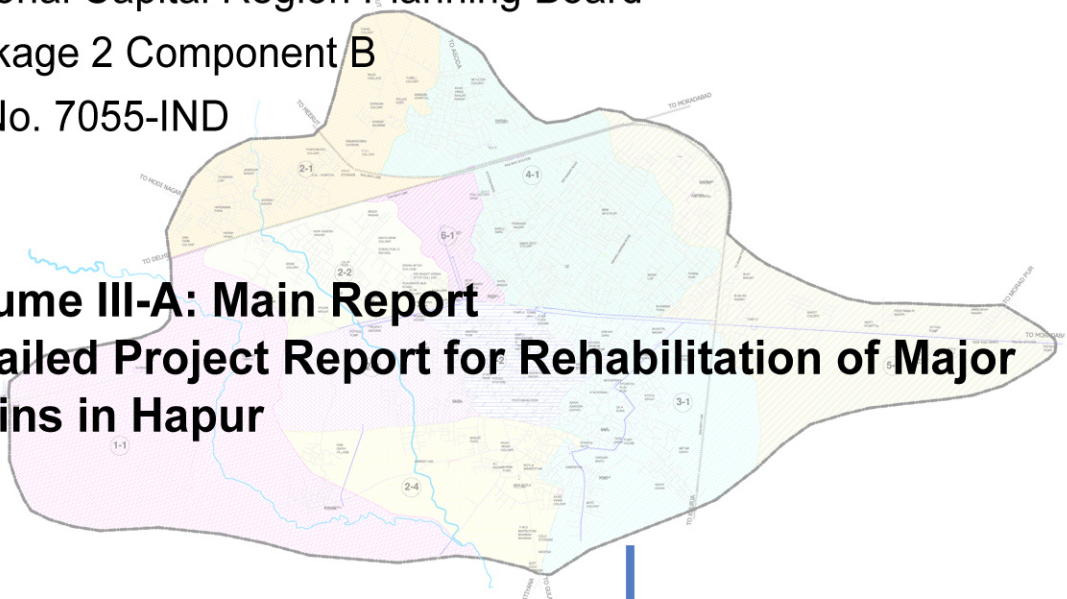
FINAL REPORT

Asian Development Bank

National Capital Region Planning Board

Capacity Development of the
National Capital Region Planning Board
Package 2 Component B
TA No. 7055-IND



Volume III-A: Main Report
Detailed Project Report for Rehabilitation of Major Drains in Hapur

WilburSmith ASSOCIATES

July 2010

NCR Planning Board
Asian Development Bank

Capacity Development of the National Capital Region Planning Board (NCRPB) – Component B

(TA No. 7055-IND)

FINAL REPORT

Volume III-A: Detailed Project Report for Rehabilitation of Major Drains in Hapur

July 2010

Abbreviations

oC	:	Degrees Centigrade
oC	:	Degrees Fahrenheit
ADB	:	Asian Development Bank
BOQs	:	Bill of Quantities
CC	:	Cement Concrete
CMA	:	Counter Magnet Areas
CPHEEO	:	Central Public Health & Environmental Engineering Organization
CWPS	:	Clear Water Pumping Station
DA	:	Development Authority
DFR	:	Draft Final Report
DMP	:	Drainage Master Plan
DPR	:	Detailed Project Report
EAF	:	Environmental Assessment Framework.
GoI	:	Government of India
GoUP	:	Government of Uttar Pradesh
HMC	:	Hapur Municipal Council
HPDA	:	Hapur-Pilkhua Development Authority
HUDA	:	Hapur Urban Development Authority
IA	:	Implementing Agencies
IDF	:	Intensity Duration Frequency
IRC	:	Indian Road Congress
IT	:	Information Technology
LA	:	Land Acquisition
LPCD	:	Liters Per Capita per Day
MLD	:	Million Liters per Day
MoUD	:	Ministry of Urban Development
MSL	:	Mean Sea Level
NCR	:	National Capital Region
NCRPB	:	National Capital Region Planning Board
NCT	:	National Capital Territory
NH	:	National Highway
NHAI	:	National Highway Authority of India
NPRR	:	National Policy on Resettlement and Rehabilitation
O & M	:	Operation and Maintenance
RCC	:	Reinforced Cement Concrete
Rs.	:	Indian Rupees
SH	:	State Highway
SOI	:	Survey of India
SOR	:	Schedule of Rates
SPS	:	Sewage Pumping Station
Sq. km	:	Square Kilo meter
Sq. m	:	Square Meter
STP	:	Sewerage Treatment Plant
SWD	:	Storm Water Drainage
TA	:	Technical Assistance

TOR	:	Terms of Reference
ULB	:	Urban Local Body
UP	:	Uttar Pradesh
WFR	:	Workforce Participation Rate

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Compendium Volumes

Besides this Volume III A, the DPR for Rehabilitation of Major Drains in Hapur, has following Volumes appended separately.

Volume III-B: Drawings
Volume III-C: Economic & Financial Analysis
Volume III-D: Initial Environmental Examination
Volume III-E: Short Resettlement Plan

1. INTRODUCTION

A. Background

1. The National Capital Region Planning Board, constituted in 1985 under the provisions of NCRPB Act, 1985, is a statutory body functioning under the Ministry of Urban Development, Government of India. NCRPB has a mandate to systematically develop the National Capital Region (NCR) of India. It is one of the functions of the Board to arrange and oversee the financing of selected development projects in the NCR through Central and State Plan funds and other sources of revenue.

2. On Government of India's request, Asian Development Bank (ADB) has formulated the technical assistance (TA) to enhance the capacities of National Capital Region Planning Board and its associated implementing agencies. The TA has been designed in three components: Component A relates to improving the business processes in NCRPB; Component B relates to improving the capacity of the implementing agencies in project identification, feasibility studies and preparing detailed engineering design; and Component C relates to urban planning and other activities.

3. ADB has appointed M/s Wilbur Smith Associates to perform consultancy services envisaged under Component B. In the context of this contract, the first deliverable – Inception Report, was submitted in October 2008. As part of the second deliverable Interim Report, Master Plan for sewerage in Hapur, Master Plan for Water Supply in Panipat, Master Plan for Drainage in Hapur, Master Plan for Solid Waste Management in Ghaziabad, Traffic and Transport Analysis Report of Ghaziabad were submitted in January 2009. The four Master Plans as stated above are also made available on NCRPB web site for use of the implementing agencies.

4. The third deliverable Draft Final Report (DFR) comprising Detailed Project Report (DPR) for water supply in Panipat, DPR for sewerage in Hapur, DPR for drainage in Hapur, DPR for drainage in Sonipat, DPR for solid waste management in Ghaziabad, DPR for four selected transport components (Flyover, Road widening, Multi-level Parking and Bus Terminal) in Ghaziabad, and a Report on Capacity Building Activities were submitted.

5. Now, this is the Final Report (FR) and is the fourth and final deliverable. The comments/feedback on Draft Final Report received from ADB, NCRPB and respective implementing agencies, if any, were duly incorporated and final DPRs for components of Water Supply, Sewerage, Drainage, Solid Waste Management, and Transport are submitted as part of this Final Report. This is the Detailed Project Report for Rehabilitation of Major Drains in Hapur.

B. Overview of this ADB TA

6. *Objectives*. The objective of this Technical Assistance (TA) is to strengthen the capacity at NCRPB, state-level NCR cells, and other implementing agencies in the area of planning for urban infrastructure and to impart necessary skills to conceive, design, develop, appraise and implement good quality infrastructure projects for planned development of NCR. The increased institutional capacity of the NCRPB and the implementing agencies will lead to effective and time scaling-up of urban infrastructure to (i) improve quality of basic urban services in the NCR; (ii) develop counter magnet towns; (iii) reduce in migration into Delhi and orderly development of NCR; and (iv) accelerate economic growth in the NCR.

7. The TA – Capacity Development of the NCRPB, Component B focuses on strengthening the capacities of NCRPB and implementing agencies relating to project feasibility studies and preparation, and detailed engineering design in the implementing agencies. Specifically this component B of the TA will support the project preparation efforts of the implementing agencies by preparing demonstration feasibility studies that include all due diligence documentation required for processing of the project in accordance with best practices, including ADB's policies and guidelines.

8. *Scope of Work*. According to the terms of reference of the TA assignment, the following activities are envisaged in component B of the TA:

   (i) Conduct technical, institutional, economic and financial feasibility analysis of identified subprojects in the six sample implementing agencies;
   (ii) Conduct safeguards due diligence on the subprojects, including environmental assessment report and resettlement plan for all subprojects covered in the sample implementing agencies;
   (iii) Prepare environmental assessment framework and resettlement framework; and
   (iv) Develop a capacity building and policy reform program for the implementing agencies, including governance strengthening, institutional development and financial management.

9. Besides, this component of the TA will also:

   (i) help in assessing the current practices and procedures of project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
   (ii) support preparation of standard procedure manuals for project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
   (iii) train the implementing agencies in the preparation of detailed project reports by using the sample subprojects, reports on deficiency of current practices and standard protocol manuals; and
   (iv) help in developing a user-friendly web-page where different manuals and guidelines for preparation of DPRs will be made available for the implementing agencies.

C. About the Final Report

10. At Interim Report stage of the TA, the Master Plans for Water Supply in Panipat, Sewerage system in Hapur, Drainage for Hapur and Municipal Solid Waste Management for Ghaziabad were prepared. The Master Plans provided 100 percent coverage of population and the area likely to be in planning horizon year 2031/2041. All works required up to planning horizon year were conceptualized, broadly designed and block cost was estimated. The Master Plans also provided phasing of investment such that under phase 1 works required to cover present spread of city were proposed.

11. At draft final report stage of the TA the Detailed Project Reports (DPRs) were prepared for Phase 1 works as suggested in the Master Plans. For preparation of DPRs, engineering surveys and investigations were conducted and various possible and feasible alternatives evaluated. Finally for the selected options the DPRs prepared with detailed designs, item wise detailed cost estimate, work specifications, implementation process and proposed implementation arrangements. Further, according to ADB procedures these DPRs in addition to technical analysis included institutional, financial and economic feasibility analysis and environmental and social safeguards due diligence – environmental assessment and resettlement plans.

12. The DPR's submitted as part of Draft Final Report was reviewed by the implementing agencies, NCRPB and the ADB. Now this is the Final Report incorporating the comments of on DFR.

13. These DPRs are proposed to be made available to the ULBs and other implementing agencies of the state governments as model DPRs so that they may replicate the methodology/approach in the future DPRs prepared by them for obtaining finances from the NCRPB.

14. *Organization of the Final Report (FR).* The Final Report of the TA Component B is organized in following Seven Volumes:

Volume I: Detailed Project Report for Water Supply System in Panipat

Volume II: Detailed Project Report for Rehabilitation and Augmentation of Sewerage System in Hapur

Volume III: Detailed Project Report for Rehabilitation of Major Drains in Hapur

Volume IV: Detailed Project Report for Improvement of Solid Waste Management System in Ghaziabad

Volume V: Detailed Project Reports for Four Transport Components in Ghaziabad

Volume VI: Detailed Project Reports Rehabilitation of Drainage in Sonipat

Volume VII: Capacity Building Activities

D. Structure of this Volume III Report

15. This is Volume III Detailed Project Report (DPR) for Rehabilitation of Major Drains in Hapur. This DPR is volume is further organized into five sub-volumes (**Volumes III-A to III-E**) as given below:

Volume III-A: Hapur Drainage DPR Main Report:

- **Section 1** Introduction;
- **Section 2** defines project rationale, scope and objectives of the DPR;
- **Section 3** describes the profile of project town Hapur including future perspectives on land use, population etc;
- **Section 4** describes the existing Drainage System in Hapur;
- **Section 5** presents the methodology and approach followed for DPR preparation;
- **Section 6** establishes planning and design criteria for preparation of DPR for drainage system in Hapur Town;
- **Section 7** presents the Detailed Design;
- **Section 8** presents the project cost estimates;
- **Section 9** defines contract packages, implementation schedule and reviews the institutional aspects of project implementation and operation and maintenance

Volume III-B: Drawings

Volume III-C: Economic & Financial Analysis

Volume III-D: Initial Environmental Examination

Volume III-E: Short Resettlement Plan

2. PROJECT RATIONALE, SCOPE & OBJECTIVES

A. Project Rationale

16. Each city/town has a natural system of drainage and is governed by the physiographic profile. Over the years, the cities has been getting urbanised and has used the available open space more intensely, which has changed the natural drainage system substantially. This often results in flooding and water logging causing considerable inconvenience and economic losses. In most of the cities these are recurring problems for which a suitable surface drainage system needs to be developed. Due to unplanned growth of population, the major drain flowing through the town have been encroached upon, thus the rain water overflows on the roads causing flooding of residential colonies located on the sides of natural drains.

15. Unfortunately due to improper maintenance of the nallas, their water carrying capacities have been reduced considerably and they have also become places of dumping garbage and discharging sewage by people living nearby. The reduction in channel section, due to dumping of garbage and silting has reduced the discharge capacity on downstream side. Further, in absence of regular cleaning and desilting, the drainage channel has been filled up to a considerable depth rendering acute flooding problem of adjoining areas.

B. Scope

16. The Scope of Work for the Drainage Master Plan includes the following tasks:

(i) Collection and review of existing information as available with the nodal agencies;
(ii) Identification of areas/zones where storm drainage system is cross-connected with the sewerage system;
(iii) Identification of other local conditions that may impact the ability of the storm drainage system to avoid flooding;
(iv) Field investigations to verify existing storm drainage system, typical cross-sections of storm water channels, roadside drains and culverts;
(v) Detail Topographical survey of the existing drain and area proposed for new drain during master plan.
(v) Collection and analysis of rainfall data and plotting the rainfall intensity duration curve for the city;
(vi) Calculation of design flows based on the hydraulic analysis;
(vii) Identification of System Deficiencies;
(viii) Based on above preparation of detailed design and estimation for rehabilitation of existing drain and construction of new drains.

C. Objectives

17. The objectives of this Detailed Project Report for Drainage include:

(i) Providing a comprehensive description and mapping of the Town storm drain system (trunk and main drains only) including unlined channels and ditches;

(ii) Updating the Town Base Map to show locations of public storm drains and facilities, including their size, material of construction, and flow directions;

(iii) Analyzing rainfall data collected over a period of 22 years, including development of intensity duration frequency (IDF) curves for different storm frequency periods;

(iv) Doing a critical evaluation of the storm drainage and channel systems in order to identify existing and future deficiencies;

(v) Design and estimation for rehabilitation and desilting of existing drains

(v) Detail design and estimates of the new proposed drains

3. PROFILE OF HAPUR TOWN

A. Physical Features

1. Location

18. Hapur Town is administratively part of Ghaziabad District in Uttar Pradesh State, and is an important town of National Capital Region. Geographically it is situated at 280 44' N latitude and 770 47' E Longitude (**Map 3-1**). It is well connected with important cities of country. National Highway 24 (Delhi-Lucknow-Muradabad Road) and National Highway 18 (Meerut-Bulandshahar Road) passes through Hapur city. The main Rail Line of Delhi-Lucknow-Howrah also passes through Hapur Town. Hapur city is situated at about 54 Km east of Delhi, 32 Km from Meerut, 39 Km from Bulandshahar and 432 Km from the State Capital, Lucknow.

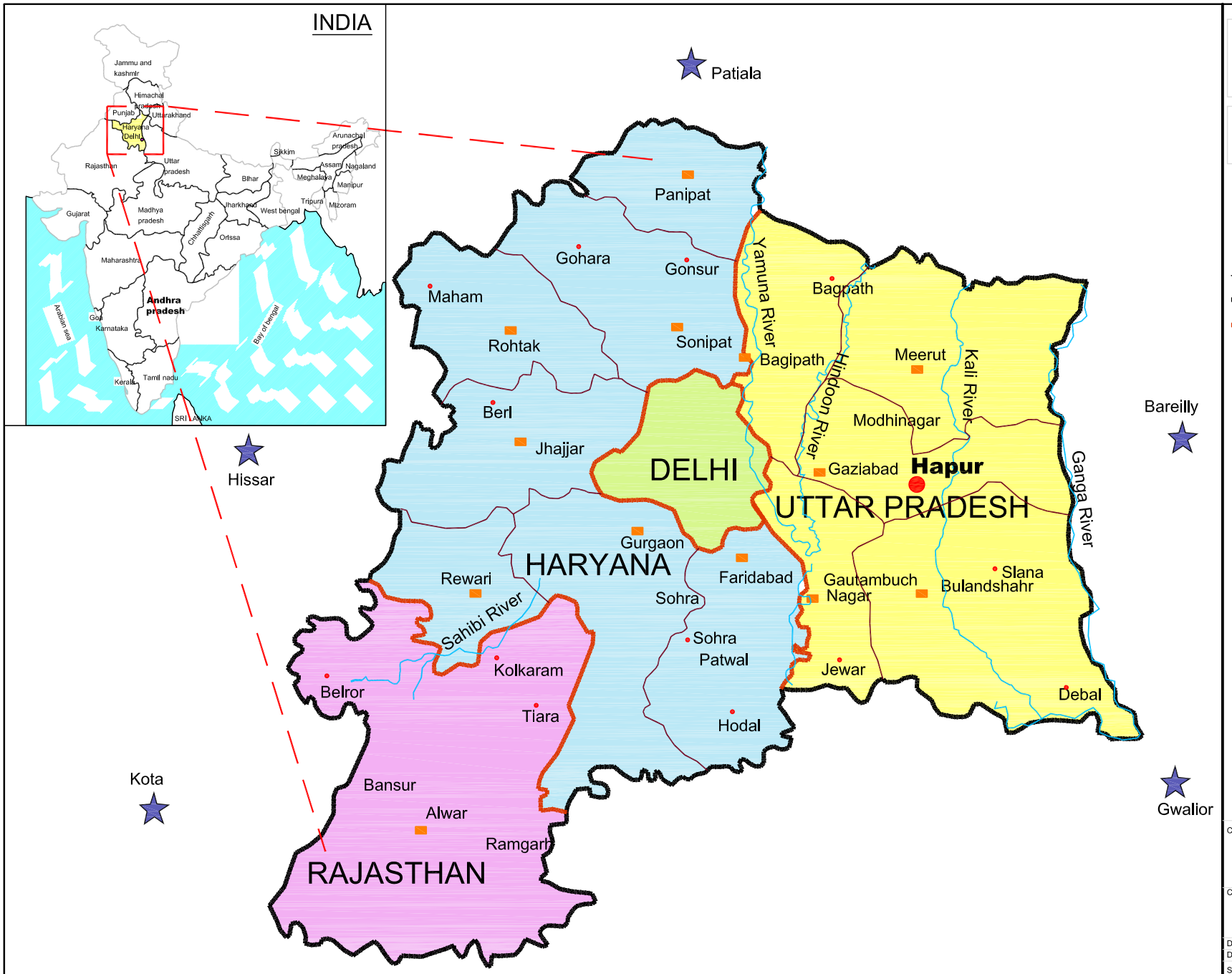
19. There are many stories around establishment and the name of Hapur. It is said that Hapur was established by King Harischandra. Some say, Shree Haridutt of Meerut/Bulandsahar established it and gave the name of Haripar. The word Hapar means garden and so the name of city is Hapur. In the 19th century a French General name Pairan appointed by Marathas started distribution of financial assistance to retired and incapacitated persons. British used this city traditionally for many years to provide land to retired and incapacitated persons after clearing forest bushes. In the year 1805, Tahasildar of Hapur Ibrahim Ali saved and protected the town from an attack by Aamir Khan Pindary. During 1857 at the time of India's struggle for independence Walidad Khan of Malagarh planned invasion of this city but because of resistance of Jats of Bhadhona it was not successful.

20. The city was surrounded all around by a wall with five gates- Delhi, Meerut, Garh Mukteshwar, Kothy and Sikandra. However, now none of these exists except some remnants. Jama Masjid in the town was constructed in the year 1670 during the rule of Emperor Aurangazeb.

21. The population of Hapur Town as per census 2001 was 211,983. Hapur Municipality (Hapur Nagar Palika Parishad) was established in 1982. At present, the municipal area of Hapur is 1,401 ha (14 sq. km).

2. Climate

22. Typical humid subtropical climate of north India prevails in Hapur, with high variation between summer and winter temperatures and precipitation. Summer starts early April and peaks in May. Winters are from November to February/March. The average temperature ranges from a minimum of 1.8oC to a maximum of 44.9oC; occasional extremes may in the ranges of 0.6oC to 47oC. Predominant winds are from north, northwest and west, followed by east and southeast. Extreme temperatures have ranged from −0.6 °C (30.9 °F) to 47 °C (116.6 °F). Annual average rainfall of the town is 732 mm.



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Regional Setting of Hapur

Legend

- NCR
- State Boundary
- District Boundary
- District Hq.
- Counter Magnet Areas
- River / Stream

Client:
Aslan Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

Drawn: Roopa	Checked: SKG
Date: August.2009	Approved: NSS
Scale: NTS	

Map 3-1

3. Topography

23. The town has almost flat topography except a small portion in the south, which is a marginally higher than the general ground level. The general slope of the town is from north to south. The difference between the maximum and minimum ground levels is about 3 m - varies from 213 to 210 m above mean sea level. The depth of groundwater in the town varies from 9-12 m. The town is located in the catchment area of the Ganges River, the most important and perennial river of India, flowing at a distance of 30 km east of the town. River Kali, a tributary of River Ganges, flows in the eastern outskirts of the town in the north-south direction. Hapur Town drains into this Kali River. The general nature of the soil is sand mixed with clay.

B. Socio Economic Conditions

24. Hapur is an important commercial centre. It is an important town in NCR area, which is being developed to decongest National Capital Delhi by improving infrastructure in NCR towns with the aim of shifting some of the offices and establishments of Government of India. It is a big mandi of Grains, Gur, and Potato etc. Six big silos of grains owned by the Ministry of Food and Agriculture of the Government of India, exist in the town. Small to medium industries manufacturing sewing machines, motor spare parts, all type of agricultural machinery & equipments, oil expellers etc. have already developed in the town. Due to enormous growth of potatoes in the area around, there are many cold storages in the town. The town has all modern amenities like transportation, electricity, telephone – landline as well as mobile, water supply, sewerage etc. the town has many technical institutions, degree colleges, intermediate colleges, tehsil office, post office, fire station etc. For all the above-mentioned reasons and its strategically important location, Hapur is a fast developing town.

25. The main occupation of inhabitants is agriculture and agro based trade and business. Therefore, the people, specially farmers and traders are generally well to do. The importance of this town is steadily increasing. Economic conditions of the people are similar to those of any average Indian small town. There are double storied houses also in the town apart from single storied pucca & kuchcha houses.

26. *Urban Economy*. Hapur is an important centre for trade and commerce in western UP sub-region. The workforce participation rate is almost constant but the size of work force in the city has maintained its increasing trend as shown in the following **Table 3-1**.

