.51**	**3.84**											
			Total	**3499.44**							3.2										**194.27**	**267.49**	**341.09**	**402.5**	**503.11**											

Table Showing Adequacy Analysis Results for Vrishabhavathi Valley (V1) - Proposed Hydraulic Flow Conditions

(Clean Condition)

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Pro. Av.Drain Depth D in m.	Area required for drain (A in m^2)					Pro. Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	V100	Sankey Reservoir	N. Subbaih Road 2 nd Cross Road	0	500	108.94	Pri.	4.5	8.23	11.18	14.02	16.19	21.07	1.8	1.83	2.49	3.12	3.6	4.68	3.5	1.02	1.38	1.73	2	2.6	AD	AD	AD	AD	AD
2	V100	N. Subbaih Road 2 nd Cross Road	Shree Ragavandra Jyothrisyalayam	500	1180	200.35	Pri.	3.43	14.71	20.06	25.26	29.34	37.78	2	4.3	5.86	7.38	8.57	11.03	5.6	2.15	2.93	3.69	4.28	5.51	AD	AD	AD	AD	AD
3	V100	Shree Ragavandra Jyothrisyalayam	Subedah Chitram Road near Malleswaram	1180	2000	401.15	Pri.	3.26	28.85	39.44	49.85	58.15	74.26	2.3	8.85	12.1	15.29	17.84	22.78	10.25	3.85	5.26	6.65	7.76	9.9	AD	AD	AD	AD	AD
4	V100	Subedah Chitram Road near Malleswaram	Lakshmi Rao Nagar, Okalipuram	2000	2480	485.09	Pri.	4.5	34.17	46.81	59.3	69.38	88.11	2.54	7.59	10.4	13.18	15.42	19.58	11.3	2.99	4.1	5.19	6.07	7.71	AD	AD	AD	AD	AD
5	V100	Lakshmi Rao Nagar, Okalipuram	Okalipuram	2480	3140	622.22	Pri.	4.5	43.64	59.78	75.71	88.56	112.51	2.5	9.7	13.28	16.82	19.68	25	13	3.88	5.31	6.73	7.87	10	AD	AD	AD	AD	AD
6	V100	Okalipuram	Near Water Effluent Treatment Plant	3140	3700	706.99	Pri.	4.27	49.45	67.78	85.92	100.61	127.55	2.36	11.58	15.87	20.12	23.56	29.87	13.5	4.91	6.72	8.52	9.98	12.66	AD	AD	AD	AD	AD
7	V100	Near Water Effluent Treatment Plant	Near Magadi road area, Gopalapura	3700	4250	1205.38	Pri.	4.5	76.25	104.53	132.55	155.27	196.72	2.7	16.94	23.23	29.45	34.5	43.71	17.5	6.28	8.6	10.91	12.78	16.19	AD	AD	AD	AD	AD
8	V100	Near Magadi road area, Gopalapura	Shankrappa Garden, Magadi Road	4250	4575	1293.08	Pri.	4.4	82.47	113.06	143.38	167.98	212.77	2.7	18.74	25.7	32.59	38.18	48.36	17.1	6.94	9.52	12.07	14.14	17.91	AD	AD	AD	AD	IA
9	V100	Shankrappa Garden, Magadi Road	Bhuvaneswari Nagar	4575	5170	1368.97	Pri.	3.78	83.54	114.56	145.35	170.38	215.59	2.4	22.11	30.33	38.48	45.1	57.07	20	9.21	12.64	16.03	18.79	23.78	AD	AD	AD	AD	IA
10	V100	Bhuvaneswari Nagar	Near Cholur Palaya Road	5170	5550	1585.97	Pri.	3.8	98.77	135.49	171.95	201.65	254.96	2.7	25.99	35.66	45.25	53.07	67.1	20	9.63	13.21	16.76	19.65	24.85	AD	AD	AD	AD	IA
11	V100	Near Cholur Palaya Road	Padarayanpura	5550	6080	1688.63	Pri.	3.82	106	145.42	184.56	216.46	273.64	2.8	27.73	38.04	48.28	56.62	71.58	23	9.9	13.59	17.24	20.22	25.57	AD	AD	AD	AD	IA
12	V100	Padarayanpura	Arif Nagar	6080	7000	2203.08	Pri.	4.5	139.66	191.92	244.11	287.07	361.08	3.2	31.04	42.65	54.25	63.79	80.24	22	9.7	13.33	16.95	19.94	25.07	AD	AD	AD	AD	IA
13	V100	Arif Nagar	Shamanna Nagar 1 st Main Road	7000	7300	2212.81	Sec.	4.5	140.12	192.58	244.98	288.14	362.3	3.7	31.14	42.8	54.44	64.03	80.51	20	8.42	11.57	14.71	17.31	21.76	AD	AD	AD	AD	IA
14	V100	Shamanna Nagar 1 st Main Road	Bapuji Nagar Bridge Road	7300	8000	2546.34	Sec.	4.5	165.29	227	288.48	338.91	427.1	3.2	36.73	50.44	64.11	75.31	94.91	22	11.48	15.76	20.03	23.54	29.66	AD	AD	AD	IA	IA
15	V100	Bapuji Nagar Bridge Road	Kavika Layout	8000	8500	2944.69	Pri.	4.5	166.97	229.39	291.67	342.88	431.58	3.42	37.1	50.98	64.82	76.2	95.91	23	10.85	14.91	18.95	22.28	28.04	AD	AD	AD	AD	IA
16	V100	Kavika Layout	Near Mysore Road	8500	8900	3207.95	Pri.	4.5	185.24	254.53	323.67	380.57	478.86	3.2	41.17	56.56	71.93	84.57	106.41	25	12.86	17.68	22.48	26.43	33.25	AD	AD	AD	IA	IA

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Pro. Av.Drain Depth D in m.	Area required for drain (A in m^2)					Pro. Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
17	V100	Near Mysore Road		8900	10000	3371.3	Pri.	4.5	189.25	260.28	331.38	390.24	489.62	2.6	42.06	57.84	73.64	86.72	108.8	30	16.18	22.25	28.32	33.35	41.85	AD	AD	AD	IA	IA
18	V100	0		10000	11000	3461.66	Pri.	4.5	192.84	265.43	338.32	398.99	499.27	2.64	42.85	58.99	75.18	88.67	110.95	30	16.23	22.34	28.48	33.59	42.03	AD	AD	AD	IA	IA
19	V101	Avalahalli	Deepanjalinagar	0	900	65.88	Pri.	4.5	5.35	7.28	9.14	10.58	13.71	2.2	1.19	1.62	2.03	2.35	3.05	4.6	0.54	0.74	0.92	1.07	1.39	AD	AD	AD	AD	AD
20	V102	Timber Yard Layout	Near Utharayappa Garden	0	350	14.52	Pri.	4.5	1.41	1.9	2.36	2.69	3.58	2.3	0.31	0.42	0.52	0.6	0.79	10	0.14	0.18	0.23	0.26	0.35	AD	AD	AD	AD	AD
21	V102	Near Utharayappa Garden	Sanjay Nagar	350	800	105.65	Pri.	3.4	8.81	12	15.1	17.52	22.61	1.42	2.59	3.54	4.45	5.16	6.66	4.5	1.83	2.49	3.13	3.63	4.69	AD	AD	AD	AD	IA
22	V102	Sanjay Nagar	Bapujinagar	800	1860	250.04	Pri.	4.5	19.41	26.54	33.54	39.12	49.96	2.2	4.31	5.9	7.45	8.69	11.1	11	1.96	2.68	3.39	3.95	5.05	AD	AD	AD	AD	AD
23	V103	Vinayaka Nagar	New Guddada Halli	0	800	67.69	Pri.	4.5	5.73	7.78	9.75	11.25	14.66	1.6	1.27	1.73	2.17	2.5	3.26	3.9	0.8	1.08	1.35	1.56	2.04	AD	AD	AD	AD	AD
24	V103	New Guddada Halli	JaiBharathnagar	800	1050	120.26	Pri.	4.5	9.7	13.2	16.59	19.21	24.86	2.5	2.15	2.93	3.69	4.27	5.52	5.5	0.86	1.17	1.47	1.71	2.21	AD	AD	AD	AD	AD
25	V104	Jagajivanramnagar	JaiBharathnagar	0	1020	38.56	Pri.	4.5	2.96	4.04	5.1	5.93	7.62	1.7	0.66	0.9	1.13	1.32	1.69	2.8	0.39	0.53	0.67	0.77	1	AD	AD	AD	AD	AD
26	V105	R.R. Nagar, Ranganatha Colony	Jagajeevanram nagar	0	500	33.93	Pri.	4.5	2.73	3.7	4.64	5.35	6.97	1.6	0.61	0.82	1.03	1.19	1.55	2.9	0.38	0.51	0.64	0.74	0.97	AD	AD	AD	AD	AD
27	V105	Jagajeevanram nagar	Binnypet	500	1320	77.52	Pri.	4.5	6	8.18	10.31	11.98	15.41	2.2	1.33	1.82	2.29	2.66	3.42	3.3	0.61	0.83	1.04	1.21	1.56	AD	AD	AD	AD	AD
28	V106	Bakshi Garden	Nethaji Nagar	0	1000	66.32	Pri.	4.35	4.9	6.7	8.47	9.87	12.62	2	1.13	1.54	1.95	2.27	2.9	4.6	0.56	0.77	0.97	1.13	1.45	AD	AD	AD	AD	AD
29	V106	Nethaji Nagar	Bhuvaneswari Nagar	1000	2000	114.24	Pri.	4.5	8.27	11.33	14.37	16.83	21.32	2	1.84	2.52	3.19	3.74	4.74	3.5	0.92	1.26	1.6	1.87	2.37	AD	AD	AD	AD	AD
30	V106	Bhuvaneswari Nagar		2000	2325	127.92	Pri.	3.42	9.16	12.57	15.95	18.71	23.65	1.7	2.68	3.68	4.67	5.47	6.92	3.9	1.58	2.16	2.74	3.22	4.07	AD	AD	AD	AD	IA
31	V106	0	K.P. Agrahara	2325	2444	188.6	Pri.	3.36	13.75	18.84	23.87	27.94	35.46	1.8	4.09	5.6	7.1	8.31	10.55	4.9	2.27	3.11	3.95	4.62	5.86	AD	AD	AD	AD	IA
32	V107	Keshavanagar	K.P. Agrahara	0	1070	54.86	Pri.	2.85	4.19	5.71	7.2	8.38	10.76	1.4	1.47	2.01	2.53	2.94	3.78	2.3	1.05	1.43	1.81	2.1	2.7	AD	AD	AD	AD	IA
33	V108	Subashnagar	Minerva Mill	0	660	53.92	Pri.	3.11	4.4	5.98	7.51	8.69	11.27	2.1	1.41	1.92	2.42	2.8	3.63	2	0.67	0.92	1.15	1.33	1.73	AD	AD	AD	AD	AD
34	V109	Dhanavantri Road	V.V.Giri Colony	0	180	91.44	Pri.	4.5	6.78	9.22	11.57	13.38	17.37	2.5	1.51	2.05	2.57	2.97	3.86	2	0.6	0.82	1.03	1.19	1.54	AD	AD	AD	AD	AD
35	V110	Kumara Park	Palace Guttahalli	0	380	61.79	Pri.	3.13	4.32	5.89	7.41	8.61	11.08	2	1.38	1.88	2.37	2.75	3.54	2.5	0.69	0.94	1.18	1.38	1.77	AD	AD	AD	AD	AD
36	V111	Hanumanthapura	Ramachandrapura	0	580	37.84	Pri.	2.87	3.26	4.44	5.59	6.49	8.37	1.5	1.14	1.55	1.95	2.26	2.92	2	0.76	1.03	1.3	1.51	1.94	AD	AD	AD	AD	AD

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Pro. Av.Drain Depth D in m.	Area required for drain (A in m^2)					Pro. Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
37	V112	Subrmananayanagar	Near Rajajinagar Kalyana Mandapam	0	1000	151.96	Pri.	4.35	12.31	16.81	21.2	24.66	31.65	1.8	2.83	3.87	4.88	5.67	7.28	4	1.57	2.15	2.71	3.15	4.04	AD	AD	AD	AD	IA
38	V112	Near Rajajinagar Kalyana Mandapam	Lakshminarayana puram	1000	1640	232.05	Pri.	3.85	18.3	25.03	31.64	36.91	47.12	2.2	4.75	6.5	8.21	9.58	12.23	6.6	2.16	2.95	3.73	4.35	5.56	AD	AD	AD	AD	AD
39	V112	Lakshminarayanapuram	Udayam Nagar	1640	2580	398.42	Pri.	4.5	30.61	41.9	53.01	61.92	78.86	2.67	6.8	9.31	11.78	13.76	17.53	6.3	2.55	3.49	4.41	5.15	6.56	AD	AD	AD	AD	IA
40	V112	Udayam Nagar	Sujatha Theater	2580	3417	457	Pri.	4.34	35	47.91	60.64	70.87	90.18	2.6	8.07	11.05	13.98	16.34	20.8	8.5	3.1	4.25	5.38	6.29	8	AD	AD	AD	AD	AD
41	V113	Maruthi Extn.	Dayanandanagar	0	470	25.82	Pri.	4.5	2.29	3.1	3.87	4.45	5.84	2.2	0.51	0.69	0.86	0.99	1.3	3.6	0.23	0.31	0.39	0.45	0.59	AD	AD	AD	AD	AD
42	V114	Gayathri Nagar	Prakashnagar	0	700	69.98	Pri.	4.5	5.66	7.71	9.68	11.21	14.52	2.8	1.26	1.71	2.15	2.49	3.23	4.5	0.45	0.61	0.77	0.89	1.15	AD	AD	AD	AD	AD
43	V115	M.E.I. Polytechnic	Magadi Road	0	940	56.26	Pri.	2.5	4.47	6.1	7.67	8.89	11.48	2.4	1.79	2.44	3.07	3.55	4.59	6.7	0.75	1.02	1.28	1.48	1.91	AD	AD	AD	AD	AD
44	V116	Near Modi Hospital Road, Manjunathanagar	Shivana Halli	0	1000	130.99	Pri.	1.8	9.33	12.78	16.18	18.92	24.06	2	5.18	7.1	8.99	10.51	13.36	5	2.59	3.55	4.5	5.26	6.68	AD	AD	AD	IA	IA
45	V116	Shivana Halli	Dasara Halli	1000	2000	265.34	Pri.	4.5	18.87	25.91	32.9	38.61	48.74	2.4	4.19	5.76	7.31	8.58	10.83	3.6	1.75	2.4	3.05	3.58	4.51	AD	AD	AD	AD	IA
46	V116	Dasara Halli	Near Rajaji Nagar Ind. Town, Mysore Road	2000	3000	400.56	Pri.	4.5	27.5	37.87	48.29	56.95	71.23	2.2	6.11	8.42	10.73	12.66	15.83	6.3	2.78	3.83	4.88	5.75	7.2	AD	AD	AD	AD	IA
47	V116	Near Rajaji Nagar Ind. Town, Mysore Road	Padarayanapura	3000	3770	464.12	Pri.	4.25	31.38	43.28	55.27	65.33	81.38	2.51	7.39	10.19	13.01	15.38	19.16	10.42	2.94	4.06	5.18	6.13	7.63	AD	AD	AD	AD	AD
48	V117	Hosahalli 80 ft. Road	Near Office of the Executive Engg. Water Supply & Sewage Division	0	1000	87.79	Pri.	4.5	6.9	9.42	11.87	13.8	17.74	1.3	1.53	2.09	2.64	3.07	3.94	3.65	1.18	1.61	2.03	2.36	3.03	AD	AD	AD	AD	AD
49	V117	Near Office of the Executive Engg. Water Supply & Sewage Division	R.P.C. Layout	1000	1584	120.92	Pri.	4	9.31	12.71	16.05	18.7	23.94	1.8	2.33	3.18	4.01	4.67	5.98	4.5	1.29	1.77	2.23	2.6	3.32	AD	AD	AD	AD	AD
50	V118	Magadi Cd Road Layout	Vijayanagar 2 nd Stage	0	850	32.36	Pri.	4.12	2.55	3.47	4.37	5.07	6.54	1.7	0.62	0.84	1.06	1.23	1.59	3	0.36	0.5	0.62	0.72	0.93	AD	AD	AD	AD	AD
51	V118	Vijayanagar 2 nd Stage	R.P.C. Layout	850	1245	188.16	Pri.	4.5	14.34	19.6	24.77	28.89	36.91	2	3.19	4.36	5.51	6.42	8.2	5	1.59	2.18	2.75	3.21	4.1	AD	AD	AD	AD	AD
52	V119	Vijayanagar East	Siddeshwara nagar	0	1000	68.07	Pri.	4.5	5.45	7.42	9.33	10.81	13.98	2	1.21	1.65	2.07	2.4	3.11	3	0.61	0.82	1.04	1.2	1.55	AD	AD	AD	AD	AD

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Pro. Av.Drain Depth D in m.	Area required for drain (A in m^2)					Pro. Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
53	V119	Siddeshwara nagar	R.P.C. Layout , Vijayanagar 2 nd Stage	1000	2000	147.71	Pri.	4.5	11.13	15.22	19.23	22.42	28.66	2	2.47	3.38	4.27	4.98	6.37	3.5	1.24	1.69	2.14	2.49	3.18	AD	AD	AD	AD	AD
54	V119	R.P.C. Layout , Vijayanagar 2 nd Stage	R.P.C. Layout	2000	3132	236.62	Pri.	4.5	17.07	23.41	29.7	34.82	44.05	2.4	3.79	5.2	6.6	7.74	9.79	3.5	1.58	2.17	2.75	3.22	4.08	AD	AD	AD	AD	IA
55	V120	Chamarajapet	Kempambudhi Tank	0	800	111.79	Pri.	3.38	8.47	11.56	14.58	16.97	21.77	1.9	2.51	3.42	4.32	5.02	6.44	7.2	1.32	1.8	2.27	2.64	3.39	AD	AD	AD	AD	AD
56	V121	Hnumanthangar	Kalidas Layout	0	1000	52.69	Pri.	4.5	4.43	6.03	7.58	8.78	11.36	2.4	0.98	1.34	1.68	1.95	2.52	6.3	0.41	0.56	0.7	0.81	1.05	AD	AD	AD	AD	AD
57	V121	Kalidas Layout	Rudrappa Garden	1000	1425	71.29	Pri.	4.5	5.94	8.1	10.19	11.83	15.26	2.5	1.32	1.8	2.27	2.63	3.39	8.8	0.53	0.72	0.91	1.05	1.36	AD	AD	AD	AD	AD
58	V122	Bank Colony	Ragavendra Nagar	0	1000	44.75	Pri.	4.5	3.65	4.96	6.23	7.21	9.35	1.8	0.81	1.1	1.38	1.6	2.08	3.2	0.45	0.61	0.77	0.89	1.15	AD	AD	AD	AD	AD
59	V122	Ragavendra Nagar	Sanjaya Gandhi Slum	1000	1600	73.85	Pri.	3.69	5.95	8.12	10.22	11.88	15.29	1.6	1.61	2.2	2.77	3.22	4.15	3.4	1.01	1.38	1.73	2.01	2.59	AD	AD	AD	AD	AD

Landuse Analysis for Vrishabhavathi Valley (V1) – Proposed Hydraulic Flow Conditions