Table 3-1: Population and Workforce of Hapur

S.No	Year	Population	Work Force	WFPR	Male Workers
				%	%
1	1971	71,266	18,123	0.25	96.7
2	1981	10,2837	26,585	0.26	95.5
3	1991	14,6591	36,648	0.25	94.0
3	2001	21,1983	72,983	0.34	93.0

Source: Master Plan 2005; Census of India 2001,

4. EXISTING DRAINAGE SYSTEM IN HAPUR

A. Overview

27. The existing municipal boundary of Hapur Town encompasses about 3.34 Sq. Km. area, whereas the Master Plan area is about 53.01 Sq. Km. The elevation of the Town is in range of 210 - 213 m above the Mean Sea Level (MSL). The general topography of the town is flat having slopes towards North-West to South-East.

B. Major Drains

28. There are four major drains flowing through the master plan area of the Hapur viz Drain No1, Drian No 2 (Choya nallah), Drain No 3 (Circular road drain) and Drain No 4 (Delhi Garh road drain). Out of these, three drains (Drain No 2, 3 & 4) flow through the municipal boundary of the town. Further the Drain no 4 flows into the Drain No 2.

29. All the drains ultimately flow into the Kali River, which is at the south of the town. Drain No 1 and Choya Nallah converge at Rampur road near Haddi meel and flow in to the Kali River. **Map 4-1** shows the existing drain network in Hapur. For study purpose, the drains have been divided into sections. **Map 4-2** shows the sections of the drain. The details of these drains are as follows:

1. Drain No. 1

30. This drain flows outside the municipal boundary of the town. The drain enters into the master plan area from Badnauli and flows to Sabli village converging with Choya Nallah and draining into the Kali River beyond the Hapur Bypass. The length of the drain is about 8.7 Km (within the master plan area)

(i) Section 1.1: Upto the Delhi Moradabad Railway Crossing: The drain flows through the agriculture fields and is kuthca taking the natural course. **Photo 1** shows the drain just at the u/s of railway crossing.

Drain 1: Photo 1

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Existing Drain Network

Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line

Overlay Legend

- Drain -1
- Drain -2
- Drain -3
- Drain -4
- Drain -5
- Other Drains

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

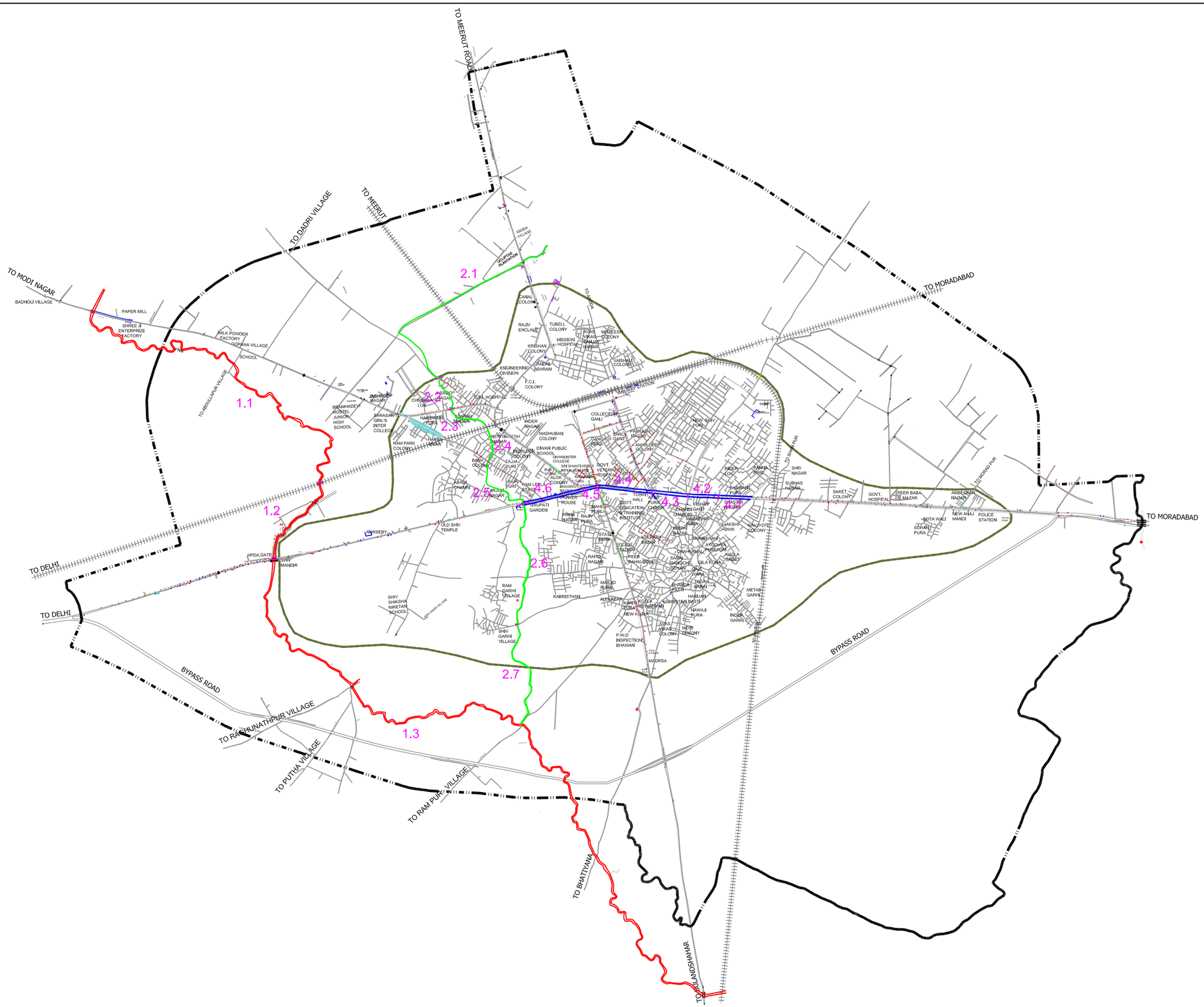
Drawn:SK
Date: August. 2009
Checked: HVS
Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 4-1

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Sections of Drain in Study Area



Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line

Overlay Legend

- Drain -1
- Drain -2
- Drain -4

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Drawn:SK	Checked: HVS
Date: August, 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 4-2

(ii) Section 1.2: From Railway Crossing to Crossing at NH24: This section is pucca trapezoidal section. The section reduces from about 35m at railway crossing to 14m at culvert near to the railway crossing. Though the section is pucca but is full of weeds, which interrupts the free flow the drain. **Photo 2** shows the bushes at the base of the drain.

Drain 1: Photo 2

(iii) Section 1.3: From Crossing at NH24 to Rampur Road via Sabli Village: The section (**Photo 3**) is kutcha with width ranging from 17m to to 15m with an average depth as 1.5m passing through the agriculture field.

Drain 1: Photo 3

31. As the drain is not flowing mainly through the city area, there are no problematic areas nearby this drain.

2. Drain No. 2 (Choya Nallah)

32. This is the main drain of the Hapur city and most important drain of the city. The drain enters the master plan area at Hasoda village and flows to Kali River passing through Jasroop Nagar, Adarsh Nagar, New Ganesh nagar, Lajja puri, Ramgarhi village and Shiv garhi village of the town. The length of the drain within the master plan area is about 4Km. For study purpose, the drain has been divided in following seven sections and the details of each section are mentioned below:

(i) Section 2.1: Hasoda to Dastoi Road. This is a pucca rectangular channel with dimensions of 3mx1.4m. The drain carries the sewerage of dheerukheda industrial area and other areas upstream of the drain. **Photo 4** shows this section of the drain.

Drain 2: Photo 4

(ii) Section 2.2: Dastoi Road to Modinagar Crossing. In this portion (**Photo 5**) the drain is almost nonexistent and all the water flows in the field and take a course from the habitation. The area is not densely populated and many fields filled up with water can be seen.

(iii) Section 2.3: Modinagar Crossing to Delhi Moradabad Railway Crossing. At Modinagar road crossing, the drain is presently dry as the black water is not finding path from the field. There is no defined path of water in this section also and colony Adarsh Nagar has come up in this section. The drain is only defined at railway crossing where width is 12m. The section is shown in **Photos 6, 7** and **8**.

(iv) Section 2.4: Railway Crossing to Chamri Road Crossing. This is the densely populated area through which the drain passes. In this section the drain takes path between the houses of colony New Ganesh Nagar. At Chamri road crossing the section is about 2mx1.5m. The pipe culvert is blocked and garbage dumping place is also at the drain, thereby making path for entry of solid waste into the drain. The section is shown in photos **9, 10** and **11**.

(v) Section 2.5: Chamri Road Crossing to Delhi Garh Road Crossing. The drain passes through Lajja puri colony and at Tirupati gardens at Delhi Garh road the section is 12m with water depth of 1.5m. The major flow from the drain on Delhi Garh road meets at this junction. The section of the Delhi Garh road at this junction is 2.2m x 3m depth. The section is shown in **Photos 12 and 13**.

(vi) Section 2.6: Delhi Garh Road Crossing to Ramgarhi Village. The drain (**Photo 14**) is also kutcha in this area and the section at Ramgarhi village is 7.4m x 1m. The area is relatively less dense.

(vii) Section 2.7: Ramgarhi Village to Rampur Road and to Kali River. The section is kutcha and flows through Idgah road and further through agricultural area to Rampur road where it converges with the flow coming from Drain No 1 and ultimately flows into the Kali river.

33. This is the major drain which has most problematic areas and particularly in absence of the sewerage system the drain acts as sewer line.

3. Circular Road Drain

34. This is a channeled drain along with the circular road of the town and flows from near Shastri Nagar at Delhi Garh road to sikander gate to Kali River. The drain passes through Shastri Nagar, Minakhshi Chowk, Ayodhya Puri, Qila Kona, Harijan Basti, Kabristan and Moti colony. The section at the start is almost a small drain with 0.3m width which increases from 0.8mx0.45m at Garh Ghati chowki to 3m x2.8m at Sikander gate. Here also the drain takes the waste water of all the habitations in course of this drain. The length of the drain is about 2.1 Km.

Photo 15

Photo 16

Drain No 3: Circular Road Drain

4. Delhi Garh Road Drain

35. The part of the drain from Khurja Delhi railway crossing flows westwards and flows ultimately to the Kali River. The major part of the other portion flows towards the Choya Nallah. The drains are at both sides of the road with a width ranging from 1.5m to 2.5m. The length of the drain is about 2 Km.

C. Flood Prone Areas

36. The information about the flood prone area was gathered from public representatives, municipal corporation officials and local public and following areas were identified. The area was physically inspected and problems were discussed with local residents. **Map 4-3** shows the flood prone areas. The details of the problematic areas are as follows:

(i) Adarsh Nagar: This is the area in the basin of Choya Nallah and in this area the nallah disappears and the water spreads in to the field and the colony. In absence of any course for the drain the problem acute during the rain. The habitation has been settled on the bed of Choya Nallah and due to house construction and other residential activities the area has become flood prone.

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Flood Prone Areas

Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line
- Drain

Overlay Legend

- Flood Prone Area

Client:
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National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn:SK	Checked: HVS
Date: August, 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 4-3

(ii) Ganesh Nagar: This area is also on the basin of Choya nallah and the drain passes through the area. As the area is densely populated the course of the nallha has been restricted to about 2m width and flows in between the houses. In absence of sewerage and proper solid waste management system, the drain acts as sewer and is blocked by solid waste.

(iii) Lajja Puri: The area's problem is similar to that of Ganesh nagar and the small drains also are full of waste water and do not take path into the drain due to inadequate size of the main drain, inadequate slope of the drain and blockage of drains due to solid waste.

(iv) Gol Market: The area is just at the Delhi Garh road. The section at this area is small and the drain flows below the shops. Due to break in the Delhi Garh drain, the water from this road takes path into this area and causes flooding.

D. Major Cross Connections to Sewers

37. In absence of the sewerage system in most part of the city, the drains act as carrier of waste water. The Choya nallah and Circular drain takes sewer of Jasroop Nagar, Adarsh Nagar, New Ganesh nagar, Lajja Puri, Ramgarhi village, Shiv garhi village.

E. Administrative and Institutional Arrangement

38. The institutions that provide and maintain Storm Water Drainage services in Hapur are Hapur Municipal Council (HMC) and Hapur Pilkhuwa Development Authority (HPDA).

1. Hapur Municipal Council

39. The HMC is the main administrative body responsible for solid waste management, water and wastewater management, and maintenance of roads, storm water disposal, street lighting and slum improvements.

2. Hapur Pilkhuwa Development Authority (HPDA),

40. Modern and planned development of Hapur is necessary in view of the geographical, historical, commercial industrial importance and planned development of NCR. As such Hapur Pilkhua Development Authority (HPDA) was established as an independent authority from GDA by U.P. Administration during 1996-97. Since its inception, the HPDA has acted as the nodal agency for all major urban development activities. These include developing housing colonies, providing social infrastructure facilities like parks, playgrounds as well as improvement of the environment, roads, drains and sanitation facilities.

3. Proposed Institutional Arrangement

41. Though there is no marked administrative responsibility for construction of new drains in Hapur city, but by a large the construction of drains within the municipal area is taken care by Hapur municipal council and outside this taken care by HPDA. The construction of the new drains by HMC is under the works department of HMC, whereas cleaning of drains is taken care by Health department of HMC.

5. STUDY APPROACH

A. Project Area

42. The present municipal corporation boundary extends to 1,401 hectares. The master plan 2005 boundary covers an area of 4,633 hectares. Recently 19 villages have been included and with these villages the area becomes 5,522 hectares. The UP NCR Cell has prepared existing land use map of Hapur in 2007 (**Map 5-1**). This has an area of 9,733 hectares.

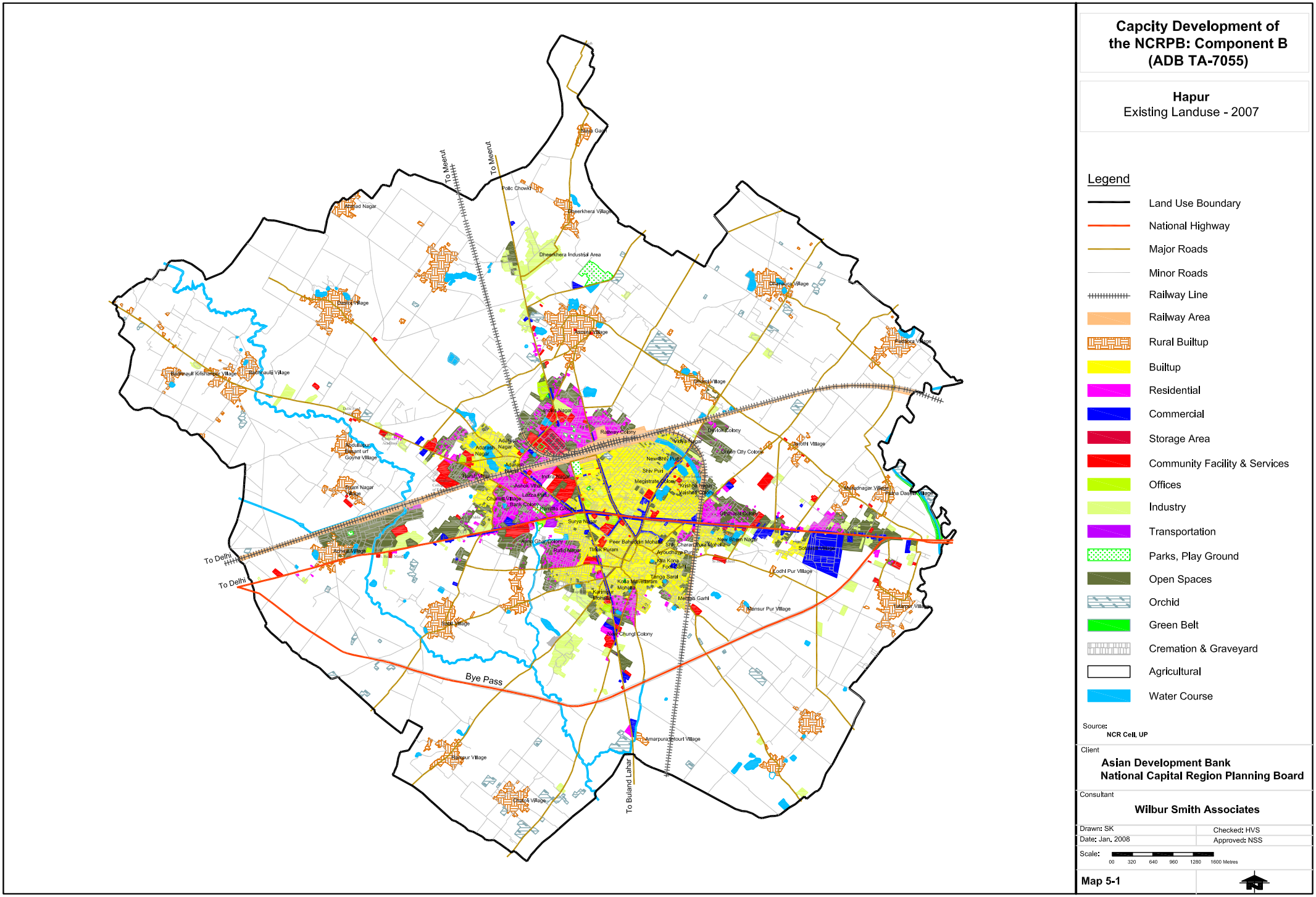
43. Project area has been taken corresponding to the land use plan of the master plan 2005 and recently extended area in view of the growth pattern of the city and in consultation with HPDA. This is because of the fact that actual growth of Hapur has been far less than that projected in the said master plan and regional plan 2001. The Population considered in Hapur Master Plan for year 2005 is 450,000 but actual census population in year 2001 was 211,983 and in year 2005 population may be about 230,377. The area under the Master Plan 2005 is 46 sq km but the habituated area at present is 14 sq. km. Moreover the projected population for year 2041 is 628,302. Thus the likely area habituated by year 2041 will be about 55 sq km which corresponds to the Master Plan area 2005 plus recently included villages.

44. The project horizon year is 2041 and as such sewerage system is required to be planned for area of city to which it will grow by the year 2041. Master plan of a city gives an idea of city as to how it will grow in future. However in case of Hapur the available Master Plan is for year 2005 and currently master plan for future is under preparation. Under the circumstances a judgment is required to ascertain likely extended area of city in the year 2041. The forecasted population for year 2041 can be accommodated in Current master plan area of 5,522 hectares with an average density of 114 persons per hectares. As such the project area for which this sewerage plan is being prepared is 5,522 hectares. The project area is delineated to include all area of Hapur Municipality, Master plan 2005 and recently included villages. Different areas are given in the following **Table 5-1**.

Table 5-1: Geographical Area of Hapur

S. No	Particulars	Area in ha
1	Municipal Area	1,401
2	Master Plan 2005 Area	4,633
3	Master Plan Area 2005 recently extended	5,522
4	Existing Land Use 2007	9,733

Source: Master Plan 2005 & HPDA



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Existing Landuse - 2007

Legend

- Land Use Boundary
- National Highway
- Major Roads
- Minor Roads
- Railway Line
- Railway Area
- Rural Builtup
- Builtup
- Residential
- Commercial
- Storage Area
- Community Facility & Services
- Offices
- Industry
- Transportation
- Parks, Play Ground
- Open Spaces
- Orchid
- Green Belt
- Cremation & Graveyard
- Agricultural
- Water Course

Source:
NCR Cell, UP

Client
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn: SK	Checked: HVS
Date: Jan. 2008	Approved: NSS

Scale: 0 320 640 960 1280 1600 Metres

Map 5-1

B. Hapur Master Plan 2005

45. The Government of Uttar Pradesh in 1978 declared the area falling under Hapur Municipality and 31 villages of Hapur and Meerut Tehsils as Hapur Viniyamit Area. Subsequently GoUP in 1993 extended area by including Pilkhua Municipal Area, Babugarh Nagar Panchayat and 51 villages. In 1998 Hapur Pilkhua Development Authority (HPDA) was created to implement Master Plan and area under Viniyamit Area. The Master Plan for Hapur for period 1979-2001 for target population of 200,000 was approved by GoUP in 1983. The regional plan NCR 2001 proposed population of Hapur in year 2001 as 450,000 and as such the Hapur Master Plan 2005 was modified considering population in the year 2005 of 450,000. Now the master plan for next 20 years is under preparation. The master plan proposes land use plan for the city with the intention of achieving balanced distribution of various land uses.

46. *Land Use*. In 1994, Hapur had residential as the major land use (49.71 percent) followed by traffic and transportation (23.95 percent). Industrial land use (5.09 percent) was not a dominant land use in 1994 (**Table 5-2**). **Map 5-2** shows the proposed 2005 land use as per Master Plan.

Table 5-2: Comparative Land Use Pattern as in 1994 and as proposed in Master Plan 2005

S. No	Category	1994	2005
1	Residential	49.71	56.27
2	Commercial	11.20	3.81
3	Industrial	5.09	6.72
4	Govt-Semi Govt	1.08	1.14
5	Community Facility	0.92	2.07
6	Traffic & Transport	23.95	10.00
7	Recreation Open Spaces/Play Grounds/others	8.05	19.98
	Total	100	100

Source: Hapur Master Plan 2005

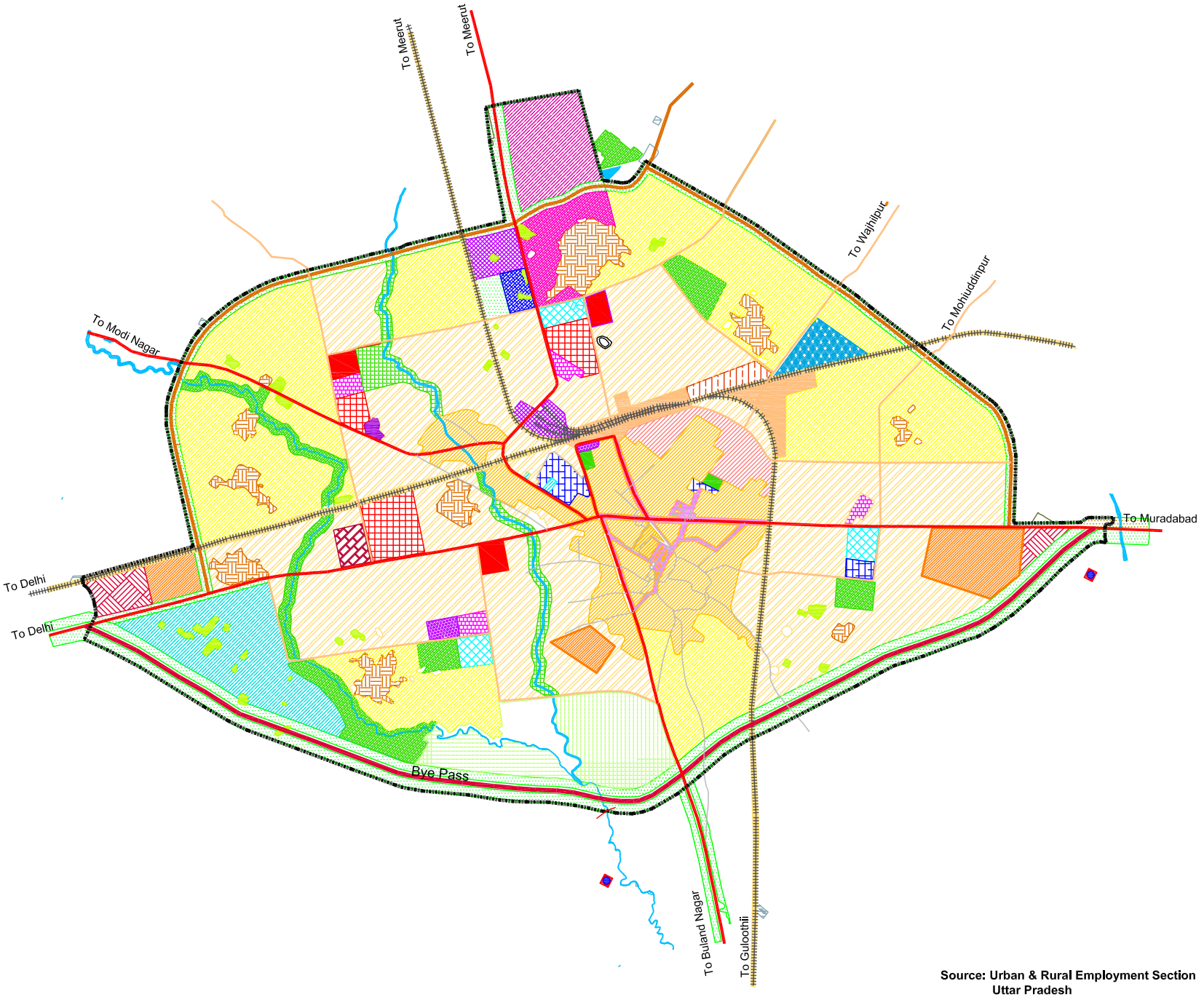
C. NCR Regional Plan

47. Regional Plan 2001 of NCR assigned population of 450,000 for Hapur in the year 2001. However actual population as per census 2001 of Hapur was 211,983. Thus the development was not as much as envisaged. The regional plan 2021 of NCR proposed six tier hierarchy of settlements, as given in the following **Table 5-3**.

Table 5-3: Proposed Six-tier Hierarchy of Settlements

S, No	Hierarchical Level	Population Range
1	Metro Centre	1 million and above
2	Regional Centre	0.3 to 1 million
3	Sub-Regional Centre	50,000 to 0.3 million
4	Service Centre	10000 to 50000
5	Central Village	5000 to 10000
6	Basic Village	Below 5000

Source: NCR Regional Plan 2021



Source: Urban & Rural Employment Section Uttar Pradesh

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Proposed Landuse - Master Plan 2005

Legend

- Master Plan Boundary
- Minor Roads
- Proposed 30m Roads
- Proposed 36m and 45m Roads
- Proposed 75m Byepass Road
- Railway Line
- Railway Land
- Urban Built Area
- Rural Built Area
- Residential Density
- Medium Residential Density
- Low Residential Density
- Urban Trade Centre
- Regional Trade Centre
- Wholesale Trade Centre
- Warehouse
- Mineral
- Small and Light Industry
- Light & Medium Industry
- Office
- Instituations
- Hospital
- Regional Park
- Park & Open Green
- Green Belt
- Bus Stand
- Truck Stand
- Inland Container Services
- Orchid
- Agricultural Land
- Garden
- Sewerage Farm
- Water Course

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National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn: SK	Checked: HVS
Date: Jan. 2009	Approved: NSS

Scale: 00 500 1000 1500 Metres

Map 5-2

48. The Regional Plan 2021 also defined Central NCR (CNCR) and area of NCR except CNCR i.e. outside CNCR. Regional Plan 2021 proposed 7 metro centres and 11 regional centres. Regional Plan 2021 defined regional centre as, well established urban centre in the region, marked by highly specialized secondary and tertiary sector activities and providing job opportunities, which normally cannot be performed by other lower order centres. The regional centres will be developed for advanced industrial and other economic activities and will have concentration of administrative and higher order service functions, which are expected to exert an increasingly dynamic influence on attraction of investment and creation of conducive living and working environment. In Regional Plan 2021 Hapur-Pilkhua has been proposed as regional centre outside CNCR and population estimated is as follows: 300,000 in 2011 and 450,000 (2021).

D. Population Growth

49. The population of Hapur has increased from 146,591 to 211,983 during 1991-2001. The town is mainly developing on both sides of Bulandsahar road towards Bulandshahar in narrow width and along Delhi- Muradabad National Highway towards Muradabad. HPDA is developing all areas in south west direction lying between Bulandsahar road and NH 24. Census data of Hapur for year 1951to 2001 are given in the following **Table 5-4**.

Table 5-4: Population Growth of Hapur

Year	Population	Decadal Population Growth Rate (%)
1951	49,260	12.2
1961	55,248	29.0
1971	71,266	44.3
1981	102,837	42.2
1991	146,262	42.2
2001	211,983	44.9

Source: Census

E. Methodology and Approach

1. Collection of Secondary Data

50. The project team collected the secondary data available from different nodal agencies. The available reports, as-built records, and O & M practices were reviewed. Town Land Use Plan prepared from the Town Development Plan 2005 was collected. Historical rainfall information, existing drainage information, flood prone areas were collected. For information about the city and drainage conditions, interaction was made with Chief Engineer HPDA, Executive Officer HMC, City Engineer, HMC, Engineer HMC, Health Officer, HMC, public representatives and local residents.

2. Preliminary Field Investigations

51. The Project Team conducted field investigations to verify existing storm drainage system, typical cross-sections of storm water channels, roadside drains & culverts and flow directions of channels. The information about the flood prone areas were collected and details of the flood frequency, history of past floods in these areas were collected from the residents/ users of the area.

3. Detail Survey and Topographical Mapping

52. Detailed Topographical survey was done with Total Station with Geo referencing. All main physical features such as roads, trees, drains, property line, road line, built up areas etc. all main roads, water courses and important buildings (i.e. schools, mosques etc.) were marked on the map for reference. All utilities (visible) such as, water mains and valves, electricity or telephone poles and lamp posts along the roads were captured and marked on the drawing. The details of the storm water drain with their width, depth, length were collected through survey. The level at top of drain and invert level of existing drains were collected. **Map 5-3** shows the topo/contor map of Hapur generated from survey.

4. Computation of Coefficient of Runoff

53. The values for "C" have been followed as listed in the "Table 17" of Manual for Sewerage and Sewage Treatment, CPHEEO. Finally adopted values are given in **Table 5-5**. The values are somewhat conservative because they assume maximum build-out in the associated zone. Some portions of rural and low-density areas may or may not develop to full potential. Because the costs of storm water drainage systems are expensive, it is generally preferable to size the system for the maximum development rather than upsizing later at additional cost as upsizing always requires some unnecessary expenditures. It may be better to plan for 80% development rather than for maximum development, as this would have a relatively minor effect in overall storm flow.

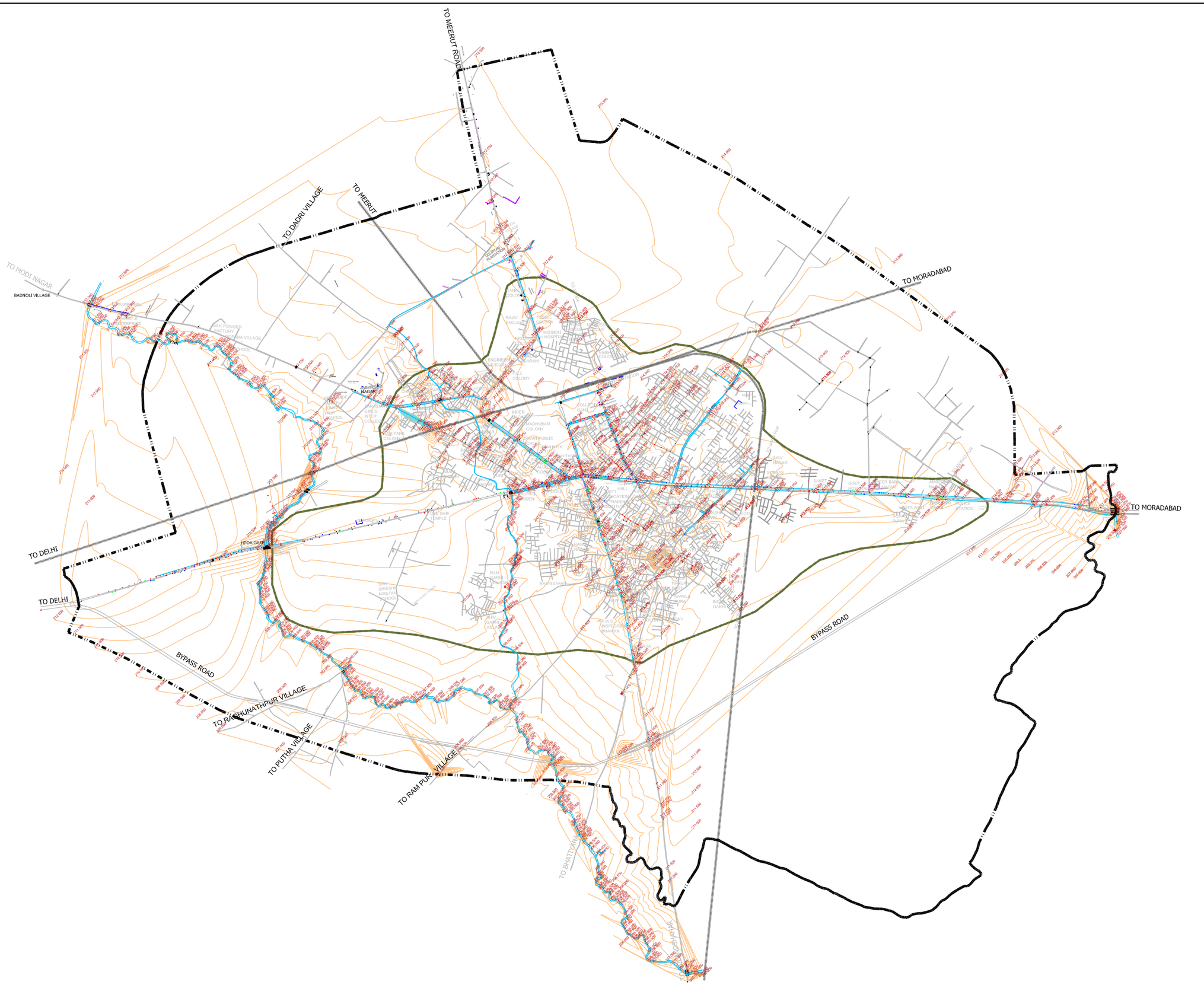
Table 5-5: Runoff Coefficient for time of Concentration and Imperviousness

Duration T (Min.)	Run-off Coefficient (C) for imperviousness	
	20%	**60%**
10	0.125	0.365
20	0.185	0.427
30	0.23	0.477
45	0.277	0.531
60	0.312	0.569
75	0.33	0.598
90	0.362	0.622
100	0.382	0.641
120	0.399	0.656
135	0.414	0.67
150	0.429	0.682
180	0.454	0.701

Source: Analysis

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Contour Map



Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line
- Drain

Overlay Legend

- Contour Line with Level

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

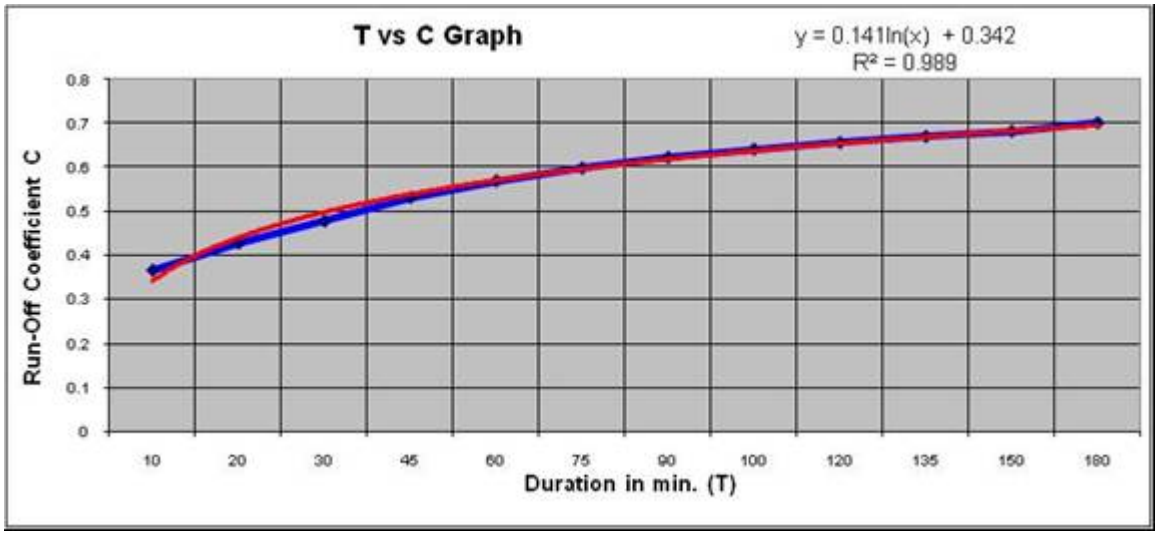
Drawn:SK	Checked: HVS
Date: August. 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 5-3

54. The town area is mainly residential with high density to low density, imperviousness cover of 60% has been considered at master plan stage. For 60% imperviousness, the corresponding runoff coefficient for respective time of concentration has been plotted in **Figure 5-1**:

Figure 5-1: T Vs C Graph



5. Analysis of Rainfall Data

55. As indicated, the best possible estimation of peak run off rate is possible where the gauge records of rainfall are available from automatic rain gauge recorder. As such the nearest rain gauge station with short duration rainfall data is Delhi. As such rainfall data of New Delhi (65 Km from Hapur) for year 1984 to 2006, as available, were used for rainfall data analysis. The isohytel map of the NCR indicates that the rainfall analysis of Delhi may be used for Hapur.

56. The amount of precipitation obtained from the rainfall data for 15, 30, 45, 60, 75 and 90 minutes are sorted in number of occurrences with 10mm, 15mm, 20mm, 25mm, 30mm, 35 mm, 40mm, 45mm, 50mm, 55mm, 60mm, 75mm, 100mm, 125mm.. **Table 5-6** presents the total counts of such occurrences over a period of 24 years obtained by summation of the corresponding values.

Table 5-6: Sorted Rainfall Occurrences

Duration	**Precipitation**												
	5 mm	**10 mm**	**15 mm**	**20 mm**	**25 mm**	**30 mm**	**35 mm**	**40 mm**	**50 mm**	**60 mm**	**75 mm**	**100 mm**	**125 mm**
15 min	346	346	344	319	265	229	177	162	79	72	66	63	46
30 min	256	252	206	151	73	44	44	37	18	17	10	10	7
45 min	128	95	37	24	24	18	12	8	4	2	2	2	0

Duration	Precipitation												
	5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	50 mm	60 mm	75 mm	100 mm	125 mm
60 min	58	31	16	15	13	13	12	8	7	7	3	3	2
75 min	38	13	13	12	11	9	6	5	0	0	0	0	0
90 min	12	4	3	3	2	1	1	1	1	0	0	0	0

Source: Report on rainfall data of New Delhi (Year 1984-2006), UPJN

57. From the sorted rainfall occurrences, the cascades for 1 year (24 occurrences) and storm frequency for different return period were developed by interpolating the higher and lower numbers of occurrences with corresponding maximum and minimum amount of precipitation, the precipitation along the cascade line is obtained. **Table 5-7** presents the cascade for 1 year storm frequency.

Table 5-7: Cascade for 1 year

Duration (t) (min.)	Higher No. of Occurrences	Lower No. of Occurrences	Intensity (mm/hr) Corresponding to Higher No. of Occurrence	Intensity (mm/hr) Corresponding to Lower No. of Occurrence	Intensity (i) (mm/hr)
15	46	17	75	100	79.31
30	37	18	40	45	41.05
45	37	24	15	20	14.23
60	31	16	10	15	12.00
75	38	13	5	10	6.80

Source: Analysis

58. Sample calculation of intensity corresponding to rainfall duration of 30 minutes:

40 + (45-40)*(22-18) / (37-18) = 41.05 mm/hr.

Once the intensity of rainfall were obtained, Root Mean Square Deviation (RMSD) calculation for the respective storm return period was carried out to obtain the values of the constants of the empirical expression given by Metcalf and Eddy (**Table 5-8**).

Table 5-8: RMSD for 1 Year

Duration (t) (min)	X =log t	Y =log i	X^2	XY		I = a/t^m
15	1.176	1.981	1.383	2.330	m =1.50564	110.05
30	1.477	1.643	2.182	2.427	Log a = 3.812	38.76
45	1.653	1.426	2.733	2.357	a =6492	21.05
60	1.778	1.114	3.162	1.981		13.65
75	1.875	0.914	3.516	1.713		9.76
	∑X = 7.9596	∑Y=7.07	∑ X2 =12.9759	∑XY =10.8		

Source: Analysis

59. Based on above, Intensity Duration Frequency curve has been plotted in **Figure 5-1**. Based on the curve, the equation for IDF curves is:

I = 6492/(t)1.5

Where I = intensity of rainfall in mm/hr; and t = Duration of rainfall

Figure 5-2: IDF Curve for One Year

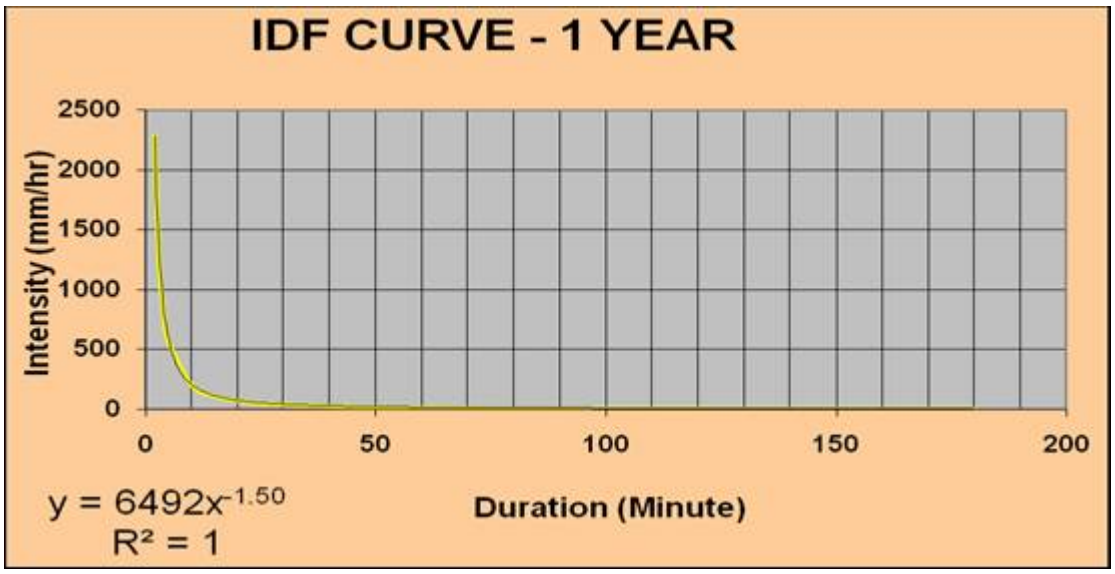


Table 5-9: Intensity of Rainfall for Duration

Duration (t) in min	Intensity (i) in mm/hour (For 1 year freq)
2	2286
3	1242
4	805
5	575
10	203
15	110
20	71
25	51
30	39
35	31
40	25
45	21
50	18
55	16
60	14
70	11
80	9
90	7
100	6
110	5
120	5
150	3
180	3

Source: Rainfall Data and Analysis

6. Identification of System Deficiencies

60. Hydraulic structures are sized to convey the maximum anticipated runoff of an area, which occurs when the building density of upstream areas reaches its saturation i.e. the maximum development allowable within the zoning under consideration. In this study, the design flow calculations are based upon the assumption that the upstream drainage area has reached maximum allowable development.

61. Hydraulic capacity of the identified drains was analyzed using Excel. Deficiencies within the storm drainage system were identified. For drainage facilities identified as undersized, the drainage area upstream of the structure was evaluated to determine whether "build-out" capacity for the town has been attained. Undersized structures located in areas that have reached "build-out" capacity for the town are given a higher priority for improvement than those located in areas where more development is anticipated.

62. In view of this the size of Drain No 1 is adequate but requires to be given proper leveling and slope. The Drain No3 is adequate to take care of the storm water. Some sections available at Drain No 2 are in adequate and need to be resized. The Drain No 2 also requires to be given proper slope correction. It was identified to construct a new link drain from upstream of Drain No 2 with Drain No 1. The drain No 4 requires to be repaired to take care of the storm water flow.

7. Preparation of Drainage Master Plan

63. The Project Team prepared a Drainage Master Plan (DMP) based on recommended system improvements identified during field investigations and hydraulic analysis. The DMP identified improvement of existing drainage facilities, and need of additional drainage facilities to minimize cross connection problems in the town to meet the growth related needs, and included a prioritized listing of each of the projects. Improvement projects are considered those located in areas with little or no anticipated future development. Growth related projects considered are those resulting from the increased runoff associated with future development. The DMP should become a tool that is used by the town to plan subsequent work. The following key elements are included:

(i) Identification of all required improvement projects;
(ii) Prioritization of projects;
(iii) Our opinion of probable construction costs;

64. All above evaluations, analyses, and recommendations performed by the Project Team are used in designing, and subsequently drawing the costs in a phased manner, and documented in the Drainage Master Plan. Based upon the findings, and after review of the available data, the Project Team performed a preliminary delineation of sub-watersheds and finalized the critical basins for hydraulic analysis purposes.

F. Recommendations of Drainage Master Plan

65. The following recommendations were made at Drainage Master Plan stage:

(i) Elimination of cross sewer connections;
(ii) Rehabilitation and desiltilng of existing drains;
(iii) Augmentation and rectifying the missing links of existing drains and
(iv) Provision of new drains.

66. The essential components of the improvement project include repair of the existing major drains, resizing/augmentation of the existing major drains based on the hydrologic and hydraulic calculations, proposal of new major drains in areas having no existing drainage facilities, and elimination of cross-connections with sewers.