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	0	500	A1(a)	52.92	35.93	16.99	57.34	12.57	0.01	1.2	3.2	2.6	2.08	17.26	0.450	60.93	82.73	103.67	119.62	155.89	4.03	5.47	6.86	7.91	10.31											
			A1(b)	56.02	40.19	15.83	59.46	12.26	0.01	1.2	3.2	2.6	2.78	17.64	0.450	60.02	81.57	102.30	118.18	153.68	4.2	5.71	7.16	8.28	10.76											
			Total	**108.94**							3.2										**8.23**	**11.18**	**14.02**	**16.19**	**21.07**	3.5	1.8	**2.6**	**3.5**	**4.4**	**5.1**	**6.6**	**1.4**	**1.9**	**2.4**	**2.8**	**3.7**
V100	500	1180	A1(a)	41.68	37.51	4.17	69.5	10.8	0.02	1.5	2.5	7.87	3.33	22	0.500	51.74	70.82	89.63	104.73	133.31	3	4.1	5.19	6.06	7.72											
			A1(b)	49.73	44.76	4.97	69.5	10.8	0.01	1.2	2.5	7.87	4.17	22.83	0.500	50.46	69.16	87.66	102.62	130.16	3.49	4.78	6.05	7.09	8.99											
			Total	**91.41**							2.5										**6.48**	**8.88**	**11.24**	**13.15**	**16.71**											
			Total	**200.35**							2.5										**14.71**	**20.06**	**25.26**	**29.34**	**37.78**	5.6	2	**5.9**	**8.0**	**10.1**	**11.7**	**15.1**	**2.9**	**4.0**	**5.1**	**5.9**	**7.6**
V110	0	380	A1(c)	61.79	41.35	20.44	56.81	12.65	0.02	1.5	2.5	2.53	4.44	19.62	0.450	55.87	76.20	95.98	111.49	143.50	4.32	5.89	7.41	8.61	11.08											
			Total	**61.79**							2.5										**4.32**	**5.89**	**7.41**	**8.61**	**11.08**	2.5	2	**1.7**	**2.4**	**3.0**	**3.4**	**4.4**	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**
V100	1180	2000	A1(c)	102.98	92.68	10.3	69.5	10.8	0.02	1.5	2.5	10	3.33	24.13	0.550	48.61	66.75	84.80	99.55	125.60	7.65	10.5	13.34	15.66	19.76											
			A1(a)	36.03	22.21	13.82	53.9	13.07	0.02	1.5	2.5	10	5.56	28.62	0.500	43.34	59.85	76.56	90.67	112.52	2.17	2.99	3.83	4.54	5.63											
			Total	**139.01**							2.5										**9.82**	**13.5**	**17.17**	**20.2**	**25.39**											
			Total	**401.15**							2.5										**28.85**	**39.44**	**49.85**	**58.15**	**74.26**	10.25	2.3	**11.5**	**15.8**	**19.9**	**23.3**	**29.7**	**5.0**	**6.9**	**8.7**	**10.1**	**12.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	2000	2480	A1(c)	50.73	41.62	9.11	65.12	11.44	0.02	1.5	3.2	12.92	5.56	29.91	0.550	42.08	58.19	74.57	88.52	109.38	3.26	4.51	5.78	6.86	8.48											
			A1(a)	33.21	26.75	6.46	64.3	11.56	0.01	1.2	3.2	12.92	6.94	31.42	0.550	40.71	56.38	72.41	86.17	105.97	2.07	2.86	3.67	4.37	5.38											
			Total	**83.94**							3.2										**5.33**	**7.37**	**9.45**	**11.23**	**13.85**											
			Total	**485.09**							3.2										**34.17**	**46.81**	**59.3**	**69.38**	**88.11**	11.3	2.54	**10.7**	**14.6**	**18.5**	**21.7**	**27.5**	**4.2**	**5.8**	**7.3**	**8.5**	**10.8**
V109	0	180	A1(d)	91.44	61.06	30.38	56.73	12.66	0.02	1.5	3.5	0.86	4.44	17.96	0.450	59.31	80.64	101.22	117.03	151.93	6.78	9.22	11.57	13.38	17.37											
			Total	**91.44**							3.5										**6.78**	**9.22**	**11.57**	**13.38**	**17.37**	2	2.5	**1.9**	**2.6**	**3.3**	**3.8**	**5.0**	**0.8**	**1.1**	**1.3**	**1.5**	**2.0**
V100	2480	3140	A2(e)	20.8	18.72	2.08	69.5	10.8	0.01	1.2	2.8	18.69	5.56	35.05	0.600	37.82	52.57	67.82	81.16	98.76	1.31	1.82	2.35	2.81	3.42											
			A3	24.89	19.91	4.98	64	11.6	0.01	1.2	2.8	18.69	6.94	37.24	0.550	36.31	50.58	65.40	78.52	94.98	1.38	1.92	2.49	2.99	3.61											
			Total	**45.69**							2.8										**2.69**	**3.75**	**4.84**	**5.8**	**7.04**											
			Total	**622.22**							2.8										**43.64**	**59.78**	**75.71**	**88.56**	**112.51**	13	2.5	**15.6**	**21.3**	**27.0**	**31.6**	**40.2**	**6.2**	**8.5**	**10.8**	**12.7**	**16.1**
V111	0	580	A2(e)	37.84	33.25	4.59	68.33	10.97	0.02	1.5	3.4	2.84	5.56	19.37	0.550	56.37	76.84	96.74	112.29	144.71	3.26	4.44	5.59	6.49	8.37											
			Total	**37.84**							3.4										**3.26**	**4.44**	**5.59**	**6.49**	**8.37**											
			Total	**37.84**							3.4										**3.26**	**4.44**	**5.59**	**6.49**	**8.37**	2	1.5	**1.0**	**1.3**	**1.6**	**1.9**	**2.5**	**0.6**	**0.9**	**1.1**	**1.3**	**1.6**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	3140	3700	A2(e)	15.5	13.49	2.01	67.87	11.04	0.02	1.5	3	20.56	7.78	39.37	0.600	34.97	48.80	63.26	76.16	91.63	0.9	1.26	1.63	1.97	2.37											
			A3	31.43	13.57	17.86	43.75	14.55	0.02	1.5	3	20.56	5.56	40.66	0.550	34.22	47.81	62.05	74.83	89.75	1.64	2.3	2.98	3.59	4.31											
			Total	**46.93**							3										**2.55**	**3.56**	**4.61**	**5.56**	**6.68**											
			Total	**706.99**							3										**49.45**	**67.78**	**85.92**	**100.61**	**127.55**	13.5	2.36	**16.5**	**22.6**	**28.6**	**33.5**	**42.5**	**7.0**	**9.6**	**12.1**	**14.2**	**18.0**
V112	0	1000	B3	61.69	54.29	7.4	68.4	10.96	0.02	1.5	3.85	4.33	4.44	19.73	0.550	55.67	75.93	95.67	111.15	142.99	5.25	7.16	9.02	10.48	13.48											
			A2(a)	38.08	32.15	5.93	66.44	11.25	0.02	1.5	3.85	4.33	4.44	20.02	0.550	55.13	75.23	94.84	110.28	141.67	3.21	4.38	5.52	6.42	8.24											
			A2(b)	52.19	29.85	22.34	51.46	13.42	0.02	1.5	3.85	4.33	3.33	21.09	0.500	53.24	72.77	91.94	107.19	137.00	3.86	5.27	6.66	7.77	9.93											
			Total	**151.96**							3.85										**12.31**	**16.81**	**21.2**	**24.66**	**31.65**											
			Total	**151.96**							3.85										**12.31**	**16.81**	**21.2**	**24.66**	**31.65**	4	1.8	**3.2**	**4.4**	**5.5**	**6.4**	**8.2**	**1.8**	**2.4**	**3.1**	**3.6**	**4.6**
V112	1000	1640	A2(a)	28.46	25.62	2.84	69.51	10.8	0.01	1.2	3.4	8.04	4.17	23	0.550	50.21	68.83	87.27	102.20	129.53	2.18	2.99	3.79	4.44	5.63											
			A2(b)	51.63	46.46	5.17	69.49	10.8	0.02	1.5	3.4	8.04	5.56	24.4	0.550	48.26	66.29	84.25	98.97	124.72	3.81	5.23	6.65	7.81	9.84											
			Total	**80.09**							3.4										**5.99**	**8.22**	**10.44**	**12.25**	**15.47**											
			Total	**232.05**							3.4										**18.3**	**25.03**	**31.64**	**36.91**	**47.12**	6.6	2.2	**5.4**	**7.4**	**9.3**	**10.9**	**13.9**	**2.4**	**3.3**	**4.2**	**4.9**	**6.3**
V114	0	700	A2(c)	52.89	41.14	11.75	62.78	11.78	0.02	1.5	4.5	2.59	3.89	18.26	0.500	58.65	79.80	100.22	115.98	150.32	4.31	5.86	7.36	8.52	11.04											
			A2(d)	17.09	12.82	4.27	61.26	12	0.02	1.5	4.5	2.59	4.44	19.04	0.500	57.03	77.70	97.75	113.36	146.34	1.35	1.84	2.32	2.69	3.47											
			Total	**69.98**							4.5										**5.66**	**7.71**	**9.68**	**11.21**	**14.52**											
			Total	**69.98**							4.5										**5.66**	**7.71**	**9.68**	**11.21**	**14.52**	4.5	2.8	**1.3**	**1.7**	**2.2**	**2.5**	**3.2**	**0.4**	**0.6**	**0.8**	**0.9**	**1.2**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V112	1640	2580	A2(a)	63.85	45.47	18.38	59.17	12.3	0.02	1.5	4.5	9.56	4.44	26.3	0.550	45.88	63.17	80.54	94.97	118.82	4.48	6.16	7.86	9.26	11.59											
			A2(d)	32.54	25.28	7.26	62.73	11.78	0.01	1.2	4.5	9.56	6.94	28.28	0.550	43.69	60.30	77.11	91.27	113.39	2.17	3	3.83	4.54	5.64											
			Total	**96.39**							4.5										**6.65**	**9.16**	**11.69**	**13.8**	**17.23**											
			Total	**398.42**							4.5										**30.61**	**41.9**	**53.01**	**61.92**	**78.86**	6.3	2.67	**6.8**	**9.3**	**11.8**	**13.8**	**17.5**	**2.5**	**3.5**	**4.4**	**5.2**	**6.6**
V113	0	470	A2(e)	25.82	22.41	3.41	67.74	11.06	0.02	1.5	4.5	1.74	3.33	16.13	0.500	63.75	86.38	107.94	124.12	162.81	2.29	3.1	3.87	4.45	5.84											
			Total	**25.82**							4.5										**2.29**	**3.1**	**3.87**	**4.45**	**5.84**											
			Total	**25.82**							4.5										**2.29**	**3.1**	**3.87**	**4.45**	**5.84**	3.6	2.2	**0.5**	**0.7**	**0.9**	**1.0**	**1.3**	**0.2**	**0.3**	**0.4**	**0.4**	**0.6**
V112	2580	3417	A2(e)	15.13	13.46	1.67	68.93	10.88	0.02	1.5	3.8	17.05	5.56	33.49	0.600	39.00	54.13	69.69	83.21	101.70	0.98	1.36	1.76	2.1	2.56											
			A4(b)	17.63	15.87	1.76	69.51	10.8	0.01	1.2	3.8	17.05	6.94	34.79	0.600	38.01	52.82	68.12	81.49	99.23	1.12	1.55	2	2.39	2.92											
			Total	**32.76**							3.8										**2.1**	**2.92**	**3.76**	**4.49**	**5.48**											
			Total	**457**							3.8										**35**	**47.91**	**60.64**	**70.87**	**90.18**	8.5	2.6	**9.2**	**12.6**	**16.0**	**18.6**	**23.7**	**3.5**	**4.8**	**6.1**	**7.2**	**9.1**
V100	3700	4250	A4(b)	15.88	13.51	2.37	66.79	11.19	0.02	1.5	3.4	25.74	4.44	41.37	0.600	33.82	47.28	61.40	74.11	88.75	0.9	1.25	1.63	1.96	2.35											
			A5(a)	25.51	20.41	5.1	64	11.6	0.02	1.5	3.4	25.74	5.56	42.89	0.600	33.01	46.20	60.09	72.67	86.71	1.4	1.96	2.55	3.09	3.69											
			Total	**41.39**							3.4										**2.3**	**3.22**	**4.18**	**5.05**	**6.04**											
			Total	**1205.38**							3.4										**76.25**	**104.53**	**132.55**	**155.27**	**196.72**	17.5	2.7	**22.4**	**30.7**	**39.0**	**45.7**	**57.9**	**8.3**	**11.4**	**14.4**	**16.9**	**21.4**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V108	0	660	A5(a)	25.69	21.88	3.81	66.84	11.19	0.03	1.5	2.8	3.93	2.22	17.34	0.500	60.73	82.48	103.38	119.31	155.42	2.17	2.94	3.69	4.26	5.55											
			A5(b)	28.23	21.76	6.47	62.39	11.83	0.02	1.5	2.8	3.93	3.33	19.1	0.500	56.91	77.54	97.57	113.17	146.04	2.23	3.04	3.83	4.44	5.73											
			Total	**53.92**							2.8										**4.4**	**5.98**	**7.51**	**8.69**	**11.27**											
			Total	**53.92**							2.8										**4.4**	**5.98**	**7.51**	**8.69**	**11.27**	2	2.1	**1.6**	**2.1**	**2.7**	**3.1**	**4.0**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
V100	4250	4575	A4(b)	18.78	16.9	1.88	69.49	10.8	0.02	1.5	2.8	27.23	5.56	43.59	0.600	32.66	45.73	59.51	72.03	85.82	1.02	1.43	1.86	2.25	2.69											
			A5(b)	15	12.75	2.25	66.75	11.2	0.02	1.5	2.8	27.23	6.67	45.1	0.600	31.92	44.74	58.31	70.70	83.95	0.8	1.12	1.46	1.77	2.1											
			Total	**33.78**							2.8										**1.82**	**2.55**	**3.32**	**4.02**	**4.78**											
			Total	**1293.08**							2.8										**82.47**	**113.06**	**143.38**	**167.98**	**212.77**	17.1	2.7	**29.5**	**40.4**	**51.2**	**60.0**	**76.0**	**10.9**	**15.0**	**19.0**	**22.2**	**28.1**
V115	0	940	A4(a)	49.79	44.81	4.98	69.5	10.8	0.04	1.5	2.5	6.27	1.67	18.73	0.500	57.65	78.50	98.69	114.36	147.86	3.99	5.43	6.82	7.91	10.22											
			A4(b)	6.47	5.78	0.69	69.13	10.85	0.02	1.5	2.5	6.27	3.33	20.45	0.500	54.34	74.21	93.63	108.99	139.72	0.49	0.67	0.84	0.98	1.26											
			Total	**56.26**							2.5										**4.47**	**6.1**	**7.67**	**8.89**	**11.48**											
			Total	**56.26**							2.5										**4.47**	**6.1**	**7.67**	**8.89**	**11.48**	6.7	2.4	**1.8**	**2.4**	**3.1**	**3.6**	**4.6**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
V100	4575	5170	A6(a)	8.42	7.58	0.84	69.51	10.8	0.02	1.5	2.6	33.14	4.44	48.38	0.650	30.44	42.77	55.91	68.03	80.24	0.46	0.65	0.85	1.03	1.22											
			A8	11.21	10.09	1.12	69.5	10.8	0.02	1.5	2.6	33.14	5.56	49.5	0.650	29.98	42.15	55.15	67.19	79.07	0.61	0.85	1.12	1.36	1.6											
			Total	**19.63**							2.6										**1.07**	**1.5**	**1.97**	**2.39**	**2.82**											
			Total	**1368.97**							2.6										**83.54**	**114.56**	**145.35**	**170.38**	**215.59**	20	2.4	**32.1**	**44.1**	**55.9**	**65.5**	**82.9**	**13.4**	**18.4**	**23.3**	**27.3**	**34.6**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V106	0	1000	A6(b)	28.54	19.98	8.56	58.5	12.4	0.01	1.2	3.5	4.76	2.78	19.94	0.500	55.28	75.42	95.07	110.52	142.03	2.19	2.99	3.77	4.38	5.63											
			A6(c)	37.78	26.33	11.45	58.33	12.42	0.01	1.2	3.5	4.76	4.86	22.05	0.500	51.66	70.73	89.52	104.60	133.13	2.71	3.71	4.7	5.49	6.99											
			Total	**66.32**							3.5										**4.9**	**6.7**	**8.47**	**9.87**	**12.62**											
			Total	**66.32**							3.5										**4.9**	**6.7**	**8.47**	**9.87**	**12.62**	4.6	2	**1.4**	**1.9**	**2.4**	**2.8**	**3.6**	**0.7**	**1.0**	**1.2**	**1.4**	**1.8**
V106	1000	2000	A6(b)	24.15	21.74	2.41	69.51	10.8	0.01	1.2	4.0	8.33	5.56	24.69	0.550	47.88	65.79	83.66	98.32	123.77	1.77	2.43	3.09	3.63	4.57											
			A6(c)	23.77	21.39	2.38	69.49	10.8	0.02	1.5	4.0	8.33	8.89	28.02	0.550	43.96	60.66	77.54	91.73	114.07	1.6	2.2	2.82	3.33	4.14											
			Total	**47.92**							4.0										**3.36**	**4.63**	**5.9**	**6.96**	**8.71**											
			Total	**114.24**							4.0										**8.27**	**11.33**	**14.37**	**16.83**	**21.32**	3.5	2	**2.1**	**2.8**	**3.6**	**4.2**	**5.3**	**1.0**	**1.4**	**1.8**	**2.1**	**2.7**
V106	2000	2325	A6(b)	5.75	5.18	0.57	69.55	10.79	0.01	1.2	3.2	12.11	5.56	28.46	0.550	43.51	60.07	76.83	90.96	112.94	0.38	0.53	0.67	0.8	0.99											
			A6(c)	7.93	7.13	0.8	69.45	10.81	0.02	1.5	3.2	12.11	6.67	29.58	0.550	42.39	58.60	75.07	89.05	110.16	0.51	0.71	0.91	1.08	1.33											
			Total	**13.68**							3.2										**0.9**	**1.24**	**1.58**	**1.88**	**2.33**											
			Total	**127.92**							3.2										**9.16**	**12.57**	**15.95**	**18.71**	**23.65**	3.9	1.7	**2.9**	**3.9**	**5.0**	**5.8**	**7.4**	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**
V107	0	1070	A6(a)	42.63	30.62	12.01	59.51	12.25	0.04	1.5	2.7	6.6	1.11	19.97	0.500	55.22	75.35	94.98	110.43	141.89	3.27	4.46	5.62	6.54	8.4											
			A6(b)	12.23	8.56	3.67	58.5	12.4	0.02	1.5	2.7	6.6	1.67	20.67	0.500	53.95	73.70	93.04	108.36	138.77	0.92	1.25	1.58	1.84	2.36											
			Total	**54.86**							2.7										**4.19**	**5.71**	**7.2**	**8.38**	**10.76**											
			Total	**54.86**							2.7										**4.19**	**5.71**	**7.2**	**8.38**	**10.76**	2.3	1.4	**1.6**	**2.1**	**2.7**	**3.1**	**4.0**	**1.1**	**1.5**	**1.9**	**2.2**	**2.8**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V106	2325	2444	A6(a)	3.1	2.79	0.31	69.5	10.8	0.01	1.2	3.2	12.73	6.94	30.47	0.600	41.55	57.50	73.74	87.62	108.07	0.21	0.3	0.38	0.45	0.56												
			A6(c)	2.72	2.44	0.28	69.34	10.82	0.01	1.2	3.2	12.73	6.94	30.5	0.600	41.53	57.47	73.71	87.58	108.02	0.19	0.26	0.33	0.4	0.49												
			Total	**5.82**							3.2										**0.4**	**0.56**	**0.72**	**0.85**	**1.05**												
			Total	**188.6**							3.2										**13.75**	**18.84**	**23.87**	**27.94**	**35.46**	4.9	1.8	**4.3**	**5.9**	**7.5**	**8.7**	**11.1**	**2.4**	**3.3**	**4.1**	**4.8**	**6.2**
V100	5170	5550	A7(a)	19.73	17.76	1.97	69.51	10.8	0.01	1.2	2.6	35.58	5.56	51.93	0.650	29.03	40.88	53.59	65.44	76.66	1.03	1.46	1.91	2.33	2.73												
			A8	8.67	7.78	0.89	69.35	10.82	0.01	1.2	2.6	35.58	6.94	53.34	0.650	28.51	40.18	52.74	64.49	75.35	0.45	0.63	0.83	1.01	1.18												
			Total	**28.4**							2.6										**1.48**	**2.09**	**2.73**	**3.34**	**3.91**												
			Total	**1585.97**							2.6										**98.77**	**135.49**	**171.95**	**201.65**	**254.96**	14	2.7	**38.0**	**52.1**	**66.1**	**77.6**	**98.1**	**14.1**	**19.3**	**24.5**	**28.7**	**36.3**
V105	0	500	A7(a)	17.21	12.04	5.17	58.48	12.4	0.02	1.5	3.7	2.25	2.78	17.43	0.450	60.51	82.19	103.03	118.95	154.87	1.3	1.77	2.22	2.56	3.33												
			A7(b)	16.72	14.71	2.01	68.39	10.96	0.02	1.5	3.7	2.25	3.89	17.1	0.500	61.29	83.21	104.22	120.20	156.79	1.42	1.93	2.42	2.79	3.64												
			Total	**33.93**							3.7										**2.73**	**3.7**	**4.64**	**5.35**	**6.97**												
			Total	**33.93**							3.7										**2.73**	**3.7**	**4.64**	**5.35**	**6.97**	2.9	1.6	**0.7**	**1.0**	**1.3**	**1.4**	**1.9**	**0.5**	**0.6**	**0.8**	**0.9**	**1.2**
V105	500	1320	A7(a)	20	18	2	69.5	10.8	0.02	1.5	4.2	5.24	4.44	20.48	0.500	54.29	74.14	93.55	108.90	139.59	1.51	2.06	2.6	3.03	3.88												
			A7(b)	23.59	20.6	2.99	68.03	11.01	0.01	1.2	4.2	5.24	7.64	23.89	0.550	48.95	67.18	85.31	100.10	126.42	1.76	2.42	3.07	3.61	4.56												
			Total	**43.59**							4.2										**3.27**	**4.48**	**5.67**	**6.63**	**8.43**												
			Total	**77.52**							4.2										**6**	**8.18**	**10.31**	**11.98**	**15.41**	3.3	2.2	**1.4**	**1.9**	**2.5**	**2.9**	**3.7**	**0.6**	**0.9**	**1.1**	**1.3**	**1.7**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V100	5550	6080	A7(b)	16.72	15.04	1.68	69.47	10.8	0.01	1.2	2.6	38.97	6.94	56.72	0.650	27.35	38.63	50.83	62.36	72.43	0.83	1.17	1.53	1.88	2.19											
			A8	8.42	7.56	0.86	69.38	10.82	0.01	1.2	2.6	38.97	8.33	58.12	0.650	26.91	38.03	50.09	61.53	71.29	0.41	0.58	0.76	0.94	1.08											
			Total	**25.14**							2.6										**1.23**	**1.74**	**2.3**	**2.82**	**3.27**											
			Total	**1688.63**							2.6										**106**	**145.42**	**184.56**	**216.46**	**273.64**	23	2.8	**40.8**	**55.9**	**71.0**	**83.3**	**105.2**	**14.6**	**20.0**	**25.4**	**29.7**	**37.6**
V116	0	1000	A9(a)	79.17	69.66	9.51	68.39	10.96	0.02	1.5	1.8	9.26	1.11	21.33	0.500	52.82	72.24	91.31	106.51	135.99	5.81	7.94	10.04	11.71	14.95											
			A9(b)	51.82	32.73	19.09	54.74	12.95	0.03	1.5	1.8	9.26	1.67	23.87	0.500	48.97	67.22	85.35	100.15	126.48	3.52	4.84	6.14	7.21	9.1											
			Total	**130.99**							1.8										**9.33**	**12.78**	**16.18**	**18.92**	**24.06**											
			Total	**130.99**							1.8										**9.33**	**12.78**	**16.18**	**18.92**	**24.06**	3.3	1.6	**5.2**	**7.1**	**9.0**	**10.5**	**13.4**	**3.2**	**4.4**	**5.6**	**6.6**	**8.4**
V116	1000	2000	A9(a)	63.6	55.16	8.44	67.7	11.06	0.02	1.5	3.7	9.01	4.44	24.52	0.550	48.10	66.08	84.01	98.70	124.33	4.67	6.42	8.16	9.59	12.08											
			A9(b)	70.75	60.84	9.91	67.3	11.12	0.01	1.2	3.7	9.01	6.94	27.07	0.550	44.99	62.02	79.16	93.48	116.63	4.86	6.7	8.56	10.1	12.61											
			Total	**134.35**							3.7										**9.54**	**13.12**	**16.72**	**19.69**	**24.69**											
			Total	**265.34**							3.7										**18.87**	**25.91**	**32.9**	**38.61**	**48.74**	3.6	2.4	**5.1**	**7.0**	**8.9**	**10.4**	**13.2**	**2.1**	**2.9**	**3.7**	**4.3**	**5.5**
V116	2000	3000	A9(a)	66.04	57.45	8.59	67.85	11.04	0.01	1.2	4.1	12.2	8.33	31.57	0.550	40.58	56.21	72.20	85.94	105.64	4.09	5.67	7.28	8.67	10.66											
			A9(b)	69.18	59.49	9.69	67.3	11.12	0.01	1.2	4.1	12.2	9.72	33.04	0.600	39.35	54.60	70.26	83.83	102.59	4.54	6.3	8.1	9.67	11.83											
			Total	**135.22**							4.1										**8.63**	**11.97**	**15.39**	**18.34**	**22.49**											
			Total	**400.56**							4.1										**27.5**	**37.87**	**48.29**	**56.95**	**71.23**	6.3	2.2	**6.7**	**9.2**	**11.8**	**13.9**	**17.4**	**3.0**	**4.2**	**5.4**	**6.3**	**7.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V116	3000	3770	A9(a)	24.93	20.02	4.91	64.17	11.58	0.02	1.5	4.1	15.33	8.89	35.79	0.600	37.29	51.87	66.97	80.24	97.44	1.55	2.16	2.78	3.33	4.05											
			A9(b)	38.63	27.43	11.2	59.05	12.32	0.01	1.2	4.1	15.33	9.72	37.37	0.600	36.22	50.46	65.27	78.36	94.77	2.33	3.25	4.2	5.05	6.1											
			Total	**63.56**							4.1										**3.88**	**5.4**	**6.98**	**8.38**	**10.15**											
			Total	**464.12**							4.1										**31.38**	**43.28**	**55.27**	**65.33**	**81.38**	10.42	2.51	**7.7**	**10.6**	**13.5**	**15.9**	**19.8**	**3.0**	**4.2**	**5.4**	**6.3**	**7.9**
V100	6080	7000	A11(a)	27.46	24.71	2.75	69.49	10.8	0.01	1.2	3.4	41.67	11.11	63.58	0.650	25.33	35.91	47.47	58.58	67.29	1.26	1.78	2.35	2.9	3.34											
			A10(d)	22.87	18.46	4.41	64.39	11.54	0.01	1.2	3.4	41.67	12.5	65.71	0.650	24.77	35.16	46.54	57.53	65.88	1.02	1.45	1.92	2.38	2.72											
			Total	**50.33**							3.4										**2.28**	**3.23**	**4.28**	**5.28**	**6.06**											
			Total	**2203.08**							3.4										**139.66**	**191.92**	**244.11**	**287.07**	**361.08**	22	3.2	**41.1**	**56.4**	**71.8**	**84.4**	**106.2**	**12.8**	**17.6**	**22.4**	**26.4**	**33.2**
V100	7000	7300	A11(a)	4.5	3.8	0.7	66.44	11.24	0.01	1.2	3.6	43.06	12.5	66.8	0.700	24.50	34.80	46.09	57.02	65.18	0.21	0.3	0.4	0.5	0.57											
			A10(d)	5.23	4.68	0.55	69.22	10.84	0.01	1.2	3.6	43.06	13.89	67.79	0.700	24.26	34.47	45.69	56.56	64.57	0.25	0.35	0.46	0.58	0.66											
			Total	**9.73**							3.6										**0.46**	**0.66**	**0.87**	**1.07**	**1.23**											
			Total	**2212.81**							3.6										**140.12**	**192.58**	**244.98**	**288.14**	**362.3**	20	3.7	**38.9**	**53.5**	**68.0**	**80.0**	**100.6**	**10.5**	**14.5**	**18.4**	**21.6**	**27.2**
V103	0	800	A11(c)	57.91	52.12	5.79	69.5	10.8	0.02	1.5	4.5	2.96	3.33	17.1	0.500	61.31	83.23	104.25	120.23	156.83	4.93	6.69	8.38	9.67	12.61											
			A11(d)	9.78	8.49	1.29	67.75	11.06	0.01	1.2	4.5	2.96	4.17	18.18	0.500	58.81	80.00	100.46	116.23	150.71	0.8	1.09	1.36	1.58	2.05											
			Total	**67.69**							4.5										**5.73**	**7.78**	**9.75**	**11.25**	**14.66**											
			Total	**67.69**							4.5										**5.73**	**7.78**	**9.75**	**11.25**	**14.66**	3.9	1.6	**1.3**	**1.7**	**2.2**	**2.5**	**3.3**	**0.8**	**1.1**	**1.4**	**1.6**	**2.0**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V104	0	1020	A11(b)	25.51	22.89	2.62	69.35	10.82	0.03	1.5	4.1	4.15	4.44	19.41	0.500	56.28	76.73	96.61	112.15	144.50	1.99	2.72	3.42	3.97	5.12											
			A11(a)	13.05	11.09	1.96	66.74	11.2	0.02	1.5	4.1	4.15	5.56	20.9	0.500	53.55	73.18	92.42	107.70	137.78	0.97	1.33	1.68	1.95	2.5											
			Total	**38.56**							4.1										**2.96**	**4.04**	**5.1**	**5.93**	**7.62**											
			Total	**38.56**							4.1										**2.96**	**4.04**	**5.1**	**5.93**	**7.62**	2.8	1.7	**0.7**	**1.0**	**1.2**	**1.4**	**1.9**	**0.4**	**0.6**	**0.7**	**0.9**	**1.1**
V103	800	1050	A11(a)	3.03	2.73	0.3	69.55	10.79	0.02	1.5	4.5	4.7	5.56	21.05	0.500	53.30	72.85	92.03	107.28	137.15	0.22	0.31	0.39	0.45	0.58											
			A11(d)	10.98	9.88	1.1	69.49	10.8	0.01	1.2	4.5	4.7	6.94	22.45	0.500	51.04	69.91	88.55	103.57	131.59	0.78	1.07	1.35	1.58	2.01											
			Total	**14.01**							4.5										**1**	**1.37**	**1.74**	**2.03**	**2.58**											
			Total	**120.26**							4.5										**9.7**	**13.2**	**16.59**	**19.21**	**24.86**	5.5	2.5	**2.2**	**2.9**	**3.7**	**4.3**	**5.5**	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**
V118	0	850	A10(a)	6.12	5.39	0.73	68.44	10.95	0.02	1.5	3.8	3.73	3.33	18.02	0.500	59.18	80.48	101.03	116.83	151.62	0.5	0.68	0.86	0.99	1.29											
			A10(b)	26.24	23.62	2.62	69.51	10.8	0.02	1.5	3.8	3.73	5	19.53	0.500	56.06	76.44	96.27	111.79	143.96	2.04	2.79	3.51	4.07	5.25											
			Total	**32.36**							3.8										**2.55**	**3.47**	**4.37**	**5.07**	**6.54**											
			Total	**32.36**							3.8										**2.55**	**3.47**	**4.37**	**5.07**	**6.54**	3	1.7	**0.7**	**0.9**	**1.1**	**1.3**	**1.7**	**0.4**	**0.5**	**0.7**	**0.8**	**1.0**
V117	0	1000	A10(c)	65.21	55.43	9.78	66.75	11.2	0.02	1.5	4.1	4.07	4.44	19.71	0.500	55.71	75.99	95.73	111.22	143.10	5.05	6.88	8.67	10.07	12.96											
			A10(d)	22.58	19.42	3.16	67.3	11.12	0.02	1.5	4.1	4.07	5.56	20.74	0.550	53.83	73.55	92.86	108.16	138.47	1.86	2.54	3.2	3.73	4.78											
			Total	**87.79**							4.1										**6.9**	**9.42**	**11.87**	**13.8**	**17.74**											
			Total	**87.79**							4.1										**6.9**	**9.42**	**11.87**	**13.8**	**17.74**	3.65	1.3	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**	**1.3**	**1.8**	**2.2**	**2.6**	**3.3**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V117	1000	1584	A10(c)	20.26	17.22	3.04	66.75	11.2	0.01	1.2	3.8	6.95	4.17	22.31	0.500	51.25	70.18	88.87	103.92	132.10	1.44	1.97	2.5	2.92	3.72											
			A10(d)	12.87	10.58	2.29	65.21	11.42	0.01	1.2	3.8	6.95	5.56	23.93	0.550	48.90	67.12	85.24	100.02	126.30	0.96	1.32	1.68	1.97	2.48											
			Total	**33.13**							3.8										**2.4**	**3.29**	**4.18**	**4.89**	**6.2**											
			Total	**120.92**							3.8										**9.31**	**12.71**	**16.05**	**18.7**	**23.94**	4.5	1.8	**2.4**	**3.3**	**4.2**	**4.9**	**6.3**	**1.4**	**1.9**	**2.3**	**2.7**	**3.5**
V118	850	1245	A10(a)	19.88	17.89	1.99	69.49	10.8	0.01	1.2	4.5	7.33	6.94	25.07	0.550	47.38	65.14	82.88	97.49	122.54	1.44	1.98	2.52	2.96	3.72											
			A10(d)	15	13.5	1.5	69.5	10.8	0.01	1.2	4.5	7.33	8.33	26.46	0.550	45.69	62.93	80.25	94.66	118.36	1.05	1.44	1.84	2.17	2.71											
			Total	**34.88**							4.5										**2.49**	**3.42**	**4.36**	**5.13**	**6.43**											
			Total	**188.16**							4.5										**14.34**	**19.6**	**24.77**	**28.89**	**36.91**	5	2	**3.2**	**4.4**	**5.5**	**6.4**	**8.2**	**1.6**	**2.2**	**2.8**	**3.2**	**4.1**
V100	7300	8000	A10(a)	5.88	5.06	0.82	67.33	11.12	0.01	1.2	3.4	49.02	11.11	71.25	0.700	23.46	33.39	44.34	55.04	62.53	0.27	0.38	0.51	0.63	0.71											
			A11(d)	19.23	17.31	1.92	69.51	10.8	0.01	1.2	3.4	49.02	12.5	72.32	0.700	23.23	33.07	43.95	54.59	61.93	0.87	1.24	1.64	2.04	2.32											
			Total	**25.11**							3.4										**1.14**	**1.62**	**2.15**	**2.67**	**3.03**											
			Total	**2546.34**							3.4										**165.29**	**227**	**288.48**	**338.91**	**427.1**	19	3.2	**48.6**	**66.8**	**84.8**	**99.7**	**125.6**	**15.2**	**20.9**	**26.5**	**31.1**	**39.3**
V120	0	800	A15	111.79	81.87	29.92	60.28	12.14	0.01	1.2	3.3	4.04	4.17	20.35	0.500	54.53	74.45	93.92	109.30	140.19	8.47	11.56	14.58	16.97	21.77											
			Total	**111.79**							3.3										**8.47**	**11.56**	**14.58**	**16.97**	**21.77**											
			Total	**111.79**							3.3										**8.47**	**11.56**	**14.58**	**16.97**	**21.77**	7.2	1.9	**2.6**	**3.5**	**4.4**	**5.1**	**6.6**	**1.4**	**1.8**	**2.3**	**2.7**	**3.5**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V102	0	350	A13	5.06	4.04	1.02	63.91	11.61	0.02	1.5	4.5	1.3	1.11	14.02	0.500	70.06	94.49	117.40	134.02	178.21	0.49	0.66	0.83	0.94	1.25												
			A18(a)	9.46	8.51	0.95	69.48	10.8	0.01	1.2	4.5	1.3	2.08	14.18	0.500	69.52	93.79	116.59	133.17	176.88	0.91	1.23	1.53	1.75	2.32												
			Total	**14.52**							4.5										**1.41**	**1.9**	**2.36**	**2.69**	**3.58**												
			Total	**14.52**							4.5										**1.41**	**1.9**	**2.36**	**2.69**	**3.58**	10	2.3	**0.3**	**0.4**	**0.5**	**0.6**	**0.8**	**0.1**	**0.2**	**0.2**	**0.3**	**0.3**
V121	0	1000	A18(a)	28.38	25.54	2.84	69.5	10.8	0.03	1.5	4.2	3.97	3.33	18.1	0.500	58.99	80.24	100.74	116.52	151.16	2.33	3.16	3.97	4.59	5.96												
			A18(b)	24.31	21.84	2.47	69.41	10.81	0.02	1.5	4.2	3.97	4.44	19.23	0.550	56.65	77.20	97.17	112.75	145.41	2.1	2.87	3.61	4.19	5.4												
			Total	**52.69**							4.2										**4.43**	**6.03**	**7.58**	**8.78**	**11.36**												
			Total	**52.69**							4.2										**4.43**	**6.03**	**7.58**	**8.78**	**11.36**	6.3	2.4	**1.1**	**1.4**	**1.8**	**2.1**	**2.7**	**0.4**	**0.6**	**0.8**	**0.9**	**1.1**
V121	1000	1425	A18(a)	9.46	8.51	0.95	69.48	10.8	0.02	1.5	4.5	5.28	4.44	20.53	0.550	54.21	74.04	93.44	108.78	139.40	0.78	1.07	1.35	1.57	2.01												
			A18(b)	9.14	8.23	0.91	69.52	10.8	0.02	1.5	4.5	5.28	5.56	21.63	0.550	52.33	71.60	90.55	105.70	134.78	0.73	1	1.26	1.48	1.88												
			Total	**18.6**							4.5										**1.51**	**2.07**	**2.61**	**3.05**	**3.9**												
			Total	**71.29**							4.5										**5.94**	**8.1**	**10.19**	**11.83**	**15.26**	8.8	2.5	**1.3**	**1.8**	**2.3**	**2.6**	**3.4**	**0.5**	**0.7**	**0.9**	**1.1**	**1.4**
V102	350	800	A13	13.18	11.86	1.32	69.49	10.8	0.01	1.2	3	10.42	2.78	24	0.550	48.80	67.00	85.09	99.87	126.06	0.98	1.35	1.71	2.01	2.54												
			A19(a)	6.66	5.99	0.67	69.47	10.8	0.01	1.2	3	10.42	4.17	25.39	0.550	46.98	64.62	82.26	96.83	121.56	0.48	0.66	0.84	0.99	1.24												
			Total	**19.84**							3										**1.46**	**2.01**	**2.55**	**3**	**3.78**												
			Total	**105.65**							3										**8.81**	**12**	**15.1**	**17.52**	**22.61**	4.5	1.42	**2.9**	**4.0**	**5.0**	**5.8**	**7.5**	**2.1**	**2.8**	**3.5**	**4.1**	**5.3**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V122	0	1000	A19(a)	18.59	15.12	3.47	64.73	11.49	0.02	1.5	4.2	3.97	2.22	17.68	0.500	59.93	81.45	102.16	118.03	153.45	1.55	2.1	2.64	3.05	3.96											
			A19(b)	26.16	23.55	2.61	69.51	10.8	0.02	1.5	4.2	3.97	3.89	18.66	0.500	57.81	78.71	98.94	114.62	148.25	2.1	2.86	3.59	4.16	5.39											
			Total	**44.75**							4.2										**3.65**	**4.96**	**6.23**	**7.21**	**9.35**											
			Total	**44.75**							4.2										**3.65**	**4.96**	**6.23**	**7.21**	**9.35**	3.2	1.8	**0.9**	**1.2**	**1.5**	**1.7**	**2.2**	**0.5**	**0.7**	**0.8**	**1.0**	**1.2**
V122	1000	1600	A19(a)	11.66	10.49	1.17	69.48	10.8	0.02	1.5	3.5	7.62	2.22	20.64	0.550	54.00	73.77	93.11	108.44	138.89	0.96	1.31	1.66	1.93	2.47											
			A19(b)	17.44	15.69	1.75	69.48	10.8	0.02	1.5	3.5	7.62	4.44	22.87	0.550	50.41	69.09	87.58	102.54	130.04	1.34	1.84	2.33	2.73	3.46											
			Total	**29.1**							3.5										**2.31**	**3.16**	**3.99**	**4.66**	**5.94**											
			Total	**73.85**							3.5										**5.95**	**8.12**	**10.22**	**11.88**	**15.29**	3.4	1.6	**1.7**	**2.3**	**2.9**	**3.4**	**4.4**	**1.1**	**1.4**	**1.8**	**2.1**	**2.7**
V102	800	1860	A13	53.32	46.92	6.4	68.4	10.96	0.01	1.2	4.1	11.93	5.56	28.45	0.550	43.52	60.08	76.85	90.98	112.97	3.55	4.89	6.26	7.41	9.2											
			A20	17.22	11.31	5.91	56.12	12.75	0.02	1.5	4.1	11.93	5.56	30.23	0.550	41.77	57.79	74.10	88.00	108.63	1.1	1.52	1.95	2.32	2.86											
			Total	**70.54**							4.1										**4.64**	**6.41**	**8.21**	**9.73**	**12.06**											
			Total	**250.04**							4.1										**19.41**	**26.54**	**33.54**	**39.12**	**49.96**	11	2.2	**4.7**	**6.5**	**8.2**	**9.5**	**12.2**	**2.2**	**2.9**	**3.7**	**4.3**	**5.5**
V100	8000	8500	A10(a)	7.98	7.18	0.8	69.49	10.8	0.02	1.5	3.3	55.56	8.89	75.25	0.700	22.61	32.24	42.92	53.42	60.37	0.35	0.5	0.67	0.83	0.94											
			A20	28.54	24.26	4.28	66.75	11.2	0.02	1.5	3.3	55.56	10	76.76	0.750	22.31	31.84	42.41	52.84	59.60	1.33	1.89	2.52	3.14	3.54											
			Total	**36.52**							3.3										**1.68**	**2.39**	**3.19**	**3.97**	**4.48**											
			Total	**2944.69**							3.3										**166.97**	**229.39**	**291.67**	**342.88**	**431.58**	23	3.42	**50.6**	**69.5**	**88.4**	**103.9**	**130.8**	**14.8**	**20.3**	**25.8**	**30.4**	**38.2**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V119	0	1000	A12(a)	21.34	19.2	2.14	69.48	10.8	0.03	1.5	3.3	5.05	1.67	17.52	0.500	60.31	81.93	102.73	118.63	154.38	1.79	2.43	3.04	3.52	4.58												
			A12(b)	46.73	41.12	5.61	68.4	10.96	0.02	1.5	3.3	5.05	3.33	19.34	0.500	56.42	76.90	96.81	112.37	144.83	3.66	4.99	6.28	7.29	9.4												
			Total	**68.07**							3.3										**5.45**	**7.42**	**9.33**	**10.81**	**13.98**												
			Total	**68.07**							3.3										**5.45**	**7.42**	**9.33**	**10.81**	**13.98**	3	2	**1.7**	**2.2**	**2.8**	**3.3**	**4.2**	**0.8**	**1.1**	**1.4**	**1.6**	**2.1**
V119	1000	2000	A12(a)	44.6	36.13	8.47	64.55	11.52	0.03	1.5	3.9	8.55	3.33	23.4	0.500	49.63	68.08	86.38	101.25	128.12	3.07	4.22	5.35	6.27	7.94												
			A12(b)	35.04	30.54	4.5	67.94	11.03	0.02	1.5	3.9	8.55	4.44	24.02	0.550	48.77	66.95	85.04	99.81	125.98	2.61	3.58	4.55	5.34	6.74												
			Total	**79.64**							3.9										**5.69**	**7.8**	**9.9**	**11.62**	**14.68**												
			Total	**147.71**							3.9										**11.13**	**15.22**	**19.23**	**22.42**	**28.66**	3.5	2	**2.9**	**3.9**	**4.9**	**5.7**	**7.3**	**1.4**	**2.0**	**2.5**	**2.9**	**3.7**
V119	2000	3132	A12(a)	53.87	48.22	5.65	69.23	10.84	0.02	1.5	4.3	12.14	4.44	27.42	0.550	44.61	61.51	78.55	92.83	115.67	3.67	5.06	6.46	7.64	9.52												
			A12(b)	35.04	30.84	4.2	68.41	10.96	0.02	1.5	4.3	12.14	6.67	29.77	0.550	42.21	58.37	74.79	88.75	109.72	2.26	3.12	4	4.75	5.87												
			Total	**88.91**							4.3										**5.93**	**8.19**	**10.47**	**12.39**	**15.39**												
			Total	**236.62**							4.3										**17.07**	**23.41**	**29.7**	**34.82**	**44.05**	3.5	2.4	**4.0**	**5.4**	**6.9**	**8.1**	**10.2**	**1.7**	**2.3**	**2.9**	**3.4**	**4.3**
V100	8500	8900	A12(a)	5.96	5.36	0.6	69.46	10.81	0.01	1.2	3	63.33	4.17	78.31	0.750	22.02	31.43	41.90	52.27	58.84	0.27	0.39	0.52	0.65	0.73												
			A20	20.68	17.37	3.31	66.2	11.28	0.01	1.2	3	63.33	5.56	80.17	0.750	21.67	30.96	41.32	51.60	57.96	0.93	1.33	1.78	2.22	2.5												
			Total	**26.64**							3										**1.21**	**1.72**	**2.3**	**2.87**	**3.23**												
			Total	**3207.95**							3										**185.24**	**254.53**	**323.67**	**380.57**	**478.86**	35	3.2	**61.7**	**84.8**	**107.9**	**126.9**	**159.6**	**19.3**	**26.5**	**33.7**	**39.6**	**49.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
V101	0	900	A22(a)	33.33	28.87	4.46	67.64	11.07	0.02	1.5	4.1	3.66	2.78	17.51	0.500	60.34	81.97	102.78	118.68	154.45	2.79	3.79	4.76	5.49	7.15											
			A22(b)	32.55	23.28	9.27	59.34	12.28	0.02	1.5	4.1	3.66	3.33	19.27	0.500	56.56	77.09	97.03	112.60	145.19	2.56	3.49	4.39	5.09	6.56											
			Total	**65.88**							4.1										**5.35**	**7.28**	**9.14**	**10.58**	**13.71**											
			Total	**65.88**							4.1										**5.35**	**7.28**	**9.14**	**10.58**	**13.71**	4.6	2.2	**1.3**	**1.8**	**2.2**	**2.6**	**3.3**	**0.6**	**0.8**	**1.0**	**1.2**	**1.5**
V100	8900	10000	A21	64.28	54.58	9.7	66.7	11.21	0.01	1.2	3.4	68.63	8.33	88.17	0.750	20.33	29.13	39.03	48.98	54.51	2.72	3.9	5.23	6.56	7.3											
			A23	33.19	12.66	20.53	40.98	14.95	0.01	1.2	3.4	68.63	6.94	90.52	0.700	19.97	28.65	38.42	48.28	53.59	1.29	1.85	2.48	3.12	3.46											
			Total	**97.47**							3.4										**4.01**	**5.75**	**7.71**	**9.68**	**10.76**											
			Total	**3371.3**							3.4										**189.25**	**260.28**	**331.38**	**390.24**	**489.62**	30	2.3	**55.7**	**76.6**	**97.5**	**114.8**	**144.0**	**24.2**	**33.3**	**42.4**	**49.9**	**62.6**
V100	10000	11000	A21	42.86	36.57	6.29	66.93	11.17	0.01	1.2	3.4	73.53	9.72	94.43	0.750	19.41	27.88	37.46	47.18	52.16	1.73	2.49	3.34	4.21	4.66											
			A23	47.5	18.99	28.51	41.99	14.8	0.01	1.2	3.4	73.53	11.11	99.44	0.750	18.75	26.97	36.32	45.86	50.45	1.86	2.67	3.59	4.54	4.99											
			Total	**90.36**							3.4										**3.59**	**5.16**	**6.94**	**8.75**	**9.65**											
			Total	**3461.66**							3.4										**192.84**	**265.43**	**338.32**	**398.99**	**499.27**	28	2.64	**56.7**	**78.1**	**99.5**	**117.4**	**146.8**	**21.5**	**29.6**	**37.7**	**44.5**	**55.6**
V100	11000	11500	C4(a)	7.89	6.9	0.99	68.1	11	0.01	1.2	3.2	80.73	11.11	102.84	0.750	18.33	26.40	35.59	45.02	49.36	0.3	0.43	0.59	0.74	0.81											
			C4(b)	29.89	11.95	17.94	41.99	14.8	0.01	1.2	3.2	80.73	9.72	105.25	0.750	18.04	26.01	35.10	44.46	48.63	1.12	1.62	2.19	2.77	3.03											
			Total	**37.78**							3.2										**1.42**	**2.05**	**2.77**	**3.51**	**3.84**											
			Total	**3499.44**							3.2										**194.27**	**267.49**	**341.09**	**402.5**	**503.11**											