1. Elimination of Cross-Connections of Sewers with Drains

67. By cross-connection between sewer and drain, it is meant any physical interconnection existing between the two owing to a deliberate construction, illegal practice, or by chance happening. All the drains of the city are acting as sewer line. Basic reason for this happening is lack of sewerage/drainage facilities in the town. Further there is no recourse but to dispose of the wastewater of unsewered areas into drains and vise versa. Major areas identified as unsewered are Jasroop Nagar, Adarsh nagar, New Ganesh Nagar, Lajja puri, Arjun nagar, Prem nagar, Rafiq nagar, ram garhi village, Shiv garhi village, Moti colony, Harijan basti, Ayodhya puri etc.

68. Apart from domestic wastewater, certain industrial effluent is also being disposed of in the drains. A major industrial waste of Dheerkhera Industrial area also discharges into u/s of Choya nallah. Effluent, treated or untreated, from all these industries, is disposed of directly or indirectly into the drains. This need to be rectified and the areas required to be sewered.

2. Rehabilitation and Augmentation of Existing Drains

69. The Drain no 1 and Drain No 2 (Choya Nallah) are earthen drains and needs to be desilted and needs to be channeled with regular shape and size as per the estimated discharge. The section-wise recommendations for rehabilitation and augmentation are as follows:

(i) Drain No 1:

a) **From railway crossing to crossing at NH24**. Though the section is channelized, but weeds have grown, thereby blocking the flow. This needs to be rehabilitated.

b) **From Crossing at NH24 to Rampur road via Sabli village**. As the drain is kutcha in this area, the drain needs to be channelized and made pucca.

(ii) Drain No 2 (Choya Nallah). This need to be linked with Drain No 1 for distributing of excess flow from upstream of this drain to Drain no 1. Presently, Hapur Pilukhwa Development authority is planning for a by-pass from drain near Dastoi road to Drain No 1 through a chak road. As link in drain no 2 breaks at this section, this will divert the flow from Dheerukhera industrial area to Drain No 1. The section wise recommendations are as follows:

a) **Hasoda to Dastoi Road**. As the drain carries the waste water, the arrangement for diverting this waste water to sewerage system is the prime necessity. As this is pucca, the drain required to be provided with cover.

b) **Dastoi Road to Modinagar road crossing and further to Delhi Moradabad railway crossing**. The drain has to be constructed in this portion. As the residential area has come up in this portion, the option for alignment either through existing roads or alignment available between the residential available has to be checked during detailed designing. The pond near Modinagar road crossing needs to be revamped, as it will prevent flooding.

c) **Railway crossing to Chamri Road crossing and further to Delhi Garh road**. As the drain passes through the populated area and sewerage makes way into the drain. It is recommended to eliminate the sewerage from the existing drain through sewerage system in adjoining colonies. The option of taking drain along the Chamri road may be explored or augmentation of existing drain may be checked, if land available. Presently, as the solid waste is dumped near the drain at Chamri Road crossing, the solid waste enters into the drain. It is recommended to provide a waste bin at this location. At crossing, the pipe culverts need to be redesigned as they have been blocked due to insufficient size.

d) **Delhi Garh road crossing to Ramgarhi village and further to Kali River**. As the drain is kutcha in this area, the drain needs to be remodeled and channelized and made pucca.

(iii) Circular Road Drain. As the drain takes the waste water of all the habitations in course of this drain, sewerage system of the adjacent colonies is the prime requirement. The drain requires desilting and cleaning to take care of storm water flow. The drain requires to be covered.

(iv) Delhi Garh Road Drain. The drain from Khurja railway line to Tirupati garden is the main secondary drain of Choya nallah and need to be augmented. The problematic area from town hall to Tirupati garden is to be identified and improvement in the section is required. The discharge has been checked for drains on both sides. The elimination of sewerage from this drain is also required.

3. New Proposed Drains

70. The drain linking Drain No 2 with Drain No 1 has been identified as new drain to be constructed. The route may be through the irrigation chak road.

71. *Secondary and Tertiary Drains*. In addition to the main drains, all the roads should have secondary drains and colonies road should have tertiary drains. The tertiary drains may be integrated along with the roads and proper slope should be provided as to drain out the storm water. During construction of roads, proper camber should be provided and sufficient longitudinal slope need to be designed and accordingly the road should be drain.

6. PLANNING AND DESIGN CRITERIA

A. Planning Capacity

72. The need for future drainage infrastructure improvement and the expansion of the Town depends on actual Town development, rainfall intensity, and storm recurrence period (storm frequency). Planning Capacity refers to maintaining proper infrastructure of the Town for projected loadings. Development planning for the town serves three purposes:

(i) It allows the system to remain effective over the required period to implement capital improvement projects (typically 2 to 5 years). Planning gives the town a mechanism to initiate master planning updates and staged improvements over the planning horizon. This should allow the Town to stay ahead of system needs.

(ii) It allows the system to accommodate unplanned or unforeseen developments and consequent storm water loads over short time periods without unduly overtaxing the system, thereby allowing the town to adjust infrastructure upgrade schedules to encounter the deviations.

(iii) It is necessary to address flow variations. Storm water flow can vary considerably from projected flows depending on actual land uses, growth trends and seasonal rainfall.

B. Design Parameters

73. The guidelines of CPHEEO manual on Sewerage have been followed for drainage system design. Based on the guidelines, the discharge that the system will require to drain off has been calculated. The discharge is dependent upon intensity and duration of precipitation characteristic of the area and the time required for such flow to reach the drain. The storm water flow for this purpose has been determined by using the rational method.

74. As part of planning, design and project formulation process, the basic design parameters have to be predetermined so as to analyze the carrying capacity of existing drains and also for the design of new drains. These parameters are as follows:

(i) Frequency of storm / return period
(ii) Depth –duration of storm
(iii) Time of concentration
(iv) Run off coefficient for the project area
(v) Method of computing flow in the channels

75. Based on the above parameters, the pattern of rainfall, runoff and time of concentration for the flood to occur, time acceptable to allow for draining have been decided. This is particularly essential as the rate of urbanization is very high. Analysis of the existing drains carrying capacity has been arrived at based on the finalized design parameters.

1. Computation of Design Flow

76. The entire storm water would not reach the Storm Water Drainage (SWD). Fraction of it would flow to SWD, which depends on the imperviousness, topography, shape of the drainage basin and duration of the storm. This imperviousness is quantified by a coefficient of runoff, which needs to be determined for each sub-catchment of the drain. The peak runoff at any given point is calculated using the following rational formula.

Qp = Cs CIA/360

Where,

Qp - peak flow in m3 /sec

C – Runoff coefficient

I – design rainfall intensity mm/hr

A – Contributory area in hectares

Cs – storage coefficient

77. *Coefficient of Runoff*. Because runoff is directly proportional to the value assigned to "C", the proper selection of this value is critical for storm water runoff calculations. Care has to be exercised in selecting this value as it incorporates all of the hydrological extractions, surface imperviousness and antecedent conditions. As development increases, the amount of runoff also increases. Runoff coefficient "C" values are based on the land use pattern, and are presented in **Table 6-1** below.

78. The land use zoning used in this study is assumed to be the most dense that could occur in the future under the Development Plan. It is important that during the actual design stage, the then current land use zoning for the specific site in question be evaluated.

Table 6-1: Runoff Coefficients "C"

Duration, t, minutes	**10**	**20**	**30**	**45**	**60**	**75**	**90**	**100**	**120**	**135**	**150**	**180**
Weighted Average Coefficients												
1) Sector concentrating in stated time												
Impervious	0.525	0.588	0.642	0.7	0.74	0.771	0.795	0.813	0.828	0.84	0.85	0.865
60% Impervious	0.365	0.427	0.477	0.531	0.569	0.598	0.622	0.641	0.656	0.67	0.682	0.701
40% Impervious	0.285	0.346	0.395	0.446	0.482	0.512	0.535	0.554	0.571	0.585	0.597	0.618
Pervious	0.125	0.185	0.23	0.277	0.312	0.33	0.362	0.382	0.399	0.414	0.429	0.454
2) Rectangle (length = 4 x width) concentrating in stated time												
Impervious	0.55	0.648	0.711	0.768	0.808	0.837	0.856	0.869	0.879	0.887	0.892	0.903
50%	0.35	0.442	0.499	0.551	0.59	0.618	0.639	0.657	0.671	0.683	0.694	0.713

Duration, t, minutes	10	20	30	45	60	75	90	100	120	135	150	180
Impervious												
30% Impervious	0.269	0.36	0.414	0.464	0.502	0.53	0.552	0.572	0.588	0.601	0.614	0.636
Pervious	0.149	0.236	0.287	0.334	0.371	0.398	0.422	0.445	0.463	0.479	0.495	0.522

Note: Values obtained from interpolation

79. *Imperviousness*. The impervious cover percentage of the drainage area can generally be obtained from the records of a particular district. In the absence of such data, Table 16 of CPHEEO Manual on Sewerage and Sewage Treatment may serve as the guide. These values are reproduced in **Table 6-2**.

Table 6-2: Guidelines for Impervious Cover

S. No.	Type of area	% of impervious cover
1	Commercial & Industrial area	70 to 90
2	Residential area	
	i) High Density	60 to 75
	ii) Low Density	35 to 60
3	Parks & Underdeveloped areas	10 to 20

Source: CPHEEO Manual on Sewerage

80. *Rainfall Intensity and Duration*. It has been observed that shorter the duration of critical rainfall, the greater would be the expected average intensity during the period. The critical duration of rainfall will be which produces maximum runoff. The duration will be equal to the time of concentration.

81. Return period or frequency of storm for which the storm drains are designed depends on the importance of the area to be drained. Storm Frequency criterion has been adopted as per CPHEEO Manual for Sewerage and sewage Treatment and are presented in the following **Table 6-3**:

Table 6-3: Storm Frequency for Different Areas

S. No.	Type of area	Storm frequency
1	Residential areas	
	i) Peripheral area	Twice a year
	ii) Central and comparatively high priced area	Once a year
2	Commercial and high priced area	Once in two years

Source: CPHEEO Manual on Sewerage

82. For determining the appropriate rainfall intensity, historical rainfall data have to be collected and accordingly the rainfall intensity duration curve have to be developed. The best possible estimation of peak run off rate is possible where the gauge records of rainfall are available from automatic rain gauge recorder. If only maximum day rainfall is available, the intensity of rainfall can be calculated as follows (IRC:SP-13-2004)

$$Ic = F/T\ (T+1/t+1)$$

Where; F= Total precipitation ; T= duration of rainfall and t= time of concentration

83. *Rainfall Data Analysis*. As indicated, the best possible estimation of peak run off rate is possible where the gauge records of rainfall are available from automatic rain gauge recorder. As such the nearest rain gauge station with short duration rainfall data is Delhi. As such rainfall data of New Delhi (65 Km from Hapur) for year 1984 to 2006, as available, were used for rainfall data analysis. The isohytel map of the NCR indicates that the rainfall analysis of Delhi may be used for Hapur.

84. *Rainfall Intensity from Occurrences*. From the sorted rainfall occurrences, the cascades for 1 year (24 occurrences), 2 year (12 occurrences) and storm frequency for different return period may be developed by interpolating the higher and lower numbers of occurrences with corresponding maximum and minimum amount of precipitation, the precipitation along the cascade line is obtained. Once the intensity of rainfall is obtained, Root Mean Square Deviation (RMSD) calculation for the respective storm return period is carried out to obtain the values of the constants of the empirical expression given by Metcalf and Eddy.

i = a/ tm

Where :

i = Intensity of rainfall (mm/hr)

a,m = Constant

t = Duration (min.)

.

85. Based on calculation, Intensity Duration Frequency curve is plotted.

86. *Time of Concentration*. Time of concentration is the longest time required for a particle to travel from the watershed divide to the watershed outlet. The remotest point in each zone is found out and then the level difference between the remote point and the point of discharge is calculated. As per Kirpich Time of Concentration (in minutes) Equations:

$$t_c = 0.0078\left(\frac{L^{0.77}}{S^{0.385}}\right)$$

Where,

L= the distance from the critical point to the point at which discharge is to be estimated, in meters.

S = Slope of the catchment area.

87. Inlet time for improved areas can vary widely and accurate values are difficult to obtain. Values between 5 and 30 minutes are used for developed areas with steep slopes or closely spaced inlets.

C. Drainage Development Strategy

1. Flood Zones

88. There are areas like Adarsh Nagar, Lajja puri, Ganesh nagar within the town that are subject to flooding during severe storm events. They are either low lying areas or wetland/ponds. Areas that are being developed at present have large vacant spaces, which are prone to flooding as construction surrounding them does not give way to over land flow.

89. Since the terrain of Hapur is generally flat, a heavy storm may exceed the capacity of the town's storm drainage system. Such an event may result in localized flooding and standing water in low areas.

2. Design Criteria

90. The design of the storm water facilities is planned to withstand a 1-year design storm while maintaining full flow in the channels. A 1-year design storm means with recurrence interval of one year. This design criterion has been used throughout the Drainage Master Plan.

3. Hydrology Model

91. The hydrology model predicts the volume of flow generated at any point of the catchment basin based on the approved rainfall data. Nodes were located at critical drainage facilities. A node represents a location where runoff rates are calculated. All nodes are designated based on the drainage sub-basins contributing to them. Each drainage basin in the study area was divided at nodes into sub-basins.

4. Hydraulic Models

92. The purpose of the hydraulic analysis was to evaluate the adequacy of the existing storm drainage system (major drains only) and to determine design options for inadequately sized channels. Channels and storm drains were simulated using the flow data generated in the hydrology model. Storm drains were simulated using Manning's equation as below:

$V = 1/n \times R^{2/3} \times S^{1/2}$

Where,

V = Velocity (m/s); n = Friction Factor; R = Hydraulic Radius (m); and S = Channel Slope (m/m)

93. *Hydraulic Analysis Methods*. The hydraulic models utilize Manning's equation to relate depth of flow in the channel to the flow rate (Q), cross sectional area of the channel (A), slope of the channel (S), and roughness of the structure (Manning's roughness coefficient, 'n').

94. *Flow Rates*. In the hydrology model, runoff flow rates were computed at each node for the appropriate design storms. Runoff is assumed to enter the drainage channels at node locations. Within the hydraulic model, the flow that enters at each node location is assumed to be flowing through the entire upstream length of the channel.

95. For this study, the following Manning's roughness coefficients were used (Manual on Sewerage and Sewage Treatment, CPHEEO):

Cement Concrete with Good finish = 0.013

Concrete channel, wood troweled = 0.015

Earth channel, ordinary condition = 0.025

Earth channel, poor condition = 0.035

Earth channel, partially obstructed with debris or weeds = 0.050

96. *Methodology for Hydraulic Modeling*. The channels to be modeled were assigned node numbers based on the sub-catchment basins (one node for each sub-basin). Using the hydrologic information of catchment basin, such as surface permeability, designed rainfall intensity and coefficient of run-off; and other relevant design parameters, such as time of concentration, catchment area etc., run-off discharges were estimated. These estimated discharges were compared with the carrying capacity of the existing drains. In case the existing sections were found inadequate, sections were adopted from the Standard **Table 6-4** for the particular discharge. In a similar manner, the sections of the proposed new drains are also adopted.

Table 6-4: Standard Drain Size

Size (m x m)		Manning's Coefficient	Wetted X-Section (Sq.m)	Wetted Perimeter (m)	Hydraulic Radius 'R' (m)	Slope	Velocity	Capacity
Width	Depth					1 in m	(m/s)	(cum/sec)
1	0.50	0.013	0.5	2	0.25	0.0003	0.557	0.279
1.5	0.75	0.013	1.125	3	0.375	0.0003	0.730	0.822
2	1.00	1.013	2	4	0.5	0.0003	0.011	0.023
2.5	1.25	0.013	3.125	5	0.625	0.0003	1.027	3.208
3	1.50	0.013	4.5	6	0.75	0.0003	1.159	5.217
3.5	1.75	0.013	6.125	7	0.875	0.0003	1.285	7.869
4	2.00	0.013	8	8	1	0.0003	1.404	11.235
4.5	2.25	0.013	10.125	9	1.125	0.0003	1.519	15.381
5	2.50	0.013	12.5	10	1.25	0.0003	1.630	20.371
5.5	2.75	0.013	15.125	11	1.375	0.0003	1.737	26.266
6	3.00	0.013	18	12	1.5	0.0003	1.840	33.126
6.5	3.25	0.013	21.125	13	1.625	0.0003	1.941	41.007
7	3.50	0.013	24.5	14	1.75	0.0003	2.039	49.967
7.5	3.75	0.013	28.125	15	1.875	0.0003	2.135	60.061
8	4.00	0.013	32	16	2	0.0003	2.229	71.340
8.5	4.25	0.013	36.125	17	2.125	0.0003	2.321	83.858
9	4.50	0.013	40.5	18	2.25	0.0003	2.411	97.665
9.5	4.75	0.013	45.125	19	2.375	0.0003	2.500	112.812

Size (m x m)		Manning's Coefficient	Wetted X-Section (Sq.m)	Wetted Perimeter (m)	Hydraulic Radius 'R' (m)	Slope	Velocity	Capacity
Width	**Depth**					**1 in m**	**(m/s)**	**(cum/sec)**
10	5.00	0.013	50	20	2.5	0.0003	2.587	129.348
10.5	5.25	0.013	55.125	21	2.625	0.0003	2.672	147.321
11	5.50	0.013	60.5	22	2.75	0.0003	2.757	166.778
11.5	5.75	0.013	66.125	23	2.875	0.0003	2.840	187.767
12	6.00	0.013	72	24	3	0.0003	2.921	210.334
12.5	6.25	0.013	78.125	25	3.125	0.0003	3.002	234.523
13	6.50	0.013	84.5	26	3.25	0.0003	3.081	260.380
13.5	6.75	0.013	91.125	27	3.375	0.0003	3.160	287.949
14	7.00	0.013	98	28	3.5	0.0003	3.237	317.274
14.5	7.25	0.013	105.125	29	3.625	0.0003	3.314	348.397
15	7.50	0.013	112.5	30	3.75	0.0003	3.390	381.361

Source: Analysis

5. Adequacy of Drains and Drainage System

97. According to the basin characteristics, coefficient of runoff, intensity of rainfall corresponding to the time of concentration, the discharge at each section has been calculated. Accordingly, the adequacies of the size of existing drains have been determined.

7. DETAILED DESIGN

A. Proposed Works

98. The Drain No 2 and 4 are most critical drains of the city. As such the rehabilitation of these 2 drains has been considered. The detail study of these drains has been done and appropriate solution for rehabilitation with construction of missing links has been made.

99. The works proposed for Drain 2 are as follows:

(i) Construction of drain in courses where the drain is nonexistent between chainage 1900 to 4200
(ii) Channelization and construction of pucca drain from chainage 1900 to chainage 6700;

100. The works proposed for Drain No 4 for chainage 5190 to chainage 6540 are as follows:

(i) Repair and construction of broken masonry wall;
(ii) Dismantling arch culverts and replacing with box culvert at identified locations;
(iii) Provision of Box culverts at identified locations;
(iv) Plastering of existing and new masonry walls;
(v) Construction of drains (missing links) in identified reach;
(vi) Provision of Covers in the missing sections

B. Detailed Investigations & Preliminary Design

1. Drain No 2

101. The detail investigation of the section 1900 to 6700 of Drain No 2 has been done. The L section of the drain is in **Drg No NCRPB-HPR-DR-01 (A&B)**[1]. The cross section of the Drain no 2 are shown in **Drg No NCRPB-HPR-DR-02(A, B &C)**.

102. HPDA has planned to construct a drain linking drain no 2 with Drain No 1 so as to divert the flow up to chainage 1700 to Drain No 1. As such the flow prior to 1700 has not been considered for design the drain. The new drain has been planned from 1900. Prior to taking the work of drainage, the cross connection with the sewer has to be eliminated. The sewer line has to be laid in the area through which the drain passes and all the connections

[1] All drawings are appended in Volume III C of this DPR

have to be diverted to the sewer line. The remaining sludge has to be removed from the drain.

103. *Design Discharge*. The contributory area for the different reaches of the drain has been demarcated as shown in **Map 7-1**. The contributory area has been marked based on the contours/Reduced levels of the area and lanes/ drains contributing to the drain. The area of sub-catchment area is as in **Table 7-1**.

Table 7-1: Catchment area for each chainage of Drain No 2

Section	Chainage	Area	Catchment Area in Ha
1	1,750-2,350	2-1(A)	3.2789
		2-1(B)	6.6135
2	2,350-2,750	2-2	7.8942
3	2,750-3,550	2-3	10.8897
4	3,550-4,250	2-4(A)	5.1453
		2-4(B)	9.356
5	4,250-5,050	2-5	23.8209
6	5,050-6,700	2-6	28.5329

104. *Time of concentration*. The time of concentration has been calculated based on Kirpich Time of Concentration (in minutes) Equations:

$$t_c = 0.0078\left(\frac{L^{0.77}}{S^{0.385}}\right)$$

Where,

L= the distance from the critical point to the point at which discharge is to be estimated in meters.