Table 4.3 Showing Check for Adequacy of Existing Culverts with measured Site Slopes - Vrishabhavathi Main Valley (V1)

(UnClean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks					Required Width (B) (mts)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)															
Vrishabhavathi Main Valley Primary Storm Drain (V100)																															
1	V-17	Venkataranga Iyenger Mn. Rd., Sheshadhari puram @2050	1	2.250	4.500	0.0060	4.400	9.900			11.050	0.896	0.030	2.400	23.756																
			2	2.250	4.500	0.0060	4.400	9.900			11.050	0.896	0.030	2.400	23.756																
				4.500			4.400	19.800	30.350	34.761				2.400		47.512	26.35	36.04	45.56	53.16	67.85	AD	AD	AD	IA	IA	2.5	3.41	4.32	5.04	6.43
Timber yard Secondary Storm Drain (V102)																															
1	13/7-C7	2 nd main road, Kariyamnapalya @230	1	4.050	1.100	0.0070	1.000	4.050			6.050	0.669	0.030	2.134	8.643																
				4.050			1.000	4.050	18.140	77.674				2.134		8.643	0.909	1.227	1.524	1.741	2.313	AD	AD	AD	AD	AD	0.43	0.57	0.71	0.82	1.08
2	13/6-C6	Pipeline road, Utharayappa Garden, Kasthuribai nagar @380	1	2.000	0.450	0.0060	0.350	0.700			2.700	0.259	0.030	1.050	0.735																
			2	2.000	0.450	0.0060	0.350	0.700			2.700	0.259	0.030	1.050	0.735																
			3	2.000	0.450	0.0060	0.350	0.700			2.700	0.259	0.030	1.050	0.735																
				6.000			0.350	2.100	14.060	85.064				1.050		2.205	2.008	2.722	3.404	3.918	5.131	AD	IA	IA	IA	IA	5.47	7.41	9.26	10.66	13.96
Guddadahalli Secondary Storm Drain (V103)																															
1	3/6A-C6A	Janatha colony main road @170	1	1.500	0.600	0.0060	0.500	0.750			2.500	0.300	0.030	1.157	0.868																
				1.500			0.500	0.750	2.270	66.960				1.157		0.868	2.708	3.677	4.608	5.317	6.929	IA	IA	IA	IA	IA	4.68	6.36	7.96	9.19	11.98

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks					Required Width (B) (mts)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
JaiBharathnagar Secondary Storm Drain (V104)																															
1	10A/10	9 th Cross Guddadahalli Nehru road, Mysore road @550	1	3.100	1.600	0.0100	1.500	4.650			6.100	0.762	0.030	2.782	12.934																
				3.100			1.500	4.650	3.230	-43.963				2.782		12.934	1.966	2.683	3.381	3.930	5.052	AD	AD	AD	AD	AD	0.47	0.64	0.81	0.94	1.21
Binnypet Secondary Storm Drain (V105)																															
1	5/11-C11	1 st main 3 rd road, R.R.Nagar, Ranganatha Colony @150	1	1.500	1.100	0.0300	1.000	1.500			3.500	0.429	0.035	2.813	4.220																
			2	1.500	1.100	0.0300	1.000	1.500			3.500	0.429	0.035	2.813	4.220																
				3.000			1.000	3.000	5.210	42.418				2.813		8.439	1.410	1.915	2.399	2.769	3.608	AD	AD	AD	AD	AD	0.5	0.68	0.85	0.98	1.28
Bakshi Garden Secondary Storm Drain (V106)																															
1	6/23-C23	Goods Shed Road, Velmuruga nagar @220	1	1.300	1.900	0.0100	1.800	2.340			4.900	0.478	0.030	2.037	4.765																
			2	1.300	1.900	0.0100	1.800	2.340			4.900	0.478	0.030	2.037	4.765																
			3	1.300	1.900	0.0100	1.800	2.340			4.900	0.478	0.030	2.037	4.765																
				3.900			1.800	7.020	17.000	58.706				2.037		14.296	2.22	3.03	3.83	4.47	5.71	AD	AD	AD	AD	AD	0.6	0.83	1.04	1.22	1.56
Kempapura Agrahara Secondary Storm Drain (V107)																															
1	7/13A-C13A	Bhuvaneswari nagar, Magadi road @ 385	1	1.800	1.250	0.0120	1.150	2.070			4.100	0.505	0.030	2.315	4.793																
				1.800			1.150	2.070	2.590	20.077				2.315		4.793	2.16	2.94	3.71	4.32	5.54	AD	AD	AD	AD	IA	0.81	1.11	1.39	1.62	2.08

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) R $^{2/3}$ S $^{0.5}$	Q = A x V	(Q total)	Discharge (Q $_{Reqd.}$) (Cumec)					Remarks					Required Width (B) (mts)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
Sheshadaripura Secondary Storm Drain (V110)																															
1	V1/C5	Nagappa Street, Sheshadari Puram @35	1	6.700	0.750	0.0050	0.650	4.355			8.000	0.544	0.030	1.571	6.844																	
				6.700			0.650	4.355	11.060	60.624				1.571		6.844	1.8	2.45	3.08	3.58	4.61	AD	AD	AD	AD	AD	1.76	2.4	3.02	3.51	4.51
Prakash Nagar Secondary Storm Drain (V112)																															
1	VS1/C7	M.K.K. Road, 2 nd stage, Rajajinagar @920	1	1.500	1.500	0.0060	1.400	2.100			4.300	0.488	0.030	1.601	3.363																	
			2	1.500	1.500	0.0060	1.400	2.100			4.300	0.488	0.030	1.601	3.363																	
			3	1.500	1.500	0.0060	1.400	2.100			4.300	0.488	0.030	1.601	3.363																	
			4	1.500	1.500	0.0060	1.400	2.100			4.300	0.488	0.030	1.601	3.363																	
				6.000			1.400	8.400	10.760	21.933				1.601		13.450	9.4	12.83	16.18	18.82	24.15	AD	AD	IA	IA	IA	4.19	5.72	7.22	8.39	10.77
2	VS1/C9	Marriyappa Palya, Prakash Nagar @1150	1	2.000	1.100	0.0090	1.000	2.000			4.000	0.500	0.030	1.992	3.984																	
			2	2.000	1.100	0.0090	1.000	2.000			4.000	0.500	0.030	1.992	3.984																	
			3	2.000	1.100	0.0090	1.000	2.000			4.000	0.500	0.030	1.992	3.984																	
				6.000			1.000	6.000	15.040	60.106				1.992		11.953	11.14	15.22	19.21	22.36	28.66	AD	IA	IA	IA	IA	5.59	7.64	9.64	11.23	14.38

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks					Required Width (B) (mts)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
3	VS1/C10	9 th Main Road, Mariyappa Palya, Prakash Nagar @1385	1	1.800	1.250	0.0050	1.150	2.070			4.100	0.505	0.030	1.494	3.094																
			2	1.800	1.250	0.0050	1.150	2.070			4.100	0.505	0.030	1.494	3.094																
			3	1.800	1.250	0.0050	1.150	2.070			4.100	0.505	0.030	1.494	3.094																
				5.400			1.150	6.210	10.200	39.118				1.494		9.281	12.95	17.69	22.35	26.05	33.31	IA	IA	IA	IA	IA	7.53	10.3	13	15.16	19.38
4	VS1/C11	12 th Main Road, Mariyappa Palya, Prakash Nagar @1440	1	1.900	1.600	0.0050	1.500	2.850			4.900	0.582	0.030	1.642	4.681																
			2	1.900	1.600	0.0050	1.500	2.850			4.900	0.582	0.030	1.642	4.681																
			3	1.900	1.600	0.0050	1.500	2.850			4.900	0.582	0.030	1.642	4.681																
				5.700			1.500	8.550	12.170	29.745				1.642		14.042	13.44	18.37	23.21	27.06	34.58	AD	IA	IA	IA	IA	5.45	7.46	9.42	10.98	14.04
5	VS1/C13	4 th Cross Road, Mariyappa Palya, Prakash Nagar @1575	1	1.900	2.000	0.0060	1.900	3.610			5.700	0.633	0.030	1.904	6.874																
			2	1.900	2.000	0.0060	1.900	3.610			5.700	0.633	0.030	1.904	6.874																
			3	1.900	2.000	0.0060	1.900	3.610			5.700	0.633	0.030	1.904	6.874																
				5.700			1.900	10.830	19.840	45.413				1.904		20.622	14.58	19.94	25.21	29.4	37.55	AD	AD	IA	IA	IA	4.03	5.51	6.97	8.13	10.38
6	VS1/C14	5 th Main Road, Prakash Nagar, Ward No. @1610	1	1.900	1.800	0.0080	1.700	3.230			5.300	0.609	0.030	2.143	6.922																
			2	1.900	1.800	0.0080	1.700	3.230			5.300	0.609	0.030	2.143	6.922																
			3	1.900	1.800	0.0080	1.700	3.230			5.300	0.609	0.030	2.143	6.922																
				5.700			1.700	9.690	12.760	24.060				2.143		20.767	15.08	20.62	26.06	30.41	38.82	AD	AD	IA	IA	IA	4.14	5.66	7.15	8.35	10.65

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – Aj/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks					Required Width (B) (mts)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
7	VS1/C25	4 th Cross Road, Ramachandra Pura @2980	1	2.400	1.500	0.0060	1.400	3.360			5.200	0.646	0.030	1.930	6.484																
			2	2.400	1.500	0.0060	1.400	3.360			5.200	0.646	0.030	1.930	6.484																
			3	2.400	1.500	0.0060	1.400	3.360			5.200	0.646	0.030	1.930	6.484																
				7.200			1.400	10.080	20.420	50.637				1.930		19.452	27.32	37.4	47.33	55.3	70.39	IA	IA	IA	IA	IA	10.11	13.84	17.52	20.47	26.05
8	VS1/C26	4 th Main 2 nd Cross Road, Ramachandra pura @3140	1	2.300	1.400	0.0060	1.300	2.990			4.900	0.610	0.030	1.858	5.554																
			2	2.300	1.400	0.0060	1.300	2.990			4.900	0.610	0.030	1.858	5.554																
			3	2.300	1.400	0.0060	1.300	2.990			4.900	0.610	0.030	1.858	5.554																
				6.900			1.300	8.970	25.630	65.002				1.858		16.662	28.05	38.39	48.59	56.78	72.27	IA	IA	IA	IA	IA	11.61	15.9	20.12	23.52	29.93
Muneshwara Secondary Storm Drain (V122)																															
1	S14-S1-C8	15 th Main Road, Kalidas Layout, Raghavendra Nagar @1225	1	1.450	1.550	0.0150	1.450	2.103			4.350	0.483	0.030	2.514	5.286																
			2	1.450	1.550	0.0150	1.450	2.103			4.350	0.483	0.030	2.514	5.286																
				2.900			1.450	4.205	9.570	56.061				2.514		10.573	4.71	6.4	8.05	9.32	12.06	AD	AD	AD	AD	IA	1.29	1.76	2.21	2.56	3.31

Table 4.4 Showing Check for Adequacy of Improved Culverts with measured Site Slopes - Vrishabhavathi Main Valley (V1)

(Clean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)										
Vrishabhavathi Main Valley Primary Storm Drain (V100)																										
1	V-17	Venkataranga Iyenger Mn. Rd., Sheshadhari puram @2050	1	2.250	4.500	0.0060	4.400	9.900			11.050	0.896	0.020	3.599	35.634												
			2	2.250	4.500	0.0060	4.400	9.900			11.050	0.896	0.020	3.599	35.634												
			3	5.000	4.400	0.0060	4.300	21.500			13.600	1.581	0.020	5.256	113.001												
				4.500			4.400	41.300	30.350	-36.079				3.599		184.269	26.35	36.04	45.56	53.16	67.85	AD	AD	AD	AD	AD
Timber yard Secondary Storm Drain (V102)																										
1	13/7-C7	2 nd main road, Kariyamnapalya @230	1	8.000	2.000	0.0070	1.900	15.200			11.800	1.288	0.020	4.953	75.278												
				8.000			1.900	15.200	18.140	16.207				4.953		75.278	0.909	1.227	1.524	1.741	2.313	AD	AD	AD	AD	AD
2	13/6-C6	Pipeline road, Utharayappa Garden, Kasthuribai nagar @380	1	7.000	2.000	0.0060	1.900	13.300			10.800	1.231	0.020	4.450	59.181												
				7.000			1.900	13.300	14.060	5.405				4.450		59.181	2.008	2.722	3.404	3.918	5.131	AD	AD	AD	AD	AD
Guddadahalli Secondary Storm Drain (V103)																										
1	3/6A-C6A	Janatha colony main road @170	1	3.500	1.500	0.0060	1.400	4.900			6.300	0.778	0.020	3.276	16.050												
				3.500			1.400	4.900	2.270	-115.859				3.276		16.050	2.708	3.677	4.608	5.317	6.929	AD	AD	AD	AD	AD

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)										
JaiBharathnagar Secondary Storm Drain (V104)																										
1	10A/10	9 th Cross Guddadahalli Nehru road, Mysore road @550	1	5.000	1.750	0.0100	1.650	8.250			8.300	0.994	0.020	4.980	41.084												
				5.000			1.650	8.250	3.230	-155.418				4.980		41.084	1.966	2.683	3.381	3.930	5.052	AD	AD	AD	AD	AD
Binnypet Secondary Storm Drain (V105)																										
1	5/11-C11	1 st main 3 rd road, R.R.Nagar, Ranganatha Colony @150	1	5.000	1.750	0.0300	1.650	8.250			8.300	0.994	0.020	8.625	71.160												
				5.000			1.650	8.250	5.210	-58.349				8.625		71.160	1.410	1.915	2.399	2.769	3.608	AD	AD	AD	AD	AD
Bakshi Garden Secondary Storm Drain (V106)																										
1	6/23-C23	Goods Shed Road, Velmuruga nagar @220	1	6.000	2.100	0.0100	2.000	12.000			10.000	1.200	0.020	5.646	67.755												
				6.000			2.000	12.000	17.000	29.412				5.646		67.755	2.22	3.03	3.83	4.47	5.71	AD	AD	AD	AD	AD

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)										
Kempapura Agrahara Secondary Storm Drain (V107)																										
1	7/13A-C13A	Bhuvaneswari nagar, Magadi road @ 385	1	3.500	1.500	0.0120	1.400	4.900			6.300	0.778	0.030	3.088	15.132											
				3.500			1.400	4.900	2.590	-89.189				3.088		15.132	2.16	2.94	3.71	4.32	5.54	AD	AD	AD	AD	AD
Sheshadaripura Secondary Storm Drain (V110)																										
1	V1/C5	Nagappa Street, Sheshadari Puram @35	1	6.000	1.700	0.0050	1.600	9.600			9.200	1.043	0.020	3.637	34.918											
				6.000			1.600	9.600	11.060	13.201				3.637		34.918	1.8	2.45	3.08	3.58	4.61	AD	AD	AD	AD	AD
Prakash Nagar Secondary Storm Drain (V112)																										
1	VS1/C7	M.K.K. Road, 2 nd stage, Rajajinagar @920	1	10.000	2.100	0.0060	2.000	20.000			14.000	1.429	0.020	4.913	98.252											
				10.000			2.000	20.000	10.760	-85.874				4.913		98.252	9.4	12.83	16.18	18.82	24.15	AD	AD	AD	AD	AD
2	VS1/C9	Marriyappa Palya, Prakash Nagar @1150	1	10.000	2.100	0.0090	2.000	20.000			14.000	1.429	0.020	6.017	120.334											
				10.000			2.000	20.000	15.040	-32.979				6.017		120.334	11.14	15.22	19.21	22.36	28.66	AD	AD	AD	AD	AD

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	V = (1/n) $R^{2/3}$ $S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)										
3	VS1/C10	9 th Main Road, Mariyappa Palya, Prakash Nagar @1385	1	10.000	2.000	0.0050	1.900	19.000			13.800	1.377	0.020	4.376	83.136											
				10.000			1.900	19.000	10.200	-86.275				4.376		83.136	12.95	17.69	22.35	26.05	33.31	AD	AD	AD	AD	AD
4	VS1/C11	12 th Main Road, Mariyappa Palya, Prakash Nagar @1440	1	10.000	2.100	0.0050	2.000	20.000			14.000	1.429	0.020	4.485	89.692											
				10.000			2.000	20.000	12.170	-64.339				4.485		89.692	13.44	18.37	23.21	27.06	34.58	AD	AD	AD	AD	AD
5	VS1/C13	4 th Cross Road, Mariyappa Palya, Prakash Nagar @1575	1	8.000	2.000	0.0060	1.900	15.200			11.800	1.288	0.020	4.585	69.694											
				8.000			1.900	15.200	19.840	23.387				4.585		69.694	14.58	19.94	25.21	29.4	37.55	AD	AD	AD	AD	AD
6	VS1/C14	5 th Main Road, Prakash Nagar, Ward No. @1610	1	8.000	2.000	0.0080	1.900	15.200			11.800	1.288	0.020	5.294	80.476											
				8.000			1.900	15.200	12.760	-19.122				5.294		80.476	15.08	20.62	26.06	30.41	38.82	AD	AD	AD	AD	AD
7	VS1/C25	4 th Cross Road, Ramachandra Pura @2980	1	10.000	2.300	0.0060	2.200	22.000			14.400	1.528	0.020	5.138	113.025											
				10.000			2.200	22.000	20.420	-7.738				5.138		113.025	27.32	37.4	47.33	55.3	70.39	AD	AD	AD	AD	AD

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	Span Width	Vertical Clearance of the culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	$V = (1/n) R^{2/3} S^{0.5}$	Q = A x V	(Q total)	Discharge ($Q_{Reqd.}$) (Cumec)					Remarks				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
		(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)										
8	VS1/C26	4 th Main 2 nd Cross Road, Ramachandrapura @3140	1	10.000	2.500	0.0060	2.400	24.000			14.800	1.622	0.020	5.346	128.299											
				10.000			2.400	24.000	25.630	6.360				5.346		128.299	28.05	38.39	48.59	56.78	72.27	AD	AD	AD	AD	AD
Muneshwara Secondary Storm Drain (V122)																										
1	S14-S1-C8	15 th Main Road, Kalidas Layout, Raghavendra Nagar @1225	1	3.500	1.600	0.0150	1.500	5.250			6.500	0.808	0.020	5.311	27.883											
				3.500			1.500	5.250	9.570	45.141				5.311		27.883	4.71	6.4	8.05	9.32	12.06	AD	AD	AD	AD	AD

Table - Schedule For Improving the Carrying Capacity of Existing Primary Storm Drains in Vrishabhavathi Main Valley (V100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
V100 – Vrishabhavathi Main Valley Primary Storm Drain:														
1	0	1000	Gayathri park Extn., 15th cross	Sangeetha apartments near Geethanjali theatre			0-500	Near Malleshwaram Swimming pool Extn. Ex-covered drain needs to be opened at regular interval & desilted by about 0.3 m depth. After desilting, steel grating to be provided at regular intervals / road crossings. Ex.Av. Width: 3.5 m.			500-600	Near Malleshwaram 10th Cross road. After desilting and drain bed deepening, Ex.BS slabs shall be relaid to proper bed slope. Ex. Av. Width: 4.0 m.		
							500-600	Near Malleshwaram 10th cross road. Ex-drain needs to be desilted by about 0.3 m depth. Further, Ex.BS slabs laid for drain bed needs to be removed and deepened by about 0.3 m. Ex.Av. Width: 4.0 m.			600-1000	Near Dattatreya temple street. After desilting and drain bed deepening, bed protection to be provided for full length and width. Ex. Av. Width: 5.5 m.		
							600-1000	Near Dattatreya temple street. Ex-drain needs to be desilted by about 0.3 m depth. Further, drain bed to be deepened by about 0.3 m. Ex.Av. Width: 5.5 m.						
2	1000	2000	Sangeetha apartments near Geethanjali theatre	Platform road near Rajiv Gandhi circle			1000-1500	Near Link road. Ex-drain needs to be desilted by about 0.3 m. Further, drain bed needs to be deepened by about 0.5 m. Ex. Av. Width: 8.5 m.			1000-1500	Near Link road. After desilting and drain bed deepening, bed protection to be provided for full length and width. Ex. Av. Width: 8.5 m.		
							1500-2000	Near Sirur park road. Ex-drain needs to be desilted by about 0.3 m. Further, drain bed needs to be deepened by about 0.5 m. Ex. Av. Width: 10.5 m.			1500-2000	Near Sirur park road. After desilting and drain bed deepening, bed protection to be provided for full length and width. Ex. Av. Width: 10.5 m.		
3	2000	3000	Platform road near Rajiv Gandhi circle	Kalappa block near Srirampura	2000-2100	Near Jakarayanakere. Both sides: Ex-drain is in natural condition and new walls to be constd on both sides for a ht. of about 2.0 m.	2000-2500	Near Jakarayanakere. Ex-drain needs to be desilted by about 0.5 m. Further, drain bed needs to be deepened by about 0.75 m. Ex. Av. Width: 11.5 m.			2000-2500	After desilting and drain bed deepening, bed protection to be provided for full length and width. Ex. Av. Width: 11.5 m.		
					2300-2500	Near Tumkur railway track. Right side: Ex-drain is in natural condition. Drain to be widened and stone revetment to be provided for a ht. of about 2.0 m. Ex. Av. Width: 10.0 m, Pro. Av. Width: 14.0 m.	2500-2550	Near Tumkur railway line. Rocky outcrop (hard rock) noticed near the railway bridge needs to be lowered (by chisilling / control blashing for a depth of about 1.2 m. Ex. Av. Width: 12.5 m.			2600-3000	After desilting and drain bed deepening, bed protection to be provided for full length and width. Ex. Av. Width: 13.0 m.		
							2550-3000	Ex-drain needs to be desilted by about 0.5 m. Ex. Av. Width: 13.0 m.						
4	3000	4000	Kalappa block near Srirampura	Gubbana Industrial area near Gopalpura	3800-3900	Near Minerva mills water treatment plant. Right side: Ex-drain is in natural condition to be widened and stone pitching to be provided on right side. Ex.Av. Width: 12.0 m, Pro.Av.Width:18.0 m, ht: 2.4 m.	3000-4000	Ex-drain needs to be desilted by about 0.5 m. Further, drain bed needs to be deepened by about 0.75 m. Ex. Av. Width: 14.0 m.			3000-4000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 14.0 m.		
5	4000	5000	Gubbana Industrial area near Gopalpura	Manjunatha nagar near Magadi main road			4000-5000	Ex-drain needs to be desilted by about 0.5 m. Further, drain bed needs to be deepened by about 1.6 m. Ex. Av. Width: 20.0 m.			4000-5000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 20.0 m.		
6	5000	6000	Manjunatha nagar near Magadi main road	Telecom layout near Padarayanapura	5150-5600	Near Manjunathanagar 10th cross road upto Bhuvaneshwarinagar main road. Right side: Ex.SSM wall to be dismantled, widened and new wall to be constd on right side. Ex.Av.Width: 12.0 m, Pro. Av. Width: 18.0 m, ht: 2.8 m.	5000-6000	Ex-drain needs to be desilted by about 1.0 m. and further, drain bed needs to be deepened by about 2.2 m. Ex. Av. Width: 22.0 m.			5000-6000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 22.0 m.		
7	6000	7000	Telecom layout near Padarayanapura	5th cross road, Shamanna garden near pipeline road, Jagajeevanramnagar	a) 6225-6300	Near Hosahalli main road bridge location. Left side: Ex-drain is in natural condition, new wall to be constd on left side for a ht of 3.2 m.	a)6000-6400	Ex-drain needs to be desilted by about 0.50 m. and drain bed needs to be deepened by about 1.0 m. Ex. Av. Width: 22.0 m.			6000-6400	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 22.0 m.		
					b) 6400-6600	Rocky area near Ramesh babu circle level crossing. Right side: Ex-drain needs to be widened by 4 m & deepened by 1.0 m. The rocky outcrop noticed near railway bridge needs to be removed by chisilling / control blasting. Ex.Av. Width: 12m, Pro.Av.Width: 16 m.	b)6600-7000	Ex-drain needs to be desilted by about 0.50 m. Ex. Av. Width: 22.0 m.			6800-7000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 23.0 m.		
					c) 6400-6600	Near Vinayakanagar. Both side: Ex-drain is in natural condition. After widening, stone revetment needs to be provided on both sides with cement grouting for a ht of about 3.0 m.									

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
					d)	Near Hosahalli main road bridge upto pipeline road near Jagajeevanramnagar. New RCC box drain of size 6 m x 2.6 m, needs to be constd for a length of about 500 m.								
8	7000	8000	5th cross road, Shamanna garden near pipeline road, Jagajeevanramnagar	Bapujinagar main road bridge near Gali Anjaneya temple	a) 7250-7450	Near Bapujinagar. Left side: Ex-drain needs to be widened on left side and new walls to be constd. Ex. Av. Width: 15.0 m, Pro. Av. Width:20.0 m, ht: 3.2 m.		Ex-drain needs to be desilted by about 0.5 m and further, drain bed needs to be deepened by about 1 m. [Ch.7000-Ch.7200 m, rock cutting by chisilling shall be considered] Ex. Av. Width: 20 m.			7200-8000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 20.0 m.		
					b) 7750-8000	Near Bapujinagar 8th cross road. Left side: Ex-drain needs to be widened on left side and new walls to be constd. Ex. Av. Width: 15.0 m, Pro. Av. Width:20.0 m, ht: 3.2 m.								
9	8000	9000	Bapujinagar main road bridge near Gali Anjaneya temple	Mysore road bridge near Chord road junction.	8400-8800	Near Kavita layout. Both sides: Ex-drain is in natural condition, to be widened and embankment to be made up with imported earth and stone revetment needs to be provided on both sides with cement grouting. Ex.Av.Width: 24 m, Pro.Av. Width: 32 m, ht: 2.6 m.	8000-8400	Ex-drain needs to be desilted by about 0.5 m and further, drain bed needs to be deepened by about 1 m. Ex. Av. Width: 23 m.			8000-8400	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 23.0 m.		
					8900-9000	Behind Rallier Industries Ltd. Ex-drain is in natural condition, to be widened and new wall constd on both sides. Ex.Av.Width: 24 m, Pro.Av. Width: 32 m, ht: 2.6 m.	8400-8800	Ex-drain needs to be desilted by about 1.0 m and further, drain bed needs to be deepened by about 1.4 m. Ex. Av. Width: 24 m.			8400-8800	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: 32.0 m.		
							8800-9000	Ex-drain needs to be desilted by about 1.0 m and further, drain bed needs to be deepened by about 1.4 m. Ex. Av. Width: 24 m.			8800-9000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 25.0 m.		
10	9000	10000	Mysore road bridge near Chord road junction.	BWSSB pipeline bridge behind Kwality biscuits factory near Mysore road.	9000-10000	Near K.H. Ranganatha colony behind Kwality biscuits factory. Both sides: Ex-drain is in natural condition, to be widened and embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on both sides. Guard stones to be provided at regular intervals. Ex.Av.Width: 24 m, Pro.Av. Width: 32 m, ht: 2.6 m.	9000-10000	Ex-drain needs to be desilted by about 0.5 m and further, drain bed needs to be deepened by about 1.8 m. Ex. Av. Width: 24 m.			9000-10000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: 32.0 m.		
11	10000	11000	BWSSB pipeline bridge behind Kwality biscuits factory near Mysore road.		10000-10500	Near Hosakere halli ring road bridge. Both sides: Ex drain is in natural condition, to be widened and embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on right side. Guard stones to be provided at regular intervals. Ex.Av.Width: 24 m, Pro.Av. Width: 32 m, ht: 2.6 m.	10000-10500	Ex-drain needs to be desilted by about 1.0 m and further, drain bed needs to be deepened by about 2.0 m. Ex. Av. Width: 24 m.			10000-11000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: 32.0 m.		
					10500-11000	Near Pantarpalya. Both sides: Ex-drain is in natural condition, to be widened and embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on left side. Guard stones to be provided at regular intervals. Ex.Av.Width: 24 m, Pro.Av. Width: 32 m, ht: 2.6 m.	10500-11000	Ex-drain needs to be desilted by about 1.0 m and further, drain bed needs to be deepened by about 2.0 m. Ex. Av. Width: 24 m.						
12	11000	12000			11000-12000	Both sides: Ex-drain is in natural condition. Dense veg. growth noticed neds to be cleared, widened. Further embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on left side. Guard stones to be provided at regular intervals. Ex.Av.Width: m, Pro.Av. Width: m.	11000-12000	Ex-drain needs to be desilted by about 1.0 m. Ex. Av. Width: m.			11000-12000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
13	12000	13000			12000-13000	Both sides: Ex-drain is in natural condition. Dense veg. growth noticed neds to be cleared, widened. Further embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on left side. Guard stones to be provided at regular intervals. Ex.Av.Width: m, Pro.Av. Width: m.	12000-13000	Ex-drain needs to be desilted by about 1.5 m. Ex. Av. Width: m.			12000-13000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: m.		
14	13000	14000			13000-14000	Both sides: Ex-drain is in natural condition. Dense veg. growth noticed neds to be cleared, widened. Further embankment to be made up with imported earth and stone revetment to be provided on both sides with cement grouting. Further, 4.5 m wide WBM Service road to be formed on left side. Guard stones to be provided at regular intervals. Ex.Av.Width: m, Pro.Av. Width: m.	13000-14000	Ex-drain needs to be desilted by about 1.5 m. Ex. Av. Width: m.			13000-14000	After drain desilting and drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: m.		

Table 6.5 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Vrishabhavathi Main Valley (V100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
V101 – Byatarayanapura Secondary Storm Drain:														
1	0	910	Avalahalli	Deepanjali nagar	a) 450-475	Near Ganapathy nagar 5th main road. Right side: Ex. drain needs to be widened on right side and new walls to be constd on right side. Ex. Av. Width: 3.0 m., Pro. Av. Width: 4.5 m., Ht: 2.0 m.	a) 0-75	Ex-covered drain needs to be opened at regular intervals and desilt by about 0.3 m. Further, steel grating to be provided at regular intervals. Ex.Av. Width: 2.0 m.			a) 75-600	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 4.0 m.		
					b) 530-580	Near Ganapathy nagar 3rd cross road. Left side: Ex. drain needs to be widened on left side and new walls to be constd on left side. Ex. Av. Width: 2.6 m., Pro. Av. Width: 4.5 m., Ht: 2.0 m.	b) 75-200	Ex-drain needs to be desilt by about 0.5 m. and further deepened by about 0.3 m. Ex.Av. Width: 3.0 m.			b) 600-910	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Pro. Av. Width: 5.0 m.		
					c) 670-700	Near Novapan Industries. Right side: Ex. drain needs to be widened on right side and new walls to be constd on right side. Ex. Av. Width: 3.5 m., Pro. Av. Width: 5.0 m., Ht: 2.0 m.	c) 200-910	Ex-drain needs to be desilt by about 0.5 m. and further deepened by about 0.3 m. Ex.Av. Width: 4.0 m.						
					d) 870-910	Near Shobha convent. Right side: Ex. drain needs to be widened on right side and new walls to be constd on right side. Ex. Av. Width: 2.5 m., Pro. Av. Width: 6.0 m., Ht: 2.2 m.								
V107 – Agrahara Secondary Storm Drain:														
1	0	1075	Keshava nagar	Bhuvaneshwari nagar near Kempapura, Agrahara		New RCC box drain of size 1.4 m x 1.2 m needs to be constd near Bhuvaneshwarinagar for a length of about 60 m.	0-215	Ex-BS slab covered drain needs to be opened at regular intervals, desilt by about 0.3 m and further, steel grating needs to be provided at regular intervals / road crossings. Ex.Av. Width: 1.6 m.			215-500	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 2.5 m.		
							215-500	Ex.drain needs to be desilt by about 0.5 m. Ex.Av.Width: 2.5 m.			560-975	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 2.2 m.		
							500-560	Ex.RCC slab covered drain needs to be opened at regular interval, desilt by about 0.5 m. Further, steel grating to be provided at regular interval / road crossings. Ex.Av.Width: 2.5 m.						
							560-975	Ex.drain needs to be desilt by about 0.5 m. Further, drain bed needs to be deepened by about 0.3 m. Ex.Av.Width: 2.2 m.						
							975-1075	Ex.RCC slab covered drain needs to be opened at regular interval, desilt by about 0.5 m. Ex.Av.Width: 2.5 m.						
V108 – Gopalpura layout Secondary Storm Drain:														
1	0	920	Subashnagar	Minerva Mill	0-60	Near Minerva Mill. Both side: Ex. drain is in natural condition. Embankment to be made up with imported earth and stone revetment to be provided on both sides for a ht of about 1.8 m.	0-920	Ex-drain needs to be desilted by about 0.3 m. from Ch.400 m-680 m. Drain reach is covered with RCC/BS slab, which needs to be opened at regular intervals and desilt the steel grating to be provided at regular intervals. Ex.Av. Width: 2.0 m.			300-680	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 2.0 m.		
V109 – Platform road Secondary Storm Drain:														
1	0	200	Dhanavantri road	V.V. giri colony	80-120	Near Shastrinagar. Left side: Ex.SSM to be dismantled, widened and new wall to be constd on left side. Ex.Av.Width: 3.8 m, Pro.Av.Width: 6.0 m.	0-200	Ex-drain needs to be desilted by about 0.3 m. from Ch.125 m-150 m. Power cutting shall be considered. Ex.Av. Width: 6.0 m.			0-125	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 6.0 m.		
											150-200	After drain desilting, drain deepening, bed protection needs to be provided for full length and width. Ex. Av. Width: 6.0 m.		
V110 – Seshadripuram Secondary Storm Drain:														
1	0	380	Kumara park	Palace Guttahalli			0-380	Ex-drain needs to be desilted by about 0.3 m. Ex.Av. Width: 2.6 m.			0-380	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 2.6 m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
V111 – Hanumanthapura Secondary Storm Drain:														
1	0	580	Gautham nagar	Saibaba nagar			0-175 175-400 400-580	Drain reach is covered with BS slab, needs to be opened at regular interval and desilt by about 0.5 m. Further, steel grating needs to be provided at regular interval/road crossings. Ex.Av. Width: 2.5 m. Ex-drain needs to be desilted by about 0.5 m. Ex.Av. Width: 3.0 m. Drain reach is covered with RCC slab, needs to be opened at regular interval and desilt by about 0.5 m. Further, steel grating needs to be provided at regular interval/road crossings. Ex.Av. Width: 2.5 m.			175-400	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 3.0 m.		
V113 – Dayanandanagar Secondary Storm Drain:														
1	0	470	Bashyam nagar	Laxminarayan pura			a) 0-200	Ex.drain needs to be desilted by about 0.3 m and deepened by about 0.3 m. Ex.Av.Width: 2.8 m.			a) 0-200	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 2.8 m.		
							b) 200-470	Ex.drain needs to be desilted by about 0.3 m and deepened by about 0.3 m. Ex.Av.Width: 3.8 m.			b) 200-470	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 3.8 m.		
V114 – Subramanyanagar Secondary Storm Drain:														
1	0	700	Gayathrinagar	Srirampura			a) 0-450 b) 450-700	Ex-covered drain needs to be opened at regular intervals and desilt by about 0.3 m. Further, steel grating to be provided at regular intervals/road crossings. Ex.Av. Width: 3.5 m. Ex.drain needs to be desilted by about 0.3 m. Ex.Av.Width: 7.0 m.			450-700	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 7.0 m.		
V115 – M.E.I. Polytechnic Secondary Storm Drain:														
1	0	940	MEI Polytechnic	Magadi road			0-250 250-550 550-940	Ex.drain needs to be desilted by about 0.3 m. Ex.Av.Width: 3.0 m. Ex-covered drain needs to be opened at regular intervals and desilt and steel grating to be provided at regular intervals/road crossings. Ex.Av. Width: 4.5 m. Ex.drain needs to be desilted by about 0.5 m. Ex.Av.Width: 7.0 m.			0-250 550-940	After drain desilting, Ex. BS slab drain bed, which is damaged, needs to be removed and reset. Ex. Av. Width: 3.0 m. After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 7.0 m.		
V117 – Hosahalli Extn. Secondary Storm Drain:														
1	0	1585	Magadi chord road layout	Shamanna layout			a) 0- 150 b) 150-400 c) 400-600 d) 600-850 e) 850-1585	Drain reach is covered with RCC slab, needs to be opened at regular interval and desilt by about 0.3 m. Further, steel grating needs to be provided at regular interval/road crossings. Ex.Av. Width: 3.5 m. Ex-Drain needs to be desilted by about 0.3 m. Ex.Av. Width: 3.5 m. Drain reach is covered with RCC slab, needs to be opened at regular interval and desilt by about 0.3 m. Further, steel grating needs to be provided at regular interval/road crossings. Ex.Av. Width: 3.5 m. Ex-Drain needs to be desilted by about 0.3 m. Ex.Av. Width: 3.5 m. Drain reach is covered with RCC slab, needs to be opened at regular interval and desilt by about 0.3 m. Further, steel grating needs to be provided at regular interval/road crossings. Ex.Av. Width: 3.5 m.						
V118 – Vijayanagar Secondary Storm Drain:														
1	0	1250	Hosahalli Extn.	RPC Layout	a) 1050-1100 b) 1150-1250	Near 14th cross Shamanna garden. Left side: Ex.SSM to be dismantled, widened and new wall to be constd on left side. Ex.Av.Width: 4.0 m, Pro.Av.Width: 6.0 m., ht: 2.2 m. Near Bapujinagar pipeline road. Left side: Ex.SSM to be dismantled, widened and new wall to be constd on left side. Ex.Av.Width: 3.5 m, Pro.Av.Width: 6.0 m.	a) 0-200 b) 200-320	Ex-covered drain needs to be opened at regular intervals and desilt by about 0.3 m. Further, steel grating to be provided at regular intervals/road crossings. Ex.Av. Width: 2.8 m. Ex-Drain needs to be desilted by about 0.3 m. Ex.Av. Width: 2.8 m.			a) 200-320 b) 550-650	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 2.8 m. After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 3.0 m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (V100)									
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection		Service Roads	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17	18	20
							c) 320-550	Ex-covered drain needs to be opened at regular intervals and desilt by about 0.3 m. Further, steel grating to be provided at regular intervals/road crossings. Ex.Av. Width: 3.5 m.			c) 850-1250	After drain desilting, drain bed protection needs to be provided for full length and width. Pro. Av. Width: 6.0 m.		
							d) 550-650	Ex-Drain needs to be desilted by about 0.3 m. Ex.Av. Width: 3.0 m.						
							e) 650-850	Ex-covered drain needs to be opened at regular intervals and desilt by about 0.3 m. Further, steel grating to be provided at regular intervals/road crossings. Ex.Av. Width: 3.5 m.						
							f) 850-1250	Ex-Drain needs to be desilted by about 0.3 m. Further, drain bed needs to be deepened by about 0.5 m from Ch.950 m - 1000 m rock cutting by chisilling / lowering shall be considered. Ex.Av. Width: 6.0 m.						
V120 – Kempegowdanagar Secondary Storm Drain:														
1	0	800	Bull temple road near Ramakrishna Ashram	Kempabudhi tank			0-700	Ex-BS slab covered drain needs to be opened at regular intervals, desilt by about 0.4 m. Ex.Av. Width: 4.0 m.			700-800	After drain desilting, drain bed protection needs to be provided for full length and width. Ex. Av. Width: 5.0 m.		
							700-800	Ex-Drain needs to be desilted by about 0.3 m. Ex.Av. Width: 5.0 m.						