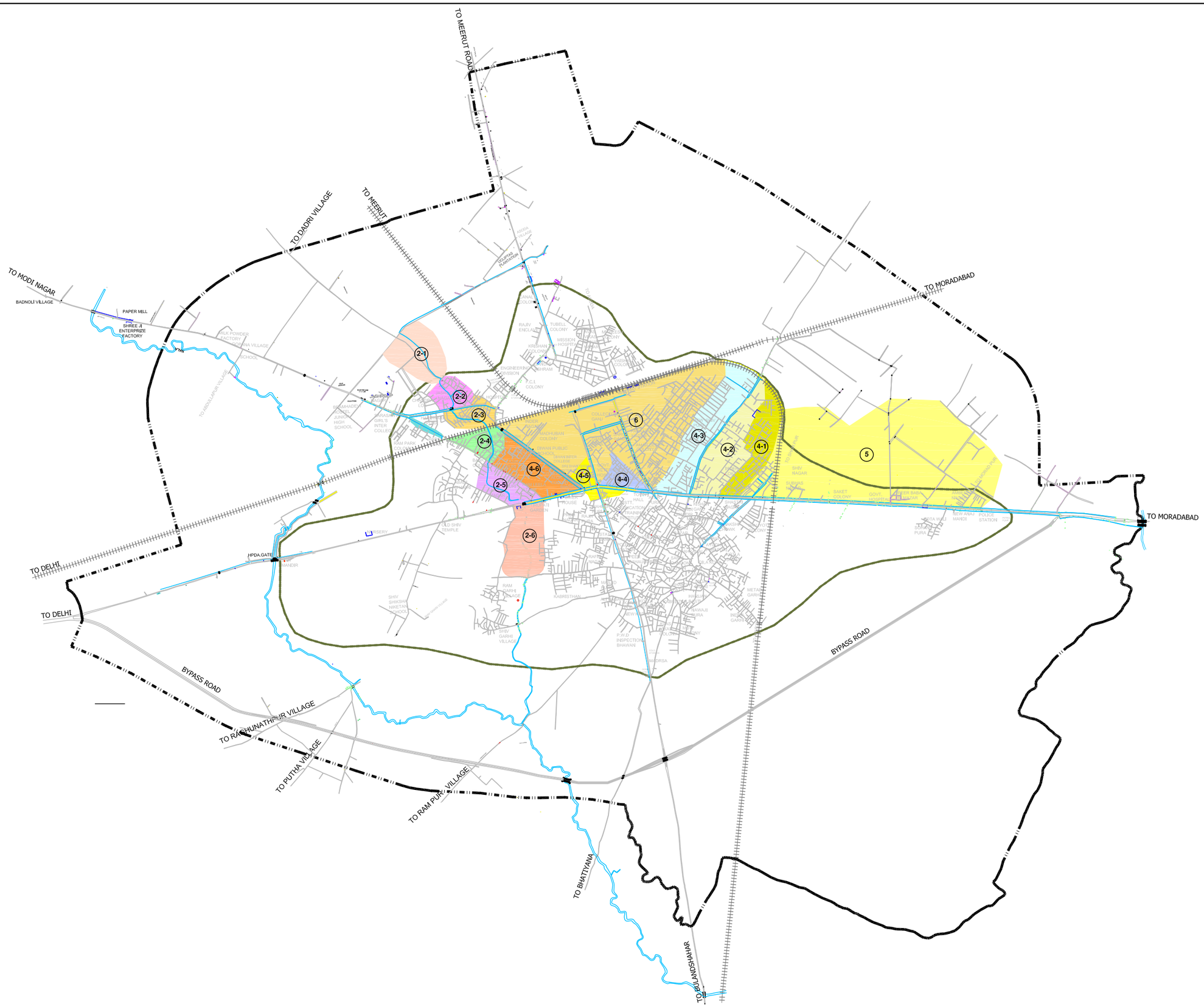
S = Slope of the catchment area.

Table 7-2: Time of Concentration for each sub catchment of Drain No 2

Section	Chainage	Area	Catchment Area in Ha	Length for Time of concentration (L) in m	Difference in RL at u/s and d/s of catchment in m	Slope of catchment (S) (E/D)	Time of Concentration (Tc) in minutes from Kirpich's equation
1	1,750-2,350	2-1(A)	3.2789	465	0.183	0.000394	25
		2-1(B)	6.6135	307	0.095	0.000309	25
2	2,350-2,750	2-2	7.8942	371	0.112	0.000302	25
3	2,750-3,550	2-3	10.8897	829	0.121	0.000146	41.31928
4	3,550-4,250	2-4(A)	5.1453	1308	0.09	6.88E-05	78.41392
		2-4(B)	9.356	365	0.112	0.000307	25
5	4,250-5,050	2-5	23.8209	751	0.205	0.000273	30.09078
6	5,050-6,700	2-6	28.5329	798	0.198	0.000248	32.71085

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Conributory Areas of Various Drains



Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line
- Drain

Overlay Legend

- Drainage Basin 1 for Drain2
- Drainage Basin 2 for Drain 2
- Drainage Basin 3 for Drain 2
- Drainage Basin4for Drain 2
- Drainage Basin 5for Drain 2
- Drainage Basin 6 for Drain 2
- Drainage Basin 1 for Drain 4
- Drainage Basin 2 for Drain 4
- Drainage Basin 3 for Drain 4
- Drainage Basin 4 for Drain 4
- Drainage Basin 5 for Drain 4
- Drainage Basin 6 for Drain 4
- Drainage Basin for Drain 5
- Drainage Basin for Drain 6

Client:
Asian Development Bank
Natlonal Capltal Reglon Plannlng Board

Consultant
Wilbur Smith Associates

Drawn:SK	Checked: HVS
Date: August, 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 7-1

105. For economical viability and fold acceptability, minimum time of concentration of 25 minutes has been considered.

106. *Design intensity of rainfall and coefficient of roughness*. The design intensity of rainfall and coefficient of roughness is based on the time of concentration. The intensity of rainfall is calculated by interpolating values from table 7of chapter 6 and coefficient of roughness from table 6 of chapter 6. The values as interpolated are given in **Table 7-3**.

Table 7-3: Runoff Coefficient for each sub catchment of Drain No 2

Section	Chainage	Area	Catchment Area in Ha	Time of Concentration (Tc) in minutes from Kirpich's equation	Intensity of rainfall (I) corresponding to Tc in mm/hr	Runoff Coefficient (C) corresponding to Tc
1	1,750-2,350	2-1(A)	3.2789	25	51	0.452
		2-1(B)	6.6135	25	51	0.452
2	2,350-2,750	2-2	7.8942	25	51	0.452
3	2,750-3,550	2-3	10.8897	41.31928	23.94458	0.517749
4	3,550-4,250	2-4(A)	5.1453	78.41392	10.15861	0.603462
		2-4(B)	9.356	25	51	0.452
5	4,250-5,050	2-5	23.8209	30.09078	38.95158	0.477327
6	5,050-6,700	2-6	28.5329	32.71085	37.55421	0.486759

107. *Design Discharge*. The discharge has been calculated based on rational formula given below. Following **Table 7-4** shows the discharge for which drain has to be designed

Qp = CIA/360

Where,

Qp – peak flow in m^3 /sec

C – Runoff coefficient

I – design rainfall intensity mm/hr

A – Contributory area in hectares

Table 7-4: Runoff Coefficient for each sub catchment of Drain No 2

Section	Chainage	Area	Catchment Area in Ha	Intensity of rainfall (I) corresponding to Tc in mm/hr	Runoff Coefficient (C) corresponding to Tc	Discharge (Q) in Cum/Sec	Cumulative Discharge in Cum/sec
1	1,750-2,350	2-1(A)	3.2789	51	0.452	0.209	
		2-1(B)	6.6135	51	0.452	0.423	0.633
2	2,350-2,750	2-2	7.8942	51	0.452	0.505	1.138
3	2,750-3,550	2-3	10.8897	23.94458	0.517749	0.375	1.513
4	3,550-4,250	2-4(A)	5.1453	10.15861	0.603462	0.087	
		2-4(B)	9.356	51	0.452	0.599	2.200
5	4,250-5,050	2-5	23.8209	38.95158	0.477327	1.230	16.633
6	5,050-6,700	2-6	28.5329	37.55421	0.486759	1.448	18.082

*The discharge also consist of discharge of 13.203 Cum from Delhi Garh Road drain

108. *Design Sections – Existing*. The existing sections of the drain were surveyed with total station and are in **Table 7-5**. The longitudinal section of the drain is in **Drg No NCRPB-HPR-DR-01 (A&B)**.

Table 7-5: Existing Sections of the Drain No 2

Chainage	Existing width in m	Existing Road/ top Level in m (A)	Existing Drain Level in m (A)	Present Depth in m
1750	-	211.202	-	-
1900	1.50	211.100	210.952	0.148
1950	1.50	211.100	210.928	0.172
2000	1.50	211.100	210.903	0.197
2050	1.50	211.000	210.870	0.130
2100	1.50	211.000	210.850	0.150
2150	1.50	211.000	210.820	0.180
2200	1.50	211.000	210.800	0.200
2250	1.50	211.000	210.780	0.220
2300	1.50	211.000	210.756	0.244
2350	1.50	211.000	210.853	0.147
2400	1.75	211.000	210.840	0.160
2450	2.00	211.000	210.839	0.161
2500	2.00	211.000	210.834	0.166
2550	2.00	211.000	210.828	0.172
2600	2.00	211.100	210.820	0.280
2650	3.20	211.100	210.816	0.284
2700	3.20	211.100	210.810	0.290
2750	2.00	211.100	210.807	0.293
2800	2.00	211.100	210.805	0.295
2850	2.00	211.000	210.820	0.180
2900	2.00	211.000	210.800	0.200
2950	2.00	211.000	210.823	0.177
3000	2.00	210.900	210.847	0.053
3050	2.00	210.900	210.871	0.029
3100	2.00	210.900	210.895	0.005
3150	2.00	210.950	210.918	0.032
3200	2.00	210.950	210.942	0.008
3250	2.00	211.000	210.966	0.034
3300	2.00	211.000	210.990	0.010
3350	2.00	210.800	210.770	0.030
3400	2.00	210.800	210.550	0.250
3450	2.00	210.700	210.339	0.361
3500	2.00	210.700	210.123	0.577
4200	9.29	210.900	210.279	0.621
4250	10.07	210.700	210.022	0.678
4300	10.00	210.500	209.766	0.734
4350	7.78	210.300	209.654	0.646
4400	5.57	210.300	209.657	0.643
4450	3.86	210.400	209.660	0.740
4500	7.68	210.000	209.499	0.501
4550	5.42	209.900	209.338	0.562
4600	7.15	209.900	209.178	0.722
4650	5.61	209.800	209.140	0.660

Chainage	Existing width in m	Existing Road/ top Level in m (A)	Existing Drain Level in m (A)	Present Depth in m
4700	7.67	209.700	209.102	0.598
4750	10.00	209.700	209.065	0.635
4800	8.58	209.600	209.027	0.573
4850	10.81	209.500	208.900	0.600
4900	10.12	209.400	208.950	0.450
4950	10.12	209.400	208.915	0.485
5000	9.76	209.300	208.659	0.641
5050	10.00	209.300	208.403	0.897
5100	9.63	209.200	208.391	0.809
5150	9.90	209.200	208.380	0.820
5200	8.20	209.100	208.369	0.731
5250	6.42	209.000	208.358	0.642
5300	4.89	209.000	208.347	0.653
5350	7.21	209.100	208.393	0.707
5400	5.98	209.100	208.439	0.661
5450	5.82	209.200	208.485	0.715
5500	7.94	209.300	208.532	0.768
5550	6.01	209.000	208.462	0.538
5600	4.95	208.800	208.435	0.365
5650	6.05	208.800	208.409	0.391
5700	5.55	208.800	208.382	0.418
5750	8.03	208.800	208.356	0.444
5800	5.80	208.700	208.322	0.378
5850	5.43	208.700	208.288	0.412
5900	5.35	208.700	208.254	0.446
5950	7.32	208.600	208.182	0.418
6000	7.63	208.500	208.111	0.389
6050	6.22	208.400	208.030	0.370
6100	4.22	208.400	207.968	0.432
6150	8.68	208.300	207.896	0.404
6200	9.48	208.200	207.825	0.375
6250	11.07	208.100	207.753	0.347
6300	3.10	208.000	207.682	0.318
6350	5.06	207.900	207.610	0.290
6400	6.94	207.900	207.539	0.361
6450	14.28	207.900	207.413	0.487
6500	4.95	207.900	207.287	0.613
6550	10.80	207.900	207.219	0.681
6600	10.80	208.100	207.131	0.969
6650	10.80	208.300	207.044	1.256
6700	10.80	208.500	206.957	1.543

109. *Proposed sections.* The sections have been proposed in view of the levels of the drain. The level at the downstream has to be maintained in accordance to the existing level. Accordingly the slope corrections have been made in the drain. The drain has been designed with proper slope. The options of the slopes were considered and finally the slope to maintain the downstream flow and for adequacy of drain to take care of the design discharge has been considered. As such the bed level is fixed and the depth available is fixed. The width required for carrying the storm water discharge has been calculated and is in **Table 7-6**. The capacity of the drain has been calculated from Manning's formula

$V = 1/n \times R^{2/3} \times S^{1/2}$

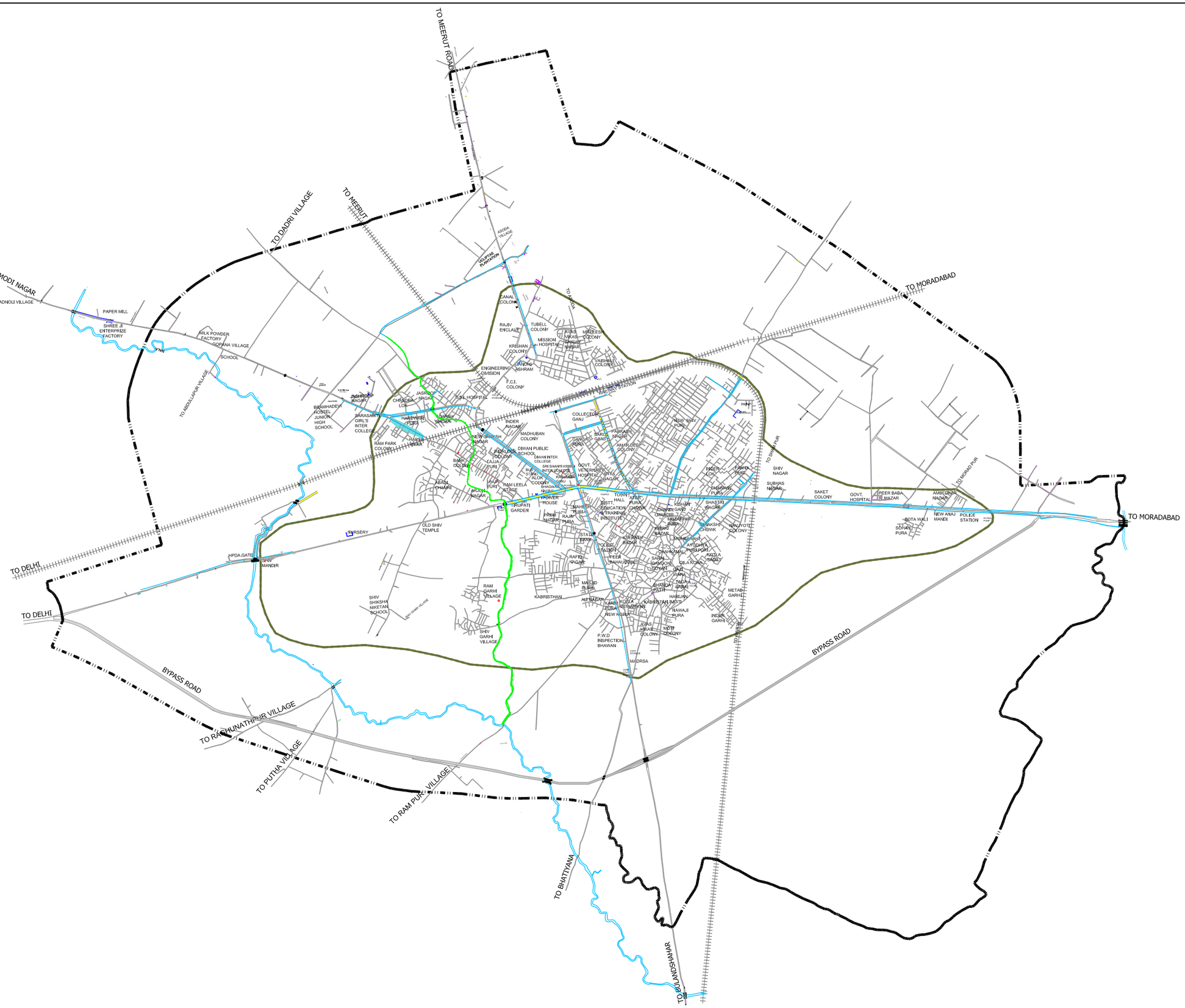
Where,

V = Velocity (m/s); n = Friction Factor; R = Hydraulic Radius (m); and S = Channel Slope (m/m)

Table 7-6: Section Required for Carrying the design discharge

Chainage	Cumulative Discharge from rainfall	Width (m)	Depth (m)	Coefficient of Roughness (n)	CS Area of Drain (A)	Perimeter of Drain (P)	R=A/P	S (1in m)	Velocity (V) in m/sec	Capacity of Drain	Adequacy
1750-2350	0.633	1.5	0.4	0.013	0.6	2.3	0.261	0.0025	1.570	0.942	OK
2350-2750	1.138	2	0.7	0.013	1.4	3.4	0.412	0.0025	2.129	2.980	OK
2750-3550	1.513	2	0.7	0.013	1.4	3.4	0.412	0.0025	2.129	2.980	OK
3550-4250	2.2	2	0.6	0.013	1.2	3.2	0.375	0.003	2.191	2.629	OK
4250-5050	16.633	7	1.2	0.013	8.4	9.4	0.894	0.001	2.257	18.957	OK
5050-6700	18.082	7	1.5	0.013	10.5	10	1.050	0.001	2.513	26.386	OK

110. **Table 7-7** shows the proposed slope, width and RL of the bed and top level for Drain No 2 from chainage 1900 to 6700. **Map 7-2** shows the portion/segment of Drain 2 proposed for improvement and **Drg No NCRPB-HPR-DR-03 (A&B)**.



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Segment of Drain No.2 Proposed for Improvement

Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line
- Existing Drain

Overlay Legend

- Drain Proposed for Improvement

Client:
Aslan Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn:SK	Checked: HVS
Date: August. 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 7-2

Table 7-7: Proposed levels of the Drain No 2

Chainage	Proposed width in m	Proposed top level in m	Proposed bed level in m (B)	Proposed Depth in m
1750	1.5	211.202	210.900	0.30
1900	1.50	211.10	210.750	0.35
1950	1.50	211.10	210.730	0.37
2000	1.50	211.10	210.710	0.39
2050	1.50	211.00	210.690	0.31
2100	1.50	211.00	210.670	0.33
2150	1.50	211.00	210.650	0.35
2200	1.50	211.00	210.630	0.37
2250	1.50	211.00	210.610	0.39
2300	1.50	211.00	210.590	0.41
2350	1.50	211.00	210.570	0.43
2400	1.75	211.00	210.550	0.45
2450	2.00	211.00	210.530	0.47
2500	2.00	211.00	210.510	0.49
2550	2.00	211.00	210.490	0.51
2600	2.00	211.10	210.470	0.63
2650	2.00	211.10	210.450	0.65
2700	2.00	211.10	210.430	0.67
2750	2.00	211.10	210.410	0.69
2800	2.00	211.10	210.390	0.71
2850	2.00	211.00	210.370	0.63
2900	2.00	211.00	210.350	0.65
2950	2.00	211.00	210.330	0.67
3000	2.00	210.90	210.310	0.59
3050	2.00	210.90	210.290	0.61
3100	2.00	210.90	210.270	0.63
3150	2.00	210.95	210.250	0.70
3200	2.00	210.95	210.230	0.72
3250	2.00	211.00	210.210	0.79
3300	2.00	211.00	210.193	0.81
3350	2.00	210.80	210.177	0.62
3400	2.00	210.80	210.160	0.64
3450	2.00	210.70	210.143	0.56
3500	2.00	210.70	210.127	0.57
4200	9.29	210.90	210.279	0.62
4250	10.07	210.70	209.400	1.30
4300	10.00	210.50	209.350	1.30
4350	7.78	210.30	209.300	1.15
4400	6.00	210.30	209.250	1.20
4450	6.00	210.40	209.200	1.35
4500	7.68	210.00	209.150	1.00
4550	6.00	209.90	209.100	0.95
4600	7.15	209.90	209.050	1.00
4650	6.00	209.80	209.000	0.95
4700	7.67	209.70	208.950	0.90
4750	10.00	209.70	208.900	0.95
4800	8.58	209.60	208.850	0.90
4850	10.81	209.50	208.800	0.85

Chainage	Proposed width in m	Proposed top level in m	Proposed bed level in m (B)	Proposed Depth in m
4900	10.12	209.40	208.750	0.80
4950	10.12	209.40	208.700	0.85
5000	9.76	209.30	208.650	0.80
5050	10.00	209.30	208.600	0.85
5100	9.63	209.20	208.550	0.80
5150	9.90	209.20	208.500	0.85
5200	8.20	209.10	208.450	0.80
5250	6.00	209.00	208.400	0.75
5300	6.00	209.00	208.350	0.80
5350	7.21	209.10	208.300	0.95
5400	6.00	209.10	208.250	1.00
5450	6.00	209.20	208.200	1.15
5500	7.94	209.30	208.150	1.30
5550	6.01	209.00	208.100	1.05
5600	6.00	208.80	208.050	0.90
5650	6.05	208.80	208.000	0.95
5700	6.00	208.80	207.950	1.00
5750	8.03	208.80	207.900	1.05
5800	6.00	208.70	207.850	1.00
5850	6.00	208.70	207.800	1.05
5900	6.00	208.70	207.750	1.10
5950	7.32	208.60	207.700	1.05
6000	7.63	208.50	207.650	1.00
6050	6.22	208.40	207.600	0.95
6100	6.00	208.40	207.550	1.00
6150	8.68	208.30	207.500	0.95
6200	9.48	208.20	207.450	0.90
6250	11.07	208.10	207.400	0.85
6300	6.00	208.00	207.350	0.80
6350	6.00	207.90	207.300	0.75
6400	6.94	207.90	207.250	0.80
6450	14.28	207.90	207.200	0.85
6500	6.00	207.90	207.150	0.90
6550	10.80	207.90	207.100	0.95
6600	10.80	208.10	207.050	1.20
6650	10.80	208.30	207.000	1.45
6700	10.80	208.50	206.957	1.69

111. *Technical options*. The option of retaining wall of masonry and cement concrete was considered. In view of the space available, the cement concrete retaining wall has been considered for section 1700 to 2350 whereas in the outskirts of the city from 4250 to 6700, the masonry section has been considered. **The Drg No NCRPB-HPR-DR-04** shows the typical detail of the masonry retaining walls for different heights. **Drg No NCRPB-HPR-DR-05** shows the typical detail of the cement concrete retaining walls.

112. The cross sections at each section are shown in **Drg No NCRPB-HPR-DR-06 (A&B)**. The drains have been provided with a central cunett for dry weather flow. For width of drain up to 3m, the cunett size of 0.3 m wide and 0.3 m depth has been considered whereas for drain with 6 m wide, the cunett section of 0.5m x 0.5 m has been considered. The drain

section with 10 m width, the cunett section of 0.5m X 1m has been considered. The slope of 1 in 20 is provided in the bed towards the centre of the cunett. At crossing of the road, box girders have been proposed. The **Drg No NCRPB-HPR-DR-07A** shows the box girder for 3m width section and **Drg No NCRPB-HPR-DR-07B** shows the box girder for 6m width section.

113. The section-wise proposed works are as follows:

(i) Ch1750 to 2350: The new drain has to be constructed. The cement concrete section has been considered. The levels have been indicated in the L section.

(ii) Ch2350 to 2700: The drain need to be channelized and made pucca with cement concrete retaining wall and CC flooring. The existing width is sufficient to carry the design storm water discharge. The levels have been indicated in the L section.

(iii) Ch2700 to 3550: At chainage 2700-2750 has Modinagar road crossing. The large area is available where the water disperses. This area near to the road crossing acts as water recharging and reduces the discharge in the downstream. The pucca drain has been constructed which passes through the habitation. The drains are full of black water. In this section, it is proposed to clean the drain and level the base and make the cement concrete floor. In some portions the wall of the drain has been broken or inexistent, the same has to be repaired or constructed as necessary.

(iv) Ch3550 to 4250: The drain crosses the road just at the upstream of Ch3550. The level of the road restricts the flow of the drain and a culvert also exists below the road. The solid waste dumping place is at the edge of the drain. The solid waste dumping into the drain at this road junction has to be stopped immediately. The drains are full of black water. In this section, it is proposed to clean the drain and level the base and make the cement concrete floor. In some portions the wall of the drain has been broken or inexistent, the same has to be repaired or constructed as necessary. The width of the existing drain restricts between chainage3750 to 3900. This needs to be widened to at least required width of 2m.

(v) Ch4250 to 6700: The drain crosses the Delhi Garh road at section 4200-4250. The retaining wall has to be constructed for proper inlet into the culvert. The drain has to be made pucca and channelized as per the drawing. At Ch5050, the box culvert has to be constructed for crossing the road at Rampur village.

114. *Details of works proposed*. The details of the work to be done for Construction of drain in courses where the drain is nonexistent between chainage 1750 to 4200 and Channelization and construction of pucca drain from chainage 1750 to chainage 6700 are as follows:

(i) Wooden balli with horizontal PVC strips Barricading is provided on both side of drain, where construction is proposed;

(ii) Cleaning jungle including up rooting of rank, vegetations grass, push, wood trees and samplings of girth for the area of the drain near Modi Nagar section and along the drain;

(iii) De-silting of Existing Drain

(iv) Excavation of Drain for making proper slope correction.

(v) Transportation of excess earth is proposed with a lead of 5 Km.

(vi) Construction of CC retaining wall from section 1700 to 2350.

(vii) Construction of broken or missing walls in section 3500 to 4250.

(viii) Construction of masonry retaining wall with cement mortar of 1:6 mix from section 4250 to 6700

(ix) Base concrete of 1:4:8 as per drawings.

(x) PCC flooring with 1:2:4 (M – 20) as per drawings.

(xi) Provision of 80 mm thick cunett for size as per drawings

(xii) Cement concrete and BT road cutting is proposed as required.

(xiii). Reinstatement of CC road.

(xiv). Weep holes will be provided on both sides of masonry wall at 1 no per Sq m in horizontal and vertical both directions.

2. Drain No 4

115. The drain on Delhi Garh road flows in 2 directions. The main drain carries storm water of the Hapur city to the Drain No 2 at junction of Tirupati Garden Hotel. The detail study from chainage 4400 to 6450 has been done. **Map 7-3** shows the section considered for renovation and rehabilitation.

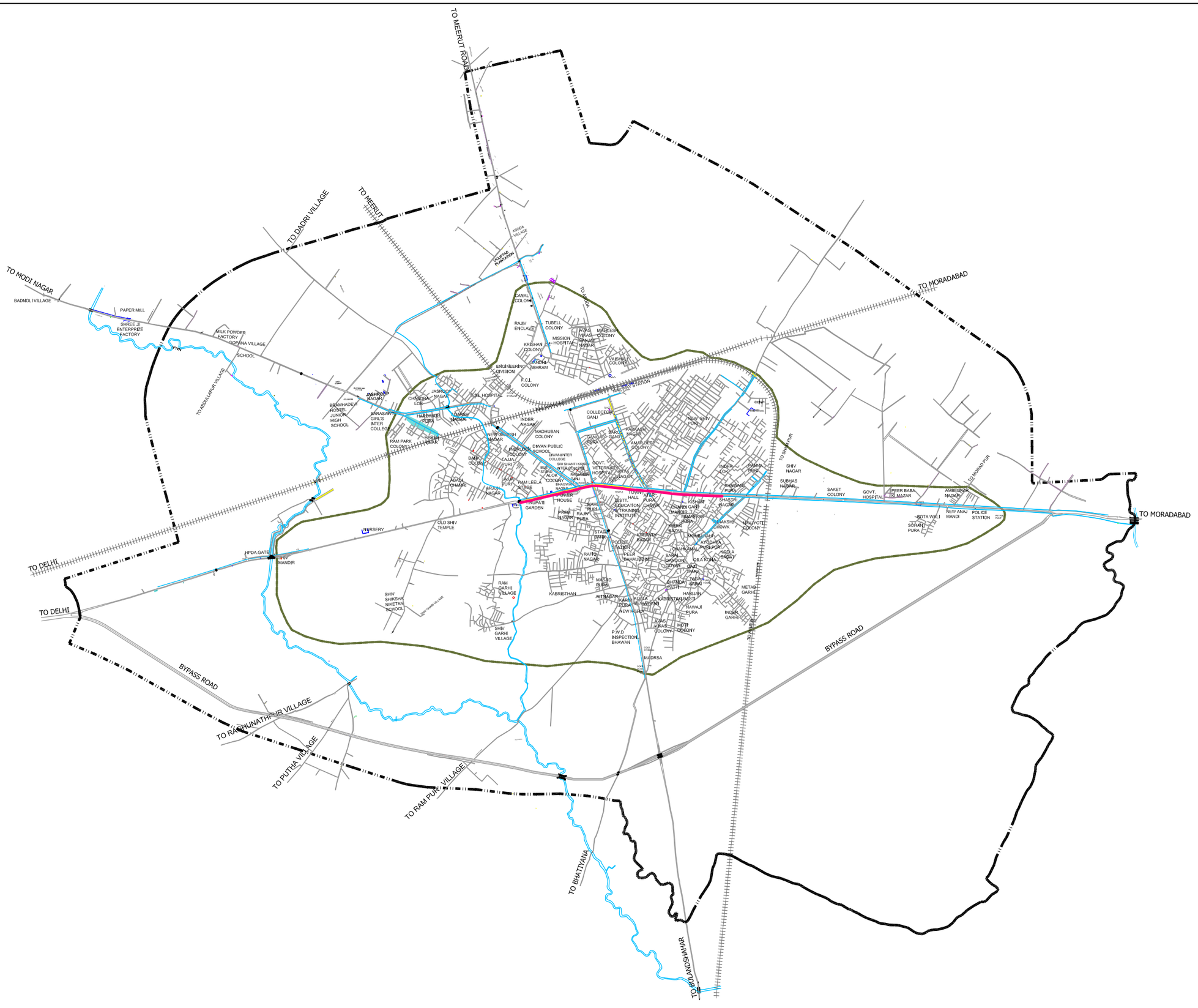
116. *Contributory Area*. The contributory area for the different reaches of the drain has been demarcated as shown in **Map 7-1**. The contributory area has been marked based on the contours/Reduced levels of the area and lanes/ drains contributing to the drain. The area of sub-catchment area is as in **Table 7-8**.

Table 7-8: Catchment area for each chainage of Drain No 4

Section	Chainage	Node	Catchment Area in ha
1	Ch4400-4530	1-2'	25.4076
2	Ch4530-4830	2-3'	33.8189
4.2		4.2-4.1'	35.4204
4.2		4.2-4.1'	6.7337
4.1		4.1-4'	32.8262
3	Ch4830-5190	3-4'	43.1018
5.2		5.2-5.1'	3.3260
5.1		5.1-5.0'	6.2630
5.3		5.3-5.0'	3.0696
4	Ch5190-5730	4-5'	8.4811
5	Ch5730-5880	5-6'	4.3219
6	Ch5880-6450	6-7'	23.8029

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Hapur
Segment of Drain 4 Proposed for Improvement



Legend

- Master Plan Boundary
- Municipal Boundary
- Bypass Road
- Road
- Railway Line
- Drain

Overlay Legend

- Renovation of Drain

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn:SK	Checked: HVS
Date: August, 2009	Approved: NSS

Scale: 0 300 600 900 1200 Meters

Map 7-3

117. *Time of Concentration*. The time of concentration has been calculated based on Kirpich Time of Concentration (in minutes) Equations. **Table 7-9** shows time of concentration for each sub catchment.

Table 7-9: Time of Concentration for each sub catchment of Drain No 4

Section	Chain-age	Node	Catchment Area in ha	Length for Time of concentration (L) in m	Difference in RL at u/s and d/s of catchment in m	Slope of catchment (S) (7/6)	Time of Concentration (Tc)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	4400-4530	1-2'	25.4076	1112	0.215	0.000193	46.489
2	4530-4830	2-3'	33.8189	1421	1.33	0.000936	30.595
4.2		4.2-4.1'	35.4204	1206	0.3	0.000249	44.911
4.2		4.2-4.1'	6.7337	586	0.1	0.000171	29.786
4.1		4.1-4'	32.8262	1496	0.3	0.000201	57.603
3	4830-5190	3-4'	43.1018	1565	0.74	0.000473	42.865
5.2		5.2-5.1'	3.326	255	0.2	0.000784	25
5.1		5.1-5.0'	6.263	475	0.1	0.000211	25
5.3		5.3-5.0'	3.0696	211	0.1	0.000474	25
4	5190-5730	4-5'	8.4811	324	2.09	0.006451	25
5	5730-5880	5-6'	4.3219	392	2.305	0.00588	25
6	5880-6450	6-7'	23.8029	751	0.755	0.001005	25

118. In view of economical viability with flood acceptability, minimum time of concentration of 25 minutes has been kept.

119. *Design intensity of rainfall and coefficient of roughness*. The design intensity of rainfall and coefficient of roughness is based on the time of concentration. The intensity of rainfall is calculated by interpolating values from table7of chapter 6 and coefficient of roughness from table 6 of chapter 6. The values as interpolated are in **Table 7-10**.

Table 7-10: Runoff Coefficient for each sub catchment of Drain No 4

Section	Chainage	Node	Time of Concentration (Tc)	Intensity of rainfall (I) corresponding to Tc	Runoff Coefficient (C) corresponding to Tc
(1)	(2)	(3)	(4)	(5)	(6)
1	Ch4400-4530	1-2'	46.489	20.106	0.534
2	Ch4530-4830	2-3'	30.595	38.047	0.479
4.2		4.2-4.1'	44.911	21.070	0.530
4.2		4.2-4.1'	29.786	39.512	0.475
4.1		4.1-4'	57.603	14.958	0.562
3	Ch4830-5190	3-4'	42.865	22.707	0.523
5.2		5.2-5.1'	25	51	0.452
5.1		5.1-5.0'	25	51	0.452

Section	Chainage	Node	Time of Concentration (Tc)	Intensity of rainfall (I) corresponding to Tc	Runoff Coefficient (C) corresponding to Tc
5.3		5.3-5.0'	25	51	0.452
4	Ch5190-5730	4-5'	25	51	0.452
5	Ch5730-5880	5-6'	25	51	0.452
6	Ch5880-6450	6-7'	25	51	0.452

120. *Design Discharge*. The discharge calculation is shown in **Table 7-11**.

Table 7-11: Cumulative Discharge for each chainage of Drain No 4

Section	Chainage	Node	Catchment Area in ha	Intensity of rainfall (i) corresponding to Tc	Runoff Coefficient (c) corresponding to Tc	Discharge (Q)	Cumulative Discharge
(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
1	4400-4530	1-2'	25.4076	20.106	0.534	0.758	0.758
2	4530-4830	2-3'	33.8189	38.047	0.479	1.712	2.471
4.2		4.2-4.1'	35.4204	21.070	0.530	1.100	1.100
4.2		4.2-4.1'	6.7337	39.512	0.475	0.351	1.451
4.1		4.1-4'	32.8262	14.958	0.562	0.767	2.219
3	4830-5190	3-4'	43.1018	22.707	0.523	1.422	6.113
5.2		5.2-5.1'	3.326	51	0.452	0.212	0.212
5.1		5.1-5.0'	6.263	51	0.452	0.401	0.401
5.3		5.3-5.0'	3.0696	51	0.452	0.196	0.196
4	5190-5730	4-5'	8.4811	51	0.452	0.543	7.254
5	5730-5880	5-6'	4.3219	51	0.452	0.276	8.309
6	5880-6450	6-7'	23.8029	51	0.452	1.524	13.203

121. *Existing sections*. The sections of existing Drain No. 4 are in given in **Table 7-12**. These needs to be checked for adequacy. As such the sections have been checked at critical sections only. As the drain is in both sides of the road, both the sections have been indicated.

Table 7-12: Existing Sections of Drain No 4

Section	Chainage	Width (m)	Depth (m)
(1)	(2)	(3)	(4)
Section 1	4530	0.8	0.6
		1	0.85
Section 2	4830	0.8	0.65
		1.1	1.58
Section 3	5190	1.3	0.8
		1	0.8
Section 4	5730	2	1
		1.5	1.10
Section 5	5880	2	1.1
		1.5	1.01
Section 6	6540	2.1	1.8
		2	2.08

122. *Adequacy of the proposed section*. The proposed section has been checked for the adequacy of the capacity of the drain to cater the design discharge with calculating capacity by Manning's formula and is in **Table 7-13**.

Table 7-13: Adequacy Check of Sections of Drain No 4

Section	Width (m)	Depth (m)	Coefficient of Roughness (n)	CS Area of Drain (A)	Perimeter of Drain (P)	R=A/P	1 in S	Velocity (V) in m/sec	Discharge (Cum/Sec)	Capacity (Cum/ sec)	Discharge from rainfall (Cum/ Sec)	Adequacy
Section 1	0.8	0.6	0.013	0.48	2	0.240	0.002	1.329	0.638	1.991	0.759	OK
	1	0.85	0.013	0.85	2.7	0.315	0.002	1.592	1.353			
Section 2	0.8	0.65	0.013	0.52	2.1	0.248	0.002	1.357	0.705	3.994	1.713	OK
	1.1	1.58	0.013	1.738	4.26	0.408	0.002	1.892	3.289			
Section 3	1.3	0.8	0.013	1.04	2.9	0.359	0.002	1.736	1.806	3.060	1.594	OK
	1	0.8	0.013	0.8	2.6	0.308	0.002	1.568	1.254			
Section 4	2	1	0.013	2	4	0.500	0.002	2.167	4.334	7.647	7.255	OK
	1.5	1.1	0.013	1.65	3.7	0.446	0.002	2.008	3.313			
Section 5	2	1.1	0.013	2.2	4.2	0.524	0.002	2.235	4.918	7.889	8.329	OK
	1.5	1.01	0.013	1.515	3.52	0.430	0.002	1.961	2.971			
Section 6	2.1	1.8	0.013	3.78	5.7	0.663	0.002	2.616	9.889	20.904	13.273	OK
	2	2.08	0.013	4.16	6.16	0.675	0.002	2.648	11.016			

123. *Technical options*. As per the above table, the section appears to be sufficient to take care of the design discharge. However, many flood prone areas are adjoining this drain. The main reason of flooding as investigated in the field is as follows:

(i) Carriage of sewer into the drain

(ii) The drain adjoining Rajkiya Krishi Beej Bhandar, Surya Vihar Market, AK & associates, sonu electric store and power house have arch culvert which reduces the section at particular junction. **Photo 16** shows the arch culvert. This needs to be dismantled and replaced with the box culvert.


Photo 16

(iii) In many stretches the drain section reduces as top bed level reduces due to entry to the nearby areas. This is particular at Hapur Nagar palika office gates, Bank of Baroda, shivnandan Prasad timber shop. **Photos 17 and 18** show the reducing of section due to entry to the shops/ property. This can be handled through provision of box culvert with ramp for accessing the areas.


Photo 17


Photo 18

(iv) In many sections the side wall has been damaged and needs to be repaired. The **Photos 19 and 20** shows the damaged wall.


Photo 19


Photo 20

(v) At Atarpura chouraha, the alignment of the drain is through back side of the shops and as such difficult for operation and maintenance. **Photo 21** shows the drain entering under the shop. As such it is suggested to construct a link.

(vi) For preventing the drain from solid waste management a drain covers are proposed which may be removed for cleaning purpose. **Photos 22 and 23** show the uncovered area of the drain.

vii) The entry of storm water to the drain has been blocked. **Photo24** shows the blockage into the drain. As such proper entry has to be provided for preventing floods on the road.

124. *Details of work proposed*.

(i) Dismantling of Arch culverts

(ii) Provision of Box culverts replacing brick arch culverts

(iii) Provision of ramp for assess to properties

(iv) Repair of masonry wall

(v) Construction of new channel at Aterpura choraha with provision of box culverts

(vi) Cement concrete and BT road cutting is proposed as required

(vii) Parapet wall is provided 15 cm above on both side of drain.

(viii). Inlet slots will be left in road side parapet wall for the entering of run – off into drain 10 m c/c distance.

(ix) RCC Slab road crossings are provided as per IRC SP – 13 plate no. 6 wherever road crossings come.

(x) covering of Drain all along the length with pre – cast RCC M – 20 slabs, except in the length of road crossings and drain openings which are provided for cleaning of drain.

8. COST ESTIMATES & CONTRACT PACKAGES

A. Cost Estimates

126. Based on the designs Bill of Quantities (BOQ) for works has been worked. Costs are based on "Uttar Pradesh Lok Nirman Vibhag Schedule of Rates for Bulandsahar, Gautam Budh Nagar & Ghaziabad districts (enforced from 20 June 2008). For items not in this SOR, the rates have been taken from "CPWD Schedule of Rates 2007".

127. The price contingency at 6% per year has been considered to bring the cost estimates applied to current market rate. Additional provision for 5% for DSC+TPI, IEC activities 1%, Physical contingency 5%, Environmental mitigation, Social intervention 1%, Institutional development and capacity building 1% has been considered.

128. The Bill of Quantities along with the quantity sheet for different works under this package has been given in **Appendix 1**. **Table 8-1** shows the abstract of cost for the work.

Table 8-1: Abstract of Drainage Work at Hapur

S. No.	Description	Cost (Rs)
1	Civil Works as per BOQ	132,553,247
2	Contingency (14 % of total cost as given below)	
(i)	Design and Supervision consultancy and TPI (3%)	3,976,597
(ii)	IEC activity (1%)	1,325,532
(iii)	Physical Contingency (3%)	3,976,597
(iv)	Environmental mitigation (as per EMP)	11,625,000
(v)	Social Intervention (1%)	1,325,532
(vi)	Institutional Development (1%)	1,325,532
(vii)	Incremental Administration (2%)	2,651,065
(vii)	Total	**158,759,102**

B. Contract Packages

129. The work of channelization, rehabilitation and renovation of Drain No 2 and Drain No 4 has been identified. As the work is of similar nature, only one package has been considered.

Table 8-2: Indicative Contract Package

S. No	Contract Package	Contract Package No	Value		Suggested Method
			INR mn	US $ mn	
1	Renovation/Remodeling of Drain 2 and Drain 4 in Hapur	HPR-SWD/01	158.76	3.3	NCB

NCB – National Competitive Bidding

APPENDICES

Appendix 1: Detailed Cost Estimates

Table 1: Hapur Drainage Abstract Estimate

S. No	Description		Cost (Rs)
1	Civil Works as per BOQ		132,553,247
2	Contingency		
(i)	Design and Supervision Consultancy and Tender Premium	3%	3,976,597
(ii)	IEC Activity	1%	1,325,532
(iii)	Physical Contingency	3%	3,976,597
(iv)	Environmental Mitigation	LS	11,625,000
(v)	Social Intervention	1%	1,325,532
(vi)	Insttitutional Development	1%	1,325,532
(vii)	Incremental Administration	2%	2,651,065
	Total Project Cost including Contigency		**158,759,104**

Table 2: Bill of Quantities (BOQs) for Strengtening of Drain No 2 and 4 in Hapur

S. No.	Description of Item	Reference	Unit	Rate (Rs.)	Quantity	Amount
1	Cleaning jungle including up rooting of rank, vegetations grass, push, wood trees and samplings of girth up to 30 cms measured at a height of 1 m above ground level and removal of rubbish up to a distance of 50 m out side the periphery of area cleared	4.06 pg 16	Per % Sqm	190.80	270	51,516
2	Earth work in cutting or in embankment in ordinary soil excavation to be in the form of regular pits not exceeding 0.50 M. in depth and earth work in embankment to be in 20 cm. layers including remming and dressing the surface to required levels and slopes and also **including 1.50 M. lift** and 30 M. lead. The earth from cutting to be used in making embankment or to be deposited as spoil banks with-in 30 M. distance as directed by the Engineer incharge. Including Royallity.	4.03 Pg 15	Per % cum	4,134.00	17,730	732,958
2	Contingency	4.04 pg 16	Per % cum	4,664.00	550	25,652
	Cartage of earth including loading and unloading upto 5 Km	3.01 Pg 11	Per Cum	34.98	19,377	677,807
	Erection of barricades consisting of two rows of horizontal wooden ballies 8 cm dia at 45 cm center to center and vertical posts of 8 cm x 10 cm size wooden bargas or 10 cm dia ballies 2.10 meter center to center 1 meter to 1.25 meter projection above ground level and 0.45 m embedded below ground level, securely tightened with superior quality of fine narial rope, inculding supply of all materials, labour, tools & plants etc required for prper completion of work as directed by Engineer in charge including its removal, levelling and dressing of the site when done with.	20.32 Pg 56	Per RM	59.36	5,450	323,512
6	Cement Concrete with 4 cm gauge approved stone ballast, coarse sand & cement in the proportion of 8:4:1 including supply of all materials, labour, Tools & plants etc. required for proper completion of the work.	5.08 pg 19	cum	2,650.00	10,675	28,288,750
7	RCC work with cement, approved coarse sand & 2 cm gauge approved stone grit in proportions of 1:2:4 in slabs excluding supply of reinforcement and its bending, but including its fixing and binding the same with 24 BWGGI binding wire and including necessary centring and shuttering etc. and supply of all materials, labour, tools & plants etc required for proper completion of the work including cost of binding wire. The rates excludes making of drip course which shall be paid extra.	5.10 pg 19	cum	3,850.00	3,350	12,897,500
8	Providing and placing in position precast reinforced cement concrete waffle units square or rectangular as per design and shape for floors and roofs in 1:1.5:3 (1 Cement:1.5 coarse sand: 3 graded stone aggregate 10 mm nominal size) including flush or deep ruled pointing at joints in cement mortar 1:2 (1 cement: 2 fine sand), making necessary holes of required sizes for carrying through service lines etc., providing steel hooks for lifting etc, form work in precasting, handling, hoisting, centering and erection complete for all floor levels but excluding the cost of reinforcement	DSR item 15.36 Pg 94	cum	10,264.14	249	2,555,771