Table - Schedule For Providing Rehabilitation to the Existing Primary Storm Drains in Vrishabhavathi Main Valley (V100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (V100)					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
V100 – Vrishabhavathi Main Valley Primary Storm Drain:										
1	0	1000	Gayathri park Extn., 15th cross	Sangeetha apartments near Geethanjali theatre			500-1000	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided for a ht of 1.8 m. on both sides.	a) 0-500	
									b) 500-1000	a) 7 Nos. of water supply pipelines exists between Ch. 550-775 m. b) 3 Nos. of sewer pipeline exists between Ch.575-600 m. c) 7 Nos. of cables exists. d) 18 Nos. of 1.2 m dia manholes exists. E) 38 Nos. of sewer outlets exists on left side and 25 Nos. on right side.
2	1,000	2000	Sangeetha apartments near Geethanjali theatre	Platform road near Rajiv Gandhi circle	1900-1925	Near Rajiv Gandhi circle. Both sides: Drain walls needs to be reconstd for a length of about 25 m on both sides for a ht of about 2.0 m.	1000-2000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	a)1000-1500	a) 3 Nos. of water supply pipelines exists between Ch. 1100 1150 m. b) 1 No. of CI sewer pipeline of 225 mm dia exists between Ch.1100-1125 m. c) 15 Nos. of 1.2 m dia manholes exists. d) 28 Nos. of sewer outlets exists on left side and 25 Nos. on right side.
									b)1500-2000	a) 4 Nos. of water supply pipelines exists. b) 2 Nos. of sewer pipeline exists. c) 2 Nos. of cables exists between Ch. 1850-1950 m. d) 7 Nos. of 1.2 m dia manholes exists. e) 25 Nos. of sewer outlets exists on left side and 15 Nos. on right side.
3	2,000	3000	Platform road near Rajiv Gandhi circle	Kalappa block near Srirampura	a) 2325-2375	Near Lakshman rao nagar. Left side: Drain walls needs to be reconstd for a length of about 50 m on both sides for a ht of about 2.4 m.	2100-2325	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.	a)2000-2500	a) 5 Nos. of 1.2 m dia manholes exists. b) 15 Nos. of sewer outlets on left side and 10 Nos. of sewer outlets exists on right side.
					b) 2425-2450	Near Tumkur railway track. Left side: Drain walls needs to be reconstd for a length of about 25 m on left sides for a ht of about 2.4 m.	2375-2500	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.6 m.	b) 2500-3000	a) 5 Nos. of 1.2 m dia manholes exists. b) 15 Nos. of sewer outlets on left side and 10 Nos. of sewer outlets exists on right side.
					c) 2650-3675	Near Srirampura. Left side: Drain walls needs to be reconstd for a length of about 10 m on left side for a ht of about 2.4 m.	2650-3000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.		
4	3,000	4000	Kalappa block near Srirampura	Gubbana Industrial area near Gopalpura	3025-3050	Near Kalappa block. Right side: Drain walls needs to be reconstd for a length of about 25 m on right side for a ht of about 2.6 m.	3000-3800	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.	a)3000-3500	a) 5 Nos. of 1.2 m dia manholes exists. b) 15 Nos. of sewer outlets on left side and 10 Nos. of sewer outlets exists on right side.
					3500-3550	Near Okalipura. Both side: Drain walls needs to be reconstd for a length of about 50 m on both sides for a ht of about 2.6 m.	3800-3900	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 3.0 m.	b) 3500-4000	a) 15 Nos. of sewer outlets on left side and 20 Nos. of sewer outlets exists on right side.
					3750-3800	Near Minerva mill water treatment plant. Left side: Drain walls needs to be reconstd for a length of about 10 m on left side for a ht of about 2.6 m.	3900-4000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 3.2 m.		
					3950-4000	Near Gopalpura. Right side: Drain walls needs to be reconstd for a length of about 50 m on right side for a ht of about 2.6 m.				
5	4,000	5000	Gubbana Industrial area near Gopalpura	Manjunatha nagar near Magadi main road	a) 4000-4050	Near Gubbanna Industrial area. Right side: Drain walls needs to be reconstd for a length of about 40 m on right side for a ht of about 2.8 m.	4000-5000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.	a)4000-4500	a) 10 Nos. of 1.2 m dia manholes exists. b) 25 Nos. of sewer outlets on left side & 20 Nos. on right side exists.
					b) 4200-4250	Near Gubbanna Industrial area. Left side: Drain walls needs to be reconstd for a length of about 30 m on left side for a ht of about 2.8 m.			b)4500-5000	a) 3 Nos. of 2.5 m dia manholes exists.
					c) 4800-4825	Near Magadi road bridge. Right side: Drain walls needs to be reconstd for a length of about 25 m on right side for a ht of about 2.8 m.				

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (V100)					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
6	5,000	6000	Manjunatha nagar near Magadi main road	Telecom layout near Padarayanapura	a) 5750-5775	Near Cholurpalya. Left side: Drain walls needs to be reconstd for a length of about 10 m on left side for a ht of about 2.8 m.	a) 5000-5150	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.8 m.	a)5000-5500	a) 9 Nos. of 1.2 m dia manholes exists. b) 25 Nos. of sewer outlets on left side and 20 Nos. on right side exists.
					b) 5925-6000	Near Telecom layout. Left side: Drain walls needs to be reconstd for a length of about 30 m on left side for a ht of about 2.8 m.	b) 5150-5600	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.8 m.	b)5500-6000	
							c) 5600-6000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.8 m.		
7	6000	7000	Telecom layout near Padarayanapura	5th cross road, Shamanna garden near pipeline road, Jagajeevanramnagar	a) 6200-6225	Near Hosahalli main road bridge. Both sides: Wing walls of the bridge are damaged on both sides, which needs to be reconstd for a ht of about 3.0 m.	a) 6300-6400	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 3.2 m.	a) 6000-6500	
					b) 6950-7000	Near Shamanna garden. Right side: Drain wall needs to be reconstd on right side for a length of about 50 m and ht 2.8 m.	b) 6900-7000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.8 m.	b) 6500-7000	a) 1 No. of 600 mm dia water supply pipeline exists near Ch. 6900-6925 m.
8	7,000	8000	5th cross road, Shamanna garden near pipeline road, Jagajeevanramnagar	Bapujinagar main road bridge near Gali Anjaneya temple	a) 7000-7100	Near Manjunathanagar. Right side: Drain wall needs to be reconstd on right side for a length of about 35 m and ht 3.2 m.	a) 7000-7250	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 3.2 m.	a) 7000-7500	
					b) 7050-7100	Near Arif nagar. Left side: Drain wall needs to be reconstd on right side for a length of about 30 m and ht 3.2 m.	b) 7250-7450	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 3.2 m.	b) 7500-8000	a) 600 mm dia CI sewer pipeline exists near the bridge location.
					c) 7725-7750	Near Bapujinagar. Right side: Drain wall needs to be reconstd on right side for a length of about 10 m and ht 3.2 m.	c) 7450-7750	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 3.2 m.		
							d) 7750-8000	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 3.2 m.		
9	8,000	9000	Bapujinagar main road bridge near Gali Anjaneya temple	Mysore road bridge near Chord road junction.	a) 8375-8500	Adjacent to Gali Anjaneya temple. Left side: Drain wall needs to be reconstd on right side for a length of about 125 m and ht 3.2 m.	a) 8000-8400	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 3.2 m.	a) 8000-9000	
							b) 8800-8900	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 3.2 m.		
10	9,000	10000	Mysore road bridge near Chord road junction.	BWSSB pipeline bridge behind Kwality biscuits factory near Mysore road.						
11	10,000	11000	BWSSB pipeline bridge behind Kwality biscuits factory near Mysore road.							
12	11,000	12000								
13	12,000	13300								
14	13,000	14000								

Table 6.6 - Schedule For Providing Rehabilitation to the Existing Secondary Storm Drains in Vrishabhavathi Main Valley (V100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (V100)					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
V101 – Byatarayanapura Secondary Storm Drain:										
1	0	910	Avalahalli	Deepanjalinagar			75-450 450-475 475-530 530-580 580-670 670-700 700-870 870-910	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.0 m. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m. Right side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.0 m. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.0 m. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.0 m.	a) 0-500 b) 500-910	a) 16 Nos. of 1.2 m dia manhole exists. b) 15 Nos. of sewer outlets exists on left side & 25 Nos. on right side. a) 3 Nos. of cables & water sewer pipelines cross the drain between Ch.850-Ch.900 m. b) 15 Nos. of 1.2 m dia manhole exists. b) 15 Nos. of sewer outlets exists on left side & 20 Nos. on right side.
V107 – Kempapura Agrahara Secondary Storm Drain:										
1	0	1075	Keshavanagar	Bhuvaneshwarinagar near Kempapura Agrahara			215-500 560-975	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering needs to be provided on both sides for a ht of 1.4 m. Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering needs to be provided on both sides for a ht of 1.4 m.	a) 0-500 b) 500-1075	a) 2 Nos. of 110 mm dia cable pipelines exists between Ch.400-425 m. b) 20 Nos. of sewer outlets exists on left side & 20 Nos. on right side. a) 2 Nos. of 1.2 m dia manhole exists. b) 25 Nos. of sewer outlets exists on left side & 20 Nos. on right side.
V108 – Gopalpura layout Secondary Storm Drain:										
1	0	980	Subashnagar	Minerva Mill	275-300	Near Gopalpura main road. Left side: Drain wall needs to be reconstd on left side for a length of about 15 m and ht. 20 m.	60-920	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.2 m.	0-920	a) 2 Nos. of 225 mm dia CI pipeline exists between Ch.200 to 250 m. b) 6 Nos. of sewer outlets are exists on left side and 10 Nos. on right side. c) 12 Nos. of sewer outlets exists on left side and 15 Nos. on right side.
V109 – Platform road Secondary Storm Drain:										
1	0	200	Dhanavantri road	V.V. giri colony			0-80 80-120 120-200	Both side: Cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m. Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.6 m. Both side: Cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.	0-200	a) 10 Nos. of sewer outlets exists on right side & 12 Nos. on left side.
V110 – Seshadripuram Secondary Storm Drain:										
1	0	380	Kumara park	Palace Guttahalli			0-380	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	0-380	a) 3 Nos. of cables exists near Nagappa street culvert location. b) 2 Nos. of water sewer pipeline exists between Ch.200-250 m.
V111 – Hanumanthapura Secondary Storm Drain:										
1	0	580	Gautham nagar	Saibaba nagar	250-275	Near Srirampura Burial guard. Both side: Ex. Drain wall needs to be reconstd. on both sides for a length of about 25 m, ht: 1.6 m.	0-400	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.6 m.	0-580	a) 3 Nos. of 1.2 m dia manholes exists. b) 15 Nos. of sewer outlets exists on left side and 20 Nos. on right side.
V113 – Dayanandanagar Secondary Storm Drain:										
1	0	470	Bashyam nagar	Laxminarayanpura	275-300	Near 7th cross Madappa garden. Right side: Ex. SSM wall needs to be reconstd. on right side for a height of about 2.2 m.	0-470	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.2 m.	0-470	a) 2 Nos. of water sewer pipeline exists between Ch.300-400m. b) 1 No. of cable of 110 mm dia exists between Ch.300-400 m. c) 10 Nos. of sewer outlets exists on left side and 6 Nos. on right side.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (V100)					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
V114 – Subramanyanagar Secondary Storm Drain:										
1	0	700	Gayathrinagar	Srirampura			450-700	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.6 m.	a) 0-500 b) 500-700	a) 10 Nos. of sewer outlets exists on left side and 8 Nos. on right side. a) 5 Nos. of 1.2 m dia manhole exists. b) 12 Nos. of sewer outlets exists on left side and 10 Nos. on right side.
V115 – M.E.I. Polytechnic Secondary Storm Drain:										
1	0	940	MEI Polytechnic	Magadi road	150-175	Near MEI polytechnic. Both side: Ex. SSM wall needs to be reconstd. for a length of about 15 m. on both sides for a ht. about 1.4 m.	0-250 550-940	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.4 m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.0 m.	a) 0-500 b) 500-940	a) 8 Nos. of sewer outlets exists on left side and 5 Nos. on right side. a) 1 No. of 1.2 m dia manhole exists. b) 4 Nos. of 180 mm dia cable exists between Ch.725-775 m. c) 20 Nos. of sewer outlets exists on left side and 25 Nos. on right side.
V117 – Hosahalli Extn. Secondary Storm Drain:										
1	0	1585	Magadi chord road layout	Shamanna layout			150-400 600-850 c) 575-825	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.8m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.8m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.8m.	a) 0-500 b) 500-1000 c) 1000-1585	a) 10 Nos. of sewer outlets on left side and 15 Nos. on right side. b) 8 Nos. of sewer outlets on left side and 10 Nos. on right side. c) 10 Nos. of sewer outlets on left side and 14 Nos. on right side.
V118 – Vijayanagar Secondary Storm Drain:										
1	0	1250	Hosahalli Extn.	RPC Layout	950-975	Near Shamanna garden 18th cross. Right side: Ex. Drain wall needs to be reconstd. on both sides for a length of about 25 m, ht: 2.2 m.	a) 200-320 b) 550-650 c) 850-1050 d) 1050-1250	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 1.6 m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.0 m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.0 m. Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of about 2.0 m.	a) 0-500 b) 500-1000 c) 1000-1250	a) 12 Nos. of sewer outlets exists on left side and 14 Nos. on right side. a) 2 Nos. of 2.6 m dia manholes exists near Railway track. b) 10 Nos. of sewer outlets exists on left side and 7 Nos. on right side. a) 5 Nos. of sewer outlets exists on left side and 10 Nos. on right side.
V120 – Kempegowdanagar Secondary Storm Drain:										
1	0	800	Bull temple road near Ramakrishna Ashram	Kempabudhi tank	700-750	Near Corp. PHC. Left side: Ex. Drain wall needs to be reconstd. for a length of about 20 m on left side, ht: 2.5 m.	700-800	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of about 2.2 m.	700-800	a) 4 Nos. of manholes exists.

CHAPTER – 7

TECHNO – ECONOMIC ANALYSIS

7.1 INTRODUCTION:

Vrishabavathi main valley originates from Sankey tank and joins Vrishabavathi valley near Mysore road and is located west of Bangalore, where natural lakes and trees abound. The valley is spread in around 70 sq. km out of a total area of 225 sq. km for the Bangalore city. The total population of Bangalore city as per 2001 census is 4.5 million (the municipal limits are divided into 100 wards) and around 2.0 million people live in the 48 wards of Vrishabavathi valley area. There are 138,088 residential and 11,331 non-residential properties in the area.

TANKS IN VRISHABAVATHI VALLEY

The main tanks in the valley are Sankey tank, Deepanjalinagara tank, Nayandahalli tank, Kempambudi tank, Halagevadarahalli tank and Hosakerehalli tank. Sankey tank has been rejuvenated to attract tourists. The other tanks are in highly contaminated stage since the storm water drains carry sewage and sullage as well. To maintain the ecosystem it is essential to clean these tanks as well as divert the sewage mixing with the storm water drain by laying a sewage network. Unless continuous fresh water supply is ensured for the lakes and tanks the habitat of the water bodies would be severely affected.

The contamination in the lakes have altered the habitat for fishes, birds and other aquatic plants; foremost being the growth of dangerous weeds like water hyacinth. The problem is further complicated by the gradual siltation over the years, creating a deep layer of artificial subsoil on the lakebed. Apart from reducing the water holding capacity of the lakes, this has completely stopped the recharge of ground water.

The Valley projects when implemented would not generate additional revenue for the principal implementing agency viz. BMP. 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, BMP would 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.

7.2 OUTCOME OF THE VALLEY PROJECTS:

Sustainable ecosystem for lakes, river beds and other water bodies around river valleys; prevention and management of floods in low-lying areas and livable environ for citizens and residents.

7.3 STAKE HOLDERS OF THE PROJECT:

The project is designed to address the varying requirements of the stakeholders. They are:

INTERNAL	EXTERNAL
Bangalore Mahanagara Palike (BMP)	Citizens (residents of the area)
Bangalore Water, Sewage and Sanitation Board (BWSSB)	Industries and other occupants of the area
Lake Development Authority (LDA)	NGOs
Civic Municipal Corporations (CMC/TMC)	Funding Agencies
Bangalore Development Authority (BDA)	Government of Karnataka (GOK)
Karnataka Pollution Control Board	Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC)
Elected representatives	Government of India (GOI)

7.4 STAKEHOLDER REQUIREMENTS, OUTPUTS AND BENEFITS

Residents	No flooding
	Odourless and free flow of drain
	Green environment
	Separation of sewage and storm water
	Excellent Water bodies
	Financially not inconvenienced
	Selected owners of land will benefit from land value appreciation
Lake Development Authority	Water entering the lakes is as per the acceptable technical standards;
	Visually fresh water fish should thrive in the lakes
	Possibility for increased tourism
Bangalore Mahanagara Palike	One major issue resolved in line with 'citizen first' approach
	Good branding possibility
	Success can be replicated in other valley projects
	Publish a comprehensive book
	Success will enhance and ensure better flow of funds for future projects.
BWSSB	One major issue resolved, rehabilitation of existing sewerage system to collect, treat and dispose the treated sewage there by abating the raw sewage flow into drains and lakes
	Diversion of sewage lines from the storm water drain network enabling proper care and maintenance of the sewerage system
GOK	Rediscover Bangalore as city of gardens, lakes etc.

GOI	A template for urban development; model toempower local governments
Funding Agency	Better chance of realizing ROI; fulfilling the purpose to assist developing countries in their efforts to develop economic and social infrastructure and stabilize their economies.

7.5 PROJECT OBJECTIVES:

1. To rectify current localized flooding problems in the critical low lying areas identified in the study.
2. To cope with additional areas being included into the BMP administered area in terms of expansion of the storm water drain network.
3. To prevent polluted water getting into lakes and river beds
4. Encourage rain water harvesting in institutions, public parks, open grounds, etc
5. To improve and extend the security of services in vulnerable areas of the current BMP administered area.
6. To improve and protect the quality of environmental attributes including aesthetic appearance of city's environs.
7. To minimize cost implication on operation and maintenance of the system.
8. To educate the residents and citizens to be aware of the effect of dumping solid waste and other wastes into the drains (which are open by design)
9. To educate and enforce measures to prevent industries and commercial establishments from discharging toxic and wastewater into drains, lakes and river beds
10. 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.

7.6 VARIABLES AND MEASUREMENTS:

It would be essential to translate the requirements in to variables that could be subject to measurement in order to monitor the performance. The table below depicts the variables and measurements and the scale as applicable for measurement.

VARIABLE	MEASURE	METRICS
Capacity of the local body of the Government (BMP)	Capacity to carry out environment management plan; ability to enforce relevant rules or regulations	Scale 1 to 5
Flexibility to accept change in terms of new approaches to environment plans	Willingness of employees and authorities of BMP and other internal stakeholders to accept professional and outcome based approaches to maintenance of ecosystem	Scale 1 to 5
Commitment to the implementation of the project	Demonstration by allocating required resources and competencies on a timely basis; enacting office orders and other instruments to facilitate implementation	Definitive
Effort to build awareness	Including a component for education and awareness in the project cost and engaging the citizens at various levels of project formulation and implementation	Definitive
Plan quality	Clarity of scope of work and definitiveness	Scale 1 to 5
Risk of flooding	Property loss, public health hazard, damages to structures	Scale 1 to 3
Regulatory policies	Permitted land uses, density controls over land use, transfer of development rights, cluster development provisions, set back requirements, site review requirements, spatial study or impact assessment requirements, building standards for flood prone area developments, financing for mitigation	Combination
Awareness	Educational awareness, voluntary real estate disclosure, flood warning systems, posting of signs to indicate flood prone areas	Definitive
Emergency planning provisions	Evacuation provisions, sheltering provisions, emergency plan provision	Scale 1 to 3
Change interventions	Willingness to train and orient personnel to achieve common and shared objectives of the local body	Scale 1 to 5

The parameters and indicators identified above have been studied in detail while preparing the detailed project report for the valley as well to develop the risk management plan. The primary risk identified for the implementation of the storm water drain project relates to coordination among various stakeholders in terms of timely execution of individual projects and schemes in order that the overall environmental condition of the valleys is restored.

7.7 ABSTRACT OF COST:

For remodeling of primary and secondary Storm Water Drains, Culverts/Bridges & its appurtenant works in Vrishabavathi Valley:

Sl.No.	**Description**	**Amount (Rs. In Crores)**
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	211.68
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	13.59
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	11.26
4	Construction of Detention Ponds / Retarding Basins	1.92
5	Construction of Wells with pumping arrangement in low lying areas	3.00
6	Procurement of desilting machine	0.45
7	Miscellaneous and rounding off	0.00
8	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	3.63
	TOTAL	**245.54**
9	Annual operating & maintenance charges	4.25
	TOTAL	**249.79**

For the purpose of seeking external funding only the core capital expenditure of Rs. 245.54 crores is considered whereas the amount required for operation and maintenance would be funded by Bangalore Mahanagara Palike out of its budget allocations (internal resources).

The direct beneficiaries of the clean environment that would ensue upon implementation of the project are the residents spread over 48 wards in the city. The demographic details of them are provided herewith:

7.8 WARD AND DEMOGRAPHICS OF VRISHABHAVATHI VALLEY:

Description	**Ward No**	**Ward Names**	**Population**	**Properties**	
				Residential	**Non-Residential**
Vrishabavathi Main Valley (V100)	5	Kodandaramapura	36,060	4074	261
	6	Sri. Dattatreya Temple	38,006	3590	674
	7	Malleshwara	37,441	6761	876
	8	Gayathrinagara	40,676	2893	176
	9	Subramanayanagara	38,879	3563	98
	15	Rajajinagara	36,950	2406	110
	19	Basaveshwaranagara	23,239	1819	61
	20	Shivanagara	28,114	1301	64
	21	Rajajinagara Industrial Town	47,694	3681	536
	22	Sri. Rama Mandira	41,336	3533	349
	23	Prakashnagara	35,378	1623	166
	24	Bashyamnagara	34,607	912	100

	25	Ramachandrapura	35,216	2313	499
	26	Sevashrama	36,625	2764	151
	29	Cottonpete	40,455	2298	663
	31	Binnypete	28,073	433	74
	32	Kempapura Agrahara	40,052	1002	108
	33	Vijayanagara	40,849	370	22
	34	R.P.C. Layout	44,775	4296	133
	40	Attiguppe	25,608	2325	44
	41	Sri. Gali Anjaneya Swami Temple	51,687	1284	145
	42	Bapujinagara	43,767	1672	168
	43	Padarayanapura	59,763	638	47
	44	Jagajevanaramanagar a	43,886	1554	41
	45	Azadnagara	41,085	1693	174
	46	Chamarajapete	40,731	2230	796
	49	Kempegowdanagara	40,997	3947	448
	52	Hanumanthanagara	35,526	2773	47
	53	Srinagara	62,305	5304	139
	99	Aramanenagara	32,532	4228	199
Kethmaranahall i & Arkavathi Valley (V200)	10	Mahalakshmipura	34,673	2665	1113
	11	Peenya Industrial Area	35,255	1237	544
	12	Nandini Layout	43,237	2743	76
	13	Geleyarabalaga Layout	38,676	1563	58

	14	Nagapura	36,677	2380	127
	16	Kamalanagara	61,303	4188	91
	17	Vrishabhavathinagara	29,311	901	172
	18	Kamakashipalya	25,823	1449	68
	35	Marenahalli	39,712	4433	91
	36	Govindarajanagara	56,291	1949	128
	37	Amarajyothinagara	21,802	1284	73
	38	Mudalapalya	15,596	558	12
	39	Chandra layout	41,182	612	58
Kathriguppe Valley (V300)	51	Basavangudi	39,335	5415	352
	54	Srinivasanagara	82,072	9114	122
	55	Padhmanabhanagara	112,184	10189	200
	56	Ganeshmandira	87,353	5977	296
	59	Yediyur	34,443	4151	381
48 Wards		**Total**	**2,017,237**	**138,088**	**11,331**

CHAPTER – 8

SUSTAINABILITY EVALUATION

8.1 LEGAL ASSESSMENT:

8.1.1 LAND ACQUISITION:

The optimal engineering solution emerging in the techno economic study would require removal of structures and houses that have sprung up along the sides of the storm water drain. There are instances where structures have been built on the side walls of the drain itself impairing scope for widening of the drains. The width of the storm water drains right through the city is greatly reduced by encroachments thus reducing the carrying capacity of the drains. There are instances of dwellings built right on top of the drains in certain areas (Yeshwantpur – beginning of Hebbal Valley drain).

Considering the prolonged process that would be necessary to enforce vacation of properties built around the storm water drain network the solution proposed avoids land acquisition on a large scale for the initiative. Where it is absolutely necessary land acquisition is envisaged considering the rehabilitation programme for people who would get displaced on account of the project implementation. The land acquisition is proposed through a process of conferring development rights (Transfer of Development Rights) by which the owner of the land who has surrendered the part of the land towards infrastructure projects would be allowed to carry out construction based on enhanced floor space index (FSI) conferred by the TDRs.

8.1.2 ENFORCEMENT MEASURES:

To deal with indiscriminate dumping of solid waste in to the storm water drains, apart from education and awareness programme, enforcement measures that act as deterrent are also required to be imposed. Based on experience in dealing with such situations it is recommended that the civic authority is empowered to deal firmly with violators of law in respect of dumping of solid waste that include construction debris, dead animals and hazardous waste material. To sustain the initiative enforcement measures are proposed against unauthorized constructions and to deal with encroachments.

Further, there are many instances of evidence that in areas outside the BMP administered region, the development authorities do not enforce and adopt even rudimentary practices for planning, construction and maintenance of primary and secondary drains and also they lack resources and technical expertise to adopt best storm drain management practices. In the new areas strict enforcement of law and procedures would discourage the citizens and commercial establishments from treating storm water drains as mere sewage drains.

8.2 ESTABLISHMENT OF INSTITUTIONAL FRAME WORK:

There are multiple agencies of the Government that are directly involved and accountable to ensure that the storm water drains in Bangalore carry only storm water and nothing else (0% impurity whether liquid waste or solid waste). The agencies are Bangalore Mahanagara Palike (BMP) who is directly responsible as the implementing agency as well as the entity vested with the construction and maintenance of the drains in the city. The other agency is Bangalore Water Supply and Sanitation Board (BWSSB) whose function is to ensure that sewage is collected and conveyed to the sewage network and that it does not mix with the storm water. The current situation, however reveals that the storm water drains in Bangalore carry much of sewage as these are either directly disposed in to the drains or they overflow from the manholes and pipes located inside the storm water drains. The third agency having a stake in the upkeep of the storm water drains is the Lake Development Authority (LDA) whose mandate is to keep the lakes on the down streams to be pollution free.

The fourth agency involved in the issue is Bangalore Development Authority (BDA) who allots and plans residential and commercial sites in and around Bangalore. When sites are allotted without considering the existence of water and sanitation networks, citizens have little choice in the disposal of waste and most often they find their way in to the storm water drains.

Institution	Primary Role	Impact on SWDs	Area of cooperation	Severity of non-cooperation/ inaction
BMP	Planning, Development, Financing, Construction, operation and maintenance	Carrying capacity, flooding, pollution of the environment	Timely execution of projects Educating the citizens on proper solid waste disposal	Medium to High
BWSSB	Collection, Conveyance and disposal of sewerage	Mixing of sewage with storm water polluting the drains, clogging, spreading odour and finally polluting the lakes and water bodies	Integrated planning and removal of sewage network components form the storm water drains	High
BDA	Land Use Planning and allotment of sites	Residents forced to discharge sewage in to SWDs where sewage networks have not been planned but construction permits given	Coordination with BMP/BWSSB to create the infrastructure in a coordinated manner while allotting sites	Medium
LDA	Upkeep of lakes and water bodies	Closing of entry points in to lakes due to polluted water entering the lakes thus making the environment around the lake unhygienic (lake itself may be pure of sewage and other contaminations)	Participate in planning and development of schemes to treat the unclean water before entry in to the lakes	Medium

To realize the outcome of 100% pure flow of storm water in the drains all the above agencies need to participate and implement plans in an integrated and coordinated manner. The Government of Karnataka represented by the Urban Development Department has constituted an inter-institutional committee with members drawn from the following to give shape to the proposal for coordination and effective management of the storm water drain initiatives:

- Commissioner, BMP – Chairman of the Committee
- Secretary, Urban Development, GOK
- Chairman, BWSSB
- Chairman, BDA
- Chairman, LDA

Another critical institutional aspect for the storm water drain projects is the need to establish a dedicated project management cell within BMP to undertake such a massive and citizen sensitive project.

8.3 RATIONALE FOR A PROJECT MANAGEMENT UNIT:

There is a need for an organization which could handle joint projects among stakeholders cutting across various government entities. Such an organization should address the needs of the city – Greater Bangalore – a Techno polis, fast emerging as an intelligent city. The informal arrangement that was started a few years back in the form of BATF (Bangalore Agenda Task Force) needs to be formalized now by establishing a new organization that would focus on delivering citizen services by concentrating on urban infrastructure planning and execution. A strategic plan for the city development in terms of urban infrastructure shall be developed by the proposed organization along with a clear road map with milestones to translate the strategy to actions.

To execute a project with multiplicity of stakeholders profound project management skills and inter-disciplinary approaches are essential. In order to effectively implement, monitor and control the schemes envisaged under the storm water drain initiative it is strongly recommended that a Project Management Unit (PMU) as an exclusive entity responsible for storm water projects be established. Funding agencies stipulate evidence of professional management skills and best practices for sanction and disbursal of funds for such of these schemes. BMP readily accepted the recommendation and it has been suggested that PMU be established as part of BMP functioning independently to carry out the storm water drain projects in accordance with JNNURM guidelines and reforms agenda agreed among the stakeholders.

It has been observed in many infrastructure project implementation schemes that cost and time overruns could have been avoided if a separate dedicated unit or cell were vested with the authority and powers to deal with the project implementation cycle. There has been a significant improvement in performance of dedicated units wherein policy, implementation and regulation are clearly isolated and delineated. It is proposed that PMU functions as an execution agency of policies framed by BMP / Government and thus focusing on deliverables in terms of performance. Weak institutional mechanism coupled with lack of application of contracting skills affect the implementation of large infrastructure schemes. Channeling right competencies required for handling such schemes is vital but found to be non-existent under bundled institutional setups created around budgetary focus for expenditure monitoring. Performance measurement in terms of timely completion and construction as per requirements and specifications, are few aspects that are not given due importance under current functioning of these institutions.

Projects executed as part of many government schemes are susceptible to delays on account of slow decision making process and sometimes by the application of bureaucratic procedures. Focused attention and clearly defined roles among implementation agencies are seldom noticed in routine schemes funded either through budgetary allocations or through external funding mechanisms. Systems of the government remain inflexible and unable to cope up and address the needs of the funding agencies and contractors to deal effectively with emerging situations, uncertainties and risks.

While establishing the PMU, its governance structure, its inter-play with various internal and external stakeholders and its role, responsibility, powers, authority and liabilities need to be defined. More importantly the framework should highlight on the organization structure, the profile and attributes of the Chief Executive Officer and outsourcing mechanisms to pool resources. The recommendation would lay the basis for the establishment and operation of the PMU as well as its future role in respect of similar large urban infrastructure projects in Bangalore city.

The likelihood of achieving the project outcomes as per the specifications and within the timeframe planned would be greatly enhanced if the PMU is mandated to design, develop, implement and oversee the operation and maintenance phases. Performance orientation and achievement of measurable goals would be the hallmark of PMU and the knowledge gained should also be gradually transferred to its contractors, outsource partners and stakeholders.

PMU should be designed and structured in such a way that it is independent and allowed to function as an autonomous unit and be part of BMP. Performance measures of PMU shall be agreed between the designated state government agency and PMU and also in consultation with major stakeholders like BMP, BWSSB, LDA, BDA, CMCs etc. PMU should be evaluated based on its efficiency and effectiveness parameters and evolve initiatives and projects that are economically viable and politically sustainable. PMU could have its resources picked up from among various constituents of the government apart from external professional pool. An organization structure that would primarily meet with the engineering and enforcement aspects of the project is developed and presented here. The administrative functions like land acquisition and arrangement of finance are to be dealt with by the inter-institutional committee recommended as part of the reforms agenda.

Organization structure of the Project Management Unit (PMU) for implementing the remodeling of storm water drain network in Bangalore City.

8.4 EDUCATION AND AWARENESS PROGRAMME:

Awareness program as a tool is 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), behavior 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 aims to create 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 in to 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 behavior 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.

8.5 OBJECTIVES OF THE INTERVENTION:

The segmented target groups for this program are primarily economically weaker sections of the society, policy makers from health sector, local bodies in charge of wastewater and solid waste disposal, commercial establishments in the Hebbal Valley apart from potential polluting industrial units. For them the objectives are to:

- Introduce awareness on disposal pattern of waste and environmental factors associated with water and wastewater; especially focusing on organic matter in the form of bacteria, viruses and the like.
- Develop and administer awareness programs and education material in simple forms for school children.
- For the local bodies' material containing information on availability of cost effective technologies, transportation, quality control, costs, impact on environment would be developed and disseminated.
- Structure media programs along with direct campaigns to instill the awareness program.
- Sustain the message and effective follow up with repeated contacts and innovative schemes.
- Craft slide presentations, printable handouts, posters, and short movies for effective communication. The material prepared and administered would be in local language and simple to understand.

8.6 TARGET GROUP(S) WITH LOCATION SPECIFIC INFORMATION:

Bangalore City consists of 100 wards and the total population in the four valleys is around 4,500,000. The target group for the communications program will comprise segmented sections of weaker sections, schools (primary, middle and higher), and policy makers from health sector and local bodies in charge of storm ware drains, sanitation and lake maintenance. These would be chosen from the wards of the valleys. The target audience would be graded into government and the private sector comprising the policy makers, influencers, decision makers and implementing authorities. Citizens would be targeted through a network of non-government organizations (NGOs) who have established direct contact at various levels of communities.

8.7 DURATION OF THE INTERVENTION:

It is estimated that the intervention would be completed within a period of 36 months from commencement. There would be an intensive planning and requirement analysis process in the initial three months period formulating plans for implementing the awareness and communications program. Review and monitoring activities would form part of the intervention schedule to make an effective impact of the awareness program. The intervention would be administered both during the construction (remodeling of the drains) and the operation phase.

8.8 JUSTIFICATION FOR UNDERTAKING THE PROPOSED INTERVENTION:

A large engineering project with an outlay over Rs 7000 million without an education and awareness component is not likely to produce sustainable results. One of the key assumptions of the storm ware project is that raw sewage will not enter the drains once remodeling is complete. This assumption can not be satisfied through and engineering intervention alone. People have to be educated and made aware of the importance of sustaining the eco-system in order to protect the environment. If practices that are currently in vogue continues after the remodeling the purpose of the project initiative would have been completely missed. In order to realize the core objectives the proposed intervention is viewed as absolutely necessary. A program of Rs 30 million administered over a period of 36 months is likely to protect the investments made to the tune of Rs 7000 million. Enforcement alone is not likely to result in achieving the desired results. By directly engaging the segmented citizens the likelihood of protecting the investment and the maintenance of the eco-system of Hebbal Valley would be greatly enhanced.

8.9 APPROACH & METHODOLOGY:

Basic research in terms of segmentation of communities in terms of language, income level, literacy and vocation would be conducted in the first three months to gather data which will enable development of suitable programs for spreading the awareness. It is proposed to conduct an analysis and requirement planning to identify the areas where communication channels for the segmented target groups should be established and improved. The identification process would also focus on designing the content of the communication and awareness program suited to the target groups identified in terms of simplicity, vernacular and easy to comprehend and relate to real life situations. In case of school children curriculum on environmental health dealing with aspects of safe disposal of waste and keeping the environment clean and health aspects would be designed and promoted to authorities in the educational sector. Similarly, biological effects of living in unclean and polluted environ and methods to prevent unsafe methods of disposal of waste would be packaged in program for the health sector department. Impact of use of safe environment around the storm water drains on the spending by the health department would be clearly captured and popularized. Pilot schemes with focus target groups would be developed and administered. Lessons from the pilot schemes would be analyzed and evaluated for use in subsequent interventions in other community development programs as part of the education and awareness intervention.

8.10 DESCRIPTION OF THE TARGET AREA, TARGET GROUP (S) ALONG WITH THEIR CURRENT SOCIOECONOMIC STATUS:

The target area comprises four valleys (Challaghatta, Hebbal, Koramangala & Vrishabavathi) spread over 100 municipal corporation wards. The socioeconomic conditions of people living in the target area and in the target groups are quite mixed but predominantly economically weaker sections. For the target groups and in fact for all consumers, health costs arising out of water borne diseases are proving to be a great burden and continuously rising. Problems of flooding in the low lying areas due to clogging of drains with silt and waste have been witnessed in the past. Residents, commercial establishments and industries today are unaware of the ill-effects of throwing waste and discharging sewage in to storm water drains.

8.11 RELEVANCE OF THE INTERVENTION TO THE WORK ALREADY GOING ON:

A number of NGOs today interact with communities in regard to various socio-economic issues affecting the lives of the society. The proposed program would be designed in such a way to take advantage of the existing communication channels and also the network of NGOs to effectively promote the campaign. The emphasis would be to prevention of dumping of solid waste in to the storm water drains. The current programme would be suitably intermixed with ongoing communication programmes that are underway so that the citizens do not feel another massive programme thrust on them.

8.12 UTILISATION OF THE EXPECTED OUTCOME FROM THE INTERVENTION AND ITS BENEFICIARIES:

The outcomes expected from this intervention are two fold: firstly, it is to ensure acceptance of the program by the community in terms of change in practices for disposal of waste; effectives to be measured in terms of creating and sustaining a clean and green environment around the storm ware drains in the Hebbal Valley. Opportunities for employment creation within the local community for operation and maintenance of facilities would also be explored and established.

8.13 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 in to 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 in to 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 BWSSB's plans with that of BMP alone will ensure the drains carrying the storm water of acceptable quality

Indiscriminate dumping of solid waste and debris in to the drains is another aspect exposed to risk. BMP has earmarked areas in each of the wards in the city where construction debris could be dumped. The exercise has begun and once implemented would greatly reduce the amount of debris being dumped in to the storm water drains. This combined with proper education and awareness programmes would help prevention of debris getting in to the drains.

8.14 RISK MANAGEMENT:

Risk	**Stakeholders**	**Severity of risk**	**Solution**
Acquisition of land	BMP, 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	BMP, 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 four valleys of Bangalore city 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 BMP is seeking citizen participation through ward committees and other for a) ***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)

CHAPTER 9

FINANCIAL AND OPERATING PLAN

The storm water drain valley projects when implemented would not generate additional revenue for the principal implementing agency viz. BMP. 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, BMP would 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, BMP is examining the possibility of levying a one time collection charges from property owners in the city 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 40% 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 BMP council and the State Government.

The revenue accrual on account of the proposed cess is summarized below – a total collection of Rs 302.50 Crores from the years 2007-08 till 2011-12.

Storm Water Drain Cess			45.00	55.00	65.00	67.50	70.00

Estimated Capital Costs

Cost in Rs Crores

Name of Component	**Capital Cost as per DPR**	**Years**					
		2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Storm Water Drain Network							
Challaghatta Valley	124.83	49.93	49.93	24.97	-	-	-
Hebbal Valley	190.13	76.05	76.05	38.03	-	-	-
Koramangala Valley	118.43	47.37	47.37	23.69	-	-	-
Vrishabhavathi valley	245.54	98.22	98.22	49.11	-	-	-
Sub-total for four valleys	**678.93**	**271.57**	**271.57**	**135.79**	**0.00**	**0.00**	**0.00**

Funding pattern for Storm Water Drain Valley Projects (Rs Crores)

Funding Pattern	**Total**	**2006-07**	**2007-08**	**2008-09**
GOI Grant 35%	237.63	95.05	95.05	47.53
GOK Grant 15 %	101.84	40.74	40.74	20.37
BMP financing	339.47	135.79	135.79	67.89
Total	**678.93**	**271.57**	**271.57**	**135.79**

The funding pattern is based on the JNNURM guidelines.

The fund flow statement for BMP for the next 10 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 320 crores in the year 2006-07 to Rs 750 Crores in the year 2015-16; this is being achieved with reforms in the property tax collection mechanism aided by GIS system for all the 100 municipal wards of BMP. The collection efficiency is estimated to go up to 85% by the year 2015-16 (the efficiency currently is 60%).