S. No.	Description of Item	Reference	Unit	Rate (Rs.)	Quantity	Amount
9	Extra for laying cement concrete in or under water and /or liquid mud including cost of pumping or bailing out water and removing slush etc: complete	DSR item 5.31 Pg 93	cum	202.44	11,220	2,271,377
10	M-150 Brick work in 1:4 one cement & four fine sand of 1.25 FM mortar in foundation and plinth including supply of all materials, labour, Tools & Plants etc required for proper completion of the work.	6.04 pg 21	cum	2,226.00	23,270	51,799,020
11	MS (tor steel or plain) in Plain work such as RCC or RB work including bending for proper shape and including supply of steel & its wastage, bend, hooks and authorised overlapping shall be measured and including supply of steel and including cost of binding wire.	10.05 pg 27	per Qtl	5,194.00	4,340	22,541,960
12	MS or iron work in purlins and rafters including drilling holes and fixing in position and including supply of all steel and bolts and nuts, wastage, labour and tools and plant etc required for proper completion of work	10.04 pg 27	per Qtl	5,724.00	1,050	6,010,200
13	Dismantling reinforced cement concrete or reinforced brick work including stacking of materials as directed by Engineer in charge within a distance of 60 meter (200 ft).	17.04 pg 46	cum	275.60	530	146,068
14	Dismantling of flexible pavement (bituminous courses) by mechanical means and disposal of dismantled material up to a lead of 1000 meters as per direction of Engineer in charge.	DSR item 15.59 Pg 231	cum	118.94	107	12,727
15	Supplying and laying water bound macadam sub base (GSB) with brick aggregate and binding material, earth etc including screening,sorting and spreading to tempelate and consolidation with light power road roller etc complete including cost of moorum etc.	DSR item 16.5.1 & 16.3.10	cum	558.05	45	25,112
16	Providing, laying ,spreading and compacting stone aggregate of specified sizes to WBM specifications including spreading in uniform thickness, hand picking, rolling with 3 wheeled road/vibratory roller 8-10 tonne in stages to proper grade and camber, applying and brooming requisite type of screening/binding material to fill up interstices of coarse aggregate watering and compacting to the required density. wooden or steel rammers and rolling over 3rd and top most layer with power roller of minimum 8 tonnes and dressing up, in embankments for roads, flood banks, marginalbanks and guide banks etc lead upto 50 m and lift upto 1.5 m as per table 400-7 of MoRT&H specifications for all kinds of soil.	DSR item 16.4				
a	Hand broken - Grade-I (90-45mm)		cum	934.85	22	20,567
b	Hand broken - Grade-II (63-45mm)		cum	961.00	17	16,337
c	Crusher broken - Grade-III (53-22.4mm)		cum	1,003.10	17	17,053
17	Providing and applying tack coat using hot straight run bitumen of grade 80/100 including heating the bitumen, spraying the bitumen with mechanically operated spray unit fitted on bitumen boiler,cleaning and preparing the existing road surface as per MoRT&H specifications on WBM new surface @ 0.75 kg/sqm	DSR item 16.30	Sqm	23.90	220	5,258

S. No.	Description of Item	Reference	Unit	Rate (Rs.)	Quantity	Amount
18	2 cm premix carpet surfacing with 1.8 cum and 0.9 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively including a tack coat with hot straight run bitumen including consolidation with road roller of 6-9 tonne capacity etc. complete (tack coat to be paid separately) with paving asphalt 80/100 heated and then mixed with solvent at the rate of 70 gms per kg of asphalt.	DSR item 16.32.1	Sqm	81.95	220	18,029
19	Providing and laying seal coat over prepared surface of road with bitumen heated in bitumen boiler fitted with the spray set spraying using 98 kg of bitumen of grade 80/100 and binding surface with 0.90 cum of stone aggregate of 6.7 mm size (passing 11.2 mm sieve and retained on 2.36 mm sieve) per 100 sqm of road surface including rolling and finishing with power road roller all complete.	DSR item 16.41	Sqm	50.00	220	11,000
20	Laying CC road slab 10 cm (4") thick consisting of 1:2:4 cement, coarse sand & approved 2 cm (3/4") gauge stone ballast over prepared sub grade after its rectifications & bringing it to proper camber and including supply of all materials, labour and T&P etc spreading the concrete, compacted using plate and needle vibrators and finished in continuous operation including provision of joint filler board 20 mm thick as per IS 1838 bitumen sealant, curing of concrete slabs for 14 days and water, finishing to lines and grade as per drawing and required for proper completion of work finished to required template as directed by Engineer in charge but excluding cost of metal required for rectification of the sub metal. As per PWD specification	20.39 (b) pg 58	Sq m	4,664.00	100	466,400
21	Providing and fixing in position weep holes of A. C. pipes of dia. 100mm of approved quality as per MOST specification clause 2706 complete in all respect including filter material as per direction of Engineer-in- charge.	Code 2023 of water supply SOR for Baghpat, bulandsahar, gautam buddha nagar, ghaziabad and merrut distrcits	Rm	-	10,450	-
22	Providing and filling in position 12 mm thick bitumen inpregnated fibre board confirming to IS:1838 including cost of primer, sealing compound in expansion joints	DSR item 5.28 pg 92	per cm depth per cm width per 100 m	374.70	9,711	3,638,673

S. No.	Description of Item	Reference	Unit	Rate (Rs.)	Quantity	Amount
23	Pumping out water caused by springs, tidal or river seepage, broken water mains or drains, sewage and the like with pumping set of following H.P. including P.O.L./ Power consumption etc. complete.	Non SOR	per hr	42.00	16200.00	680400.00
24	Earth work in Excavation for removal of sludge/debris/ solid waste (saturated in water or dry) and cleaning of **drains** and disposal of excavated debris and solid wast i/c all lead and lift as directed by Engineer	Non SOR	cum	225.00	7750.00	1743750.00
	TOTAL					**132,553,247**

Note: The price contingency at 6% per year has been considered to bring the cost estimates applied to current market rate. As such 6% contingeny has been done for items from PWD SOR 2007 and 12% contingency on item from DSR 2008.

Table 3: Measurement Sheet for Drain No 4

S.No	Description	Units	No's	Length	Breadth	Depth	Quantity	Say
1	Dismantling of brick work		6	3.00	1.50	0.45	12.15	15.00
	Contingency	**say**						15.00
2	Excavation		1	90.00	2.00	1.65	297.00	
			1	25.00	3.00	1.65	123.75	
							420.75	430.00
	Cartage							460.00
3	Iron work	**Qtl**		200.00	2.00		40.00	50.00
4	Brick masonary		1	220.00	0.20	1.50	66.00	70.00
5	Barricading		1	2,300.00				2,300.00
6	Cement concrete M 10		1	2,300.00	0.30	0.10	69.00	75.00
7	Cement concrete M 20							
	For base		1	2,300.00	2.00	0.01	46.00	
	RCC for ramp		7	5.00	1.50	0.30	15.75	
	RCC for coping		2	2,300.00	0.40	0.01	18.40	
	Covers			3,220.00	2.00	0.15	966.00	
	Total						1,046.15	1,050.00
8	RCC for box culvert						61.20	65.00
9	Steel for box culvert and ramp						1,338.00	1,340.00
10	Dismantling of flexible pavement		8	3.00	2.00	0.30	14.40	35.00
11	CC road		8	3.00	2.00		48.00	120.00

Table 4: Measurement Sheet for Drain 2 (Choya Nalla)

S.No	Description	Units	No's	Length	Breadth	Depth	Quantity	Remarks
				m	m	m	m3	
1	Site Clearance	100 sqm	1.00				270	Appendix 1
2	Contingency							
	0 to 1.5 m						17,300	Appendix 2
	1.5 m to 3 m						550	
3	Barricading	m					3,150	
4	CC M 10							
	Retaining wall							
	Ch 1750 to 2250			500	1.40	0.10	140	
	Ch 2250 to 2600			350	1.40	0.10	98	
	Ch 2600 to 2700			100	1.40	0.10	28	
	Ch 2700 to 4150			290	1.40	0.10	81	
	Ch 4150 to 5000			850	2.10	0.15	536	20% length considered
	Ch 5000 to 6700			1,700	2.10	0.15	1,071	
				1,700	9.00	0.20	3,060	
	Base						4,618	Appendix 3
	Total						9,631	
							10,594	
	say	cum					10,600	
5	CC M20							
	wall						1,732	Appendix 4
	Base							
	Ch 1750 to 2250			500	1.20	0.01	6	
	Ch 2250 to 2600			350	1.50	0.01	5	
	Ch 2600 to 2700			100	2.70	0.01	3	
	Ch 2700 to 4150			290	5.70	0.01	17	
	Ch 4150 to 5000			850	8.00	0.01	68	
	Ch 5000 to 6700			1,700	9.00	0.01	153	
	cunnet							
	Ch 1750 to 2700			950	0.90	0.01	9	
	Ch 2700 to 4150			290	1.50	0.01	4	
	Ch 4150 to 6700			2,550	2.00	0.01	51	
	Total						2,048	
	contingency 10%						2,253	
	say	cum					2,300	
6	Box culvert						184	Appendix 5
7	Reinforcement (1.2 Qtl/ Cum)	Qtl					2,981	1.2 x (item 5+Item 6)
	say						3,000	
8	Brick masonary							
	Ch 4150 to 6700			2,550	0.60	0.50	1,530	
				2,550	0.90	0.50	2,295	
				2,550	1.35	0.50	3,443	
				2,550	1.80	1.50	13,770	
							21,038	
	contingency 10%						23,141	
		cum					23,200	

S.No	Description	Units	No's	Length	Breadth	Depth	Quantity	Remarks
9	Dismantling of RCC	cum					500	LS
10	Dismantling of flexible pavement		4.00	3	2.00	0.30	7	
			9.00	3	6.00	0.30	49	
			1.00	3	10.00	0.30	9	
							65	
	contingency 10%						71	
	say						72	
11	Flexible pavement							As Appendix 8
12	CC road slab							
		Sqm					100	
12	Weep holes						-	Appendix 6
13	Expansion Joints @ 45m interval in retaining wall	sqm.					9,695	Appendix 7
14	Pumping	Rs per hr					42	Appendix 9
15	Cleaning of drain	cum					7750	Appendix 10

Table 5: Quantity for Jungle Clearance at Modinagar

1	Area from Map in Sq m	4,937.00	(2278+2659)
Chainage	**Existing width (B) in m**	**Length (L) in m**	**Area in Sq m (BxL)**
3150	6.00	50.00	300.00
3200	6.00	50.00	300.00
3250	6.00	50.00	300.00
3300	6.00	50.00	300.00
3350	6.00	50.00	300.00
3400	6.00	50.00	300.00
3450	6.00	50.00	300.00
3500	6.00	50.00	300.00
3550	3.00	50.00	150.00
3600	1.00	50.00	50.00
3650	1.76	50.00	88.00
3700	2.50	50.00	125.00
3750	1.72	50.00	86.00
3800	0.39	50.00	19.50
3850	1.27	50.00	63.50
3900	3.17	50.00	158.50
3950	7.58	50.00	379.00
4000	6.01	50.00	300.50
4050	10.63	50.00	531.50
4100	3.37	50.00	168.50
4150	3.57	50.00	178.50
4200	9.29	50.00	464.50
4250	10.07	50.00	503.50
4300	10.00	50.00	500.00
4350	7.78	50.00	389.00
4400	5.57	50.00	278.50
4450	3.86	50.00	193.00
4500	7.68	50.00	384.00
4550	5.42	50.00	271.00
4600	7.15	50.00	357.50
4650	5.61	50.00	280.50
4700	7.67	50.00	383.50
4750	10.00	50.00	500.00
4800	8.58	50.00	429.00
4850	10.81	50.00	540.50
4900	10.12	50.00	506.00
4950	10.12	50.00	506.00
5000	9.76	50.00	488.00
5050	10.00	50.00	500.00
5100	9.63	50.00	481.50
5150	9.90	50.00	495.00

Chainage	Existing width (B) in m	Length (L) in m	Area in Sq m (BxL)
5200	8.20	50.00	410.00
5250	6.42	50.00	321.00
5300	4.89	50.00	244.50
5350	7.21	50.00	360.50
5400	5.98	50.00	299.00
5450	5.82	50.00	291.00
5500	7.94	50.00	397.00
5550	6.01	50.00	300.50
5600	4.95	50.00	247.50
5650	6.05	50.00	302.50
5700	5.55	50.00	277.50
5750	8.03	50.00	401.50
5800	5.80	50.00	290.00
5850	5.43	50.00	271.50
5900	5.35	50.00	267.50
5950	7.32	50.00	366.00
6000	7.63	50.00	381.50
6050	6.22	50.00	311.00
6100	4.22	50.00	211.00
6150	8.68	50.00	434.00
6200	9.48	50.00	474.00
6250	11.07	50.00	553.50
6300	3.10	50.00	155.00
6350	5.06	50.00	253.00
6400	6.94	50.00	347.00
6450	14.28	50.00	714.00
6500	4.95	50.00	247.50
6550	10.80	50.00	540.00
6600	10.80	50.00	540.00
6650	10.80	50.00	540.00
6700	10.80	50.00	540.00
			24,438.50
	Add extra 10% for curvature and extra area		2,443.85
	Total Quantity in Sq m		26,882.35
	In Percent Sqm		268.82
	Say		270.00

Table 6: Hapur Drainage: Abstract Estimate: Quantity for Excavation

Chainage	Existing Road Level/Ground Level	Existing Drain Level in m (A)	Length	Proposed slope	Diff in bed level	Proposed width	Propsed bed level in m (B)	Present Depth	Excavation at center of drain	Excavation at edge of drain	Average excavation depth in m	Excavation for wall in cum	Excavation in cum	Excavation for 0 to 1.5m in cum	Excavation greater than 1.5m in cum
1700	211.20	211.20	200.00	2,500.00	0.08	1.50	210.90	-	0.30	0.30	0.30	1.02	151.02	151.02	-
1900	211.10	210.95	50.00	2,500.00	0.02	1.50	210.75	0.15	0.20	0.35	0.28	1.19	35.69	35.69	-
1950	211.10	210.93	50.00	2,500.00	0.02	1.50	210.73	0.17	0.20	0.37	0.28	1.26	36.76	36.76	-
2000	211.10	210.90	50.00	2,500.00	0.02	1.50	210.71	0.20	0.19	0.39	0.29	1.33	37.76	37.76	-
2050	211.00	210.87	50.00	2,500.00	0.02	1.50	210.69	0.13	0.18	0.31	0.25	1.05	31.68	31.68	-
2100	211.00	210.85	50.00	2,500.00	0.02	1.50	210.67	0.15	0.18	0.33	0.26	1.12	33.00	33.00	-
2150	211.00	210.82	50.00	2,500.00	0.02	1.50	210.65	0.18	0.17	0.35	0.26	1.19	33.69	33.69	-
2200	211.00	210.80	50.00	2,500.00	0.02	1.50	210.63	0.20	0.17	0.37	0.27	1.26	35.01	35.01	-
2250	211.00	210.78	50.00	2,500.00	0.02	1.50	210.61	0.22	0.17	0.39	0.28	1.33	36.33	36.33	-
2300	211.00	210.76	50.00	2,500.00	0.02	1.50	210.59	0.24	0.17	0.41	0.29	1.39	37.39	37.39	-
2350	211.00	210.85	50.00	2,500.00	0.02	1.50	210.57	0.15	0.28	0.43	0.36	1.46	46.02	46.02	-
2400	211.00	210.84	50.00	2,500.00	0.02	1.75	210.55	0.16	0.29	0.45	0.37	1.53	52.41	52.41	-
2450	211.00	210.84	50.00	2,500.00	0.02	2.00	210.53	0.16	0.31	0.47	0.39	1.60	60.02	60.02	-
2500	211.00	210.83	50.00	2,500.00	0.02	2.00	210.51	0.17	0.32	0.49	0.41	1.67	62.72	62.72	-
2550	211.00	210.83	50.00	2,500.00	0.02	2.00	210.49	0.17	0.34	0.51	0.42	1.73	65.33	65.33	-
2600	211.10	210.82	50.00	2,500.00	0.02	2.00	210.47	0.28	0.35	0.63	0.49	2.14	75.64	75.64	-
2650	211.10	210.82	50.00	2,500.00	0.02	3.20	210.45	0.28	0.37	0.65	0.51	2.21	108.89	108.89	-
2700	211.10	210.81	50.00	2,500.00	0.02	3.20	210.43	0.29	0.38	0.67	0.53	2.28	112.53	112.53	-
2750	211.10	210.81	50.00	2,500.00	0.02	6.00	210.41	0.29	0.40	0.69	0.54	2.35	192.57	192.57	-
2800	211.10	210.81	50.00	2,500.00	0.02	6.30	210.39	0.29	0.42	0.71	0.56	2.41	207.73	207.73	-
2850	211.00	210.82	50.00	2,500.00	0.02	6.00	210.37	0.18	0.45	0.63	0.54	2.14	191.14	191.14	-
2900	211.00	210.80	50.00	2,500.00	0.02	6.00	210.35	0.20	0.45	0.65	0.55	2.21	194.71	194.71	-
2950	211.00	210.82	50.00	2,500.00	0.02	6.00	210.33	0.18	0.49	0.67	0.58	2.28	205.80	205.80	-
3000	210.90	210.85	50.00	2,500.00	0.02	6.00	210.31	0.05	0.54	0.59	0.56	2.01	199.23	199.23	-
3050	210.90	210.87	50.00	2,500.00	0.02	6.00	210.29	0.03	0.58	0.61	0.60	2.07	210.50	210.50	-
3100	210.90	210.90	50.00	2,500.00	0.02	6.00	210.27	0.00	0.63	0.63	0.63	2.14	221.77	221.77	-
3150	210.95	210.92	50.00	2,500.00	0.02	6.00	210.25	0.03	0.67	0.70	0.68	2.38	241.78	241.78	-
3200	210.95	210.94	50.00	2,500.00	0.02	6.00	210.23	0.01	0.71	0.72	0.72	2.45	253.05	253.05	-
3250	211.00	210.97	50.00	2,500.00	0.02	6.00	210.21	0.03	0.76	0.79	0.77	2.69	273.24	273.24	-
3300	211.00	210.99	50.00	3,000.00	0.02	6.00	210.19	0.01	0.80	0.81	0.80	2.74	283.33	283.33	-
3350	210.80	210.77	50.00	3,000.00	0.02	6.00	210.18	0.03	0.59	0.62	0.61	2.12	215.04	215.04	-
3400	210.80	210.55	50.00	3,000.00	0.02	6.00	210.16	0.25	0.39	0.64	0.52	2.18	182.43	182.43	-
3450	210.70	210.34	50.00	3,000.00	0.02	6.00	210.14	0.36	0.20	0.56	0.38	1.89	133.55	133.55	-
4200	210.90	210.28	50.00		0.02	9.29	210.28	0.62	-	0.62	0.31	2.86	162.61	162.61	-
4250	210.70	210.02	50.00		0.02	10.07	209.42	0.68	0.60	1.28	0.94	5.88	525.62	525.62	-
4300	210.50	209.77	50.00	1,000.00	0.05	10.00	209.37	0.73	0.39	1.13	0.76	5.41	423.96	423.96	-
4350	210.30	209.65	50.00	1,000.00	0.05	7.78	209.32	0.65	0.33	0.98	0.66	4.69	292.24	292.24	-
4400	210.30	209.66	50.00	1,000.00	0.05	6.00	209.27	0.64	0.39	1.03	0.71	4.93	252.21	252.21	-
4450	210.40	209.66	50.00	1,000.00	0.05	6.00	209.22	0.74	0.44	1.18	0.81	5.65	288.45	288.45	-
4500	210.00	209.50	50.00	1,000.00	0.05	7.68	209.17	0.50	0.33	0.83	0.58	3.97	254.61	254.61	-
4550	209.90	209.34	50.00	1,000.00	0.05	6.00	209.12	0.56	0.22	0.78	0.50	3.73	177.68	177.68	-
4600	209.90	209.18	50.00	1,000.00	0.05	7.15	209.07	0.72	0.11	0.83	0.47	3.97	194.28	194.28	-
4650	209.80	209.14	50.00	1,000.00	0.05	6.00	209.02	0.66	0.12	0.78	0.45	3.73	160.53	160.53	-
4700	209.70	209.10	50.00	1,000.00	0.05	7.67	208.97	0.60	0.13	0.73	0.43	3.49	189.47	189.47	-
4750	209.70	209.07	50.00	1,000.00	0.05	10.00	208.92	0.63	0.14	0.78	0.46	3.73	257.01	257.01	-
4800	209.60	209.03	50.00	1,000.00	0.05	8.58	208.87	0.57	0.16	0.73	0.44	3.49	214.97	214.97	-
4850	209.50	208.90	50.00	1,000.00	0.05	10.81	208.82	0.60	0.08	0.68	0.38	3.25	226.46	226.46	-
4900	209.40	208.95	50.00	1,000.00	0.05	10.12	208.77	0.45	0.18	0.63	0.40	3.01	227.08	227.08	-

Chainage	Existing Road Level/Ground Level	Existing Drain Level in m (A)	Length	Proposed slope	Diff in bed level	Proposed width	Propsed bed level in m (B)	Present Depth	Excavation at center of drain	Excavation at edge of drain	Average excavation depth in m	Excavation for wall in cum	Excavation in cum	Excavation for 0 to 1.5m in cum	Excavation greater than 1.5m in cum
4950	209.40	208.92	50.00	1,000.00	0.05	10.12	208.72	0.49	0.19	0.68	0.44	3.25	245.39	245.39	-
5000	209.30	208.66	50.00	1,000.00	0.05	9.76	208.67	0.64	(0.01)	0.63	0.31	3.01	168.45	168.45	-
5050	209.30	208.40	50.00	1,000.00	0.05	10.00	208.62	0.90	(0.22)	0.68	0.23	3.25	129.48	129.48	-
5100	209.20	208.39	50.00	1,000.00	0.05	9.63	208.57	0.81	(0.18)	0.63	0.22	3.01	121.80	121.80	-
5150	209.20	208.38	50.00	1,000.00	0.05	9.90	208.52	0.82	(0.14)	0.68	0.27	3.25	149.31	149.31	-
5200	209.10	208.37	50.00	1,000.00	0.05	8.20	208.47	0.73	(0.10)	0.63	0.26	3.01	123.76	123.76	-
5250	209.00	208.36	50.00	1,000.00	0.05	6.00	208.42	0.64	(0.06)	0.58	0.26	2.77	92.72	92.72	-
5300	209.00	208.35	50.00	1,000.00	0.05	6.00	208.37	0.65	(0.02)	0.63	0.30	3.01	108.54	108.54	-
5350	209.10	208.39	50.00	1,000.00	0.05	7.21	208.32	0.71	0.07	0.78	0.42	3.73	177.99	177.99	-
5400	209.10	208.44	50.00	1,000.00	0.05	6.00	208.27	0.66	0.17	0.83	0.50	3.97	178.10	178.10	-
5450	209.20	208.49	50.00	1,000.00	0.05	6.00	208.22	0.71	0.26	0.98	0.62	4.69	221.87	221.87	-
5500	209.30	208.53	50.00	1,000.00	0.05	7.94	208.17	0.77	0.36	1.13	0.74	5.41	337.98	337.98	-
5550	209.00	208.46	50.00	1,000.00	0.05	6.01	208.12	0.54	0.34	0.88	0.61	4.21	217.67	217.67	-
5600	208.80	208.44	50.00	1,000.00	0.05	6.00	208.07	0.37	0.36	0.73	0.55	3.49	194.42	194.42	-
5650	208.80	208.41	50.00	1,000.00	0.05	6.05	208.02	0.39	0.39	0.78	0.58	3.73	209.07	209.07	-
5700	208.80	208.38	50.00	1,000.00	0.05	6.00	207.97	0.42	0.41	0.83	0.62	3.97	220.62	220.62	-
5750	208.80	208.36	50.00	1,000.00	0.05	8.03	207.92	0.44	0.43	0.88	0.66	4.21	300.40	300.40	-
5800	208.70	208.32	50.00	1,000.00	0.05	6.00	207.87	0.38	0.45	0.83	0.64	3.97	227.62	227.62	-
5850	208.70	208.29	50.00	1,000.00	0.05	6.00	207.82	0.41	0.47	0.88	0.67	4.21	239.41	239.41	-
5900	208.70	208.25	50.00	1,000.00	0.05	6.00	207.77	0.45	0.48	0.93	0.71	4.45	251.20	251.20	-
5950	208.60	208.18	50.00	1,000.00	0.05	7.32	207.72	0.42	0.46	0.88	0.67	4.21	282.52	282.52	-
6000	208.50	208.11	50.00	1,000.00	0.05	7.63	207.67	0.39	0.44	0.83	0.63	3.97	277.33	277.33	-
6050	208.40	208.03	50.00	1,000.00	0.05	6.22	207.62	0.37	0.41	0.78	0.59	3.73	217.81	217.81	-
6100	208.40	207.97	50.00	1,000.00	0.05	6.00	207.57	0.43	0.40	0.83	0.61	3.97	218.17	218.17	-
6150	208.30	207.90	50.00	1,000.00	0.05	8.68	207.52	0.40	0.37	0.78	0.58	3.73	282.52	282.52	-
6200	208.20	207.83	50.00	1,000.00	0.05	9.48	207.47	0.38	0.35	0.73	0.54	3.49	286.72	286.72	-
6250	208.10	207.75	50.00	1,000.00	0.05	11.07	207.42	0.35	0.33	0.68	0.50	3.25	307.72	307.72	-
6300	208.00	207.68	50.00	1,000.00	0.05	6.00	207.37	0.32	0.31	0.63	0.47	3.01	167.16	167.16	-
6350	207.90	207.61	50.00	1,000.00	0.05	6.00	207.32	0.29	0.29	0.58	0.43	2.77	154.32	154.32	-
6400	207.90	207.54	50.00	1,000.00	0.05	6.94	207.27	0.36	0.27	0.63	0.45	3.01	180.67	180.67	-
6450	207.90	207.41	50.00	1,000.00	0.05	14.28	207.22	0.49	0.19	0.68	0.43	3.25	335.21	335.21	-
6500	207.90	207.29	50.00	1,000.00	0.05	6.00	207.17	0.61	0.12	0.73	0.42	3.49	151.02	151.02	-
6550	207.90	207.22	50.00	1,000.00	0.05	10.80	207.12	0.68	0.10	0.78	0.44	3.73	261.86	261.86	-
6600	208.10	207.13	50.00	1,000.00	0.05	10.80	207.07	0.97	0.06	1.03	0.54	4.93	325.60	325.60	-
6650	208.30	207.04	50.00	1,000.00	0.05	10.80	207.02	1.26	0.02	1.28	0.65	6.13	389.63	389.63	-
6700	208.50	206.96	50.00	1,000.00	0.05	10.80	206.97	1.54	(0.01)	1.53	0.76	7.33	453.67	-	454
Total Excavation													**16,162**	**15,708**	**454**
Increase by 10%														**17,279**	**499**
Say														**17,300**	**550**

Table 7: Quantity for M 10 Base

Chainage	Width of Drains	Length	Depth of M 10	Width of Base concrete	Quantity
	m	*m*	*m*	*m*	*m3*
1700					
1900	1.50	50.00	0.15	1.20	9.00
1950	1.50	50.00	0.15	1.20	9.00
2000	1.50	50.00	0.15	1.20	9.00
2050	1.50	50.00	0.15	1.20	9.00
2100	1.50	50.00	0.15	1.20	9.00
2150	1.50	50.00	0.15	1.20	9.00
2200	1.50	50.00	0.15	1.20	9.00
2250	1.50	50.00	0.15	1.20	9.00
2300	1.50	50.00	0.15	1.20	9.00
2350	1.50	50.00	0.15	1.20	9.00
2400	1.75	50.00	0.15	1.45	10.88
2450	2.00	50.00	0.15	1.70	12.75
2500	2.00	50.00	0.15	1.70	12.75
2550	2.00	50.00	0.15	1.70	12.75
2600	2.00	50.00	0.15	1.70	12.75
2650	3.20	50.00	0.15	2.90	21.75
2700	3.20	50.00	0.15	2.90	21.75
2750	6.00	50.00	0.15	5.70	42.75
2800	6.30	50.00	0.15	6.00	45.00
2850	6.00	50.00	0.15	5.70	42.75
2900	6.00	50.00	0.15	5.70	42.75
2950	6.00	50.00	0.15	5.70	42.75
3000	6.00	50.00	0.15	5.70	42.75
3050	6.00	50.00	0.15	5.70	42.75
3100	6.00	50.00	0.15	5.70	42.75
3150	6.00	50.00	0.15	5.70	42.75
3200	6.00	50.00	0.15	5.70	42.75
3250	6.00	50.00	0.15	5.70	42.75
3300	6.00	50.00	0.15	5.70	42.75
3350	6.00	50.00	0.15	5.70	42.75
3400	6.00	50.00	0.15	5.70	42.75
3450	6.00	50.00	0.15	5.70	42.75
3500	6.00	50.00	0.15	5.70	42.75
3550	3.00	50.00	0.15	2.70	20.25
3600	2.00	50.00	0.15	1.70	12.75
3650	2.00	50.00	0.15	1.70	12.75
3700	2.50	50.00	0.15	2.20	16.50
3750	2.00	50.00	0.15	1.70	12.75
3800	2.00	50.00	0.15	1.70	12.75
3850	2.00	50.00	0.15	1.70	12.75
3900	3.17	50.00	0.15	2.87	21.53
3950	7.58	50.00	0.15	7.28	54.60
4000	6.01	50.00	0.15	5.71	42.83
4050	10.63	50.00	0.15	10.33	77.48
4100	3.37	50.00	0.15	3.07	23.03
4150	3.57	50.00	0.15	3.27	24.53

Chainage	Width of Drains	Length	Depth of M 10	Width of Base concrete	Quantity
4200	9.29	50.00	0.15	8.99	67.43
4250	10.07	50.00	0.15	9.57	71.78
4300	10.00	50.00	0.15	9.50	71.25
4350	7.78	50.00	0.15	7.28	54.60
4400	6.00	50.00	0.15	5.50	41.25
4450	6.00	50.00	0.15	5.50	41.25
4500	7.68	50.00	0.15	7.18	53.85
4550	6.00	50.00	0.15	5.50	41.25
4600	7.15	50.00	0.15	6.65	49.88
4650	6.00	50.00	0.15	5.50	41.25
4700	7.67	50.00	0.15	7.17	53.78
4750	10.00	50.00	0.15	9.50	71.25
4800	8.58	50.00	0.15	8.08	60.60
4850	10.81	50.00	0.15	10.31	77.33
4900	10.12	50.00	0.15	9.62	72.15
4950	10.12	50.00	0.15	9.62	72.15
5000	9.76	50.00	0.15	9.26	69.45
5050	10.00	50.00	0.15	9.50	71.25
5100	9.63	50.00	0.15	9.13	68.48
5150	9.90	50.00	0.15	9.40	70.50
5200	8.20	50.00	0.15	7.70	57.75
5250	6.00	50.00	0.15	5.50	41.25
5300	6.00	50.00	0.15	5.50	41.25
5350	7.21	50.00	0.15	6.71	50.33
5400	6.00	50.00	0.15	5.50	41.25
5450	6.00	50.00	0.15	5.50	41.25
5500	7.94	50.00	0.15	7.44	55.80
5550	6.01	50.00	0.15	5.51	41.33
5600	6.00	50.00	0.15	5.50	41.25
5650	6.05	50.00	0.15	5.55	41.63
5700	6.00	50.00	0.15	5.50	41.25
5750	8.03	50.00	0.15	7.53	56.48
5800	6.00	50.00	0.15	5.50	41.25
5850	6.00	50.00	0.15	5.50	41.25
5900	6.00	50.00	0.15	5.50	41.25
5950	7.32	50.00	0.15	6.82	51.15
6000	7.63	50.00	0.15	7.13	53.48
6050	6.22	50.00	0.15	5.72	42.90
6100	6.00	50.00	0.15	5.50	41.25
6150	8.68	50.00	0.15	8.18	61.35
6200	9.48	50.00	0.15	8.98	67.35
6250	11.07	50.00	0.15	10.57	79.28
6300	6.00	50.00	0.15	5.50	41.25
6350	6.00	50.00	0.15	5.50	41.25
6400	6.94	50.00	0.15	6.44	48.30
6450	14.28	50.00	0.15	13.78	103.35
6500	6.00	50.00	0.15	5.50	41.25
6550	10.80	50.00	0.15	10.30	77.25
6600	10.80	50.00	0.15	10.30	77.25
6650	10.80	50.00	0.15	10.30	77.25
6700	10.80	50.00	1.15	10.30	592.25

Chainage	Width of Drains	Length	Depth of M 10	Width of Base concrete	Quantity
Total M 10 base					4,617.50

Table 8: Quantity for M 20 Wall

Chainage	Length of Drain Section	Depth of drain (D) in m	M 20 wall 2*(0.25*(D+0.9))*L
1700	200.00	0.30	120.00
1900	50.00	0.35	31.25
1950	50.00	0.37	31.75
2000	50.00	0.39	32.25
2050	50.00	0.31	30.25
2100	50.00	0.33	30.75
2150	50.00	0.35	31.25
2200	50.00	0.37	31.75
2250	50.00	0.39	32.25
2300	50.00	0.41	32.75
2350	50.00	0.43	33.25
2400	50.00	0.45	33.75
2450	50.00	0.47	34.25
2500	50.00	0.49	34.75
2550	50.00	0.51	35.25
2600	50.00	0.63	38.25
2650	50.00	0.65	38.75
2700	50.00	0.67	39.25
2750	50.00	0.69	39.75
2800	50.00	0.71	40.25
2850	50.00	0.63	38.25
2900	50.00	0.65	38.75
2950	50.00	0.67	39.25
3000	50.00	0.59	37.25
3050	50.00	0.61	37.75
3100	50.00	0.63	38.25
3150	50.00	0.70	40.00
3200	50.00	0.72	40.50
3250	50.00	0.79	42.25
3300	50.00	0.81	42.67
3350	50.00	0.62	38.08
3400	50.00	0.64	38.50
3450	50.00	0.56	36.42
3500	50.00	0.57	36.83
3550	50.00	0.59	37.25
3600	50.00	0.60	37.50
3650	50.00	0.69	39.63
3700	50.00	0.67	39.25
3750	50.00	0.66	38.90
3800	50.00	0.64	38.53
3850	50.00	0.63	38.25
3900	50.00	0.61	37.78

Chainage	Length of Drain Section	Depth of drain (D) in m	M 20 wall 2*(0.25*(D+0.9))*L
3950	50.00	0.60	37.40
4000	50.00	0.58	37.03
4050	50.00	0.67	39.15
4100	50.00	0.65	38.78
4150	50.00	0.64	38.40
4200	50.00	0.62	38.03
Total			**1,732.35**

Table 9: Quantity for Box culvert

Section	Width	Length	Height	Quantity	Reference
2350-2400	2.00	3.00	1.50	8.10	(0.3*3.6*2)+((H-0.6)*0.3*2))*w
2400-2450	2.00	3.00	1.25	7.65	
2	Contingenc	3.00	1.25	7.65	
2550-2600	2.00	3.00	1.00	7.20	
2850-2900	6.00	3.00	1.00	13.14	(0.3*6.9*2)+((H-0.6)*0.3*2))*w
2900-2950	6.00	3.00	1.00	13.14	
2950-3000	6.00	3.00	1.00	13.14	
3000-3050	6.00	3.00	1.50	14.04	
3250-3300	6.00	3.00	2.50	15.84	
3300-3350	6.00	3.00	1.50	14.04	
3350-3400	6.00	3.00	1.50	14.04	
3400-3450	6.00	3.00	1.25	13.59	
3500-3550	6.00	3.00	1.25	13.59	
5000-5050	10.00	3.00	1.40	19.66	(0.3*6.9*2)+((H-0.6)*0.3*2))*w
Total				174.82	
5% contingency				183.56	
Total Quantity				**184.00**	

Table 10: Quantification & Rate Analysis for Weep Holes

Quantity for Weep Holes

S. No	Item	Quantity
1	Ch 1700 to 3500 and Ch 4150 to 6700	
2	Length of drain	4,350.00
3	width	2.00
4	Area	8,700.00
5	No of weep holes (1 per Sqm)	8,700.00
6	Length of each weep hole in m	1.20
7	Total length in m	10,440.00
	say	10,450.00

Rate analysis for Weep hole

S. No	Item	Rate
1	Rate of 100 mm AC pipe (per m) As per SOR for water supply	11.50
2	Quantity of filler (π/4*D^2)*L	0.01
3	Rate of sand per cum	500.00
4	rate of filler material	3.93
5	Total rate of AC pipe with filler	15.43

Table 11: Quantity for Expansion Joint

Chainage	Hieght of Wall	Expansion joint (width of wall in cm) x (height of wall in cm)
1900	0.600	1,500.000
1950	0.650	1,625.000
2000	0.700	1,750.000
2100	0.700	1,750.000
2150	0.750	1,875.000
2200	0.800	2,000.000
2250	0.850	2,125.000
2300	0.900	2,250.000
2350	0.950	2,375.000
2400	1.000	2,500.000
2450	1.050	2,625.000
2500	1.100	2,750.000
2550	1.150	2,875.000
2600	1.300	3,250.000
2650	1.350	3,375.000
2700	1.400	3,500.000
2750	1.450	3,625.000
2800	1.500	3,750.000
2850	1.450	3,625.000
2900	1.500	3,750.000
2950	1.550	3,875.000
3000	1.500	3,750.000
3050	1.550	3,875.000
3100	1.600	4,000.000
3150	1.700	4,250.000
3200	1.750	4,375.000
3250	1.850	4,625.000
3300	1.900	4,750.000
3350	1.750	4,375.000
3400	1.800	4,500.000
3450	1.750	4,375.000
3500	1.800	4,500.000
3550	1.850	4,625.000
3600	1.900	4,750.000
3650	2.050	5,125.000
3700	2.100	5,250.000
3750	2.150	5,375.000
3800	2.200	5,500.000
3850	2.250	5,625.000
3900	2.300	5,750.000
3950	2.350	5,875.000
4000	2.400	6,000.000
4050	2.550	6,375.000
4100	2.600	6,500.000
4150	2.650	6,625.000
4200	2.700	6,750.000
4250	2.525	6,312.500

Chainage	Hieght of Wall	Expansion joint (width of wall in cm) x (height of wall in cm)
4300	2.350	17,580.000
4350	2.175	17,265.000
4400	2.200	17,310.000
4450	2.325	17,535.000
4500	1.950	16,860.000
4550	1.875	16,725.000
4600	1.900	16,770.000
4650	1.825	16,635.000
4700	1.750	16,500.000
4750	1.775	16,545.000
4800	1.700	16,410.000
4850	1.625	16,275.000
4900	1.550	16,140.000
4950	1.575	16,185.000
5000	1.500	16,050.000
5050	1.525	16,095.000
5100	1.450	15,960.000
5150	1.475	16,005.000
5200	1.400	15,870.000
5250	1.325	15,735.000
5300	1.350	15,780.000
5350	1.475	16,005.000
5400	1.500	16,050.000
5450	1.625	16,275.000
5500	1.750	16,500.000
5550	1.475	16,005.000
5600	1.300	15,690.000
5650	1.325	15,735.000
5700	1.350	15,780.000
5750	1.375	15,825.000
5800	1.300	15,690.000
5850	1.325	15,735.000
5900	1.350	15,780.000
5950	1.275	15,645.000
6000	1.200	15,510.000
6050	1.125	15,375.000
6100		13,350.000
6150	1.075	15,285.000
6200	1.000	15,150.000
6250	0.925	15,015.000
6300	0.850	14,880.000
6350	0.775	14,745.000
6400	0.800	14,790.000
6450	0.825	14,835.000
6500	0.850	14,880.000
6550	0.875	14,925.000
6600	1.100	15,330.000
6650	1.325	15,735.000
6700	1.550	16,140.000
Total		969,452.500

Chainage	Hieght of Wall	Expansion joint (width of wall in cm) x (height of wall in cm)
Total per 100m		9,695.000

Table 12: Quantity for restoration of road

S. No	Item	unit	No	Length	Breadth	Depth	Quantity
				m	*m*	*m*	*m3*
1	GSB	cum	4	3.00	2.00	0.20	4.80
			9	3.00	6.00	0.20	32.40
2	Contingency		1	3.00	10.00	0.20	6.00
	Total GSB						43.20
	say						45.00
3	WBM						
	I	cum	4	3.00	2.00	0.10	2.40
			9	3.00	6.00	0.10	16.20
			1	3.00	10.00	0.10	3.00
							21.60
							22.00
	II	cum	4	3.00	2.00	0.08	1.80
			9	3.00	6.00	0.08	12.15
			1	3.00	10.00	0.08	2.25
							16.20
							17.00
	III	cum	4	3.00	2.00	0.08	1.80
			9	3.00	6.00	0.08	12.15
			1	3.00	10.00	0.08	2.25
							16.20
							17.00
4	Tack coat/ Premix carpet and seal coat	Sqm	4	3.00	2.00		24.00
			9	3.00	6.00		162.00
			1	3.00	10.00		30.00
							216.00
							220.00

Table 13: Quantity of Pumping Out of Accumlated Water

S. No	Item	Unit	Quantity	
I	**Quantitity of pumping**			
1	Number of pumps	No	3.00	
2	Hrs of pumping	hrs	12.00	
3	Pump Hour / day	hr/day	36.00	
4	Days of runnning pump	days	450.00	
5	Total Pump Hour	hr	16,200.00	
II	**Rate of Pumping**			
1	Hire charges of pump set of capacity 4000 lit/ hr	Rs per day	336.00	As per DSR 2007 Pg 1 updated to 2009 at 12%
2	For 12 hr use	Rs per hrs	28.00	
3	Electricity charges	Rs per hrs	4.50	
4	Connection per hr	Rs per hrs	0.50	
5	Contingency and contractor profit		8.25	
6	Total rate per hour		41.25	
	Say	Rs per hrs	42.00	

Table 14: Qunatity for removal of debris/ sludge

Chainage	Length	Proposed width	Depth of debris	Qty of debris
	m	*m*	*m*	*m3*
1700	200.00	1.50	-	-
1900	50.00	1.50	-	-
1950	50.00	1.50	-	-
2000	50.00	1.50	-	-
2050	50.00	1.50	-	-
2100	50.00	1.50	-	-
2150	50.00	1.50	-	-
2200	50.00	1.50	-	-
2250	50.00	1.50	-	-
2300	50.00	1.50	-	-
2350	50.00	1.50	-	-
2400	50.00	1.75	0.30	26.25
2450	50.00	2.00	0.30	30.00
2500	50.00	2.00	0.30	30.00
2550	50.00	2.00	0.30	30.00
2600	50.00	2.00	0.30	30.00
2650	50.00	3.20	0.30	48.00
2700	50.00	3.20	0.30	48.00
2750	50.00	6.00	0.30	90.00
2800	50.00	6.30	0.30	94.50
2850	50.00	6.00	0.30	90.00
2900	50.00	6.00	0.30	90.00
2950	50.00	6.00	0.30	90.00
3000	50.00	6.00	0.30	90.00
3050	50.00	6.00	0.30	90.00
3100	50.00	6.00	0.30	90.00
3150	50.00	6.00	0.30	90.00
3200	50.00	6.00	0.30	90.00
3250	50.00	6.00	0.30	90.00
3300	50.00	6.00	0.30	90.00
3350	50.00	6.00	0.30	90.00
3400	50.00	6.00	0.30	90.00
3450	50.00	6.00	0.30	90.00
4200	50.00	9.29	0.30	139.35
4250	50.00	10.07	0.30	151.05
4300	50.00	10.00	0.30	150.00
4350	50.00	7.78	0.30	116.70
4400	50.00	6.00	0.30	90.00
4450	50.00	6.00	0.30	90.00
4500	50.00	7.68	0.30	115.20
4550	50.00	6.00	0.30	90.00

Chainage	Length	Proposed width	Depth of debris	Qty of debris
	m	*m*	*m*	*m3*
4600	50.00	7.15	0.30	107.25
4650	50.00	6.00	0.30	90.00
4700	50.00	7.67	0.30	115.05
4750	50.00	10.00	0.30	150.00
4800	50.00	8.58	0.30	128.70
4850	50.00	10.81	0.30	162.15
4900	50.00	10.12	0.30	151.80
4950	50.00	10.12	0.30	151.80
5000	50.00	9.76	0.30	146.40
5050	50.00	10.00	0.30	150.00
5100	50.00	9.63	0.30	144.45
5150	50.00	9.90	0.30	148.50
5200	50.00	8.20	0.30	123.00
5250	50.00	6.00	0.30	90.00
5300	50.00	6.00	0.30	90.00
5350	50.00	7.21	0.30	108.15
5400	50.00	6.00	0.30	90.00
5450	50.00	6.00	0.30	90.00
5500	50.00	7.94	0.30	119.10
5550	50.00	6.01	0.30	90.15
5600	50.00	6.00	0.30	90.00
5650	50.00	6.05	0.30	90.75
5700	50.00	6.00	0.30	90.00
5750	50.00	8.03	0.30	120.45
5800	50.00	6.00	0.30	90.00
5850	50.00	6.00	0.30	90.00
5900	50.00	6.00	0.30	90.00
5950	50.00	7.32	0.30	109.80
6000	50.00	7.63	0.30	114.45
6050	50.00	6.22	0.30	93.30
6100	50.00	6.00	0.30	90.00
6150	50.00	8.68	0.30	130.20
6200	50.00	9.48	0.30	142.20
6250	50.00	11.07	0.30	166.05
6300	50.00	6.00	0.30	90.00
6350	50.00	6.00	0.30	90.00
6400	50.00	6.94	0.30	104.10
6450	50.00	14.28	0.30	214.20
6500	50.00	6.00	0.30	90.00
6550	50.00	10.80	0.30	162.00
6600	50.00	10.80	0.30	162.00
6650	50.00	10.80	0.30	162.00
6700	50.00	10.80	0.30	162.00
Total Excavation for debris				7,729.05
Say				**7,750.00**

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