The revenue accretion from the State Government is estimated to move up from Rs 121 Crores in the year 2006-07 to Rs 302 Crores in the year 2015-16. 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 302.50 crores over a period of 5 years

The total capital expenditure programme envisaged by BMP under JNNURM is approximately Rs 8000 crores including the basic services to urban poor component. Out of this BMP needs to mobilize Rs 4000 crores. It is assumed that BMP would arrange for term loans to the extent of Rs 1000 crores and the balance Rs 3000 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 7% per annum and the bonds would be redeemed after 7 years period

The interest rate for future loans is assumed as 7.5 % per annum

The projections show a deficit in the terminal years when the bonds get redeemed; BMP proposes to identify additional sources of revenue from the year 2008-09 to improve its financial position in order to fund capital expenditure as well as honour financial commitments

The projections based on the assumptions are as follows:

Projected Funds Flow Statement for BMP

(Rs. In Crores)

REVENUE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
REVENUE RECEIPTS											
Tax Revenues											
Property Tax	320.00	400.00	450.00	550.00	650.00	675.00	700.00	725.00	750.00	750.00	750.00
Advertisement Taxes	15.47	16.86	18.55	20.40	22.44	24.68	27.15	29.87	32.86	36.14	39.75
Surcharge on Stamp Duty	15.00	20.00	22.00	24.20	26.62	29.28	32.21	35.43	38.97	42.87	47.16
	350.47	436.86	490.55	594.60	699.06	728.97	759.36	790.30	821.83	829.01	836.91

Non Tax Revenues											
Grants											
SFC Grants	110.00	131.00	149.00	182.00	219.00	231.00	240.00	257.00	257.00	257.00	257.00
Other Grants:	11.00										
Grants towards electricity		25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Incentivisation		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Twelfth Finance Commission		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	121.00	176.00	194.00	227.00	264.00	276.00	285.00	302.00	302.00	302.00	302.00

Service Charges											
Infrastructure Cess / User charges	20.00	-	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
SWM Cess	30.00	30.00	30.00	30.00	30.00	30.00	30.00	36.00	36.00	36.00	36.00
Service chgs on Tax exempt Props	15.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	65.00	55.00	75.00	75.00	75.00	75.00	75.00	81.00	81.00	81.00	81.00
Fees & Fines											
Building License Fees	5.25	11.60	11.60	11.60	11.60	11.60	11.60	12.76	12.76	12.76	12.76
Compounding Fees	4.50	10.00	11.00	12.10	13.31	14.64	16.11	17.72	19.49	21.44	23.58
Development Charges	3.00	8.86	9.75	10.72	11.79	12.97	14.27	15.70	17.27	18.99	20.89
Ground Rent	3.06	8.24	9.06	9.97	10.97	12.06	13.27	14.60	16.06	17.66	19.43
Road Cutting Charges	6.02	0.45	0.50	0.54	0.60	0.66	0.72	0.80	0.88	0.96	1.06
Khata Transfer & Extract fees	8.94	11.35	12.49	13.73	15.11	16.62	18.28	20.11	22.12	24.33	26.76
Hotel / Power License Fees	3.50	5.00	5.50	6.05	6.66	7.32	8.05	8.86	9.74	10.72	11.79
Fee for Quality Control	-	5.00	5.50	6.05	6.66	7.32	8.05	8.86	9.74	10.72	11.79
Others	44.94	24.86	27.35	30.08	33.09	36.40	40.04	44.04	48.45	53.29	58.62
	79.21	85.36	92.74	100.85	109.77	119.59	130.39	143.43	156.50	170.87	186.68

Receipts from Corporation Properties											
Rent from Shops /Leased	9.31	23.50	23.50	23.50	23.50	23.50	23.50	25.85	25.85	25.85	25.85
Others	1.08	0.81	0.85	0.89	0.94	0.98	1.03	1.09	1.14	1.20	1.26
	10.39	24.31	24.35	24.39	24.44	24.48	24.53	26.94	26.99	27.05	27.11
Total Revenue Receipts	**626.07**	**777.53**	**876.63**	**1,021.8**	**1,172.2**	**1,224.04**	**1,274.2**	**1,343.67**	**1,388.32**	**1,409.93**	**1,433.70**

REVENUE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Capital Grants											
MOU Grants	81.90	-	-	-	-	-	-	-	-	-	-
JNNURM Funds	-	434.04	902.54	929.64	666.75	603.75	457.75		-	-	-
	81.90	434.04	902.54	929.64	666.75	603.75	457.75	-	-	-	-
Long Term Loans											
Loans from Financial Institutions for JNNURM matching grants	-	108.06	224.70	231.45	166.00	150.31	113.96	-	-	-	-
Bonds for JNNURM matching grants		325.98	677.84	698.20	500.75	453.44	343.79	-	-	-	-
Loans from Financial Institutions others	545.53	396.60	-	-	-	-	-	-	-	-	-
	545.53	830.64	902.54	929.65	666.75	603.75	457.75	-	-	-	-
Others											
Improvement Charges	30.00	30.00	30.00	30.00	30.00	30.00	36.00	36.00	36.00	36.00	36.00
Bldg Deviation Regularisation	100.00	10.00	100.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Sale of Properties	16.25	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50
	146.25	61.50	151.50	61.50	61.50	61.50	67.50	67.50	67.50	67.50	67.50

Total Capital Receipts	**773.68**	**1,326.1**	**1,956.58**	**1,920.7**	**1,395.0**	**1,269.00**	**983.00**	**67.50**	**67.50**	**67.50**	**67.50**

Other Receipts

Cesses collected on Property Tax	108.80	136.00	153.00	187.00	221.00	229.50	238.00	246.50	255.00	255.00	255.00
Storm Water Drain Cess			45.00	55.00	65.00	67.50	70.00				
Deposits, Statutory Deductions etc	52.45	62.14	143.48	143.48	143.48	143.48	143.48	20.00	20.00	20.00	20.00
	161.25	198.14	341.48	385.48	429.48	440.48	451.48	266.50	275.00	275.00	275.00
TOTAL RECEIPTS	**1,561.00**	**2,301.85**	**3,174.68**	**3,328.11**	**2,996.75**	**2,933.52**	**2,708.76**	**1,677.67**	**1,730.82**	**1,752.43**	**1,776.20**

EXPENDITURE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Administrative Expenses											
Salaries											
Pay of Officers	6.26	5.81	6.39	7.03	7.73	8.51	9.36	10.29	11.32	12.45	13.70
Pay of Establishment	62.37	72.74	80.01	88.02	96.82	106.50	117.15	128.86	141.75	155.92	171.52
Allowances	63.00	64.18	70.60	77.66	85.42	93.97	103.36	113.70	125.07	137.58	151.33
Pension / Gratuity	30.50	34.50	37.95	41.75	45.92	50.51	55.56	61.12	67.23	73.95	81.35
	162.13	177.23	194.95	214.45	235.89	259.48	285.43	313.97	345.37	379.91	417.90
Advertisement & Publicity	2.12	2.33	2.80	3.36	4.03	4.83	5.80	6.96	8.35	3.08	3.69
Printing & Stationery	3.25	1.58	1.74	1.91	2.10	2.31	2.54	2.80	3.08	3.39	3.73
Telephone Charges	0.84	1.19	1.25	1.31	1.38	1.45	1.52	1.59	1.67	1.76	1.85
Electricity Charges	30.54	25.60	26.88	28.22	29.64	31.12	32.67	34.31	36.02	37.82	39.71
Water Charges	4.30	2.20	2.31	2.43	2.55	2.67	2.81	2.95	3.10	3.25	3.41
Council related Expenditure	3.90	5.49	5.76	6.05	6.36	6.67	7.01	7.36	7.72	8.11	8.52
Office Infrastructure	3.98	4.61	4.84	5.08	5.34	5.60	5.88	6.18	6.49	6.81	7.15
Vehicles - M & R Cost	10.03	10.25	10.76	11.30	11.87	12.46	13.08	13.74	14.42	15.14	15.90
Other Expenses	93.63	65.66	68.95	72.40	76.02	79.82	83.81	88.00	92.40	97.02	101.87

	152.59	118.91	125.29	132.06	139.26	146.93	155.12	163.87	173.25	176.38	185.83
Welfare Activities											
18% Allocation	14.53	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76
Backward Classes & Minority Welfare	2.58	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35
Women Welfare	6.48	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99
General	0.70	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	24.29	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90
Educational Promotion Activities											
18% allocation	2.02	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
General	3.47	7.20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78
Sports Activities	1.55	1.07	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
	7.04	8.47	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50

Health & Sanitation

Cleaning of Garbage	40.00	50.00	52.50	55.13	57.88	60.78	63.81	67.00	70.36	73.87	77.57
Decentralised Composting	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.16
Street Dog Management	0.85	1.50	1.58	1.65	1.74	1.82	1.91	2.01	2.11	2.22	2.33
Tipping Fees	2.50	2.00	2.10	2.21	2.32	2.43	2.55	2.68	2.81	2.95	3.10
Others	3.95	15.61	16.39	17.21	18.07	18.97	19.92	20.92	21.96	23.06	24.22
	47.40	69.21	72.67	76.30	80.12	84.13	88.33	92.75	97.39	102.25	107.37
EXPENDITURE	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**

Financial Expenses

Interest on Loans	76.51	120.61	147.68	220.20	278.55	320.47	355.84	385.78	364.64	304.37	237.50
Interest on Municipal Bonds	-	21.00	63.00	112.00	147.00	178.50	199.50	199.50	199.50	178.50	136.50
	76.51	141.61	210.68	332.20	425.55	498.97	555.34	585.28	564.14	482.87	374.00
Total Revenue Expenditure	**469.96**	**560.33**	**657.99**	**809.42**	**935.23**	**1,043.91**	**1,138.62**	**1,210.27**	**1,234.55**	**1,195.81**	**1,139.50**

CAPITAL EXPENDITURE

Public Works											
Solid Waste Management	7.90	6.60	6.93	7.28	7.64	8.02	8.42	8.84	9.29	9.75	10.24
Engineering - Zonal	462.44	383.19	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94
Multi Purpose Engg Divisions	33.77	29.55	20.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Projects	138.27										
Infrastructure	134.37										
Comprehensive Development Plan	43.60										
Storm Water Drain Network											
Challaghatta Valley		49.93	49.93	24.97	-	-	-	-	-	-	-
Hebbal Valley		76.05	76.05	38.03	-	-	-	-	-	-	-
Koramangala Valley		47.37	47.37	23.69	-	-	-	-	-	-	-
Vrishabhavathi valley		98.22	98.22	49.11	-	-	-	-	-	-	-
Sub-total for four valleys		**271.57**	**271.57**	**135.79**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Extension work into CMC areas		**86.00**	**106.00**	**106.00**	**106.00**	**106.00**	**-**	**-**	**-**	**-**	**-**

Environment Management											
Tanks		15.00	17.00	17.00	17.00	17.00	17.00	-	-	-	-
Parks		15.00	8.00	8.00	7.00	6.00	6.00	-	-	-	-
Incinerator, Crematorium and Abattoirs		9.00	16.00	16.00	17.00	17.00	16.00	-	-	-	-
Tree Plantation and Nurseries		1.50	1.50	1.50	1.50	1.50	1.50	-	-	-	-
Urban Renewal											
Decongestion			30.00	30.00	30.00	30.00	30.00	-	-	-	-
Development of CBD			20.00	20.00	20.00	20.00	20.00	-	-	-	-
Road Network											
Arterial and Sub arterial roads		125.00	150.00	400.00	325.00	250.00	250.00	-	-	-	-
* **Includes IT/BT, Flood damaged roads**											
Grade Separators		120.00	200.00	150.00	150.00	200.00	80.00	-	-	-	-
Pedestrian subways		5.00	15.00	15.00	15.00	15.00	10.00	-	-	-	-
Foot Over Bridges		-	5.00	5.00	5.00	5.00	5.00	-	-	-	-
Foot Path improvements		-	20.00	20.00	20.00	20.00	20.00	-	-	-	-
Internal Core Ring Road			200.00	200.00		-	-	-	-	-	-

Road Widening		120.00	180.00	180.00	110.00	110.00	100.00	-	-	-	-
Waste Management											
Scientific Land fill stations at Mandur, Mavallipura, Manavarthekaval and near Ramanagaram		-	175.00	70.00	-	-	-	-	-	-	-
Transfer stations		-	40.00	35.00	60.00	60.00	60.00	-	-	-	-
Basic Services to Urban Poor	-	100.00	350.00	450.00	450.00	350.00	300.00	-	-	-	-
Traffic Engineering Cell	14.91	43.85									
Electrical Engg	23.72	34.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40
Horticulture	56.84	28.72	30.16	31.66	33.25	34.91	36.65	38.49	40.41	42.43	44.55
	915.82	**1,665.96**	**2,201.13**	**2,112.66**	**1,454.35**	**1,331.77**	**1,043.37**	**131.64**	**135.60**	**139.76**	**144.13**
Repayment of Long Term Liabilities											
Repayment of Loans to Fin Instns	70.18	112.46	160.59	216.36	257.10	280.35	289.54	207.18	146.27	108.88	78.63
Repayment of Municipal Bonds	-	-	-	-	-	-	-	-	300.00	600.00	700.00
	70.18	112.46	160.59	216.36	257.10	280.35	289.54	207.18	446.27	708.88	778.63
Total Capital Expenditure	**986.00**	**1,778.42**	**2,361.72**	**2,329.03**	**1,711.45**	**1,612.12**	**1,332.91**	**338.82**	**581.88**	**848.64**	**922.76**

Other Payments											
Repayment of Cesses - Current	27.84	36.00	114.75	140.25	165.75	172.13	178.50	184.88	191.25	191.25	191.25
Repayment of Cesses - Arrears	-	32.73	-	-	-	-	-	-	-	-	-
Repayment of Statutory Deductions / Deposits	41.52	45.48	43.04	43.04	100.43	100.43	100.43	14.00	14.00	14.00	14.00
	69.36	114.21	157.79	183.29	266.18	272.56	278.93	198.88	205.25	205.25	205.25
TOTAL PAYMENTS	**1,525.32**	**2,452.97**	**3,177.51**	**3,321.74**	**2,912.86**	**2,928.59**	**2,750.46**	**1,747.97**	**2,021.67**	**2,249.69**	**2,267.51**
Net Surplus / Deficit	**35.68**	**(151.12)**	**(2.82)**	**6.38**	**83.89**	**4.93**	**(41.70)**	**(70.30)**	**(290.85)**	**(497.26)**	**(491.31)**

CHAPTER - 10

IMPLEMENTATION PLAN

10.1 INTRODUCTION:

This chapter provides a strategic framework to ensure that the Remodeling of storm water drain project proposed for Bangalore city 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 also needs to adopt 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. BMP also proposes to have a separate project implementation unit within BMP (other than members from stake holders dept.), headed by a senior officer from the Engineering wing, Revenue wing, consortia of Technical consultants, Financial advisors, Project management consultants, co ordination committee members (other stake holders dept. members), PRO's & NGO's.

10.2 STAGES OF THE PROJECT:

The proposed project is take up in two stages and it is proposed that Stage – I activities will be carried out by external Technical Consultants and Stage – II activities shall be monitored by the design consultants and the same will be over seen by BMP.

Stage – I PREPARATION OF DETAILED PROJECT REPORT:

Phase 1: Technical, Economical and Environmental Feasibility Study of the Project of Remodeling of the Storm Water Drain System.

Phase 2: Detailed engineering design, preparation of tender documents, cost estimates for the remodeling work, Preparation of Bid document and assist BMP to entrust the work to experienced, competent and successful agency.

A brief scope of assignment to be rendered by the Technical Consultants is given below:

- Detailed topographical and geo-technical survey
- Assessment of quantity of runoff
- Adequacy analysis of existing drains
- Hydraulic and structural designs and drawings
- Cost estimation and Bill of Quantities
- Technical specifications.
- Bid Documents
- Slicing and Packaging (Phasing for Implementation)
- Assistance in Inviting and evaluating Bids
- Project management and Quality assurance

The outline methodology Phase – I & Phase- II works & activity bar chart for Stage – I works is enclosed in this chapter as Fig. 10.1, Fig. 10.2 & Fig. 10.3.

Stage – II PROJECT IMPLEMENTATION:

The works envisaged in the project are grouped into 16 packages and each package costing around Rs. 20 Crores.

The details of the works identified are narrated in detail in the previous chapters and the summary of the same is indicated packages are as mentioned in the Table 10.1. and the same is depicted in Figure no. 10.4.

Name of the Valley	Drain Length, (Km.)		Total No. of Culverts/Bridges Considered for Remodelling	Tender Package No.
	Primary	Secondary		
Koramangala Valley				
Koramangala Main Valley	12.000	17.710	12	K1VD – I, K1VD- II & K1VD- IV
Tavarekere Valley	7.650	18.825	9	K2VD - III
Challaghatta Valley				
Challaghatta Main Valley	12.000	13.400	14	C1VD - II & C1VD- III
Ulsoor Valley	4.150	4.170	9	C2VD - I
Hebbal Valley				
Hebbal Main Valley	4.425	4.800	5	H1VD- I
Hebbal Main Valley - I	9.000	10.695	6	H2VD- II
Hebbal Minor Valley - I	7.375	9.330	16	H3VD- III
Hebbal Minor Valley - II	5.000	0.950	1	H4VD- IV
Vrishabhavathi Valley				
Vrishabhavathi Main Valley	14.000	30.945	18	V1VD - I & V1VD- II
Kethmaranahalli & Arkavathi Valley	13.300	14.675	15	V2VD - III & V2VD- IV
Kathriguppe Valley	4.850	11.400	6	V3VD- V

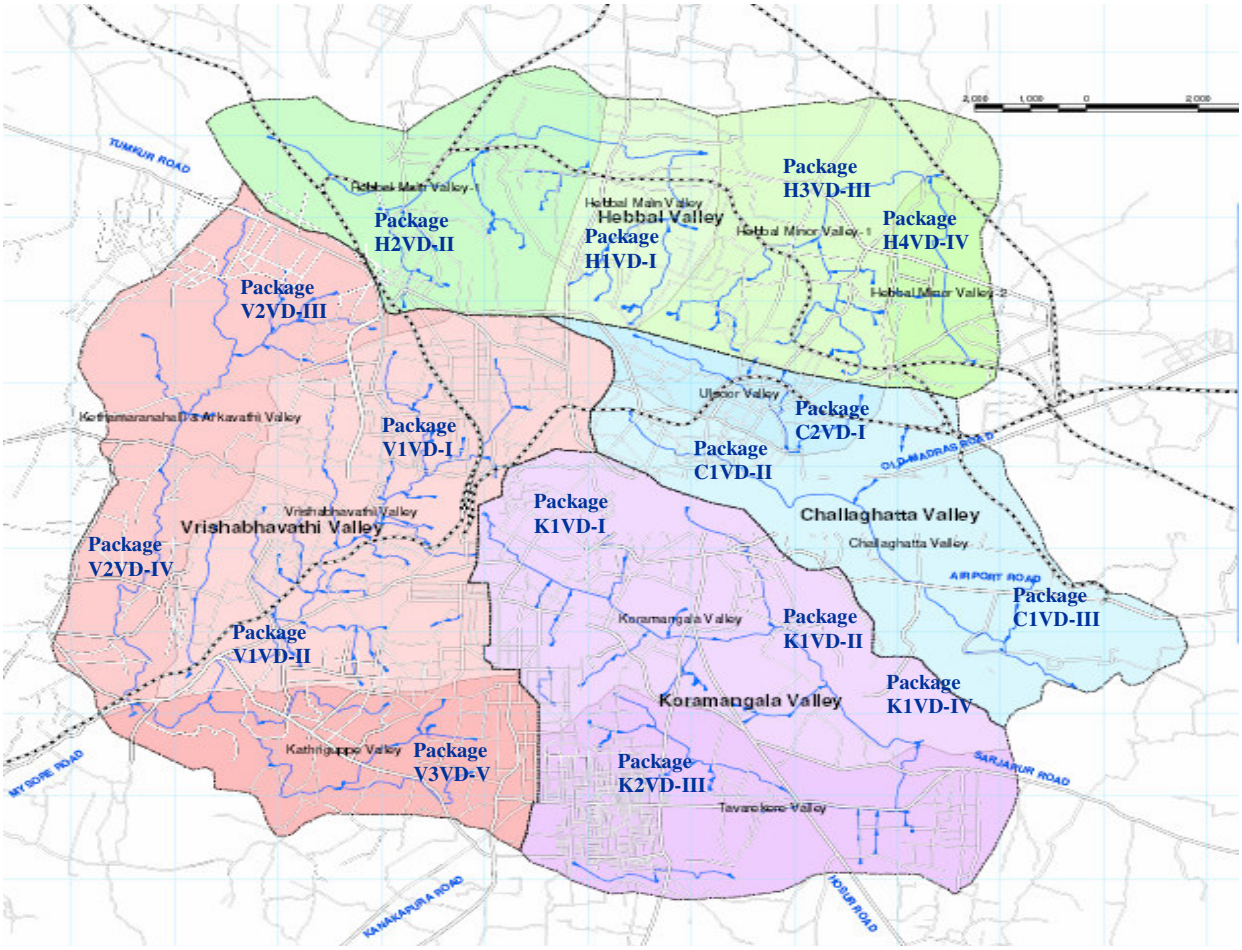

Figure 10.4 Packages Details

The site activities envisaged in all the 16 packages are classified into five categories viz'

Rehabilitation works to existing system:

I. Reconstruction of collapsed wall
II. Restoration of broken wall
III. Cavity filling, restoration of eroded stones, providing pointing to the existing drain walls etc.

Carrying capacity improvement works:

I. Widening of Drains
II. Desilting and drain deepening
III. Drain bed protection

Remodeling of existing inadequate vent way/Structurally unstable - bridges/culverts.

Removal of obstacles – pipe lines, manholes, cables etc.

Training & Community awareness campaigns.

The works proposed for remodeling of storm drains shall be taken up in a phased manner simultaneously in all the packages. Since, some of the critical issues like coordination from other agencies in several instances, community participation, acquisition of land from government & public, shifting of major utilities, traffic diversion at several places etc., are envisaged in all the packages.

After having several discussion with senior officials of BMP and other stake holders and beneficiaries of the project. Work programme with a broader contest 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 etc., also for smooth and successful implementation of the project, which is as narrated below,

Brief Work Programme for Remodeling of Storm Water Drains in Bangalore City:

- 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.
- Shifting of service lines which are noticed all along the entire length of 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 over the entire length shall be taken up simultaneously in all the packages.
- Desilting of drains, removal of debris/solid wastes etc., which are noticed over the entire length of storm drain, 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.
- 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 in the entire length of drain, 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 entire length of existing SSM storm 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.
- 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.

10.3 IMPLEMENTATION PROGRAMME:

It is estimated that the work envisaged under remodeling of storm water drain project would involve period of 24 months from bidding with first six months dedicated to tender process and award of contract, which will be done as per KTTP act and 18 months for the execution of civil works.

It is proposed that BMP, the nodal agency will set up a separate implementation unit whose responsibilities would include ensuring the deployment of adequate staff, usage of quality materials, construction practices of acceptable standards and quality of works carried out, monitoring and reporting the project progress to the project monitoring agencies.

Tender specifications and construction practices are reflected in the bid document issued by BMP for its works related to construction of system components. The contractor would also adhere to the environmental regulations in practices and keep the citizens informed of the scheduled of the project underway in a periodic manner.

Detailed item wise implementation schedule for the execution of the project is enclosed in this report.